May—June, 1997

Vol. 3 No. 3

Literature Update on

Wheat, Barley, and Triticale

CIMMYT

ICARDA

Distribution Restricted to Developing Countries Only.

May-Jun, 1997 Vol. 3 No. 3

Literature Update on

Wheat, Barley, and Triticale

CIMMYT

agris

ISI

ICARDA

Distribution Restricted to Developing Countries Only.

CIMMYT and ICARDA are two internationally funded, nonprofit scientific research and training organizations headquartered in Mexico and Syria respectively. Together with 16 other nonprofit international agricultural research and training centers, CIMMYT and ICARDA are supported by the Consultative Group on International Agricultural Research (CGIAR), which is sponsored by the Food and Agriculture Organization (FAO) of the United Nations, the International Bank for Reconstruction and Development (World Bank), and the United Nations Development Programme (UNDP). The CGIAR consists of some 40 donor countries, international and regional organizations, and private foundations.

The Institute for Scientific Information (ISI), based in Philadelphia, Pennsylvania, USA, maintains one of the largest bibliographic databases in the world. A wide range of information resources - in a variety of media - are created from this database, including "*Current Contents on CD-ROM with Abstracts*". ISI has generously made a special dispensation permitting CIMMYT and ICARDA to reproduce its records and distribute them to developing countries.

The International Information System for the Agricultural Sciences and Technology (AGRIS), with headquarters at Rome, is coordinated by the Food and Agriculture Organization (FAO) of the United Nations. It is a worldwide cooperative information network of some 135 national, regional and international centers and produces a database growing at the rate of about 120 000 bibliographic records per year.

Inquiries concerning current mailings and back numbers of *Literature Update on Wheat, Barley and Triticale* should be sent to the Library, CIMMYT, A.P. 6-641, 06600 Mexico, DF.

Copyright notice: Part of the data presented in *Literature Update on Wheat, Barley and Triticale* is extracted from the Licensed Product of the Institute for Scientific Information®, Inc. (ISI®), Philadelphia, Pennsylvania USA: © Copyright Institute for Scientific Information® 1995. In accordance with normal practice, single copies may be made for non-commercial use in research and study, but the distribution of both the original and any copies is restricted to persons in developing countries.

ISSN 1405-1672

Several CIMMYT staff made important contributions to this document: Dr. Edith Hesse, Information Technology Manager (editor); Fernando García, Electronic Information Specialist, and Pedro Santamaría, Database Administrator (data processing); Corinne de Gracia, Head Librarian, Efrén Orozco, Cataloguer, and José Juan Caballero, Cataloguer (categorization); Miguel Mellado, Coordinator of Design and Photography Department, and Eliot Sánchez, Design Assistant (design); Laura González, Bilingual Secretary (production, coordination and distribution).

Literature Update on Wheat, Barley, and Triticale

CONTENTS

Page

Preface iv

Sample Entries vi

Notes to Readers vi

Citations and Abstracts 1

Author Index 116

Keyword Index 124

How to Obtain the Full Text of Documents 142

CIMMYT Addresses 143

ICARDA Addresses 144

Subject Headings and Reference Numbers

	Ref. No.
Agricultural Research	2420
Extension	2421
Legislation	2422-2423
Agricultural Economics and Policies	2424-2429
Investment, Finance and Credit	2430
Development Economics and Policies	2431
Production Economics	2432-2438
Organization, Administration and Management of Agricultural Enterprises or Farms	2439-2442
Trade, Marketing and Distribution	2443-2445
International Trade	2446-2451
Crop Husbandry	2452-2521
Plant Propagation	2522-2532
Seed Production	2533-2540
Fertilizing	2541-2591
Irrigation	2592-2600
Soil Cultivation	2601-2608
Cropping Patterns and Systems	2609-2634
Plant Genetics and Breeding	2635-2833
Plant Ecology	2834-2841
Plant Structure	2842-2848
Plant Physiology and Biochemistry	2849-2916
Plant Physiology-Nutrition	2917-2947
Plant Physiology Growth and Development	2948-2976
Plant Physiology-Reproduction	2977
Plant Taxonomy and Geography	2978
Protection of Plants - General Aspects	2979-2980
Pests of Plants	2981-3050
Plant Diseases	3051-3173
Miscellaneous Plant Disorders	3174-3199
Weeds	3200-3244
Handling, Transport, Storage and Protection of Plant Products	3245-3259
Handling, Transport, Storage and Protection of Non-Food or Non-Feed Agricultural Products	3260
Animal Feeding	3261-3269
Animal Physiology - Nutrition	3270-3281
Miscellaneous Animal Disorders	3282
Agricultural Structures	3283
Agricultural Machinery and Equipment	3284
Soil Chemistry and Physics	3285-3297
Soil Biology	3298-3311
Soil Fertility	3312-3316
Soil Erosion, Conservation and Reclamation	3317-3319
Meteorology and Climatology	3320-3321
Food Science and Technology	3322-3324
Food Processing and Preservation	3325-3359
Food Contamination and Toxicology	3360-3368
Food Composition	3369-3443
Feed Processing and Preservation	3444-3448
Feed Contamination and Toxicology	3449
Feed Composition	3450-3456
Feed Additives	3457
Processing of Non-Food or Non-Feed Agricultural Products	3458-3459
Human Nutrition - General Aspects	3460
Physiology of Human Nutrition	3461
Diet and Diet - Related Diseases	3462-3464
Pollution	3465-3469
Mathematical and Statistical Methods	3470-3472
Research Methods	3473

PREFACE

To maintain quality in their research and training work, scientists need prompt and reliable access to up-to-date scientific information. However, in developing countries, the information resources are often weak, and the scientists are at a great disadvantage as compared with their colleagues in more developed countries and in international institutions. For lack of foreign currency, their librarians may be unable to buy the more recent scientific books and journals; and, for lack of access to bibliographic data, the scientists themselves cannot easily identify the most useful reprints to request from their colleagues in other countries.

CIMMYT and ICARDA seek to offset these disadvantages: they sponsor workshops at which researchers can exchange knowledge, and they produce publications which are made available free of charge to research institutions in developing countries. For a decade or so (1984-1994), CIMMYT also purchased bulk subscriptions to *Wheat, Barley and Triticale Abstracts* from CAB International, and the individual issues were sent directly to developing-country recipients that CIMMYT had nominated.

Both CIMMYT and ICARDA recognize the high quality of the products from CAB International; however, our budgetary realities require that we look for the least costly means to provide announcements of current information. In 1994, contacts were made with the Institute for Scientific Information (ISI), the private corporation based in Philadelphia, Pennsylvania, which produces *Current Contents*: *Agriculture, Biology and Environmental Sciences*. This is a weekly CD-ROM service giving abstracts of articles from the current issues of the world's most influential scientific journals. ISI has authorized us to extract the abstracts that deal with wheat, barley and triticale and to distribute these abstracts - in printed form - to collaborators in developing countries.

This authorization is the basis on which CIMMYT and ICARDA are now offering *Literature Update on Wheat, Barley and Triticale*. However, since *Current Contents* covers only the more prominent journals, it lacks coverage of other types of publication - for example, reports and conference proceedings - and it does not report the articles that appear in the less well known journals, many of which are published in the developing countries themselves. Therefore, to give more balance to the product, we are also including references and abstracts from the AGRIS database.

AGRIS, the International Information System for the Agricultural Sciences and Technology, is managed by FAO, and its database is constructed by contributions from some 135 participating centers which represent most of the countries of the world plus many of the regional and international organizations working in the agricultural sector. Relevant AGRIS items are extracted from tapes obtained from FAO and are merged with the items from *Current Contents*. Because CIMMYT and ICARDA are two of the centers contributing to the AGRIS database, we are able to use this material without payment of royalties.

Today's product was designed for greater economy, but we believe recipients will now welcome speed of reporting on the one hand (material from *Current Contents*) and in-depth coverage on the other (material from AGRIS).

CIMMYT and ICARDA back up this product with an offer to provide photocopies of individual articles that readers need and are unable to obtain. Details are explained separately, but this service has to be on a very limited basis, both to respect copyright restrictions and because of our own modest capacity to respond.

We welcome comments and suggestions on how to improve our product; we emphasize that it can be distributed only in developing countries; we thank the Institute for Scientific Information for allowing us to reproduce its material; and we salute our fellow-participants who, with the leadership of FAO, have built AGRIS into one of the world's richest sources of bibliographic information in agriculture.

Timothy Reeves
Director General, CIMMYT

Adel El-Beltagy
Director General, ICARDA

a) Sample entry retrieved from ISI-Current Contents (journal article)

1 → 172 Reynolds, MP.; Sayre, KD.; Vivar, HE. (1994) **INTERCROPPING WHEAT AND BARLEY WITH N-FIXING LEGUME SPECIES - A METHOD FOR IMPROVING GROUND COVER, N-USE EFFICIENCY AND PRODUCTIVITY IN LOW INPUT SYSTEMS.** *Journal of Agricultural Science. 123(Part 2):175-183.* English [CIMMYT WHEAT PROGRAM LISBOA 27 APDO POSTAL 6-641 MEXICO CITY 06600 DF MEXICO].

(2 = Author(s); 3 = Publication year; 4 = Title in English; 6 = Source; 7 = Language of text; 8 = Organization where work was carried out)

b) Sample entry retrieved from AGRIS (journal article)

1 → 69 Alizaga, R. (Costa Rica Univ., San Jose (Costa Rica). Centro para Investigaciones en Granos y Semillas); Sterling, F.; Herrera, J. (1992) 4 → **[Evaluation of the vigor in maize seeds and its relationship with the behaviour in the field]. Evaluacion del vigor en semillas de maiz y su relacion con el comportamiento en el campo.** *Agronomia Costarricense (Costa Rica) v. 16(2) p. 203-210.* 20 ref.; grafs. Spanish . (AGRIS 94-116456).

(2 = Author(s); 8 = Organization where work was carried out; 3 = Publication year; 4 = Title in English; 5 = Original title; 6 = Source; 7 = Language of text; 9 = AGRIS Reference Number)

c) Sample entry retrieved from AGRIS (article in conference proceedings)

1 → 1 Gonzalez Estrada, Adrian (INIFAP. C.E. Valle de Mexico. Ap. Postal 10, Chapingo, Mex. 56230 (Mexico)) (1992) **[Economic aspects of agricultural research in relation to the production of wheat in Mexico]. Aspectos economicos de la investigacion agricola en el cultivo del trigo en Mexico.** Primera conferencia nacional sobre la produccion de trigo en Mexico. (Memoria); Cd. Obregon, Sonora (Mexico); 22-25 Mar 1988. [National conference on wheat production in Mexico. (1, 1988, Cd. Obregon, Son.) (Proceedings)]. Conferencia nacional sobre la produccion de trigo en Mexico. (1, 1988, Cd. Obregon, Son.) (Memoria). *Publicacion Especial. Centro de Investigacion Regional del Noroeste (Mexico); no. 4 p. 539-550.* Centro de Investigacion Regional del Noroeste. 21 ref. 2o. tomo. Spanish. (AGRIS 94-114649).

(2 = Author(s); 8 = Organization where work was carried out; 3 = Publication year; 4 = Title in English; 5 = Original title; 6 = Source; 7 = Language of text; 9 = AGRIS Reference Number)

1 Entry number
2 Author(s)
3 Publication year
4 Title in English
5 Original title (only in entries retrieved from AGRIS)
6 Source
7 Language of text
8 Organization where work was carried out
9 AGRIS Reference Number, only for entries retrieved from AGRIS

Note to Readers

The source of each entry - whether *Current Contents* or AGRIS - can be readily inferred from its appearance: TITLES from *Current Contents* are wholly in uppercase, whereas those from AGRIS are in upper and lower case. For non-English documents, *Current Contents* gives only an English translation of the title, but AGRIS normally gives both the translation and the title in its original language. There are many other minor differences in the presentation and sequencing of data from the two sources. In the case of entries from AGRIS, please note the reference number given in parentheses at the end of the bibliographic description: often, this number may be used as a surrogate for the whole description in communications between libraries seeking loans or photocopies.

Users of the indexes are also cautioned that the same item may appear in two slightly different forms: for example, the author Kim, S.K. may also be listed as Kim, SK and the subject AFLATOXIN may be followed by a separate entry for AFLATOXINS. To harmonize such data from two different systems would require complex programming and operations, and we hope that our readers will not find these minor anomalies too troublesome.

A50 AGRICULTURAL RESEARCH

2420 Mills, BF.; Karanja, DD. (1997) **PROCESSES AND METHODS FOR RESEARCH PROGRAMME PRIORITY SETTING - THE EXPERIENCE OF THE KENYA AGRICULTURAL RESEARCH INSTITUTE WHEAT PROGRAMME.** *Food Policy. 22(1):63-79.* English. [INT SERV NAT AGR RES POB 93375 NL-2509 AJ THE HAGUE NETHERLANDS].

As funding for agricultural research in developing countries becomes increasingly scarce, national research institutes must develop efficient processes for targeting available resources to meet client needs, This paper presents the application of a rigorous process for setting national commodity programme research priorities both spatially and by major research theme, The exercise is conducted in three phases with the Kenya Agricultural Research Institute Wheat Programme, First, a working group of Wheat Programme scientists develops a consensus on programme target zones as well as the potential for the generation and adoption of technologies in those zones, Secondly, the working group assumptions are combined with available economic data to develop ex ante economic surplus measures of programme impact, Thirdly, the results are presented to a larger group of programme stakeholders in order to review the working group assumptions, establish research priorities and then translate those priorities into guidelines for research managers on resource allocation decisions, (C) 1997 Elsevier Science Ltd. [References: 16].

C20 EXTENSION

2421 Wondimagegnehu Seyoum (Adet Research Center, Bahir Dar (Ethiopia)); Gebrehiwot Hailemariam; Daniel Shamebo; Dejene Abesha (1996) **Barley technology transfer.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 152-157.* IAR/ICARDA. 7 tables; 8 ref. English. (AGRIS 97-043427).

Barley technology transfer has been conducted through demonstrations by FFHC, CADU, EPID and MOA/IAR since 1967. Several food and malting barley varieties have been demonstrated in many areas. Currently five varieties are under production. The earlier fertilizer demonstration trials showed a value cost ratio for application of 100 kg ha-1 di-ammonium-phosphate ranged from 1.9 to 3.8.

D50 LEGISLATION

2422 Jensen, P.E.; Noye, G.; Hartvig, P.; Rubow, T. (1996) **Weed, 1995, 1: Results from testing of herbicides and growth regulators: Agriculture, horticulture, forestry: Cereals, rape, peas.** Statens Planteavlsforsoeg, Slagelse (Denmark). Afdeling for Ukrudtsbekaempelse og Pesticidoekologi. *Ukrudt, 1: Afproevning: Resultater fra afproevning af herbicider og vaekstreguleringsmnidler: Landbrug, havebrug, skovbrug 1995 195 p.* SP. 25 ill., 180 tables. English. (AGRIS 97-029439).

2423 Malasky, A.R. (Arent Fox Kintner Plotkin and Kahn, Washington, DC.); Kelley, C.R.; Schneider, S.A. (1993) **Resolving federal farm program disputes: recent developments.** NCALRI. references. Paper presented at the annual meeting of the American Agricultural Law Association, September 26, 1992, Chicago, Illinois. 47 p. English. (AGRIS 97-043530).

E10 AGRICULTURAL ECONOMICS AND POLICIES

2424 Araji, A.A. (University of Idaho.); White, F.C. (1995) **The impact of agricultural research on United States exports.** *Research bulletin (Idaho Agricultural Experiment Station) (USA); no. 155 12 p.* references. English. (AGRIS 97-043612).

2425 Azzam, A.; Azzam, S.; Lhaloui, S.; Amri, A.; Elbouhssini, M.; Moussaoui, M. (1997) **ECONOMIC RETURNS TO RESEARCH IN HESSIAN FLY (DIPTERA, CECIDOMYIIDAE) RESISTANT BREAD-WHEAT VARIETIES IN MOROCCO.** *Journal of Economic Entomology. 90(1):1-5.* English. [UNIV NEBRASKA DEPT AGR ECON 207C FILLEY HALL LINCOLN, NE 68583 USA].

Approximately $1.5 million has been invested by the United States and Morocco since 1980 in Morocco to develop bread-wheat varieties resistant to the Hessian fly, Mayetiola destructor (Say). Although this effort has proven to be successful in the development of resistant varieties, research programs of this the rarely are evaluated for economic returns. As part of a comprehensive impact assessment of the USAID-funded Dryland Applied Agricultural Research Project of Morocco's National Institute of Agronomic Research and the mid-America International Agricultural Consortium, this study assessed the benefits and costs of developing resistant varieties. Benefits, in terms of new germplasm, were realized by both Morocco and the United States. Overall benefits and costs were calculated using a reasonable, least favorable case. The internal rate of return was 39%. Compared with other rates of return on agricultural research efforts across countries, commodities, and time periods, 39% represents a high payoff. [References: 11].

2426 Heatherly, LG.; Elmore, CD.; Wesley, RA.; Spurlock, SR. (1996) **NET RETURNS FROM NO-TILL DOUBLECROP WINTER WHEAT AND IRRIGATED SOYBEAN ON A CLAY SOIL.** *Journal of Production Agriculture. 9(4):554-558.* English. [USDA ARS SOYBEAN RES UNIT POB 343 STONEVILLE, MS 38776 USA].

Economic evaluation of agronomic production practices is required to determine their feasibility in cropping systems with two or more crops. Net returns from continuous double-cropped wheat (Triticum aestivum L.) and irrigated soybean [Glycine max (L.) Merr.] were calculated using data from plantings made in 1988, 1989, and 1990 near Stoneville, MS, on a Tunica clay (clayey over loamy, montmorillonitic, nonacid, thermic, Vertic Haplaquept) in tilled and no-till seedbeds in both burned and standing wheat stubble. Yield of soybean was not affected by stubble management or seedbed preparation. Yield of wheat was reduced in plantings made following soybean that was planted in standing wheat stubble in the first 2 yr of the study. Seedbed preparation for wheat planting had an inconsistent effect on wheat yield. Wheat yields declined as the study progressed. Combined net returns were greater from the burned stubble treatment in 2 of the 3 yr, and this was attributed to the higher net returns from wheat in this treatment. Combined net returns from the tilled seedbed treatment were similar to those from the no-till treatment in 1988 and 1989; in 1990, net returns from the tilled seedbed treatment were higher. These results indicate that highest combined net returns from a continuous wheat-soybean doublecrop system will be obtained when soybean is planted in burned wheat stubble. Low and declining wheat yields in this short-term study (confounded with year effects) indicate that continuous wheat-soybean doublecropping using no-till planting of wheat is not a viable management option. This conclusion has to be verified with longer-term research, however. [References: 28].

2427 Klein, KK.; Freeze, B.; Walburger, AM. (1996) **ECONOMIC RETURNS TO YIELD-INCREASING RESEARCH ON WHEAT IN WESTERN CANADA.** *Canadian Journal of Agricultural Economics-Revue Canadienne d Economie Rurale. 44(3):207-218.* English. [UNIV LETHBRIDGE DEPT ECON LETHBRIDGE AB T1K 3M4 CANADA].

A multi-sector mathematical programming model of Canadian agriculture (CRAM) is employed to determine the rate of return to yield-increasing research on wheat conducted during 1962-91. The estimated internal rate of return to yield-increasing research ranged between 27% and 31% for the low wheat price scenarios. It was higher at 34-39% for the high wheat price scenarios. Producers captured 80-90% of the benefits. The results support the magnitude of estimated economic benefits reported in previous studies. [References: 26].

2428 Lakshminarayan, PG.; Gassman, PW.; Bouzaher, A.; Izaurralde, RC. (1996) **A METAMODELING APPROACH TO EVALUATE AGRICULTURAL POLICY IMPACT ON SOIL DEGRADATION IN WESTERN CANADA.** *Canadian Journal of Agricultural Economics-Revue Canadienne d Economie Rurale. 44(3):277-294.* English. [IOWA STATE UNIV CTR AGR & RURAL DEV DEPT ECON RESOURCE & ENVIRONM POLICY DEV AMES, IA 50011 USA].

A novel approach for integrating economic and environmental models is described in the context of evaluating soil degradation impacts of agricultural policy in western Canada. The key element of this approach is the development of metamodels, which are statistical summary functions of simulation data obtained from carefully designed experiments with physical process models. The metamodels ave in turn used to predict the soil degradation impacts of farmers' land management responses to policy options. The metamodels provide flexibility to perform repeated policy scenarios without having to rerun the time- and resource-consuming

physical process simulation models. The estimated wind and water erosion metamodels are very robust, with the majority possessing R-square values in the range of 0.80 to 0.97. The efficiency of the metamodels in facilitating the integration of a policy modeling system is described and applied to a scenario of increased crop residue management. Using regional aggregates of net farm income, total economic surplus (consumer plus producer surplus) and total soil loss the economic and environmental tradeoff between the status quo and a no-till policy scenario is evaluated. The model-predicted economic welfare and environmental quality interaction suggests a clear win-win situation for society under this alternative policy scenario. [References: 33].

2429 Marshall, GR.; Parton, KA.; Hammer, GL. (1996) **RISK ATTITUDE, PLANTING CONDITIONS AND THE VALUE OF SEASONAL FORECASTS TO A DRYLAND WHEAT GROWER.** *Australian Journal of Agricultural Economics. 40(3):211-233.* English. [UNIV NEW ENGLAND DEPT AGR & RESOURCE ECON ARMIDALE NSW AUSTRALIA].

The value of a seasonal forecasting system based on phases of the Southern Oscillation was estimated for a representative dryland wheat grower in the vicinity of Goondiwindi. In particular the effects on this estimate of risk attitude and planting conditions were examined. A recursive stochastic programming approach was used to identify the grower's utility-maximising action set in the event of each of the climate patterns over the period 1894-1991 recurring In the imminent season. The approach was repeated with and without use of the forecasts. The choices examined were, at planting, nitrogen application rate and cultivar and, later in the season, choices of proceeding with or abandoning each wheat activity, The value of the forecasting system was estimated as the maximum amount the grower could afford to pay for its use without expected utility being lowered relative to its non use. [References: 48].

E13 INVESTMENT, FINANCE AND CREDIT

2430 Christensen, G. (1993) **Review of the subsidiary and support system for wheat and bread in Albania.** FAO, Rome (Italy). Food and Nutrition Div. 68 p. FAO-ESN--GCP/ALB/001/ITA. English. (AGRIS 97-029710).

E14 DEVELOPMENT ECONOMICS AND POLICIES

2431 Das, K.; Bordaloi, P.K. (Assam Agricultural University, Assam (India). Regional Agricultural Research Station) (1995) **Frontline demonstrations show the way to high yield of wheat.** *Indian Farming (India) v. 45(8) p. 5.* English. (AGRIS 97-043769).

E16 PRODUCTION ECONOMICS

2432 Chilot Yirga (IAR, Addis Abeba (Ethiopia)); Shapiro, B.I.; Mulat Demeke (1996) **Factors influencing adoption of new Wheat technologies in Wolmera and Addis Alem areas of Ethiopia.** *Ethiopian Journal of Agricultural Economics (Ethiopia) v. 1(1) p. 63-84.* 7 tables; 17 ref. English. (AGRIS 97-043832).

A study was conducted in two Woredas, Addis Alem and Wolmera, to investigate (1) the level of farmers' awareness and adoption of recommended and demonstrated technologies; (2) the extent and intensity to which farmers have adopted these technologies; and (3) the objective and subjective factors affecting adoption. A total of 156 farmers were randomly selected and interviewed using a pre-tested questionnaire. The study showed that the vast majority of the surveyed farmers had reached the state of continuous adoption: about 89 percent for fertilizer, 79 percent for herbicide and 49 percent for newly improved varieties of wheat. Although fertilizer and herbicide (2, 4-D) are widely used in the study areas, average fertilizer and herbicide application were well below the recommended rate for all the crops. The probit and tobit regression models were used for this study and the results indicated that the perceived profitability of the new wheat technologies and the timely availability of fertilizer and herbicide had the most significant effect on farmers' decisions to adopt. Distance of respondents' homes from extension centers also influenced the probability of adopting improved wheat variety, as well as the intensity of fertilizer and herbicide use. Characteristics of the household and household heads had little influence on the adoption decisions of these farmers. This suggests that improved production packages have been extensively diffused so that the knowledge of the benefits of using the new technologies is widespread. Moreover, extension efforts and input availiability are most crucial in influencing adoption.

2433 Gavian Sarah; Gemechu Degefa (ILRI, Addis Abeba (Ethiopia)) (1996) **The profitability of wheat production in Ethiopia: The case of Tiyo Woreda in Arsi zone.** *Ethiopian Journal of Agricultural Economics (Ethiopia) v. 1(1) p. 38-62.* 2 tabels; 2 fig., 12 ref. English. (AGRIS 97-043831).

The profitability of different wheat production systems in Arsi Zone was investigated by comparing farmers' practices in the 1994 crop season with on-farm demonstrations led by both Sasakawa-Golbal 2000 and Kulumsa Research Center of the institute of Agriculture Research. Overall, yields on the demonstration plots were higher than those on unsupervised farmers' plots; while farms do plant improved wheat varieties, they tend to recycle seeds retained from their own stock rather than purchasing new seeds each year. Additionally, they use far less fertilizer and herbicide than either MOA extension agents' or researchers' recommendations. A breakdown of farmer practices by the amount of purchased inputs shows that the top 4 percent of the farmers surveyed were able to produce as much or more grain on their fields as on the demonstration plots with comparable or greater profits. On the whole, however, the demonstration plots offer yields and profits greater than those most wheat farmers in this region are achieving, even after adjusting for capital costs and possible price fluctuations. The results of the economic analyses suggest the need for broader testing of the experimental packages. At the same time, the inability of many farmers to adopt existing high-input packages indicates the need to decrease the costs and the difficulty of obtaining purchased inputs. Furthermore, the study pointed out an apparent deficiency in the research/extension package: high-cost herbicides must be targeted for wheat fields having weed densities greater than some economic threshold levels.

2434 Hailu Beyene; Chilot Yirga (IAR, Addis Abeba (Ethiopia)); Asmare Yalew (1996) **Smallholder barley production practices and constraints.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 138-144.* IAR/ICARDA. 5 tables; 12 ref. English. (AGRIS 97-043797).

In most areas barley is grown in the main season (meher). However, in Welo north Shewa and Bale barley is also grown in the short rainy season (belg). In Adet, Bahir Dar and Debre Tabor barley is sometimes double cropped when rainfall is conducive. In Debre Tabor, Dabat and Debark farmers grow mixtures of wheat and barley. Planting in the main season is usually done from mid May to end of July in areas where double cropping is practiced the second crop is planted during August through October. Farmers' weed management practice involves a number of operations: frequent plowing, use of high seed rates and hand pulling of the major weeds late in the season after the critical stage of weed competition. A number of barley cultivars are grown in the survey areas most of which are unimproved local varieties. In some of the survey areas about nine different barley varieties are being cultivated. The proportion of farmers applying fertilizer on barley ranges from zero in Debre Tabor to 100 percent around Kulumsa. The most common fertilizer used is di-amonium phospate. Urea is generally not applied on barley. Barley production constraints include low soil fertility weeds, diseases and pests, frost and hail, waterlogging, seasonal labor shortage, seasonal food shortage, shortage of arable land, shortage and late delivery of fertilizer, and shortage of draft power.

2435 Nadassky, S.; Jesko, J. (Vyskumny Ustav Ekonomiky Polnohospodarstva a Potravinarstva, Bratislava (Slovakia)) (1996) **[Agricultural production and its intensity in the CEFTA countries and in Slovenia]. Polnohospodarska produkcia a intenzita vyroby v statoch CEFTA a v Slovinsku.** *Zemedelska Ekonomika - UZPI (Czech Republic) v. 42(7) p. 329-336.* 13 tables; 6 ref. Slovak. (AGRIS 97-029878).

2436 Regasa Ensermu; Chilot Yirga (IAR, Addis Abeba (Ethiopia)); Girma Gebrekidan; Asmare Yalew (1996) **Economics of smallholder barley production and technologies tested on-farm.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 145-151.* IAR/ICARDA. 7 tables; 9 ref. English. (AGRIS 97-043798).

Most of the research efforts on barley emphasized improved production packages. The major evaluation criterion has been biological yield. The inclusion of economic criteria to derive research recommendations has not been sufficiently considered. Only few studies were initiated to assess the feasibility of barley production under smallholder conditions. Technologies meant to improve production and economic return of food barley were evaluated on various sites including farmers' fields in different regions of the country. The trials focused on varieties, fertilizer weed control methods, planting time, seeding rate and surface drainage.

2437 Robison, M.H. (University of Idaho.); Foltz, J.C.; Meyer, N.L.; Wolf, S.A.; Smathers, R.L. (1994) **The role of the wheat industry in Idaho 's economy.** *Bulletin (University of Idaho. College of Agriculture) (USA); no. EXT 768 7 p.* English. (AGRIS 97-043815).

2438 Santos, H.P. dos; Ambrosi, I.; Ignaczak, J.C.; Sandini, I. (1996) **[Economic analysis of crop rotation systems for barley, under no-tillage]. Analise economica de sistemas de rotacao de culturas para cevada, sob sistema plantio direto.** *Pesquisa Agropecuaria Brasileira (Brazil) v. 31(3) p. 165-171.* 14 ref. Portuguese. (AGRIS 97-029840).

E20 ORGANIZATION, ADMINISTRATION AND MANAGEMENT OF AGRICULTURAL ENTERPRISES OR FARMS

2439 Adam, B.D. (Oklahoma State University.); Betts, S.; Brorsen, B.W. (1996) **Effects of reduced government deficiency payments on post-harvest wheat marketing strategies.** *Current farm economics (USA) v. 69(1) p. 17-32.* references. English. (AGRIS 97-043943).

2440 Allen, E. (1996) **U.S. wheat acreage responds to high prices.** *Agricultural outlook (Washington, D.C. : 1975) (USA) (no. 232) p. 10-13.* English. (AGRIS 97-029999).

2441 Grossardt, T. (University of Kentucky.) (1996) **Harvest(ing) hoboes: the production of labor organization through the wheat harvest.** *Agricultural history (USA) v. 70(2) p. 283-301.* references. In the special issue: Twentieth-century farm policies. Paper presented at a symposium held June 8-10, 1995, College Park, Maryland. English. (AGRIS 97-030004).

2442 Johnson, P.A.; Chambers, P.A.; Smith, P.N. (1996) **The economics of reducing nitrate loss: experiences with a five course limestone rotation in Lincolnshire.** *Farm Management (United Kingdom) v. 9(7) p. 317-323.* 6 ref. English. (AGRIS 97-029914).

E70 TRADE, MARKETING AND DISTRIBUTION

2443 Delwiche, S.R. (BARC, Instrumentation and Sensing Laboratory, ARS, USDA, Beltsville, MD.); Massie, D.R. (1996) **Classification of wheat by visible and near-infrared reflectance from single kernels.** *Cereal chemistry (USA) v. 73(3) p. 399-405.* references. English. (AGRIS 97-030360).

Identification of wheat class is a necessary component of the official inspection of U.S. wheat, owing to differences in functionality and hence in trade value. Because of the numerous cultivars for the several U.S. wheat classes, segregation by cultivar is generally impractical during postharvest handling. Cultivars of differing wheat classes are sometimes inadvertently mixed, resulting in classification of the lot to a mixed category, thus lowering its value. Single-kernel near-infrared reflectance scans from two spectral regions (551-750 nm for distinctions based on color, 1.120-2.476 nm for distinctions based on intrinsic properties) were collected on 10 randomly drawn kernels from each of 318 unique samples obtained from commercial sources. Partial least squares and multiple linear regression analyses were used to develop binary decision models for various combinations of two wheat classes, choosing from five classes: hard white (HWH), hard red spring (HRS), hard red winter (HRW), soft red winter (SRW), and soft white (SWH). Two-class model accuracy, defined as the proportion of correctly identified kernels of a known wheat class, was greatest (99) when red and white classes such as HRW vs. HWH were compared. Accuracies declined to typically 78-91 when the two classes were of similar color (e.g. HRW vs. SRW, HWH vs. SWH). Using a cascade of binary comparisons similar to two-class models, a five-class model structure was developed. Five-class model accuracy ranged from 65 for SRW wheat to 92 for SWH.

2444 Hoffman, L.A.; Schwartz, S.J.; Chomo, G.V. (1995) **Wheat: background for 1995 farm legislation.** United States. Dept. of Agriculture. Economic Research Service. *Agricultural economic report (USA); no. 712 46 p.* U.S. Dept. of Agriculture, Economic Research Service. ill. bibliographical ref. (p. 32-33). Cover title. "April 1995"--P. [i]. English. (AGRIS 97-030361).

2445 Mdadila, J.M. (1993) **1992/93 industry review of maize, rice and wheat.** FAO, Rome (Italy). Agricultural Operations Div.; Ministry of Agriculture and Livestock Development, Dar es Salaam (Tanzania). Marketing Development Bureau. 54 p. FAO-AGO--URT/101/URT/R8/93. English. (AGRIS 97-030289).

E71 INTERNATIONAL TRADE

2446 Carlson, P. (University of Idaho.); Jones, J.R.; Wiese, M.V. (1993) **A technology-cost assessment of alternatives for shipping dwarf bunt (TCK) free wheat to China from the Pacific Northwest.** *Research bulletin (Idaho Agricultural Experiment Station) (USA); no. 154 22 p.* references. English. (AGRIS 97-044351).

2447 Mohanty, S.; Peterson, EWF. (1996) **PRICE ASYMMETRY IN THE INTERNATIONAL WHEAT MARKET - REPLY.** *Canadian Journal of Agricultural Economics-Revue Canadienne d Economie Rurale. 44(3):319-321.* English. [IOWA STATE UNIV CTR AGR & RURAL DEV AMES, IA 50011 USA].

2448 Mohanty, S.; Peterson, EWF.; Smith, DB. (1996) **RELATIONSHIPS BETWEEN US AND CANADIAN WHEAT PRICES - COINTEGRATION AND ERROR CORRECTION APPROACH.** *Canadian Journal of Agricultural Economics-Revue Canadienne d Economie Rurale. 44(3):265-276.* English. [IOWA STATE UNIV FOOD & AGR POLICY RES INST AMES, IA 50011 USA].

This paper examines relationships between U.S. and Canadian wheat prices using the cointegration and error correction approach. The use of the error correction model is appropriate because U.S. and Canadian wheat prices are first-differenced stationary and cointegrated. The results suggest that both U.S. durum and hard spring wheat prices respond to restore equilibrium relationships with the corresponding Canadian price, while the Canadian prices do not. That is, the structure of the respective policies is such that the Canadian markets are largely insulated from influences flowing directly from the U.S., while U.S. markets are not insulated from Canadian influences. These results could be interpreted to support the contention that Canadian production subsidies and the implicit export subsidies would tend to undermine the U.S. price support program. The results also support the price leadership role for Canada in the durum and hard spring wheat markets. The implication is that with respect to durum and spring wheats, U.S. policies to artificially support domestic prices are not effective over the long run. [References: 25].

2449 Uri, N.D. (Economic Research Service, USDA, Washington, DC.) (1996) **Hyberg, B.** *Journal of food distribution research (USA) v. 27(2) p. 8-21.* references. English. (AGRIS 97-044381).

2450 Uri, N.D.; Beach, E.D. (Economic Research Service, U.S. Department of Agriculture, Washington, D.C. (USA)) (1996) **The significance of quality differences for the United States and Canada wheat trade.** *Applied Economics (United Kingdom) v. 28(8) p. 985-997.* 71 ref. English. (AGRIS 97-044352).

2451 Voncramontaubadel, S.; Loy, JP. (1996) **PRICE ASYMMETRY IN THE INTERNATIONAL WHEAT MARKET - COMMENT.** *Canadian Journal of Agricultural Economics-Revue Canadienne d Economie Rurale. 44(3):311-317.* English. [INST AGRAROKON OLSHAUSENSTR 40 D-24118 KIEL GERMANY].

F01 CROP HUSBANDRY

2452 **Eighty-eighth Annual Report, 1995-1996** (1996) Morley Research Centre, Wymondham (United Kingdom). Morley Research Centre. 153 p. English. (AGRIS 97-044527).

2453 [New triticale for summer grain areas]. Korog-nuweling vir somersaaidele (1996) Landbouweekblad, Cape Town (South Africa). *Landbouweekblad (South Africa) (no.972) p. 22-23.* Afrikaans. (AGRIS 97-030935).

2454 Adamu Mola (Sheno Research Center Debre Birhan (Ethiopia)); Amanuel Gorfu; Yeshanew Ashagrie; Zewdu Yilma (1996) Food barley agronomy research. 1. Proceedings of the Barley Research Reviews Workshop. Addis Abeba (Ethiopia). 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 68-84.* IAR/ICARDA. 22 tables; 29 ref. English. (AGRIS 97-044704).

Sowing date experiments showed that optimum sowing time for food barley depends upon location, soiltype, varietal maturity period, and seasonal distribution of rain fall. Seed rates could vary due to soil type and method of covering. Fallowing did not appear economical at Bedi. Rotation of food barley with legumes and oil crops was found beneficial for grain yield of barley. At Holetta, linseed, field pea, faba bean, rapeseed or fodder oats were good precursor crops to barley. At Sheno vetch and faba bean were the best precursor crops. Fertilization of preceding crops showed no residual effect on succeeding barley. On vertisols at Adet, using improved drainage, double cropping of main season barley with chickpea on residual moisture was found beneficial. Tillage experiments on both red and black soils at Holetta showed that mould board plowing by a tractor in mid-March, or twice plowing by the local plow (marsha) after mid-April was beneficial for barley production. In drier areas at Mekele and Quiha frequent tillage by local plow showed no effect on both barley grain yield and moisture content of soil.

2455 Altom, W.; Rogers, JL.; Raun, WR.; Johnson, GV.; Taylor, SL. (1996) LONG-TERM RYE-WHEAT-RYEGRASS FORAGE YIELDS AS AFFECTED BY RATE AND DATE OF APPLIED NITROGEN. *Journal of Production Agriculture. 9(4):510-516.* English. [OKLAHOMA STATE UNIV DEPT AGRON STILLWATER, OK 74078 USA].

Forage yield and quality can be affected by time and rate of N application. This study was conducted to evaluate the longterm impacts of time and rate of applied N on rye (Secale cereale L.,)-wheat (Triticum aestivum L.)-ryegrass (Lolium multiflorum Lam.) forage yield and protein considering seasonal (fall-winter and spring) production differences. Rye-wheat-ryegrass mixtures have been commonly used to extend the forage production season. A long-term experiment was initiated in 1979 to evaluate the effects of N timing (all N applied preplant in the fall, all N applied in the spring, or split applied in the fall and spring), N rate (0, 50, 75, 100, 150, and 200 lb N/acre) and applied lime (no time or single application of 2 tons/acre). Harvests were classified into two groups, fall-winter (November through February) and spring (March through June) with 5 March being the separation date between the two groups. An average of five harvests were obtained each year (two in the fall-winter and three in the spring). No differences in fall-winter, spring, or total forage production and forage protein were observed as a result of applied lime. Tn general a linear response to applied N up to 200 lb of N/acre was observed in fall-winter, spring, and total forage yields. Fall-winter forage production was higher when N was applied in the fall. Similarly, spring forage production was higher when N was applied in the spring. No differences in total forage production were observed over this 14-yr period between fall, spring, and split applied N. Forage protein was much higher in fall-winter harvests (before 5 March) than spring harvests. Total forage N removed (fall-winter plus spring production) tended to be somewhat higher when all fertilizer N was applied in the fall compared with split and spring N applications. Estimated N use efficiencies did not decrease with increasing N applied as has been reported in grain production systems. Forage production systems may have lower plant gaseous N loss (improved N use efficiency) because the plant is never allowed to approach flowering when N losses have been found to be greater. [References: 16].

2456 Amsal Tarekegn (IAR, Addis Abeba (Ethiopia)); Adamu Mola; Amanuel Gorfu; Zewdu Yilma (1996) Malting barley agronomy research. 1. Proceedings of the Barley Research Reviews Workshop. Addis Abeba (Ethiopia). 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 85-91.* IAR/ICARDA. 6 tables; 14 ref. English. (AGRIS 97-044742).

Sowing malting barley in Mid-June to Mid-July was optimum at Lole, Dixis, Goffer and Garadella farms. At these farms, early planting without fertilizer resulted in higher grain yield and lower protein contents than late planting dates. sowing from March 29 to April 8 at Robe and Sinana, and early sowing until Mid-March at Gololcha farm in 'belg' season were optimum for variety Beka, while in 'meher' season sowing early until mid-August was optimum at Sinana farm. Optimum sowing date for malting barley production was around June 25 on red soil and June 15 on black soil at Holetta, Mid-June at Sheno, first week of July at Bekoji and late March to early April (in belg) and early July (in meher) at Sinana. Earlier studies at Holetta suggested that broadcasting 100 to 125 kg ha-1 seed on red soil and drilling 100 kg ha-1 seed on black soil were found optimum rates for large-seeded varieties, while for small-seeded varieties 75 to 100 kg ha-1 seed was optimum on both red and black soils. From seed rate studies conducted by the Arsi Agricultural Development Enterprise at different farms, 100 and 125 kg ha-1 with application of 18 kg N and 20 kg P2O5 ha-1 were recommended for drill and broadcast sowing respectively. Two-cycle cropping sequence experiment on malting barley variety Holkr at Bekoji indicated that the first crop malting barley after faba bean or rapeseed out yielded continuous barley by 37 perecent, while the second crop malting barley after faba bean or rapeseed had 17 perecent yield increment. On vertisols grain yield of malting barley can be substantially increased by improved surface drainage with optimum fertilizer application.

2457 Anderson, WK.; Sawkins, D. (1997) PRODUCTION PRACTICES FOR IMPROVED GRAIN YIELD AND QUALITY OF SOFT WHEATS IN WESTERN AUSTRALIA. *Australian Journal of Experimental Agriculture. 37(2):173-180.* English. [WESTERN AUSTRALIA DEPT AGR 3 BARON HAY COURT S PERTH WA 6151 AUSTRALIA].

The aim of our experiments was to determine whether the soft-grained, club-head wheats used for the Australian Soft grade (cvv. Tincurrin and Corrigin), required different management to maximise grain yield and quality than the standard-head wheats used for other grades. Two series of field experiments were conducted in the 300-500 mm rainfall zone in the southern wheatbelt of Western Australia between latitudes 32 and 34 degrees S from 1989 to 1993. Agronomic variables examined in the experiments included sowing time, nitrogen (N) fertiliser and seed rate. Grain yield, grain protein concentration, hectolitre weight and small grain sievings (below a 2 mm slotted screen) were measured on the grain samples. It was concluded that the optimum time for sowing the soft wheats, both of which are of mid-season maturity, was May. Small grain sievings and grain proteins of the soft wheats exceeded the receival standards for the grade when sown outside this period and were more sensitive to earlier or later sowings in this regard than the other wheats. The soft wheats had smaller kernels and were more likely than other cultivars to produce grain samples with high levels of sievings associated with sowing at inappropriate times and the use of N fertiliser. They had consistently 1-1.5% lower grain protein concentrations than the other cultivars used in the experiments. Hectolitre weights seldom fell below the receival standard of 74 kg/hL for any of the grain samples. Increasing seed rate did not increase the level of sievings at all sites. Although sievings were affected by sowing time, N fertiliser and cultivar, there were large influences associated with site factors that also caused excessive sievings. Fertile sites where the crop did not respond to N fertiliser and sites where the crop was infected by leaf rust were associated with high levels of sievings. Standard-head wheats were less susceptible to dockages, but lower yielding than the club-head, soft wheats. Seed rates for the soft wheats should be chosen to maximise yield rather than to attempt to avoid price dockages at receival. [References: 13].

2458 Atkinson, P.M. (Department of Geography, University of Southampton, Highfield, Southampton SO17 1BJ (United Kingdom)) (1996) Optimal sampling strategies for raster-based geographical information systems. *Global Ecology and Biogeography Letters (United Kingdom) v. 5(4/5) p. 271-280.* 29 ref. English. (AGRIS 97-044657).

2459 Baker, R.H.; Ibraheem, K. (Baghdad Univ. Coll. of Agric. Crop Science Dept. (Iraq)) (1994) [Response of two barley cultivars to clipping frequency.]. 'istij"a:bat al-h"a:s*l al-3alafy wa al-h"ubu:by lis*infai:n min al-s"a3i:r litakra:r al-h"as". *Mij"alat al-3ulu:m al-zira:3iyyat al-3ira:qiyyat (Iraq). The Iraqi Journal of Agricultural Sciences v. 25(no.1) p. 146-152.* Arabic. (AGRIS 97-030745).

A field experiment was conducted to examine the effectiveness of clipping treatment (no clipping, clipping the plant once and twice) on green forage and green yield of two barley cultivars, Numman and Erevate. Grain yield was significantly decreased for two clipping treatments in comparison with no clipping and clipping once treatment in all three seasons. However, no signficant differences were revealed between the later treatments.

2460 Bede, M. (Agrigenetics, Osijek (Croatia)) (1996) **[Issues of winter wheat breeding, regarding higher yields and quality].** **Pravci oplemenjivanja ozime psenice na povecanu radost i kvalitet.** Simpozij Novi izzivi v poljedelstvu (Symposium on New Challenges in Field Crop Production). Radenci (Slovenia). 9-10 Dec 1996. *Proceedings of the Symposium on New Challenges in Field Crop Production. Sesek, P. (ed.). Zbornik Simpozija Novi izzivi v poljedelstvuNew Challenges in Field Crop Production (Slovenia). University of Ljubljana, Biotechnical Faculty, Ljubljana (Slovenia). Agronomy Dept. p. 145-148.* 1 table; 4 ref. Hungarian. (AGRIS 97-030941).

Today's high yield winter wheat varieties were created as the results of long term breeding and genetics work. These varieties have 20 higher genetics potential for yield than standard variety Zitarka. Also, these new varieties have much better flour quality than standard varieties. More over, main characteristics of new variety are pointing out possibilities for rational wheat production.

2461 Belicka, I. (Latvian University of Agriculture, Jelgava (Latvia). Dept. of Crop Production) (1995) **[Winter wheat lines, their quality and evaluation].** **Ziemas kviesu linijas, to kvalitate un vertiba.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil management in the Baltic states (no.182) p. 14-18.* 3 tables; 4 ref. English. (AGRIS 97-044905).

During 1991.1993 the best selected awned and awnless winter wheat lines for yield and quality were evaluated. The higher quality was noted to awned lines, obtained on the bases of variety 'Donskaja polukarlikovaja'. The protein content was 10.6 - 12.3 per cent, gluten 28.0 - 29.2 per cent and glassiness 46 - 64 per cent. These indices were lower of awnless lines: protein content 9.1 - 10.9 per cent, gluten 19.1 - 26.8 per cent, glassiness 28 - 54 per cent. The five lines were tested on the mineral nitrogen N 100 kg ha (-1) background. The quality of wheat grains depends on the timing of mineral N applications. With breeding work and optimised agrotechnical measures is possible to choose the winter wheat varieties for backing industry.

2462 Berhane Lakew; Hailu Gebre; Fekadu Alemayehu (IAR, Addis Abeba (Ethiopia)) (1996) **Barley poduction and research.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-10 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 1-8.* IAR/ICARDA. 8 tables; 10 ref. English. (AGRIS 97-044703).

Despite its long history of cultivation and wide range of uses in different communities the yield of barley is very low (1.0 t ha-1). The major production constraints of barley include diseases (such as scald, netblotch, spot blotch, rusts and smuts), insect pests (such as Russian wheat aphid and barley fly), poor soil fertility poor soil drainage, frost and moisture stresses. Barley research in Ethiopia started at the Debre Zeit Research Center in 1955. Since 1967 the IAR is coordinating barley improvement efforts. Currently, research on barley is being carried out at seven research centers and sub-centers with several testing sites representing the major barley growing regions. The research program follows a multi-disciplinary approach. Several high yielding food and malting barley varieties with their appropriate production packages are released. At present some of them are under production. Research on barley has several setbacks, which include inadequate research centers, shortage of trained work force and facilities and slow transfer of technologies.

2463 Bowerman, P.; Davies, D.B.; Jones, A.E. (ADAS Boxworth Research Centre, Cambridgeshire (United Kingdom)) (1995) **The long-term effects of straw incorporation on winter wheat yields.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 448-452.* Wye College Press. 3 ref. English. (AGRIS 97-044942).

2464 Bulson, HAJ.; Snaydon, RW.; Stopes, CE. (1997) **EFFECTS OF PLANT DENSITY ON INTERCROPPED WHEAT AND FIELD BEANS IN AN ORGANIC FARMING SYSTEM.** *Journal of Agricultural Science. 128(Part 1):59-71.* English. [ELM FARM RES CTR HAMSTEAD MARSHALL NEWBURY RG20 0HR BERKS ENGLAND].

In field trials in 1987/88 near Pangbourne, England, wheat (Triticum aestivum) and held beans (Vicia faba) were grown in an organic farming system as sole crops and additive intercrops. The sole crops were grown at 25, 50, 75, 100 and 150 % of the recommended density (RD) for conventionally grown crops. The intercrops consisted of all density combinations of wheat and beans from 25 to 100 % RD in a factorial experiment. The grain yield of sole cropped wheat and beans increased significantly as their density was increased. The highest yield of both was achieved at 100 % RD, indicating that the conventional recommendation was the optimum when applied to organically grown crops. Land equivalent ratio (LER) values for the intercrops were significantly greater than 1.0 when the wheat was sown at > 5 % RD and beans at > 50 % RD. The highest LER of 1.29 was achieved when wheat and beans were both sown at 75 % RD. There was resource complementarity, expressed as relative yield total (RYT) > 1.0, in all of the density combinations. There was a significant decrease in resource complementarity with increasing wheat and bean density. The nitrogen content of the wheat grain and whole plant biomass was significantly increased when the density of beans in the intercrops was increased; this was reflected in a significant increase in grain protein at harvest. The total amount of N accumulated by the wheat, however, decreased with increasing bean density due to a reduction in the biomass of wheat. Beans also showed a significant increase in %N as the density of the other component increased and a decrease in total N accumulation due to reduced biomass. All of the intercrops accumulated more N than the sole cropped wheat, but did not exceed that accumulated by sole-cropped beans. The biomass of weeds was greater under beans than under wheat. Weed biomass in intercrops was significantly reduced when the density of wheat and brans was increased, resulting in a lower weed biomass in the intercrops than was achieved in either the sole cropped wheat or beans. The N content of weeds was significantly reduced with increasing wheat density but was significantly increased with increasing bean density. The total amount of N accumulated by weeds per unit area was reduced significantly by increasing the density of both components. The levels of disease on the wheat were low, but mildew (Erysiphe graminis) increased significantly as bean density increased. The incidence of chocolate spot (Botrytis fabae) increased significantly with increased bean density. The experiment demonstrated that it was possible to harvest the crop with a combine harvester and the wheat and beans can be planted separately mechanically, therefore this system is suited to mechanized agricultural systems. [References: 72].

2465 Campbell, CA.; Selles, F.; Zentner, RP.; Mcconkey, BG.; Brandt, SA.; Mckenzie, RC. (1997) **REGRESSION MODEL FOR PREDICTING YIELD OF HARD RED SPRING WHEAT GROWN ON STUBBLE IN THE SEMIARID PRAIRIE.** *Canadian Journal of Plant Science. 77(1):43-52.* English. [AGR & AGRI FOOD CANADA RES CTR SWIFT CURRENT SK S9H 3X2 CANADA].

Soil testing laboratories require predictive equations to make accurate fertilizer recommendations to cereal producers in the Canadian prairies. We used results from two 12-yr experiments (one studying snow management x fertilizer rates, and the other a tillage experiment), conducted on a medium-textured Orthic Brown Chernozem at Swift Current, Saskatchewan, to develop a regression model to estimate grain yield of hard red spring wheat (Triticum aestivum L.) grown on stubble. Stepwise regression, with backward elimination, was used to develop the relationship: Y = 1006 + 10.53 WU - 0.017 WU2 + 5.52 FN - 0.095 FN2 - 33.16 SN + 0.436 SN2 - (0.112 FN x SN) + (0.057 FN x WU) + (0.159 SN x WU)- 1.26 DD (R(2) = 0.89, P = 0.001, n = 262) where Y = grain yield (kg ha(-1)), WU = estimated water use (mm), SN = soil test N (kg ha(-1)), FN = rate of fertilizer N (kg ha(-1)), and DD = degree days >5 degrees C (degrees C-days). Water use was available spring water in the 0- to 1.2-m depth plus 1 May to 31 July precipitation + irrigation, and SN was NO3-N in 0- to 0.6-m depth, measured in fall. We validated this model using data from two other experiments in the Brown soil zone and one in the Dark Brown soil zone in Saskatchewan, and an irrigation x N rate experiment in the Brown soil zone in southern Alberta. The results showed that this model will provide reasonable yield estimates for fine-, medium- and coarse-textured soils, when SN less than or equal to 55 kg ha(-1), over a wide range of

water use. We recommend that this equation be tested by colleagues who have appropriate data and be considered for use by soil testing laboratories in Saskatchewan, Alberta, Montana and the Dakotas. [References: 23].

2466 Campbell, CA.; Selles, F.; Zentner, RP.; Mcconkey, BG.; Mckenzie, RC.; Brandt, SA. (1997) **FACTORS INFLUENCING GRAIN N CONCENTRATION OF HARD RED SPRING WHEAT IN THE SEMIARID PRAIRIE.** *Canadian Journal of Plant Science. 77(1):53-62.* English. [AGR & AGRI FOOD CANADA SEMIARID PRAIRIE AGR RES CTR SWIFT CURRENT SK S9H 3X2 CANADA].

Prairie producers are now being rewarded with significant premiums for producing wheat (Triticum aestivum L.) of high protein concentration. We analyzed data from two 12-yr experiments conducted on a medium-textured Orthic Brown Chernozem at Swift Current, Saskatchewan, to determine and quantify factors influencing grain N concentration of hard red spring wheat grown on stubble land. Results of one of the 12-yr studies, a snow management x fertilizer N, zero-tillage experiment, showed that under hot, dry conditions, grain N concentration was very high and increased with moderate rates of fertilizer N (FN), then levelled off at higher rates of N. Under cool, wet conditions, grain N first decreased (due to N dilution by yield) then increased with further addition of FN. Under warm intermediate moisture conditions, grain N concentration increased at moderate rates in response to FN. Data for the two 12-yr experiments were pooled and multiple regression, with backward elimination, and stepwise selection used to develop the relationship: Grain N (g kg(-1)) = -7.63 + 0.05 WU - 0.000094 WU2 + 0.30 SN -0.0022 SN2 - (0.0010 SN x WU) + (0.0017 FN x SN) + 0.0189 DD (R(2) = 0.64, P = 0.001, n = 262) where WU = water use (mm), SN = soil test N (kg ha(-1)), FN = (kg ha(-1)), and DD = degree-days > 5 degrees C (degrees C-days) from 1 May to 31 August. WU was available spring soil water in 0- to 1.2-m depth plus 1 May to 31 July precipitation, and SN was NO3-N in the 0- to 0.6-m depth, measured in the fall. We attempted to validate this model using data from a long-term crop rotation and a fertilizer trial experiment in the Brown soil zone, a tillage x rotation experiment in the Dark Brown soil zone in Saskatchewan, and an irrigation x N fertilizer experiment in the Brown soil zone of southern Alberta. Validation met with only modest success (R(2) up to 0.70, P = 0.001). Generally, estimated grain N concentrations were lower than the measured values. Water use (negatively related) and temperature (DD) (positively related) were the most important factors influencing grain N, while FN and SN (positively related) were much less important. Because of the complexity of response in grain N to the aforementioned factors, and since farmers cannot predict weather conditions, fertilizer management to achieve high protein remains a challenge under dryland conditions. [References: 28].

2467 Chen Shilin; Ren Yongxing; Ma Quanhua (Henan Vocation Technical Teachers College, Xinxiang (China)) (1995) **[The application of MET in high-yield cultivation of inplanting wheat with peanut].** *Journal of Henan Vocation-Technical Teachers College (China) v. 23(1) p. 11-15.* 6 tables; 2 ref. Chinese. (AGRIS 97-044909).

2468 Couvreur, F. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Soft wheat: to select and to adjust sowing rate]. Ble tendre: choisir et ajuster la densite de semis.** *Perspectives Agricoles (France) (no 216) p. 36-41.* French. (AGRIS 97-030501).

2469 Edwards, LM.; Kimpinski, J. (1997) **RELATIONSHIPS BETWEEN SOIL PENETRATION RESISTANCE AND SOIL NEMATODE BURDEN IN BARLEY ON PRINCE EDWARD ISLAND.** *Biology & Fertility of Soils. 24(1):13-17.* English. [AGR & AGRI FOOD CANADA CHARLOTTETOWN RES CTR POB 1210 CHARLOTTETOWN PE C1A 7M8 CANADA].

Fifty sloping fields of barley with different short-term cropping histories across Prince Edward Island were examined for variations in root-zone depth and the severity of soil parasitic nematodes as part of a wider study of relationships between cropping sequence, topographic position, soil physical conditions and crop performance. Root lesion nematode (Pratylenchus penetrans) density in the roots was significantly greater (13%) at foot slopes than at top slopes, and stunt nematode (Tylenchorhynchus spp.) was significantly greater (8%) at top slopes where the soil was drier. The density of stunt nematodes and root lesion nematodes in the soil was significantly greater (>15%) under miscellaneous cereals-barley sequences than under potato-barley or hay-barley, attributable to level of carryover. Root lesion nematode density in the roots was significantly greater (12%) under hay-barley than either of the other two sequences. This nematode also showed a strong tendency to increase in number with increasing root-zone depth, and may be explained on the basis that increased root-zone depth provides increased host root mass (substrate). Stunt nematodes, on the other hand, increased with decreasing root-zone depth and may be explained by the known propensity of these organisms for drier, shallower soil conditions. [References: 30].

2470 Epplin, F.M. (Oklahoma State University, Stillwater, OK.); Fofana, N.F.; Peeper, T.F.; Solie, J.B. (1996) **Optimal wheat seedling rates for conventional and narrow rows for cheat-free and cheat-infested fields.** *Journal of production agriculture (USA) v. 9(2) p. 265-270.* references. English. (AGRIS 97-044774).

Serious cheat (Bromus secalinus L.) infestations often result after several years of conservation tillage in continuously cropped winter wheat (Triticum aestivum L.) fields in the U.S. Southern Great Plains. This study was conducted to determine profit maximizing seeding rates for conventional and narrow row production systems for both cheat-free and cheat-infested fields. Maximum likelihood methods were used to estimate wheat response functions. The profit maximizing seeding rate was relatively insensitive to the price of seed and the price of wheat. However, optimal seeding rates were found to be greater in cheat-infested plots. Reducing row spacing from conventional (9 in.) to narrow (3 in.) rows, with the seeding rate held constant, resulted in increased yields in both cheat-free and cheat-infested plots. It is appropriate to recommend that seeding rate be increased in fields that are heavily infested with cheat. However, the cheat problem can not be solved by changing either row spacing or seeding rate.

2471 Falih, T.K. (Basrah Univ. Coll. of Agric. (Iraq)) (1994) **[Effect of seeding rate and date of growth and yield of triticale]. T'at"i:r mau:a:3i:d al-zira:3at wa kamiyyat al-bid"a:r 3ala numuw wa h"a:s"l al-qamh" al-s"aylamy.** *Mij"alat al-3ulu:m al-zira:3iyyat al-3ira:qiyyat (Iraq). The Iraqi Journal of Agricultural Sciences v. 25(no.1) p. 153-160.* Arabic. (AGRIS 97-030897).

The experiments were conducted to study the effect of four sowing dates 1st Nov., 15th. Nov. and three seeding rates 60, 80, 100 kg/ha on yield and yield components of triticale. Results indicated that the second sowing date (15th. of Oct.) gave higher yield and number of spike per plant; also indicated that the seeding rate (80 kg/ha) gave higher yield, higher number of trillers and spike per plant in both seasons.

2472 Gagro, M. (Krizevci Agricultural Inst. (Croatia)) (1996) **[Application of integral agricultural engineering in wheat production]. Zbornik Simpozija Novi izzivi v poljedelstvu.** Simpozij Novi izzivi v poljedelstvu (Symposium on New Challenges in Field Crop Production). Radenci (Slovenia). 9-10 Dec 1996. *Proceedings of the Symposium on New Challenges in Field Crop Production. Sesek, P. (ed.). New Challenges in Field Crop Production (Slovenia). University of Ljubljana, Biotechnical Faculty, Ljubljana (Slovenia). Agronomy Dept. p. 69-73.* 3 tables; 13 ref. Slovenian. (AGRIS 97-030936).

In a three year survey we have tested 2 wheat varieties Zitarka and Super zlatna and 6 variants of agricultural engineering: 1. control variant, 2. standard agricultural engineering + 2 top dressings + herbicides, 3. standard agricultural engineering + 2 top dressing + herbicides + fungicides, 4. standard agricultural engineering + 2 top dressings + herbicides + fungicides + insecticides, 5. integral agricultural engineering + 2 top dressings + herbicides at the beginning of stalk formation + fungicides + insecticides + CCC and 6. integral agricultural engineering + 2 top dressings and herbicides at the beginning of stalk formation + fungicides + insecticides + CCC, and at the beginning of spike formation, 30 kg of urea, fungicides and insecticides together through foliar application. By combining and completing agricultural engineering we obtained a considerably better health condition of plants, higher TKW (thousand kernels weight) and higher yield. The best results were obtained by the application of integral agricultural engineering with 2 top dressings, and at the beginning of stalk formation, herbicides, fungicides, insecticides and CCC preparations together, and at the beginning of spike formation, foliar application of 30 kg/ha of urea, fungicides and insecticides together. This variant, in relation to the standard agricultural engineering variant + 2 top dressings + herbicides, gave a higher yield for 1393 kg/ha and was marked with mark 1.

2473 Gooding, MJ.; Smith, G.; Davies, WP.; Kettlewell, PS. (1997) **THE USE OF RESIDUAL MAXIMUM LIKELIHOOD TO MODEL GRAIN QUALITY CHARACTERS OF WHEAT WITH VARIETY, CLIMATIC AND NITROGEN FERTILIZER EFFECTS.** *Journal of Agricultural Science. 128(Part 2):135-142.* English. [UNIV READING DEPT AGR EARLEY GATE POB 236 READING RG6 2AT BERKS ENGLAND].

Year x variety means of wheat grain crude protein content (CP) and Hagberg falling number (HFN) surveyed in the UK from 1974 to 1993 were investigated with a residual maximum likelihood (REML) analysis using variety, nitrogen fertilizer application (kg N/ha), average monthly temperatures (degrees C), and total monthly rainfall (mm) as fixed terms, and year as a random term. Annual variety means were weighted according to the inverse of their variances. The statistical significance of fixed terms as they were added to the model was evaluated by comparing the Wald test statistic with critical values of chi-squared. CP, except for 1976 which was associated with prolonged drought conditions, was best described with a model combining effects for variety ($P < 0.001$), nitrogen application rate (0.0143, S.E. = 0.00312, $P < 0.001$), July temperature (0.184, S.E. = 0.0582, $P < 0.01$) and May rainfall (-0.00952, S.E. = 0.00233, $P < 0.001$). A model describing HFN combined effects for variety ($P < 0001$), August rainfall (-0.930, S.E. = 0.2579, $P < 0001$) and June temperature (24.4, S.E. = 7.37, $P < 0.001$). These models were evaluated for describing CP and HFN of cv. Avalon grown on sandy-loam from 1982 to 1992 at one site. Correlation coefficients of 0.51 ($P = 0.1$) and 0.72 ($P = 0.012$) were obtained between observed values at this site and those predicted from the nationally derived models for CP and HFN respectively. Variety effects suggested that the varieties commonly used in the mid 1970s would give higher CP and lower HFN than their more modern counterparts if grown at similar levels of nitrogen and in the same climatic conditions. [References: 27].

2474 Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) (1996) **Barley research in Ethiopia: Past work and future prospect. 1.** *Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993.* IAR/ICARDA. 195 p. English. (AGRIS 97-044702).

2475 Hansen, E.M.; Djurhuus, J.; Rasmussen, K.J. (1996) **[Soil treatment for spring barley: effects on yields and nitrate loss]. Jordbearbejdning til vaarbyg: effekt paa udbytter og nitratudvaskning.** Statens Planteavlsforsoeg, Foulum (Denmark).. *Groen Viden. Landbrug (Denmark); no. 176 4 p.* SP. 3 ill. Danish. (AGRIS 97-044700).

2476 Henselova, M.; Konecny, V. (Vyskumny Ustav Chemickej Technologie, Bratislava (Slovakia)) (1995) **[Rastim 30 DKV - plant growth regulator]. Rastim 30 DKV - regulator rastu zvysujuci urodu a zlepsujuci kvalitu osetrenych plodin.** *Agrochemia (Slovakia) v. 35(1-2) p. 19-21.* 4 tables; 7 ref. Slovak. (AGRIS 97-031009).

A new plant growth regulator for use on tomatoes, barley, maize and sweet peppers is registered in Slovakia. Possibilities exist also for use on oilseed rape and sugar beets.

2477 Hvid, S.K.; Nielsen, K.V. (1997) **[Survey 1996, G: Soil treatment]. Oversigt 1996, G: Kulturteknik.** Landsudvalget for Planteavl, Aarhus (Denmark). *Oversigt over Landsforsoegene (Denmark) (no.1996) p. 195-198.* 4 ill., 2 tables. Danish. (AGRIS 97-044553).

2478 Iragavarapu, TK.; Randall, GW. (1997) **YIELD AND NITROGEN UPTAKE OF SPRING WHEAT PLANTED IN A RIDGE-TILL SYSTEM.** *Journal of Production Agriculture. 10(1):117-122.* English. [UNIV MINNESOTA SO EXPT STN 35838 120TH ST WASECA, MN 56093 USA].

Conservation tillage and inclusion of a cover crop that provides surface residue cover are two management options for reducing soil erosion losses commonly found in a corn (Zea mays L.)-soybean [Glycine max (L.) Merr] rotation. Information is lacking, however, on the performance of a small grain planted in a ridge-tillage system in the Northern Corn Belt. A 3-yr (1992-1994) study was conducted to determine the effect of row position (ridge, shoulder, furrow, and wheel track furrows) on yield and N uptake of hard red spring wheat (Triticum aestivum L.) planted in a ridge-tillage system on poorly drained Webster clay loam (fine-loamy, mixed, mesic Typic Haplaquoll) soil at two locations in southern Minnesota. Spring wheat was planted after soybean in 15 ft wide strips. Wheat performance was affected by the position of the row. across the ridged seedbed. Averaged across the 3 yr, grain yield of the wheat rows planted on ridge top and shoulder positions was 31% greater than those rows planted in the furrows at both locations. Grain yield of wheat in the wheel track furrows was reduced by 38% at Freeborn and by 33% at Waseca compared with those planted on ridge tops and shoulders when averaged across years. Moreover, grain yield in the wheel track furrows was reduced by 18% at Freeborn and by 12% at Waseca compared with non-wheel track furrows across years. Similar to grain yield, straw yield and total N uptake were greater in the ridge top and shoulder positions than in either non-wheel track or wheel track furrow positions. Lesser grain yield in the furrows and wheel track furrows correlated well with reduced head numbers in these row positions compared with ridge top and shoulder positions. The results from this study indicate that wheat can be successfully planted in a ridge-tillage system. Yield losses, however, occur in the furrows and controlled wheel track furrows, especially in wet years in this ridge-till system. [References: 19].

2479 Jia, Y.Q. (Laboratoire de Physiologie Vegetale, Toulouse, France.); Masbou, V.; Aussenac, T.; Fabre, J.L.; Debaeke, P. (1996) **Effects of nitrogen fertilization and maturation conditions on protein aggregates and on the breadmaking quality of soissons, a common wheat cultivar.** *Cereal chemistry (USA) v. 73(1) p. 123-130.* references. English. (AGRIS 97-030996).

Formation of storage proteins and their aggregation in response to available nitrogen and maturation conditions were investigated for the French wheat cultivar Soissons. N-fertilization level greatly influences the accumulation of the different classes of storage and metabolic proteins by modifying the relative composition of the protein pool, which can be expressed by a decrease of the ratio of glutenins to gliadins and also by variations in baking strength. Changes in glutenin content, high molecular weight glutenin subunits (HMW-GS), and aggregates were monitored by nitrogen determination, sodium dodecyl sulfate (SDS) polyacrylamide gel electrophoresis, size-exclusion high-performance liquid chromatography, and reversed-phase high-performance liquid chromatography. Whereas the composition in HMW-GS remained unchanged, the aggregation level of glutenic polymers developed differently depending on the maturation conditions. These aggregation variations are discussed in connection with the specific contribution of some HMW-GS to the formation of both soluble and insoluble SDS-glutenic aggregates and also with baking strength response.

2480 Kabashnikova, L.F.; Klimovich, A.S.; Mikhajlova, S.A.; Shanbanovich, N.N.; Chajka, M.T. (Academy of Sciences of Belarus, Minsk (Belarus). Institute of Photobiology) (1996) **[Study of efficiency of new protection-stimulating compounds influence on the growth and development of cereal crops]. Izuchenie ehffektivnosti dejstviya novykh zashchitno-stimuliruyushchikh sostavov na rost i razvitie zlakovykh kul'tur.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 121-123.* BRIPP. Russian. (AGRIS 97-044698).

2481 Kaerner, E.; Kaerner, M. (Estonian Agricultural Univ., Tartu (Estonia). Inst. of Soil Management and Plant Product Technology) (1995) **[About the influence of farm practice on the yield formation of early barley]. Agrotehnika mojust varase odra saagi kujunemisele.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil management in the Baltic states (no.182) p. 55-58.* 3 ill. English. (AGRIS 97-044695).

Barley is the most extensively cultivated cereal in Estonia. Since it is a producer of feeding grain the greater part of its production is used for feeding purposes. Early barley is also largely used as a fodder grain crop. Comparing with the other cereals early barley is quite particular about the preceeding crop, soil tillage and fertilization due to its shorter period of growth and root system developed rather weakly.

2482 Khabaz Saberi, H.; Ghomi, S. (1994) **Determination of appropriate seeding rates for promising bread Wheat Varieties.** Agricultural Research Center of Gorgan and Gonbad, Gorgan (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research (Iran Islamic Republic) v. 9(3-4) p. 6.* Persian. (AGRIS 97-030868).

2483 Koszanski, Z.; Karczmarczyk, S.; Podsiadlo, C. (Akademia Rolnicza, Szczecin (Poland). Zaklad Podstaw Produkcji Roslinnej i Nawadniania Roslin) (1995) **[Response of winter wheat cultivated on a good-rye soil complex to sprinkling irrigation and nitrogen fertilization. Pt. 1 Winter wheat yield]. Reakcja pszenicy ozimej, uprawianej na glebie kompleksu zytniego dobrego, na deszczowanie i nawozenie azotem. Cz. 1. Plonowanie pszenicy ozimej.** *Zeszyty Naukowe. Akademia Rolnicza w Szczecinie. Rolnictwo (Poland) (no.165) p. 3-9.* 7 tables; 7 ref. Polish. (AGRIS 97-030939).

The effects of overhead irrigation and various nitrogen doses (0, 75, 100, 125, 150 kg/ha) were tested in the years 1987-89 in field experiments. Integration caused a 40 percent increase of winter wheat grain yield. For irrigated winter wheat, a dose of 150 kg nitrogen per 1 ha proved to be optimal, whereas nonirrigated winter wheat yielded the best when supplied with 125 kg N/ha. Irrigation caused a 37 percent increase of the nitrogen unitary productivity. The highest productivity of 1 kg N was found on irrigated plots, which had been fertilized with 100 kg N/ha.

2484 Koszanski, Z.; Karczmarczyk, S.; Podsiadlo, C.; Roy, M. (Akademia Rolnicza, Szczecin (Poland). Zaklad Podstaw Produkcji Roslinnej i Nawadniania Roslin) (1995) **[Response of winter wheat cultivated on a good-rye soil complex to irrigation and nitrogen fertilization. Pt. 2. Chemical composition of the crop]. Reakcja psenicy ozimej uprawianej na glebie kompleksu zytniego dobrego, na deszczowanie i nawozenie azotem. Cz. 2. Sklad chemiczny plonu.** *Zeszyty Naukowe. Akademia Rolnicza w Szczecinie. Rolnictwo (Poland) (no.165) p. 11-15.* 2 tables; 5 ref. Polish. (AGRIS 97-030940).

Sprinkling irrigation did not affect the content of N, P, K, Ca, Mg or Na, neither in the grain nor in the straw of winter wheat. Nitrogen fertilization caused a significant increase of total and nitrate nitrogen content. High doses of nitrogen had significantly decreased the K level in grain but increased its straw content.

2485 Kuht, J. (Estonian Agricultural Univ., Tartu (Estonia). Inst. of Soil Management and Crop Product Technology) (1995) **[Effect of soil loosening during sowing on the yield of barley]. Kuelviaegse reavahede kobestamise moju odra saagile.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil mangement in the Baltic states (no.182) p. 62-64.* 2 tables. English. (AGRIS 97-044696).

According to prof. E. Haller, a yield depends in the first place on the environmental conditions during the germination period of seeds. Germination of seeds and development of a root system depend above all on the soil conditions - bulk density, solidity and porosity. A high yield is greatly dependent on the root system. In thickened and rapidly thickening soils a normal root development is disturbed by mechanical resistance of a soil and its poor aeration. In thick soils the roots can normally develope only in cavities left by the roots of preliminary crops. The bulk density of 1.2 cm (-3).1.4 g cm (-3) is considered to be the optimum for the growth of grain crops. In thicker soils the normal development of roots is hindered and it results in a lower yield. The results of the field experiments showed that with minimization less intensive tillage produces environment more favourable for germination of seeds than in the case of traditional technology. Combined soil tillage and use of sowing aggregate enable us to create the best physical conditions for seed germination. The positive effect of local fertilizing on the yield is widely known. But its co-effect the loosening of the soil between the rows - on the grain crop has not been studied yet.

2486 Lantmann, AF.; Deoliveria, MCN.; Roessing, AC.; Sfredo, GJ. (1997) **PRODUCTIVITY OF WHEAT FOLLOWING NON-FERTILIZED SOYBEAN IN A DYSTROPHIC DUSKY RED LATOSOL.** *Pesquisa Agropecuaria Brasileira. 32(3):257-265.* Portuguese. [CTR NACL PESQUISA SOJA CAIXA POSTAL 231 BR-86001970 LONDRINA PR BRAZIL].

This research evaluates the soil fertility potential for wheat of a dystrophic Dusky Red Latosol of the state of Parana Brazil, and the technical and economical yield response of wheat, double cropped wheat-soybean, as a function of phosphorus and potassium rates applied to wheat and/or soybean. The experiment was carried out at National Soybean Research Center/Embrapa, Londrina, PR, from 1990 to 1995. The treatments were six rates of P and K fertilization arranged in the following way: 1) no fertilization for both soybeans or wheat; 2) 30 kg/ha of K2O for wheat; 3) 50 kg/ha of P2O5 for wheat; 4) 50 kg/ha of P2O5 and 30 kg/ha of K2O for wheat; 5) 50 kg/ha of P2O5 and 30 kg/ha of K2O for wheat, 30 kg/ha of P2O5 and 50 kg/ha of K2O for soybeans; 6) 50 kg/ha of P2O5 and 30 kg/ha of K2O5 for wheat, 60 kg/ha of P2O5 and 100 kg/ha of K2O for soybeans. Every year, the fertilizers were mechanically applied in the sowing furrow. The soil maintained its originally high fertility level during the three first years, even when no fertilizer was applied for soybeans. Application exclusively for wheat crop of 50 kg/ha of P2O5 was enough to maintain the P content in the soil above medium levels during the six years. When P and K contents in the soil approached the critical levels, the effect of the fertilization applied for soybeans was detected in the wheat crop. The net income from wheat crop fertilization became bigger as soil P and K contents dropped approaching the critical levels. [References: 24].

2487 Lark, R.M.; Stafford, J.V. (Silsoe Research Institute, Wrest Park, Silsoe, Bedford MK45 4HS (United Kingdom)) (1996) **Classification as a first step in the interpretation of temporal and spatial variability of crop yield.** *Aspects of Applied Biology (United Kingdom) (no.46) p. 139-142.* 7 ref. Modelling in applied biology: spatial aspects, 25-27 June 1996, Brunel University, London, UK. English. (AGRIS 97-031001).

2488 Lauk, E.; Jaama, E. (Estonian Agricultural Univ., Tartu (Estonia). Inst. of Field Crop Husbandry) (1995) **[The productivity and the crops' quality of the mixed culture of spring wheat and common vetch]. Suvinisu ja suviviki segukuelvi produktiivsusest ja saagi kvaliteedist.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil management in the Baltic states (no.182) p. 68-75.* 2 ill., 2 ref. English. (AGRIS 97-044906).

The article discusses the seed norms for mixed seeding of spring wheat and common vetch, and the different proportions of the components on the soils without nitrogenous fertilizers and with weak nitrogenous background. During the research the optimum seed norm and proportions for the components were found. It turned out that the mixed seeding of spring wheat and common vetch has advantages when compared with the single crop of wheat. The general productivity of the mixed seed can be up to 1100 kg ha (-1) higher than the yield from the single crop of wheat. In the mixed seeding of vetch and wheat the crude protein content in the wheat grain was remarkably higher than that of the single crop of wheat. The influence of the common vetch to the productivity of the mixed seed was equal to 100 kg ha (-1) of ammonium nitrate, but if we base our calculations on the protein yield, the influence turns out to be three times stronger than that of the above mentioned amount of the fertilizers.

2489 Li Yizhen (Fujian Academy of Agricultural Sciences, Fuzhou (China). Inst. of Rice and Wheat) (1995) **Studies on the yield components for high yielding wheat in annual three-crop system.** *Journal of Fujian Academy of Agricultural Sciences (China) v. 10(2) p. 5-9.* 3 ttables; 1 ill., 10 ref. Chinese. (AGRIS 97-044902).

2490 Makke, A. (Estonian Agricultural Univ., Tartu (Estonia). Inst. of Soil Management and Crop Product Technology) (1995) **[Influence of nitrogen fertilizer rate and date of seed sowing on the barley yield and its quality]. Laemmastikvaetise normide ja kuelviaegade moju odra saagile ja kvaliteedile.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil management in the Baltic states (no.182) p. 86-89.* 1 table; 4 ref. English. (AGRIS 97-044697).

Over the periods of 1981.1983 and 1987.1989 the effect of nitrogen fertilizer and seed sowing dates on the yield of barley variety 'Julia' and its quality was studied. The experiment was designed to study the following problems: the requirements of barley with respect to the hydrothermal medium conditions; agronomically efficient rates of nitrogen fertilizer applied at early, late and very late sowing dates; is it possible to prevent the decrease in the yield of barley and its quality in case of late sowing date by application of appropriate rates of nitrogen fertilizer.

2491 Mcconkey, BG.; Ulrich, DJ.; Dyck, FB. (1997) **SLOPE POSITION AND SUBSOILING EFFECTS ON SOIL WATER AND SPRING WHEAT YIELD.** *Canadian Journal of Soil Science. 77(1):83-90.* English. [AGR CANADA RES CTR SWIFT CURRENT SK S9H 3X2 CANADA].

A study was conducted on a 4-m-high ridge in southwestern Saskatchewan to determine the relationship of slope position with the soil water regime and spring wheat (Triticum aestivum L.) production and to determine if those relationships were altered by subsoiling. In all years,

available soil water in the spring to 120 cm increased significantly with distance upslope. This pattern was attributed to residual subsoil water in the rooting zone that had not been used by previous crops in a long-term crop-fallow rotation. After 3 yr of annual spring wheat production, soil water to 1.2 m at all slope positions approximately equalled the water content wilting point (4.0 MPa) water content, showing this residual water had been largely consumed. Apparent use of soil water between seeding and harvest at the upper slope positions was equal to or greater than that at the lower slope positions. Over-winter soil water conservation, using tall (greater than or equal to 30-cm-high) wheat stubble for snow trapping, at the upper slope positions was equal to or greater than that at the lower slope positions. In the non-drought years of 1987 and 1989, wheat yields and crop water use efficiency increased significantly with distance downslope. Since these slope effects were not related to water use or availability, they were attributed to higher soil productivity, probably related to more historical net erosion with distance upslope. During the drought year of 1988, wheat yields and water use efficiency were greatest at the upslope positions, but these results were confounded by uneven crop emergence. Subsoiling to 35 cm or deeper increased the amount and depth of infiltration of water in years with near-average November-April precipitation. Subsoiling had little effect on wheat yields and no effect on crop water use. [References: 47].

2492 Molnarova, J. (Vysoka Skola Polnohospodarska, Nitra (Slovakia). Katedra Rastlinnej Vyroby) (1995) **[Yield formation in winter barley in connection with basic factors of agrotechniques and agroecological conditions.]. Urodotvorny proces ozimneho jacmena vo vztahu k niektorym zakladnym clankom agrotechniky a agroekologickym podmienkam rocnika.** *Polnohospodarstvo (Slovakia) v. 41(11) p. 828-838.* 5 tables; 9 ref. Slovak. (AGRIS 97-030747).

Based on the results of different fertilization levels, sowing terms and sowing rates in a corn production area, in evaluation of winter barley yield formation process the biggest share in the reduction from germination failure and from losses over winter was caused by the sowing term, in dependence on agroecological conditions. In the year with a dry September, the October sowing date was more suitable. The plant number in comparison with that of September was higher (after germination and the winter period) by 22.9 to 137.4 . In the corn production area the sowing rate (where the higher number was achieved by the higher sowing rate) influenced pre-harvest plant number. The influence of fertilization on the plant number reduction process was not significant. The highest average number of shoots (3.8 shoots per plant) was achieved by full nutrient rate (160 kg N+P regardless of the soil nutrient content) in interaction with the September sowing date and sowing rate of 3.5 mi. germinable grains. Yields over 8t per ha were achieved by 420-500 spikes per square meter.

2493 Navvabi, A.R.; Zolghadr, M. (1996) **Effect of sowing date on yield and related traits in two barley cultivars.** seed and Plant Improvement Institute, Karadj (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research Seed and Plant Improvement Institute (Iran Islamic Republic) v. 12(1) p. 6.* Persian. (AGRIS 97-030895).

2494 Nielsen, K.A.; Mikkelsen, M. (1997) **[Survey 1996, K: Forage production]. Oversigt 1996, K: Grovfoderproduktion.** Landsudvalget for Planteavl, Aarhus (Denmark). *Oversigt over Landsforsoegene (Denmark) (no.1996) p. 226-266.* 8 ill., 60 tables. Danish. (AGRIS 97-044532).

2495 Norwood, CA.; Currie, RS. (1997) **DRYLAND CORN VS. GRAIN SORGHUM IN WESTERN KANSAS.** *Journal of Production Agriculture. 10(1):152-157.* English. [SW RES EXTENS CTR 4500 E MARY GARDEN CITY, KS 67846 USA].

Dryland crop yields in the U.S. Great Plains are limited by low precipitation and high potential evapotranspiration. In western Kansas wheat (Triticum aestivum L.) and grain sorghum [Sorghum bicolor (L.) Moench] are grown commonly, whereas corn (Zea mays L.) is believed to lack sufficient drought and heat tolerance for dryland production. A study was conducted near Garden City, KS, from 1991 through 1995 to determine whether corn could be grown successfully. No-till (NT) and conventional-till (CT) corn and grain sorghum were compared. In the driest year, sorghum yielded 137% more than corn with CT and 85% more with NT, but in 3 of 5 yr, NT corn yielded from 34% to 112% more than NT sorghum. In the remaining year, CT sorghum yielded more than CT corn, but NT yields did not differ. Overall, NT increased corn yields by 28% and net return by 69%, but increased sorghum yields by only 11% add had no effect on net return. No-till corn yielded 28% more than NT sorghum and produced 169% more net return, whereas CT corn yielded 11% more than CT sorghum and produced 48% more net return. Dryland corn can be grown in western Kansas if lower yields and returns are accepted in dry years in exchange for yields and returns considerably higher than those of sorghum in favorable years. No tillage will substantially increase yields in most years and is essential to assure adequate corn yields in dry years. [References: 30].

2496 Ohlander, L.; Bergkvist, G.; Stendahl, F.; Kvist, M. (1996) **YIELD OF CATCH CROPS AND SPRING BARLEY AS AFFECTED BY TIME OF UNDERSOWING.** *Acta Agriculturae Scandinavica Section B-Soil & Plant Science. 46(3):161-168.* English. [SWEDISH UNIV AGR SCI DEPT CROP PROD SCI POB 7043 S-75007 UPPSALA SWEDEN].

The possibility to reduce the influence of competition from undersown catch crops on spring barley by delaying the time of undersowing, without seriously affecting the autumn growth of the catch crop, was studied in six field experiments. Up to the harvest of barley, catch crops undersown in connection with the sowing of barley, when roots emerged from kernels, when the first leaf reached the top of the coleoptile and when the barley had three leaves fully developed, produced 588, 468, 250 and 50 kg above-ground biomass per ha, respectively, when 80 kg N ha(-1) was applied. The catch crops tested, Italian rye-grass, perennial rye-grass and red clover, produced 452, 291 and 273 kg ha(-1), respectively. The production of rye-grass was similar when 40 kg N ha(-1) was applied, but that of the red clover was about twice as large. The influence of the catch crops on the grain yield of barley varied among experiments and no general differences depending on catch crop or time of undersowing could be determined. Biomass production in the autumn was only affected by the amount of catch crop at the harvest of barley if the stand was very sparse or very dense. Italian rye-grass, perennial rye-grass and red clover increased their biomass during autumn with 1138, 981 and 1239 kg ha(-1), respectively. [References: 27].

2497 Osorio Alcala, Leodegario; Munoz Orozco, Abel; Rodriguez Perez, Juan Enrique (1993) **[Behaviour of venture wheats varieties and the temporalera M-87 variety under drought at Mixteca alta, Oaxaca]. Comportamiento de trigos ventureros y de la variedad temporalera M-87, bajo sequia en la Mixteca alta.** *Agrociencia (Mexico). Serie Fitociencia v. 4(3) p. 111-124.* 5 grafs., 5 tablas, 18 ref. Tambien como tesis de (MC). Colegio de Postgraduados, Montecillo, Mex. (Mexico). Spanish. (AGRIS 97-044465).

Four wheat varieties (venture wheats) from the Mixteca Alta region at Oaxaca state, and the Temporalera M-87 variety, were studied under residue humidity in that region. The experiment was stablished on October 19th, 1990. There was 40 mm of rain fall at the begining of their growing cycles. The venture wheats were under severe dry conditions since their growing stage and temporalera variety since its reproductive stage, the last one showed earlier growing cycle, more wax content, higher transpiration rate, more production and plant hight that venture wheats, which showed lower transpiration rate and higer stomatal resistance. It means that venture wheats have more capacity to save water, representing important conditioning to survive under drought. The venture wheats can showed their drought resistance capacity, if there is certain soil moisture, enough to let the development of the root system and the area structure Cuatro variedades de trigo en la Mixteca Alta Oaxaquena, conocidas como trigos ventureros y la variedad Temporalera M-87, se estudiaron en dicha region bajo el sistema de humedad residual. El experimento se establecio el 19 de Octubre de 1990. Se registraron 40 mm de precipitacion que ocurrieron al principio del ciclo. Los trigos ventureros estuvieron bajo severa sequia desde la etapa vegetativa, y Temporalera M-87, a partir de la reproductiva. Temporalera M-87 fue mas precoz, alcanzo mayor altura, mayor rendimiento y acumulo cera; los trigos ventureros a pesar de que bajo otras condiciones pueden crecer mas que Temporalera M-87, mostraron menor produccion, menor altura de planta, asimismo bajas tasas transpiratorias y altas resistencias estomatales, lo que indica su capacidad para ahorrar agua, representando acondicionamientos importantes para la sobrevivencia bajo sequia. Los trigos ventureros pueden mostrar su potencial de resistencia a sequia siempre y cuando tengan un minimo de humedad que les permita desarrollar sus estructuras aereas y subterraneas.

2498 Pageau, D.; Tremblay, GF. (1996) **INTERFERENCE BETWEEN CHENOPODIUM ALBUM AND TRITICUM AESTIVUM AT**

DIFFERENT SEEDING RATES AND ROW SPACINGS. *Phytoprotection. 77(3):119-128.* French. [AGR & AGROALIMENTAIRE CANADA FERME RECH NORMANDIN PQ G8M 4K3 CANADA].

A 4-yr study was conducted to evaluate the effect of two row spacings (10 and 18 cm) and five seeding rates (100, 200, 300, 400, and 500 viable seeds m(-2)) of wheat (Triticum aestivum 'Max') on the interference between lamb's-quarters (Chenopodium album) and the crop. Narrow row spacing increased wheat yield by 16% regardless of the presence or absence of lamb's-quarters. Seeding rate was a more important factor than row spacing. At a seeding rate of 100 seeds m(-2), the yield reduction caused by lamb's-quarters was 23% whereas it was 11% when wheat was seeded at 500 seeds m(-2). Yield reductions were attributed to a decrease in the number of spikes m(-2). Lamb's-quarters also reduced the number of spikes per plant and the number of kernels per spike, and, to a lesser extent, the 1000 kernel weight and the harvest index. Nitrogen and phosphorus content of wheat grain were reduced by the presence of Chenopodium. High seeding rates or narrow row spacing did not reduce the density of lamb's-quarters but did reduce the weed biomass. [References: 36].

2499 Pandey, A.K.; Prasad, K.; Singh, P.; Bhatnagar, V.K.; Prakash, V. (Project Directorate of Cropping Systems Research, Modipuram (India)) (1996) **Technology for improving wheat productivity in hills of Uttar Pradesh.** *Indian Farming (India) v. 45(11) p. 11-13, 20.* 2 tables; 2 ill. English. (AGRIS 97-030937).

2500 Pedersen, J.B.; Kristensen, H.; Nielsen, G.C.; Petersen, P.H. (1997) **[Survey 1996, B: Winter crops]. Oversigt 1996, B: Vintersaed.** Landsudvalget for Planteavl, Aarhus (Denmark). *Oversigt over Landsforsoegene (Denmark) (no.1996) p. 17-84.* 22 ill., 99 tables. Danish. (AGRIS 97-044910).

2501 Pedersen, J.B.; Nielsen, G.C.N.; Kristensen, H. (1997) **[Survey 1996, C: Spring crops]. Oversigt 1996, C: Vaarsaed.** Landsudvalget for Planteavl, Aarhus (Denmark). *Oversigt over Landsforsoegene (Denmark) (no.1996) p. 85-119.* 6 ill., 62 tables. Danish. (AGRIS 97-044701).

2502 Prasad, K.; Singh, P. (Project Directorate for Cropping Systems Research, Modipuram (India)); Ram, D. (Vivekananda Parvatiya Krishi Anusandhan Shala, Almora (India)) (1996) **It pays to enhance seed rate of rainfed wheat in hills of Uttar Pradesh.** *Indian Farming (India) v. 45(11) p. 23-25.* 1 table; 3 ill. English. (AGRIS 97-030938).

2503 Prusakova, L.D.; Chizhova, S.I.; Khripach, V.A. (1995) **[Resistance to lodging and yielding capacity of cereals under effect of brassinosteroids]. Ustojchivost' k poleganiyu i produktivnost' yarovogo yachmenya i mnogoletnej pshenitsy pod vlinyaiem brassinosteroidov.** *Sel'skokhozyajstvennaya biologiya. Seriya Biologiya rastenij (Russian Federation) (no.1) p. 93-97.* 19 ref. Russian. (AGRIS 97-030746).

The effect of synthetic analogs of brassinosteroids (brassinolid, epibrassinolid, homobrassinolid) on the growth, the stem firmness, and productivity of the spring barley cultivar Nosovsky 9 and the perennial wheat cultivar Zernokormovaya 169 has been studied in greenhouse and field experiments. The aim of experiments was to develop principally new approaches to the increase of cereals' resistance to the lodging. It has been shown that brassinosteroids possessed a high physiological activity, expressed in the induced activity of alpha-amylase in the barley endosperm, the increase of the grain weight per ear, the 1000-gain weight, and the yield. Under the spraying with synthetic analogs (10^{**} (-5) mg/l) during the flowering, the barley stem diameter and firmness also increased, which conditioned an improved resistance to the lodging.

2504 Radmehr, M.; Lotfali Aeineh, G. (1996) **Study on the effect of heat stress on agronomic traits, grain yield and yield components in twenty five bread wheat genotypes.** Agricultural Research Center, Khuzestan Ahwaz (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research Seed and Plant Improvement Institute (Iran Islamic Republic) v. 12(1) p. 3.* Persian. (AGRIS 97-030693).

2505 Rimar, J. (Oblastny Vyskumny Ustav Agroekologie Michalovce (Slovakia)) (1995) **[Ecological crop production and its possibility in soils contaminated by immissions]. Moznosti ekologickeho hospodarenia na podach kontaminovanych imisiami.** *Agrochemia (Slovakia) v. 35(5-6) p. 87-91.* 5 tables. Slovak. (AGRIS 97-030748).

The contribution deals with the possibility of utilizing a new dual-ingredient combination: fertilizer and zeolit, which has been developed by the chemical factory Chemko Strazske and Research Institute of Agroecology, Michalovce (Slovakia). The effective influence of this dual-ingredient combination on crop yields (spring barley, onion, tomatoes) was determinated to range from 40:60 to 70:30 of zeolit to fertilizer.

2506 Rodriguez, A. (International Center for Agricultural Research in the Dry Areas, Aleppo, Syria.) (1996) **Sustainability and economic viability of cereals grown under alternative treatments of water-harvesting in Highland Balochistan, Pakistan.** *Journal of sustainable agriculture (USA) v. 8(1) p. 47-59.* references. English. (AGRIS 97-044798).

2507 Ruza, A.; Dominiece, I. (Latvian University of Agriculture, Jelgava (Latvia). Dept. of Crop Production) (1995) **[Spring wheat - yielding capacity and quality of grains]. Vasaras kviesu skirnu raziba un kvalitate.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil management in the Baltic states (no.182) p. 101-103.* 2 tables. English. (AGRIS 97-044877).

The most appropriate rate of nitrogen fertilizer use produce comparatively high and qualitative grain yields of spring wheat under Latvian conditions. Response to nitrogen application is higher with spring wheat varieties high in potential yielding capacity to result in top-quality grains.

2508 Ruza, A.; Kreita, D. (Latvian University of Agriculture, Jelgava (Latvia). Dept. of Crop Production) (1995) **[Effect of nitrogen fertilizer on winter wheat yield and quality]. Slapekla mesiojuma ietekme uz ziemas kviesu razu un tas kvalitati.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil management in the Baltic states (no.182) p. 104-108.* 4 tables. English. (AGRIS 97-044907).

With agrotechnics suitable to each variety in itself high and stable annual grain yields of winter wheat, meeting the quality requirements, are possible. Due to potentially high yielding grain crop varieties heavier rates of nitrogen fertilizer are needed to provide quality requirements of grains.

2509 Schonbeck, M.; Elder, P.; DeGregorio, R. (1995) **Winter annual cover crops for the home food garden.** *Journal of sustainable agriculture (USA) v. 6(2/3) p. 29-53.* references. English. (AGRIS 97-044750).

2510 Sesek, P. (Ljubljana Univ. (Slovenia). Biotechnical Fac., Agronomy Dept.) (1996) **[Modelling the dependence of dry matter yield of grains of winter wheat (Triticum aestivum L.) cv. Reska on mineral nitrogen fertilization]. Modeliranje odvisnosti pridelka suhe snovi zrnja ozimne psenice (Triticum aestivum L.) cv. 'reska' od gnojenja z mineralnim dusikom.** Simpozij Novi izzivi v poljedelstvu (Symposium on New Challenges in Field Crop Production). Radenci (Slovenia). 9-10 Dec 1996. *Proceedings of the Symposium on New Challenges in Field Crop Production. Sesek, P. (ed.). Zbornik Simpozija Novi izzivi v poljedelstvuNew Challenges in Field Crop Production (Slovenia). University of Ljubljana, Biotechnical Faculty, Ljubljana (Slovenia). Agronomy Dept. p. 207-211.* 2 tables; 2 ill., 6 ref. Slovenian. (AGRIS 97-030942).

In this paper the curves of the third approximation of the yield law for modelling the yields of the grain dry matter of winter wheat cv. Reska in 1996 as a function of the mineral nitrogen fertilization had been evaluated. The specific parameters of curves which had been estimated by Quasi-Newton's method of nonlinear estimation are compared regarding different locations (Jable - central Slovenia; Rakian -eastern Slovenia) and different farming systems (with (I) and without (II) animal husbandries). The parameters 'M' showed significant difference between locations for both farming systems and between different systems on location Jable only. The only significant difference between parameters 'm' appeared for the farming systems II (without animal husbandries). The NBI Index values ranged from 39.6 to 47.8 meaning more than half of calculated maxima was the result of mineral nitrogen fertilization.

2511 Steppuhn, H.; Wall, KG. (1997) GRAIN YIELDS FROM SPRING-SOWN CANADIAN WHEATS GROWN IN SALINE ROOTING MEDIA. *Canadian Journal of Plant Science. 77(1):63-68.* English. [AGR & AGRI FOOD CANADA SEMIARID PRAIRIE AGR RES CTR RES BRANCH POB 1030 SWIFT CURRENT SK S9H 3X2 CANADA].

Farmers seek information about the salt tolerances of wheat. Two greenhouse rests conducted at the Swift Current Salt Tolerance Testing Laboratory determined the response of four spring-sown Canadian wheat cultivars (Katepwa, Biggar, Fielder and Kyle) to increasingly saline rooting media. The first test followed the United States Salinity Laboratory procedure of increasing root-zone salinity gradually after plant emergence, and the second provided full complements of salts before seeding. The plants were grown in sand tanks irrigated four limes daily with hydroponic solutions containing salt concentrations of up to 14 dS m(-1) equivalent electrical conductivity for saturated soil paste extracts (EC(e)). Grain yield and plant height began to decline within all cultivars at equivalent EC(e)-values ranging between 0.5 and 2.5 dS m(-1). At 4 dS m(-1), grain production dropped to 80% or less of that produced in non-saline rooting media. Kyle and Fielder plants showed slightly more salt tolerance than those of Katepwa or Biggar (i.e., moderately sensitive rather than sensitive). Gradually adding the salts after plant emergence resulted in a tendency for greater salt-tolerance estimates than obtained by subjecting the plants to the full complement of salts at seeding. At the concentrations tested, the salinity affected the number of fertile spikes per plant more than it affected the number of plants reaching harvest. [References: 29].

2512 Stockton, RD.; Krenzer, EG.; Solie, J.; Payton, ME. (1996) **STAND ESTABLISHMENT OF WINTER WHEAT IN OKLAHOMA - A SURVEY.** *Journal of Production Agriculture. 9(4):571-575.* English. [OKLAHOMA STATE UNIV DEPT AGRON STILLWATER, OK 74078 USA].

Timely and adequate stand establishment of winter wheat (Triticum aestivum L.) is critical in the southern Great Plains, where wheat is frequently grazed by livestock in the winter followed by grain harvest. Poor stands reduce forage yield potential. Percentage of viable wheat seed planted that produced seedlings was determined by surveying wheat fields during the 1992 and 1993 planting seasons. Causes of poor emergence were identified. Data collected included: cultivation practices prior to planting, type of planting equipment, depth of planting, and seeding rate. Seed samples for germination tests, seed size determinations, and planter calibrations were collected at each location. Actual stand counts and seeding depth measurements were made about 2 wk after planting. Average emergence rate was 57% of viable seed planted in both years. Inaccurate planting depth and variation in planting depth within a field were identified as major causes of poor emergence. Other causes for poor emergence were placing seed in dry soil and use of small seed. Oklahoma wheat fields have too few wheat plants for the number of viable seed planted. Limiting cultivation depth prior to seeding, using depth gauges on individual row openers, and not planting seed weighing less than 7 oz/1000 seed can help improve wheat stands. [References: 12].

2513 Tret'yakov, N.N.; Shevchenko, V.A.; Sechkin, A.D. (1995) **[Effect of root medium volume on plant growth and production of corn, barley and potatoes]. Vliyanie ob"ema sredy korneobitaniya na rost i produktivnost' rastenij kukuruzy, yachmenya i kartofelya.** *Izvestiya Timiryazevskoj sel'skokhozyajstvennoj akademii (Russian Federation) (no.2) p. 101-117.* 17 ref. Russian. (AGRIS 97-030880).

Conditions arising with higher soil density, soil tillage at different depth, too thick sowing that under field conditions results in lower volume of soil medium per 1 plant were modelled in greenhouse experiments. Different volumes of root medium were produced by growing plants in glass vessels of volume 10, 20, 200, 600 cm**3 (water culture), and in net chambers with cell diameter of 0.15 mm with a volume of 100, 200, 400, 800 and 6000 cm**3. Phenophases, linear growth and leaf surface, formation of root system, growth of total plant biomass, gas exchange and yield structure were taken into consideration. The procedures used allow to determine optimum volumes of root medium and those limiting growth, development and productivity of plants, to find maximum possible filling the soil volume with roots, which is important for improving the practices of farm crop cultivation.

2514 Unger, P.W. (USDA ARS Conserv. and Prod. Res. Lab., Bushland, TX.) (1996) **Dryland no-tillage winter wheat response to planter type.** *Journal of production agriculture (USA) v. 9(2) p. 256-260.* references. English. (AGRIS 97-044886).

Crop planting becomes increasingly difficult as surface residue amounts increase, as with conservation tillage. Planters for such conditions are available, but costly. With relatively low residue amounts, as for winter wheat (Triticum aestivum L.) and grain sorghum [Sorghum bicolor (L.) Moench.] grown in rotation on dryland, it was hypothesized that drills used under conventional tillage conditions could satisfactorily plant wheat into no-tillage sorghum residues. Objectives of this study were to test this hypothesis. The information would show whether different planting equipment is needed when switching to a conservation tillage system. Drills were John Deere 8200 (Deere and Co., Moline, IL) with single-disk, Graham-Hoeme PD-160 (United Farm Tools, Oelwein, IA) and Fabco M-10 (Fabco Ltd., Swift Current, SK, Canada) with double-disk, and International 7100 (J.I. Case, Racine, WI) with hoe openers. No drill provided 1.5 in. (target depth) of seed coverage; it was least (0.75 in.) with the John Deere, which moved more soil from the seed row than other drills. The number of seedlings emerged was not affected by drill types. Mean yields with the John Deere (2000 lb/acre grain; 4200 lb/acre residue) were lower than with other drills (2410 to 2670 lb/acre grain; 4900 lb/acre for residue). Differences in seed coverage depth and soil removal from the drill row possibly caused the yield differences. A suitable drill should be used for planting wheat under conservation tillage, but using a heavy-weight drill, as the Fabco, is not warranted when grain sorghum residues on dryland are similar to the amounts present under the conditions of this study (4900 lb/acre).

2515 Wang Bingkui; Jin Ziyu; Zhao Miaozhen (Zhejiang Academy of Agricultural Sciences, Hangzhou (China). Inst. for Application of Atomic Energy) (1995) **Effect of TM [plant growth inhibitor] on lodging resistance and yield components of barley.** *Acta Agriculturae Nucleatae Sinica (China) v. 9(4) p. 200-202.* 5 tables; 3 ref. Chinese. (AGRIS 97-044699).

2516 Wang Fahong (Shandong Academy of Agricultrual Sciences, Jinan (China). Inst. of Crops) (1995) **Production potential of winter wheat and the key measure to further raise the yield in Shandong, China.** *Journal of Shandong Agricultural Sciences (China) (no. 1) p. 4-7.* Chinese. (AGRIS 97-044904).

2517 Wang Zhenlin (Shandong Agricultrual Univ., Tai'an (China). Dept. of Agronomy) (1996) **Partitioning of 14C-photoassimilates during grain filling, yield components and their relation to source-sink manipulation of late sown winter wheat.** *Scientia Agricultura Sinica (China) v. 29(1) p. 50-58.* 1 table; 7 ill., 10 ref. Chinese. (AGRIS 97-044903).

2518 Xie Fenggen (Zhejiang Academy of Agricultural Sciences, Hangzhou (China)) (1995) **Effect of rice straw mulch on yield of barley.** *Soils and Fertilizers (China) (no. 4) p. 18-20.* 7 tables. Chinese. (AGRIS 97-044694).

2519 Yau, SK. (1997) **EFFICIENCY OF ALPHA-LATTICE DESIGNS IN INTERNATIONAL VARIETY YIELD TRIALS OF BARLEY AND WHEAT.** *Journal of Agricultural Science. 128(Part 1):5-9.* English. [ICARDA GERMPLASM PROGRAM POB 5466 ALEPPO SYRIA].

Use of an alpha-lattice design in 714 international yield trials of barley, durum wheat and bread wheat in 1990/91 to 1992/93 resulted in an average efficiency 18% higher than the randomized complete block design when average variance was used as the comparison criterion. Alpha-lattice was generally most efficient when the c.v.s of the trials were high. It was also slightly more efficient for low-yielding than for high-yielding trials, and for rainfed than for irrigated trials. Since the changeover to alpha-lattice designs requires no new major input or changes in present field layout, its use for international trials is recommended. [References: 11].

2520 Zemede Asfaw (Addis Abeba University, Addis Abeba (Ethiopia)) (1996) **Barley in Ethiopia: The link between botany and tradition.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 182-192.* IAR/ICARDA. 4 tables; 40 ref. English. (AGRIS 97-044705).

A brief review of the general botany of barley and traditons associated with barley cultivation in Ethiopia is presented. The main groups of barley are given under the classical method of grouping as six-row, two-row and irrigular types, while the hulled, hull-less and partially hulled types are treated in the formal taxonomic contexts. Characters of universal occurrence include forms with long spikes, lax spikes, hulled kernels, white kernels, black kernels, and awned lemmas with long, rough, persistent awns, while others are restricted to one or two of the main groups. Systems of barley nomenclature and classification used by farmers for ages are discussed, noting the parallelism with that of formal

taxonomy. The oral tradition has been sampled as a testimony of the significance of barley to Ethiopia.

2521 Zhang Guoping (Zhejiang Agricultural Univ., Hangzhou (China). Dept. of Agronomy) (1996) **Modification of GA3 on some growth and physiological effects of PP333 on wheat.** *Journal of Zhejiang Agricultural University (China) v. 22(2) p. 162-167.* 3 tables; 3 ill., 5 ref. English. (AGRIS 97-044908).

F02 PLANT PROPAGATION

2522 Brisibe, EA.; Olesen, A.; Andersen, SB. (1997) **CHARACTERIZATION OF ANTHER CULTURE-DERIVED CELL SUSPENSIONS EXCLUSIVELY REGENERATING GREEN PLANTLETS IN WHEAT (TRITICUM AESTIVUM L).** *Euphytica. 93(3):321-329.* English. [ROYAL VET & AGR UNIV DEPT AGR SCI SECT PLANT BREEDING & BIOTECHNOL THORVALDSENVEJ 40 DK-1871 COPENHAGEN DENMARK].

A reproducible procedure for deriving highly regenerable cell suspensions that can readily and consistently regenerate green plantlets in wheat is described. Initiation and selection of the right type of callus from anther cultures, which consisted of friable early embryogenic portions that can easily disperse in liquid medium was important for the establishment of rapidly growing embryogenic suspensions. Using this type of inoculum no significant variation between three different independent replications was noted when cell suspensions from eleven specially recombined doubled haploid lines were maintained in General medium supplemented with dicamba and a predominance of amino acid nitrogen. This approach also enhanced a long-term embryogenic competence of the cell cultures, with some of the suspensions retaining their morphogenic capacity over a period of more than 15 months. Depending on the medium composition high frequencies of embryogenesis (over 70%) and green plantlet regeneration (repeatedly producing 90-100% of green regenerants) were obtained from the cell aggregates for most of the embryogenic cell lines. Potential advantages of anther culture-derived embryogenic cell suspensions for transformation purposes are the high number of cell lines which can be established routinely and the apparent maintenance of a stable haploid genome by the regenerants in culture. It is anticipated that an increased use of anther or microspore derived doubled haploid techniques in future wheat breeding programmes may favour selection in the breeding material of plant types generally responsive to such protocols. [References: 35].

2523 Bruins, MBM.; Rakoczytrojanowska, M.; Snijders, CHA. (1996) **ISOLATED MICROSPORE CULTURE IN WHEAT (TRITICUM AESTIVUM L) - THE EFFECT OF CO-CULTURE OF WHEAT OR BARLEY OVARIES ON EMBRYOGENESIS.** *Cereal Research Communications. 24(4):401-408.* English. [DLO CPRO POB 16 NL-6700 AA WAGENINGEN NETHERLANDS].

In this study the effects of different ovary co-culture methods on sporophytic development of wheat microspores were investigated. Mechanically isolated microspores of greenhouse grown donor plants of wheat (Triticum aestivum L.) were co-cultured with wheat or barley ovaries either in agarose rings or in culture plate inserts. The viability of the microspores was better in co-culture with wheat ovaries from one cultivar as compared to co-culture with a mixture of wheat ovaries from four cultivars. Co-culture of the microspores with ovaries in culture plate inserts had no significant effect on viability of the microspores, but had, in comparison with culture in agarose rings, a large positive effect on the percentage swollen microspores. No clear genotype effect could be detected. A significant correlation between the number of swollen microspores and the number of multicellular structures was found. [References: 22].

2524 Hu Shanglian; Zeng Hanbing; Li Wenxiong (Northeast Agricultural Univ., Harbin (China). Dept. of Agronomy) (1996) **Studies on single cell culture in vitro in wheat.** *Journal of Northeast Agricultural University (China) v. 27(1) p. 1-8.* 5 tables; 9 ref. Chinese. (AGRIS 97-045065).

2525 Kosulina, L.G. (1995) **[Some specifities of regeneration process in common wheat callus culture]. Osobennosti protsessa regeneratsii v kallusnoj kul'ture zrelykh zarodyshej pshenitsy (Triticum aestivum L.).** *Sel'skokhozyajstvennaya biologiya. Seriya Biologiya rastenij (Russian Federation) (no.1) p. 78-84.* 15 ref. Russian. (AGRIS 97-031070).

The conditions for the embryogenic calluses' development in the culture of mature wheat embryos have selected, using the Mironovskaya yarovaya cultivar as an example. The callus tissue developed two days after the placement of mature embryos on the Murashige-Skoog medium, supplemented with 2 mg/l 2, 4-D, the frequency of callusogenesis induction being 80-90 . The increase of 2, 4-D concentration to 5 mg/l and the addition of 250 mg/l proline resulted in the development of embryogenic callus tissue with a high potential of the organogenic structures' formation. Under the induced morphogenesis, numerous meristemic zones appeared on the surface and in the callus tissue. The pattern of the zones' set allows to determine their further development. The scanning electron microscopy showed that surface of the calluc tissue was non-uniform. The cells, giving rise to organogenic structures, differ from other callus cells in the increased accumulation of total cytoplasmic proteins.

2526 Li Wenze (Laiyang Agricultural Coll., Shandong (China). Dept. of Agronomy) (1995) **Effects of the different pretreatment methods on barley anther culture.** *Hereditas (China) v. 17(5) p. 5-7.* 4 tables; 4 ref. Chinese. (AGRIS 97-045011).

2527 Liang Hui (Chinese Academy of Sciences, Beijing (China). Inst. of Generatics) (1996) **Effects of abscisic acid in immature embryo culture of wheat.** *Journal of Agricultural Biotechnology (China) v. 4(1) p. 52-55.* 1 table; 1 ill., 14 ref. Chinese. (AGRIS 97-045064).

2528 Puolimatka, M.; Laine, S.; Pauk, J. (1996) **EFFECT OF OVARY CO-CULTIVATION AND CULTURE MEDIUM ON EMBRYOGENESIS OF DIRECTLY ISOLATED MICROSPORES OF WHEAT.** *Cereal Research Communications. 24(4):393-400.* English. [AGR RES CTR PLANT BREEDING RES SECT FIN-31600 JOKIOINEN FINLAND].

Culture of directly isolated microspores of wheat (Triticum aestivum L.) was studied in six defined liquid culture media differing in their nutrient composition. Microspores were isolated from spring wheat genotypes 'Mahti' and 'Hja 24201' using microblender and cultured with or without wheat ovaries. Ovary co-cultivation was found to be necessary for the development of embryo-like structures from directly isolated microspores. With ovary co-cultivation, microspore-derived embryo-like structures developed in all the different induction media. The induction media showed some variation in inducing microspore embryogenesis. As a total, 1113 embryo-like structures were plated on the regeneration medium and 95 green and 115 albino plants were obtained. Seventy-five of the green plants were either fertile or partially fertile and 20 were sterile. In contrast, in cultures without ovaries only some initial cell divisions were observed, but the induced multicellular structures did not develop beyond two weeks. [References: 23].

2529 Varshney, A.; Kant, T.; Sharma, VK.; Rao, A.; Kothari, SL. (1996) **HIGH FREQUENCY PLANT REGENERATION FROM IMMATURE EMBRYO CULTURES OF TRITICUM AESTIVUM AND T-DURUM.** *Cereal Research Communications. 24(4):409-416.* English. [UNIV RAJASTHAN DEPT BOT JAIPUR 302004 RAJASTHAN INDIA].

Tissue cultures of 12 genotypes of Triticum aestivum and 2 genotypes of T. durum were established from immature embryos on Murashige and Skoog's (MS) (1962) medium supplemented with 2, 4-dichlorophenoxyacetic acid (2, 4-D) (2.5 mg/l). Both the non-regenerative and the regenerative type of calluses developed from all the genotypes. The compact, white regenerative callus was maintained on the medium having 2, 4-D (2.5 mg/l) by regular sub-culturing for more than 3 years. Plant regeneration from the regenerative type of callus occurred on MS medium supplemented with Indole-3-acetic acid (IAA) (0.2 mg/l) + 6-benzylaminopurine (BAP) (1.0 mg/l). Regenerated shoots or plantlets were rooted on MS medium supplemented with IAA (0.5 mg/l). The well developed plantlets were transferred to pots under field conditions. Seeds were collected from fertile plants for somaclonal variation studies in the subsequent generations. [References: 15].

2530 Zeng Hanbing; Hu Shanglian; Liu Jinjiang (Northeast Agricultural Univ., Harbin (China). Dept. of Agronomy) (1996) **Studies on in vitro culture of immature wheat embryo--Pollen fertility in progeny of regenerated plant.** *Journal of Northeast Agricultural University (China) v. 27(2) p. 105-108.* 1 table; 4 ill., 6 ref. Chinese. (AGRIS 97-045066).

2531 Zhang Chaomei; Zhang Zaijun (Hubei Agricultural Coll., Jingsha (China). Dept. of Agronomy) (1995) **The approaches for enhancing induction frequency of pollen plant in anther culture of wheat.** *Journal of Hubei Agricultural College (China) v. 15(4) p. 305-309.* 46 ref. Chinese. (AGRIS 97-045068).

2532 Zhang Zaijun; Zhang Caomei; Zhang Xingzi (Hubei Agricultural Coll., Jingsha (China). Dept. of Agronomy) (1995) **The effect of two media on calli in anther culture of wheat.** *Journal of Hubei Agricultural College (China) v. 15(4) p. 269-272.* 2 tables; 9 ref. Chinese. (AGRIS 97-045067).

F03 SEED PRODUCTION

2533 Dapkus, R.; Ruzgas, V. (Lithuanian Inst. of Agriculture (Lithuania)) (1995) **Concept of cereals seed multiplication system in Lithuania.** 4. Regional Conference on Mechanization of Field Experiments (IAMFE/BALTIC '95). Kaunas (Lithuania). 8-10 Aug 1995. *Proceedings of the fourth regional conference on mechanization of field experiments (IAMFE/BALTIC '95) Kaunas/Dotnuva, Lithuania, August 8-10, 1995. Leuchovius, T.; Hallerstroem, B.; Lazauskas, S. (eds.) p. 60-61.* Sveriges Lantbruksuniv. 5 ref. English. (AGRIS 97-045153).

2534 Dell'Aquila, A.; Di Turi, M. (Germplasm Institute CNR, Bari (Italy)) (1996) **The germination response to heat and salt stress in evaluating vigour loss in aged wheat seeds.** Proceedings of the International Seed Testing Association. *Seed Science and Technology (Switzerland); v. 24(2) p. 309-319. International Seed Testing Association's Secretariat, Reckenholz (Switzerland).* International Seed Testing Association. 1 table, 6 graphs, 20 ref. English. (AGRIS 97-045151).

Wheat seeds were aged under different moisture content, temperature and storage time conditions without any apparent change in germination percentage and rate. To improve the seed vigour pattern prediction of a standard germination test, this was conducted by including stress factors prior to the radicle emergence phase: treatments with 40 deg C or 40-45 deg C temperature regimes as well as soaking in 0.4-0.6M NaCl solutions, during 16-24 h germination at 20 deg C induced a progressive variation of germination percentage and mean germination time in deteriorating seeds. Moreover, close relationships between germination parameters of treated aged seeds and leachate conductivity and embryo (3H) leucine incorporation, measured in corresponding untreated aged seeds, were established while the magnitude of correlation coefficients indicated that mean germination time was the most sensitive parameter in monitoring induced heat and salt tolerance in relation to the progress of deterioration. The combined effects of two processes opposing a normal germination behaviour may amplify ageing symptoms in wheat seeds. Hence, the relative germination test appears to be suitable for evaluating seed quality before a large decline in viability.

2535 Griffin, M. (1995) **Now every body wants it.** *Ceres. The FAO Review (FAO) v. 27(5, = no.155) p. 43-45.* Arabic. (AGRIS 97-031120).

2536 Jelic, M.; Milovanovic, M.; Lomovic, S. (Institut za istrazivanja u poljoprivredi "Srbija", Kragujevac (Yugoslavia). Centar za strna zita) (1995) **[Seed production of spring triticale in the dependance on different agrotechnical measurements]. Proizvodnja semena jarog tritikale zavisno od nekih agrotehnickih mera.** Simpozijum "Semenarstvo krmnog bilja u funkciji stocne hrane i unapredjenje stocarstva". Herceg Novi (Yugoslavia). 26-29 Apr 1995. *Selekcija i semenarstvo (Yugoslavia) v. 2(3-4) p. 341-344.* 2 graphs; 2 tables; 8 ref. Serbian. (AGRIS 97-045150).

The investigations was carried out on the agrotechnical field trial at the Centre for small grains in Kragujevac (Yugoslavia) during 1990-1993. The effect of rates of nitrogen fertilizers and seeding rate of spring triticale (cultivars Zlatar and Soko) were examined. Soil type was vertisol. The cultivar Zlatar had higher grain yield than the cultivar Soko. The highest grain yields for both cultivars were obtained at the seeding rate of 700 germinated grains/square m and 120 kg N/ha.

2537 Li Youchun (Zhanjiang Agricultural Coll., Guangdong (China)) (1995) **The genetic improvement on seed viability of A-line and hybrid in wheat with T. timopheevi cytoplasm.** *Hereditas (China) v. 17(6) p. 12-16.* 4 tables; 16 ref. Chinese. (AGRIS 97-045152).

2538 Ognjanovic, R.; Maksimovic, D.; Milovanovic, M.; Krstic, M. (Institut za istrazivanja u poljoprivredi "Srbija", Kragujevac (Yugoslavia). Centar za strna zita) (1995) **[Agricultural measures necessary for seed production of feed barleys]. Agrotehnicke mere neophodne u proizvodnji semena krmnog jecma.** Simpozijum "Semenarstvo krmnog bilja u funkciji stocne hrane i unapredjenje stocarstva". Herceg Novi (Yugoslavia). 26-29 Apr 1995. *Selekcija i semenarstvo (Yugoslavia) v. 2(3-4) p. 345-348.* 3 tables; 7 ref. Serbian. (AGRIS 97-045112).

Influences of different sowing densities and amounts of nitrogen on some characteristics at 6 cultivars of feed barley, during the period 1990/91-1991/92, on the soil of smonitza type (vertisol) after maize as previous crop (without fertilization), were investigated. Grain yield, mass of hectolitre and 1000-grains were investigated. For successful seed production of cultivars Partizan, Gruzanin and Rudnicanin, it is necessary to perform sowing as earlier as possible in October, with 450 germinating seeds per square meter and fertilization by nitrogen with 90 kg/ha.

2539 Phirke, P.S. (Post Harvest Technology Scheme (ICAR), Akola (India)); Patil, M.N.; Umbarkar, S.P.; Dudhe, Y.H. (1996) **The application of magnetic treatment to seeds: methods and responses.** Proceedings of the International Seed Testing Association. *Seed Science and Technology (Switzerland); v. 24(2) p. 365-373. International Seed Testing Association's Secretariat, Reckenholz (Switzerland).* International Seed Testing Association. 4 tables, 4 graphs, 1 photo, 15 ref. English. (AGRIS 97-045107).

Using response surface analysis, the optimum magnetic field strength (MFS) was determined for enhancing yield of magnetically treated seed in the field. The range for MFS was 0.072 to 0.128 tesla in combination with seed exposure time (SET) varying from 13 to 27 min. The study revealed that SET was found to be a more effective factor than MFS for soybean, cotton, and wheat seed sown in the field. An MFS of 0.10 tesla was the optimal level for all three crops and SET optimal levels of 25 minutes were obtained for soybean and cotton but only 13 minutes for wheat seed. The respective yields of the three crops were increased by about 46, 32, and 35 . It was concluded that at constant rotational speed of the disc and MFS level, SET varies from crop to crop.

2540 Stephenson, M.M.P. (McDonald Campus of McGill Univ., Quebec (Canada). Plant Science Dept.); Kushalappa, A.C.; Raghavan, G.S.V. (1996) **Effect of selected combinations of microwave treatment factors on inactivation of Ustilago nuda from barley seed.** Proceedings of the International Seed Testing Association. *Seed Science and Technology (Switzerland); v. 24(3) p. 557-570. International Seed Testing Association's Secretariat, Reckenholz (Switzerland).* International Seed Testing Association. 5 tables, 6 graphs, 24 ref. English. (AGRIS 97-045111).

The effects of combinations of absorbed microwave power (AMP) and pulsing (PUL) on barley seeds highly infected (68.9) with the loose smut pathogen Ustilago nuda (Jens.) Rostr. were investigated. On the basis of a previous study the moisture content of the seeds was fixed at 21 on a dry weight basis and the microwave treatment duration at 75 min. Barley seed germination and seedling vigour, the latter measured as the mean plumule length (MPL), were not significantly affected by most of the microwave treatments compared to a non-treated control, except at high levels of AMP and PUL. The percentage of seed germination was highly correlated with the MPL (r = 0.86). A multiple regression model explained 82 of the variation in the percentage seed germination and 74 of the MPL as functions of AMP and PUL. The effectiveness of microwave treatments to inactivate U. nuda was evaluated based on seedling infection (SI) at the second true leaf stage and plant infection or smutted plants at maturity (PI). There was a poor correlation between SI and PI (r = 0.46). Although most of the microwave treatments had a significantly lower SI than the untreated control, there was no significant effect of AMP or PUL within the range of levels studied. In contrast, the PI data showed that there was a significant interaction of AMP*PUL on PI. The SI and PI were reduced to 26.7 and 11.6 , respectively, for the best microwave treatments, as compared to 50.1 and 45.3 , for the untreated control. Therefore, up to 74.3 reduction of the effective inoculum was achieved by using 0.5 W/g AMP and 50/10 s of PUL. At 0.5 W/g AMP, when PUL was reduced to 40/20 s, the effective inoculum was reduced by more than 56 without significantly affecting seed germination and vigour.

F04 FERTILIZING

2541 Abu Dahi, Y.M. (Baghdad Univ. Coll. of Agric. (Iraq)) (1994) **[Effect of nitrogen levels and sources on nitrogen concentration and its uptake on growth and yield of wheat (Triticum aestivum L.) cultivar (Abu-Grhaib-3)]. T'at"i:r kami:yyat wa mas*a:dir al-sama:d al-nitru:j"i:ny fi: tarki:z al-nitru:j:i:n wa 'imts*a:s*ah wa fi: numuw wa h"a:s*l naba:t al-h"unt*at lil-s*inf abu:-g"rI;b-3.** *Mij"alat al-3ulu:m al-zira:3iyyat al-3ira:qiyyat (Iraq). The Iraqi Journal of Agricultural Sciences v. 25(no.1) p. 183-193.* Arabic. (AGRIS 97-031323).

A pot experiment using silty clay soil was conducted in the seasons 1991/1992 and 1992/1993 to evaluate the effects of various levels and sources of nitrogen (0, 180, 240 kgN/ha) on nitrogen concentration and its uptake, dry matter yield of roots, and shoots, grain yield and its quality of wheat, cultivar (Abu-Ghrib-3). Results indicated that the application of nitrogen had significantly increased the dry matter of root, shoot and grain yield/pot, weight of 1000 seeds, seed protein percentage, N concentration and its uptake in roots and shoots.

2542 Al Zubaidi, A.H.; Jalil, S.; Al Babrawi, R. (Baghdad Univ. Coll. of Agric. (Iraq)) (1994) **[Potassium regime and response for potash fertilizer application in reclaimed soil]. H"a:lat al-bu:ta:si:u:m wa al-'istij"a:bat lil'asmidat fi: turabat mustas*lah"at.** *Mij"alat al-3ulu:m al-zira:3iyyat al-3ira:qiyyat (Iraq). The Iraqi Journal of Agricultural Sciences v. 25(no.1) p. 58-70.* Arabic. (AGRIS 97-031271).

Samples of saline soil were leached in special lysimeters, then growth with barley (Hordeum vulgare L.) was followed by corn (Zea mays L.). Two sources of potash fertilizer (KCl and K2SO4) were applied in this experiment: 0 (control), 140 kg.k/ha (1 KCl or K2SO4) were applied in this experiment: zero (control), 140 Kg.K/ha (1KCL or 1 K2SO4) and 280 kg (2KCl or 2K2SO4). Plant samples were collected for analysis every three weeks intervals for barley and every two weeks intervals for corn. The results showed that application of potash fertilizer to the reclaimed (leached) soil caused a significant increase in dry matter and potassium uptake of both barley and corn grown successful in this soil.

2543 Ben, J.R.; Dechen, A.R. (1996) **[Behavior of wheat genotypes in relation to phosphorus in the soil]. Comportamento de genotipos de trigo em relacao a fosforo no solo.** *Revista Brasileira de Ciencia do Solo (Brazil) v. 20(1) p. 77-82.* 18 ref.; 5 tables. Portuguese. (AGRIS 97-031306).

2544 Berg, WA. (1997) **RESIDUAL NITROGEN EFFECTS ON WHEAT FOLLOWING LEGUMES IN THE SOUTHERN PLAINS.** *Journal of Plant Nutrition. 20(2-3):247-254.* English. [USDA ARS 2000 18TH ST WOODWARD, OK 73801 USA].

Increasing nitrogen (N) fertilizer prices give rise to the question of N benefits from legumes in cropping systems in the Southern Great Plains. This study quantified wheat (Triticum aestivium L.) hay production and N uptake over seven years following six years of alfalfa (Medicago sativa L.), cicer milkvetch (Astragalus cicer L.), or grass (Old World bluestem, Bothriochloa ischaemum L.) production in western Oklahoma. Precipitation over the seven years averaged 550 mm . yr(-1). The major residual N effects were measured within the first five years. On a fine sandy loam soil, wheat hay yields averaged 3, 070 kg . ha(-1). yr(-1) over five years following alfalfa, 2, 580 kg . ha(-1). yr(-1) following milkvetch, and 950 kg . ha(-1)yr(-1) following grass with N uptake attributed to the residual effect from legumes (calculated by the difference method) averaged 34 kg N ha(-1). yr(-1) from alfalfa and 25 kg . ha . yr(-1) from milkvetch. On a deep loamy sand soil, wheat hay yields averaged 1, 290 kg . ha(-1). yr(-1) over five years following alfalfa and 710 kg . ha(-1). yr(-1) following grass with N uptake attributed to the residual effect from alfalfa averaged 8 kg N ha(-1). yr(-1). Thus, the residual N effect attributed to legumes was substantial on the fine sandy loam soil and relatively small on the deep loamy sand soil. [References: 14].

2545 Boskovic, Lj. (Faculty of Agronomy, Cacak (Yugoslavia)) (1996) **Effects of urea and ureaformaldehyde on winter wheat yield on various types of soil.** *Journal of Scientific Agricultural Research (Yugoslavia) v. 57(204) p. 61-67.* 1 table; 11 ref. English. (AGRIS 97-045442).

The effects of urea and ureaformaldehyde on winter wheat yield were tested in vegetation containers on four types of soil: alluvium, pseudogley, smonitza and brown forest soil. The wheat variety KG-56 was used in the trials. Fertilization was entirely performed prior to planting: phosphorus and potassium fertilizers were added to all vegetation containers, while urea and/or ureaformaldehyde were added according to the appropriate scheme. The trials lasted for three years. The results obtained point to the positive impact of the urea and ureaformaldehyde on the yield increase. The yiels achieved on the three types of soil, alluvium, smonitza and pseudogley, had appromaximately the same values, while on the other hand, the yield on the brown forest soil was statistically significant lower.

2546 Boskovic, Lj.; Bokan, N. (Faculty of Agronomy, Cacak (Yugoslavia)) (1996) **Nitrogen contents in wheat depending on fertilization.** *Journal of Scientific Agricultural Research (Yugoslavia) v. 57(204) p. 69-74.* 3 tables; 6 ref. English. (AGRIS 97-045443).

The effect of two nitrogen rates, 60 and 90 kg N/ha, on the nitrogen content was studied through a field microtrial on alluvial smonitza over the stages of stem extension and flowering in two wheat varieties: Jugoslavija and Rana niska. The crop density was 600 kernels/m. Obtained results indicate that the nitrogen content in the above ground plant part increased proportionally with the nitrogen rate increase of 30 kg/ha. The differences in the nitrogen content were statistically highly significant, except in the variety Jugoslavija during stem extension (1991) and in the variety Rana niska during flowering (1992).

2547 Breland, TA. (1996) **GREEN MANURING WITH CLOVER AND RYEGRASS CATCH CROPS UNDERSOWN IN SMALL GRAINS - EFFECTS ON SOIL MINERAL NITROGEN IN FIELD AND LABORATORY EXPERIMENTS.** *Acta Agriculturae Scandinavica Section B-Soil & Plant Science. 46(3):178-185.* English. [AGR UNIV NORWAY DEPT BIOTECHNOL SCI POB 5040 N-1432 AS NORWAY].

In three field trials in southern Norway, Italian ryegrass (Lolium multiflorum Lam.), white clover (Trifolium repens L.) or subterranean clover (T. subterraneum L.) was undersown in spring grain at three N fertilizer rates and ploughed under in late October as a green manure for a succeeding spring grain crop. The content of topsoil (0-20 cm) mineral nitrogen was determined during the growth of the grain crop, after grain harvest and after ploughing. In addition, mineralization of nitrogen and carbon was measured in green-manured soil incubated at 15 degrees C and controlled moisture conditions. During grain crop growth, ryegrass tended to reduce soil mineral N compared with the other treatments. After grain harvest, in a small-plot experiment where extra nitrate was added, ryegrass reduced soil nitrate N (0-18 cm) from 4.2 to 0.4 g m(-2) within 13 days, while the clovers had negligible effect compared with bare soil. Up to 9.4 g N m(-2) was present in above-plus below-ground ryegrass biomass at ploughing. In incubated ryegrass soil, there was a temporary net N immobilization of up to 0.9 g N m(-2) as compared with unamended soil. In clover-amended soil, mineral N exceeded that in unamended soil by up to 5 g N m(-2). [References: 26].

2548 Briski, L.; Gregorcic, A.; Kmecl, V.; Znidarsic Pongrac, V. (Agricultural Inst. of Slovenia, Ljubljana (Slovenia)) (1995) **[Winter wheat fertilization on the basis of measurement of mineral nitrogen in soil]. Gnojenje ozimne psenice na podlagi meritev mineralnega dusika v tleh.** *Sodobno kmetijstvo (Slovenia) v. 28(10) p. 457-461.* 6 tables; 1 ill., 6 ref. Slovenian. (AGRIS 97-031305).

The research was conducted to study the possibility of optimization of nutrition of winter wheat with N in order to be able to contribute to the increased economical efficiency of fertilization as well as reduction of further pollution with nitrates of drinking water underground sources. Results show that to reach the optimum yield of wheat an adequate dose at the first supplementary fertilization applied at the end of winter is of a crucial importance. With the analysis of content of nitrate nitrogen in soil after the wheat harvest of the experimental fields of Jablje and Rakican it was established that fertilization with excessive nitrogen doses influenced the content of nitrate in soil above the recommended value.The results of the research in the first year have already shown that the analysis of soil using Nmin method is a sound basis for the guided fertilization of winter wheat with nitrogen.

2549 Chen Lijun (Academia Sinica, Shenyang (China). Inst. of Applied Ecology) (1995) **Effect of fertilization on root development, root metabolism of spring wheat.** *Plant Nutrition and Fertilizer Sciences (China) v. 1(2) p. 26-32.* 5 tables; 3 ill., 15 ref. Chinese. (AGRIS 97-045417).

2550 Deffune, G.; Scofield, A.M. (Sustainable Agriculture Research Group, Wye College, University of London (United Kingdom)) (1995) **The effects of humic acids and three bio-dynamic preparations on the growth of wheat seedlings.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 364-371.* Wye College Press. 12 ref. English. (AGRIS 97-045406).

2551 Fathi, G.; Mcdonald, GK.; Lance, RCM. (1997) **RESPONSIVENESS OF BARLEY CULTIVARS TO NITROGEN FERTILISER.** *Australian Journal of Experimental Agriculture. 37(2):199-211.* English. [UNIV ADELAIDE WAITE AGR RES INST DEPT PLANT SCI PO GLEN OSMOND GLEN OSMOND SA 5064 AUSTRALIA].

Genotypic differences in responses to nitrogen (N) fertiliser of 6 cultivars of barley (Clipper, Stirling, Weeah, Schooner, Chebec, Skiff) grown at 8 different rates of N were examined in 2 seasons. Measurements of vegetative growth, N content, grain yield, grain protein concentration (GPC) and yield components were taken to identify traits that may contribute to high yield responsiveness. The optimum rates of N for dry matter production at (DM(ee)) were greater than 80 kg N/ha for all cultivars and often growth increased up to 105 kg N/ha. Optimum rates of N for grain yield (N-opt) were lower and ranged, on average, from 50 kg N/ha for Clipper to 96 kg N/ha for Chebec. The initial response to N varied from 13-14 kg/kg N in Chebec, Weeah and Schooner, to 36 kg/kg N in Skiff. The N-opt for the semi-dwarf cultivar Skiff was 71 kg N/ha and it tended to show the greatest yield response to N. It produced 19 kernels/g DM(ee) compared with 15-17 kernels/g DM(ee) in the other cultivars. Unlike most other cultivars, Skiff's yield was consistently and positively correlated with ears/m(2); Stirling was the only other cultivar to show a similar relationship. However, the average kernel weight of Skiff was up to 5 mg lower than that of Clipper, Weeah and Schooner, and varied more than these cultivars between sites, suggesting that consistent grain size may be a problem in this cultivar. By comparison, Clipper and Schooner had lower N-opt(51 kg/ha) and a less variable kernel weight. There were no signs of differences in GPC of the 6 cultivars used here at 3 N-responsive sites. Adding N increased GPC up to the highest rate of N and the responses were generally linear, but GPC at N exceeded the upper limit for malting quality of 11.8% all cultivars. Average N rates of between 38 kg N/ha (Schooner) and 58 kg N/ha (Skiff) were sufficient to raise GPC above 11.8%. The experiments showed that the N rates for optimum yields varied considerably among cultivars, but applying rates to achieve maximum yields may cause GPC to exceed the maximum value for malting barley. The use of semi-dwarf cultivars, such as Skiff, which are very responsive to N, can provide some leeway in the choice of N, but there may be a trade-off in quality associated with reduced grain size. [References: 21].

2552 Gulewicz, K.; Aniszewski, T.; Cwojdzinski, W. (1997) **EFFECTS OF SOME SELECTED LUPIN BIOPREPARATIONS ON THE YIELDS OF WINTER WHEAT (TRITICUM AESTIVUM L SSP VULGARE VILL) AND POTATO (SOLANUM TUBEROSUM L).** *Industrial Crops & Products. 6(1):9-16.* English. [POLISH ACAD SCI INST BIOORGAN CHEM NOSKOWSKIEGO 12-14 PL-61704 POZNAN POLAND].

Evaluation of the effect of some selected lupin biopreparations on the yield of winter wheat and potatoes was carried out. Extracts from seeds of Lupinus angustifolius cv. Mirela (bitter) and Emir (sweet) as well as the A(4) fraction obtained from the Mirela extract during its fractionation with organic solvents were investigated. Field experiments carried out for 2 years showed that the applied biopreparations have a statistically confirmed effect on the yield of winter wheat. In the case of potato, this influence was not statistically confirmed. (C) 1997 Elsevier Science B.V. [References: 13].

2553 Isfan, D. (Soils and Crops Research and Development Centre, Quebec (Canada)); Lamarre, M. (Soils and Crops Research and Development Centre, Sainte Foy, Quebec (Canada)); D'Avignon, A. (1995) **Nitrogen-15 fertilizer recovery in spring wheat and soil as related to the rate and time of application.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 175-187. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA–STI/PUB/947. English. (AGRIS 97-045454).

2554 Jaber, A.S. (Baghdad Univ. Coll. of Agric. Soil Dept. (Iraq)) (1994) **[Effect of potassium and magnesium application on barley yield (Hordeum vulgare L.) in calcareous soils]. Ta't"i:r 'id°a:fat al-bu:ta:si:u:m wa al-mag"ni:si:u:m 3ala h"a:s°l al-s"a:3i:r s°nif (Hordeum vulgare L.) fi: al-turab al-kilsiyyat.** *Mij"alat al-3ulu:m al-zira3iyyat al-3ira:qiyyat (Iraq). The Iraqi Journal of Agricultural Sciences v. 25(no.1) p. 25-29.* Arabic. (AGRIS 97-031215).

A field experiment was conducted to show the effect of potassium and magnesium application on barley yield of seeds and dry matter in calcareous soil using five levels of K2SO4 (0, 50, 100, 150, and 200 kg/ha). The results showed significant increase in barley yield (Hordeum vulgare L.) of seeds and dry matter (leaves and stems) attaining 2897, 2431 kg/ha of seeds and 8105, 6810 kg/ha of dry matter at 100 and 60 kg/ha of potassium and magnesium respectively.

2555 Kanampiu, FK.; Raun, WR.; Johnson, GV. (1997) **EFFECT OF NITROGEN RATE ON PLANT NITROGEN LOSS IN WINTER WHEAT VARIETIES.** *Journal of Plant Nutrition. 20(2-3):389-404.* English. [OKLAHOMA STATE UNIV DEPT AGRON 044 N AGR HALL STILLWATER, OK 74078 USA].

Gaseous nitrogen (N) loss from winter wheat (Triticum aestivum L.) plants has been identified, but has not been simultaneously evaluated for several genotypes grown under different N fertility. Two field experiments were initiated in 1993 and 1994 at the Agronomy Research Station in Stillwater and Perkins to estimate plant N loss from several cultivars as a function of N applied and to characterize nitrogen use efficiency (NUE). A total of five cultivars were evaluated at preplant N rates ranging from 30 to 180 kg . ha(-1). Nitrogen loss was estimated as the difference between total forage N accumulated at anthesis and the total (grain + straw)N at harvest. Forage, grain, straw yield, N uptake, and N loss increased with increasing N applied at both Stillwater and Perkins. Significant differences were observed among varieties for yield, N uptake, N loss, and components of NUE in forage, grain, straw, and grain + straw. Estimates of N loss over this two-year period ranged from 4.0 to 27.9 kg . ha(-1) (7.7 to 59.4% of total forage N at anthesis). Most N losses occurred between anthesis and 14 days post-anthesis. Avoiding excess N application would reduce N loss and increase NUE in winter wheat varieties. Varieties with high harvest index (grain yield/total biomass) and low forage yield had low plant N loss. Estimates of plant loss suggest N balance studies should consider this variable before assuming that unaccounted N was lost to leaching and denitrification. [References: 12].

2556 Knudsen, L.; Birkmose, T.; Oestergaard, H.S. (1997) **[Survey 1996, F: Fertilizing and liming]. Oversigt 1996, F: Goedskning og kalkning.** Landsudvalget for Planteavl, Aarhus (Denmark). *Oversigt over Landsforsoegene (Denmark) (no.1996) p. 150-194.* 10 ill., 50 tables. Danish. (AGRIS 97-045308).

2557 Koszanski, Z.; Karczmarczyk, S.; Podsiadlo, C. (Akademia Rolnicza, Szczecin (Poland). Zaklad Podstaw Produkcji Roslinnej i Nawadniania Roslin) (1995) **[Effect of sprinkling irrigation and nitrogen fertilization on winter wheat and winter triticale cultivated on a good rye soil complex. Pt. 1. Yields]. Wplyw deszczowania i nawozenia azotem na pszenice i pszenzyto ozime uprawiane na glebie kompleksu zytniego dobrego. Cz. 1. Plonowanie roslin.** *Zeszyty Naukowe. Akademia Rolnicza w Szczecinie. Rolnictwo (Poland) (no.165) p. 35-41.* 7 tables; 6 ref. Polish. (AGRIS 97-031307).

The best doses of nitrogen for the two grains, as well as the productivity of water and nitrogen unit were determined. Triticale gave a higher yield than wheat; sprinkling irrigation had increased the yield of winter wheat by 40 and triticale by 15 percent, whereas the nitrogen fertilization by 104 and 131 percent respectively. The interaction of the both treatments had increased the yield of winter wheat by 198 and triticale by 157 percent. On irrigated fields a dose of 100-125 kg N/ha is sufficient. The productivity of 1 kg N applied on watered winter wheat plots was by 37.5 percent higher than on control ones; in case of triticale it was higher by 33 percent.

2558 Kpakpo, ADF.; Horiuchi, T.; Miyagawa, S. (1997) **INFLUENCE OF SPLIT AMMONIUM SULFATE ON NITROGEN AVAILABILITY FROM N-15-LABELED MATURED SOYBEAN AS GREEN MANURE FOR BUCKWHEAT (FAGOPYRUM ESCULENTUM MOENCH).** *Japanese Journal of Crop Science. 66(1):76-84.* English. [GIFU UNIV UNITED GRAD SCH AGR SCI YANAGIDO 1-1 GIFU 50111 JAPAN].

A poc experiment was conducted at the Experimental Farm of Gifu University to study the effects of N-15-labeled matured soybean as green manure, with and without splitted ammonium sulfate, on the growth and nitrogen (N) nutrition of buckwheat. Crop yield ranged between 0.7 to 2.8g/pot. Applying green manure together with ammonium sulfate split in a ratio of 2.

2559 Leblanc, PV.; Gupta, UC.; Christie, BR. (1997) **ZINC NUTRITION OF SILAGE CORN GROWN ON ACID PODZOLS.** *Journal of Plant Nutrition. 20(2-3):345-353.* English. [AGR & AGRI FOOD CANADA RES BRANCH RES FARM POB 667 BOUCTOUCHE NB E0A 1G0 CANADA].

Field studies were conducted at Bouctouche Research Farm in New Brunswick, Canada to determine the effect of zinc (Zn) and nitrogen (N) on silage corn. Soils at these sites are coarse texture loamy sand with pH values of 6.0-6.3 and organic matter content of 2.6 to 2.7 mg . g(-1). In Experiment 1, Zn application at 0.5 to 1.0 kg . ha(-1) foliar or 10 to 20 kg . ha(-1) soil applied significantly increased the silage corn dry matter yield. Leaf Zn levels of 8.8 to 10.1 mg . kg(-1) and available soil Zn at 0.8 mg . kg(-1) in the check treatments were related to Zn deficiency in corn. No response to Zn was noted in Experiment 2 and this was associated with leaf Zn levels of 15 to 16 mg . kg(-1) in the control treatment. In the Zn x N field study, a significant dry matter yield response to N and Zn was obtained. Nitrogen applications with or without added Zn increased leaf Zn. Leaf Zn increases were highest at the highest rate of added N. Corn leaf Zn levels at 9 mg . kg(-1) were associated with lower yield. Zinc deficiency in corn can be controlled by 1 kg Zn ha(-1) foliar or 10 to 20 kg Zn ha(-1) soil applied. [References: 20].

2560 Li Dingxin; Dang Zengchun; Xu Xuexuan (Academia Sinica, Yangling, Shaanxi (China). Inst. of Soil and Water Conservation) (1995) **Study on optimum model of fertilizing for spring wheat in loess hilly areas of south Ningxia [China].** *Bulletin of Soil and Water Conservation (China) v. 15(5) p. 29-34, 63.* 9 tables; 3 ref. Chinese. (AGRIS 97-045418).

2561 Li Guibao (Henan Academy of Agricultural Sciences, Zhengzhou (China). Inst. of Soils and Fertilizers) (1996) **Effect of application of potash fertilizer on wheat growth and potassium content in selected soils.** *Soils and Fertilizers (China) (no. 1) p. 34-36.* 4 tables; 2 ref. Chinese. (AGRIS 97-045447).

2562 Li Guibao (Henan Academy of Agricultural Sciences, Zhengzhou (China). Inst. of Soils and Fertilizers) (1995) **Study on the technique of nitrogen applied to winter wheat by 15N-trace in fluro-aquic soil of Henan, China.** *Soils and Fertilizers (China) (no. 1) p. 32-34.* 4 tables; 3 ref. Chinese. (AGRIS 97-045440).

2563 Lotfollahi, M.; Alston, AM.; Mcdonald, GK. (1997) **EFFECT OF NITROGEN FERTILISER PLACEMENT ON GRAIN PROTEIN CONCENTRATION OF WHEAT UNDER DIFFERENT WATER REGIMES.** *Australian Journal of Agricultural Research. 48(2):241-250.* English. [UNIV ADELAIDE WAITE AGR RES INST DEPT SOIL SCI GLEN OSMOND SA 5064 AUSTRALIA].

Two experiments were conducted in pots 105 cm deep and 11 cm in diameter to determine the effects of subsoil nitrogen (N) on grain yield and grain protein concentration (GPC) of wheat (Triticum aestivum L. cv. Molineux). In both experiments, KNO3 was applied in solution at different times and depths in the profile. In the first experiment, in which a sandy soil low in available N was used, application of 150 mg N at 60 cm, 2 weeks after anthesis, significantly increased grain yield and GPC. The N was taken up gradually by the plant after N was applied. Adding N to the subsoil increased root growth and this resulted in increased water use and water use efficiency. Although there was an increase in the rate of N uptake by the roots, the main factor that influenced the utilisation of subsoil N was the root length density. In the second experiment, the effects of depth and time of N application, and of a reduction in post-anthesis water supply, were determined. A more fertile soil was used than the one in the first experiment. There were 5 KNO3 treatments: nil N; 150 mg N applied to the topsoil at sowing; 75 mg N to the topsoil and 75 mg N to the subsoil (60 cm depth) at sowing; 150 mg N to the subsoil at sowing; 75 mg N to the topsoil at sowing and 75 mg N to the subsoil 1 week after anthesis. The effect of post-anthesis water stress was assessed by allowing the topsoil to dry and then supplying half the amount of water used by the well-watered control treatment at 60 cm in half of the pots. Adding N increased yield and GPC but there was no significant difference in yield and GPC between the different N treatments. When N was applied to the topsoil only, most of it was used by the wheat plants or leached to the subsoil by anthesis; post-anthesis uptake of N depended on the amount of N in the subsoil. Adding N, irrespective of the depth of placement or time of application, increased water use and water use efficiency. In both experiments, increasing the availability of N in the soil after anthesis reduced the amount of N that was remobilised from the roots and stem to the grain. The recovery of applied N in both experiments was high (about 80%). These experiments have shown that N available in the subsoil after anthesis can be used very efficiently and can contribute to both grain yield and GPC. A critical factor in the efficient use of this N appears to be root length density in the subsoil. [References: 25].

2564 Malesevic, M. (Institut za ratarstvo i povrtarstvo, Novi Sad (Yugoslavia)); Starcevic, Lj.; Bogdanovic, D.; Przulj, N. (1996) **[The effect of nitrogen on yields and grain protein content in winter forage barley (Hordeum vulgare spp. vulgare)]. Uticaj azota na prinos i sadrzaj proteina u zrnu ozimog stocnog jecma (Hordeum vulgare spp. vulgare).** 8. jugoslovenski simpozijum o krmnom bilju sa medjunarodnim ucescem. Novi Sad (Yugoslavia). 28-31 May 1996. *Zbornik radova - Institut za ratarstvo i povrtarstvo (Yugoslavia) (no. 26) p. 415-422.* 2 tables; 20 ref. Serbian. (AGRIS 97-031217).

The subject of the 17-years long study was the effect of nitrogen (N) on the grain yield and protein content. The experiments were conducted on a chernozem soil of high potential fertility. The results of the study led to the following conclusions. The yields of winter forage barley depended less on the N rate applied than on conditions in a particular year. Since the content of nitrate N at the depth of 0-90 cm varied considerably on a yearly basis, it approximated 100 kg/ha, the optimum amount of fertilizer N should be determined with exactness. N affected the grain protein content, which increased as the rate of N applied was augmented, up to the rate of 120 kg/ha. The grain yields increased up to the rate of 30 kg/ha, whereas the protein yields increased up to the rate twice as high (60 kg/ha).

2565 Manoharan, V. (Massey University, Palmerston North, New Zealand.); Loganathan, P.; Tillman, R.W.; Parfitt, R.L. (1996) **Assessing aluminum phytotoxicity in long-term phosphate fertilized pasture soils.** *Communications in soil science and plant analysis (USA) v. 27(5/8) p. 1731-1748.* references. Paper presented at the 1995 International Symposium on Soil Testing and Plant Analysis: Quality of Soil and Plant Analysis in View of Sustainable Agriculture and the Environment held August 5-10, 1995, Wageningen, The Netherlands. English. (AGRIS 97-031206).

A short-term bioassay was carried out to study the effect of continuous inputs of calcium (Ca), fluoride (F), and sulphate (SO4) from phosphate (P) fertilizers and changes in pH on aluminum (Al) phytotoxicity. Soil samples (40-100 mm) were collected from two adjacent pasture sites, one of which had no phosphate fertilizer applied for over 20 years (low phosphorus, LP) and the other which had high phosphorus input (375 kg ha-1 yr-1 single superphosphate) for 20 years (high phosphorus, HP). Soil samples were incubated at 80 field capacity for 6 weeks with either Ca(OH)2 or HCl to obtain varying pH levels. Short-term root growth bioassay was conducted using barley (Hordeum vulgare L.) seedlings. Decreasing soil pH markedly increased the soil solution Ca, total monomeric Al (Al(t)) and total soluble F in the HP soil compared with the LP soil. Aluminum3+ and Al(OH)2+ were the dominant monomeric inorganic Al species below pH 4.0, but Al-F complexes dominated at pH 4.0 to 5.5 in the HP soil. The inability of total monomeric Al, and 0.02M CaCl2- extractable Al (CaCl2 - Al) to explain the variation in root growth indicated that the relative proportions of the toxic Al were different for fertilized and unfertilized soils. These differences may be due to higher proportions of the less-toxic AlF complexes in the HP soil. Barley root growth was at 90 of maximum relative root length (RRL) at pH (H2O) of 4.8 and 5.5 and CaCl2-Al of 7 and 5 microgram g-1 in the HP and the LP soils respectively. RRL of 90 was observed at the Al(t) concentration of 35 micromolar and 6.5 micromolar and toxic Al (Al3 + Al(OH)2+ + Al(OH)2(+)) activity of 2.4 micromolar and 0.9 micromolar in the HP and the LP soil respectively. The Al3+/Ca2+ activity ratio associated with 90 RRL was 4.2 X 10(-4) and 4.5 X 10(-4) for the HP and the LP soils respectively. The study indicates that Al3+/Ca2+ activity ratio would be the most consistent predictor of Al toxicity in soils with phosphate fertilizer history.

2566 Mohsin Iqbal, M.; Mahmood Shah, S. (Nuclear Inst. for Food and Agriculture, Peshawar (Pakistan)); Khurshid Hussain, S.; Siddiqui, S.H. (1995) **Crop nitrogen recovery and soil nitrogen residues from 15N**

labelled urea applied to wheat. Nuclear methods in soil-plant aspects of sustainable agriculture. Proceedings of an FAO/IAEA Regional Seminar for Asia and the Pacific, Colombo, Sri Lanka, 5-9 April 1993. *Technical Document (IAEA); no. 785 p. 43-49. Joint FAO/IAEA Div. of Nuclear Techniques in Food and Agriculture, Vienna (Austria).* IAEA. IAEA-TECDOC-785. English. (AGRIS 97-045455).

2567 Nenajdenko, G.N.; Sibiryakova, T.V. (1995) **[Crop yield and quality of barley grain depending on the action of phosphate forms under conditions of grey forest soils in Vladimir oblast, Russian Federation]. Urozhajnost' i kachestvo zerna yachmenya v zavisimosti ot dejstviya form fosfatov v usloviyakh serykh lesnykh pochv Vladimirskoj oblasti.** *Agrokhimiya (Russian Federation) (no.10) p. 52-54.* Russian. (AGRIS 97-031216).

2568 Rasmussen, K.; Rasmussen, J.; Petersen, J. (1996) **EFFECTS OF FERTILIZER PLACEMENT ON WEEDS IN WEED HARROWED SPRING BARLEY.** *Acta Agriculturae Scandinavica Section B-Soil & Plant Science. 46(3):192-196.* English. [DANISH INST PLANT & SOIL SCI DEPT WEED CONTROL & PESTICIDE ECOL DK-4200 SLAGELSE DENMARK].

A series of six field experiments on spring barley were conducted to test the effect of fertilizer placement compared with broadcast application on weeds and crop yield. The experiments were carried out in 1993, 1994 and 1995, on two soil types, with three levels of fertilizing and without use of pesticides. Fertilizer placement reduced weed biomass by 55% and weed density by 10% and increased grain yield by 28%, on average. The strong effects on weeds were presumably due to a positive interaction between crop competition and weed control by weed harrowing. The biomass of almost all frequent weed species was reduced by fertilizer placement. The effect of fertilizer placement on weed density was weaker than on biomass. Fertilizer placement increased grain yield more on coarse sand than on sandy loam. All the effects were more pronounced in 1993 than in 1994 and 1995, most likely owing to dry weather in the spring of 1993. [References: 18].

2569 Readman, R.J.; Kettlewell, P.S.; Beckwith, C.P. (Crop and Environment Research Centre, Harper Adams Agricultural College, Newport (United Kingdom)) (1995) **The foliar application of urea to winter wheat and nitrate leaching.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 569-573.* Wye College Press. 9 ref. English. (AGRIS 97-045472).

2570 Sarkar, A. (1997) **ENERGY-USE PATTERNS IN SUB-TROPICAL RICE-WHEAT CROPPING UNDER SHORT TERM APPLICATION OF CROP RESIDUE AND FERTILIZER.** *Agriculture Ecosystems & Environment. 61(1):59-67.* English. [PROJECT DIRECTORATE CROPPING SYST SYST MANAGEMENT SECT MEERUT 250110 UTTAR PRADESH INDIA].

Rice-wheat cropping in the sub-tropics is energy intensive, requiring a major input from fossil fuel. These crops produce lots of residue, part of which is often wasted in burning, the incorporation of which is beneficial when applied with fertilizer. Reserves of fossil fuel is decreasing at an increasing rate. Therefore, it is more important to know the effect of application of residue production from these crops in the light of recycling of energy and its output. Keeping this in view in a field experiment between 1990 and 1992, three levels of residue incorporation: (i) nil, (ii) half, (iii) full of residue production from one crop to the other were combined with two levels of mineral fertilizer: (i) no fertilizer, (ii) standard level of 120, 60, 60 kg N, P2O5 and K2O per hectare as treatments. The trade-off studies showed that applications of half the crop residue with fertilizer consistently produced the highest grain yield of rice and wheat. Addition of residue without fertilizer had little benefit while application of fertilizer without residue had moderate effects. The combined application of half the residue with fertilizer proved to be the best combination providing the maximum production of crop per unit use of fossil fuel. The highest labour productivity (crop production/hour of labour) was also found under the same treatment. But further addition of residue with fertilizer declined the crop production per unit area, per unit of fossil fuel or per hour of labour. So keeping in view the fast depleting commercial energy sources, incorporating half the residue production of the crop with recommended fertilizer in a rice-wheat cropping may be a wise practice in solving the energy problem for higher production in this part of the subtropics. [References: 16].

2571 Saviozzi, A.; Leviminzi, R.; Riffaldi, R.; Vanni, G. (1997) **LABORATORY STUDIES ON THE APPLICATION OF WHEAT STRAW AND PIG SLURRY TO SOIL AND THE RESULTING ENVIRONMENTAL IMPLICATIONS.** *Agriculture Ecosystems & Environment. 61(1):35-43.* English. [UNIV PISA INST AGR CHEM VIA S MICHELE SCALZI 2 I-56124 PISA ITALY].

In a laboratory experiment, wheat straw (WS), pig slurry (PS) and a mixture of the two materials (WSPS) were added to soil at the rate of 2% on a dry soil basis. Samples of the soil alone and with the amendments were collected at various intervals of time during a one year period and analysed for: pH, electrical conductivity (EC.), NO3-, HPO42-, phenolic compounds and volatile acids. A germination index (G.I) using the Lepidium sativum test was carried out. The fractionation of the different forms of Cu and Zn was investigated. In comparison with the control, the WS-treated soil showed a constant diminution of NO3-, a slight lowering of pH and a net increase of EC. Sixty days after amendment, phenolic compound and volatile acid contents became equal to those of the control, The WS did not show any germination effect and did not significantly influence the content and distribution of soil Cu and Zn. The addition of PS to soil produced an increase of EC., NO3- and HPO42-, 2-, with a consequent lowering of the pH, a moderate effect on phenolic substances and volatile acids and a toxic effect on seed germination until the 7(th) day after the amendment. Total levels of Cu and Zn and their organic and inorganic bound fractions increased. The most consistent effect on soil properties from the WSPS mixture was for NO3-, which was released slowly but progressively. This mixture increased the germination index in comparison with PS added alone to the soil. [References: 34].

2572 Schneider, AD.; Howell, TA. (1997) **METHODS, AMOUNTS, AND TIMING OF SPRINKLER IRRIGATION FOR WINTER WHEAT.** *Transactions of the ASAE. 40(1):137-142.* English. [USDA ARS PO DRAWER 10 BUSHLAND, TX 79012 USA].

The yield response of winter wheat to LEPA double-ended-sock, LEPA bubble and overhead spray sprinkler methods was measured in the Southern High Plains with four irrigation amount and two irrigation timing treatments. Irrigation amount treatments ranged from zero to 100% of soil water replenishment in 33% increments. Irrigation timing treatments were shortening the 100% irrigation season by delaying irrigation until booting or by terminating irrigation during early grain Filing. TAM 202 variety wheat was raised on Pullman clay loam soil, and irrigations were applied with a lateral move irrigation system during the 1993-1994 and 1994-95 cropping seasons. Grain yields did not vary significantly among the spray and LEPA sprinkler methods although in 1995 yields with the spray method were generally larger In 1994, grain yields increased a statistically significant 1 Mg/ha for each 33% increase in irrigation, bur significant yield increases occurred only for the first two irrigation increments in 1995. Deficit irrigation with the 33% and 66% irrigation amounts, generally increased the grain yield per unit of irrigation water more than deficit irrigation with the Two irrigation timing treatments. [References: 18].

2573 Shatilov, I.S.; Artemov, V.M.; Artemov, E.M.; Fridman, Sh.D.; Zamaraev, A.G.; Chapovskaya, G.V. (1995) **[Quantitative estimation of air ammonia absorption by winter wheat]. K voprosu o pogloshchenii atmosfernogo ammiaka rasteniyami ozimoj pshenitsy i ratsional'nom ispol'zovanii azotnykh udobrenij.** *Sel'skokhozyajstvennaya biologiya. Seriya Biologiya rastenij (Russian Federation) (no.5) p. 74-84.* 20 ref. Russian. (AGRIS 97-031308).

The original technology has been described which allowed to estimate the quantity of the air ammonia absorbed by winter wheat plants in the field during the growth period. The method is based on the use of the ammonia absorption rate in an isolated chamber and the real mean of the coefficient of the turbulent diffusion. It has been found that the nitrogen accumulated in the winter wheat due to the absorption of the air ammonia made about 0.05 fresh plant weight during the grain filling period and increased to 0.08 as the leaves died. The recommendation on the application of nitrogen fertilizers at various stages of the winter wheat development has been given.

2574 Shen A'lin (Henan Academy of Agricultural Sciences, Zhengzhou (China). Inst. of Soils and Fertilizers) (1995) Influence of optimal

fertilization on yield increase and water use efficency of wheat in arid land of Western Henan, China. *Soils and Fertilizers (China) (no. 1) p. 9-12.* 4 tables; 6 ref. Chinese. (AGRIS 97-045451).

2575 shideed, K.H.; Adary, A.H. (Ipa Agric. Res. Center (Iraq)) (1994) **[Economic evaluation of fertilizer use in barley production within the framework of risk analysis]. Taqi:ym 'aqtis*a:dy li'ast3ma:l al-'asmidat fi: 'anta:j" al-s"3i:r d*min 'at*a:r tah"lil al-mh*a:t*arat.** *Mij"alat 'iba:' lil'abh"a:t" al-zira:3iyyat (Iraq). Ipa Journal of Agricultural Research v. 4(no.1) p. 86-97.* Arabic. (AGRIS 97-031214).

The selection among alternative variety/fertilizer treatments and technological packages could be related to their profitability and the degree of risk associated with them. Stochastic dominance analysis was applied using data on barley fertilization under rainfed conditions in Mosul province. The results show that fertilized treatments dominate those without fertilizer for both Jazera and local varieties. However, no clear preference between full-and farmer-package technologies is established. This implies that producers who are risk averse would choose either variety (with fertilizer) regardless of the technological package involved.

2576 Sieling, K.; Guntherborstel, O.; Hanus, H. (1997) **EFFECT OF SLURRY APPLICATION AND MINERAL NITROGEN FERTILIZATION ON N LEACHING IN DIFFERENT CROP COMBINATIONS.** *Journal of Agricultural Science. 128(Part 1):79-86.* English. [CHRISTIAN ALBRECHTS UNIV KIEL INST CROP SCI & PLANT BREEDING HERMANN RODEWALD STR 6 D-24118 KIEL GERMANY].

Nitrogen (N) fertilizer not used by the crop can increase the risk of nitrate leaching into the groundwater. In two growing seasons, 1990/91 and 1991/92, the relationships between N fertilization and yield, N uptake by the grain and the N leaching in the subsequent percolation period were investigated in a multifactorial field experiment at Hohenschulen Experimental Station near Kiel in NW Germany. The crop rotation was oilseed rape - winter wheat - winter barley, and effects of soil tillage (minimum tillage without ploughing, conventional tillage), application of pig slurry (none, application in autumn, application in autumn and in spring), mineral N fertilization (none, 80 or 200 kg N ha(-1) to oilseed rape and 120 or 240 kg N ha(-1) to cereals) and application of fungicides (none, intensive) were all tested. In each year, the rotation and the treatments were located on the same plots. Mineral N fertilization and fungicide application increased yield and N uptake by grain or seed in all crops. In contrast, the application of slurry, especially in autumn, had only small effects on yield and N uptake. Nitrogen losses by leaching (measured using porous ceramic cups) were affected mainly by the year and the crop. In 1992/93, averaged over all factors, 80 kg N ha(-1) was leached compared with 28 kg N ha(-1) the previous year. Oilseed rape reduced N losses, whereas under winter wheat up to 160 kg N ha(-1) was leached. Due to a lower N-use efficiency, autumn applications of slurry increased N leaching, and mineral N fertilization of the preceding crop also led to higher N losses. Since the amount of leached N depends both on the nitrogen left by the preceding crop (unused fertilizer N as well as N in residues) and on N uptake by the subsequent crop, it is not possible to apportion the N losses to any particular crop in the rotation. The cropping sequence, together with its previous and subsequent crops, must also be considered. To minimize leaching, N fertilization must meet the needs of the growing crop. In order to improve the efficiency further, investigations must be conducted in order to understand the dynamics of N in the plant-soil system in conjunction with the weather and crop management practices. [References: 19].

2577 Snow, C.S.R.; Marrs, R.H. (Ness Botanic Gardens, University of Liverpool, Ness, Neston, South Wirral L64 4AY (United Kingdom)) (1996) **The effect of harvesting four crops under varying fertiliser regimes on nutrient offtake and selected soil properties.** *Aspects of Applied Biology (United Kingdom) (no.44) p. 413-418.* 9 ref. Vegetation management in forestry, amenity and conservation areas: managing for multiple objectives. 19-20 March 1996, Univ. of York (United Kingdom). English. (AGRIS 97-031281).

2578 Sticksel, E.; Maidl, FX.; Ludwig, A.; Fischbeck, G. (1996) **YIELD OF MAIZE AND WINTER WHEAT AS AFFECTED BY AVAILABLE WATER CAPACITY AND N-FERTILIZATION IN DRY YEARS.** *Bodenkultur. 47(3):163-172.* German. [TECH UNIV MUNCHEN WEIHENSTEPHAN LEHRSTUHL PFLANZENBAU & PFLANZENZUCHTUNG D-85350 FREISING GERMANY].

In two dry years yield formation of maize and winter wheat was determined as affected by N-fertilization on soils of an available water capacity (awe) ranging between 30 mm and 240 mm in order to develop site specific N-fertilization strategies. On soils with low awe maize reached highest yields (220 dt/ha up to 123 dt/ha) if the first N-application was applied at a plant height of 15 cm. A lower plant density stimulated yields on soils with low awe also. A starter fertilization > 60 kg N/ha, however, gave highest yield increases (> 0.44 dt/ha*mm nFK) with increasing awc. Wheat reached highest yield (69 dt/ha) on soils with low awe and the highest yield increase with increasing awe (18.6 dt/ha*ln mm nFK) if moderate N-fertilization in early spring (30 kg N/ha) together with 60 kg N/ha in EC 30 were applied. A total amount of 160 kg N/ha was necessary over the whole range of the examined awe to achieve highest yields. Starter fertilization > 30 kg N/ha lowered yields. [References: 30].

2579 Taye Bekele (IAR, Addis Abebe (Ethiopia)); Yeshanew Ashagrie; Balesh Tulema; Girma Gebrekidan (1996) **Soil fertility management in barley. 1.** Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past Work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 92-99.* IAR/ICARDA. 4 tables; 13 ref. English. (AGRIS 97-045309).

This paper presents an overview of several fertilizer trials that have been conducted in different parts of the country with the aim of improving the soil nutrient balance and availability and finding out the optimum level of N and P fertilizer for barley. Results at Holetta showed that the responses of food and malt barley to N and P and N/P interaction was significant on the Nitosols and vertisols, which are the two major soil types in the area. The best levels of N and P on both soil type were 60 and 26 kg ha-1 of N and P respectviley. The application of lime significantly increased the grain yield of barley by almost tenfold at Chencha. After a series of investigations at Sheno it was found out that soil burning could be replaced by deep ploughing or camber-beds and the use of fertilizers. It was established that sources of phosphate such as bone meal, basic slag and rock phosphate can effectively be used to increase yield of barley. The results of EPID fertilizer trials showed that N/P response at the level of 41 kg N and 20 kg P was more economical than other levels tested. More recently ADD and NFIU revised the recommendation based on soil color, region and crop.

2580 Van Cleemput, O. (Ghent Univ. (Belgium). Faculty of Agricultural and Applied Biological Sciences); Hera, C. (1995) **Links between fertilizer N efficiency and loss of N out of the rooting zone.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 537-548. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA--STI/PUB/947. English. (AGRIS 97-045441).

2581 Wagner, GM. (1997) **AZOLLA - A REVIEW OF ITS BIOLOGY AND UTILIZATION [Review].** *Botanical Review. 63(1):1-26.* English. [UNIV DAR ES SALAAM DEPT ZOOL & MARINE BIOL POB 35064 DAR ES SALAAM TANZANIA].

The Azolla-Anabaena symbiosis is outstanding due to its high productivity combined with its ability to fix nitrogen at high rates. Because of this, in recent decades, countless studies have been conducted on this association, but with insufficient synthesis and coordination. This paper, therefore, attempts to review and synthesize past and recent findings concerning the biology and utilization of Azolla in hopes that this will facilitate increased future collaborative research on this "green gold mine." It reviews the taxonomy, distribution, morphology, physiology, and reproduction of Azolla as well as new developments in its manifold uses. Because of the growing concern about conservation of the environment and the need for deploying renewable, sustainable resources; the application of Azolla as a biofertilizer on agricultural crops, in order to provide a natural source of the crucial nutrient nitrogen, can be very beneficial to the future of our planet. Besides the environmental appropriateness of the use of Azolla, for multitudes of farmers in many parts of the world who cannot afford chemical fertilizers, Azolla application can enhance their economic status, increasing yields while minimizing costs. Due to the fact that rice paddy fields form an ideal environment for Azolla, one of its most suitable applications is on rice.

Besides its utilization as a biofertilizer on a variety of crops, Azolla can be used as an animal feed, a human food, a medicine, and a water purifier. It may also be used for the production of hydrogen fuel, the production of biogas, the control of weeds, the control of mosquitoes, and the reduction of ammonia volatilization which accompanies the application of chemical nitrogen fertilizer. [References: 122].

2582 Wang Caibin (Shandong Research Inst. of Peanut, Laixi (China)) (1996) **Research application of potash fertilizers in wheat-peanut rotational cropping system.** *Peanut Science and Technology (China) (no. 1) p. 18-21.* 5 tables; 4 ref. Chinese. (AGRIS 97-045196).

2583 Wang Heqing (Hubei Agricultural Coll., Jingsha (China). Inst. of Plant Genetics and Breeding) (1995) **Effects of nitrogen element on grain yield in barley.** *Journal of Hubei Agricultural College (China) v. 15(1) p. 1-5.* 5 tables; 5 ref. Chinese. (AGRIS 97-045306).

2584 Westfall, D.G. (Colorado State University, Fort Collins, CO.); Havlin, J.L.; Hergert, G.W.; Raun, W.R. (1996) **Nitrogen management in dryland cropping systems.** *Journal of production agriculture (USA) v. 9(2) p. 192-199.* references. Paper presented at the symposium "Cropping Systems of the Great Plains" held during the ASA-CSSA-SSSA annual meetings 1994, Seattle. English. (AGRIS 97-045461).

Management of fertilizer N in dryland cropping systems in the semi-arid Great Plains is important to the economic and environmental sustainability of these systems. As producers shift from the traditional tilled winter wheat (Triticum aestivum L.)-fallow (WF) cropping systems to those that include summer crops in the rotation, N management becomes more important because yield losses as a result of underfertilization become greater. Fertilizer N rate is more important in obtaining optimum yields of dryland crops than N placement in drier environments, while placement becomes more important as rainfall increases. Soil testing is an accurate method of quantifying the residual soil nitrate-N level in the root zone. However, a combination of soil testing, fertilizer N experiences of the producer, and projected N requirement (expected yield) are the best factors producers can use in determining fertilizer N rates. If soil testing occurs early in the spring/summer fallow period preceding planting, a correction to the fertilizer N recommendation should be made to account for N mineralization that occurs between soil sampling and planting. This can prevent overfertilization. Dryland systems appear to have a soil-plant N buffer capacity that prevents inorganic N accumulation at fertilizer N rates that exceed optimal N requirements to meet crop needs. Recent research has reported N buffering in the range of 21 to 76 lb N/acre per yr for annually cropped dryland wheat production systems. This means that the application of from 21 to 76 lb N/acre per yr did not result in an accumulation of inorganic N in the soil. This concept should be evaluated on additional datasets, and, if found to be applicable to a range of conditions, it could have an effect on establishing environmentally safe fertilizer N rates for dryland cropping systems.

2585 Wivstad, M.; Salomonsson, L.; Salomonsson, AC. (1996) **EFFECTS OF GREEN MANURE, ORGANIC FERTILIZERS AND UREA ON YIELD AND GRAIN QUALITY OF SPRING WHEAT.** *Acta Agriculturae Scandinavica Section B-Soil & Plant Science. 46(3):169-177.* English. [SWEDISH UNIV AGR SCI DEPT CROP PROD SCI POB 7043 S-75007 UPPSALA SWEDEN].

Effects of two green manure crops-persian clover and persian clover/Westerwolth ryegrass-and three fertilizers-liquid manure, meat bone meal and urea-oil subsequent spring wheat yields and quality characters were studied in four field experiments. No significant differences between green manure crops in production or effects on wheat were found. The yield was up to 2500 kg/ha higher after the green manure crops than after oats, but the effect on wheat protein content was less pronounced. Fertilization did not increase the yield as much as green manuring, but significantly increased protein content in two of the experiments. In a partial least square regression (PLSR) model, the wheat yield was largely explained by the amount of green manure herbage ploughed in during the autumn and the amount of mineral N in the soil in spring. The prediction model of protein content was weak. [References: 37].

2586 Xia Peizhen (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. of Soils and Fertilizers) (1995) **Influence of npk fertilizers on amino acid content in grains of wheat and corn.** *Soils and Fertilizers (China) (no. 2) p. 9-12.* 9 tables; 3 ref. Chinese. (AGRIS 97-045450).

2587 Yan Huijun (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. of Soils and Fertilizers) (1996) **Effect of fertilizers on photosynthesis and qualities of wheat in saline habitat.** *Soils and Fertilizers (China) (no. 1) p. 30-33.* 1 table; 5 ill. Chinese. (AGRIS 97-045448).

2588 Yin, ZH.; Raven, JA. (1997) **A COMPARISON OF THE IMPACTS OF VARIOUS NITROGEN SOURCES ON ACID-BASE BALANCE IN C-3 TRITICUM AESTIVUM L AND C-4 ZEA MAYS L PLANTS.** *Journal of Experimental Botany. 48(307):315-324.* English. [UNIV MANCHESTER SCH BIOL SCI 3614 STOPFORD BLDG OXFORD RD MANCHESTER M13 9PT LANCS ENGLAND].

This work aimed to study the impacts of acquisition and assimilation of various nitrogen sources, i.e. NO3- NH4+ or NH4NO3, in combination with gaseous NH3 on plant growth and acid-base balance in higher plants, Plants of C-3 Triticum aestivum L. and C-4 Zea mays L. grown with shoots in ambient air in hydroponic culture solutions with 2 mol m(-3) of nitrogen source as NO3-, NH4+ or NH4NO3 for 21 d and 18 d, respectively, had their shoots exposed either to 320 mu g m(-3) NH3 or to ambient air for 7 d. Variations in plant growth (leaves, stubble and roots), and OH- and H+ extrusions as well as the relative increases in nitrogen, carbon and carboxylate were determined, These data were computed as Delta H+/Delta N, Delta H+/Delta C, Delta(C-A)/Delta N, and Delta(C-A)/Delta C to analyse influences of different nitrogen sources on acid-base balance in C-3 Triticum aestivum and C-4 Zea mays plants, Root growth in dry weight gain was significantly reduced by treatment with 320 mu g m(-3) NH3 in Triticum aestivum and Zea mays growing with different N-forms, whereas leaf growth was not significantly affected by NH3. In comparison with C-3 Triticum aestivum, non-fumigated C-4 Zea mays had low ratios of Delta OH-/Delta N in NO3--grown plants and of Delta H+/Delta N in NH4+- and NH4NO3-grown plants, Utilization of NH3 from the atmosphere reduced both the Delta OH-/Delta N ratios in NO3--grown plants and the Delta H+/Delta N ratio in NH4+- and NH4NO3-grown plants of both species. Furthermore, Zea mays had higher ratios of Delta(C-A)/Delta N in NH4+- and NH4NO3-grown plants than Triticum aestivum, This means that C-4 Zea mays had synthesized more organic anion per unit increase in organic N than C-3 Triticum aestivum plants, Within both species, different nitrogen sources altered the ratios of Delta(C-A)/Delta N in the order: NH4NO3>NH4+>NO3-. Fumigation with NH, increased organic acid synthesis in NO3-- and NH4+-grown plants of Triticum aestivum, whereas it decreased organic acid synthesis in Zea mays plants under the same conditions, Furthermore, these differences in acid-base regulation between C-3 Triticum aestivum and C-4 Zea mays plants growing with different nitrogen sources are discussed. [References: 37].

2589 Yuan Zhenge (Changyi Municipal Station of Soils and Fertilizers, Shandong (China)) (1996) **Effect of application combined Si, Zn and Mn on growth of wheat and corn.** *Soils and Fertilizers (China) (no. 1) p. 46-48.* 4 tables; 2 ref. Chinese. (AGRIS 97-045446).

2590 Zhang Mingkui (Zhejiang Agricultural Univ., Hangzhou (China). Dept. of Soil and Agro Chemistry) (1995) **Impacts of neutral fertilizer application on acidity of the soil solution in erode red earth and on barley growth.** *Journal of Zhejiang Agricultural Sciences (China) (no. 5) p. 225-228.* 3 tables; 3 ref. Chinese. (AGRIS 97-045305).

2591 Zhang Wumin (Huzhou Municipal Inst. of Agriculture, Zhejiang (China)) (1995) **Effect of trace element fertilizer on disease and pests damage to rice and wheat.** *Chinese Journal of Soil Science (China) v. 26(6) p. 285-287.* 5 tables; 3 ref. Chinese. (AGRIS 97-045376).

F06 IRRIGATION

2592 Biswas, CR.; Benbi, DK. (1996) **SUSTAINABLE YIELD TRENDS OF IRRIGATED MAIZE AND WHEAT IN A LONG-TERM EXPERIMENT ON A LOAMY SAND IN SEMI-ARID INDIA.** *Nutrient Cycling in Agroecosystems. 46(3):225-234.* English. [PUNJAB AGR UNIV DEPT SOILS LUDHIANA 141004 PUNJAB INDIA].

Long-term field experiments play an important role in understanding the complex interactions of plants, soils, climate and management and

their effects on sustainable crop production. A long-term fertilizer experiment with maize-wheat-cowpea (fodder) is in progress since 1971 at Punjab Agricultural University farm Ludhiana, India. The experimental result for the first 21 years showed that application of N alone or in combination with P did not produce as much maize and wheat grains a the; applications of N P and K together. Eight years after thp start nf thp experiment, the optimal levels of N, P and K application (100% NPK) were unable to sustain the similar (maize) yield level as before because of Zn deficiency. Whereas in FYM amended plots the Zn deficiency did not appear and the higher crop yields could be sustained. The chemical control of weeds could not sustain the maize productivity at the same level as the manual removal of weeds. IL was concluded that the high level of crop production can be sustained with the application of N, P and K under intensive cropping system provided deficiency of any of the micronutrient does not crop up. The deficiency of Zn is most likely to occur in semi-arid light textured alluvial soils under intensive cropping without the addition of farm yard manure/organic manures. In maize based cropping systems, manual control of weeds may be preferred to the chemical one. Addition of FYM in conjunction with 100% NPK is most beneficial both from bio-physical and economic point of view. [References: 10].

2593 Bonnifet, J.P. (Institut Technique des Cereales et des Fourrages, Paris (France)); Bouthier, A.; Bonnefoy, M.; Deumier, J.M. (1996) **[Malting barley: to adapt irrigation to requirements of quality]. Orge brassicole: adapter l'irrigation aux exigences de qualite.** *Perspectives Agricoles (France) (no 212) p. 73-79.* 14 graph. French. (AGRIS 97-031349).

2594 Frizzone, J.A.; Mello Junior, A.V.; Folegatti, M.V.; Botrel, T.A. (1996) **[Different water depths and nitrogen fertilization effect on wheat crop yield]. Efeito de diferentes niveis de irrigacao e adubacao nitrogenada sobre componentes de produtividade da cultura do trigo.** *Pesquisa Agropecuaria Brasileira (Brazil) v. 31(6) p. 425-434.* 36 ref. Portuguese. (AGRIS 97-031421).

2595 Koszanski, Z.; Karczmarczyk, S.; Podsiadlo, C. (Akademia Rolnicza, Szczecin (Poland). Zaklad Podstaw Produkcji Roslinnej i Nawadniania Roslin) (1995) **[Effect of sprinkling irrigation and nitrogen fertilization on winter wheat and winter triticale cultivated on a good rye soil complex. Pt. 3. Water management and chemical properties of the soil]. Wplyw deszczowania i nawozenia azotem na pszenice i pszenzyto ozime uprawiane na glebie kompleksu zytniego dobrego. Cz. 3. Gospodarka wodna oraz chemiczne wlasciwosci gleby.** *Zeszyty Naukowe. Akademia Rolnicza w Szczecinie. Rolnictwo (Poland) (no.165) p. 51-56.* 2 fig., 2 tables; 10 ref. Polish. (AGRIS 97-031425).

The watering and high nitrogen fertilization causes increased water consumption but, if calculated for production of crop units its use was significantly lower. Application of high nitrogen doses and supplemental irrigation on the same field for several years increases the soil acidity and the amount of minerals taken up by plants. Thus, it creates the need for increased and more frequent liming and the soil minerals replenishing to secure optimal growth and development conditions for plants.

2596 Koszanski, Z.; Karczmarczyk, S.; Podsiadlo, C. (Akademia Rolnicza, Szczecin (Poland). Zaklad Podstaw Produkcji Roslinnej i Nawadniania Roslin); Sciazko, D. (Akademia Rolnicza, Szczecin (Poland). Katedra Biochemii) (1995) **[Effect of sprinkling irrigation and nitrogen fertilization on winter wheat and winter triticale cultivated on a good rye soil complex. Pt. 2. Chemical composition of the crop]. Wplyw deszczowania i nawozenia azotem na pszenice i pszenzyto ozime uprawiane na glebie kompleksu zytniego dobrego. Cz. 2. Sklad chemiczny plonu.** *Zeszyty Naukowe. Akademia Rolnicza w Szczecinie. Rolnictwo (Poland) (no.165) p. 43-49.* 5 tables; 5 ref. Polish. (AGRIS 97-031424).

The watering had no effect on N, P, K, Ca, Mg and Na content, neither in wheat nor in triticale grain; a significant decrease in Zn content in triticale grain was found. The nitrogen fertilization had caused in both plants a significant increase of total nitrogen, nitrates, protein, fat and fibre contents, as well a decrease of potassium grain level and increase of its straw level.

2597 Nikolov, G. (Institut po Pamuka i Tv"rdata Pshenitsa, Chirpan (Bulgaria)) (1996) **[Effect and prospects for durum wheat irrigation]. Efekt i perspektivi na napoyavaneto na tv"rdata pshenitsa.** Selskostopanska Akademiya, Sofia (Bulgaria). *Selskostopanska Nauka (Bulgaria). Agricultural Science v. 34(2) p. 11-13.* 3 tables; 13 ref. Bulgarian. (AGRIS 97-031427).

The increase of grain yield produced as a result of irrigation maintaining an optimal regime 85 of maximal evapotranspiration, realized by an average rate of 129.7 mm for 14 years was 41.7, i.e. 28.3 in normal years, 50.5 in moderately dry years and 75.5 in dry years. Durum wheat has a more pronounced reaction to irrigation than soft wheat. In conditions of rational irrigation regime the effect of irrigation on it is 25.8 increased grain yield, while in soft wheat this increase is only 7.8. Taking into account its higher purchasing price, it seems more economically feasible to use the field rotation areas intended for wheat by sowing durum wheat in the regions where it is grown.

2598 Padole, V.R. (Punjabrao Krishi Vidyapeeth, Akola (India). Department of Soil Sciences and Agricultural Chemistry); Bhalkar, D.V. (Agriculture College, Akola (India)); Kale, V.B. (Punjabrao Krishi Vidyapeeth, Akola (India)) (1995) **Effect of quality of irrigation water on wheat grown under conditions of salinity-sodicity.** *Punjabrao Krishi Vidyapeeth Research Journal (India) v. 19(1) p. 34-38.* 3 tables; 19 ref. English. (AGRIS 97-031422).

2599 Podsiadlo, C.; Koszanski, Z. (Akademia Rolnicza, Szczecin (Poland). Zaklad Podstaw Produkcji Roslinnej i Nawadniania Roslin) (1995) **[Response of spring wheat cultivars to sprinkling irrigation and mineral fertilization]. Reakcja odmian pszenicy jarej na deszczowanie i nawozenie mineralne.** *Zeszyty Naukowe. Akademia Rolnicza w Szczecinie. Rolnictwo (Poland) (no.165) p. 105-110.* 6 tables; 6 ref. Polish. (AGRIS 97-031426).

As an effect of supplemental irrigation the grain yield increased by 1.35 t/ha whereas high levels of mineral fertilization caused a 0.73 t/ha yield increase of the tested cultivars, with Henika being the best (5.67 t/ha); one mm of water was also most effective for Henika and Kadett. Irrigation and fertilization had affected positively the number and weight of grains per spike, and the weight of 1000 grains.

2600 Wada, M.; Carvalho, LJCB.; Rodrigues, GC.; Ishii, R. (1997) **YIELD RESPONSE OF SPRING WHEAT CULTIVARS AT DIFFERENT IRRIGATION RATES.** *Japanese Journal of Crop Science. 66(1):92-99.* English. [NATL AGR RES CTR TSUKUBA IBARAKI 305 JAPAN].

We found in a previous study that Brazilian tall cultivars of spring wheat (Triticum aestivum L.) were more resistant to drought in respect of photosynthesis as compared to Mexican and Japanese semidwarf cultivars. In this study, a yield trial was performed with the same 20 cultivars to elucidate the yield and yield component responses to the soil water conditions in Cerrados, a semiarid region of Brazil. Under dry conditions, the dry matter yield of the Brazilian cultivars was significantly higher than the yields of the Mexican and Japanese cultivars. The grain field of the Brazilian cultivars was also 34-46% greater than those of the Mexican and Japanese cultivars. Under fully-irrigated conditions, however, the Mexican and Japanese cultivars showed higher harvest indices and 18-21% greater grain yield than the Brazilian cultivars, although no practical difference was found among the cultivar groups in terms of dry matter yield. An analysis of yield components showed that the Brazilian cultivars had a larger 1000 kernel weight than the Mexican and Japanese cultivars under dry conditions, while the Mexican and Japanese cultivars had a higher kernel number than the Brazilian cultivars under fully-irrigated conditions. The reverse rotation of yield ranking among the cultivars under non-irrigated and fully-irrigated conditions is due to the fact that the Mexican and Japanese cultivars are more sensitive to soil moisture than the Brazilian cultivars. [References: 17].

F07 SOIL CULTIVATION

2601 Aleixo, A.L.; Pacheco, C.A.; Pinto, P.A.; Coelho, J.C. (Instituto Superior de Agronomia, Tapada da Ajuda, Lisboa (Portugal)) (1995) **The influence of alternative tillage systems on crop productivity and soil physical properties.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 556-560.* Wye College Press. 4 ref. English. (AGRIS 97-045613).

2602 Cheong, J.I.; Choi, M.G.; Noh, T.H. (Rural Development Administration, Iksan (Korea Republic). National Honam Agricultural

Experiment Station); Lee, J.H.; Kwon, T.O. (Wonkwang University, Iksan (Korea Republic). College of Agriculture) (1996) **Changes in chemical components of stagnant water by tillage method and amount of nitrogen application in wet seeded rice after barley straw mulching.** *Korean Journal of Crop Science (Korea Republic) v. 41(4) p. 411-419.* 9 illus.; 1 table; 18 ref. Korean. (AGRIS 97-031437).

2603 Rubenis, J.; Krogere, R.; Liepins, J.; Ausmane, M. (Latvian University of Agriculture, Jelgava (Latvia). Dept. of Soil Management) (1995) **Reduced depth of tillage and its effect on soil agrochemical properties, weed level and grain yield.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil management in the Baltic states (v.182) p. 95-100.* 3 tables; 2 ref. English. (AGRIS 97-045619).

Conventional mode of ploughing at the depth of 0.22.0.24 metres is expensive and labour-consuming in Latvia. In world tillage practise attempts have been made to replace ploughing by subsurface cultivation, rototilling, chisel ploughing as well as by reduced depth of ploughing. Since 1983 Dept. of Soil Management of Latvia University of Agriculture has been engaged in research. These studies show that changes in organic matter content between variants of soil tillage are insignificant. Diverse effect of studied soil tillage systems on grain yield level, amount of weed plants and their ratio in grain crop stands in tillering was not stated. Reduced soil tillage system is feasible in ameliorated soil free from perennial weeds.

2604 Shepherd, M.A.; May, M.J. (ADAS Gleadthorpe, Meden Vale, Mansfield, Nottinghamshire (United Kingdom)) (1995) **The effect of cultivation on the establishment and growth of cover crops.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 475-483.* Wye College Press. 9 ref. English. (AGRIS 97-045607).

2605 Wlodek, S. (1996) **[Optimizing soil tillage for winter wheat grown after combine-harvested small grains]. Optymalizacja uprawy roli pod pszenice ozima uprawiana po zbozach zbieranych kombajnem.** Instytut Uprawy Nawozenia i Gleboznawstwa, Pulawy (Poland). Zaklad Uprawy Roli.. *Instytut Uprawy Nawozenia i Gleboznawstwa. Seria R (Poland); no. 329 66 p.* Dzial Wydawnictw Naukowych IUNG. 14 fig., 21 tables; 47 ref. Polish. (AGRIS 97-031458).

The trials were laid out as randomized block design with six replications. The plot size at harvest was 50 sq.m. The aim of the study was to determine the optimum sowing date and adequate tillage practices for winter wheat grown i a field in which high stubble was left from combine-harvest cultivation, preplant plowing 15 or 20 cm deep, conventional tillage involving post harvest chiselling 10 cm deep and preplant plowing at 25 cm, post-harvest plowing at 15 or 25 cm and shallow preplant disking or spring-tining.

2606 Zhang Shigui; Liu Dongqing; Que Daoming (Shandong Research Center of Cotton, Jinan (China)) (1995) **Study on yield increase and anti-senescence of cotton covered by plastic film and wheat straw.** *China Cottons (China) v. 22(4) p. 13-14.* 5 tables; 2 ref. Chinese. (AGRIS 97-045599).

2607 Zhang Zhitian (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. of Soils and Fertilizers) (1995) **The effect of conservation tillage on soil water regime in rainfed wheat fields.** *Chinese Journal of Soil Science (China) v. 26(5) p. 200-203.* 6 tables; 4 ill., 6 ref. Chinese. (AGRIS 97-045614).

2608 Zhu Peili (Jiangsu Academy of Agricultural Sciences, Nanjing (China). Inst. of Soils and Fertilizers) (1995) **Influence of tillage and management measures on yield of wheat after rice in lime concretion black soil.** *Soils and Fertilizers (China) (no. 4) p. 21-24.* 7 tables; 2 ref. Chinese. (AGRIS 97-045615).

F08 CROPPING PATTERNS AND SYSTEMS

2609 **[Rotational cropping of cotton, maize and wheat]. Katoen wissel puik met mielies en koring** (1996) Landbouweekblad, Cape Town (South Africa). *Landbouweekblad (South Africa) (no.969) p. 26-28.* Afrikaans. (AGRIS 97-031516).

2610 Alfoldi, T.; Spiess, E.; Niggli, U.; Besson, J.M. (Research Institute of Biological Agriculture, Oberwil (Switzerland)) (1995) **Energy input and output for winter wheat in biodynamic, bio-organic and conventional production systems.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 574-578.* Wye College Press. 11 ref. English. (AGRIS 97-045707).

2611 Atkins, C.A. (Western Australia Univ., Nedlands (Australia). Dept. of Botany and Co operative Research Centre for Legumes in Mediterranean Agriculture) (1995) **Lupins in the sustainable wheat-legume rotation based farming systems of the western Australian wheat belt.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 483-497. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA–STI/PUB/947. English. (AGRIS 97-045709).

2612 Atkinson, D.; Watson, C.A.; Hooker, J.E.; Black, K.E. (Land Resources Department, School of Agriculture, Aberdeen (United Kingdom)) (1995) **Nutrient conservation in organic crop production systems: implications for root systems.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 54-60.* Wye College Press. 6 ref. English. (AGRIS 97-045770).

2613 Dhuyvetter, K.C. (Kansas State University, Manhattan, KS.); Thompson, C.R.; Norwood, C.A.; Halvorson, A.D. (1996) **Economics of dryland cropping systems in the Great Plains: a review.** *Journal of production agriculture (USA) v. 9(2) p. 216-222.* references. Paper presented at the symposium "Cropping Systems of the Great Plains" held during the ASA-CSSA-SSSA annual meetings 1994, Seattle. English. (AGRIS 97-045767).

Dryland wheat (Triticum aestivum L.) in the Great Plains generally is planted in a wheat-fallow (WF) rotation. Wheat grown in rotation with a summer row crop like corn (Zea mays L.), sorghum [Sorghum bicolor (L.) Moench], or sunflower [Helianthus annuus var. macrocarpus (DC.) Ck11.] increases cropping intensity, allowing a crop to be produced annually on 67 to 100 of tillable acres. A review of economic analyses of dryland cropping systems in the Great Plains was conducted to compare net returns, production costs, financial risk, and compatibility with the 1990 Farm Bill. Seven of eight studies reported that net returns were greater from a more intensive crop rotation than from WF when reduced-tillage (RT) or no-till (NT) were used following wheat harvest and prior to the summer crop planting. With government program payments, WF was more profitable with conventional tillage (CT) than with NT. Production costs increased as cropping intensity increased and tillage decreased. Economic risk analysis showed that wheat-sorghum-fallow (WSF) was less risky than WF in Kansas. Cropping systems using more intensive rotations with less tillage had higher production costs than WF, but also had increased net returns and reduced financial risk, while remaining in compliance with 1990 Farm Bill provisions.

2614 Duncan, SR.; Schapaugh, WT. (1997) **RELAY-INTERCROPPED SOYBEAN IN DIFFERENT WATER REGIMES, PLANTING PATTERNS, AND WINTER WHEAT CULTIVARS.** *Journal of Production Agriculture. 10(1):123-129.* English. [KANSAS STATE UNIV 1600 N LORRAINE SUITE 125 HUTCHINSON, KS 67501 USA].

Relay-intercropping soybean [Glycine max (L.) Merr.] into winter wheat [Triticum aestivum L.) at the boot stage may be a profitable production alternative in environments where doublecropped soybean production after wheat harvest is unreliable. However, moisture availability, planting pattern, and growth characteristics of different wheat cultivars may influence soybean survival and final yield. To better define the conditions under which relay-intercropping would be acceptable to growers, we compared the influences of water regimes, planting patterns, and wheat cultivars on soybean growth and yield. In 1988 and 1989, five wheat cultivars were planted in solid and skip-row patterns near Manhattan and Rossville, KS, and 'Resnik' soybean was intercropped in wheat at the late boot stage. All plots received equal irrigation prior to wheat harvest and

different amounts (limited vs. full) during the remaining growing season. Soybean yields at Rossville were not affected by irrigation regime, but at Manhattan, fully irrigated soybean yields were 27% greater than soybean under limited irrigation. The intercrop competition period averaged 16 d longer in 1989 than in 1990. Wheat was planted in 8 in. rows in a solid and one-out-of-three skip-row pattern. Soybean in all planting patterns was in 24 in. rows - between the 8 in. wheat rows, in the middle of the 16 in. skip, or in a conventionally tilled, sole cropped (SC) planting. When intercropped in solid wheat stands (SI), soybean yielded 52 and 37% of soybean in skip-row intercropped (SRI) and SC patterns, respectively, in 1989, and 80 and 64% of SRI and SC yields, respectively, in 1990. Solid intercropped soybean received 36 and 64% of the total measured photosynthetically active radiation that reached SC and SRI soybean canopies, respectively. Seventy six percent of unharvested soybean plots (reduced or eliminated populations) were SI. Soybean intercropped into short wheat cultivars had higher (14 to 20%) yields than soybean in taller wheat cultivars. Wheat cultivar maturity had no consistent effect on intercropped soybean yield. Of the soybean plots abandoned because of reduced populations, 76% were intercropped into tall or medium-late maturing wheat cultivars. If relay intercropping soybean into winter wheat is to be implemented on soils that are droughty or have low moisture-holding capacity, supplemental irrigation must be available. Using an SRI planting pattern with wheat cultivars of shorter stature will increase chances for soybean survival and profitable yields. [References: 19].

2615 Follet, R.F.; Porter, L.K. (United States Dept. of Agriculture, Fort Collins , CO (USA). Agricultural Research Service); Halvorson, A.D. (1995) **Nitrogen-15 labelled fertilizer dynamics in soil in a 4 year, no till cropping sequence.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 164-174. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA--STI/PUB/947. English. (AGRIS 97-045760).

2616 Holford, ICR.; Crocker, GJ. (1997) **A COMPARISON OF CHICKPEAS AND PASTURE LEGUMES FOR SUSTAINING YIELDS AND NITROGEN STATUS OF SUBSEQUENT WHEAT.** *Australian Journal of Agricultural Research. 48(3):305-315.* English. [NEW S WALES AGR & FISHERIES TAMWORTH CTR CROP IMPROVEMENT TAMWORTH NSW 2340 AUSTRALIA].

Six treatments were compared for their effects on wheat yields, nitrogen (N) uptake, protein content, and fertiliser N requirements in a long-term rotation study on a black earth and a red clay in northern New South Wales. Three of the treatments were lucerne, subterranean clover, and snail medic, all grown simultaneously from 1988 to 1990 and all followed by 3 years of wheat. The other 3 treatments were biennial rotations of chickpea-wheat and long-fallow-wheat as well as a continuous wheat monoculture, all lasting 6 years. With the exception of the first wheat crop, which experienced very low growing-season rainfall, lucerne was more beneficial than other legumes to following wheat crops in terms of yield, protein content, and fertiliser N requirement. Clover closely followed lucerne in the magnitude of its positive effects: whereas medic and chickpea produced much smaller effects. Because of the amount of N removed in the chickpea grain, it appeared that the small positive effects of chickpea were due to soil N sparing or rapid mineralisation from crop residues rather than any net contribution of N fixation to soil N accretion. Average yields of the 3 wheat crops following lucerne and clover were much higher than average yields 20 years previously following lucerne: even though average yields of continuously grown wheat have declined over the past 20 years. However, lucerne eliminated the need for N fertiliser for no more than 2 following wheat crops, and clover for only the first wheat crop. It appears that the longer duration of lucerne benefits reported in earlier studies was due to the higher background soil N levels as well as the lower yield potential in the earlier years. Nevertheless, lucerne lowered the fertiliser requirement of the third wheat crop by more than 50%. In contrast to lucerne, annual legumes are probably most beneficial if grown in alternate years with wheat. The large benefits of long fallowing particularly on the black earth were apparently caused by its enhancement of soil moisture and mineral N accumulation. However, these N effects were surprisingly large considering the degree of depletion of organic matter in long-fallowed soils. [References: 12].

2617 Hussain, T. (University of Agriculture, Faisalabad, Pakistan.); Jilani, G.; Parr, J.F.; Ahmad, R. (1995) **Transition from conventional to alternative agriculture in Pakistan: the role of green manures in substituting for inorganic N fertilizers in a rice-wheat farming system.** *American journal of alternative agriculture (USA) v. 10(3) p. 133-137.* references. English. (AGRIS 97-045732).

Nitrogen, a vitally important plant nutrient, is subject to various losses that affects its efficiency. We tested prilled urea (PU), urea supergranules (USG), green manures (CM) and farmyard manure (FYM) in a rice-wheat cropping system to determine which were the most efficient and economical N sources. The maximum rice growth, yield and N-uptake occurred with USG and with GM (Sesbania rostrata) plus PU. Incorporation of GM saved 60 kp N/ha. On the following wheat crop, GM (S. aculeata) plus PU and FYM plus PU had the highest residual effect on the number of tillers per m2, and straw and grain yield. An increase in N recovery efficiency occurred with combined use of PU and organic/green manures compared with PU along. In areas were USG is costly or unavailable and FYM is scarce, green manures can be a cheap N source that allows small-scale farmers to get sustainable yields in a rice-wheat rotation.

2618 Jiang Jianping; Liu Tingzhi; Zhang Xiurong (Henan Agricultural Univ., Zhengzhou (China)) (1995) **Changes of ecological conditions and their effect on the yield of wheat in Paulownia-crop intercropping system.** *Acta Agriculturae Universitatis Henanensis (China) v. 29(4) p. 313-318, 327.* 6 tables; 3 ill. Chinese. (AGRIS 97-045761).

2619 Lavier, B. (Ecole Superieure d'Agriculture d'Angers (France)); Verjux, N. (1996) **[To manage frequent wheat crop. Wheat after wheat: what frequency in France?]. Gerer un assolement frequent de ble. Ble sur ble: frequence en France?** *Perspectives Agricoles (France) (no 216) p. 71-72.* French. (AGRIS 97-031481).

2620 Liu Guojiang (Agrotechnique Extension Center of Zhaoyuan City, Shandong (China)) (1995) **Research and extension of multiple cropping techniques for groundnut with wheat and vegetables.** *Peanut Science and Technology (China) (no. 4) p. 18-20.* 2 tables. Chinese. (AGRIS 97-045657).

2621 Maikhuri, R.K.; Rao, K.S.; Saxena, K.G. (G.B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, PO Box 92, Srinagar Garhwal, 246174, U.P. (India)) (1996) **Traditional crop diversity for sustainable development of Central Himalayan agroecosystems.** *International Journal of Sustainable Development and World Ecology (United Kingdom) v. 3(3) p. 8-31.* 61 ref. English. (AGRIS 97-045721).

2622 Man Huimin; Yu Guuohua; Zhan Shumin (Laiyang Agricultural Coll., Shandong (China)) (1995) **Study on physiological characteristics of winter wheat in drought land.** *Acta Agriculturae Nucleatae Sinica (China) v. 9(3) p. 159-162.* 3 tables; 2 ill., 11 ref. Chinese. (AGRIS 97-045759).

2623 Painter, K.M. (Washington State University, Pullman, WA.); Young, D.L.; Granatstein, D.M.; Mulla, D.J. (1995) **Combining alternative and conventional systems for environmental gains.** *American journal of alternative agriculture (USA) v. 10(2) p. 88-96.* references. English. (AGRIS 97-031552).

Two conventional cropping systems (winter wheat/dry peas and winter wheat/spring barley/dry peas) in the dryland grain region of southeastern Washington were compared with several alternative systems regarding profitability and environmental impacts. Two of the alternative systems use green manure crops and have low fertilizer and pesticide requirements. The remaining two are otherwise conventional rotations modified to include soil-building crops, bluegrass seed and rapeseed. Estimates of annual off-site erosion damage ranged from $6.56 to $20.50 per rotational acre, while on-site damage estimates ranged from $0.50 to $1.55 per rotational acre. Estimated leaching losses of pesticides to a water table 3.6 feet deep were negligible, but significant leaching losses of nitrate-N were predicted to occur from fall-applied inorganic fertilizer. Including bluegrass in a conventional grain rotation increased estimated net returns over variable costs by 16 and decreased soil loss by 33 compared with the most profitable conventional rotation. The next most profitable alternative system, rapeseed plus a conventional grain rotation, had slightly higher net returns over variable costs than the second most profitable conventional rotation, with slightly less soil loss. When fixed costs of machinery depreciation and land are included, the alternative

systems fared relatively better. An experimental wheat/pea/medic system had higher projected net returns over total costs than the most profitable conventional rotation, while averaging just one-third as much soil loss per year. A wheat/barley/sweetclover green manure rotation was similar in profitability to the less profitable conventional rotation, but had only two-thirds as much soil loss. We constructed a mixed-integer linear programming model to determine the profit maximizing combination of conventional and alternative rotations under 1990 farm bill provisions. Planting all or nearly all land to the bluegrass plus conventional.

2624 Pan Xuebiao (Chinese Academy of Agricultural Sciences, Anyang, Henan (China). Research Inst. of Cotton) (1995) **Effects of interplanting of wheat and cotton on solar radiation and temperature of row middle centre.** *Acta Gossypii Sinica (China) v. 8(1) p. 44-49.* 5 tatbles; 6 ref. Chinese. (AGRIS 97-045691).

2625 Papastylianou, I. (Ministry of Agriculture, Natural Resources and Environment, Nicosia (Cyprus). Agricultural Research Inst.) (1995) **Contribution of vetch to maintaining a sustainable cropping system under rain fed Mediterranean conditions.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 273-281. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA--STI/PUB/947. English. (AGRIS 97-045698).

2626 Pelikan, M.; Hrivna, L. (Jihoceska Zemedelska Univ., Ceske Budejovice (Czech Republic). Zemedelska Fakulta) (1995) **[Quality and yield of selected crops grown under organic and traditional farming in marginal region]. Jakost a vynos vybranych zemedelskych plodin pri organickem a konvencnim zpusobu hospodareni v marginalni oblasti.** *Sbornik Jihoceske Univerzity. Zemedelska Fakulta Ceske Budejovice. Fytotechnicka Rada (Czech Republic) v. 12(Spec.no.) p. 77-84.* 4 tables. Czech. (AGRIS 97-031523).

2627 Santos, H.P. dos; Siqueira, O.J.W. de (1996) **[No-tillage and crop rotation systems for barley effects on soil fertility]. Plantio direto e rotacao de culturas para cevada: efeitos sobre a fertilidade do solo.** *Revista Brasileira de Ciencia do Solo (Brazil) v. 20(1) p. 163-169.* 23 ref. Portuguese. (AGRIS 97-031517).

2628 Shan Yushan (Yan Tai Agricultural School, Shandong (China)) (1996) **Studies on the mathematical model of the comprehensive effects of soil, fertilizer and water in the one year-two-crop system of wheat and maize.** *Scientia Agricultura Sinica (China) v. 29(2) p. 34-44.* 8 tables; 4 ill., 5 ref. Chinese. (AGRIS 97-045762).

2629 Singh, J.P.; Sharma, S.K. (Project Directorate for Cropping System Research, Modipuram (India)) (1996) **A new agrotechnique for higher yields in wheat-sugarcane intercropping.** *Indian Farming (India) v. 45(11) p.* 21-22. 1 table; 1 ill. English. (AGRIS 97-031547).

2630 Sun Benpu; Zhang Baomin; Wang Yong (Bingzhou Prefectural Inst. of Agricultural Sciences, Shandong (China)) (1995) **Observation on field microclimate in the spring cotton intercropped with wheat.** *China Cottons (China) v. 22(5) p. 25-26.* 1 table; 2 ill. Chinese. (AGRIS 97-045692).

2631 Tersboel, M. (1997) **[Survey 1996, H: Organic farming and biodynamic farming]. Oversigt 1996, H: Oekologisk og biodynamisk dyrkning.** Landsudvalget for Planteavl, Aarhus (Denmark). *Oversigt over Landsforsoegene (Denmark) (no.1996) p. 199-210.* 10 ill., 22 tables. Danish. (AGRIS 97-045763).

2632 Verjux, N. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[To manage frequent wheat crop. Productivity: lower always below than "rotating wheat" productivity]. Gerer un assolement frequent de ble. Productivite: toujours inferieure a celle d'un "ble assole".** *Perspectives Agricoles (France) (no 216) p. 74-77.* 6 graph. French. (AGRIS 97-031482).

2633 Verjux, N. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[To manage frequent wheat crop. Yield losses: precautions to be taken]. Gerer un assolement frequent de ble. Pertes de rendement: les precaution a prendre.** *Perspectives Agricoles (France) (no 216) p. 78-83.* 9 ref. French. (AGRIS 97-031483).

2634 Zhang Shuming (Shandong Academy of Agricultural Sciences, Jinan (China). Inst. of Soils and Fertilizers) (1995) **Rational distribution of phosphorus fertilizer on the winter wheat and summer corn cropping system.** *Soils and Fertilizers (China) (no. 1) p. 26-28.* 4 tables; 2 ref. Chinese. (AGRIS 97-045758).

F30 PLANT GENETICS AND BREEDING

2635 Abad, M.S. (Monsanto Company, Chesterfield, MO.); Rosenberger, C.A.; Shah, D.M. (1995) **A genomic clone encoding a phospholipid transfer protein from barley.** *Plant physiology (Lancaster, Pa.) (USA) v. 108(2) p. 871.* references. English. (AGRIS 97-046290).

2636 Abebe Demissie (Norges Landbrukshoegskole, Aas (Norway). Inst. for Plantefag) (1996) **Morphological and molecular markers diversity in Ethiopian landrace barleys [Hordeum]: implications to in situ and ex situ conservation of landrace materials.** Norges Landbrukshoegskole, Aas (Norway). *Agricultural University of Norway. Doctor Scientiarum Theses (Norway); no. 1996:6 163 p.* Norges Landbrukshoegskole. Tables, figures; ref. 4 papers are incl. in the thesis. English. (AGRIS 97-031875).

2637 Adamski, T.; Surma, M.; Jezowski, S. (Polska Akademia Nauk, Poznan (Poland). Inst. Genetyki Roslin) (1995) **[Studies on introduction of Hordeum bulbosum cytoplasm into selected barley (H. vulgare L.) genotypes]. Badania nad introdukcja cytoplazmy Hordeum bulbosum do wybranych genotypow jeczmienia uprawnego (H. vulgare L.).** *Hodowla Roslin Aklimatyzacja i Nasiennictwo (Poland) v. 39(6) p. 103-110.* 1 fig., 4 tables; 13 ref. Polish. (AGRIS 97-031870).

The paper presents results of crossing four Hordeum bulbosum (2x) clones to 11 H. vulgare cultivars and breeding lines with different morphological characters. The experiment was performed with the aim to introduce H. bulbosum cytoplasm into cultivated barley genotypes. Elimination of H. bulbosum chromosomes occurring after crossing between these two species was a basis for obtaining H. vulgare haploids. The influence of genotypes on seed setting and haploid production efficiency was estimated.

2638 Albani, D.; Hammondkosack, MCU.; Smith, C.; Conlan, S.; Colot, V.; Holdsworth, M.; Bevan, MW. (1997) **THE WHEAT TRANSCRIPTIONAL ACTIVATOR SPA - A SEED-SPECIFIC BZIP PROTEIN THAT RECOGNIZES THE GCN4-LIKE MOTIF IN THE BIFACTORIAL ENDOSPERM BOX OF PROLAMIN GENES.** *Plant Cell. 9(2):171-184.* English. [JOHN INNES CTR PLANT SCI RES DEPT MOL GENET COLNEY LANE NORWICH NR4 7UJ NORFOLK ENGLAND].

The conserved bifactorial endosperm box found in the promoter of wheat storage protein genes comprises two different cis elements that are thought to be involved in regulating endosperm-specific gene expression. Endosperm nuclear extracts contain binding activities. One is called ESBF-I, which binds to the endosperm motif (EM), and the other is called ESBF-II, which binds to the GCN4-like motif (GLM). Here, we present a functional analysis of the endosperm box of a low-molecular-weight glutenin gene found on the 1D1 chromosome of hexaploid wheat (LMWG-1D1) in transgenic tobacco plants. Our analysis demonstrates the necessity of the EM and GLM for endosperm-specific gene expression and suggests the presence in tobacco of functional counterparts of wheat ESBF-I and ESBF-II. Furthermore, we describe the isolation and characterization of cDNA clones encoding SPA, a seed-specific basic leucine zipper protein from wheat that can activate transcription from the GLMs of the -326-bp LMWG-1D1 promoter in both maize and tobacco leaf protoplasts. This activation is also partially dependent on the presence of functional EMs, suggesting interactions between SPA with ESBF-I-like activities. [References: 38].

2639 Allen, F.L. (Univ. of Tennessee.); Conger, B.V.; Duck, B.N.; Miller, R.D.; Reich, V.H.; West, D.R. (1994) **UT's crop breeding and genetics program.** *Tennessee farm and home science : progress report (USA) (no. 172) p.* 47-52. English. (AGRIS 97-046778).

2640 Altpeter, F. (University of Florida, Gainesville, FL.); Vasil, V.; Srivastava, V.; Vasil, I.K. (1996) **Integration and expression of the high-**

molecular-weight glutenin subunit 1Ax1 gene into wheat. *Nature biotechnology (USA) v.14(9) p. 1155-1159.* references. English. (AGRIS 97-046837).

2641 Anamthawatjonsson, K.; Bodvarsdottir, SK.; Bragason, BT.; Gudmundsson, J.; Martin, PK.; Koebner, RMD. (1997) **WIDE HYBRIDIZATION BETWEEN WHEAT (TRITICUM L) AND LYMEGRASS (LEYMUS HOCHST).** *Euphytica. 93(3):293-300.* English. [AGR RES INST IS-112 REYKJAVIK ICELAND].

A total of 240 F-1 hybrids was made beween wheat [Triticum aestivum L. em. Thell. (2n = 6x = 42) and T. carthlicum Nevski (2n = 4x = 28)] and perennial lymegrass [North European Leymus arenarius (L.) Hochst. (2n = 8x = 56) and North American L. mollis (Trin.) Pilger (2n = 4x = 28)]. The wide crosses yielded embryos in 20% of caryopses and 96% of the embryos developed into normal hybrid plants. The hybrids were vegetatively vigorous, with evidence of the Leymus rhizomatous habit. Those deriving from L. arenarius survived overwintering in Iceland, but the hybrids from L. mollis did not, whereas in a milder environment, both showed perenniality. Cytogenetic analysis of root tip cells before the plants were treated with colchicine showed that 21 out of 28 hybrids investigated had chromosome mosaics, with a population of both amphihaploid and amphidiploid cells. This spontaneous doubling of somatic chromosomes occurred in all cross combinations, with the highest average frequency of diploid cells (28%) in T. carthlicum x L. arenarius crosses. A few selfed seeds have been obtained from a T. aestivum x L. arenarius hybrid. All the hybrids were treated twice with colchicine, but the treatment appeared to have little or no effect on the frequency of chromosome doubling in the hybrids deriving from I: aestivum. The frequency of diploid cells, however, increased significantly (e.g. to 80%) in the hybrids deriving from the T. carthlicum parent. Genomic in situ hybridization confirmed the hybridity of the plants and showed that the hybrids were amphiploids containing genomes of both wheat and lymegrass. In situ hybridization using ribosomal DNA probe differentiated chromosomes oft. mollis, L. arenarius from those of wheat. The hybrids are being backcrossed with lymegrass pollen, aiming to domesticate the wild, perennial species. [References: 38].

2642 Andersen, M.D.; Skriver, K. (1995) **Characterization of a barley chitinase by molecular modelling and site-directed mutagenesis.** Bio Tek Symposium 1995. Copenhagen (Denmark). 24-25 Oct 1995. *Pharmacology and Toxicology. Supplement (Denmark) v. 77(2) p. 17.* English. (AGRIS 97-046273).

2643 Anderson, O. (USDA, 800 Bucannan Street, Albany, CA 94710 (USA)) (1996) **Molecular approaches to cereal quality improvement.** *Cereal grain quality. Henry, R.J.; Kettlewell, P.S. (eds.) p. 371-404.* Chapman and Hall Ltd. 8 pp. of ref. English. (AGRIS 97-046866).

2644 Anon. (1996) **Small grains add to state's centennial.** *Utah science (USA) v. 57(1) p. 16-17.* English. (AGRIS 97-046291).

2645 Autrique, E.; Nachit, M.M.; Monneveux, P.; Tanksley, S.D.; Sorrells, M.E. (1996) **Genetic diversity in durum wheat based on RFLPs, morphophysiological traits, and coefficient of parentage.** *Crop science (USA) v. 36(3) p. 735-742.* references. English. (AGRIS 97-032211).

Estimation of genetic diversity present in gene pools is an important determination for breeding programs. This study was conducted to determine the level of variation in durum wheat cultivars (Triticum turgidum L. var durum) based on different measures. Genetic diversity in durum wheat was measured in a collection of 113 improved cultivars and landraces of diverse ecogeographical origin by means of restriction fragment length polymorphism (RFLP), morphophysiological traits, and coefficient of parentage (COP). Thirty-nine clones and a single restriction enzyme were used to measure the RFLP-based genetic distance. Average taxonomic distances were calculated for the morphophysiological traits evaluated in four location-years. Lower genetic distances were observed for both RFLP and morphophysiological traits for the improved cultivars and for some landraces from Morocco and Jordan, while genetic distances were larger for the rest of the landraces. Patterns of variation for morphophysiological traits were associated with days to heading, plant height, and harvest index. Landraces contained 99 of the total fragments observed in the pool of improved varieties and showed 13 unique fragments. Coefficient of parentage analysis revealed 15 ancestral lines that contributed 72 of the genetic make up of improved cultivars. Thirty-nine different ancestors contributed to the remaining 28. Correlation of distances based on different measures was higher for average taxonomic distance and Nei's genetic distance (r = 0.47) while COP relationship with the other two measures was lower. Narrower genetic diversity in breeding lines based on the measures used, suggests the utilization of other sources of variation.

2646 Baenziger, P.S. (USDA, ARS, Lincoln, NE.); Moreno Sevilla, B.; Peterson, C.J.; Schmidt, J.W.; Shelton, D.R.; Baltensperger, D.D.; Nelson, L.A.; McVey, D.V.; Hatchett, J.H. (1996) **Registration of 'Niobrara' wheat.** *Crop science (USA) v. 36(3) p. 803.* references. English. (AGRIS 97-031940).

2647 Bahraei, S. (1996) **The use of random amplified polymorphic DNA (RAPD) markers in genetic diversity studies of Triticum boeoticum and T. urartu.** Seed and Plant Improvement Institute, Karadj (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research Seed and Plant Improvement Institute (Iran Islamic Republic) v. 12(1) p. 5.* Persian. (AGRIS 97-031820).

2648 Basford, K.E.; Kroonenberg, P.M.; Cooper, M. (Department of Agriculture, University of Queensland, Brisbane, Qld 4072 (Australia)) (1996) **Three-mode analytical methods for crop improvement programs.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 291-305.* CAB INTERNATIONAL. 23 ref. English. (AGRIS 97-032246).

2649 Baum, BR.; Nevo, E.; Johnson, DA.; Beiles, A. (1997) **GENETIC DIVERSITY IN WILD BARLEY (HORDEUM SPONTANEUM C KOCH) IN THE NEAR EAST - A MOLECULAR ANALYSIS USING RANDOM AMPLIFIED POLYMORPHIC DNA (RAPD) MARKERS.** *Genetic Resources & Crop Evolution. 44(2):147-157.* English. [AGR & AGRI FOOD CANADA CTR LAND & BIOL RESOURCES RES CENT EXPT FARM OTTAWA ON K1A 0C6 CANADA].

We analyzed the genetic diversity in 88 genotypes from 20 populations of wild barley (Hordeum spontaneum C. Koch) from Israel, Turkey and Iran, by randomly amplified polymorphic DNA (RAPD). Twenty two of the 33 primers used yielded scorable products with 1-11 polymorphic bands. No duplicate patterns were found except for four haplotypes. When the total genetic diversity was estimated, 75% of the variation detected was partitioned within the 88 genotypes and 25% among the populations. When variation between countries was assessed, no substantial differences were found, because most of the variation detected (97%) was partioned within the 20 populations and the remainder among countries. The results of this limited survey indicate that the extensive genetic diversity is present in natural stands of wild barley throughout the Fertile Crescent. [References: 36].

2650 Berna, A.; Bernier, F. (1997) **REGULATED EXPRESSION OF A WHEAT GERMIN GENE IN TOBACCO - OXALATE OXIDASE ACTIVITY AND APOPLASTIC LOCALIZATION OF THE HETEROLOGOUS PROTEIN.** *Plant Molecular Biology. 33(3):417-429.* English. [UNIV LOUIS PASTEUR STRASBOURG 1 INST BOT CNRS IBMP 28 RUE GOETHE F-67083 STRASBOURG FRANCE].

Wheat (Triticum aestivum) germin is a homopentameric glycoprotein whose synthesis is allied with seed germination. Germin pentamers show an unusual resistance to dissociation and possess an oxalate oxidase (OxO) activity. In order to increase our knowledge of germin gene expression, the function(s) of germin during development and possible uses in plant genetic engineering, an in vivo expression system is required. To this end, a gene for germin, named gf-2.8, was studied by expressing either promoter-GUS fusions or the intact gene in transgenic tobacco (Nicotiana tabacum) plants. Heterologous gene transcription was monitored in vitro and in vivo by GUS or OxO activity and was found to occur in developing seeds and in seedlings. This transcription was stimulated by auxins, as would be expected because of the presence of putative auxin-responsive elements in the promoter of the gf-2.8 Auxin stimulation also extended to young leaves since OxO activity could be detected in treated but not in untreated leaves. The biochemical characteristics of wheat germin were also conserved in a transgenic host: the OxO activity was present under the form of a doublet co-migrating with germin G and G' isoforms. Also, germin distributed between a soluble and an apoplastic fractions despite the fact that wheat cell wall substantially differs from tobacco cell wall. Therefore, tobacco constitutes a suitable host for in vivo studies of this monocotyledon gene. [References: 44].

2651 Bernicot, M.H. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Barley cultivars, in France]. Les varietes d'orge.** *Perspectives Agricoles (France) (no 213) p. 76-93.* 8 tableaux, 15 graph. French. (AGRIS 97-031571).

2652 Bernicot, M.H. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Cereal cultivars. Registration rules in CTPS [Permanent technical committee for plant breeding]: a lever for directing plant breeding (France)]. Les varietes de cereales. Regles d'inscription au CTPS [Comite Technique Permanent de la Selection]: un levier d'orientation pour la selection (France).** *Perspectives Agricoles (France) (no 213) p. 36-41.* French. (AGRIS 97-031568).

2653 Bernicot, M.H. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Soft wheat cultivars, in France]. Les varietes de ble tendre.** *Perspectives Agricoles (France) (no 213) p. 48-75.* 12 tableaux, 11 graph. French. (AGRIS 97-031570).

2654 Bernicot, M.H. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Spring barley: cultivars for malting]. Orge de printemps: les varietes elues par les malteurs.** *Perspectives Agricoles (France) (no 219) p. 76-79.* French. (AGRIS 97-045802).

2655 Bezant, J.; Laurie, D.; Pratchett, N.; Chojecki, J.; Kearsey, M. (1997) **MAPPING QTL CONTROLLING YIELD AND YIELD COMPONENTS IN A SPRING BARLEY (HORDEUM VULGARE L) CROSS USING MARKER REGRESSION.** *Molecular Breeding. 3(1):29-38.* English. [JOHN INNES CTR PLANT SCI RES COLNEY LANE NORWICH NR4 7UH NORFOLK ENGLAND].

An RFLP map constructed from 99 doubled haploid lines of a cross between two spring barley varieties (Blenheim x Kym) was used to localize quantitative trait loci (QTL) controlling grain yield and yield components by marker regression and single-marker analysis. Trials were conducted over three years. Genotype-by-year interaction was detected for plant grain weight and ear grain weight so they were analysed separately for each year. None was detected for thousand-grain weight and ear grain number so data were pooled over years. A total of eleven QTL were detected for plant grain weight over two years and fourteen for ear grain weight over three years. Seven QTL were detected for plot yield. The locus with the largest effect was on chromosome 2(2H)L and accounted for 19% of the Variation in the progeny. Eight QTL were detected for thousand-grain weight and five for ear grain number. Many of the QTL detected were in comparable positions in each year. Yield and yield components were only partly correlated. Comparisons based on common RFLP markers showed that some QTL were found in positions similar to those identified in other studies. For a number of QTL the identification of linked markers provided suitable opportunities for marker-assisted selection and improvement of barley and reference markers with which to analyse the homoeologous chromosome regions of wheat and other cereals. [References: 29].

2656 Biyashev, RM.; Ragab, RA.; Maughan, PJ.; Maroof, MAS. (1997) **MOLECULAR MAPPING, CHROMOSOMAL ASSIGNMENT, AND GENETIC DIVERSITY ANALYSIS OF PHYTOCHROME LOCI IN BARLEY (HORDEUM VULGARE).** *Journal of Heredity. 88(1):21-26.* English. [VIRGINIA POLYTECH INST & STATE UNIV DEPT CROP & SOIL ENVIRONM SCI BLACKSBURG, VA 24601 USA].

Phytochromes belong to a family of photoreceptors that perceive, interpret, and translate light signals that effect plant growth and development. The objectives of this study were to use a heterologous phytochrome cDNA probe from oat to (1) identify phytochrome loci in barley, (2) determine the chromosomal and genomic location of phytochrome gene(s) in barley, and (3) assess the extent of genetic variation at phytochrome loci in cultivated barley (Hordeum vulgare). Restriction fragment length polymorphism (RFLP) analysis detected four distinct phytochrome loci in barley, arbitrarily designated phy1, phy2, phy3, and phy4. Wheat-barley addition line analysis indicated that phy1, phy2, and phy3 are located on barley chromosomes 7, 4, and 5, respectively, while phy4 represents duplicate loci located on barley chromosomes 2 and 7. Linkage mapping confirmed our results using wheat-barley addition line analysis and located the phy1 and phy3 loci to the short arm of barley chromosome 7 and to the centromeric region of barley chromosome 5, respectively. Two to three alleles were detected at each of the five phytochrome loci examined. Genetic diversity values for the phytochrome loci were near previous estimates for RFLPs. Division of the barley samples based on spike morphology indicated that the revel of diversity in two- and six-rowed barley is about equal, although significant differences in allelic frequencies were detected between the subgroups. [References: 29].

2657 Blake, T.K. (USDA, ARS, Bozeman, MT.); Hockett, E.A.; Hensleigh, P.F.; Bowman, H.F.; Carlson, G.A.; Oberthur, L.E.; Kushnak, G.; Wichman, D.; Eckhoff, J. (1996) **Registration of 'Chinook' barley.** *Crop science (USA) v. 36(3) p. 809-810.* English. (AGRIS 97-031934).

2658 Braun, P. (Institut Technique des Cereales et des Fourrages, Paris (France)); Bernicot, M.H. (1996) **[Durum wheat cultivars]. Les varietes de ble dur.** *Perspectives Agricoles (France) (no 213) p. 94-100.* French. (AGRIS 97-031572).

2659 Bregitzer, P. (USDA, ARS, National Small Grains Germplasm Research Facility, Aberdeen, ID.); Wesenberg, D.M.; Jones, B.L. (1995) **Effect of the ANT-13 locus (proanthocyanidin-free) on the malting quality and agronomic performance of barley.** *American Society of Brewing Chemists (USA) v. 53(4) p. 191-193.* references. English. (AGRIS 97-031919).

2660 Buerstmayr, H.; Lemmens, M.; Patschka, G.; Grausgruber, H.; Ruckenbauer, P. (1996) **HEAD BLIGHT (FUSARIUM SPP.) RESISTANCE OF WHEAT CULTIVARS REGISTERED IN AUSTRIA.** *Bodenkultur. 47(3):183-190.* English. [INTERUNIV FORSCH INST AGRARBIOTECHNOL ABT BIOTECHNOL PFLANZENPROD KONRAD LORENZ STR 20 A-3430 TULLN AUSTRIA].

Within the scope of a resistance breeding program against Fusarium head blight (FHB, scab) of wheat, the resistance of in Austria registered wheat cultivars and breeding lines in national list trials was tested. The wheat genotypes were artificially inoculated and disease development as well as yield loss were determined. The results of a three years' investigation are presented in this contribution. Based on visual observations the most resistant winter wheat genotypes were Martin, Livius, Karat, Extrem, Expert and Perlo. Of the investigated spring wheat cultivars Kadett, Delos and Hans showed the highest resistance level. All Triticum durum genotypes reacted very susceptible. [References: 10].

2661 Cadalen, T.; Boeuf, C.; Bernard, S.; Bernard, M. (1997) **AN INTERVARIETAL MOLECULAR MARKER MAP IN TRITICUM AESTIVUM L EM THELL AND COMPARISON WITH A MAP FROM A WIDE CROSS.** *Theoretical & Applied Genetics. 94(3-4):367-377.* English. [INRA STN AMELIORAT PLANTES DOMAINE CROUELLE F-63039 CLERMONT FERRAND 2 FRANCE].

An intervarietal molecular marker map covering most of the nuclear genome was developed in Triticum aestivum. One hundred and six androgenetic-derived doubled haploid lines obtained from the F-1 between monosomics of 'Chinese Spring' and 'Courtot' were analysed for genetic mapping. The map covered 18 of the 21 chromosomes with an identical distribution of markers in the A and B genome, and only small segments of the D genome. Distorted markers were mapped using Bailey's 2-point method and revealed skewed regions on 1A, 1DS, 2A, 2B, 4AS and 6B. Comparison with a wide cross ['Opata' x Synthetic hexaploid (T. tauschii/'Altar 84')] showed colinearity for markers on homologous chromosomes, but revealed a large proportion (25%) of markers mapped on non-homoeologous chromosomes, i.e. heterologous markers. The origin of the material and distortion segregation are discussed with particular emphasis on investigations of D-genome markers. [References: 54].

2662 Castagna, R.; Gnocchi, S.; Perenzin, M.; Heun, M. (1997) **GENETIC VARIABILITY OF THE WILD DIPLOID WHEAT TRITICUM URARTU REVEALED BY RFLP AND RAPD MARKERS.** *Theoretical & Applied Genetics. 94(3-4):424-430.* English. [IST SPERIMENTALE CEREALICOLTURA VIA MULINO 3 I-20079 SAN ANGELO LODIGIANO LO ITALY].

Genetic variability among 49 accessions of Triticum urartu was estimated by RFLP and RAPD marker analyses, and the two data sets were compared. One T. timopheevii accession and two accessions of T. durum and T. aestivum, respectively, were included to identify T. urartu accessions closely related to these polyploid wheats. Twenty eight RFLP clones and 29 RAPD primers generated 451 and 155 polymorphic bands, respectively. The three accessions from Armenia clustered together and were well separated from all other accessions, which showed less

pronounced geographical patterns. Genetic similarity and co-phenetic values calculated with RAPD markers were very similar to those calculated with RFLP markers for the intraspecific comparisons, but not for the interspecific comparisons. The identification of individual T. urartu accessions which are more related to polyploid wheats than others was not possible. [References: 42].

2663 Castilho, A.; Miller, TE.; Heslopharrison, JS. (1997) **ANALYSIS OF A SET OF HOMOEOLOGOUS GROUP 1 WHEAT AEGILOPS UMBELLULATA RECOMBINANT CHROMOSOME LINES USING GENETIC MARKERS.** *Theoretical & Applied Genetics. 94(2):293-297.* English. [JOHN INNES CTR PLANT SCI RES COLNEY LANE NORWICH NR4 7UH NORFOLK ENGLAND].

Eleven wheat-Ae. umbellulata recombinant lines involving chromosome 1U, including an important high-molecular-weight glutenin locus, were characterized by protein and RFLP markers. Four 1U-1A recombinants, one 1U-1B recombinant, two 1U deletions with either nullisomy for chromosome 1A or 1B and a 1U ditelosomic addition line were detected, while 3 recombinant lines involved 1U and non-homoeologous wheat chromosomes. Similar recombination events were found in independent lines, and no small segmental translocations of Ae. umbellulata chromatin were detected. Correlation of the markers with physical maps of the wheat-Ae. umbellulata breakpoints obtained using in situ hybridization enabled the marker order to be established on chromosomes 1A, 1B and 1U. The short arm of chromosome 1A probably differs from both 1U and IB by one inversion. As now being found to be universal in the Triticeae, clustering of the genetical map in the distal physical regions of the group chromosomes was found. [References: 29].

2664 Ceccarelli, S. (ICARDA, PO Box 5466, Aleppo (Syria)) (1996) **Positive interpretation of genotype by environment interactions in relation to sustainability and biodiversity.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 467-486.* CAB INTERNATIONAL. 57 ref. English. (AGRIS 97-031707).

2665 Ceccarelli, S.; Grando, S. (ICARDA, Aleppo (Syria)) (1996) **Importance of specific adaptation in breeding for marginal conditions. 1.** Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 34-58.* IAR/ICARDA. 13 tables; 5 fig., 49 ref. English. (AGRIS 97-046283).

The paper discusses evidence showing that the use of breeding principles developed for and successfully applied in favorable environments may be the main reason for the lack of breeding progress in marginal environments. Very little breeding work has been done in marginal environments, although the theory of correlated responses to selection suggests that selection conducted in good environments or in well-managed experiment stations is not expected to be very efficient when genotype by environment interactions of a cross-over type exist. The assumptions that heritability is higher under good conditions and that there is a carry-over effect of high yield potential are not supported by experimental evidence. If the target environment is below the cross-over point, selection has to be conducted for specific adaptation to that environment. The concept of wide adaption is more geographical than environmental and it reduces genetic diversity and increases genetic vulnerability eventually the issue of genetic heterogeneity versus genetic uniformity is discussed in relation to specific adaptation to marginal environments.

2666 Chen Wanquan; Hu Changcheng; Yan Sibai (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. of Plant Protection) (1995) **Chromosome location of genes for leaf rust resistance in winter wheat cultivar Beijing 837 [China].** *Acta Phytopathologica Sinica (China) v. 25(4) p. 297-300.* 2 tables; 8 ref. Chinese. (AGRIS 97-046807).

2667 Christou, P. (Laboratory for Transgenic Technology and Metabolic Pathway Engineering, John Innes Centre, Norwich NR4 7UH (United Kingdom)) (1996) **Transformation technology.** *Trends in Plant Science (United Kingdom) v. 1(12) p. 423-431.* 65 ref. English. (AGRIS 97-046152).

2668 Ciuffetti, LM.; Tuori, RP.; Gaventa, JM. (1997) **A SINGLE GENE ENCODES A SELECTIVE TOXIN CAUSAL TO THE DEVELOPMENT OF TAN SPOT OF WHEAT.** *Plant Cell. 9(2):135-144.* English. [OREGON STATE UNIV DEPT BOT & PLANT PATHOL CORDLEY HALL CORVALLIS, OR 97331 USA].

The identification and characterization of pathogenicity factors are essential to an understanding of the molecular events that regulate the interaction of plant-pathogenic microbes with their hosts. We have isolated the gene that encodes a host-selective toxic protein produced by the fungus Pyrenophora tritici-repentis and confirmed that this gene functions in the plant as the primary determinant of pathogenicity in the Pyrenophora-wheat interaction. These results demonstrate that a single gene encodes the production of a host-selective toxin and that transformation of this gene into a non-toxin-producing isolate of P. tritici-repentis leads to both toxin production and pathogenicity. [References: 43].

2669 Clamot, G. (Centre de Recherches Agronomiques, Gembloux (Belgium). Station d'Amelioration des Plantes); Boxus, P. (eds.) (1996) **[Plants breeding, in vitro propagation and plant genetic resources valorization [Ceratonia siliqua; in Belgium]]. Amelioration des plantes, multiplication in vitro et valorisation des ressources phytogenetiques. [Activity report 1993-1994].** *Rapport d'Activite. Centre de Recherches Agronomiques - Gembloux (Belgium) ISSN 0770-8343 p. 27-55. Centre de Recherches Agronomiques de l'Etat, Gembloux (Belgium).* Centre de Recherches Agronomiques, Service des Relations Publiques. 11 ill.; 10 tables. French. (AGRIS 97-032184).

2670 Collado, L.S. (The University of Hong Kong, Hong Kong.); Corke, H. (1996) **Use of wheat-sweet potato composite flours in yellow-alkaline and white-salted noodles.** *Cereal chemistry (USA) v. 73(4) p. 439-443.* references. English. (AGRIS 97-046516).

Chinese-style yellow alkaline noodles (YAN) and Japanese-style white salted noodles (WSN) were prepared from a standard brand of hard red winter wheat flour (Red Bicycle) and from composite flours containing the wheat flour plus 25 sweet potato flour (SPF). SPF from four Philippine genotypes (CL-941-25, Miracle L, CN-941-32, and CL-1489-89) was used. The composite flours showed two distinct gelatinization endotherms corresponding to the two types of starch present. The gelatinization enthalpies of the composite flours were generally slightly lower than all-wheat flour, except for CL-1489-89, which had minimal amylase activity. Rapid Visco-Analyser (RVA) viscoamylographs of composite flours were significantly different under slightly acidic conditions (pH 5.7-6.0) but not under alkaline conditions (pH 10), primarily due to differences in SPF amylase activity. Correspondingly, YAN were firmer and had lower cooking loss than WSN. Sweet potato genotypes differed significantly in the color imparted to the composite flour noodles. The modified Pekar Slick test was conducted on SPF under alkaline and under slightly acidic conditions to show the extent of discoloration during processing. For wheat-sweet potato composite flours, the addition of ascorbic acid tended to increase noodle firmness. However, a higher degree of browning after 24 hr of storage at 4 degrees C was observed in noodles containing ascorbic acid. RVA viscoamylographs and the modified Pekar slick test results can be used to screen sweet potato cultivars for noodle quality.

2671 Cooper, M.; Brennan, P.S.; Sheppard, J.A. (Department of Agriculture, University of Queensland, Brisbane, Qld 4072 (Australia)) (1996) **A strategy for yield improvement of wheat which accommodates large genotype by environment interactions.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 487-511.* CAB INTERNATIONAL. 76 ref. English. (AGRIS 97-032247).

2672 Cooper, M.; DeLacy, I.H.; Basford, K.E. (Department of Agriculture, University of Queensland, Brisbane, Qld 4072 (Australia)) (1996) **Relationships among analytical methods used to analyse genotypic adaptation in multi-environment trials.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 193-224.* CAB INTERNATIONAL. 46 ref. English. (AGRIS 97-032031).

2673 Cooper, M.; Fox, P.N. (Department of Agriculture, University of Queensland, Qld 4072 (Australia)) (1996) **Environmental characterization based on probe and reference genotypes.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 529-547.* CAB INTERNATIONAL. 35 ref. English. (AGRIS 97-032248).

2674 Cuadrado, A.; Vitellozzi, F.; Jouve, N.; Ceoloni, C. (1997) **FLUORESCENCE IN SITU HYBRIDIZATION WITH MULTIPLE REPEATED DNA PROBES APPLIED TO THE ANALYSIS OF WHEAT-**

RYE CHROMOSOME PAIRING. *Theoretical & Applied Genetics. 94(3-4):347-355.* English. [UNIV TUSCIA DEPT AGROBIOL & AGROCHEM I-01100 VITERBO ITALY].

Fluorescence in situ hybridization (FISH) with multiple probes has been applied to meiotic chromosome spreads derived from phlb common wheat x rye hybrid plants. The probes used included pSc74 and pSc 119.2 from rye (the latter also hybridizes on wheat, mainly B genome chromosomes), the Ae. squarosa osa pAs1 probe, which hybridizes almost exclusively on D genome chromosomes, and wheat rDNA probes pTa71 and pTa794. Simultaneous and sequential FISH with a two-by-two combination of these probes allowed unequivocal identification of all of the rye (R) and most of the wheat (W) chromosomes, either unpaired or involved in pairing. Thus not only could wheat-wheat and wheat-rye associations be easily discriminated, which was already feasible by the sole use of the rye-specific pSc74 probe, but the individual pairing partners could also be identified. Of the wheat-rye pairing observed, which averaged from about 7% to 11% of the total pairing detected in six hybrid plants of the same cross combination, most involved B genome chromosomes (about 70%), and to a much lesser degree, those of the D (almost 17%) and A (14%) genomes. Rye arms 1RL and 5RL showed the highest pairing frequency (over 30%), followed by 2RL (11%) and 4RL (about 8%), with much lower values for all the other arms. 2RS and 5RS were never observed to pair in the sample analysed. Chromosome arms 1RL, 1RS, 2RL, 3RS, 4RS and 6RS were observed to be exclusively bound to wheat chromosomes of the same homoeologous group. The opposite was true for 4RL (paired with 6BS and 7BS) and 6RL (paired with 7BL). 5RL, on the other hand, paired with 4WL arms or segments of them in more than 80% of the cases and with 5WL in the remaining ones. Additional cases of pairing involving wheat chromosomes belonging to more than one homoeologous group occurred with 3RL, 7RS and 7RL. These results, while adding support to previous evidence about the existence of several translocations in the rye genome relative to that of wheat, show that FISH with multiple probes is an efficient method by which to study fundamental aspects of chromosome behaviour at meiosis, such as interspecific pairing. The type of knowledge attainable from this approach is expected to have a significant impact on both theoretical and applied research concerning wheat and related Triticeae. [References: 37].

2675 Cyran, M.; Rakowska, M.; Lapinski, B. (Department of Nutritional Evaluation of Plant Materials, Institute of Plant Breeding, Radzikow, P.O. Box 1019, 00 950 Warsaw (Poland)) (1996) **Content and composition of non-cellulosic polysaccharides of alloplasmic rye compared to parental species - tetraploid triticale and rye.** *Agri-food quality: an interdisciplinary approach. Fenwick, G.R.; Hedley, C.; Richards, R.L.; Khokhar, S. (eds.) p. 192-195.* Royal Society of Chemistry. 8 ref., Special Publication No. 179. English. (AGRIS 97-046663).

2676 D'Ovidio, R. (Universita della Tuscia, Viterbo, Italy.); Simeone, M.; Masci, S.; Porceddu, E.; Kasarda, D.D. (1995) **Nucleotide sequence of a gamma-type glutenin gene from a durum wheat: correlation with a gamma-type glutenin subunit from the same biotype.** *Cereal chemistry (USA) v. 72(5) p. 443-449.* references. English. (AGRIS 97-032200).

A gene coding for an apparent gamma type glutenin subunit has been cloned from the biotype Lira 45 of the durum wheat cultivar Lira and sequenced. The nucleotide sequence of the gene from clone pTD9 showed almost perfect homology with a complete gamma-type glutenin gene of Triticum aestivum L. and with an incomplete, presumably gamma-glutenin gene isolated from a different cultivar of Triticum durum Desf. All three genes code for proteins that have an additional cysteine residue in the N-terminal region at residue 26; there are nine cysteines in the molecule rather than the eight that are typical of gamma-gliadins. This odd cysteine makes it reasonably certain that the equivalent protein will be incorporated into glutenin polymers, because all other cysteines were homologous to those in classical gamma-gliadins, making it likely that they form the usual four intramolecular disulfide bonds characteristic of gamma-gliadins. Accordingly, the ninth (odd) cysteine should be available for intermolecular disulfide bond formation. The ability to form only a single intermolecular disulfide bond would cause the molecule to act as a chain terminator during formation of glutenin polymers. In support of this, a gamma-type glutenin was purified from a glutenin preparation derived from the same biotype (Lira 45) and characterized by N-terminal amino acid sequencing to show perfect homology at the N-terminus with the protein sequence derived from sequencing of the pTD9 clone, including the cysteine at residue 26. A computer molecular model of the protein equivalent to pTD9, based on the sequence and on the disulfide bond arrangements found for gamma-gliadins (Kohler et al 1993), provides a hypothetical three-dimensional structure for the gamma-type glutenin subunit.

2677 Dahiya, M.; Uppal, S.; Chandani, M.; Chawla, D.V. (Chaudhary Charan Singh Haryana Agricultural University, Hisar (India). Departmentof Genetics) (1995) **Plant regeneration from immature embryos and somaclonal variation in wheat.** *Indian Journal of Plant Physiology (India) v. 38(1) p. 10-14.* 2 tables; 3 ill., 14 ref. English. (AGRIS 97-032187).

2678 Davoyan, R.O.; Zhirov, E.G. (1995) **[Genome-substituted form Avrodes as source of common wheat resistance to leaf rust and mildew]. Genomno-zameshchennaya forma avrodes kak istochnik ustojchivosti rastenij myagkoj pshenitsy k listovoj rzhavchine i muchnistoj rose.** *Sel'skokhozyajstvennaya biologiya. Seriya Biologiya rastenij (Russian Federation) (no.1) p. 98-101.* 11 ref. Russian. (AGRIS 97-032194).

The hexaploid common wheat form Avrodes in which the genome D of the common wheat had been substituted for the genome S of Aegilops speltoides has been used instead of the natural relative for the transfer of the common wheat resistance to the leaf rust and the mildew. The resistance of Avrodes to the leaf rust has been found to be controlled both by juvenile genes, acting at all ontogenesis stages, and the genes, acting at the stage of the mature plant only. It has been observed that the use of Avrodes capable to cause the homeologous conjugation substantially promoted the transfer of resistance genes to wheat plants. The backcrossing with the recurrent parental form (the winter wheat cultivar Avrora) resulted in the development of lines with morphological similarity to Avrora, but possessing a higher resistance to the leaf rust and the mildew.

2679 Dawit Tadese; Hailu Mekbeb (PGRC/E, Addis Abeba (Ethiopia)) (1996) **Barley genetic resources. 1.** Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 59-67.* IAR/ICARDA. 4 tables; 1 fig., 10 ref. English. (AGRIS 97-046284).

Barley in Ethiopia is a rain fed crop and predominately grows in the highlands over 2, 800 m altitude. It is produced both in the main and short rainy seasons. The cultivation of barley is being pushed to the marginal areas, therefore, genetic erosion is at an accelerating rate due to several factors. Operations for germplasm collecting are undertaken in both seasons by the Plant Genetic Resources (Centre/Ethiopia (PGRC/E). Collections made before the establishment of PGRC/E by foreign explorers and Ethiopians are described. The total number accessions conserved by the gene bank is 14, 591. Until the end of 1992 cropping season PGRC/E has collected and conserved 4, 462 germplasm accessions from various regions of the country. The distribution of these collections both in regions and altitudes is described. Some qualitative characters of barley by regions are also elaborated.

2680 Day, J.L. (The University of Georgia.); Raymer, P.L. (ed.); Coy, A.E. (ed.) (1995) **1994-95 small grains performance tests.** *Research report (University of Georgia. College of Agriculture. Experiment Stations) (USA); no. 636 54 p.* English. (AGRIS 97-031831).

2681 Dechev, D. (Institut po Pamuka i Tv"rdata Pshenitsa, Chirpan (Bulgaria)) (1996) **[The world's utilization of durum wheat and its grain requirements]. Upotreba na tv"rdata pshenitsa v sveta i iziskvaniya k"m kachestvoto na z"rnoto.** Selskostopanska Akademiya, Sofia (Bulgaria). *Selskostopanska Nauka (Bulgaria). Agricultural Science v. 34(3) p. 14-15.* 3 tables; 7 ref. Bulgarian. (AGRIS 97-032205).

Durum wheat (Triticum durum Desf) is grown on approximately 300 million dka in the world and provides about 8 of the total world's wheat grain production. The production is concentrated in definite world regions, where the main foods of the population are producted from the same crop. The most popular products of durum wheat are various makaroni, couscouss, local bread, groats, tc. These products have definite requirements concerning the grain qualities. Most important among those are high vitreousness, high contents of carotenoids, protein and glutene, as well as glutene quality. The Bulgarian durum wheat cultivars and selected lines produce high results concerning grain quality and are a prequisite for durum wheat production in Bulgaria.

2682 DeLacy, I.H.; Ratnasiri, W.G.A.; Mirzawan, P.D.N. (Department of Agriculture, University of Queensland, Brisbane, Qld 4072 (Australia)) (1996) **Retrospective analysis of historical data sets from multienvironment trials - case studies.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 269-290.* CAB INTERNATIONAL. 26 ref. English. (AGRIS 97-032245).

2683 Demissie, A.; Bjornstad, A. (1997) **GEOGRAPHICAL, ALTITUDE AND AGRO-ECOLOGICAL DIFFERENTIATION OF ISOZYME AND HORDEIN GENOTYPES OF LANDRACE BARLEYS FROM ETHIOPIA - IMPLICATIONS TO GERMPLASM CONSERVATION.** *Genetic Resources & Crop Evolution. 44(1):43-55.* English. [BIODIVERS INST ETHIOPIA POB 30726 ADDIS ABABA ETHIOPIA].

An analysis of the variability of genes encoding six isozyme systems (15 loci) and two storage proteins (2 loci) in landrace barley from Ethiopia is reported. The materials consisted of populations collected from sites as low as 1650 and as high as 3750 meters, covering a wide range of agro-ecological conditions and geographical areas. Of the 17 loci 7 were polymorphic and 10 monomorphic when the 95% criterion of polymorphism was applied. Despite the disproportionate monomorphic loci, polymorphism was detected in all populations when this criterion is used. The populations were found to possess fairly low mean number of alleles per locus (A = 1.5), low mean value of expected heterozygosity (H = 0.134) and a fairly high mean percentage of polymorphic loci (P = 35.3%). The mean F-ST = 0.474 for the populations is typical of inbreeding species. The result indicated that allelic richness is concentrated in altitude class 3 (2500-3000 m) followed by altitude class 1 (<2000 m). Altitude class 2 (2000-2500) holds an intermediate place though it is the highest in terms of expected heterozygosity (H = 0.245). Higher genetic diversity is concentrated in some geographical regions such as Shewa, Arsi, Bale compared to others (Welo, Gamu Gofa, Gojam). Genetic differentiation among the agro-ecological zones was more profound than both among the altitudes and among regions. Correlation analysis between phenotypic diversity (Shannon-Weaver diversity index) and expected heterozygosity (H) for isozyme/hordein loci revealed non significant associations except with respect to agro-ecological zones. Zn general, it was detected that sites in highland areas in central and northern regions may be more desirable for in situ conservation than sites in peripheral regions in terms of isozyme/hordein diversity and current rate of varietal replacement. [References: 43].

2684 Demorenko, I.F. (1995) **[Spring wheat Kantegirskaya 89]. Yarovaya pshenitsa Kantegirskaya 89.** *Selektsiya i semenovodstvo (Russian Federation) (no.2) p. 44-45.* Russian. (AGRIS 97-032197).

2685 Dencic, S.; Kobiljski, B.; Malesevic, M. (Institute of Field and Vegetable Crops, Novi Sad (Yugoslavia)) (1995) **Productivity of hybrids in the crosses of wheat genotypes with different spike architecture.** *Zbornik radova Matice srpske za prirodne nauke (Yugoslavia) (no. 88) p. 33-37.* 1 table; 9 ref. English. (AGRIS 97-046812).

Wheat genotypes differing in spike architecture (branched, tetrastichon and normal) were crossed and F1 and F2 generations analysed for: number of fertile spikelets/spike, number of grains/spike and grain weight/spike, in order to estimate hybrid vigour for these traits. The F1 and F2 generations were compared with better parents. The F1 and F2 progenies, except those from the cross Sava x Forlani (normal x normal spike) were lower in the number of fertile spikelets/spike, as compared with better parent. In the crosses normal x branched spike, the F1 and F2 hybrids formed a significantly lower number of grains/spike. On the contrary, the F1 generation of crosses normal x tetrastichon spike showed a high heterosis, particularly the cross Forlani x ZG 171/1. In regard to the grain weight/spike, the F1 and F2 hybrids except of cross Sava x ZG 172 exibited significant heterosis.

2686 Dorffling, K.; Dorffling, H.; Lesselich, G.; Luck, E.; Zimmermann, C.; Melz, G.; Jurgens, HU. (1997) **HERITABLE IMPROVEMENT OF FROST TOLERANCE IN WINTER WHEAT BY IN VITRO SELECTION OF HYDROXYPROLINE-RESISTANT PROLINE OVERPRODUCING MUTANTS.** *Euphytica. 93(1):1-10.* English. [UNIV HAMBURG INST GEN BOT D-22609 HAMBURG GERMANY].

In a previous study (Dorffling et al., J. Plant Physiol. 142, 222-225, 1993) in vitro-selection and regeneration of hydroxyproline (Hyp)-resistant lines of winter wheat (Triticum aestivum cv. Jo 3063) with increased frost tolerance and increased proline contents was reported. In this study the heritability of these traits was investigated. The F-1 progenies derived from the pollination of regenerated plants with pollen from wild type plants developed higher mean frost tolerance (lower LT(50) values) and higher proline levels compared with in vitro-controls and wild type plants. In the F-2 generation, which was obtained by self-pollination, segregation of the Hyp-lines in a 3:1 phenotypic ratio with regard to the traits frost tolerance and proline content was observed. Subsequent selection of extremes in the F-2 yielded homozygous plants in the F-3 generation. Lower LT(50) values and increased proline contents in those F-3 plants were significantly correlated. Furthermore, improved frost tolerance of one of the selected mutants was also observed in studies with whole plants in the F-4 generation. These results, which are similar to results of parallel studies on winter barley, provide strong evidence for the heritability of the traits 'increased frost tolerance' and 'increased proline content' obtained by this in vitro-selection procedure. The mutation seems to be due to a single incompletely dominant gene. A comparison of frost tolerance values from F-3 Hyp-progenies with those of seven standard varieties differing in frost tolerance indicates a considerable improvement of frost tolerance by the described in vitro-selection method. [References: 18].

2687 Dubcovsky, J. (University of California, Davis, CA.); Luo, M.C.; Zhong, G.Y.; Bransteitter, R.; Desai, A.; Kilian, A.; Kleinhofs, A.; Dvorak, J. (1996) **Genetic map of diploid wheat, Triticum monococcum L., and its comparison with maps of Hordeum vulgare L.** *Genetics (USA) v. 143(2) p. 983-999.* references. English. (AGRIS 97-032209).

A genetic map of diploid wheat, Triticum monococcum L., involving 335 markers, including RFLP DNA markers, isozymes, seed storage proteins, rRNA, and morphological loci, is reported. T. monococcum and barley linkage groups are remarkably conserved. They differ by a reciprocal translocation involving the long arms of chromosomes 4 and 5, and paracentric inversions in the long arm of chromosomes 1 and 4; the latter is in a segment of chromosome arm 4L translocated to 5L in T. monococcum. The order of the markers in the inverted segments in the T. monococcum genome is the same as in the B and D genomes of T. aestivum L. The T. monococcum map differs from the barley maps in the distribution of recombination within chromosomes. The major 5S rRNA loci were mapped on the short arms of T. monococcum chromosomes 1 and 5 and the long arms of barley chromosomes 2 and 3. Since these chromosome arms are colinear, the major 5S rRNA loci must be subjected to positional changes in the evolving Triticeae genome that do not perturb chromosome colinearity. The positional changes of the major 5S rRNA loci in Triticeae genomes are analogous to those of the 18S5.8S-26S rRNA loci.

2688 Dweikat, I.; Ohm, H.; Patterson, F.; Cambron, S. (1997) **IDENTIFICATION OF RAPD MARKERS FOR 11 HESSIAN FLY RESISTANCE GENES IN WHEAT.** *Theoretical & Applied Genetics. 94(3-4):419-423.* English. [PURDUE UNIV DEPT AGRON 1150 LILLY HALL W LAFAYETTE, IN 47907 USA].

The pyramiding of genes that confer race- or biotype-specfic resistance has become increasingly attractive as a breeding strategy now that DNA-based marker-assisted selection is feasible. Our objective here was to identify DNA markers closely linked to genes in wheat (Triticum aestivum L.) that condition resistance to Hessian fly [Mayetiola destructor (Say)]. We used a set of near-isogenic wheat lines, each carrying a resistance gene at 1 of 11 loci (H3, H5, H6, H9, H10, H11, H12, H13, H14, H16 or H17) and developed by backcrossing to the Hessian fly-susceptible wheat cultivar 'Newton'. Using genomic DNA of these 11 lines and 'Newton', we have identified 18 randomly amplified polymorphic DNA (RAPD) markers linked to the 11 resistance genes. Seven of these markers were identified by denaturing gradient gel electrophoresis and the others by agarose gel electrophoresis. We confirmed linkage to the Hessian fly resistance loci by cosegregation analysis in Fz populations of 50-120 plants for each different gene. Several of the DNA markers were used to determine the presence/absence of specific Hessian fly resistance genes in resistant wheat lines that have 1 or possibly multiple genes for resistance. The use of RAPD markers presents a valuable strategy for selection of single and combined Hessian fly resistance genes in wheat improvement. [References: 16].

2689 Ehl' Khal'favi, K.A.; Yunis, S. (1994) **[Genes of resistance to powdery mildew in wheat]. Geny ustojchivosti k muchnistoj rose u pshenitsy.** *Izvestiya Timiryazevskoj sel'skokhozyajstvennoj akademii (Russian Federation) (no.4) p. 189-195.* 13 ref. Russian. (AGRIS 97-032196).

2690 Evers, A.D.; Flintham, J.E. (Campden and Chorleywood Food Research Association, Chipping Campden, Gloucestershire GL55 6LD (United Kingdom)) (1996) **Improvement of sprouting control in wheat; roles of embryo cavity waxes and grain colour genes.** *HGCA Project Report (United Kingdom) (no.130) p. 1-68.* 42 ref. English. (AGRIS 97-046865).

2691 Faris, JD.; Anderson, JA.; Francl, LJ.; Jordahl, JG. (1997) **RFLP MAPPING OF RESISTANCE TO CHLOROSIS INDUCTION BY PYRENOPHORA TRITICI-REPENTIS IN WHEAT.** *Theoretical & Applied Genetics. 94(1):98-103.* English. [KANSAS STATE UNIV THROCKMORTON PLANT SCI CTR DEPT PLANT PATHOL MANHATTAN, KS 66506 USA].

Tan spot, caused by Pyrenophora tritici-repentis, is an economically important disease in major wheat production areas. The fungus can produce two genetically distinct symptoms on leaves of susceptible wheat genotypes: tan necrosis (nec) and extensive chlorosis (chl). Our objectives were to determine the number of genes conditioning resistance to tan spot in a population of wheat recombinant inbred lines, and map the chromosomal location of the resistance genes using RFLPs. Conidia produced by the P. tritici-repentis isolate Pti2 (nec + chl +) were used to inoculate seedlings of 135 recombinant inbred lines derived from the cross of the synthetic hexaploid wheat W-7984 with Opata 85. A subset of the population was inoculated with conidia produced by the isolates D308 (nec - chl +) and 86-124 (nec + chl -). Inoculated seedlings were rated on a scale of 1 to 5 based on lesion type. Necrosis-inducing culture filtrate produced by the isolate 86-124 was also used to screen the entire population. A map consisting of 532 markers was employed to identify significant associations between marker loci and tan spot resistance. The entire population was insensitive to culture filtrate produced by the isolate 86-124, and the entire subset was resistant to conidial inoculation of the same isolate. The population segregated for reaction to isolates D308 and Pti2, indicating that this population segregates for resistance to extensive chlorosis only, and not to tan necrosis. RFLP analysis indicated the presence of a gene with a major effect in 1AS, a gene with a minor effect in 4AL, and an interaction between the 1AS gene and a gene in 2DL. Together, these loci explained 49.0% of the variation in this population for resistance to tan spot produced by the isolate Pti2. Two regions one in 1BL and one in 3BL, were significantly associated with resistance to extensive chlorosis, but were not significant in the multiple regression model. It should be feasible to introgress these resistance loci into adapted genetic backgrounds by using a marker-assisted selection scheme. [References: 36].

2692 Fekadu Alemayehu; Berhanu Bekele (IAR, Addis Abeba (Ethiopia)); Fedadu Tufa; Adisie Nuramo; Tesfaye Getachew (1996) **Malting barley breeding. 1.** Proceedings of the Barly Research Review Workshop. Addis Abeba (Ethiopia). 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); van leur, Joop (eds.) p. 24-33.* IAR/ICARDA. 13 tables; 4 ref. English. (AGRIS 97-046356).

Research on malting barley was started with introduced malting barley varieties. Between 1964 and 1985 over 900 exotic varieties were evaluated for adaptation, disease resistance and other agronomic characters. Between 1964 and 1971 many exotic varieties were tested out of which three outstanding malt barley varieties; Beka, Proctor and Kenya Research were identified and recommended for production. Varieties Holkr and Balkr were identified from the hybridization program between 1975 and 1978. None of the local germplasm showed the required malting quality from the early research work.

2693 Fox, P.N. (CIMMYT, Apdo. Postal 6 641, 06600 Mexico, D.F (Mexico)) (1996) **The CIMMYT Wheat Program's international multi-environment trials.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 175-183.* CAB INTERNATIONAL. 8 ref. English. (AGRIS 97-032243).

2694 Fox, P.N.; Skovmand, B. (CIMMYT, Apdo. Postal 6 641, 06600 Mexico, D.F (Mexico)) (1996) **The International Crop Information System (ICIS) - connects genebank to breeder to farmer's field.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 317-326.* CAB INTERNATIONAL. 10 ref. English. (AGRIS 97-032244).

2695 Fuentesdavila, G.; Rajaram, S.; Vanginkel, M.; Rodriguezramos, R.; Abdalla, O.; Mujeebkazi, A. (1996) **ARTIFICIAL SCREENING FOR RESISTANCE TO TILLETIA INDICA.** *Cereal Research Communications. 24(4):469-475.* English. [CIMMYT INT MAIZE & WHEAT IMPROVEMENT CTR APDO POSTAL 6-641 MEXICO CITY 06600 DF MEXICO].

Advanced bread wheat lines (Triticum aestivum); durum wheat (T. durum), hybrids derived from T. aestivum with Agropyron spp. and lines from basic germplasm were evaluated for resistance to Tilletia Indica. Plants were artificially inoculated during boot stage with a sporidial suspension of 10(4)/ml on three planting dates at CIANO, Cd. Obregon, Sonora, Mexico, during 1990-91. Percentages of lines with levels of infection below 5% were 33.3 for lines derived from intergeneric crosses, 36.4 for bread wheats, 59.5 for lines from the basic germplasm development program and 80.8 for durum wheats. The average percent infection of the susceptible check was 73%. [References: 6].

2696 Gao Mingjun (Qingdao Ocean Univ., Shandong (China). Dept. of Bioengineering) (1995) **Application of isozyme gene locations on the wheat chromosome engineering.** *Hereditas (China) v. 17(Suppl.) p. 19-23.* 2 tables; 41 ref. Chinese. (AGRIS 97-046822).

2697 Gill, K.S. (Kansas State University, Manhattan, KS.); Gill, B.S. (1996) **A PCR-based screening assay of Ph1, the chromosome pairing regulator gene of wheat.** *Crop science (USA) v. 36(3) p. 719-722.* references. English. (AGRIS 97-032203).

Ph1 is the principle gene regulating chromosome pairing of wheat (Triticum aestivum L. em Thell.). Ph1 dictates that only the homologous (not homoeologous) chromosomes can pair at MI of meiosis. In the absence of the gene, homoeologous chromosomes may also pair, however. Homoeologous chromosome pairing can be activated by temporarily replacing the normal copy of the gene with its null allele, which is present in the ph1b mutant. One of the main difficulties during these manipulations is the scoring plants for the presence or absence of the Ph1 gene. We developed a polymerase chain reaction (PCR) based screening assay for the Ph1 gene. The probe pHvksu8, which maps in the interstitial deletion of the ph1b mutant encompassing the Ph1 gene, was sequenced and forward and a reverse primers, 20 bp each, were generated. These primers amplified a fragment each for chromosomes 5A, 5B, and 5D. The 5B specific fragment was not amplified in the ph1b mutant, and can be used as a diagnostic fragment to score plants for the presence of Ph1 gene. The reliability of the primers for the Ph1 gene scoring was tested on an F2 population of 40 plants, segregating for the Ph1 gene. No discrepancy was observed between the PCR-based assay and gel blot DNA hybridization for detection of the fragment associated with the Ph1 gene.

2698 Gill, K.S. (Kansas State University, Manhattan, KS.); Gill, B.S.; Endo, T.R.; Boyko, E.V. (1996) **Identification and high-density mapping of gene-rich regions in chromosome group 5 of wheat.** *Genetics (USA) v. 143(2) p. 1001-1012.* references. English. (AGRIS 97-032201).

The distribution of genes and recombination in the wheat genome was studied by comparing physical maps with the genetic linkage maps. The physical maps were generated by mapping 80 DNA and two phenotypic markers on an array of 65 deletion lines for homoeologous group 5 chromosomes. The genetic maps were constructed for chromosome 5B in wheat and 5D in Triticum tauschii. No marker mapped in the proximal 20 chromosome region surrounding the centromere. More than 60 of the long arm markers were present in three major clusters that physically encompassed < 18 of the arm. Because 48 of the markers were cDNA clones and the distributions of the cDNA and genomic clones were similar, the marker distribution may represent the distribution of genes. The gene clusters were identified and allocated to very small chromosome regions because of a higher number of deletions in their surrounding regions. The recombination was suppressed in the centromeric regions and mainly occurred in the gene-rich regions. The bp/cM estimates varied from 118 kb for gene-rich regions to 22 Mb for gene-poor regions. The wheat genes present in these clusters are, therefore, amenable to molecular manipulations parallel to the plants with smaller genomes like rice.

2699 Gilmour, R.F.; Hunter, R.A.; Brown, G.A.; Portmann, P.A. (Department of Agriculture, Baron Hay Court, South Perth, WA 6151 (Australia)) (1996) **Analysis and interpretation of data from the Crop Variety Testing Program in Western Australia.** *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 185-192.* CAB INTERNATIONAL. 16 ref. English. (AGRIS 97-032242).

2700 Gilmour, R.F.; Tarr, A.W.; Harasymow, S.E. (Department of Agriculture, Baron Hay Court, South Perth, WA 6151 (Australia)) (1996)

Selection for grain quality traits in early generation barley breeding trials using residual maximum likelihood (REML). *Plant adaptation and crop improvement. Cooper, M.; Hammer, G.L. (eds.) p. 307-316.* CAB INTERNATIONAL. 21 ref. English. (AGRIS 97-031706).

2701 Gubler, F.; Watts, RJ.; Kalla, R.; Matthews, P.; Keys, M.; Jacobsen, JV. (1997) CLONING OF A RICE CDNA ENCODING A TRANSCRIPTION FACTOR HOMOLOGOUS TO BARLEY GAMYB. *Plant & Cell Physiology. 38(3):362-365.* English. [COOPERAT RES CTR PLANT SCI POB 475 CANBERRA ACT 2601 AUSTRALIA].

A cDNA clone, OsGAmyB, which encodes a homologue to the barley Myb-like transcription factor, HvGAMSyb, was isolated from a rice endosperm cDNA library. The clone was used to show that expression of the OsCAmyb gene in aleurone cells was stimulated by gibberellic acid and the gene product was shown to transactivate an alpha-amylase gene promoter in transient expression analyses. [References: 18].

2702 Gusta, LV.; Oconnor, BJ.; Machutcheon, MG. (1997) THE SELECTION OF SUPERIOR WINTER-HARDY GENOTYPES USING A PROLONGED FREEZE TEST. *Canadian Journal of Plant Science. 77(1):15-21.* English. [UNIV SASKATCHEWAN CTR CROP DEV 51 CAMPUS DR SASKATOON SK S7N 5A8 CANADA].

Methods of assessing the freezing tolerance of winter cereals must be improved in order to distinguish small differences due to genotype or environment. Seed of eight winter wheat (Triticum aestivum L. em Thell) cultivars, ranging in winter hardiness, were sown either in mid-August, the first week of September or mid-September. Individual plants of each were collected in late October and stored at either -4 degrees or -8 degrees C. In December controlled freeze tests, employing a cooling rate of 2 degrees C h(-1), could not distinguish the less freezing-tolerant cultivars stored at -4 degrees C. However, by March the less winter-hardy cultivars from the third seeding date stored at -4 degrees C could be distinguished. Seedlings stored at -8 degrees C declined in freezing tolerance more rapidly than seedlings stored at -4 degrees C. In December, the less hardy winter wheat cultivars, Rose, Rita and Siouxland, were less freezing tolerant than the hardy cultivars (e.g. Norstar). Seedlings of Rita and Siouxland from the second and third seeding date died by February when stored at -8 degrees C. Seedings of all winter wheat cultivars were dead by March, except Norstar and Alabaskaja, the most winter-hardy cultivars. Storage of seedlings of wheat, triticale (x Triticosecale Rimpani Wit.) and rye (Secale cereale L.) at either -12 degrees or -15 degrees C readily identified the superior winter-hardy genotypes. For example, in mid-winter both Siouxland and Norstar winter wheat had a similar LT(50) (temperature at which 50% of the plants are killed). However, Siouxland could not tolerate storage at either -12 degrees or -15 degrees C for the same length of time as Norstar. These results support the theory that winter kill in nature is more a function of duration of exposure to sub-lethal temperatures rather than exposure to a minimum low temperature for a short duration as programmed in a conventional freeze test. A more realistic and precise freeze test would be to determine the ability of genotypes to survive lengthy exposure to sub-lethal low temperatures. [References: 29].

2703 Hailu Gebre; Berhane Lakew (IAR, Addis Abeba (Ethiopia)); Fekadu Fufa; Berhanu Bekele; Alemayehu Asefa; Tesfaye Getachew (1996) Food barley breeding. 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 9-23.* IAR/ICARDA. 9 tables; 18 ref. English. (AGRIS 97-046282).

Food barley breeding in the 1950s and 1960s was mainly conducted at the Debre Zeit Agricultural Experiment Station of the College of Agriculture and Mechanical Arts. Local and introduced germplasms were evaluated from which high yielding selections were identified. The breeding program was expanded and strengthened with the establishment of Holetta Research Center and Chilalo Agricultural Development Unit in the mid-1960s and other research centers lately. Several exotic and local germplasm were evaluated at Holetta and other locations. Exotic varieties were poorly adapted and susceptible to diseases and insects. A number of local varieties showed good adaption and tolerance or resistance to diseases and insect pests, but had a low yield potential. Hybridization and selection were done on local and introductions were conducted at scald and net blotch, lodging and other environmental stresses. Several high lysine lines were identified. Variety trials of selections from crosses, local collections, and introductions were conducted at several locations in the country. High yielding varieties such as Composite 29, IAR/H/485, AHOR 880/61, HB-42 and ARDU 12-60B were released for the central and eastern highlands. Farmers' varieties were found unexcelled at locations with stress enviornments.

2704 Haley, S.D. (South Dakota State University, Brookings, SD.); Moreno Sevilla, B.; Baenziger, P.S.; Peterson, C.J.; Schmidt, J.W.; Shelton, D.R.; Baltensperger, D.D.; Nelson, L.A.; McVey, D.V. (1996) Registration of 'Nekota' wheat. *Crop science (USA) v. 36(3) p. 803-804.* references. English. (AGRIS 97-032144).

2705 Han, F.; Kleinhofs, A.; Kilian, A.; Ullrich, SE. (1997) CLONING AND MAPPING OF A PUTATIVE BARLEY NADPH-DEPENDENT HC-TOXIN REDUCTASE. *Molecular Plant-Microbe Interactions. 10(2):234-239.* English. [WASHINGTON STATE UNIV DEPT CROP & SOIL SCI PULLMAN, WA 99164 USA].

The NADPH-dependent HC-toxin reductase (HCTR), encoded by Hm1 in maize, inactivates HC-toxin produced by the fungus Cochliobolus carbonum, and thus confers resistance to the pathogen. The fact that e. carbonum only infects maize (Zea mays) and is the only species known to produce HC-toxin raises the question: What are the biological functions of HCTR in other plant species? An HCTR-like enzyme may function to detoxify toxins produced by pathogens which infect other plant species (R. B. Meeley; G. S. Johal, S. E. Briggs, and J. D. Walton, Plant Cell, 4:71-77, 1992). Hm1 homolog in rice (Y. Hihara, M. Umeda, C. Hara, Q. Liu, S. Aotsuka, K. Toriyama, and H. Uchimiya, unpublished) and HCTR activity in barley, wheat, oats and sorghum have been reported (R. B. Meeley and J. D. Walton, Plant Physiol. 97:1080-1086, 1993). To investigate the sequence conservation of Hm1 and HCTR in barley and the possible relationship of barley Hm1 homolog to the known disease resistance genes, we droned and mapped a barley (Hordeum vulgare) Hm1-like gene. A putative full-length cDNA clone, Bhm1-18, was isolated from a cDNA library consisting of mRNA from young leaves, inflorescences, and immature embryos. This 1, 297-bp clone encodes 363 amino acids which show great similarity (81.6%) with the amino acid sequence of HM1 in maize. Two loci were mapped to barley molecular marker linkage maps with Bhm1-18 as the probe; locus A (Bhm1A) on the long arm of chromosome 1, and locus B (Bhm1B) on the short arm of chromosome 1 which is syntenic to maize chromosome 9 containing the Hm2 locus. The Bhm1-18 probe hybridized strongly to a Southern blot of a wide range of grass species, indicating high conservation of HCTR at the DNA sequence level among grasses. The HCTR mRNA was detected in barley roots, leaves, inflorescences, and immature embryos. The conservation of the HCTR sequence, together with its expression in other plant species (R. B. Meeley and J. D. Walton, Plant Physiol. 97:1080-1086, 1993), suggests HCTR plays an important functional role in other plant species. [References: 29].

2706 Hayes, P.; Prehn, D.; Vivar, H.; Blake, T.; Comeau, A.; Henry, I.; Johnston, M.; Jones, B.; Steffenson, B.; St Pierre, C.A. (1996) Multiple Disease resistance loci and their relationship to agronomic and quality loci in a spring barley population. Crop Science Society of America. references. v. 2 p. 1089-2796. English. (AGRIS 97-046292).

2707 Helm, J.H. (Alberta Agriculture, Lacombe, AB, Canada.); Cortez, J.; Salmon, D.F.; Jedel, P.E.; Stewart, W.M. (1996) Registration of 'Falcon' barley. *Crop science (USA) v. 36(3) p. 807.* English. (AGRIS 97-031643).

2708 Helm, J.H. (Alberta Agriculture, Lacombe, Canada.); Cortez, M.J.; Salmon, D.F.; Jedel, P.E.; Stewart, W.M. (1996) Registration of 'Phoenix' barley. *Crop science (USA) v. 36(3) p. 807-808.* references. English. (AGRIS 97-031644).

2709 Helm, J.H. (Alberta Agriculture, Lacombe, AB, Canada.); Cortez, M.J.; Salmon, D.F.; Jedel, P.E.; Stewart, W.M. (1996) Registration of 'Seebe' barley. *Crop science (USA) v. 36(3) p. 808-809.* references. English. (AGRIS 97-031645).

2710 Helm, J.H. (Alberta Agriculture, Lacombe, AB, Canada.); Cortez, M.J.; Salmon, D.F.; Jedel, P.E.; Stewart, W.M. (1996) Registration of 'Tukwa' barley. *Crop science (USA) v. 36(3) p. 809.* English. (AGRIS 97-031646).

2711 Henry, R.J. (Queensland Agricultural Biotechnology Centre, Gehrmann Laboratories, University of Queensland 4072 (Australia)) (1996)

Improvement of the quality of barley for beer production. *Agri-food quality: an interdisciplinary approach. Fenwick, G.R.; Hedley, C.; Richards, R.L.; Khokhar, S. (eds.) p. 15-18.* Royal Society of Chemistry. 12 ref., Special Publication No. 179. English. (AGRIS 97-046357).

2712 Henry, R.J.; Kettlewell, P.S. (eds.) (Correspondence address: Centre for Plant Conservation Genetics, Southern Cross University, PO Box 157, Lismore, NSW 2480 (Australia)) (1996) **Cereal grain quality.** Chapman and Hall Ltd. ref. at ends of chapters. xiv + 488 p. English. (AGRIS 97-046871).

2713 Henry, RJ.; Ko, HL.; Weining, S. (1997) **IDENTIFICATION OF CEREALS USING DNA-BASED TECHNOLOGY.** *Cereal Foods World. 42(1):26-29.* English. [SO CROSS UNIV CTR PLANT CONSERVAT GENET LISMORE NSW AUSTRALIA].

2714 Hraska, S.; Marencik, A. (Vysoka Skola Pedagogicka, Nitra (Slovakia). Katedra Biologie); Matejovic, I.; Masarova, K. (1995) **[Heterogeneity of some quality traits of F1 generation hybrids of Triticum durum (Desf.) and Hordeum vulgare (L.) distant hybridization]. Heterogenita niektorych znakov kvality hybridov F1 generacie vzdialeneho krizenia Triticum durum (Desf.) a Hordeum vulgare (L.).** *Polnohospodarstvo (Slovakia) v. 41(11) p. 839-849.* 2 tables, 5 ill.; 10 ref. Slovak. (AGRIS 97-032207).

Triticum durum cultivars grown in Slovakia have relatively low protein. To increase protein in wheat grains, the Hiproly spring barley cultivar with grains with 2-4 collaterally positioned aleuronic layers was used, and the cultivar was hybridised with Soldur, Slovakia's most productive durum wheat cultivar. Regenerants obtained from unripe embryos were amphidiploidized with use of colchicine 0.2 solution. Twelve regenerants were obtained with fertility of ears and that of flowers ranging from 1-80 . Mean protein content in regenerant grains was intermediate between content values of parental components. Two to three irregular aleuronic layers positioned collaterally and in the region of the abdominal crack were characteristic of the regenerants with higher protein content.

2715 Hu Yunlin (Tianjin Inst. of Crops (China)) (1995) **New winter wheat variety "TBT6".** *Tianjin Agricultural Sciences (China) v. 1(3) p. 15-16.* 2 tables. Chinese. (AGRIS 97-046805).

2716 Huang, D.Y. (North Dakota State University, Fargo, ND.); Khan, K. (1996) **Unexpected solubility changes in wheat proteins during fermentation and oven stages of the breadmaking process.** *Cereal chemistry (USA) v. 73(4) p. 512-513.* references. English. (AGRIS 97-046864).

2717 Hurkman, W.J. (USDA, ARS, Western Regional Research Center, Crop Improvement and Utilization Research Unit, Albany, CA.); Tanaka, C.K. (1996) **Effect of salt stress on germin gene expression in barley roots.** *Plant physiology (Lancaster, Pa.) (USA) v. 110(3) p. 971-977.* references. English. (AGRIS 97-031881).

Germin gene expression in barley (Hordeum vulgare L.) seedlings responds to developmental and environmental cues. During seed germination, germin mRNA levels were maximal 2 d after the start of imbibition in control seedlings and declined to low levels by 6 d. When seeds were sown in the presence of 200 mM NaCl, germin mRNA levels were also maximal after 2 d, but NaCl treatment, which slowed seedling growth, prolonged germin gene expression for an additional 1 d. In 4-d-old seedlings, germin mRNA levels were highest in roots and higher in the vascular transition region than in shoots. In roots of 6-d-old seedlings, germin gene expression was regulated by salt shock and plant growth regulators. Induced germin mRNA levels were maximal 8 h after treatment with NaCl, salicylate, methyl salicylate, or methyl jasmonate and 4 h after treatment with abscisic acid and indoleacetic acid. Like germin mRNA, dehydrin mRNA levels were maximal 8 h after NaCl treatment. In contrast, peroxidase mRNA levels declined to less than control levels within 30 min of treatment. Germin gene expression is regulated developmentally by salt stress and by treatments with plant hormones. Since germin is an oxalate oxidase, these results imply that oxalate has important roles in plant development and homeostasis.

2718 Iyamabo, O.E.; Hayes, P.M. (Oregon State Univ., Corvallis (USA). Dept. of Crop and Soil Science) (1995) **Effects of plot type on detection of quantitative-trait-locus effects in barley (Hordeum vulgare L.).** *Plant Breeding (Germany) v. 114(1) p. 55-60.* 2 tables; 17 ref. English. (AGRIS 97-046278).

Hill plots offer advantages in testing large germplasm arrays with limited area and seed. However, the relationship of trait expression between hill vs. row plots remains in question. The development of quantitativetrait-locus (QTL) analysis offers alternative methods of testing hypotheses regarding levels of coincident gene effects in divergent plots. The objective of this study was to compare hill and row plots in terms of QTL detection, number of common QTLs and plot-type-specific QTLs for various characters in barley. Assessments were based on sets of 100 F1-derived doubled haploid progeny from two environments of hillplot data and two sets of multiple-environment row-plot data. Common large-effect QTLs for height, heading date, and 1000-kernel weight were detected in both plot types. Fewer QTLs were detected in the hill-plot data, with only one QTL detected for grain yield. There were no hillplot-specific QTL effects. Hill plots appear to be best suited to highly heritable characters such as height, heading date, and 1000-kernel weight. Evaluation of grain yield is best deferred until larger experimental units can be employed.

2719 Iyamabo, O.E.; Hayes, P.M. (Oregon State Univ., Corvallis (USA). Dept. of Crop and Soil Science) (1995) **Effects of selection and opportunities for recombination in doubled-haploid populations of barley (Hordeum vulgare L.).** *Plant Breeding (Germany) v. 114(2) p. 131-136.* 2 graphs, 5 tables; 23 ref. English. (AGRIS 97-046279).

Doubled-haploid breeding systems are typically based on sampling gametes from F1 plants. However, in the case of repulsion linkages, additional recombination could be advantageous. Pre-selection of gamete donors might also shift progeny performance in a desired direction. The objectives of this study were to quantify the effects of an additional round of recombination and assess the effectiveness of preanthesis selection in the production of barley doubled haploids. Assessments were conducted on: 1. 100 F1-derived lines representing a subset of lines used in previous genome-mapping studies; 2. 100 random F2-derived lines; and 3. 50 F2-derived lines from gamete donors selected for early heading. An additional round of recombination had only a modest effect on generating more favourable genotypes. Pre-anthesis selection was ineffective in generating an earlier heading population. According to published quantitative-trait locus (QTL) analyses based on the F1-derived population, there are few repulsion linkages between (QTL determining the traits measured in this experiment. Any advantages to be gained from postponing the generation of derivation of doubled haploids must be weighed against the delay and additional cost.

2720 Jaaska, V. (1997) **ISOENZYME DIFFERENCES BETWEEN THE WILD DIPLOID AND TETRAPLOID WHEATS.** *Genetic Resources & Crop Evolution. 44(2):137-146.* English. [INST ZOOL & BOT DEPT BOT TARTU ESTONIA].

Variability of acid phosphatase (ACP), esterase (EST), and superoxide dismutase (SOD) isoenzymes among 660 accessions of wild diploid wheats Triticum boeoticum (475) and T urartu (185) and among 35 accessions of wild tetraploid wheats T araraticum (21) and T dicoccoides (14) was studied with the use of polyacrylamide gel electrophoresis. The wild diploids are differentiated by the electrophoretic variants of ACP-B, ACP-C, EST-A, EST-B, EST-C, EST-D, and SOD-B. Triticum urartu matches the A genome of wild tetraploid wheats ir: araraticum and T. dicoccoides by allozymes of ACP-B, ACP-C and SOD-B, but differs distinctly by the monomorphic allozyme EST-A66. Triticum boeoticum fits the A genome of polyploid wheats by allozymes of EST-A and EST-B, but differs in allozymes of ACP-B and SOD-B. Thus, none of the two contemporary diploid wheats corresponds exactly to the A genome of wild tetraploid wheats by all diagnostic isoenzymes. Triticum boeoticum and T. araraticum share EST-C46 and EST-D71, whereas T. urartu and T. dicoccoides are fixed for silent EST-CO and share EST-D73, suggesting independent origin of the two tetraploid wheats with a contribution from ancestral forms of both diploids. [References: 23].

2721 Jensen, R.B.; Welinder, K.G. (1995) **Cloning, expression and in vitro folding of a recombinant barley peroxidase.** Bio Tek Symposium 1995. Copenhagen (Denmark). 24-25 Oct 1995. *Pharmacology and Toxicology. Supplement (Denmark) v. 77(2) p. 34.* English. (AGRIS 97-046281).

2722 Ji Fenggao (Huai Yin Municipal Inst. of Agriculture, Jiangsu (China)) (1996) **A report on the breeding of dominant male-sterile Triticum**

durum and beared Triticum dicoccum. *Scientia Agricultura Sinica (China) v. 29(2) p. 23-27.* 2 tables; 9 ref. Chinese. (AGRIS 97-046839).

2723 Jia Gaofeng (Nanjing Agricultural Univ. (China). Inst. of Soybean); Li Guifang; Jin Zhengxun (1996) **Studies on combining ability of quality characteristics in interspecific wheat hybrids.** *Heilongjiang Agricultural Sciences (China) (no. 1) p. 1-5.* 7 tables; 5 ref. Chinese. (AGRIS 97-046813).

2724 Johnson, J.W. (Univ. of Georgia, Griffin, GA.); Buntin, G.D.; Cunfer, B.M.; Roberts, J.J.; Bland, D.E. (1996) **Registration of 'GA-Dozier' wheat.** *Crop science (USA) v. 36(3) p. 801.* references. English. (AGRIS 97-031832).

2725 Johnson, J.W. (Univ. of Georgia, Griffin, GA.); Cunfer, B.M.; Buntin, G.D.; Roberts, J.J.; Bland, D.E. (1996) **Registration of 'GA-Stuckey' wheat.** *Crop science (USA) v. 36(3) p. 801.* references. English. (AGRIS 97-031833).

2726 Joshi, A.K.; Dhari, R.; Rai, B. (Banaras Hindu University, Varanasi (India). Department of Genetics and Plant Breeding) (1996) **Varieties to face wheat cultivation challenges in Uttar Pradesh.** *Indian Farming (India) v. 45(11) p. 17-20.* 1 table; 4 ill. English. (AGRIS 97-032190).

2727 Kervinen, T.; Peltonen, S.; Utriainen, M.; Kangasjarvi, J.; Teeri, TH.; Karjalainen, R. (1997) **CLONING AND CHARACTERIZATION OF CDNA CLONES ENCODING PHENYLALANINE AMMNONIA-LYASE IN BARLEY.** *Plant Science. 123(1-2):143-150.* English. [UNIV HELSINKI DEPT PLANT BIOL SECT PLANT PATHOL POB 28 FIN-00014 HELSINKI FINLAND].

Five cDNA clones encoding phenylalanine ammonia-lyase from a barley root cDNA library were isolated. Southern analysis of barley genomic DNA also revealed at least five different pal genes in barley genome. Three nearly full-length cDNA clones (hpal2, hpal3, and hpal7) were further characterized and found to be highly similar to wheat and rice PAL sequences. The amount of pal transcripts was highest in the roots and lowest in the leaves. Transcript levels of pal were rapidly and strongly, but transiently, increased after treatment with mercuric chloride, whereas the expression was later after fungal inoculation. (C) 1997 Elsevier Science Ireland Ltd. [References: 28].

2728 Ketata, H. (Icarda, Aleppo (Syria). Cereal Improvement program); Ghazal, H.; Nauseh, Gh.H. (Aleppo Univ (Syria). Faculty of Agriculture) (1993) **[Study of selection of strategy in Durum Wheat aiming at finding well adapted varieties].** *Research Journal of Aleppo University (Syria). Agricultural Sciences Series (no.20) p.13-41.* 15 ref.; 10 tables. English. (AGRIS 97-032208).

2729 Khan, I.M.; Ahmad, H.; Khan, S.I. (Peshawar Univ. (Pakistan). Dept. of Botany) (1993) **Enhanced chromosomal observation in barley (Hordeum vulgare L.) meiosis.** *Sarhad Journal of Agriculture (Pakistan) v. 9(1) p. 75-77.* 1 plate, 6 ref. English. (AGRIS 97-031876).

A modified fixative used both for the purpose of fixation and preservation of barley anthers is presented here. Best staining and a high degree of separations were obtained by a modified method applied in this study. Quality of the material remained best even after 8 months of fixation.

2730 Kim, HS.; Ward, RW. (1997) **GENETIC DIVERSITY IN EASTERN US SOFT WINTER WHEAT (TRITICUM AESTIVUM L EM THELL) BASED ON RFLPS AND COEFFICIENTS OF PARENTAGE.** *Theoretical & Applied Genetics. 94(3-4):472-479.* English. [MICHIGAN STATE UNIV DEPT CROP & SOIL SCI E LANSING, MI 48824 USA].

Genetic diversity in a set of 11 red and 11 white wheat lines from the Eastern U.S. soft wheat germplasm pool was measured using restriction fragment length polymorphism (RFLP) assay and coefficients of parentage (COP) analysis. On average, 78% of all bands revealed by three enzymes with 48 RFLP clones were monomorphic. Average pairwise genetic similarity (CS) was 0.97 when data from all enzymes were pooled. Probe Polymorphic Information Content (PIG) indexes ranged from 0 to 0.73 with a mean of 0.2. Fewer than 55% of the probes revealed any polymorphism. The frequency of polymorphism in the Eastern U.S. soft white winter (SWW) wheat gene pool was much lower than that observed in the Eastern U.S. soft red winter (SRW) wheat gene pool. SWW lines formed a single group on a dendrogram based on cluster analysis of RFLP-derived GS estimates, while SRW lines did not form a single group. COP values for all pairs of the Eastern U.S. soft wheat lines ranged from 0.02 to 0.9 with a mean of 0.21. SWW wheat lines traced to 53 ancestral lines and had an average COP of 0.51. The SRW wheat gene pool had more complex parentages (mean COP = 0.15 and a total of 65 ancestral lines). COPs were correlated with RFLP-based GS for all line pairs ($r = 0.73$, $P < 0.01$). However, correlations between the two similarity measures were substantially lower when the SRW and SWW wheat gene pools were considered individually (r values of 0.23 and 0.28, respectively). The actual GS among unrelated lines in the U.S. Eastern soft wheat gene pool appears to be higher than that observed for unrelated landraces from Southwest Asia (0.96 vs. 0.905), suggesting that the ancestral landrace parents of this gene pool were themselves drawn from a base population where inbreeding, i.e., F, was greater than zero. [References: 24].

2731 Kisaka, H.; Kisaka, M.; Kanno, A.; Kameya, T. (1997) **PRODUCTION AND ANALYSIS OF PLANTS THAT ARE SOMATIC HYBRIDS OF BARLEY (HORDEUM VULGARE L) AND CARROT (DAUCUS CAROTA L).** *Theoretical & Applied Genetics. 94(2):221-226.* English. [TOHOKU UNIV INST GENET ECOL SENDAI MIYAGI 98077 JAPAN].

In order to obtain plants that were somatic hybrids of barley (Hordeum vulgare L.) and carrot (Daucus carota L.), we fused protoplasts that had been isolated from 6-month-old suspension cultures of carrot cells with protoplasts isolated from barley mesophyll by electrofusion. After culture for 1 month at 25 degrees C, the cells were cultured for 5 weeks at 4 degrees C, and were then returned to 25 degrees C for culture on a shoot-inducing medium. Three plants (nos. 1, 2 and 3) were regenerated from the cells. The morphology of the regenerated plants closely resembled that of the parental carrot plants. A cytological analysis of callus cultures induced from these plants indicated that most of the cells had about 24 chromosomes, fewer than the sum of the numbers of parent chromosomes which was 32. Southern hybridization analysis with fragments of the rgp1 gene used as probe showed that the regenerated plants contained both barley and carrot genomic DNA. Chloroplast (ct) and mitochondrial (mt) DNAs were also analyzed with several probes. The ctDNA of the regenerated plants yielded hybridization bands specific for both barley and carrot when one fragment of rice ctDNA was used as probe. Furthermore, the regenerated plants yielded a barley specific band and a novel band with another fragment of rice ct DNA as a probe. One of the regenerated plants (no. 1) yielded a novel pattern of hybridized bands of mt DNA (with an atp6 probe) that was not detected with either of the parents. These results indicated that the regenerated plants were somatic hybrids of barley and carrot and that recombination of both the chloroplast genomes and the mitochondrial genomes might have occurred. [References: 27].

2732 Kishka, M.N. (1996) **[New perspective variety of winter barley Nimfa].** Research Institute of Field Crops, Beltsy (Republic of Moldova). *Novyi perspektivnyi sort ozimogo yachmenya Nimfa 30 p.* Institute of Technical and Economical Information. Russian. (AGRIS 97-032070).

Nimfa - sort intensivnogo tipa, poluchen v Institute Polevykh kul'tur(Beltsy, Republic of Moldova) metodom mutageneza v sochetanii s gibridizatsiei , vysota steblya 73-113 sm, prochnyi, chto obesppechivaet vysokuyu ustoichivost' k poleganiyu, vegetatsionnyi period 248-260 dnei. Zimostoikost' vysokkkaya, zasukhoustoichivost' srednyaayya. Potentsial'naya urozhainost' sorta - 80 tsentnerov na gektar i bolee.

2733 Kjaerulff, S. (1996) **Genetic manipulation of Fe-S type reaction centers [including 5 publications].** Kongelige Veterinaer- og Landbohoejskole, Copenhagen (Denmark). KVL. 11 ill., 3 tables; 103 ref. 66 p. English. (AGRIS 97-031872).

2734 Koo, B.C. (Rural Development Administration, Suwon (Korea Republic). National Crop Experiment Station); Maluszynski, M. (Silesian University, Katowice (Poland)) (1996) **Improvement of mutation rate and reduction of somatic effects by double treatment of chemical mutagens in barley.** *Korean Journal of Crop Science (Korea Republic) v. 41(3) p. 348-353.* 7 tables; 9 ref. Korean. (AGRIS 97-031874).

2735 Kopus', M.M.; Samofalova, N.E.; Kopus', N.G. (1995) **[On correlation of gliadin component structure with economic traits in winter wheat Triticum turgidum]. O svyazi komponentnogo sostava gliadina s khozyajstvenno tsennymi priznakami u ozimoj turgidnoj pshenitsy.** *Selektsiya i semenovodstvo (Russian Federation) (no.2) p. 23-26.* Russian. (AGRIS 97-032210).

2736 Krugman, T.; Levy, O.; Snape, JW.; Rubin, B.; Korol, A.; Nevo, E. (1997) **COMPARATIVE RFLP MAPPING OF THE CHLOROTOLURON RESISTANCE GENE (SU1) IN CULTIVATED WHEAT (TRITICUM AESTIVUM) AND WILD WHEAT (TRITICUM DICOCCOIDES).** *Theoretical & Applied Genetics. 94(1):46-51.* English. [UNIV HAIFA INST EVOLUT IL-31905 HAIFA ISRAEL].

Chlorotoluron is a selective phenylurea herbicide widely used for broad-leaved and annual grass weed control in cereals. Variation in the response to chlorotoluron (CT) was found in both hexaploid bread wheat (Triticum aestivum L.) and wild tetraploid wheat (Triticum dicoccoides KERN.). Here, we describe the comparative mapping of the CT resistance gene (Su1) on chromosome 6B in bread and wild wheat using RFLP markers. In bread wheat, mapping was based on 58 F-4 single-seed descent (SSD) plants of the cross between a genotype sensitive to chlorotoluron, 'Chinese Spring' (CS), and a resistant derivative, the single chromosome substitution line, CS ('Cappele-Desprez' 6B) CCS (CAP6B). In T. dicoccoides, mapping was based on 37 F-2 plants obtained from the cross between the CT-susceptible accession B-7 and the resistant accession B-35. Nine RFLP probes spanning the centromere were chosen for mapping. In bread wheat Su1 was found to be linked to alpha-Amy-1 (9.84 cM) and Xpsr371 (5.2 cM), both on the long arm of 6B, and Nor2 (2.74 cM) on the short arm. In wild wheat the most probable linkage map was Nor2-Xpsr312-Su1-Pgk2, and the genetic distances between the genes were 24.8 cM, 5.3 cM, and 6.8 cM, respectively. These results along with other published map data indicate that the linear order of the genes is similar to that found in T. aestivum. The results of this study also show that the Su1 gene for differential response to chlorotoluron has evolved prior to the domestication of cultivated wheat and not in response to the development and use of chemicals. [References: 37].

2737 Kump, B.; Sinkovic, T.; Javornik, B. (Ljubljana Univ. (Slovenia). Biotechnical Fac., Agronomy Dept.) (1995) **[Identification of 1BL/1RS wheat-rye translocation by n-banding]. Identifikacija 1BL/1RS psenicno-rzene translokacije z n-bandingom.** *Zbornik Biotehniske fakultete Univerze v Ljubljani (Slovenia). Kmetijstvo (no.65) p. 19-24.* 1 table; 1 ill., 16 ref. English. (AGRIS 97-032183).

11 bread wheat cultivars having donors of 1BL/1RS translocation in their pedigree were chosen for cytological analysis by the N-banding technique to confirm the presence of translocation. All of the analysed cultivars showed an unbanded terminal short arm of the 1B chromosome and, in addition, 7 cultivars had an extra paracentromeric N-band indicating differences in the size of translocation.

2738 Kunzel, G.; Sorokin, A.; Marthe, F. (Institute of Plant Genetics and Crop Plant Research, Corrensstr. 3, D 06466 Gatersleben (Germany)) (1995) **Progress in relating genetic to physical distances of marker sequences on micro-isolated barley chromosomes.** *Proceedings of the Kew chromosome conference IV, held at the Jodrell Laboratory, Royal Botanic Gardens, Kew, UK, 30 August-2 September 1994. Brandham, P.E.; Bennett, M.D. (eds.) p. 149-155.* Royal Botanic Gardens, Kew. 35 ref. English. (AGRIS 97-045950).

2739 Kuz'min, N.A.; Malokostova, E.I.; Malorod, V.I. (1995) **[Spring durum wheat Voronezhskaya 7]. Yarovaya tverdaya pshenitsa Voronezhskaya 7.** *Selektsiya i semenovodstvo (Russian Federation) (no.2) p. 43-44.* Russian. (AGRIS 97-032206).

2740 Lafiandra, D.; Tucci, GF.; Pavoni, A.; Turchetta, T.; Margiotta, B. (1997) **PCR ANALYSIS OF X- AND Y-TYPE GENES PRESENT AT THE COMPLEX GLU-A1 LOCUS IN DURUM AND BREAD WHEAT.** *Theoretical & Applied Genetics. 94(2):235-240.* English. [UNIV TUSCIA DIPARTIMENTO AGROBIOL & AGROCHIM VIA S CAMILLO LELLIS I-01100 VITERBO ITALY].

Genes (x-type) corresponding to different high-molecular-weight glutenin subunits encoded at the Glu-A1 locus present in bread- and durum-wheat cultivars have been selectively amplified by the polymerase chain reaction (PCR). DNA fragments corresponding to an unexpressed x-type gene were also amplified. As unexpressed y-type genes may or may not contain an 8-kb transposonlike insertion, two different sets of primers were designed to obtain amplification of DNA fragments corresponding to these genes. Amplified DNA fragments were also digested with restriction enzymes. The digestion patterns of amplified fragments corresponding to unusual x-type subunits showed similarities with genes encoding the most common subunits 2* and 1. The unexpressed amplified x-type gene showed a restriction pattern similar to the one obtained with the allelic gene encoding high-molecular-weight glutenin subunit 1; homologies were also found within the repetitive region of the linked y-type genes. On the basis of these observations it is postulated that an ancestral active x-type gene, most likely corresponding to subunit 1, was silenced following the insertion of the 8-kb transposon-like fragment into the linked y-type gene. [References: 23].

2741 Lagudah, E.S. (CSIRO, Canberra, ACT, Australia.); Appels, R.; McNeil, D.; Schachtman, D.P. (1993) **Exploiting the diploid 'D' genome chromatin for wheat improvement.** *Gene conservation and exploitation : 20th Stadler Genetics Symposium p. 87-107.* Plenum Press. references. English. (AGRIS 97-046811).

2742 Lakew, B.; Semeane, Y.; Alemayehu, F.; Gebre, H.; Grando, S.; Vanleur, JAG.; Ceccarelli, S. (1997) **EXPLOITING THE DIVERSITY OF BARLEY LANDRACES IN ETHIOPIA.** *Genetic Resources & Crop Evolution. 44(2):109-116.* English. [AGR RES INST HOLETTA RES CTR POB 2003 ADDIS ABABA ETHIOPIA].

The paper describes a methodology to incorporate the collection of barley landraces available in the Plant Genetic Resources Centre of Ethiopia (PGRC/E), as well as future collections, in the Ethiopian barley breeding program. Six hundred pure lines extracted from thirty Ethiopian barley landraces were evaluated and selected, along with the original populations, between 1989 and 1993. Three lines were identified which significantly outyielded the local landrace in some of the testing sites and had a higher average yield across sites and seasons. The yield of these lines was similar to the best improved variety also developed from a landrace population. Despite the relatively small number of landrace-lines (600) in the original population, the exploitation of the diversity existing within Ethiopian barley germplasm has produced in only five years promising lines for yield at low input conditions and for disease and insect resistance. Some lines had a yield potential comparable with the best breeding lines produced earlier, and one is under multiplication for release. [References: 26].

2743 Lanning, SP.; Talbert, LE.; Martin, JM.; Blake, TK.; Bruckner, PL. (1997) **GENOTYPE OF WHEAT AND BARLEY AFFECTS LIGHT PENETRATION AND WILD OAT GROWTH.** *Agronomy Journal. 89(1):100-103.* English. [MONTANA STATE UNIV PLANT SOILS & ENVIRONM SCI DEPT BOZEMAN, MT 59717 USA].

Cereal breeders have selected for traits that confer resistance to diseases and insects, with the goal of stabilizing yield potential and reducing inputs. The possibility exists that, by selecting for growth habits that impede weed development, cultivars can be developed , sith increased tolerance to weed infestations. Our objective was to determine whether wheat (Triticum aestivum L.) and barley (Hordeum vulgare L.) lines differ in their ability to prevent penetration of light into interrow spaces and suppress wild oat (Avena fatua L.) growth. Based on our results, significant genotypic variation exists within winter and spring wheat and spring barley for the amount of sunlight allowed to penetrate to interrow spaces. A negative correlation existed between height and light penetration in four of seven nurseries studied. Six barley lines and six spring wheat lines, of similar heights but allowing different amounts of light penetration, were tested for suppression of wild oat growth. Barley was a much better competitor with wild oat than wheat was, allowing approximately one-half the wild oat biomass and seed production. Barley Lines allowed approximately 43% less light penetration than wheat. Significant variation for wild oat growth variables also existed among lines within the crops. High positive correlations of light penetration with wild oat growth existed within barley, suggesting that lines may be selected to contribute to integrated wild oat management. [References: 18].

2744 Laroche, G. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Triticale cultivars]. Les varietes de triticales.** *Perspectives Agricoles (France) (no 213) p. 101-102.* French. (AGRIS 97-031573).

2745 Larson, S.; Bryan, G.; Dyer, W.; Blake, T. (1996) **Evaluating gene effects of a major barley seed dormancy QTL in reciprocal backcross populations.** Crop Science Society of America. references. v. 2 p. 1089-2796. English. (AGRIS 97-046293).

2746 Lawson, WR.; Godwin, ID.; Cooper, M.; Brennan, PS. (1997) **GENETIC ANALYSIS OF PREHARVEST SPROUTING TOLERANCE IN THREE WHEAT CROSSES.** *Australian Journal of Agricultural Research.*

48(2):215-221. English. [UNIV QUEENSLAND DEPT AGR ST LUCIA QLD 4072 AUSTRALIA].

Three recombinant inbred populations were assessed for tolerance to preharvest sprouting (PHS). Genetic analysis of the PHS scores, as assessed under artificial rain treatment, indicated that for 2 of the populations, tolerance to sprouting was simply inherited and was controlled by 2 independent genes, both of which are necessary for full tolerance. The data presented here show that in these 2 populations the trait is highly heritable under controlled environment situations. It was also demonstrated that the red seed colour gene, derived from Aus1490 and traditionally associated with tolerance, is not necessary for full tolerance to sprouting, although indirect selection for preharvest sprouting tolerance can be performed very effectively by selecting for red grain. The presence of white-seeded lines, recovered from this cross with a red-seeded donor of PHS tolerance, that are at least as tolerant as the most tolerant red-seeded individuals demonstrates that red-seeded donors of PHS tolerance should not be discarded for improvement of this trait. [References: 12].

2747 Li Hongen (Shaanxi Academy of Agricultural Sciences, Yangling (China)) (1995) **Determination and evaluation on the main quality characters of wheat germplasm resources in China.** *Scientia Agricultura Sinica (China) v. 28(5) p. 29-37.* 6 tables; 10 ref. Chinese. (AGRIS 97-046827).

2748 Linde Laursen, L; Bothmer, R. von; Jacobsen, N. (Plant Genetics Section, Environmental Science and Technology Department, Risoe National Laboratory, DK 4000 Roskilde (Denmark)) (1995) **Karyotype differentiation and evolution in the genus Hordeum (Poaceae).** *Proceedings of the Kew chromosome conference IV, held at the Jodrell Laboratory, Royal Botanic Gardens, Kew, UK, 30 August-2 September 1994. Brandham, P.E.; Bennett, M.D. (eds.) p. 233-247.* Royal Botanic Gardens, Kew. 37 ref. English. (AGRIS 97-046286).

2749 Liu Jianjun (Shandong Academy of Agricultural Sciences, Jinan (China). Inst. of Crops) (1995) **Hybrid vigor of precipitation in winter wheat and analysis of combining ability.** *Journal of Shandong Agricultural Sciences (China) (no. 4) p. 10-12.* 4 tables; 9 ref. Chinese. (AGRIS 97-046806).

2750 Liu Siheng (Fujian Agricultural Univ., Fuzhou (China). Dept. of Agronomy) (1995) **A study on genetic trend of plant height of Aibai wheat.** *Journal of Fujian Academy of Agricultural Sciences (China) v. 10(3) p. 11-15.* 3 tables; 1 ill., 4 ref. Chinese. (AGRIS 97-046803).

2751 Lu Shihua (Sichuan Academy of Agricultural Sciences, Chengdu (China). Inst. of Soils and Fertilizers) (1995) **The screening of wheat varieties tolerant of Mn deficiency.** *Chinese Journal of Soil Science (China) v. 26(5) p. 219-221.* 3 tables; 6 ref. Chinese. (AGRIS 97-046816).

2752 Lu Tiegang (Academia Sinica, Beijing (China). Inst. of Botany) (1996) **Establishment of an efficient system for the haploid production in Triticum durum.** *Scientia Agricultura Sinica (China) v. 29(3) p. 61-65.* 1 table; 10 ref. Chinese. (AGRIS 97-046840).

2753 Lukaszewski, AJ. (1997) **THE DEVELOPMENT AND MEIOTIC BEHAVIOR OF ASYMMETRICAL ISOCHROMOSOMES IN WHEAT.** *Genetics. 145(4):1155-1160.* English. [UNIV CALIF RIVERSIDE DEPT BOT & PLANT SCI RIVERSIDE, CA 92521 USA].

To determine which segments of a chromosome arm are responsible for the initiation of chiasmate pairing in meiosis, a series of novel isochromosomes was developed in hexaploid wheat (Triticum aestivum L.). These isochromosomes are deficient for different terminal segments in tile two arms. It is proposed to call them "asymmetrical." Meiotic metaphase I pairing of these asymmetrical isochromosomes was observed in plants with various doses of normal and deficient arms. The two arms of an asymmetrical isochromosome were bound by a chiasma in only two of the 1134 pollen mother cells analyzed. Pairing was between arms of identical length whenever such were available; otherwise, there was no pairing. However, two arms deficient for the same segment paired with a frequency similar to that of normal arms, indicating that the deficient arms retained normal capacity for pairing. Pairing of arms of different length was prevented not by the deficiency itself, but rather, by the heterozygosity for the deficiency. Whether two arms were connected via a centromere in an isochromosome or were present in two different chromosomes had no effect on pairing. This demonstrates that in the absence of homology in the distal regions of chromosome arms, even if relatively short, very long homologous segments may remain unrecognized in meiosis and will not be involved in chiasmate pairing. [References: 26].

2754 Luthar, Z. (Ljubljana Univ. (Slovenia). Biotechnical Fac., Agronomy Dept.) (1996) **[Transformation of buchwheat, barley and potato]. Transformacije ajde, jecmena in krompirja.** Simpozij Novi izzivi v poljedelstvu (Symposium on New Challenges in Field Crop Production). Radenci (Slovenia). 9-10 Dec 1996. *Proceedings of the Symposium on New Challenges in Field Crop Production. Sesek, P. (ed.). Zbornik Simpozija Novi izzivi v poljedelstvuNew Challenges in Field Crop Production (Slovenia). University of Ljubljana, Biotechnical Faculty, Ljubljana (Slovenia). Agronomy Dept. p. 133-137.* 24 ref. Slovenian. (AGRIS 97-031791).

The isolated cotyledons of the buckwheat cv. Darina were infected by Agrobacterium tumefaciens carrying b-glucuronidase reporter (GUS) gene. The microspores of the barley cv. Arda were transformed by electroporation of the beta-glucuronidase reporter (GUS) gene and DHDPS 7 gene for high lysine content in the seeds. The tuber discs of the potato cv. Desiree were indirectly transformed with the two protease inhibitors KTi3 and C-II genes. The products of these two genes had a negative effect upon the alimentary tract, upon the growth and development of larvae of nematode (Nematoda sp.) and colorado beetle (Leptinotarsa decemlineata), according to standard.

2755 Luthra, J.K.; Prabhu, K.V. (Indian Agricultural Research Institute, New Delhi (India). Division of Genetics); Verma, R.P.S. (Directorate of Wheat Research, Karnal (India)) (1995) **'HS 295': a high-yielding wheat for northern hills.** *Indian Farming (India) v. 45(4) p. 6.* 3 tables. English. (AGRIS 97-032188).

2756 Ma Ruikun (Hebei Academy of Agriculture and Forestry , Shijiazhuang (China). Inst. of Cereal and Oil Crops) (1995) **Physiological characters and integrated evaluation for high-yielding and water saving wheat genotypes.** *Scientia Agricultura Sinica (China) v. 28(6) p. 32-39.* 5 tables; 14 ref. Chinese. (AGRIS 97-046825).

2757 Macewicz, J.B. (Instytut Hodowli i Aklimatyzacji Roslin, Radzikow (Poland). Zaklad Genetyki) (1995) **[Protein content heritability in selection of barley basing on intraplant variation in kernel anatomical structure]. Odziedziczalnosc zawartosci bialka w selekcji wykorzystujacej zroznicowanie budowy anatomicznej ziarniakow pojedynczej rosliny jeczmienia.** *Hodowla Roslin Aklimatyzacja i Nasiennictwo (Poland) v. 39(6) p. 3-26.* 9 fig., 6 tables; 24 ref. Polish. (AGRIS 97-031877).

The objective of this study was the verification of the hypothesis assuming genetic determination of grain protein content stored in the subaleurone tissue, beyond the aleurone layer and embryo. This specific tissue occurs only in a fraction of kernels set on single plant and causes differences in grain protein content. The effectiveness of the selection supports the hypothesis on the heterogenity of the initial cultivar population and on the genetic determination of the subaleurone tissue size in individual plant kernels.

2758 Macewicz, J.B. (Instytut Hodowli i Aklimatyzacji Roslin, Radzikow (Poland). Zaklad Genetyki) (1995) **[Use of anatomical structure variation in grains for breeding of high protein barley. Conclusions]. Wykorzystanie zmiennosci budowy anatomicznej ziarniakow jeczmienia w hodowli odmian o podwyzszonej zawartosci bialka.** *Hodowla Roslin Aklimatyzacja i Nasiennictwo (Poland) v. 39(6) p. 27-39.* 2 fig., 1 table; 21 ref. Polish. (AGRIS 97-031878).

The selection of single high-protein kernels, lasting for five generations, caused three-fold increase of the high-protein kernels fraction in the selected lines. The response to selection proved the genetic determination of the character. The progress reached during single kernels selection was shown by heritability coeffcient 0.26-0.55.

2759 Machado, N. (1995) **[Development of hybrid wheat in Argentina]. Desarrollo de trigos hibridos en Argentina.** *[Wheat breeding in Argentina: Thirty years of cooperative investigation with CIMMYT; Balcarce, Argentina; 7-8 Oct 1992]. El mejoramiento de trigo en Argentina: Treinta anos de investigacion cooperativa con el CIMMYT; Balcarce, Argentina; 7-8 Oct 1992. Kohli, M.M.; Nisi, J.E.; Rajaram, S. (eds.). Centro Internacional de Mejoramiento de Maiz y*

Trigo (CIMMYT), Mexico, DF (Mexico) p. 53-57. CIMMYT. Spanish. (AGRIS 97-032182).

Cargill Wheat Program in Argentina started in 1970. Initially, the objective of the program was to produce varieties as well as hybrids. Five bread wheat varieties were registered and from 1986 on, six commercial hybrids were released of which five remained in the market. The hybrids were obtained utilizing genetic male sterility from Triticum timopheevii. The chemical gametocides were tested but their utilization depends on commercial availability. The hybrids must possess resistance to major diseases, and tolerance to water stress and lower temperatures. All these characters must be combined with high yield potential and yield stability under different environmental conditions. To achieve these characters, traditional Argentine germplasm, winter wheats from USA and spring wheats from CIMMYT were utilized. Materials from different origins specially France and Australia were also used. Annually, between 2000 and 3000 crosses are made and both, individual and mass selection are utilized. Regarding future priorities, it is necessary to organize a system of regional disease surveillance throughout the Southern Cone countries. The access to the data and germplasm in the gene banks will help the task of the breeders. Utilization of new techniques from biotechnology applicable to plant breeding must also be developed. The Cargill Program considers the importance of CIMMYT in the development of germplasm and information El Programa de Trigos Hibridos que Cargill desarrolla en Argentina se inicio en el ano 1970. En sus comienzos tuvo como objetivo la obtencion tanto de cultivares como de hibridos. Se inscribieron cinco cultivares y a partir del ano 1986 seis hibridos permaneciendo en el mercado cinco de ellos. Los hibridos obtenidos se hacen utilizando el sistema de macho esterilidad genetico provenientes de T. timopheevii. Se han analizado pruebas con gametocidas quimicos y la posibilidad de su utilizacion depende de su disponibilidad commercial. Teniendo en cuenta las problematicas de cada subregion triguera, los hibridos obtenidos deben poseer: resistencia a las principales enfermedades, tolerancia a stress hidrico, a bajas temperaturas. Todas estas caracteristicas sumado a un destacado rendimiento y estabilidad en diferentes ambientes. Para lograr las caracteristicas mencionadas se utilizo germoplasma argentino tradicional, invernales de EE. UU. y primaverales del CIMMYT. Tambien fueron usados materiales de diferentes origenes, especialmente de Francia y Australia. Anualmente se realizan de 2000 a 3000 cruzamientos y los metodos de seleccion utilizados son el de combinar seleccion individual con masal. En relacion a las prioridades futuras es necesario organizar un sistema de relevamientos sanitarios con sentido regional, abarcando los paises del Cono Sur. El acceso a banco de datos y germoplasma facilitaria la labor de los mejoradores. Otro aspecto a desarrollar es la utilizacion de tecnicas biotecnologicas aplicables al mejoramiento. El programa de Cargill considera importante del CIMMYT el aporte en relacion al conocimiento y materiales. Todas estas acciones apuntan a mejorar la eficiencia.

2760 Malik, B.S. (Directorate of Wheat Research, Karnal (India)); Bisht, S.S. (Vivekananda Parvatiya Krishi Anusandhanshala, Almora (India)); Tandon, J.P. (Indian Council of Agricultural Research, New Delhi (India)) (1995) **'Sangam; a high-yielding rust-resistant wheat for north-western plains.** *Indian Farming (India) v. 45(4) p. 7.* English. (AGRIS 97-032189).

2761 Martin, G. (Institut Technique des Cereales et des Fourrages, Paris (France)); Bernicot, M.H. (1996) **[Wheat quality: the new cultivars]. Qualite des bles: les nouvelles varietes.** *Perspectives Agricoles (France) (no 213) p. 42-46.* 13 graph. French. (AGRIS 97-031569).

2762 Martin, R.; Busch, W.; Herrmann, R.G.; Wanner, G. (Botanisches Institut der Ludwig Maximillians Universitat, Munchen (Germany)) (1995) **In situ hybridization and signal detection by high resolution scanning electron microscopy.** *Proceedings of the Kew chromosome conference IV, held at the Jodrell Laboratory, Royal Botanic Gardens, Kew, UK, 30 August-2 September 1994. Brandham, P.E.; Bennett, M.D. (eds.) p. 159-166.* Royal Botanic Gardens, Kew. 17 ref. English. (AGRIS 97-045951).

2763 Milovanovic, M.; Pavlovic, M.; Popovic, A.; Ognjanovic, R.; Jelic, M.; Stojanovic, S. (Institut za strna zita Kragujevac, Kragujevac (Yugoslavia)) (1995) **[Results of spring triticale breeding in Kragujevac [Yugoslavia]]. Rezultati oplemenjivanja jarog tritikalea u Kragujevcu [Jugoslavija].** Simpozijum "Semenarstvo krmnog bilja u funkciji stocne hrane i unapredjenje stocarstva. Herceg Novi (Yugoslavia). 26-29 Apr 1995. *Selekcija i semenarstvo (Yugoslavia) v. 2(3-4) p. 333-340.* 6 tables; 19 ref. Serbian. (AGRIS 97-046801).

Satisfying progress in breeding of spring triticale was attained. Some of new promissing lines in comparison with existing cultivars of spring 6x triticale, demonstrated advantage, especially for traits: height of stem and lodging resistance. The most promising genotypes have height of stem about 90 cm. Investigated genotypes of spring triticale distinguish with large kernel and higher content of protein in relation to facultative triticale cultivar Kg.20 (sown in spring). Hectolitre mass and sedimentation are unsatisfying, which points out that on improving of these traits in the future must be turned more attention. Kernel shrivelling is usually most expressed in spring types of triticale. Cultivar and lines of spring triticale achieved higher grain yields in relation to facultative triticale sown in spring. Almost whole investigated spring triticale were immune to causers of stem rust and powdery mildew. Work on breeding of spring triticale is necessary to continue.

2764 Moharramipour, S.; Tsumuki, H.; Sato, K.; Murata, S.; Kanehisa, K. (1997) **EFFECTS OF LEAF COLOR, EPICUTICULAR WAX AMOUNT AND GRAMINE CONTENT IN BARLEY HYBRIDS ON CEREAL APHID POPULATIONS.** *Applied Entomology & Zoology. 32(1):1-8.* English. [OKAYAMA UNIV BIORESOURCES RES INST LAB BIOL COMMUN KURASHIKI OKAYAMA 710 JAPAN].

Using four marker genotypes of F-2 hybrids derived from crosses between aphid resistant and susceptible barley lines, the effects of leaf color, epicuticular wax and gramine indole alkaloid on aphid infestation were studied in natural populations of cereal aphids, mainly the corn leaf aphid (Rhopalosiphum maidis) during 1994-1995. Resistant lines, OUH603 and OUH689 (Hordeum vulgare subsp. spontaneum), were the normal type (green waxy) with a higher amount of gramine. However, a susceptible line, OUL117 (Hordeum vulgare subsp. vulgare), was the yellow waxless type with a lower content of gramine. In the F-2 populations of OUL117 x OUH689, OUH603 x OUL117 and OUL117 x OUH603, the aphid densities on the marker genotypes were low in the normal type, intermediate in the green waxless and yellow waxy types, and high in the yellow waxless type. Gramine content was low and did not differ significantly among the genotypes measured in 158 F-2 plants of OUL117 x OUH689 in 1994. Additionally, there was no significant correlation between aphid density and gramine content within each genotype in the F-2 populations. These results showed that the genes controlling color and wax types had additive effects on normal plant genotype resistance to aphids, but did not affect gramine content. [References: 19].

2765 Mori, S. (Tokyo Univ. (Japan). Faculty of Agriculture) (1995) **A strategy for cloning the genes in the synthetic pathway of mugineic acid-family phytosiderophores.** *Genetic manipulation of crop plants to enhance integrated nutrient management in cropping systems - 1. Phosphorus: proceedings of an FAO-ICRISAT Expert Consultancy Workshop 15-18 Mar 1994, ICRISAT Asia Center, Patancheru, India. Johansen, C. (ed.); Lee, K.K. (ed.); Sharma, K.K. (ed.); Subbarao, G.V. (ed.); Kueneman, E.A. (ed.). FAO, Rome (Italy). Plant Production and Protection Div.; IAEA, Vienna (Austria); International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India) p. 129-144.* ICRISAT. English. (AGRIS 97-046295).

2766 Munchgarthoff, S.; Neuhaus, JM.; Boller, T.; Kemmerling, B.; Kogel, KH. (1997) **EXPRESSION OF BETA-1, 3-GLUCANASE AND CHITINASE IN HEALTHY, STEM-RUST-AFFECTED AND ELICITOR-TREATED NEAR-ISOGENIC WHEAT LINES SHOWING SR5- OR SR24-SPECIFIED RACE-SPECIFIC RUST RESISTANCE.** *Planta. 201(2):235-244.* English. [RHEIN WESTFAL TH AACHEN INST BIOL 1 WORRINGER WEG 1 D-52074 AACHEN GERMANY].

Pathogenesis-related expression of the two antifungal hydrolases beta-1, 3-glucanase (EC 3.2.1.39) and chitinase (EC 3.2.1.14) was studied in wheat (Triticum aestivum L.) as part of the defence response to stem rust (Puccinia graminis f.sp. tritici; Pgt), mediated by the semi-dominantly acting resistance genes Sr5 and Sr24. Complete resistance (infection type 0), mediated by the Sr5 gene in cultivar Pre-Sr5, closely correlates with the hypersensitive response of penetrated cells at early stage of the interaction, when the first haustorium is formed. In contrast, cultivar Pre-Sr24 shows intermediate resistance (infection type 2-3) which is not directly linked to cell death. In both cases, the plant response included a rapid increase in beta Phi-1, 3-glucanase activity between 24 and 48 h after inoculation. One main extracellular 30-kDa isoform of beta-1, 3-glucanase was present in

both lines, as shown by polyacrylamide-gel electrophoresis. Two additional minor isoforms (32 and 23 kDa) were detected only in Pre-Sr24, and only at later time points. Increased enzyme activity and the appearance of new isoforms in the resistant lines was preceded by accumulation of mRNAs encoding beta-1, 3-glucanases and chitinases. However, there were no changes in chitinase activity or isoforms. A high constitutive level of chitinase activity was observed in all wheat genotypes. Serological studies indicated the presence of a class II chitinase of 26 kDa. Accumulation of beta-1, 3-glucanase and chitinase transcripts was detected before the pathogen penetrated the leaves through stomata and approximately 16 h before the typical hypersensitive response was observed, indicating that signal(s) for defense gene activation were recognised by the host plant long before a tight contact between the pathogen and a host cell is established. A glycoprotein (Pgt elicitor) derived from hyphal walls, strongly induced beta-1, 3-glucanase. We discuss the possible role of the elicitor in the early signalling mediating Sr5 and Sr24-specified resistance in wheat. [References: 54].

2767 My Yiquan; Chi Yongqin; Liu Hong (Heilongjiang Provincial Academy of Agricultural Science, Keshan (China). Inst. of Wheat) (1996) **The utilization of the marginal effect index in breeding of spring wheat varieties tolerant to dense population.** *Journal of Jilin Agricultural University (China) v. 18(2) p. 13-16.* 2 tables; 8 ref. Chinese. (AGRIS 97-046765).

2768 Nair, RB.; Baga, M.; Scoles, GJ.; Kartha, KK.; Chibbar, RN. (1997) **ISOLATION, CHARACTERIZATION AND EXPRESSION ANALYSIS OF A STARCH BRANCHING ENZYME II CDNA FROM WHEAT.** *Plant Science. 122(2):153-163.* English. [NATL RES COUNCIL CANADA INST PLANT BIOTECHNOL 110 GYMNASIUM RD SASKATOON SK S7N 0W9 CANADA].

A full-length cDNA (2970 bp) encoding a starch branching enzyme II (SBEII; EC 2.4.1.18) in wheat (Triticum aestivum L. cv Fielder) kernel was isolated from a cDNA library. The translated region of the cDNA predicted a 823 amino acid primary product with a molecular mass of 91.4 kDa. A 54 amino acid transit peptide was postulated to be cleaved from the pre-protein to give a 769 amino acid (85.4 kDa) mature polypeptide, which showed extensive sequence similarity to SBEII sequences characterized from maize, rice and pea. Expression of the isolated cDNA in a BE-deficient E. coli strain demonstrated that it encoded a functional BE. RNA analysis of Sbe2 gene expression during seed development revealed that Sbe2 mRNA levels were highest in young kernels (5-10 days post-anthesis) and declined as the kernels matured. [References: 33].

2769 Ohsako, T.; Wang, GZ.; Miyashita, NT. (1996) **POLYMERASE CHAIN REACTION SINGLE STRAND CONFORMATIONAL POLYMORPHISM ANALYSIS OF INTRA- AND INTERSPECIFIC VARIATIONS IN ORGANELLAR DNA REGIONS OF AEGILOPS MUTICA AND RELATED SPECIES.** *Genes & Genetic Systems. 71(5):281-292.* English. [KYOTO UNIV GRAD SCH AGR LAB PLANT GENET SAKYO KU KYOTO 60601 JAPAN].

In order to study the phylogeny of Aegilops mutica in the genera of Triticum and Aegilops, variations in chloroplast and mitochondrial DNA regions were investigated by polymerase chain reaction-single strand conformational polymorphism (PCR-SSCP) analysis. Nine lines, each of Ae. mutica and Ae. speltoides, were studied together with nine other Triticum and Aegilops species, including T. aestivum. By analyzing 9.7-kb chloroplast and 13.1-kb mitochondrial DNA regions, a total of 268 bands were detected, of which 176 (65.7%) showed variation within and/or between species. The level of intraspecific variation of Ae. mutica was lower than that of Ae. speltoides. The low level of the intraspecific variation of Ae. mutica was contrary to the expectation from previous studies on morphological and cytolo-gical characters. In the phylogenetic trees based on SSCP, Ae. mutica, Ae. speltoides and the other four species of the section Sitopsis (the subsection Emarginata) were separated into three different clusters. In addition, T. aestivum was included in the cluster of Ae. speltoides in the phylogenetic trees. This result suggests that Ae. speltoides is the cytoplasmic donor of common wheat. [References: 46].

2770 Ordon, F.; Schiemann, A.; Friedt, W. (1997) **ASSESSMENT OF THE GENETIC RELATEDNESS OF BARLEY ACCESSIONS (HORDEUM VULGARE SL) RESISTANT TO SOIL-BORNE MOSAIC-INDUCING VIRUSES (BAMMV, BAYMV, BAYMV-2) USING RAPDS.** *Theoretical & Applied Genetics. 94(3-4):325-330.* English. [UNIV GIESSEN INST CROP SCI & PLANT BREEDING 1 LUDWIGSTR 23 D-35390 GIESSEN GERMANY].

Thirty-six Hordeum vulgare varieties and 12 H. spontaneum germplasms originating from different parts of the world and showing different reactions to the barley yellow mosaic virus complex (BaMMV, BaYMV, BaYMV-2) were analyzed for genetic similarity using RAPDs. On the basis of an analysis of 20 selected RAPD-primers corresponding to 544 bands genetic similarity according to-Nei and Li (1979) was estimated to be between 0.685 and 0.964. Associations between the 48 genotypes were calculated using UPGMA-clustering and principal coordinate analysis. By applying these methods we were able to separate H. spontaneum accessions from H. vulgare varieties, and within these groups all the genotypes were clustered correctly according to their origin. Consequently, RAPD analysis can be considered a very useful and efficient tool for the fast estimation of genetic relationships in barley. The correlation between genetic similarity with respect to German varieties and adaptation of exotic barley varieties to German growing conditions is discussed. [References: 39].

2771 Ouyang Xirong (Hunan Agricultural Univ., Changsha (China). Dept. of Agronomy) (1995) **Effects of donor plant environment on anther culture response in barley.** *Journal of Hunan Agricultural University (China) v. 21(4) p. 342-348.* 3 tables; 19 ref. Chinese. (AGRIS 97-046277).

2772 Qi Shiyu; Wang Shi'en; Xiao Zhimin (Heilongjiang Provincial Academy of Agricultural Sciences, Harbin (China). Inst. of Plant Breeding) (1996) **Selection and extension of a high-yielding and high-quality spring wheat variety--Longmai 19.** *Heilongjiang Agricultural Sciences (China) (no. 4) p. 1-6.* 2 tables; 1 ill. Chinese. (AGRIS 97-046766).

2773 Quick, J.S. (Colorado State University, Fort Collins, CO.); Albrechtsen, R.S.; Stack, M. (1996) **Registration of 'Sylvan' wheat.** *Crop science (USA) v. 36(3) p. 802.* English. (AGRIS 97-032219).

2774 Ramon Lopez, J. (1995) **[Bread wheat breeding in the southeast of the Buenos Aires province]. Mejoramiento de trigo pan en el sureste de la provincia de Buenos Aires.** *[Wheat breeding in Argentina: Thirty years of cooperative investigation with CIMMYT; Balcarce, Argentina; 7-8 Oct 1992]. El mejoramiento de trigo en Argentina: Treinta anos de investigacion cooperativa con el CIMMYT; Balcarce, Argentina; 7-8 Oct 1992. Kohli, M.M.; Nisi, J.E.; Rajaram, S. (eds.). Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), Mexico, DF (Mexico) p. 19-27.* CIMMYT. 5 tables. Spanish. (AGRIS 97-032181).

Mixed animal-agriculture system in rotation with approximately 1 million hectares of wheat predominates the region under the influence of INTA Experimental Station at Bordenave. The region is characterized by a strong water deficit which reaches 153 mm per year. The objectives of the breeding program are to obtain varieties with high yield potential and good agronomic type, tolerant to the environmental limitations, green bug and having good industrial and commercial quality. The incorporation of Mexican germplasm in local crosses started in 1967. The CIMMYT derived winter spring crosses and germplasm from the Oregon State Universities helped achieve advanced lines with high yield potential. As a result, six new varieties, including widely adopted Cochico INTA and PROINTA Pigue have been released by the program. The program at Bordenave also develops double purpose wheats (for grain and forage production). In the semiarid pampa region, these wheats are used for grazing by winter steers and nursing lambs. Amongst the breeding priorities for the future, development of germplasm with tolerance to drought, resistance to green bug and Russian wheat aphid are important. La zona de influencia de INTA Bordenave es una region en que predomina el sistema mixto ganadero-agricola en rotacion con una superficie cultivada de trigo, cercana a 1 millon de hectareas. El area se caracteriza por un marcado deficit hidrico que alcanza a las 153 mm/ano. Los objetivos del programa de mejoramiento son obtener cultivares con elevada capacidad productiva, buenas caracteristicas agronomicas, tolerante a factores climaticos adversos, pulgon verde y buena calidad industrial y comercial. La incorporacion de germoplasma mexicano en el ar70 1967 en materiales de origen local, especialmente de cruzas de trigos primaverales por invernales provenientes del CIMM YT y de la Universidad de Oregon permitieron la obtencion de lineas de mayor productividad. Como resultado de estas acciones se obtuvieron seis cultivares, algunos de los cuales presentan amplia difusion tales como Cochico INTA y PROINTA Pigue. Otra linea de trabajo del Programa de Bordenave es el desarrollo de trigos para doble

proposito (forraje y grano). En la region semi-arida pampeana estos trigos son utilizados para el pastoreo de novillos de invierno y ovejas en lactancia. Las prioridades de mejoramiento para los proximos anos son: desarrollo de germoplasma con mecanismos de tolerancia a sequia, incorporacion de resistencia al pulgon verde de los cereales y al pulgon ruso.

2775 Rana, R.K.; Subhadra Madan; Shashi Madan (Wheat Research, Department of Plant Breeding, CCS HAU, Hisar 125004 (India)) (1996) **Improvement of nutritional quality of wheat through somaclones and mutants.** *Agri-food quality: an interdisciplinary approach. Fenwick, G.R.; Hedley, C.; Richards, R.L.; Khokhar, S. (eds.) p. 19-22.* Royal Society of Chemistry. 8 ref., Special Publication No. 179. English. (AGRIS 97-046869).

2776 Raut, S.K. (College of Agriculture, Nagpur (India)); Manjaya, J.G. (Punjabrao Krishi Vidyapeeth, Akola (India). Department of Agricultural); Khorgade, P.W. (College of Agriculture, Akola (India)) (1995) **Selection criteria in wheat (Triticum aestivum L.).** *Punjabrao Krishi Vidhyapeeth Research Journal (India) v. 19(1) p. 17-20.* 2 tables; 8 ref. English. (AGRIS 97-032192).

2777 Reichel, C. (Max Planck Institut fur Zuchungsforschung, Koln, Germany.); Mathur, J.; Eckes, P.; Langenkemper, K.; Koncz, C.; Schell, J.; Reiss, B.; Maas, C. (1996) **Enhanced green fluorescence by the expression of an Aequorea victoria green fluorescent protein mutant in mono- and dicotyledonous plants cells.** *Proceedings of the National Academy of Sciences of the United States of America (USA) v. 93(12) p. 5888-5893.* references. English. (AGRIS 97-031944).

The expression of the jellyfish green fluorescent protein in (GFP) in plants was analyzed by transient expression in protoplasts from Nicotiana tabacum, Arabidopsis thaliana, Hordeum vulgare, and Zea mays. Expression of GFP was only observed with a mutated cDNA, from which a recently described cryptic splice site had been removed. However, detectable levels of green fluorescence were only emitted from a small number of protoplasts. Therefore, other mutations in the GFP cDNA leading to single-amino acid exchanges in the chromophore region, which had been previously studied in Escherichia coli, were tested in order to improve the sensitivity of this marker protein. Of the mutations tested so far, the exchange of GFP amino acid tyrosine 66 to histidine (Y66H) led to detection of blue fluorescence in plant protoplasts, while the exchange of amino acid serine 65 to cysteine (S65C) and threonine (S65T) increased the intensity of green fluorescence drastically, thereby significantly raising the detection level for GFP. For GFP S65C, the detectable number of green fluorescing tobacco (BY-2) protoplasts was raised up to 19-fold, while the fluorimetrically determined fluorescence was raised by at least 2 orders of magnitude.

2778 Ren, SX.; Mcintosh, RA.; Lu, ZJ. (1997) **GENETIC SUPPRESSION OF THE CEREAL RYE-DERIVED GENE PM8 IN WHEAT.** *Euphytica. 93(3):353-360.* English. [CHINESE ACAD SCI INST GENET BEIJING 100101 PEOPLES REPUBLIC OF CHINA].

The location of wheat gene Pm8 for resistance to powdery mildew in the 1RS chromosome segment derived from cereal rye cultivar Petkus was confirmed. There was reduced transmission of the 1BL.1RS chromosome relative to its wheat homologue in four of the five crosses examined. Pm8 was not expressed in some wheat cultivars and selections, which possessed the 1RS chromosome identified by the presence of relevant genes for resistance to the three rusts, due to the presence of a dominant suppressor gene(s) in the wheat genome. The frequency of suppression in 1BL.1RS wheats from Mexico was significantly higher than in a group of wheats (both local and exotic) introduced from China and was probably much higher than in European wheats. [References: 32].

2779 Rogers, WJ.; Miller, TE.; Payne, PL.; Seekings, JA.; Sayers, EJ.; Holt, LM.; Law, CN. (1997) **INTRODUCTION TO BREAD WHEAT (TRITICUM AESTIVUM L) AND ASSESSMENT FOR BREAD-MAKING QUALITY OF ALLELES FROM T-BOEOTICUM BOISS SSP THAOUDAR AT GLU-A1 ENCODING TWO HIGH-MOLECULAR-WEIGHT SUBUNITS OF GLUTENIN.** *Euphytica. 93(1):19-29.* English. [UNIV NACL CTR PROV BUENOS AIRES FAC AGRON AV INTENDENTE GIRAUT S-N CC 178 RA-7300 AZUL BUENOS AIRES ARGENTINA].

Two alleles, Glu-A1r encoding high-molecular-weight (HMW) glutenin subunits 39+40 and Glu-Als encoding HMW glutenin subunits 41+42, were introgressed to bread wheat (Triticum aestivum L.) cv. Sicco from two accessions of T. boeoticum Boiss. ssp. thaoudar (A genome species, 2n=2x=14). Alleles at Glu-A1 in current commercial bread wheats encode zero or one subunit, and alleles at the homoeoloci Glu-BI and Glu-D1 encode a maximum of two subunits; hence the maximum number of subunits found in commercial wheats is five, whereas the lines incorporating Glu-A1r and Glu-A1s carry six. Using near-isogenic lines, the current results demonstrated that the introduction of Glu-A1r- resulted in diminished dough stickiness and improved stability during mixing compared with Glu-Ala encoding subunit 1, and a small improvement in gluten strength as shown by the SDS-sedimentation test. The introduction of Glu-A1s also resulted in a small improvement in gluten strength predicted by the SDS-sedimentation test. Thus the alleles are of potential value in breeding programmes designed to improve bread-making quality. [References: 46].

2780 Sammons, D.J. (Purdue Univ., West Lafayette, IN.); Kratochvil, R.J. (1996) **Registration of 'Catoctin' wheat.** *Crop science (USA) v. 36(3) p. 802.* English. (AGRIS 97-031923).

2781 Satoh, J.; Baba, K.; Nakahira, Y.; Shiina, T.; Toyoshima, Y. (1997) **CHARACTERIZATION OF DYNAMICS OF THE PSBD LIGHT-INDUCED TRANSCRIPTION IN MATURE WHEAT CHLOROPLASTS.** *Plant Molecular Biology. 33(2):267-278.* English. [KYOTO UNIV GRAD SCH HUMAN & ENVIRONM STUDIES SAKYO KU YOSHIDA NIHONMATU CHO KYOTO 60601 JAPAN].

Dynamical aspects of three chloroplast promoters responding to change in light condition were examined in mature chloroplasts of wheat (Triticum aestivum) by in vitro transcription. The wheat psbD/C operon has four distinct promoters, two of which named as D/C-3 and D/C-4 promoters dominantly function in mature chloroplasts to produce the mRNAs encoding D2/CP43 and CP43 alone, respectively. Activity of the D/C-3 promoter in mature chloroplasts was reduced to less than 30% by 24 h dark adaptation and recovered by re-illumination to the original level within 30 to 60 min. The activation of the D/C-3 promoter which requires de novo cytoplasmic protein synthesis was induced by low fluence of light (e.g. 16 mu E m(-2) s(-1)), but the extent of activation increased with increasing light fluence. The accumulation of mRNAs from the D/C-3 promoter saturated at 2- to 3-fold higher level within 2 h when the dark-adapted seedlings were transferred to the light at 72 mu E m(-2) s(-1), concomitant with the increase in rate of D2 synthesis, suggesting that synthesis of D2 in mature chloroplasts is controlled via the D/C-3 promoter activity in a light-dependent way. Activity of the D/C-4 promoter slightly increased in the dark and decreased in the light. Effect of light on the psbA promoter activity was not observed at all in mature chloroplasts. In vitro transcriptional analysis of the D/C-3 promoter with 5' deletion mutations revealed that at least two cis elements which are located within the sequences of -78 to -47 and -46 to -29 of the transcription initiation site, respectively, act as enhancing elements in the D/C-3 promoter. The light-switching element of the transcription, however, was suggested to be located in the core promoter sequence downstream of the -35 element. [References: 37].

2782 Schachermayr, G.; Feuillet, C.; Keller, B. (1997) **MOLECULAR MARKERS FOR THE DETECTION OF THE WHEAT LEAF RUST RESISTANCE GENE LR10 IN DIVERSE GENETIC BACKGROUNDS.** *Molecular Breeding. 3(1):65-74.* English. [SWISS FED RES STN AGROECOL & AGR DEPT RESISTANCE & QUAL BREEDING RECKENHOLZSTR 191 CH-8046 ZURICH SWITZERLAND].

We recently showed that the Lr10 wheat leaf rust resistance gene cosegregated with the candidate resistance gene Lrk10 which encodes a putative receptor-like kinase. The aim of this study was to develop Lrk10-derived molecular markers for the detection of the Lr10 gene in breeding material. Different subfragments of Lrk10 were tested as RFLP markers for the Lr10 resistance gene. The most specific fragment (Lrk10-6) was converted into the PCR-based STS marker STSLrk10-6. Both the RFLP and the STS marker did not give a signal with near isogenic lines containing a different Lr gene. The applicability of these markers for the detection of Lr10 in genetically diverse material was tested with 62 wheat and spelt breeding lines, mostly from European breeding programmes. Twelve varieties known to have Lr10 showed the same alleles as the originally characterized line ThatcherLr10. Most of the lines with unknown

composition at the Lr10 locus had a null allele with both the RFLP marker Lrk10-6 and the marker STSLrk10-6 whereas 20% of the lines had a different allele. For six lines, including a traditional spelt variety derived from a landrace, both markers showed the same allele as Thatcher Lr10. Artificial infections of these lines with an isolate avirulent on Lr10 resulted in a hypersensitive reaction of all these lines, indicating also the presence of the Lr10 resistance gene. These data demonstrate that the markers derived from sequences of Lrk10 are highly specific for the Lr10 gene in breeding material of very diverse genetic origin. The markers will allow the defined deployment of Lr10 in wheat breeding programmes and will contribute to the elucidation of the role of Lr10 in polygenic resistances against leaf rust. [References: 23].

2783 Schwarzacher, T.; Wang, ML.; Leitch, AR.; Miller, N.; Moore, G.; Heslopharrison, JS. (1997) **FLOW CYTOMETRIC ANALYSIS OF THE CHROMOSOMES AND STABILITY OF A WHEAT CELL-CULTURE LINE.** *Theoretical & Applied Genetics. 94(1):91-97.* English. [JOHN INNES CTR PLANT SCI RES COLNEY LANE NORWICH NR4 7UH NORFOLK ENGLAND].

A rapidly growing, long-term suspension culture derived from Triticum aestivum L. (wheat) was synchronized using hydroxyurea and colchicine, and a chromosome suspension with 2-3 x 10(6) chromosomes ml(-1) was made. After staining with the DNA-specific fluorochromes Hoechst 33258 and Chromomycin A(3), univariate and bivariate flow-cytometry histograms showed 15 clearly resolved peaks corresponding to individual chromosome types or groups of chromosomes with similar DNA contents. The flow karyotype was closely similar to a histogram of DNA content measurements of Feulgen-stained chromosomes made by microdensitometry. We were able to show the stability of the flow karyotype of the cell line over a year, while a parallel subculture had a slightly different, stable, karyotype following different growth conditions. The data indicate that flow cytometric analysis of plant karyotypes enables accurate, statistically precise chromosome classification and karyotyping of cereals. There was little overlap between individual flow-histogram peaks, so the method is useful for flow sorting and the construction of chromosome specific-recombinant DNA libraries. Using bivariate analysis, the AT:GC ratio of all the chromosomes was remarkably similar, in striking contrast to mammalian flow karyotypes. We speculate about a fundamental difference in organization and homogenization of DNA sequences between chromosomes within mammalian and plant genomes. [References: 42].

2784 Shahmoradi, S.J. (1994) **Study of the relationship among certain Barley characters and their utilization in Barley breeding programmes.** Seed and Plant Improvement Institute, Karadj (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research Seed and Plant Improvement Institute (Iran Islamic Republic) v. 10(3-4) p. 1.* Persian. (AGRIS 97-031736).

2785 Shen Xiaorong; Lu Weizhong; Xu Renlin (Jiangsu Provincial Academy of Agricultural Sciences, Nanjing (China). Inst. of Agrobiological Genetics and Physiology) (1996) **Comparison of resistance to scab, agronomic traits and RAPD analysis between the somaclonal wheat line 895004 and its donor parent.** *Jiangsu Journal of Agricultural Sciences (China) v. 12(1) p. 7-10.* 1 table; 2 ill., 10 ref. Chinese. (AGRIS 97-046814).

2786 Shen, Q. (Washington University, St. Louis, MO.); Zhang, P.; Ho, T.H.D. (1996) **Modular nature of abscisic acid (ABA) response complexes: composite promoter units that are necessary and sufficient for ABA induction of gene expression in barley.** *The Plant cell (USA) v. 8(7) p. 1107-1119.* references. English. (AGRIS 97-031882).

The modular nature of the abscisic acid response complex (ABRC), the promoter unit necessary and sufficient for abscisic acid (ABA) induction of gene expression in barley, is defined in this study. We investigated ABA induction of a barley late embryogenesis abundant (Lea) gene, HVA1, and found that the ABRC of this gene consists of a 10-bp box with an ACGT core (ACGT-box) and the 11 bp directly upstream, named coupling element 3 (CE3). Only one copy of this ABRC is sufficient to confer ABA induction when linked to a minimal promoter. Because we previously reported another ABRC in the barley HVA22 gene, which consists of an ACGT-box with a distal coupling element (CE1), exchange experiments were conducted to study the interaction among modular elements in these ABRCs. We show that ACGT-boxes in these ABRCs are interchangeable, indicating that an ACGT-box can interact with either a distal or a proximal coupling element to confer ABA response. However, the two coupling elements are not fully exchangeable. Although CE3 can function either proximal or distal to the ACGT-box, CE1 is only functional at the distal position. The presence of both the distal and the proximal coupling elements has a synergistic effect on the absolute level of expression as well as on ABA induction. These ABRCs function in both seed and vegetative tissues. In seeds, ABA induction of the ABRC containing the proximal CE3, but not the ABRC with the distal CE1, is enhanced in the presence of the transcription regulator Viviparous1, indicating that these two ABRCs are mediated by different ABA signal transduction pathways.

2787 Shewry, P.R.; Tatham, A.S.; Greenfield, J.; Halford, N.G.; Barro, F.; Barcelo, P.; Lazzeri, P. (IACR Long Ashton Research Station, Department of Agricultural Sciences, University of Bristol, Long Ashton, Bristol BS18 9AF (United Kingdom)) (1996) **Manipulation of wheat protein quality.** *Agri-food quality: an interdisciplinary approach. Fenwick, G.R.; Hedley, C.; Richards, R.L.; Khokhar, S. (eds.) p. 117-123.* Royal Society of Chemistry. 16 ref., Special Publication No. 179. English. (AGRIS 97-046870).

2788 Singh, S.B.; Chaubey, A.K. (Govind Ballabh Pant University of Agriculture and Technology, Ujhani (India)) (1995) **Varietal performance of wheat (timely-sown irrigated) under mid-western plain zone of Uttar Pradesh.** *Indian Farming (India) v. 45(8) p. 3-4.* 1 table; 1 ill. English. (AGRIS 97-032191).

2789 Soave, D.; Freitas, J.G. de (1996) **[Efficiency and response of wheat genotypes to nitrogen having in view protein content and protein yield]. Eficiencia e resposta de genotipos de trigo a doses de nitrogenio em relacao ao teor e a quantidade de proteina bruta.** *Revista de Agricultura (Brazil) v. 71(1) p. 135-144.* 13 ref. Portuguese. (AGRIS 97-032185).

2790 Song Zhihong (Henan General Station of Soils and Fertilizers, Zhengzhou (China)) (1995) **Patterns of dry matter accumulation and NPK absorption by K-type hybrid wheat.** *Chinese Journal of Soil Science (China) v. 26(5) p. 216-218.* 4 tables; 3 ref. Chinese. (AGRIS 97-046817).

2791 Sowa, W.; Cygankiewicz, A.; Gielo, S.; Krysiak, H. (Instytut Hodowli i Aklimatyzacji Roslin, Radzikow (Poland)) (1995) **High gluten content and good baking quality of new triticale strains.** *Hodowla Roslin Aklimatyzacja i Nasiennictwo (Poland) v. 39(6) p. 81-84.* 2 tables; 8 ref. English. (AGRIS 97-032180).

The paper describes new winter triticale strains possessing proper bread baking quality. The new triticale strains were superior to the standard cultivars of triticale in kernel weight, falling number, sedimentation value (SDS), protein content, gluten index, water absorption, dough handling characteristic and bread test. The results confirm the hypothesis that even if hexaploid triticale are lacking the D genome, the breeders still have enough genes in the A, B and R genomes for improving triticale quality (according to the literature, the main genes effecting quality of hexaploid wheat are located in D genome).

2792 Spetsov, P.; Mingeot, D.; Jacquemin, JM.; Samardjieva, K.; Marinova, E. (1997) **TRANSFER OF POWDERY MILDEW RESISTANCE FROM AGILOPS VARIABILIS INTO BREAD WHEAT.** *Euphytica. 93(1):49-54.* English. [INST WHEAT & SUNFLOWER BU-9520 GEN TOSHEVO BULGARIA].

Winter hexaploid wheat (Triticum aestivum L.) was crossed with Aegilops variabilis to transfer resistance to powdery mildew into wheat. Following two backcrosses to wheat and from 5 to 9 generations of selfing, several disomic addition and substitution lines of hexaploid wheat resistant to the mildew pathogen were isolated. A pair of short satellited chromosomes was always observed in the resistant lines. Further evidence utilizing as markers for homoeologous group 1 HMW glutenin subunits and DNA hybridization with probe pGBX 3076 showed that an alien substitution involved this homoeologous group. [References: 13].

2793 Stankov, I. (Institut po Introduktsiya i Rastitelni Resursi, Sadovo (Bulgaria)) (1996) **[Use of the gene pool of wildgrowing and cultivated Tricticinae species in interspecific and intergeneric hybridization with Triticum sphaerococcum]. Izpolzvane na genofonda ot divi i kulturni vidove ot Triticinae v mezhduvidova i mezhdurodova khibridizatsiya s Triticum sphaerococcum Perc.** Selskostopanska Akademiya, Sofia (Bulgaria). *Selskostopanska Nauka (Bulgaria). Agricultural Science v. 34(4) p. 5-7.* 23 ref. Bulgarian. (AGRIS 97-032179).

Results are presented from studies of intergeneric hybridization between Triticum sphaerococcum and diploid, triploid, and hexaploid species of the genus Aegilops, diploid forms of Secale, Haynatricum (6x) and Triticale (6x). The investigations include problems of crossability, qualities of hybrid seeds and plants in the first generation, as well as the form developing process in F2 and the breeding possibilities presented by this hybridization.

2794 Staver, L.P. (1996) **[The productivity of winter barley varieties in the conditions of unstable moistening of Beltsy steppe].** Research Institute of Field Crops, Beltsy (Republic of Moldova). *Produktivnost' sortov yarovogo yachmenya v usloviyakh neustoichivogo uvlazhneniya Beltskoi stepi 30 p.* Institute of Technical and Economical Information. Russian. (AGRIS 97-032069).

Naibolee rasprostranennym v selektsionnoi praktike metodom opredeleniya zasukhoustoichivosti sortov yavlyaetsya sravnenie urozhainosti i sostavlyayushchikh ee ehlementov, poluchennoi v zasushlivye i blagopriyatnye po vlagoobespechennosti gody, a takzhe variabel'nost' ehtikh priznakov po godam. Provedennaya otsenka pozvolyaet vydelit' ryad sortov i linii, kotorye v silu anatomo-morfologicheskogo stroeniya nadzemnoi chasti, kornevoi sistemy i drugikh priznakov okazalis' bolee zasukhoustoichivymi i sformirovali polnotsennoe zerno i urozhai svyshe 50 tsentnerov s gektara. V chislo sortov i linii, vydelyayushchikhsya po urozhainosti, voshli 2 sorta Instituta Polevykh Kul'tur (Beltsy, Republic of Moldova) - Auriu i Sokor.

2795 Sun Guangzu; Wang Guangjin; Chen Yichun (Heilongjiang Academy of Agricultural Sciences, Harbin (China). Inst. of Crop Breeding) (1995) **Variations and selection of wheat mutant resistant to scab.** *Acta Agriculturae Nucleatae Sinica (China) v. 9(1) p. 1-6.* 3 tables; 2 ill., 12 ref. Chinese. (AGRIS 97-046830).

2796 Tamm, Ue.; Kueuets, H. (Jogeva Plant Breeding Inst., Jogeva (Estonia)) (1995) **[Malting barley varieties in Estonia]. Olleodra sordid Eestis.** Estonian Agricultural Univ., Tartu (Estonia). *Transactions of the Estonian Agricultural University (Estonia). Agronomy. Problems of field crop husbandry and soil management in the Baltic states (no.182) p. 149-152.* 2 tables. English. (AGRIS 97-046274).

Barley is the most widely grown cereal in Estonia covering about 55 per cent of the total grain cultivation area. Barley is generally regarded as a feed crop but is also used for malt and food. Consumption of beer is 25.30 l per capita in Estonia. Every year 10 000 tons of barley is used and evidently it will double in future.

2797 Taran, M.G.; Kovalik, U.K.; Postolatii, A.A. (1996) **[Productivity and grain quality of perspective winter wheat varieties]. Urozhai i kachestvo zerna perspektivnykh sortov ozimoi pshenitsy.** Research Institute of Field Crops, Beltsy (Republic of Moldova). *Buletin informativ (Republic of Moldova) (no. 17) p. 5-10.* Russian. (AGRIS 97-046656).

V stat'e privodyatsya dannye urozhaya razlichnykh sortov ozimoi pshenitsy za 1992-1994 gody. Analiz dannykh svidetel'stvuyut o tom, chto v gruppe vysokoroslykh sortov urozhai zerna bol'shinstva novykh sortov vyshe, chem u standarta Prometei. Naibol'shie pribavki obespechili sorta Fantazia Odesskaya, Beltsyanka 7 i Kodryanka. V gruppe korotkostebel'nykh sortov srednii urozhai izuchaemykh sortov nizhe standarta, za isklyucheniem Odesskoi 132. V laboratorii otsenki kachestva produktsii Instituta Polevykh kul'tur (Bel'tsy) byl proveden analiz kachestva zerna sortov ozimoi pshenitsy, vozdelyvaemykh v 993-1994 godakh. Rezul'taty privedeny v tablitse. Tekhnologicheskie i khlebopekarnye kachestva izuchaemykh v sortoispytanii sortov vysoki. Ob'em khleba, vypechennogo iz 100 g muki, kolebletsya v predelakh 637-765 sm cub, a obshchaya khlebopekarnaya otsenka khleba vyshe ikh ballov. Byli opredeleny i fizicheskie svoistva zerna. Ves 1000 zeren izuchaemykh sortov nakhoditsya na urovne 41, 6-50, 2 g, natura zerna ochen' vysoka i var'iruet v predelakh 810-843 g/l, a steklovidnost' - 95, 9-100.

2798 Thirtle, C.; Bottomley, P.; Palladino, P.; Schimmelpfennig, D. (1995) **The rise and fall of public sector plant breeding in the UK: a recursive model of basic and applied research, and diffusion.** *Discussion Papers in Economics - Department of Economics, University of Reading (United Kingdom); no. 321 37 p.* Reading Univ. 44 ref. English. (AGRIS 97-046808).

2799 Tinker, N.A.; Mather, D.E. (1995) **Methods for QTL analysis with progeny replicated in multiple environments.** Crop Science Society. references. vp. English. (AGRIS 97-046294).

2800 Tsunewaki, K.; Wang, GZ.; Matsuoka, Y. (1996) **PLASMON ANALYSIS OF TRITICUM (WHEAT) AND AEGILOPS .1. PRODUCTION OF ALLOPLASMIC COMMON WHEATS AND THEIR FERTILITIES.** *Genes & Genetic Systems. 71(5):293-311.* English. [FUKUI PREFECTURAL UNIV DEPT BIOSCI MATSUOKA FUKUI 91011 JAPAN].

Plasmons (= cytoplasms) of eight Triticum species (ten accessions) and 24 Aegilops species (36 accessions) have been introduced by repeated backcrosses to 12 genotypes of hexaploid, common wheat. At transfer problems such as crossing barrier, preferential transmission of a gametocidal or parthenogenesis-inducing chromosome, and mistagging of the material occurred, all of which hindered the plasmon transfer program. Of the 552 genotype-plasmon combinations produced, 532 (96.4%) had reached the B-10 or a later backcross generation, 15 (2.7%) the B-7 similar to B-9 generation, and the remaining 5 (0.9%) the B-4 similar to B-6 generation by summer, 1996. Pollen and selfed seed fertilities were observed in plants of all the field-grown lines in the 1992 - 1993 winter crop season, and backcrossed and selfed seed fertilities of plants grown in a greenhouse under a long day condition (17-h light) were assessed in the five latest backcross generations. Selfed seed fertility was found to be a better parameter of male fertility than was pollen fertility. Female fertility, as estimated from the backcrossed seed fertility, was about three times more tolerant to genetic stress caused by the alien plasmon transfer than was male fertility evaluated from both the pollen and selfed seed fertilities. The plasmons studied could be classified into 14 fertility spectrum groups. Most, excluding 15 plasmons belonging to the B, D, D-2, S, and S-b plasmon types, were considered the male sterile plasmon to common wheat. [References: 39].

2801 Untila, I.; Gaina, L.; Postolatii, A. (1996) **[High intensive varieties of winter wheat Dana and Dachia].** Research Institute of Field Crops, Beltsy (Republic of Moldova). *Vysokointensivnye sorta ozimoi pshenitsy Dana i Dachiya 30 p.* Institute of Technical and Economical Information. Russian. (AGRIS 97-032071).

Dana khozyaistvennaya kharakteristika sortov ozimoi pshenitsy Dana i Dachiya (za 3 goda). Sort Dana sozdan metodom individual'nogo otbora iz gibridnoi populyatsii (Donskaya ostistaya X Kavkaz) X (Odesskaya polukarlikovaya) X Lavrin-38. Sort Dachiya takzhe sozdan metodom gibridizatsii i otbora ehlitnykh rastenii iz gibridnoi populyatsii (Partizanka X Odesskaya-51) X Obrii. Sorta otlichayutsya khoroshei zimostoikost'yu, vysokoi stepen'yu kustistosti, vysokozernennym kolosom, khoroshei ustoichivost'yu k muchnistoi rose. Sorta Dachiya i Dana - gruppy pshenits s vysokim potentsialom produktivnosti.

2802 Van Leur, Joop; Grando, S.; Ceccarelli, S. (ICARDA, Aleepo (Syria)) (1996) **Use of barley landraces in breeding and selection program aimed at low input environments: the syrian experience. 1.** Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 123-127.* IAR/ICARDA. 1 table; 1 fig., 7 ref. English. (AGRIS 97-046285).

Most farmers in Syria and other west Asian countries, north Africa and Ethiopia are cultivating barley landraces using minimal levels of inputs. Improved germplasm must be developed, to realize full profit from production inputs invested by the farmer. Because better plant development is positively associated with disease development, new germplasm needs greater disease resistance than landraces presently grown by farmers. Lines may be selected from the local germplasm that have adequate disease resistance and are adapted both to local climate and to improved practices. What is most important is that, the use of homogenous lines should be avoided.

2803 Vensel, WH.; Adalsteins, AE.; Kasarda, DD. (1997) **PURIFICATION AND CHARACTERIZATION OF THE GLUTENIN SUBUNITS OF TRITICUM TAUSCHII, PROGENITOR OF THE D GENOME IN HEXAPLOID BREAD WHEAT.** *Cereal Chemistry. 74(2):108-114.* English. [USDA ARS WESTERN REG RES CTR 800 BUCHANAN ST ALBANY, CA 94710 USA].

N-terminal amino acid sequences and sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) molecular weights have been determined for high-performance liquid chromatography (HPLC)-

purified high molecular weight (HMW) and low molecular weight (LMW) glutenin subunits (GS) of Triticum tauschii sap. strangulata, contributor of the D genome to hexaploid bread wheat. The use of three different extraction procedures resulted in similar glutenin preparations. On the basis of N-terminal sequences, the same types of glutenin subunits that have been reported in bread and durum wheats (HMW-GS of both the x and y types and LMW-GS of the LMW-s, LMW-m, alpha-, and gamma-types) were found in T. tauschii. However, the HMW-GS in T. tauschii were in greater proportion relative to LMW-GS when compared to reported values for a bread and durum wheat. Our results support the likelihood that differences in the proportions of the various subunits contributed by the A, B, and D genomes, rather than qualitative differences in the types of subunits, are responsible for the major differences in quality characteristics between bread wheat and durum wheat. [References: 31].

2804 Verschoor, A. (New York State Department of Health, Albany, NY.); Srivastava, S.; Grassucci, R.; Frank, J. (1996) **Native 3D structure of eukaryotic 80S ribosome: morphological homology with the E. coli 70S ribosome.** *The Journal of cell biology (USA) v. 133(3) p. 495-505.* references. English. (AGRIS 97-032199).

A three-dimensional reconstruction of the eukaryotic 80S monosome from a frozen-hydrated electron microscopic preparation reveals the native structure of this macromolecular complex. The new structure, at 38 angstroms resolution, shows a marked resemblance to the structure determined for the E. coli 70S ribosome (Frank, J., A. Verschoor, Y. Li, J. Zhu, R.K. Lata, M. Radermacher, P. Penczek, R. Grassucci, R.K. Agrawal, and S. Srivastava. 1996b. In press; Frank, J., J. Zhu, P. Penczek, Y. Li, S. Srivastava, A. Verschoor, M. Radermacher, R. Grassucci, R.K. Lata, and R. Agrawal. 1995. Nature (Lond.). 376:441-444.) limited to a comparable resolution, but with a number of eukaryotic elaborations superimposed. Although considerably greater size and intricacy of the features is seen in the morphology of the large subunit (60S vs 50S), the most striking differences are in the small-subunit morphology (40S vs 30S): the extended beak and crest features of the head, the back lobes, and the feet. However, the structure underlying these extra features appears to be remarkably similar in form to the 30S portion of the 70S structure. The intersubunit space also appears to be strongly conserved, as might be expected from the degree of functional conservation of the ribosome among kingdoms (Eukarya, Eubacteria, and Archaea). The internal organization of the 80S structure appears as an armature or core of high-density material for each subunit, with the two cores linked by a single bridge between the platform region of the 40S subunit and the region below the presumed peptidyltransferase center of the 60S subunit. This may be equated with a close contact of the 18S and 28S rRNAs in the translational domain centered on the upper subunit:subunit interface.

2805 Vetelainen, M.; Suominen, M.; Nissila, E. (1997) **AGRONOMIC PERFORMANCE OF CROSSES BETWEEN NORDIC AND EXOTIC BARLEYS.** *Euphytica. 93(2):239-248.* English. [NORDIC GENE BANK POB 41 S-23053 ALNARP SWEDEN].

Exotic germplasm may be useful for the improvement of agronomic performance of barley breeding material. This study was conducted in order 1) to evaluate if it is possible to improve performance of Nordic barley breeding material by utilizing exotic germplasm sources (unadapted landraces and *H. spontaneum*), 2) to evaluate incorporation of exotic germplasm into agenetic base widely adapted to the agro-ecological conditions of the extreme Scandinavian north as well as to the base adapted to the conditions of the south of this geographical region, and 3) to evaluate whether an index composed of several traits corresponded to 'breeder's phenotypic evaluation' of the progenies. Earliness, straw length, number of ears/plant, yield/plant, seed shattering, persistence of awns and an index computed from these traits were studied in Swedish and Finnish 4-way crosses along with their adapted parents. Most of the crosses headed earlier than their adapted parents and none of the crosses outyielded the adapted parents. The most favorable frequency distributions for the index were found in the crosses with only cultivated barleys as parents. Transgressive segregates were also found in progenies with H. spontaneum parents. Incorporation of exotic barleys was most successful into the local genetic base. Comparisons between indices and breeder's phenotypic evaluation suggested reconsideration of evaluation methods early in parent development. [References: 19].

2806 Villand, P. (Norges Landbrukshoegskole, Aas (Norway). Lab. for Molekylaer Plantebiologi) (1995) **[ADP-glucose pyrophosphorylase in barley and Arabidopsis]. ADP-glukose pyrofosforylase i bygg og Arabidopsis.** Norges Landbrukshoegskole, Aas (Norway).. *Agricultural University of Norway. Doctor Scientiarum Theses (Norway); no. 95:8 48 p.* Norges Landbrukshoegskole. tables, figures; ref. 6 papers are incl. in the thesis. English. (AGRIS 97-046289).

2807 Villasenor Mir, Hector E.; Moreno Galvez, Rodolfo (1993) **[Wheat variety temporalera M-87, a multilineal variety in rainfed culture]. Temporalera M-87, un concepto de variedad multilineal en siembras de temporal.** *Agrociencia (Mexico). Serie Fitociencia v. 4(1) p. 53-64.* 1 graf., 5 tablas, 18 ref. Spanish. (AGRIS 97-045846).

After a spike purification by row and due to an observed variation for the character auricles color and heading time, five different genotypes for both characters were selected out of the wheat variety "Temporalera M-87". In order to purity or improve the original variety through the extraction of sub-lines, since "Temporalera M-87" could be conceived as a multilineal variety, taking in consideration its phenotypic variation. The selected genotypes and the original variety were grown during summer of 1989 in four rainfall environments: Toluca, Chapingo and Tecamac in the state of Mexico, and Huamantla, in Tlaxcala. The results show no significant difference nor by site, nor in the whole for the recorded traits: seed yield, disease reaction, plant height and phenology. Due to the above results, it is convenient to keep the original variety with its different components, since as a whole these probably have a highest capacity to soften the biotic and abiotic changes, and therefore the variety will last more time in the market. Con motivo de la variacion observada en la variedad de trigo Temporalero M-87 en los caracteres color de auriculas y tiempo de espigamiento, fueron seleccionados dentro de ella, despues de un proceso de purificacion de espiga por surco, cinco genotipos diferentes para ambos caracteres, con el objetivo de analizar la posibilidad de mejorar la variedad original mediante la obtencion de sublineas, partiendo del concepto de que por su amplia variacion Temporalera M-87 se puede concebir como una variedad multilineal. Los genotipos seleccionados y la variedad original fueron evaluados durante el verano de 1989 en cuatro ambientes de temporal: Toluca, Chapingo y Tecamac, Mex. y Huamantla, Tlax. Los resultados indican que no hubo diferencia significativa en los analisis por localidad y conjunto entre genotipos para las variables rendimiento de grano, reaccion a enfermedades, altura de planta y fenologia. De acuerdo con los resultados obtenidos, es conveniente mantener la variedad original con sus diferentes componentes, ya que probablemente estos en conjunto tengan mayor capacidad para amortiguar cambios bioticos y abioticos y asi perdurar por mas tiempo la variedad en el mercado.

2808 Vladova, R.; Petkolicheva, K. (1996) **USE OF ISOZYMES AND SEED STORAGE PROTEINS AS CHROMOSOME MARKERS IN THE STUDY OF TETRAPLOID TRITICALES.** *Cereal Research Communications. 24(4):417-424.* English. [BULGARIAN ACAD SCI INST GENET ACAD D KOSTOV BU-1113 SOFIA BULGARIA].

Electrophoretically separated isozymes and seed storage proteins were proposed as convenient markers for express identification of wheat chromosomes in tetraploid triticale forms. The 4x triticales contained a whole rye genome and a wheat complement which consists of chromosome pairs belonging to the A and B genomes. The following enzymes and proteins were suggested as chromosome markers for the seven homoeologous group of wheat: 1A, 1B - seed MDH-2, leaf acidic peroxidase; 2A, 2B - leaf basic peroxidase; 3A, 3B - seed Est-1; 4A, 4B - seed ADH-1; 5A, 5B - seed ShDH; 6A, 6B - leaf Est-4, a gliadins; 7A, 7B - leaf Est-3. On that ground it was supposed that the investigated tetraploid triticales contain the following wheat chromosomes: 1BL, 1BS, 3AS, 4AS, 5AS, 6AL, 6AS and 7BS. [References: 28].

2809 Vojdani, P.; Sepahvand, N. (1994) **Study of the general and specific combining ability of certain characters in bread-Wheat cultivars by diallel crosses.** Seed and Plant Improvement Inst., Karadj (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research (Iran Islamic Republic) v. 9(3-4) p. 4.* Persian. (AGRIS 97-046810).

2810 Vothknecht, U.C. (Carlsberg Laboratory, Copenhagen Valby, Denmark.); Kannangara, C.G.; Wettstein, D. von (1996) **Expression of catalytically active barley glutamyl tRNA(Glu) reductase in Escherichia coli as a fusion protein with glutathione S-transferase.** *Proceedings of the National Academy of Sciences of the United States of America (USA) v. 93(17) p. 9287-9291.* references. English. (AGRIS 97-031880).

delta-Aminolevulinate in plants, algae, cyanobacteria, and several other bacteria such as Escherichia coli and Bacillus subtilis is synthesized from glutamate by means of a tRNAGlu mediated pathway. The enzyme glutamyl tRNAGlu reductase catalyzes the second step in this pathway, the reduction of tRNA bound glutamate to give glutamate 1-semialdehyde. The hemA gene from barley encoding the glutamyl tRNAGlu reductase was expressed in E. coli cells joined at its amino terminal end to Schistosoma japonicum glutathione S-transferase (GST). GST-glutamyl tRNAGlu reductase fusion protein and the reductase released from it by thrombin digestion catalyzed the reduction of glutamyl tRNAGlu to glutamate 1-semialdehyde. The specific activity of the fusion protein was 120 pmol.micrograms-1.min-1. The fusion protein used tRNAGlu from barley chloroplasts preferentially to E. coli tRNAGlu and its activity was inhibited by hemin. It migrated as an 82-kDa polypeptide with SDS/PAGE and eluted with an apparent molecular mass of 450 kDa from Superose 12. After removal of the GST by thrombin, the protein migrated as an approximately 60-kDa polypeptide with SDS/PAGE, whereas gel filtration on Superose 12 yielded an apparent molecule mass of 250 kDa. Isolated fusion protein contained heme, which could be reduced by NADPH and oxidized by air.

2811 Waga, J.; Grzywa, M. (Instytut Hodowli i Aklimatyzacji Roslin, Radzikow (Poland). Zaklad Roslin Zbozowych) (1995) **[Relationships between hordein protein fractions and resistance to powdery mildew (Erysiphe graminis f. sp. hordei) in spring barley]. Powiazanie bialek hordeinowych z odpornoscia na maczniaka prawdziwego (Erysiphe graminis f. sp. hordei) jeczmienia jarego.** *Hodowla Roslin Aklimatyzacja i Nasiennictwo (Poland) v. 39(6) p. 41-50.* 4 fig., 2 tables; 13 ref. Polish. (AGRIS 97-031879).

Barley storage proteins (hordeins) of 250 plants of F2 generation selected from the cross combination between two spring barley forms have been analysed. Linkage of two hordein loci, which code for middle and fast migrating protein fractions has been shown. Relationship between fast migrating protein bands and resistance to powdery mildew has been observed.

2812 Wang Guixue; Zhu Xiaoda (Southwest Agricultural Univ., Chongqing (China). Dept. of Agronomy) (1995) **Genetic study on heading time and plant height of wheat irradiated by 137Cs and 60Co gamma-rays.** *Acta Agriculturae Nucleatae Sinica (China) v. 9(1) p. 20-24.* 3 tables; 9 ref. Chinese. (AGRIS 97-046831).

2813 Wang Wenmei (Shandong Academy of Agricultural Sciences, Jinan (China). Inst. for Application of Atomic Energy) (1995) **Genetic analysis of early maturity in wheat - Lumai No. 20.** *Journal of Shandong Agricultural Sciences (China) (no. 3) p. 8-11.* 5 tables; 8 ref. Chinese. (AGRIS 97-046829).

2814 Wettstein, D. von (Carlsberg Lab., Copenhagen (Denmark)) (1995) **Protein engineering in the breeding of value added cereals.** Bio Tek Symposium 1995. Copenhagen (Denmark). 24-25 Oct 1995. *Pharmacology and Toxicology. Supplement (Denmark) v. 77(2) p. 11.* English. (AGRIS 97-046280).

2815 Wrigley, C.W.; Morris, C.F. (CSIRO Grain Quality Research Laboratory, Division of Plant Industry, PO Box 7, North Ryde, Sydney, NSW 2113 (Australia)) (1996) **Breeding cereals for quality improvement.** *Cereal grain quality. Henry, R.J.; Kettlewell, P.S. (eds.) p. 321-369.* Chapman and Hall Ltd. 10 pp. of ref. English. (AGRIS 97-046169).

2816 Wu Xidong (Tianjin Agricultural Coll. (China)) (1995) **Correlation analysis on yield characters of late sowing winter wheat.** *Tianjin Agricultural Sciences (China) v. 1(3) p. 21-23.* 4 tables; 4 ref. Chinese. (AGRIS 97-046804).

2817 Wu Zhenlu; Chen Yukui; Fan Zheru (Xinjiang Academy of Agricultural Sciences, Urumqi (China). Inst. of Nuclear and Biological Technologies) (1995) **Parental combination of wheat hybrids irradiated with gamma-ray.** *Acta Agriculturae Nucleatae Sinica (China) v. 9(4) p. 193-199.* 2 tables; 9 ref. Chinese. (AGRIS 97-046832).

2818 Xue Xi (Harbin Normal Univ., Heilongjiang (China)) (1995) **Relationship between cytoplasmic male sterility and nuclear genome and its chromosome in wheat.** *Acta Genetica Sinica (China) v. 22(6) p. 445-454.* 4 tables; 20 ref. Chinese. (AGRIS 97-046820).

2819 Yang Jiashu; Yu Quanlin; Cao Yuanyin (Shenyang Agricultural Univ. (China). Lab. of Plant Immunology) (1995) **On mechanisms of tolerance to powdery mildew in spring wheat cultivar " Tiechun 1".** *Acta Phytopathologica Sinica (China) v. 25(3) p. 227-232.* 2 tables; 1 ill., 8 ref. Chinese. (AGRIS 97-046767).

2820 Yang Li (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. of Crop Breeding and Cultivation) (1995) **Gibberellic acid reaction for dwarf-abortive wheat.** *Crops (China) (no. 6) p. 10.* 1 table. Chinese. (AGRIS 97-046819).

2821 Zantoko, L.; Shukle, RH. (1997) **GENETICS OF VIRULENCE IN THE HESSIAN FLY TO RESISTANCE GENE H13 IN WHEAT.** *Journal of Heredity. 88(2):120-123.* English. [PURDUE UNIV USDA ARS DEPT ENTOMOL W LAFAYETTE, IN 47907 USA].

The present work was undertaken to determine if virulence in the Hessian fly operates on a gene-for-gene basis with respect to resistance gene H13, an undeployed gene for resistance being incorporated into wheat cultivars for Hessian fly protection, Results revealed virulence was controlled by a single recessive, sex-linked gene (virulence to H13, vrH13), Additionally, genetic analysis of virulent/avirulent phenotypes confirmed previous observations that males express only maternally derived sex chromosomes in the soma, Segregation of white and dark eye color in H13 virulent F-2 backcross individuals showed a significant ($P < .001$) deviation from the expected 1:1 phenotypic ratio, which indicated the locus controlling the white-eye trait was linked to the locus controlling virulence to H13. Recombination frequency between the white allele and vrH13 was 24.3 +/- 0.02%. Application of knowledge concerning the genetic control of virulence in the Hessian fly to resistance in wheat is discussed with respect to the pyramiding of resistance genes in wheat, and use of the white-eye phenotype to facilitate identifying molecular markers linked to H13 virulence is described. [References: 28].

2822 Zecevic, V. (1996) **Genetic identification of different winter wheat cultivars (Triticum aestivum ssp. vulgare).** Poljoprivredni fakultet, Novi Sad (Yugoslavia). *Geneticka identifikacija razlicitih sorti ozime psenice (Triticum aestivum ssp. vulgare) 98 p.* 27 tables; Bibliography p. 85-98. Serbian. (AGRIS 97-032204).

Fifty wheat genotypes from different selection centers of Yugoslavia nad World were studied. Variability, heritability and components of phenotypic variance for yield components and quality components were done. The simple, genetic and phenotypic correlations and "path" analysis of genetic correlations coefficients were calculated. The significant differences in mean values for all the studied parameters among investigated cultivars were determined. High variability for productive tillering and kernel weight per plant, lower for kernel weight per spike, number of kernels per spike and harvest index, and the lowest variability for spike length and number of spikelets per spike was found. Studied cultivars showed high protein content and sedimentation. The heritability for all traits was high, except for grain protein content.

2823 Zhan Kekui; Wang Futing; Cui Dangqun (Henan Agricultural Univ., Zhengzhou (China). Coll. of Agronomy) (1995) **Genetic analysis of flour quality characters in wheat.** *Acta Agriculturae Universitatis Henanensis (China) v. 29(4) p. 348-352.* 4 tables; 8 ref. Chinese. (AGRIS 97-046815).

2824 Zhang Aimin (Beijing Agricultural Univ. (China). Dept. of Agronomy) (1995) **Effect of field machinery of wheat breeding.** *Acta Agriculturae Universitatis Pekinensis (China) v. 21(3) p. 271-274.* 3 tables; 5 ref. Chinese. (AGRIS 97-046818).

2825 Zhang Shaonan (Fujian Academy of Agricultural Scinces, Fuzhou (China). Inst. of Rice and Wheat) (1995) **Improvement of resistance to headblight of wheat by recurrent selection with Taigu nucleus sterile line.** *Journal of Fujian Academy of Agricultural Sciences (China) v. 10(2) p. 1-4.* 1 table; 1 ill., 6 ref. Chinese. (AGRIS 97-046802).

2826 Zhang Wenjun (Academia Sinica, Beijing (China). Inst. of Genetics) (1995) **The creation and application of wheat-rye chromosome translocation.** *Hereditas (China) v. 17(Suppl.) p. 1-5.* 1 table; 57 ref. Chinese. (AGRIS 97-046824).

2827 Zhang Wenjun (Academia Sinica, Beijing (China). Inst. of Genetics) (1995) **The identification of wheat-rye chromosome translocation.** *Hereditas (China) v. 17(Suppl.) p. 6-8.* 36 ref. Chinese. (AGRIS 97-046823).

2828 Zhang Xiangqi (Academia Sinica, Beijing (China). Inst. of Genetics) (1995) **Chromosome composition and resistance to powdery mildew of three wheat-rye doubled haploid lines.** *Acta Genetica Sinica (China) v. 22(5) p. 387-393.* 3 tables; 11 ref. Chinese. (AGRIS 97-046821).

2829 Zhao Yufang; Ling Beibei; Lin Xiaoxia (Zhejiang Agricultural Univ., Hangzhou (China). Inst. of Nuclear Agricultural Science) (1995) **Gamma-ray irradiation effects on DNA's unscheduled synthesis and replication of barley embryos during their imbitition.** *Acta Agriculturae Nucleatae Sinica (China) v. 9(2) p. 65-69.* 3 ill., 8 ref. Chinese. (AGRIS 97-046275).

A study of irradiation effects on DNA synthesis activities of barley embryos (in vitro) with high vitality during their imbibition was carried out. There was an apparent initiation stage of DNA's replication synthesis of the barley embryos started from 11th hour since their imbibition. The DNA's replication synthesis was delayed for about 4 hours under 286Gy of gamma-ray irradiation. The acceleration effects on unscheduled DNA's synthesis was changed into restraint ones as gamma doses increased, while the effects on DNA's replication synthesis were all inhibited at different levels.

2830 Zhivotkov, L.A.; Dubovoj, V.I.; Novokhatka, V.G.; Golovatyuk, L.A. (1995) **[Experience of producing spring-winter wheat hybrids under conditions of artificial climate]. Opyt polucheniya yarovoozimykh gibridov pshenitsy v usloviyakh iskusstvennogo klimata.** *Selektsiya i semenovodstvo (Russian Federation) (no.2) p. 14-17.* Russian. (AGRIS 97-032198).

2831 Zhogin, A.F. (1995) **[On perspectives of new mutational properties' use in breeding of winter common wheat]. Indutsirovannye mutatsii listovoj poverkhnosti v kachestve iskhodnogo materiala v selektsii ozimoj myagkoj pshenitsy.** *Sel'skokhozyajstvennaya biologiya. Seriya Biologiya rastenij (Russian Federation) (no.1) p. 27-31.* 13 ref. Russian. (AGRIS 97-032195).

"Bulbous" and "reduced" leaf mutations (BL and LL) in various lines of the common winter wheat have been studied. The lines were used as the initial material for the breeding of resource-saving cultivars, resistant to the leaf cereal beetle. It has been shown that the involvement of RL-genes in the cross-hybridization enables the optimization of the leaf area surface, the increase of the wheat photosynthetic intensity and the yielding capacity being the result. The development of RLLL recombinants can serve as a tool when selecting cereal plants, resistant to the cereal leaf beetle.

2832 Zhu Jinbao (Beijing Municipal Lab. of Plant Cell Bioengineering (China)) (1996) **High and low molecular subunits of glutenin and their relationships with wheat quality.** *Scientia Agricultura Sinica (China) v. 29(1) p. 34-39.* 4 tables; 15 ref. Chinese. (AGRIS 97-046828).

2833 Zhu Muyuan (Hangzhou Univ., Zhejiang (China). Dept. of Biological Science and Biotechnology) (1995) **Molecular biology and genetic engineering of barley yellow mosaic disease II. Molecular analysis of a resistance-breaking strain of barley yellow mosaic virus.** *Acta Phytopathologica Sinica (China) v. 25(2) p. 117-122.* 4 ill., 23 ref. Chinese. (AGRIS 97-046276).

F40 PLANT ECOLOGY

2834 Chen Ming; Tan Jianan (Academia Sinica, Beijing (China). Inst. of Geography) (1995) **Biocycling of nine nutrient elements in winter wheat on a calcareous alluvial soil from Beijing [China].** *Acta Phytoecologica Sinica (China) v. 19(1) p. 64-71.* 3 tables; 12 ref. Chinese. (AGRIS 97-047035).

2835 Harrison, PA.; Butterfield, RE. (1996) **EFFECTS OF CLIMATE CHANGE ON EUROPE-WIDE WINTER WHEAT AND SUNFLOWER PRODUCTIVITY.** *Climate Research. 7(3):225-241.* English. [UNIV OXFORD ENVIRONM CHANGE UNIT 1A MANSFIELD RD OXFORD OX1 3TB ENGLAND].

Spatially explicit crop models were developed from mechanistic principles to investigate the regional impacts of climate change. The approach highlights the spatial variability of crop responses to altered environmental conditions. The mechanistic nature of the models allows some confidence to be placed in the results that are produced under climate change scenarios. Two crop models have been constructed and applied across a large European region: EuroWheat (winter wheat) and EuroSunfl (sunflower). Model results were compared with observed phenology and yield across a variety of scales and found to capture the current spatial variability in wheat and sunflower productivity. Climate change scenarios from both equilibrium and transient general circulation model experiments were applied to each crop model. Wheat yields are predicted to increase throughout Europe for all climate change scenarios. Conversely, water-limited sunflower yields decrease in most regions and scenarios. More positive effects are predicted for winter wheat than sunflower due to a lower sensitivity to increased temperature and a higher sensitivity to elevated concentrations of CO2. The lowest yield increases for wheat and the largest yield decreases for sunflower are found in western Europe, whilst the most positive responses for both crops occur in central and eastern Europe. Predictions for southern Europe are highly sensitive both within the region and between the scenarios. The old generation of equilibrium climate change scenarios gives the worst predictions (lowest yield increases or highest yield decreases). More beneficial responses are observed for the new generation of transient scenarios for both wheat and sunflower. Area averaged results for Europe, based on the United Kingdom Meterorological Office transient experiment (UKTR), indicate a rate of increase in winter wheat yields of 0.2 t ha(-1) decade(-1) up to the 2020s and 0.36 t ha(-1) decade(-1) beyond. Smaller changes are predicted for sunflower: a rate of decrease of 0.05 t ha(-1) decade(-1) up to the 2020s followed by an increase of 0.05 t ha(-1) decade(-1). [References: 67].

2836 Hronec, O. (Vysoka Skola Polnohospodarska, Kosice (Slovakia). Detasovane Pracovisko); Szabova, T. (1995) **[Mercury, lead, cadmium, chromium and arsenic in plants of the central Spis region (Slovakia)]. Ortut, olovo, kadmium, chrom a arzen v rastlinach Stredneho Spisa.** *Polnohospodarstvo (Slovakia) v. 41(10) p. 749-758.* 3 tables; 11 ref. Slovak. (AGRIS 97-047036).

Over 1992-1993 plant samples in the emission exhalation sources region in the central Spis region were taken. The content of hazardous elements was: Cd less than Cr less than Hg less than Pb less than As. The accumulation in the generative parts of crops was smaller than in the vegetative parts. The highest concentration of hazardous elements was observed in alfalfa and hay. In the emission sources region it is important to know the accumulation of pollutants in crops in order to decrease the impact of pollution and to choose suitable crops.

2837 Lakatos, L. (1997) **CLIMATIC MODEL FOR DRY MATTER PRODUCTION OF WINTER WHEAT IN HUNGARY.** *Agricultural & Forest Meteorology. 83(3-4):231-246.* English. [DEPT AGROPHYS & AGROMETEOROL POB 36 H-4015 DEBRECEN HUNGARY].

A dynamic model was developed to describe the total above ground dry matter production and dry matter production of ears for winter wheat, 'Jubilejnaja 50'. It also estimates the occurrence of phenological stages and yields with an accuracy of approximately +/- 10 days and +/- 0.5 tha(-1), respectively. The model uses 4 variables, while the nutrient supply submodel uses 3 variables. These variables are air temperature at 2 m, plant available water at a depth of 1 m, global radiation to characterize the radiation, and a submodel to describe the soil nutrient supply. The 3 variables of the submodel are: temperature at a depth of 1 m, soil moisture content of a 1 m deep soil layer, and precipitation. The results calculated by our model apply to the Eastern part of the Great Hungarian Plain. [References: 34].

2838 Magan, N.; Baxter, ES. (1996) **EFFECT OF INCREASED CO2 CONCENTRATION AND TEMPERATURE ON THE PHYLLOSPHERE MYCOFLORA OF WINTER WHEAT FLAG LEAVES DURING RIPENING.** *Annals of Applied Biology. 129(2):189-195.* English. [CRANFIELD UNIV APPL MYCOL GRP CTR BIOTECHNOL CRANFIELD MK43 0AL BEDS ENGLAND].

The impact of elevated carbon dioxide (CO2, 600/700 mu mol mol(-1)) and temperature (+ 4 degrees C) on phyllosphere fungi colonising flag leaves of mini crops of winter wheat cv. Mercia between anthesis and harvest was determined in a computer-controlled environment facility in

1993 and 1994. In both years the total fungal populations (cm(2) leaf) were found to have increased due to exposure to either elevated CO2 and elevated CO2 + temperature treatments. This was mainly due to significant increases in populations of Cladosporium spp. (C. cladosporioides and C. herbarum) on the flag leaves during ripening. Other phyllosphere component species such as white and pink yeasts were not markedly affected by treatments. The range of fungal species found in such controlled environment chambers was narrower than that commonly found on nag leaves of field grown crops. Common and important colonisers of leaves and ripening ears such as Aureobasidium pullulans, Epicoccum nigrum and Fusarium spp. were seldom isolated. [References: 14].

2839 Saarikko, RA.; Carter, TR. (1996) **ESTIMATING THE DEVELOPMENT AND REGIONAL THERMAL SUITABILITY OF SPRING WHEAT IN FINLAND UNDER CLIMATIC WARMING.** *Climate Research. 7(3):243-252.* English. [FINNISH METEOROL INST POB 503 FIN-00101 HELSINKI FINLAND].

Models relating development rate to temperature were used in conjunction with indices of growing season length to evaluate the regional thermal suitability for spring wheat Triticum aestivum cultivation in Finland. Thermal suitability was computed using interpolated temperature data for the baseline period 1961-1990 over a regular 10 km grid. Confidence limits of the development model were re-interpreted as spatial uncertainties in modelled suitability. The effects of climatic warming on modelled suitability were investigated by adjusting the baseline temperatures both systematically and according to scenarios of future temperature change. Three main results were obtained: (1) the thermal suitability for spring wheat cultivation could shift northwards by some 160 to 180 km per 1 degrees C increase in mean annual temperature; (2) in regions of present-day suitability, climatic warming shifts the timing of crop development to earlier in the year and shortens the development phases; and (3) the range of predictions of future climate imposes substantially greater uncertainty on estimates of suitability than the uncertainties of the suitability model itself. [References: 23].

2840 Zhang Qinghui (Weifang Coll. of Education, Shandong (China)); Xu Budong (1996) **A comparative study on the canopy structure in high-yielding wheat fields.** *Chinese Journal of Ecology (China) v. 15(2) p. 15-20.* 9 tables; 6 ill., 3 ref. Chinese. (AGRIS 97-047037).

2841 Zyablitskaya, E.Ya.; Goncharova, L.I.; Koz'min, G.V.; Aleksakhin, R.M.; Zejnalov, A.A. (1995) **[Comparative sensitivity of farm crops to separate and combined effect of UV-B and UHF radiation]. Sravnitel'naya chuvstvitel'nost' sel'skokhozyajstvennykh rastenij k razdel'nomu i kombinirovannomu dejstviyu ul'trafioletovogo V i sverkhvysokochastotnogo izluchenij.** *Doklady RASKhN (Russian Federation) (no.1) p. 14-17.* 16 ref. Russian. (AGRIS 97-032340).

F50 PLANT STRUCTURE

2842 Bjornstad, A.; Demissie, A.; Kilian, A.; Kleinhofs, A. (1997) **THE DISTINCTNESS AND DIVERSITY OF ETHIOPIAN BARLEYS.** *Theoretical & Applied Genetics. 94(3-4):514-521.* English. [AGR UNIV NORWAY DEPT HORT & CROP SCI N-1432 AS NORWAY].

The relative diversity and distinctness of Ethiopian barleys has been investigated using (1) morphology/isozyme/hordein polymorphisms and (2) RFLP markers. In the former a set of 51 landraces from over the whole of Ethiopia was compared with Iranian landraces based on data from previous studies and new hordein data. The two sets of landraces were found to have a comparable diversity. The Ethiopian ones are more diverse morphologically (5 traits), are similar in numbers of alleles per protein locus (17 loci) and in genetic differentiation, but are less diverse in average heterozygosity per locus and degree of polymorphism. However, on the basis of the hordein data the two sources of germplasm are very distinct. The correlation between morphological and protein diversity is very low. In the RFLP study 28 probes evenly distributed across the genome were used to analyse 43 Ethiopian landraces (represented by one single genotype) and to compare them with modern cultivars from North America, Europe and Japan, as well as 3 landraces from Iran, 1 from Nepal, and 1 accession of H. spontaneum from Afghanistan. The major finding was that the Ethiopian germplasm appears to be significantly less diverse than the modern germplasm but that it is genotypically very distinct. The apparent contradiction between a high diversity of useful genes coming from Ethiopia and an apparently low diversity at the DNA level is discussed. [References: 25].

2843 Boissard, P.; Valery, P.; Akkal, N.; Helbert, J.; Lewis, P. (Institut National de la Recherche Agronomique, Unite de Bioclimatologie, 78850 Thiverval Grignon (France)) (1996) **Dynamic 3D plant modelling: a morphological and structural approach based upon stereo data acquisition.** *Aspects of Applied Biology (United Kingdom) (no.46) p. 125-129.* 8 ref. Modelling in applied biology: spatial aspects, 25-27 June 1996, Brunel University, London, UK. English. (AGRIS 97-032357).

2844 Dencic, S.; Kastori, R. (Institute of Field and Vegetable Crops, Novi Sad (Yugoslavia)) (1994) **Number of stomata in wheat genotypes of different origin.** *Zbornik Matice srpske za prirodne nauke (Yugoslavia) (no. 87) p. 59-64.* 2 graphs; 1 table; 12 ref. English. (AGRIS 97-047138).

One hundred and two wheat genotypes from different parts of the world were studied for a number of stomata. The number of stomata per leaf area unit varied according to genotype studied. The respective number of stomata on the adaxial and abaxial leaf surface ranged from 44 to 81 and from 34 to 67 per square mm. In all the studied genotypes, the average number of stomata on the adaxial and abaxial leaf surface was 61.5 and 45.4 per square mm, respectively. High positive correlation was found between the height of plants and the number of stomata.

2845 Fedulov, Y. (1996) **ASSESSMENT OF THE FROST RESISTANCE OF WINTER WHEAT BY CHLOROPHYLL DELAYED FLUORESCENCE METHOD.** *Cereal Research Communications. 24(4):425-431.* English. [KUBAN STATE AGR UNIV DEPT PLANT PHYSIOL & BIOCHEM KALININ STR 13 KRASNODAR 350044 RUSSIA].

The potential of the delayed chlorophyll fluorescence technique in predicting genotypic frost resistance of winter wheat was assessed by registration the temperature dependence of delayed fluorescence (DF). DF intensity at the temperature 2-3 degrees C lower then the temperature of the DF low-temperature maximum in frost resistant variety had a high correlation coefficient with plant survival after controlled freezing. The method was rapid and could be used as a tool for preliminary frost resistance estimation of winter cereals. [References: 19].

2846 Ivezic, J.; Merkulov, L.; Kraljevicbalalic, M. (1996) **COMPONENTS OF THE PHENOTYPIC VARIABILITY OF MORPHO-ANATOMICAL CHARACTERISTICS OF WHEAT FLAG LEAF.** *Cereal Research Communications. 24(4):433-439.* English. [UNIV NOVI SAD INST BIOL YU-21000 NOVI SAD YUGOSLAVIA].

Leaf blade area, blade thickness (on vein and between veins), thickness of mesophyll, cell size (height, width) of the photosynthetic tissue, and size (height, width) of vascular bundles were examined in thirty wheat genotypes of different geographical origin. Significant differences among genotype were obtained in all the means characteristics under consideration. Calculated values of the variance components (sigma(2)g, sigma(2)e, sigma(2)f), variation coefficient, and heritability show the importance of the genetic variance in blade area and height of cells of the photosynthetic tissue while the role of the ecological variance is more evident in the expression of other traits. [References: 15].

2847 Stoilov, L.M.; Mirkova, V.N.; Dimitrova, A.; Uzunova, V.; Gecheff, K.I. (Institute of Genetics, Department of Molecular Genetics, 1113 Sofia (Bulgaria)) (1996) **Restriction endonucleases induce chromosomal aberrations in barley.** *Mutagenesis (United Kingdom) v. 11(1) p. 119-123.* 26 ref. English. (AGRIS 97-047065).

2848 Wang Zhong; Chen Gang; Li Kewu (Jiangsu Agricultural Coll., Yangzhou (China). Dept. of Agronomy) (1996) **Division of free nuclei of rice and wheat endosperm.** *Journal of Jiangsu Agricultural College (China) v. 17(1) p. 11-20.* 4 tables; 3 ill., 7 ref. Chinese. (AGRIS 97-047114).

F60 PLANT PHYSIOLOGY AND BIOCHEMISTRY

2849 Anderson, A.; Hood, B.; Singh Cundy, A. (1995) **USU researchers study space-borne wheat plants.** *Utah science (USA) v. 56(1) p. 22-24.* English. (AGRIS 97-033090).

2850 Antikainen, M.; Griffith, M. (1997) **ANTIFREEZE PROTEIN ACCUMULATION IN FREEZING-TOLERANT CEREALS.** *Physiologia Plantarum. 99(3):423-432.* English. [TURKU UNIV DEPT BIOL PLANT PHYSIOL & MOL BIOL LAB FIN-20014 TURKU FINLAND].

Freezing-tolerant plants withstand extracellular ice formation at subzero temperatures. Previous studies have shown that winter rye (Secale cereale L.) accumulates proteins in the leaf apoplast during cold acclimation that have antifreeze properties and are similar to pathogenesis-related proteins. To determine whether the accumulation of these antifreeze proteins is common among herbaceous plants, we assayed antifreeze activity and total protein content in leaf apoplastic extracts from a number of species grown at low temperature, including both monocotyledons (winter and spring lye, winter and spring wheat, winter barley, spring oats, maize) and dicotyledons (spinach, winter and spring oilseed rape [canola], kale, tobacco). Apoplastic polypeptides were also separated by SDS-PAGE and immunoblotted to determine whether plants generally respond to low temperature by accumulating pathogenesis-related proteins. Our results showed that significant levels of antifreeze activity were present only in the apoplast of freezing-tolerant monocotyledons after cold acclimation at 5/2 degrees C. Moreover, only a closely related group of plants, rye, wheat and barley, accumulated antifreeze proteins similar to pathogenesis-related proteins during cold acclimation. The results indicate that the accumulation of antifreeze proteins is a specific response that may be important in the freezing tolerance of some plants, rather than a general response of all plants to low temperature stress. [References: 36].

2851 Aslam, M. (University of California, Davis, CA.); Travis, R.L.; Huffaker, R.C. (1995) **Effect of pH and calcium on short-term NO3(-) fluxes in roots of barley seedlings.** *Plant physiology (Lancaster, Pa.) (USA) v. 108(2) p. 727-734.* references. English. (AGRIS 97-047385).

The effect of pH and Ca2(+) on net NO3(-) uptake, influx, and efflux by intact roots of barley (Hordeum vulgare L.) seedlings was studied. Seedlings were induced with NO3(-) or NO2(-). Net NO3(-) uptake and efflux, respectively, were determined by following its depletion from, and accumulation in, the external solution. Since roots of both uninduced and NO2(-)-induced seedlings contain little internal NO3(-), initial net uptake rates are equivalent to influx (M. Aslam, R.L. Travis, R.C. Huffaker [1994] Plant Physiol 106: 1293-1301). NO3(-) uptake (influx) by these roots was little affected at acidic pH. In contrast, in NO3(-)-induced roots, which accumulate NO3(-), net uptake rates decreased in response to acidic pH. Under these conditions, NO3(-) efflux was stimulated and was a function of root NO3(-) concentration. Conversely, at basic pH, NO3(-) uptake by NO3(-)- and NO2(-)-induced and uninduced roots decreased, apparently because of the inhibition of influx. Calcium had little effect on NO3(-) uptake (influx) by NO2(-)-induced roots at either pH 3 or 6. However, in NO3(-)-induced roots, lack of Ca2(+) at pH 3 significantly decreased net NO3(-) uptake and stimulated efflux. The results indicate that at acidic pH the decrease in net NO3(-) uptake is due to the stimulation of efflux, whereas at basic pH, it is due to the inhibition of influx.

2852 Aude, M.I. da S.; Bisognin, D.A.; Zanini, W. (1996) **[Dry matter accumulation and duration of grain filling period in triticale]. Acumulo de materia seca e duracao do periodo de enchimento de graos do triticale.** *Ciencia Rural (Brazil) v. 26(1) p. 23-27.* 12 ref. Portuguese. (AGRIS 97-033053).

2853 Berecz, K.; Ragasits, I. (Pannon Agrartud. Egyet., Keszthely (Hungary)); Kissimon, J. (Magyar Tud. Akad., Martonvasar (Hungary). Mezog. Kutatoint.) (1995) **[Changes in protein composition during the grain of wheat as a function of nitrogen fertilization using classical fractionation and SDS-PAGE methods]. Feherje-osszetetel valtozas a buza szemfejlodese soran nitrogen-mutragyazas fuggvenyeben, klasszikus frakcionalasi es SDS-PAGE modszerekkel vizsgalva.** *Novenytermeles (Hungary) v. 44(1) p. 19-32.* 6 Tables; 4 ill.; 28 ref. Hungarian. (AGRIS 97-047631).

The effect of different levels of N supply on the development, accumulation and composition of wheat grain protein was studied during grain filling using classical fractionation and gel electrophoresis. The field N fertilisation experiment was carried out on Romann's brown forest soil in Keszthely (Hungary). Grain for analysis were removed by hand from 100 ears every 7 days on a total of 6 occasions after the grains had reached 70 percent moisture content.

2854 Bethke, P.C. (University of California, Berkeley, CA.); Hillmer, S.; Jones, R.L. (1996) **Isolation of intact protein storage vacuoles from barley aleurone. Identification of aspartic and cysteine proteases.** *Plant physiology (Lancaster, Pa.) (USA) v. 110(2) p. 521-529.* references. English. (AGRIS 97-032686).

Within the cereal aleurone reserve proteins are stored in specialized organelles, the protein storage vacuoles (PSV). We developed an aqueous method for the isolation of intact PSV. Barley (Hordeum vulgare L. cv Himalaya) aleurone protoplasts were gently lysed by passing them through a syringe needle. PSV were separated from cytoplasmic components by microfiltration and low-speed centrifugation. Isolated PSV appeared by light microscopy to be identical with those within barley aleurone protoplasts. Luminal contents were retained throughout the isolation procedure. We used isolated PSV to identify and characterize PSV-associated proteolytic activities. Isolated PSV contained cysteine proteases and aspartic proteases (APs). Gibberellic acid treatment of protoplasts increased cysteine protease activity. Protein blots probed with anti-H. vulgare aspartic proteinase (HvAP) indicated that one PSV-AP was HvAP. Immunocytochemical localization by electron microscopy confirmed the presence of HvAP within the lumen of PSV. We conclude that isolated barley aleurone PSV will be useful in further characterizing this organelle.

2855 Blum, U. (1997) **BENEFITS OF CITRATE OVER EDTA FOR EXTRACTING PHENOLIC ACIDS FROM SOILS AND PLANT DEBRIS.** *Journal of Chemical Ecology. 23(2):347-362.* English. [N CAROLINA STATE UNIV DEPT BOT BOX 7612 RALEIGH, NC 27695 USA].

The effectiveness of various citrate extractions to recover ferulic acid, a phenolic acid, from Cecil A(p) and B-t soil and plant surface debris (crimson clover, rye, subterranean clover, and wheat) was compared with that of EDTA extractions. Citrate extractions were equivalent to or better than EDTA in recovering phenolic acids from soil and plant debris. Citrate, unlike EDTA, did not interfere with the Folin & Ciocalteu's phenol reagent when determining total phenolic acid content in soil and plant debris extracts. Care, however, must be taken when using Folin & Ciocalteu's phenol reagent to estimate total phenolic acid content, particularly in the presence of soil organic matter. Citrate was also more effective in extracting phenolic acids from A-horizon soils. Thus, citrate extractions overcome some of the major limitations observed for EDTA extractions. [References: 22].

2856 Botha, CEJ.; Cross, RHM. (1997) **PLASMODESMATAL FREQUENCY IN RELATION TO SHORT-DISTANCE TRANSPORT AND PHLOEM LOADING IN LEAVES OF BARLEY (HORDEUM VULGARE) - PHLOEM IS NOT LOADED DIRECTLY FROM THE SYMPLAST.** *Physiologia Plantarum. 99(3):355-362.* English. [RHODES UNIV DEPT BOT SCHONLAND BOT LABS POB 94 ZA-6140 GRAHAMSTOWN SOUTH AFRICA].

We investigated the phloem loading pathway in barley, by determining plasmodes-matal frequencies at the electron microscope level for both intermediate and small blade bundles of mature barley leaves. Lucifer yellow was injected intercellularly into bundle sheath, vascular parenchyma, and thin-walled sieve tubes. Passage of this symplastically transported dye was monitored with an epifluorescence microscope under blue light. Low plasmodesmatal frequencies endarch to the bundle sheath cells are relatively low for most interfaces terminating at the thin- and thick-walled sieve tubes within this C-3 species. Lack of connections between Vascular parenchyma and sieve tubes, and low frequencies (0.5% plasmodesmata per mu m cell wall interface) of connections between vascular parenchyma and companion cells, as well as the very low frequency of pore-plasmodesmatal connections between companion cells and sieve tubes in small bundles (0.2% plasmodesmata per mu m cell wall interface), suggest that the companion cell-sieve tube complex is symplastically isolated from other Vascular parenchyma cells in small bundles. The degree of cellular connectivity and the potential isolation of the companion cell-sieve tube complex was determined electrophysiologically, using an electrometer coupled to microcapillary electrodes. The less negative cell potential (average -52 mV) from mesophyll to the vascular parenchyma cells contrasted sharply with the more negative potential (-122.5 mV) recorded for the companion cell-thin-walled sieve tube complex. Although intercellular injection of lucifer yellow clearly demonstrated rapid (0.75 mu m s(-1)) longitudinal and radial transport in the bundle sheath-vascular parenchyma complex, as

well as from the bundle sheath through transverse veins to adjacent longitudinal veins, we were neither able to detect nor present unequivocal evidence in support of the symplastic connectivity of the sieve tubes to the vascular parenchyma. Injection of the companion cell-sieve tube complex, did not demonstrate backward connectivity to the bundle sheath. We conclude that the low plasmodesmatal frequencies, coupled with a two-domain electropotential zonation configuration, and the negative transport experiments using lucifer yellow, precludes symplastic phloem loading in barley leaves. [References: 21].

2857 Chanda, SV.; Singh, YD. (1997) **CHANGES IN PEROXIDASE AND IAA OXIDASE ACTIVITIES DURING WHEAT GRAIN DEVELOPMENT.** *Plant Physiology & Biochemistry. 35(3):245-250.* English. [SAURASHTRA UNIV DEPT BIOSCI RAJKOT 360005 GUJARAT INDIA].

Grain dry weight, water content and changes in the activities of soluble and salt-extracted (ionically bound) peroxidase and IAA oxidase were investigated in three grains (differing in their final dry weight and position on the spike) of wheat (Triticum aestivum L.) cultivar Lok-1 during the entire period of grain development. Based on biphasic regression analysis of grain dry weight and water content data, the wheat grain development was divided into four phases: (d) cell division, (b) cell elongation, (c) dry matter accumulation, and (d) maturation. In all the three grains, soluble IAA oxidase activity increased during the elongation phase while ionically bound activity increased during dry matter accumulation and maturation phases. Changes in ionically bound peroxidase activity showed inverse correlation with the process of cell elongation whereas no relationship between soluble peroxidase activity and grain development was discernible. The close correlation between cessation of elongation growth and increase in wall peroxidase and IAA oxidase activities points to an important role of these enzymes in the termination of elongation phase, in wheat grain development. [References: 33].

2858 Ciaffi, M.; Dominici, L.; Lafiandra, D. (1997) **GLIADIN POLYMORPHISM IN WILD AND CULTIVATED EINKORN WHEATS.** *Theoretical & Applied Genetics. 94(1):68-74.* English. [UNIV TUSCIA DIPARTIMENTO AGROBIOL & AGROCHIM I-01100 VITERBO ITALY].

To study the relationships between different species of the Einkorn group, 408 accessions of Triticum monococcum, T. boeoticum, T. boeoticum ssp. thauodar and T. urartu were analyzed electrophoretically for their protein composition at the Gli-1 and Gli-2 loci. In all the species the range of allelic variation at the loci examined is remarkable. The gliadin patterns of T. monococcum and T. boeoticum were very similar to one another but differed substantially from those of T. urartu. Several accessions of T. boeoticum and T. monococcum were shown to share the same alleles at the Gli-1 and Gli-2 loci, confirming the recent nomenclature that considers these wheats as different subspecies of the same species, T. monococcum. The gliadin composition of T. urartu resembled that of the A genome of polyploid wheats more than did T. boeoticum or T. monococcum, supporting the hypothesis that T. urartu, rather than T. boeoticum, is the donor of the A genome in cultivated wheats. Because of their high degree of polymorphism the gliadin markers may help in selecting breeding parents from diploid wheat germ plasm collections and can be used both to search for valuable genes linked to the gliadin-coding loci and to monitor the transfer of alien genes into cultivated polyploid wheats. [References: 37].

2859 Cross, J.W. (National Science Foundation, Arlington, VA.); Herzmark, P.; Guilford, W.L.; Patterson, T.G.; Labovitz, J.N. (1995) **Transport and metabolism of pollen suppressant SC-2053 in wheat.** *Journal of agricultural and food chemistry (USA) v. 43(2) p. 548-556.* references. English. (AGRIS 97-033066).

SC-2053, 1-(4-chlorophenyl)-4-oxo-5-(methoxyethoxy)cinnoline-3 - carboxylic acid, is a pollen suppressant (chemical hybridizing agent) in wheat. Metabolism of this compound was studied using [14C]SC-2053 labeled uniformly in the chlorophenyl ring. Wheat plants were treated when the spike was 2-4 cm in length. The floral spike contained about 10 of the label taken up into the plant 4 days after treatment, 1% 14 days after treatment. Unchanged [14C]SC-2053 plus two more polar metabolites were 90-95 of the total 14C extracted from the plants 14 days after treatment. The more polar metabolite was a glycoside of the other. Treated wheat plants and wheat callus cultures metabolized [14C]SC-2053 by a similar route. The aglycon purified from a callus culture filtrate was identified as 1-(4-chlorophenyl)-4-oxo-5-(2-hydroxyethoxy)cinnoline 3-carboxylic acid. This alcohol results from demethylation of the 5-methoxyethoxy group. In plants this metabolite is glycosylated, but in callus cultures only the initial demethylated compound accumulated in the medium. The major metabolite in mature straw was the glycoside.

2860 Dahlin, C.; Franzen, LG. (1997) **CAROTENOID-DEFICIENT YOUNG WHEAT ETIOPLASTS ARE ABLE TO BIND PRECURSOR PROTEINS ON THE PLASTID SURFACE BUT ARE IMPAIRED IN THEIR TRANSLOCATION ABILITY.** *Physiologia Plantarum. 99(2):279-285.* English. [UNIV GOTHENBURG DEPT PLANT PHYSIOL CARL SKOTTSBERGS GATA 22B S-41319 GOTHENBURG SWEDEN].

Young carotenoid-deficient etioplasts, isolated from Norflurazon (NF)-treated wheat seedlings, were used to study the role of coloured carotenoids in the binding and import reactions of different nuclear-encoded plastid proteins. Plastids from control seedlings exhibited significantly higher import efficiencies than did plastids from NF-treated plants. Etioplasts containing normal levels of carotenoids imported approximately 2000 and 800 molecules per plastid of the precursors of the small Rubisco subunit (pSS) and the Rieske FeS protein (pFeS), respectively. Plastids from NF-treated plants imported approximately 100 and 70 pSS and pFeS molecules per plastid, respectively. In addition, a maximum binding capacity of NF-treated plastids of 1200 protein molecules per plastid was observed for both pSS and pFeS when assayed at 25 degrees C; and a maximum binding capacity of approximately 1300 molecules per plastid was noted at 4 degrees C. For control plastids, a similar amount of binding, or approximately 1400 protein molecules per plastid, could only be observed if import was inhibited by low ATP concentrations at 4 degrees C. When these plastids were washed and transferred to conditions promoting import at 25 degrees C and 10 mM Mg-ATP, close to 60% of the envelope-associated precursor protein molecules were imported. These results indicate that control and NF-treated young etioplasts contain similar amounts of binding sites far precursor proteins. However, only in the case of control plastids the binding was productive and lead to import and processing in the stroma upon transfer to conditions promoting import. Plastids isolated from wheat seedlings grown in weak red Light and containing different amounts of carotenoids, were assayed for their ability to bind and import a protein with unusual import characteristics, the Chlamydomonas reinhardtii PsaF precursor of PSI (pPsaF) and transit peptide deletion constructs. The PsaF protein was imported in a transit peptide-dependent manner into control etioplasts, whereas import of pPsaF into young wheat etioplasts isolated from NF-treated plants was inhibited at low levels of plastid carotenoids. [References: 24].

2861 Dakheel, A.J.; Makdis, F. (Aleppo Univ. (Syria). Faculty of Agriculture); Khetata, H. (Icarda, Aleppo (Syria)) (1994) **[Effects of glaucousness and awns on transpiration efficiency and yield in durum wheat isolines].** *Research Journal of Aleppo University (Syria). Agricultural Sciences Series (no.21) p. 133-159.* 9 ref.; 3 fig.; 5 tables. Arabic. (AGRIS 97-033071).

2862 Drozdowicz, Y.M. (University of California, Berkeley, CA.); Jones, R.L. (1995) **Hormonal regulation of organic and phosphoric acid release by barley aleurone layers and scutella.** *Plant physiology (Lancaster, Pa.) (USA) v. 108(2) p. 769-776.* references. English. (AGRIS 97-047387).

The release of acid from the aleurone layer and scutellum of barley (Hordeum vulgare L. cv Himalaya) was investigated. Aleurone layers isolated from mature barley grains acidify the external medium by releasing organic and phosphoric acids. Gibberellic acid and abscisic acid stimulate acid release 2-fold over control tissue incubated in 10 mM CaCl2. Gibberellic acid causes medium acidification by stimulating the release of phosphoric and citric acids, whereas abscisic acid stimulates the release of malic acid. The accumulation of these acids in the incubation medium buffers the medium against changes in pH, particularly between pH 4 and 5. The amounts of amino acids that accumulate in the medium are low (2-12 nmol/layer) compared to other organic and phosphoric acids (100-500 nmol/layer). The scutellum does not play a major role in medium acidification but participates in the uptake of organic acids. The organic acid composition of the starchy endosperm changes after 3 d of imbibition; malic, succinic, and lactic acids decrease, whereas citric and phosphoric acids remain unchanged or increase. These results indicate that during postgerminative growth, the acidity of the starchy endosperm is maintained by acid production by the aleurone layer.

2863 Farkhutdinov, RG.; Veselov, SU.; Kudoyarova, GR.; Valcke, R. (1997) **INFLUENCE OF TEMPERATURE INCREASE ON EVAPOTRANSPIRATION RATE AND CYTOKININ CONTENT IN WHEAT SEEDLINGS.** *Biologia Plantarum. 39(2):289-291.* English. [INST BIOL PR OKIYABRYA 69 UFA 450054 RUSSIA].

The content of cytokinins especially zeatin nucleotide decreased in shoots as a result of temperature increase. Simultaneously the cytokinins accumulated in roots. The changes in cytokinins distribution were followed by a decline of evapotranspiration after its initial temperature-induced uprising. [References: 7].

2864 Frank, A.B. (USDA, ARS, Northern Great Plains Research Laboratory, Mandan, ND.); Bauer, A. (1996) **Temperature, nitrogen, and carbon dioxide effects on spring wheat development and spikelet numbers.** *Crop science (USA) v. 36(3) p. 659-665.* references. English. (AGRIS 97-033069).

Spring wheat (Triticum aestivum L.) responds favorably to elevated atmospheric carbon dioxide concentration ([CO2]) at optimum temperatures. Predictions are for air temperatures to increase as global [CO2] increases. Since spring wheat grain yields generally decline as temperature increases, there is a need to understand the effects of both [CO2] and temperature on spring wheat growth, development, and yield potential. Objectives were to evaluate combinations of [CO2], air temperature, and applied N levels on leaf and apex development, spike components, tiller numbers, dry matter, plant height, and water use in spring wheat. 'Amidon' spring wheat was grown in controlled environment chambers at all combinations of 350, 650, and 950 microliter L-1 [CO2], 0, 100, and 300 kg N ha-1, and 14/18 degrees C and 22/26 degrees C night/day air temperatures. Temperature affected the Haun stage by growth degree-days (GDD) relationship more than N or [CO2]. The phyllochron in GDD was greater for plants grown at 22/26 degrees C (433 GDD) than at 14/18 degrees C (345 GDD). The Haun stage at apex double ridge and terminal spikelet increased as applied N and [CO2] increased. Fertile spikelet numbers increased as [CO2] and N level increased at 14/18 degrees C, but at 22/26 degrees C, spikelets increased as N increased and decreased as [CO2] increased. Fertile spikelets were greatest at 14/18 degrees C and 650 microliter L-1 [CO2]. Results suggest that at elevated [CO2] and adequate soil water, air temperature is more important than [CO2] in controlling grain yield potential. Because wheat yield potential at higher temperatures decreased as [CO2] increased, a northly shift in the spring wheat growing areas may occur if global temperatures increased in concert with [CO2].

2865 Fricke, W. (1997) **CELL TURGOR, OSMOTIC PRESSURE AND WATER POTENTIAL IN THE UPPER EPIDERMIS OF BARLEY LEAVES IN RELATION TO CELL LOCATION AND IN RESPONSE TO NACL AND AIR HUMIDITY.** *Journal of Experimental Botany. 48(306):45-58.* English. [SWEDISH UNIV AGR SCI DEPT PROD ECOL POB 7042 S-75007 UPPSALA SWEDEN].

Previous single-cell studies on the upper epidermis of barley leaves have shown that cells differ systematically in their solute concentrations depending on their location relative to stomatal pores and veins and that during NaCl stress, gradients in osmotic pressure (pi) develop (Fricke et al., 1995, 1996; Hinde, 1994). The objective of the present study was to address the question to which degree these intercellular differences in solute concentrations and pi are associated with intercellular differences in turgor or water potential (psi). Epidermal cells analysed were located at various positions within the ridge regions overlying large lateral or intermediate veins, in the trough regions between those veins or in between stomata (i.e. interstomatal cells). Turgor pressure of cells was measured using a cell pressure probe, and pi of extracted cell sap was determined by picolitre osmometry. For both large and intermediate lateral veins, there were no systematic differences in turgor between cells located at the base, mid or top of ridges, regardless of whether plants were analysed at low or high PAR (less than or equal to 10 or 300-400 mu mol photons m(-2) s(-1)). However, turgor within a ridge region was not necessarily uniform, but could vary by up to 0.14 MPa (1.4 bar) between adjacent cells. In 60 out of 63 plants, turgor of ridge cells was either slightly or significantly higher than turgor of trough (lowest turgor) or interstomatal cells (intermediate turgor). The significance and magnitude of turgor differences was higher in plants analysed under high PAR or local air flow than in plants analysed under low PAR. The largest (up to 0.41 MPa) and consistently significant differences in turgor were found in plants treated for 3-9 d prior to analysis with 100 mM NaCl. For both NaCl-treated and non-treated (control) plants, differences in turgor between cell types were mainly due to differences in pi since differences in psi were negligible (0.01-0.04 MPa). Epidermal cell psi in NaCl-treated plants was about 0.38 MPa more negative than in control plants due to higher pi. Turgor pressures were similar. Following a sudden change in rooting-medium psi or air humidity, turgor of both ridge and trough cells responded within seconds and followed the same time-course of relaxation. The half time (T(1/)2) of turgor relaxation was not limited by the cell's T-1/2 for water exchange. [References: 33].

2866 Gan, Y. (Agric. and Agri Food Canada, Swift Current, SK, Canada.); Stobbe, E.H. (1996) **Mainstem leaf stage and its relation to single plant grain yield in spring wheat.** *Crop science (USA) v. 36(3) p. 628-632.* references. English. (AGRIS 97-032763).

Mainstem leaf stage (MLS), determined with the Haun scale, has been used to indicate plant development in small grain crops, but it is not clear whether MLS can be used to predict final grain yield. A field study was conducted on a Neuhorst clay loam (fine-loamy, frigid, Aquic Haploboroll) at Portage la Prairie, MB, Canada, in 1990 and 1991, to determine the relationship between MLS and single plant grain yields within a canopy of spring wheat (Triticum aestivum L.). Plants were grown with small (2.2-2.4 mm wide), large (3.0-3.2 mm wide), and mixed (>2.2 but <3.2 mm wide) seed sizes. The MLS was determined 2, 3, 4, and 5 wk after initial seedling emergence (the date of the first seedling emergence in a plot), and grain yields were determined at maturity, on a single plant basis. Seed size had a significant effect on MLS only during the early seedling stages; plants grown from large seeds had greater MLS and lower plant-to-plant variation in MLS than those from small or mixed seed sizes. Within a canopy, early-emerging plants had greater MLS and were more uniform than late-emerging plants. Plant grain yields linearly responded to the MLS determined 2, 3, and 4 wk after seedling emergence. The MLS determined 230 degree-days from planting most accurately reflected final grain yield. With the Haun scale, MLS measured 2 to 4 wk after seedling emergence can be used to predict single plant grain yield in hard red spring wheat.

2867 Grindstaff, K.K. (Washington University, St. Louis, MO.); Fielding, L.A.; Brodl, M.R. (1996) **Effect of gibberellin and heat shock on the lipid composition of endoplasmic reticulum in barley aleurone layers.** *Plant physiology (Lancaster, Pa.) (USA) v. 110(2) p. 571-581.* references. English. (AGRIS 97-032687).

The heat-shock responses of barley (Hordeum vulgare L. cv Himalaya) aleurone layers incubated with or without gibberellic acid (GA3) were compared. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis revealed that heat shock blocked the synthesis and secretion of secretory proteins from GA3-treated layers but not untreated layers. This suppression of secretory protein synthesis has been correlated with changes in endoplasmic reticulum (ER) membranes (F.C. Belanger, M.R. Brodl, T.-h.D. Ho [1986] Proc Natl Acad Sci USA 83: 1354-1358; L. Sticher, A.K. Biswas, D.S. Bush, R.L. Jones [1990] Plant Physiol 92: 506-513). Our secretion data suggested that the ER membranes of aleurone layers incubated without GA3 may be more heat shock tolerant. To investigate this, the lipid profiles of membrane extracts in aleurone layers labeled with [14C]glycerol were examined. Heat shock markedly increased [14C]glycerol incorporation into phosphatidylcholine (PC), and gas chromatography revealed an increase in the amount of saturated fatty acids associated with thin layer chromatography-purified PC in GA3-treated layers. In contrast, aleurone layers incubated without GA3 at normal temperature contained PC-associated fatty acids with a greater degree of saturation than GA3-treated layers. Heat shock modestly increased the degree of fatty acid saturation in untreated aleurone layers. This same trend was noted in fatty acids isolated from ER membranes purified by continuous sucrose density centrifugation. We propose that increased fatty acid saturation may help sustain ER membrane function in heat-shocked aleurone layers incubated in the absence of GA3.

2868 Guglielminetti, L.; Wu, Y.; Boschi, E.; Yamaguchi, J.; Favati, A.; Vergara, M.; Perata, P.; Alpi, A. (1997) **EFFECTS OF ANOXIA ON SUCROSE DEGRADING ENZYMES IN CEREAL SEEDS.** *Journal of Plant Physiology. 150(3):251-258.* English. [DIPARTIMENTO BIOL PIANTE AGR SEZ FISIOL VEGETALE VIA MARISCOGLIO 34 I-56124 PISA ITALY].

We report here data on the effects of anaerobic conditions on the status of cytosolic sucrose degrading enzymes. The activities of sucrose synthase

(EC 2.4.1.13) and cytosolic alkaline invertase (EC 3.2.1.26) were studied in rice (Oryza sativa L.), maize (Zea mais L.), wheat (Triticum aestivum L.), and barley (Hordeum vulgare L.) seeds and seedlings subjected to air-anoxia transition or directly sown under anaerobic conditions. The activity of alcohol dehydrogenase (EC 1.1.1.1) is also reported, to allow comparison with a typical anaerobic polypeptide. The data, discussed and compared with the other available reports on this subject, indicate sucrose synthase induction at the transcriptional level also in maize seedlings, and suggest that sucrose synthase is the major sucrose-degrading enzyme in cereal seeds directly sown under anaerobic conditions. [References: 30].

2869 Hamberg, M. (Karolinska Institutet, Stockholm, Sweden.); Hamberg, G. (1996) **Peroxygenase-catalyzed fatty acid epoxidation in cereal seeds. Sequential oxidation of linoleic acid into 9(S), 12(S), 13(S)-trihydroxy-10(E)-octadecenoic acid.** *Plant physiology (Lancaster, Pa.) (USA) v. 110(3) p. 807-815.* references. English. (AGRIS 97-032454).

Peroxygenase-catalyzed epoxidation of oleic acid in preparations of cereal seeds was investigated. The 105, 000g particle fraction of oat (Avena sativa) seed homogenate showed high peroxygenase activity, i.e. 3034 +/- 288 and 2441 +/- 168 nmol (10 min)-1 mg-1 protein in two cultivars, whereas the corresponding fraction obtained from barley (Hordeum vulgare and Hordeum distichum), rye (Secale cereale), and wheat (Triticum aestivum) showed only weak activity, i.e. 13 to 138 nmol (10 min)-1 mg-1 protein. In subcellular fractions of oat seed homogenate, peroxygenase specific activity was highest in the 105, 000g particle fraction, whereas lipoxygenase activity was more evenly distributed and highest in the 105, 000g supernatant fraction. Incubation of [1-14C]linoleic acid with the 105, 000g supernatant of oat seed homogenate led to the formation of several metabolites, i.e. in order of decreasing abundance, 9(S)hydroxy-10 (E)12(Z)-octadecadienoic acid, 9(S), 12(S), 13(S)-trihydroxy-10(E)-octadecenoic acid, cis-9, 10-epoxy-12(Z)-octadecenoic acid [mainly the 9(R), 10(S) enantiomer], cis-12, 13-epoxy-9(Z)-octadecenoic acid [mainly the 12(R), 13(S) enantiomer], threo-12, 13-dihydroxy-9(Z)-octadecenoic acid, and 12(R), 13(S)-epoxy-9(S)-hydroxy-10 (E)-octadecenoic acid. Incubation of linoleic acid with the 105, 000g particle fraction gave a similar, but not identical, pattern of metabolites. Conversion of linoleic acid into 9(S), 12(S), 13(S)-trihydroxy-10(E)-octadecenoic acid, a naturally occurring oxylipin with antifungal properties, took place by a pathway involving sequential catalysis by lipoxygenase, peroxygenase, and epoxide hydrolase.

2870 Handley, LL.; Robinson, D.; Forster, BP.; Ellis, RP.; Scrimgeour, CM.; Gordon, DC.; Nevo, E.; Raven, JA. (1997) **SHOOT DELTA-N-15 CORRELATES WITH GENOTYPE AND SALT STRESS IN BARLEY.** *Planta. 201(1):100-102.* English. [SCOTTISH CROP RES INST DEPT CELLULAR & ENVIRONM PHYSIOL DUNDEE DD2 5DA SCOTLAND].

Given a uniform N source, the delta(15)N of barley shoots provided a genotypic range within treatments and a separation between control and salt-stress treatments as great as did delta(13)C*. Plant delta(15)N has been represented in the literature as a bioassay of external source delta(15) and used to infer soil N sources, thus precluding consideration of the plant as a major cause in determining its own delta(15)N. We believe this to be the first report of plant delta(15)N as a genetic trait. No mechanistic model is needed for use of delta(15)N as a trait in controlled studies; however, a qualitative model is suggested for further testing. [References: 17].

2871 Harrigan, KA. (1997) **PARTICLE SIZE ANALYSIS USING AUTOMATED IMAGE ANALYSIS.** *Cereal Foods World. 42(1):30-35.* English. [MAZTECH MICROVIS LTD SALES & BUSINESS DEV OTTAWA ON CANADA].

2872 Harsch, S.; Gunther, T.; Kling, CI.; Rozynek, B.; Hesemann, CU. (1997) **CHARACTERIZATION OF SPELT (TRITICUM SPELTA L) FORMS BY GEL ELECTROPHORETIC ANALYSES OF SEED STORAGE PROTEINS .1. THE GLIADINS.** *Theoretical & Applied Genetics. 94(1):52-60.* English. [UNIV HOHENHEIM INST GENET D-70593 STUTTGART GERMANY].

A comparison betweeen the electropherograms of the spelt and wheat cultivars showed specific differences in the gliadin band patterns which provided the possibility of a clear classification into spelt or wheat. A special nomenclature was developed to be able to improve the presentation of the gliadin band pattern of spelt, which is different from that of wheat. This nomenclature, however, has not yet been applied to other cereals. The gliadin band patterns were presented in a schematic form. As a parameter for comparison, idealized band patterns of both wheat and spelt were developed by comparing the proportions of the bands of all available types. When comparing the gliadin band patterns of the spelt cross-breeds with their corresponding parental generations, it was noted that the same parental bands were not always transmitted and that the cross-breeds showed differences in the intensity, mobility, occurrence, and the splitting of single bands. In general it can be said that the band pattern of the daughter generation - even in the examined F-5 and F-6 generations - is more similar to the band pattern of the mother than to that of the father, which proves a maternal effect. [References: 31].

2873 Hartel, H. (Humboldt Universitat zu Berlin, Berlin, Germany.); Lokstein, H.; Grimm, B.; Rank, B. (1996) **Kinetic studies on the xanthophyll cycle in barley leaves. Influence of antenna size and relations to nonphotochemical chlorophyll fluorescence quenching.** *Plant physiology (Lancaster, Pa.) (USA) v. 110(2) p. 471-482.* references. English. (AGRIS 97-032685).

Xanthophyll-cycle kinetics as well as the relationship between the xanthophyll de-epoxidation state and Stern-Volmer type nonphotochemical chlorophyll (Chl) fluorescence quenching (qN) were investigated in barley (Hordeum vulgare L.) leaves comprising a stepwise reduced antenna system. For this purpose plants of the wild type (WT) and the Chl b-less mutant chlorina 3613 were cultivated under either continuous (CL) or intermittent light (IML). Violaxanthin (V) availability varied from about 70 in the WT up to 97 to 98 in the mutant and IML-grown plants. In CL-grown mutant leaves, de-epoxidation rates were strongly accelerated compared to the WT. This is ascribed to a different accessibility of V to the de-epoxidase due to the existence of two V pools: one bound to light-harvesting Chl a/b-binding complexes (LHC) and the other one not bound. Epoxidation rates (k) were decreased with reduction in LHC protein contents: k(WT) > k(mutant) >> k(IML) plants. This supports the idea that the epoxidase activity resides on certain LHC proteins. Irrespective of huge zeaxanthin and antheraxanthin accumulation, the capacity to develop qN was reduced stepwise with antenna size. The qN level obtained in dithiothreitol-treated CL- and IML-grown plants was almost identical with that in untreated IML-grown plants. The findings provide evidence that structural changes within the LHC proteins, mediated by xanthophyll-cycle operation, render the basis for the development of a major proportion of qN.

2874 Hicks, G.R. (Michigan State University, East Lansing, MI.); Smith, H.M.S.; Lobreaux, S.; Raikhel, N.V. (1996) **Nuclear import in permeabilized protoplasts from higher plants has unique features.** *The Plant cell (USA) v. 8(8) p. 1337-1352.* references. English. (AGRIS 97-047477).

The import of proteins into the nucleus is a poorly understood process that is thought to require soluble cytosolic factors in vertebrates and yeast. To test this model in plants and to identify components of the import apparatus, we developed a direct in vitro nuclear import assay by using tobacco protoplasts that were permeabilized without detergents such as digitonin or Triton X-100. Substrates were imported specifically by a mechanism that required only guanine nucleotides. Moreover, in vitro import did not require exogenous cytosol. To investigate this novel finding, we isolated a tail-length cDNA encoding an Arabidopsis homolog of vertebrate and yeast nuclear localization signal receptors and produced an affinity-purified antibody. The plant receptor was tightly associated with cellular components in permeabilized protoplasts, even in the presence of 0.1 Triton X-100, indicating that this factor and probably others were retained to an extent sufficient to support import. The lectin wheat germ agglutinin bound to the nucleus; however, it did not block translocation in our system, indicating the direct interaction with polysaccharide modifications at the nuclear pore complex was probably not essential for import in plants. Other features of in vitro import included reduced but significant import at low temperature.

2875 Hill, R.D. (University of Manitoba, Winnipeg, Manitoba, Canada.); Liu, J.H.; Durnin, D.; Lamb, N.; Shaw, A.; Abrams, S.R. (1995) **Abscisic acid structure-activity relationships in barley aleurone layers and protoplasts.** *Plant physiology (Lancaster, Pa.) (USA) v. 108(2) p. 573-579.* references. English. (AGRIS 97-047384).

Optically active forms of abscisic acid (ABA) and their oxygenated metabolites were tested for their biological activity by examining the effects of the compounds on the reversal of gibberellic acid-induced alpha-amylase activity in barley (Hordeum vulgare cv Himalaya) aleurone layers

and the induction of gene expression in barley aleurone protoplasts transformed with a chimeric construct containing the promoter region of an albumin storage protein gene. Promotion of the albumin storage protein gene response had a more strict stereochemical requirement for elicitation of an ABA response than inhibition of alpha-amylase gene expression. The naturally occurring stereoisomer of ABA and its metabolites were more effective at eliciting an ABA-like response. ABA showed the highest activity, followed by 7'-hydroxyABA, with phaseic acid being the least active. Racemic 8'-hydroxy-2', 3'-dihydroABA, an analog of 8'-hydroxyABA, was inactive, whereas racemic 2', 3'-dihydroABA was as effective as ABA. The differences in response of the same tissue to the ABA enantiomers lead us to conclude that there exists more than one type of ABA receptor and/or multiple signal transduction pathways in barley aleurone tissue.

2876 Hiner, A.N.P.; Rasmussen, C.B.; Welinder, K.G. (1995) **Barley peroxidase, 1: Reactions with hydrogen peroxide and fluoride.** Bio Tek Symposium 1995. Copenhagen (Denmark). 24-25 Oct 1995. *Pharmacology and Toxicology. Supplement (Denmark) v. 77(2) p. 29.* English. (AGRIS 97-047382).

2877 Ishida, N.; Koizumi, M.; Kano, H. (1997) **LOCATION OF SUGARS IN BARLEY SEEDS DURING GERMINATION BY NMR MICROSCOPY (VOL 19, PG 1415, 1996).** *Plant Cell & Environment. 20(3):409.* English.

2878 Jeong, B.R. (Taegu University, Kyungsan (Korea Republic). College of Natural Resources); Housley, T.L. (Purdue University, Indiana (U.S.A.). Department of Agronomy) (1996) **Purification and properties of wheat fructan exohydrolase.** *Korean Journal of Crop Science (Korea Republic) v. 41(4) p. 456-464.* 7 illus.; 2 tables; 24 ref. English. (AGRIS 97-033060).

2879 Jiang Xiuyong (Fujian Academy of Agricultural Sciences, Fuzhou (China). Inst. of Soil and Fertilizer) (1995) **The changes of lamella structure and photosynthetic properties on etiolated wheat seedlings during greening stages.** *Journal of Fujian Academy of Agricultural Sciences (China) v. 10(1) p. 23-27.* 2 tables; 2 ill., 15 ref. Chinese. (AGRIS 97-047626).

2880 Jones, B.L. (Cereal Crops Research Unit, ARS, USDA, Madison, WI.); Marinac, L.A. (1995) **Barley LTP1 (PAPI) and LTP2: inhibitors of green malt cystein endoproteinases.** *American Society of Brewing Chemists (USA) v. 53(4) p. 194-195.* references. English. (AGRIS 97-032756).

2881 Kang, Y.K. (Cheju National University, Cheju (Korea Republic). Department of Agronomy); Richards, R.A.; Condon, A.G. (CSIRO, Canberra (Australia). Division of Plant Industry and Cooperative Research for Plant Science) (1996) **Interactions among carbon isotope discrimination, water use efficiency and nitrogen nutrition in wheat and barley.** *Korean Journal of Crop Science (Korea Republic) v. 41(3) p. 318-331.* 8 tables; 36 ref. English. (AGRIS 97-033061).

2882 Kawai, S.; Murakami, T.; Kuwajima, K.; Hirai, T.; Ishigami, M. (1997) **RAPID INCORPORATION OF C-14 OF GLUCOSE INTO PHYTOSIDEROPHORES IN IRON-DEFICIENT BARLEY ROOTS.** *Soil Science & Plant Nutrition. 43(1):75-84.* English. [IWATE UNIV FAC AGR MORIOKA IWATE 020 JAPAN].

Feeding experiments with C-14-labeled compounds were conducted to clarify the biosynthetic pathway of methionine for the production of the mugineic acid family of phytosiderophores (MAs) assuming that glucose may be converted to MAs through the glycolytic pathway, TCA cycle, and homoserine. Carbon-14 labeled glucose or homoserine was fed to intact roots of iron-deficient barley (Hordeum vulgare L. cv. Minorimugi) plants, and C-14-labeled glucose, malate, succinate, pyruvate, or glycerol was fed to excised roots of iron-deficient barley. In the feeding experiment with C-14-glucose using intact roots, C-14 Of glucose was incorporated into MAs rapidly and the molar radioactivity of the amino butanoic acid unit (C-4 unit) of the MAs was higher than that of citrate and malate. Carbon-14 of homoserine was incorporated into threonine rather than into MAs. Carbon-14 of malate, succinate, or pyruvate fed to the excised roots was not incorporated into MAs, while C-14 Of glycerol was incorporated into MAs. It was suggested that MAs may be synthesized from glucose through an unknown pathway that bypasses the organic acids of the TCA cycle, aspartate and homoserine; and that glycerol may be involved in the unknown pathway. [References: 20].

2883 Kettlewell, PS.; Cashman, MM. (1997) **ALPHA-AMYLASE ACTIVITY OF WHEAT GRAIN FROM CROPS DIFFERING IN GRAIN DRYING RATE.** *Journal of Agricultural Science. 128(Part 2):127-134.* English. [HARPER ADAMS AGR COLL CROP & ENVIRONM RES CTR NEWPORT TF10 8NB SHROPS ENGLAND].

The hypothesis was tested that slow grain drying stimulates pre-maturity alpha-amylase activity in wheat (Triticum aestivum L.). Grain drying rate in 91 commercial crops of cultivars Avalon or Mercia grown over the years 1988-90 was estimated from the slope of linear regressions of moisture content on time. Incipient sprouting was detected in some samples from 1988 using the fluorescein dibutyrate test, but results from a beta-limit dextrin gel assay indicated that pre-maturity alpha-amylase was probably the major source of alpha-amylase activity in these samples. Although year-to-year differences in In alpha-amylase activity and Hagberg falling number tended to be associated with seasonal differences in drying rate, there was no evidence of a relationship between either In alpha-amylase activity or Hagberg falling number and drying rate after the year effect was removed by an analysis of covariance. A second dataset from one crop in each of 14 years at one site showed significant positive linear relationships between cumulative potential evapotranspiration calculated over different periods during grain ripening and Hagberg falling number (excluding 3 years when incipient sprouting was thought to occur). It was concluded that pre-maturity alpha-amylase activity was stimulated by an unknown environmental factor differing between seasons and associated with seasonal differences in drying rate and cumulative potential evapotranspiration. [References: 28].

2884 Kim, B.J.; Jung, C.S. (Rural Development Administration, Milyang (Korea Republic). National Yeongnam Agricultural Experiment Station); Park, E.H. (Yeungnam University, Kyungsan (Korea Republic). College of Natural Resources) (1996) **Effects of chemical contents variation in covered barley seed on near infrared reflectance spectroscopy.** *Korean Journal of Crop Science (Korea Republic) v. 41(3) p. 354-361.* 4 illus.; 4 tables; 14 ref. Korean. (AGRIS 97-032683).

2885 Knetsch, M.L.W. (Max Planck Institute for Medical Research, Heidelberg, Germany.); Wang, M.; Snaar Jagalska, B.E.; Heimovaara Dijkstra, S. (1996) **Abscisic acid induces mitogen-activated protein kinase activation in barley aleurone protoplasts.** *The Plant cell (USA) v. 8(6) p. 1061-1067.* references. English. (AGRIS 97-032684).

Abscisic acid (ABA) induces a rapid and transient mitogen-activated protein (MAP) kinase activation in barley aleurone protoplasts. MAP kinase activity, measured as myelin basic protein phosphorylation by MAP kinase immunoprecipitates, increased after 1 min, peaked after 3 min, and decreased to basal levels after approximately 5 min of ABA treatment in vivo. Antibodies recognizing phosphorylated tyrosine residues precipitate with myelin basic protein kinase activity that has identical ABA activation characteristics and demonstrate that tyrosine phosphorylation of MAP kinase occurs during activation. The half-maximal concentration of ABA required for MAP kinase activation, 3 X 10(-7) M, is very similar to that required for ABA-induced rab16 gene expression. The tyrosine phosphatase inhibitor phenylarsine oxide can completely block ABA-induced MAP kinase activation and rab16 gene expression. These results lead us to conclude that ABA activates MAP kinase via a tyrosine phosphatase and that these steps are a prerequisite for ABA induction of rab16 gene expression.

2886 Kocjan Acko, D. (Ljubljana Univ. (Slovenia). Biotechnical Fac., Agronomy Dept.) (1996) **[The importance of knowing the internal structure of wheat cultivars in seed and crop production]. Pomen poznavanja notranje sestave psenicnih kultivarjev v procesu semenarjenja in pridelovanja.** Simpozij Novi izzivi v poljedelstvu (Symposium on New Challenges in Field Crop Production). Radenci (Slovenia). 9-10 Dec 1996. *Proceedings of the Symposium on New Challenges in Field Crop Production. Sesek, P. (ed.). Zbornik Simpozija Novi izzivi v poljedelstvuNew Challenges in Field Crop Production (Slovenia). University of Ljubljana, Biotechnical Faculty, Ljubljana (Slovenia). Agronomy Dept. p. 139-143.* 3 tables; 19 ref. Slovenian. (AGRIS 97-033063).

In order to study the influence of the method of producing seeds and changes in the internal structure of cultivars on winter wheat yields (Triticum aestivum L. var. aestivum), field trials were conducted in 1985-1987 and 1988-1991 in Ljubljana with the cultivars 'Lonja' (L), 'Nizija' (N), 'Jugoslavija' (J) and the following mixtures: L+N, L+J, N+J, and L+N+J

using certified and uncertified seed. In 1985 certified seed was sown in the ratio 300:300 germination seeds per m2 or 200:200:200 germination seeds per square m. In the process of home-produced seeding uncertified mixed seed was sown in 1986, 1988, 1989 and 1990 in the same proportions among cultivars as the previous year's yield. The method of seeding showed a statistically significant ($p<0.05$) increase in the yield due to certified seed, averaging 8.85 for three cultivars; for L the difference was 16.7 or 940 kg/ha in comparison with the uncertified variety. The yield of N and J in the certified variant did not justify the use of certified seed The shares of cultivars in mixtures showed statistically significant deviations ($p<0.05$) in the survival rate of cultivars in individual year relative to the initial proportions. After five years of seeding the rat in the mixtures were as follows: L+N=47:53, L+J=36:64, N+J=42:58 and L+N+J=19:32:49. The changes noted came about due to biological influences among cultivars depending on ecological conditions. Familitarity with the internal structure of wheat cultivars important to the success of the seeding process.

2887 Kotake, T.; Nakagawa, N.; Takeda, K.; Sakurai, N. (1997) **PURIFICATION AND CHARACTERIZATION OF WALL-BOUND EXO-1, 3-BETA-D-GLUCANASE FROM BARLEY (HORDEUM VULGARE L) SEEDLINGS.** *Plant & Cell Physiology. 38(2):194-200.* English. [HIROSHIMA UNIV FAC INTEGRATED ARTS & SCI DEPT ENVIRONM STUDIES HIGASHIHIROSHIMA 739 JAPAN].

A beta-D-glucanase activity hydrolyzing 1, 3:1, 4-beta-D-glucan was released from the cell walls of barley by 3 M LiCl treatment. It was purified by sequential cation-exchange, gel-filtration and hydrophobic chromatography. The molecular mass of the glucanase was 66 kDa as determined by SDS-polyacrylamide gel electrophoresis. Sequence determination of the first thirty amino acids of the N-terminus revealed a high homology of this enzyme to the Pseudomonas 1, 4-beta-D-glucosidase (56.5%). The purified beta-D-glucanase has a pH optimum at 5.0, and hydrolyzes oligosaccharides containing beta-D-1, 3 or beta-D-1, 4 linkage. The glucanase showed maximum hydrolytic activity toward laminaritetraose, the rate being about two times that of cellotetraose and about four times that of gentiobiose. Polysaccharides such as lichenan, 1, 3:1, 4-beta-D-glucan (from barley), laminarin and pustulan are also hydrolyzed, but not carboxymethyl-curdlan, carboxymethyl-cellulose, xyloglucan and maltose. The purified beta-D-glucanase yielded monomeric glucose from laminarihesaose, and exhibited characteristics of an exo-1, 3-beta-D-glucanase (EC 3.2.1.58). The activity and biochemical characteristics of this enzyme suggest that it is an exo-1, 3-beta-D-glucanase involved in the rapid turnover of 1, 3:1, 4-beta-D-glucan in barley cell walls during seedling growth. [References: 22].

2888 Li Xiaobing; Li Wenxiong; Zhou Peng (Northeast Agricultural Univ., Harbin (China)) (1996) **Accumulation and partitioning of dry matter and assimilation and translocation of nitrogen in relation to grain yield and protein content in spring wheat.** *Journal of Northeast Agricultural University (China) v. 27(2) p. 116-123.* 4 tables; 10 ref. Chinese. (AGRIS 97-047602).

2889 Liu Jintong; Cai Hong; Yuan Xiaoliang (Academia Sinica, Henan (China). Shijiazhuang Inst. of Agricultural Mordernization) (1995) **The dynamic model of the relations between water consumption of stage and yield in winter wheat and its application.** *Journal of Henan Vocation-Technical Teachers College (China) v. 23(1) p. 6-10.* 5 tables; 1 ill., 9 ref. Chinese. (AGRIS 97-047627).

2890 Marr, K.M.; McFeeters, R.L.; Lyon, M.K. (1996) **Isolation and structural analysis of two-dimensional crystals of photosystem II from Hordeum vulgare viridis zb63.** *Journal of structural biology (USA) v. 117(2) p. 86-98.* references. English. (AGRIS 97-047389).

2891 Matsunaka, T.; Watanabe, Y.; Miyawaki, T.; Ichikawa, N. (1997) **PREDICTION OF GRAIN PROTEIN CONTENT IN WINTER WHEAT THROUGH LEAF COLOR MEASUREMENTS USING A CHLOROPHYLL METER.** *Soil Science & Plant Nutrition. 43(1):127-134.* English. [RAKUNO GAKUEN UNIV EBETSU HOKKAIDO 069 JAPAN].

A field trial was conducted over a 3-year period at the Hokkaido Kitami Agricultural Experiment Station to examine whether the grain protein content (GPC) of a winter wheat cultivar (Triticum aestivum L, cv, Chihokukomugi) suitable for Japanese noodle-making could be predicted before harvest, The prediction of the GPC was accurate based on the color of the second leaf (just below the flag leaf) at the end of the emergence of the inflorescence, when nitrogen application was graded, In order to evaluate the reliability of this test, a survey of 95 wheat fields in the eastern part of Hokkaido was also carried out during a 3-year period, The prediction of the GPC for this cultivar based on the color of the second leaf was less accurate across many sites, The results of this survey, however, suggested that the leaf color could be used as an index for ranking the GPC as low or high in relation to processing requirements, When the leaf color value of the second leaf measured with a chlorophyll meter at the end of the emergence of the inflorescence was less than 40, it was predicted that the GPC would be lower than the processing requirement, This index could be applied to the cultivars grown in the eastern part of Hokkaido, except for those grown on peat soils. [References: 20].

2892 Mcneill, AM.; Zhu, CY.; Fillery, IRP. (1997) **USE OF IN SITU N-15-LABELING TO ESTIMATE THE TOTAL BELOW-GROUND NITROGEN OF PASTURE LEGUMES IN INTACT SOIL-PLANT SYSTEMS.** *Australian Journal of Agricultural Research. 48(3):295-304.* English. [UNIV WESTERN AUSTRALIA CTR LEGUMES MEDITERRANEAN AGR NEDLANDS WA 6907 AUSTRALIA].

A leaf-feeding technique for in situ N-15-labelling of intact soil-pasture plant systems was assessed, using subterranean clover (Trifolium subterraneum L.) and serradella (Ornithopus compressus L.) grown under glasshouse conditions. Total recoveries of fed N-15 were 87-100% following leaf-feeding of plants at flowering but were lower (74-84%) following the feed at the vegetative stage. Below-ground recovery of fed N-15 ranged from 7 to 26%, with serradella partitioning a greater proportion of labelled N below ground than subterranean clover. Additionally, plants of both species fed at the vegetative stage accumulated a greater proportion of the N-15 label below ground than did those fed at flowering. Dry sampling procedures, which utilised freeze-drying, enabled fractionation of the below-ground portion of the system into 'clean' nodulated macro-roots with no adhering soil, residual uncleaned root, rhizosphere, and bulk soil. Calculated specific enrichment for the 'clean' roots at different depths demonstrated a relatively uniform distribution of N-15 label in the subterranean clover roots: whereas the presence of large indeterminate nodules in the crown region of serradella roots contributed to apparent uneven distribution of label. Approximately half of the N in the residual fraction of both species consisted of labelled material, postulated to be mostly fine root. Additionally, 5-20% of the rhizosphere N and 0.5-3% of the N in Sulk soil was legume root-derived, with some N-15 detected in the extractable total soluble N and microbial N pools. Rhizodeposition of N represented approximately 10% of total plant N and 17-24% of total below-ground N for subterranean clover, whereas values for serradella were 20 and 34-37%, respectively. Estimated total below-ground N of subterranean clover reached a maximum value of 177 mg N/plant at 98 days after sowing, which corresponded with a peak shoot N of 243 mg N. Maximum below-ground N for serradella attained 196 mg N/plant 84 days after sowing with a corresponding shoot biomass of 225 mg N. There was a decline in the total below-ground N of serradella at maturity. Overall, recovered clean root N represented 30-62% of estimated total below-ground N; so it was concluded that standard root recovery procedures might be likely to underestimate severely the total below-ground N accretion and N turnover by legumes. The implications of these results for field estimation of total legume N yield, biological N fixation, and the N benefit from legumes in rotations are discussed. [References: 47].

2893 Metodiev, M.V. (Bulgarian Academy of Sciences, Sofia, Bulgaria.); Tsonev, T.D.; Popova, L.P. (1996) **Effect of Jasmonic acid on the stomatal and nonstomatal limitation of leaf photosynthesis in barley leaves.** *Journal of plant growth regulation (USA) v. 15(2) p. 75-80.* references. English. (AGRIS 97-032688).

The effect of long-term (7 days) and short-term (up to 2 h) treatment of barley plants with jasmonic acid (JA) on the components contributing to stomatal and nonstomatal limitation of photosynthesis was studied. Net CO2 assimilation rate (A) responses to intercellular CO2 concentration (Ci), i.e., A/Ci curves, were used to assess the photosynthetic ability. Long-term treatment of barley plants with JA led to a noticeable decrease in both the initial slope of the A/Ci curves and the maximum A at saturating Ci. The proportion of stomatal and nonstomatal factors in limitation of photosynthesis depended on the applied JA concentration. Short-term treatment with JA affected neither the stomatal conductivity for CO2 nor the rate of photosynthetic CO2 assimilation. We suggest that JA

may affect photosynthesis indirectly, either as a stress-modulating substance, or through the alterations in gene expression.

2894 Motta, CAP.; Dasilva, WR. (1997) **EFFECTS OF HYDRATION AND DEHYDRATION ON PHYSIOLOGICAL PERFORMANCE OF WHEAT SEEDS.** *Pesquisa Agropecuaria Brasileira. 32(4):379-390.* Portuguese. [IAPAR CAIXA POSTAL 481 BR-86001970 LONDRINA PR BRAZIL].

With the purpose of evaluating the effect of drying during the germinative process, wheat (Triticum aestivum L. cv. OCEPAR 7 - Batuira) seeds were exposed to different periods of hydration, ranging from 3 to 48 hours, at intervals of three hours. The seed population of each period of hydration was separated into groups based on characteristics of the embryonic development and after that, dried up to original humidity. The samples of each group were evaluated in relation to the physiological performance. The results obtained for each group were evaluated and compared with the seeds of different groups and with the original population in each treatment. The analysis of the results allowed the following conclusions: the best performance and tolerance to dehydration are found in seeds that reach a more advanced development stage in a shorter period of hydration. The emission of the primary root alone is not a suitable indicator for determination of the moment, during the germination process, in which seeds become sensitive to drying. The dehydration after the root emission resulted in the death of the primary root; however, the root development takes place after rehydration by secondary root initiations. [References: 28].

2895 Nakatsu, S.; Nomura, T.; Imai, T. (1997) **A RAPID AND CONVENIENT METHOD FOR ALPHA-AMYLASE ANALYSIS OF WHEAT BY AN AUTO-ANALYZER AND ITS APPLICATION TO ESTIMATION OF MAXIMUM AMYLOGRAPH VISCOSITY [Japanese].** *Japanese Journal of Crop Science. 66(1):35-41.* Japanese. [HOKKAIDO CENT AGR EXPT STN NAGANUMA HOKKAIDO 06913 JAPAN].

In order to estimate the maximum amylograph viscosity of wheat, an automatic method for the measurement of alpha-amylase activity was developed using a commercial blocked rho-nitrophenyl maltoheptaoside as a suitable substrate. A Type AAIIauto-analyzer (Bran + Luebbe) partially modified can rapidly and conveniently analyze alpha-amylase activity at almost 50 samples per hour, and can save the cost of reagents as compared to manual analysis. There was no significant difference between alpha-amylase activity measured by hand and the auto-analyzer. The alpha-amylase activity in flour correlated well with the maximum amylograph viscosity (r=-0. 922**). The correlation coefficient between alpha-amylase activity and maximum amylograph viscosity was slightly lower in ground wheat (r=-0.906**). With regard to fresh wheat, there was no apparent relationship in wheat sampled before maturity, but a high correlation (r=-0.884**) was exhibited after maturity. To monitor the levels of maximum amylograph viscosity in cargo samples and classify grades, we made tentative criterion for alpha-amylase activity in fresh wheat. Group 1 : most of the wheat with alpha-amylase activity below 300 mU/g showed a high amylograph Viscosity (mean = 755B.U.). Group 2 : wheat with alpha-amylase activity between 300 to 500 mU/g widely ranged from low to high viscosity (mean = 502B.U.). Group 3 : most of the wheat with alpha-amylase activity over 500 mU/g showed unacceptably levels of amylograph viscosity (mean=109B.U.). Therefore, the autoanalyzer can be utilized to rank wheat quality at receival points, and can also be adapted as a selection method for the development of low alpha-amylase varieties in wheat breeding. [References: 3].

2896 Nato, A.; Mirshahi, A.; Tichtinsky, G.; Mirshahi, M.; Faure, JP.; Lavergne, D.; Debuyser, J.; Jean, C.; Ducreux, G.; Henry, Y. (1997) **IMMUNOLOGICAL DETECTION OF POTENTIAL SIGNAL-TRANSDUCTION PROTEINS EXPRESSED DURING WHEAT SOMATIC TISSUE CULTURE.** *Plant Physiology. 113(3):801-807.* English. [UNIV PARIS 11 LAB MORPHOGENESE EXPT VEGETALE BATIMENT 360 F-91405 ORSAY FRANCE].

An immunochemical approach was used to detect the expression of putative guanine nucleotide-binding proteins (G-proteins), arrestin, and nucleoside diphosphate kinases during wheat (Triticum aestivum) tissue culture initiated from immature embryos. Both the soluble and membrane extracts from the immature embryos revealed bands of 58, 40, and 16 kD with antibodies to G-protein (alpha subunit), arrestin, and nucleoside diphosphate kinase, respectively. These proteins were overexpressed in vitro in both nonembryogenic callus and embryogenic cultures. An additional soluble protein (32 kD) was detected by anti-G alpha antibodies in cultured tissues but not in immature embryos, suggesting a possible function in cell multiplication. Moreover, somatic embryogenesis was associated with the appearance of a 29-kD protein reactive with anti-arrestin antibodies, both in soluble and membrane fractions. Tissue-cultured genetic stocks of Chinese Spring wheat, including the disomic, 36 ditelosomic, and 6 nullisomic-tetrasomic wheat lines, were used to ascertain the chromosomal location of the genes encoding the 29-kD arrestin-like protein. The lack of a signal with the nonembryogenic ditelosomic 3 D short chromosome arm line suggests that the 3 D long chromosome arm possesses at least one gene involved in the expression of the 29-kD protein. The putative role of the 29-kD protein in signal-transduction regulating embryogenesis is discussed. [References: 56].

2897 Pande, P.C.; Nagarajan, S.; Gambhir, P.N. (Indian Agricultural Research Institute, New Delhi (India)) (1995) **Physiological constraints in improvement of grain size and grain filling in wheat.** *Indian Journal of Plant Physiology (India) v. 38(2) p. 121-125.* 5 ill., 12 ref. English. (AGRIS 97-033058).

2898 Pasqualini, S.; Panara, F.; Ederli, L.; Batini, P.; Antonielli, M. (1997) **MULTIPLE ACID PHOSPHATASE IN BARLEY COLEOPTILES - ISOLATION AND PARTIAL CHARACTERIZATION OF THE 63 KDA SOLUBLE ENZYME FORM.** *Plant Physiology & Biochemistry. 35(2):95-101.* English. [UNIV PERUGIA DIPARTIMENTO BIOL VEGETALE BORGO XX GIUGNO 74 I-06121 PERUGIA ITALY].

The soluble acid phosphatase (EC 3.1.3.2) from barley (Hordeum vulgare) coleoptiles was purified 46-fold by ammonium sulphate fractionation, DEAE-cellulose, Concanavalin A-Sepharose 4B and gel filtration chromatography. The molecular mass of the native enzyme was 63 kDa as determined by gel filtration on a Sephadex G-100 column. The subunit molecular mass of the purified enzyme, determined by SDS-PAGE, was 57.5 kDa. Of the numerous divalent cations tested, the purified enzyme was inhibited about 77% by 1 mM molybdate; Cu+2, Mg+2 and Zn+2 also inhibited the enzyme, but at higher concentrations. The enzyme hydrolyzes a wide variety of natural and synthetic phosphate esters. In particular, this enzyme showed high specificity for inorganic pyrophosphate with a K-m value of 0.19 mM. The pH dependence studies between pH 4.3-7.9 using p-nitrophenylphosphate (p-NPP) as substrate indicate the importance of two dissociable groups in the hydrolysis mechanism, one at pH 5.0 and the other at pH 5.8. The first probably represents the ionization of the substrate (p-NPP), while the second could be attributed to the dissociation of a histidine residue. [References: 32].

2899 Paulin, J.; Tajnsek, A. (Ljubljana Univ. (Slovenia). Biotechnical Fac., Agronomy Dept.) (1996) **[The effect of nitrogen content in wheat (Triticum aestivum L.) stem on its mechanical stability]. (Vpliv vsebnosti dusika v psenicni (Triticum aestivum L.) bili na njeno mehansko odpornost na lom).** Simpozij Novi izzivi v poljedelstvu (Symposium on New Challenges in Field Crop Production). Radenci (Slovenia). 9-10 Dec 1996. *Proceedings of the Symposium on New Challenges in Field Crop Production. Sesek, P. (ed.). Zbornik Simpozija Novi izzivi v poljedelstvuNew Challenges in Field Crop Production (Slovenia). University of Ljubljana, Biotechnical Faculty, Ljubljana (Slovenia). Agronomy Dept. p. 223-228.* 5 tables; 13 ref. English. (AGRIS 97-033064).

A field study was conducted on shallow loamy sand soil near Ljubljana (Slovenia) to determine the mechanical stability of wheat stem in connection with its N content and population density. Analysis showed statistically high significant influence of N nutrition on the amount and content of N in the stem, as well as of population density, however by the highest rates (220 units of N) N content in the stem was not significantly higher than by 180 units of N. Population density affected the absolute amount of N in the stem but not the concentration. Regression analysis defined high significant parabolic dependence of mechanical stability on the amount of N in the stem, while N concentration in the stem affected the stem brekage only in EC 45 by both population densities and in EC 81/82 by lower population density. Results also showed increased resistence to stem breakage at the beginning of increasing the amount of N in plant, while further increase of N content in plants caused a decrease of mechanical stability.

2900 Rasmussen, C.B.; Howes, B.; Welinder, K.G.; Smulewich, G. (1995) **Electronic absorption and resonance Raman spectroscopic characterization of an unusual peroxidase from barley grain:**

relationships to reaction kinetics. Bio Tek Symposium 1995. Copenhagen (Denmark). 24-25 Oct 1995. *Pharmacology and Toxicology. Supplement (Denmark) v. 77(2) p. 65.* English. (AGRIS 97-047383).

2901 Robertson, E.J. (University of York, Heslington, York, UK.); Williams, M.; Harwood, J.L.; Lindsay, J.G.; Leaver, C.J.; Leech, R.M. (1995) **Mitochondria increase three-fold and mitochondrial proteins and lipid change dramatically in postmeristematic cells in young wheat leaves grown in elevated CO2.** *Plant physiology (Lancaster, Pa.) (USA) v. 108(2) p. 469-474.* references. English. (AGRIS 97-047632).

A dramatic stimulation in mitochondrial biogenesis during the very early stage of leaf development was observed in young wheat plants (Triticum aestivum cv Hereward) grown in elevated CO2 (650 microliter L-1). An almost 3-fold increase in the number of mitochondria was observed in the very young leaf cells at the base of the first leaf of a 7-d-old wheat plant. In the same cells large increases in the accumulation of a mitochondrial chaperonin protein and the mitochondrial 2-oxoglutarate dehydrogenase complex and pyruvate dehydrogenase complex were detected by immunolabeling. Furthermore, the basal segment also shows a large increase in the rate of radiolabeling of diphosphatidylglycerol, a lipid confined to the inner mitochondrial membrane. This dramatic response in very young leaf cells to elevated CO2 suggests that the numerous documented positive effects of elevated CO2 on wheat leaf development are initiated as early as 12 h postmitosis.

2902 Sardi, K. (Pannon University of Agricultural Sciences, Keszthely, Hungary.); Beres, I. (1996) **Effects of fertilizer salts on the germination of corn, winter wheat, and their common weed species.** *Communications in soil science and plant analysis (USA) v. 27(5/8) p. 1227-1235.* references. Paper presented at the 1995 International Symposium on Soil Testing and Plant Analysis: Quality of Soil and Plant Analysis in View of Sustainable Agriculture and the Environment held August 5-10, 1995, Wageningen, The Netherlands. English. (AGRIS 97-033133).

Laboratory and greenhouse experiments were carried out to study the effects of the fertilizer salts, NH4NO3, ammonium nitrate-limestone, (NH4)2SO4, urea, KCl, K2SO4, superphospate, and triple superphosphate, on the germination of corn, winter wheat, and their common weed species (ABUTH and AMARE for corn and GALAP and MATIN for wheat). Increasing rates of fertilizer salts from 10, 100, and 1,000 ppm were applied in five replicates in both laboratory and greenhouse experiments on 0.5 kg of a loamy soil. In the laboratory experiments, seeds were germinated on top of paper at 22 degrees C. Germination of winter wheat seeds was inhibited only by the highest dose of urea, while that of its weed species was highly affected by the applied fertilizers. Germination and emergence of corn was only slightly affected by the fertilizer salts. Significant changes in germination of AMARE could be observed with each fertilizer salt and each concentration; these changes tended to be positive even with the highest level of superphosphates. Emergence of ABUTH was only slightly affected by the lower sates of fertilizers while it was significantly reduced by higher doses of nitrogen (N) fertilizers. Results of these studies may serve as means of integrated weed control.

2903 Sasek, A.; Cerny, J. (1997) **GLIADIN AND GLUTENIN SIGNAL GENES OF SPELT (TRITICUM SPELTA L).** *Rostlinna Vyroba. 43(3):149-151.* Czech. [RES INST CROP PROD DRNOVSKA 507 CR-16106 PRAGUE 6 RUZYNE CZECH REPUBLIC].

Analysis of six breeders' lines of spelt (Triticum spelta L.) of the German origin was carried out using signal genes which determined gliadins and the high molecular weight (HMW) glutenins of wheat grain. Electrophoretic spectra of gliadins were obtained by the method SGE (Sasek, Sykorova, 1989); high molecular weight (HMW) glutenins by using the method SDS-PAGE (sodium dodecyl sulphate polyacrylamide gel electrophoresis; Laemmli, 1970). Allelic blocks of gliadin zones were separated according to the procedure of Sobko, Poperelja (1986), allelic blocks of zones of the HMW glutenins according to Payne et al. (1981, 1987, 1988). In electrophoretic structure of gliadins new allelic blocks GLD 1-1A N3 and GLD 6B N11 were found, not classified till now. According to the occurrence of allelic blocks of gliadins and HMW glutenins - markers of baking quality, frost hardiness and resistance to powdery mildew of cereals and grasses - potential agronomic value of tested new breeders' lines of spelt was assessed. Indices of identity of sets of allelic blocks of gliadins and HMW glutenins were used to evaluate the relation of new breeders' lines of spelt tested. [References: 6].

2904 Sharma, VK.; Jain, PK.; Maheshwari, SC.; Khurana, JP. (1997) **RAPID BLUE-LIGHT-INDUCED PHOSPHORYLATION OF PLASMA-MEMBRANE-ASSOCIATED PROTEINS IN WHEAT.** *Phytochemistry. 44(5):775-780.* English. [UNIV DELHI DEPT PLANT MOL BIOL S CAMPUS NEW DELHI 110021 INDIA].

When the microsomal membranes isolated from 4-day-old etiolated wheat seedlings are irradiated in vitro with blue light and subjected to phosphorylation with [gamma-P-32]ATP in vitro, the polypeptides of 110, 102, 82 and 70 kDa are heavily phosphorylated. The induction of phosphorylation is extremely rapid as it can be triggered by even 5 sec blue light irradiation, although maximal response is obtained with 15 sec blue irradiation. The response is observed most strongly in the microsomal fraction isolated from the highly photosensitive tip portion of the seedlings, and its intensity is higher in the leaf than in the tubular coleoptile fraction. The aqueous two-phase partitioning of the microsomal fraction has shown that all these four blue-light-responsive phosphopolypeptides are associated with the plasma membrane. The kinase involved in phosphorylating these polypeptides in vitro is sensitive to staurosporine. The presence of blue-light-responsive phosphopolypeptides in both the coleoptile sheath and the leaf encased inside, and the kinetics of induction of this response indicate that the phosphorylation of plasma membrane proteins may be one of the early steps in blue-light-elicited signal transduction chain, associated not only with phototropism but perhaps also with low-fluence blue responses in general. Copyright (C) 1997 Elsevier Science Ltd. [References: 26].

2905 Sharma, VK.; Jain, PK.; Malik, MK.; Maheshwari, SC.; Khurana, JP. (1997) **LIGHT- AND CALCIUM-MODULATED PHOSPHORYLATION OF PROTEINS FROM WHEAT SEEDLINGS.** *Phytochemistry. 44(5):781-786.* English. [UNIV DELHI DEPT PLANT MOL BIOL S CAMPUS NEW DELHI 110021 INDIA].

In vivo white light irradiation (for 1 hr or more) of four-day-old etiolated wheat seedlings followed by in vitro phosphorylation decreased the phosphorylation of 52 and 48 kDa polypeptides in the proteins of the soluble fraction; short pulses of white light or red/far-red were not effective. Studies using norflurazon, a bleaching herbicide, suggest that dephosphorylation of this polypeptide may be linked with light-dependent development of plastids. Studies employing a Ca2+ chelator, EGTA, and several calmodulin (CaM) inhibitors indicate that phosphorylation of 52, 48, 34 and 31 kDa polypeptides, both in the dialysed and undialysed soluble fractions, is Ca2+-CaM dependent. The depletion of Ca2+ also retarded the mobility of a 52 kDa polypeptide by 4-6 kDa, particularly in the undialysed fraction, which was restored to control level by increasing the Ca2+ level, a property unique to Ca2+-binding proteins. Strikingly, the phosphorylation status of a doublet (17 and 15 kDa phosphopolypeptides), visible primarily in the dialysed fraction, was not affected by light and/or Ca2+-CaM antagonists. The results suggest the existence of Ca2+/CaM-dependent protein kinase(s) in young wheat seedlings, whose activity, directly or indirectly, is down-regulated by white light. Copyright (C) 1997 Elsevier Science Ltd. [References: 40].

2906 Shukla, D.S.; Kapashi, S.B.; Pande, P.C.; Panwar, J.D.S. (Indian Agricultural Research Institute, New Delhi (India). Division of Plant Physiology) (1995) **Structural component of wheat grain and the post anthesis high temperature tolerance.** *Indian Journal of Plant Physiology (India) v. 38(2) p. 151-154.* 1 table; 3 ill., 7 ref., English. (AGRIS 97-033059).

2907 Smith, G.P.; Gooding, M.J. (Royal Agricultural College, Cirencester GL7 6JS (United Kingdom)) (1996) **Models describing wheat crude protein content and Hagberg Falling Number in regions of England between 1974 and 1993.** *Aspects of Applied Biology (United Kingdom) (no.46) p. 131-134.* 7 ref. Modelling in applied biology: spatial aspects, 25-27 June 1996, Brunel University, London, UK. English. (AGRIS 97-032608).

2908 Tripathy, B.C. (Jawaharlal Nehru University, New Delhi, India.); Brown, C.S.; Levine, H.G.; Krikorian, A.D. (1996) **Growth and photosynthetic responses of wheat plants grown in space.** *Plant physiology (Lancaster, Pa.) (USA) v. 110(3) p. 801-806.* references. English. (AGRIS 97-033067).

Growth and photosynthesis of wheat (Triticum aestivum L. cv Super Dwarf) plants grown onboard the space shuttle Discovery for 10 d were examined. Compared to ground control plants, the shoot fresh weight of space-grown seedlings decreased by 25. Postflight measurements of the O2

evolution/photosynthetic photon flux density response curves of leaf samples revealed that the CO2-saturated photosynthetic rate at saturating light intensities in space-grown plants declined 25 relative to the rate in ground control plants. The relative quantum yield of CO2-saturated photosynthetic O2 evolution measured at limiting light intensities was not significantly affected. In space-grown plants, the light compensation point of the leaves increased by 33, which likely was due to an increase (27) in leaf dark-respiration rates. Related experiments with thylakoids isolated from space-grown plants showed that the light-saturated photosynthetic electron transport rate from H2O through photosystems II and I was reduced by 28. These results demonstrate that photosynthetic functions are affected by the microgravity environment.

2909 Tsurusaki, K.; Takeda, K.; Sakurai, N. (1997) **CONVERSION OF INDOLE-3-ACETALDEHYDE TO INDOLE-3-ACETIC ACID IN CELL-WALL FRACTION OF BARLEY (HORDEUM VULGARE) SEEDLINGS.** *Plant & Cell Physiology. 38(3):268-273.* English. [FUKUYAMA UNIV FAC LIBERAL ARTS FUKUYAMA HIROSHIMA 72902 JAPAN].

The cell-wall fraction of barley seedlings was able to oxidize indole-3-acetaldehyde (IAAld) to form IAA, whereas the fraction did not catalyze the conversion of indole3-acetonitrile or indole-3-acetamide to IAA. The activity was lower in a semi-dwarf mutant that had an endogenous IAA level lower than that of the normal isogenic strain [Inouhe ct al. (1982) Plant Cell Physiol. 23: 689]. The soluble fraction also contained some activity; the activity was similar in the normal and mutant strains. The optimal pH for the conversion of IAAld to IAA in the cell-wall fraction was 7; that of soluble fraction was 6. The K-m value of the cell-wall fraction for IAAld was 5 mu M; that of soluble fraction was 31 mu M. The activity was not solubilized by treatments with 1% Nonidet P-40, 1 M NaCl, 3 M LiCl, or 50 mM MgCl2. The oxidation activity was increased by the addition of NAD(+). These results suggest that IAAld oxidation activity is bound to cell-wall components and that the lower level of IAA in the mutant probably results from reduced activity of oxidation enzyme bound to cell-wall components. [References: 45].

2910 Vandenboogaard, R.; Alewijnse, D.; Veneklaas, EJ.; Lambers, H. (1997) **GROWTH AND WATER-USE EFFICIENCY OF 10 TRITICUM AESTIVUM CULTIVARS AT DIFFERENT WATER AVAILABILITY IN RELATION TO ALLOCATION OF BIOMASS.** *Plant Cell & Environment. 20(2):200-210.* English. [DEPT FRUIT & VEGETABLES KIRSTINEBJERGVEJ 6 DK-5792 AARSLEV DENMARK].

In environments where the amount of water is limiting growth, water-use efficiency (biomass production per unit water use) is an important trait. We studied the relationships of plant growth and water use efficiency with the pattern of biomass allocation, using 10 wheat cultivars, grown at two soil moisture levels in a growth chamber. Allocation pattern and relative growth rate were not correlated, whereas allocation pattern and water use efficiency were. Variation in transpiration per plant resulted from variation in the rate of transpiration per unit leaf area or root a eight, rather than from differences in leaf area or root weight per plant. Transpiration per unit leaf area or root weight was lower when the leaf area or root weight per unit plant weight was larger. Also, the efficiency of water use at the plant and leaf levels was higher for plants with a higher leaf area per unit plant weight, and it was not correlated with the plant's growth rate. Differences in water-use efficiency at the leaf level were related to variation in stomatal conductance, rather than in the rate of photosynthesis. A high photosynthetic water-use efficiency was associated with a low efficiency of nitrogen use for photosynthesis. [References: 49].

2911 Wakabayashi, K.; Hoson, T.; Kamisaka, S. (1997) **OSMOTIC STRESS SUPPRESSES CELL WALL STIFFENING AND THE INCREASE IN CELL WALL-BOUND FERULIC AND DIFERULIC ACIDS IN WHEAT COLEOPTILES.** *Plant Physiology. 113(3):967-973.* English. [OSAKA CITY UNIV FAC SCI DEPT BIOL SUMIYOSHI KU OSAKA 558 JAPAN].

The relationship between the mechanical properties of cell walls and the levels of wall-bound ferulic (FA) and diferulic (DFA) acids was investigated in wheat (Triticum aestivum L.) coleoptiles grown under osmotic stress (60 mM polyethylene glycol [PEG] 4000) conditions. The cell walls of stressed coleoptiles remained extensible compared with those of the unstressed ones. The contents of wall-bound FA and DFA increased under unstressed conditions, but the increase was substantially reduced by osmotic stress. In response to PEG removal, these contents increased and reached almost the same levels as those of the unstressed coleoptiles. A close correlation was observed between the contents of FA and DFA and the mechanical properties of cell walls. The activities of phenylalanine ammonia-lyase and tyrosine ammonia-lyase increased rapidly under unstressed conditions. Osmotic stress substantially reduced the increases in enzyme activities. When PEG was removed, however, the enzyme activities increased rapidly. There was a close correlation between the FA levels and enzyme activities. These results suggest that in osmotically stressed wheat coleoptiles, reduced rates of increase in phenylalanine ammonia-lyase and tyrosine ammonia-lyase activities suppress phenylpropanoid biosynthesis, resulting in the reduced level of wall-bound FA that, in turn, probably causes the reduced level of DFA and thereby maintains cell wall extensibility. [References: 46].

2912 Wakabayashi, K.; Hoson, T.; Kamisaka, S. (1997) **OSMOTIC STRESS-INDUCED GROWTH SUPPRESSION OF DARK-GROWN WHEAT (TRITICUM AESTIVUM L) COLEOPTILES.** *Plant & Cell Physiology. 38(3):297-303.* English. [OSAKA CITY UNIV FAC SCI DEPT BIOL SUMIYOSHI KU OSAKA 558 JAPAN].

Application of 60 mM polyethylene glycol (PEG) to dark-grown wheat (Triticum aestivum L.) roots substantially reduced growth of coleoptiles, However, when PEG was removed, the growth rate of these coleoptiles greatly increased. Cell walls of stressed coleoptiles remained loosened as compared with those of unstressed ones. The osmotic potential of the stressed coleoptiles decreased to that of the 60 mM PEG solution. On the other hand, the extent of decrease in the osmotic potential of stressed Feats was smaller than that of stressed coleoptiles. The osmotic potential difference (Delta pi) between the cell sap and the incubation medium of stressed roots was substantially higher than that of unstressed ones, The amount of ink moved from roots, where it was applied, to the apical region of coleoptiles was significantly reduced under osmotic stress conditions, When water was exogenously applied to abraded coleoptiles, the growth of these stressed coleoptiles was greatly promoted. These results suggest that inhibition of coleoptile growth under osmotic stress conditions is not directly related to a decrease in cell wall extensibility or to loss of the capacity to maintain osmotic potential gradients, but is caused by the reduction of the water supply from the roots to the coleoptiles. [References: 25].

2913 Walker, D.J. (IACR Rothamsted, Harpenden, Hertfordshire, United Kingdom.); Leigh, R.A.; Miller, A.J. (1996) **Potassium homeostasis in vacuolate plant cells.** *Proceedings of the National Academy of Sciences of the United States of America (USA) v. 93(19) p. 10510-10514.* references. English. (AGRIS 97-032689).

Plant cells contain two major pools of K+, one in the vacuole and one in the cytosol. The behavior of K+ concentrations in these pools is fundamental to understanding the way this nutrient affects plant growth. Triple-barreled microelectrodes have been used to obtain the first fully quantitative measurements of the changes in K+ activity (aK) in the vacuole and cytosol of barley (Hordeum vulgare L.) root cells grown in different K+ concentrations. The electrodes incorporate a pH-selective barrel allowing each measurement to be assigned to either the cytosol or vacuole. The measurements revealed that vacuolar aK declined linearly with decreases in tissue K+ concentration, whereas cytosolic aK initially remained constant in both epidermal and cortical cells but then declined at different rates in each cell type. An unexpected finding was that cytoplasmic pH declined in parallel with cytosolic aK, but acidification of the cytosol with butyrate did not reveal any short-term link between these two parameters. These measurements show the very different responses of the vacuolar and cytosolic K+ pools to changes in K+ availability and also show that cytosolic K+ homeostasis differs quantitatively in different cell types. The data have been used in thermodynamic calculations to predict the need for, and likely mechanisms of, active K+ transport into the vacuole and cytosol. The direction of active K+ transport at the vacuolar membrane changes with tissue K+ status.

2914 Walker, D.J. (IACR Rothamsted, Hertfordshire, UK.); Smith, S.J.; Miller, A.J. (1995) **Simultaneous measurement of intracellular pH and K+ or NO3(-) in barley root cells using triple-barreled, ion-selective microelectrodes.** *Plant physiology (Lancaster, Pa.) (USA) v. 108(2) p. 743-751.* references. English. (AGRIS 97-047386).

The manufacture and use of triple-barreled microelectrodes, which are capable of simultaneous in vivo measurement of intracellular pH and the activities of K+ or NO3- and cell membrane potential (Em), are described. Scanning electron micrographs showed that the three tips were aligned and that the overall tip diameter was approximately 0.8 micromolar. When

filled with 100 mM KCl, all three barrels simultaneously reported identical transmembrane potentials, showing that all three tips were located in the same subcellular compartment. Intracellular estimates of Em in barley (Hordeum vulgare L. cv Klaxon) root epidermal cells obtained with these triple-barreled microelectrodes were indistinguishable from those obtained using single- or double-barreled microelectrodes. Measurements made with triple-barreled K+ and pH-selective microelectrodes in root cells of 7-d-old barley plants grown in a nutrient solution containing 0.5 mM K+ yielded cytosolic and vacuolar populations having mean K+ activity values of 71.3 and 68., mM, respectively. The associated mean pH values (+/- SE) were 7.26 +/- 0.06 (cytosol) and 5.18 +/- 0.08 (vacuole). Analysis of whole tissue digests confirmed the microelectrode measurements. Measurements made using triple-barreled pH- and nitrate-selective microelectrodes confirmed earlier double-barreled measurements of pH and nitrate in barley root epidermal cells growing in 10 mM nitrate.

2915 Wang Jinsheng; Guo Cunrong (Shanxi Agricultural Univ., Taigu (China). Dept. of Basic Courses) (1995) **Effect of rare earth nitrate on the activity of succinic dehydrogenase in wheat seedling.** *Journal of Southwest Forestry College (China) v. 15(1) p. 59-63.* 5 ill., 9 ref. Chinese. (AGRIS 97-047628).

2916 Zhang, Z. (The Royal Veterinary and Agricultural University, Copenhagen, Denmark.); Yang, J.; Collinge, D.B.; Thordal Christensen, H. (1996) **Ethanol increases sensitivity of oxalate oxidase assays and facilitates direct activity staining in SDS gels.** *Plant molecular biology reporter (USA) v. 14(3) p. 266-272.* references. English. (AGRIS 97-047390).

F61 PLANT PHYSIOLOGY-NUTRITION

2917 An, LZ.; Wang, XL. (1997) **CHANGES IN POLYAMINE CONTENTS AND ARGININE DECARBOXYLASE ACTIVITY IN WHEAT LEAVES EXPOSED TO OZONE AND HYDROGEN FLUORIDE.** *Journal of Plant Physiology. 150(1-2):184-187.* English. [LANZHOU UNIV DEPT BIOL LANZHOU 730000 PEOPLES REPUBLIC OF CHINA].

The effects of O-3, HF or both on wheat leaves were shown by chlorophyll loss and changes in membrane permeability. The changes of the ADC activity and polyamine contents were also examined in wheat leaves exposed to pollutants. The ADC activity and polyamine contents increased significantly in pollutant-treated leaves when visible injury was hardly apparent. The increase in ADC activity may be a mechanism to increase the polyamine levels in pollutant-treated leaves so as to minimize the damaging effects of the pollutants. ADC activity and polyamine contents decreased, although Spd and Spm remained higher when visible injury was considerable. The above results may reflect an adaptive mechanism to stresses. The role of polyamines in conferring pollutant-resistance in plants is also discussed. [References: 21].

2918 Ashraf, M.; Shamsi, SRA.; FAROOQEAZAM. (1996) **FOLIAR ABSORPTION OF (NH)-N-15 BY WHEAT AND RICE VARIETIES.** *Pakistan Journal of Botany. 28(2):195-202.* English. [NUCL INST AGR & BIOL DIV SOIL BIOL FAISALABAD PAKISTAN].

Plant tops are considered as both sink and source of various N gases and other air pollutants which therefore, may influence the gaseous N content of the environment. Five varieties each of wheat (Triticum aestivum L. and T. durum L.) viz., Pak-81, LU-26, Sarsabz, Durum and M-143 and rice (Oryza sativa L.) viz., Bas-370, Bas-385, DM-25, Kashmir Basmati and IR-6, were compared for NH3 absorption and its correlation with leaf area and N content of the plants. Eight week old plants grown in plastic pots were exposed to (NH3)-N-15 for 24 h in an air-tight canopy able to provide a limited supply of CO2. Labelled NH3 was generated by reacting N-15-labelled ammonium sulphate with NaOH in the canopy. Total N and N-15 content of the dried and powdered plant material was then determined. Upto 44% in rice and 50% in wheat of the (NH3)-N-15 generated in the canopy was assimilated by the plants. Varietal differences in foliar absorption of NH3 were observed. No correlation was obtained between leaf area and the amount of (NH3)-N-15 absorbed by different varieties indicating that NH3 absorption was not solely dependent on leaf area and/or photosynthetic activity of the plants. [References: 21].

2919 Bazza, M. (Institut Agronomique et Veterinaire Hassan II, Rabat (Morocco). Dept. de l'Equipement et de l'Hydraulique); Kumarasinghe, K.S. (1995) **Carbon-13 discrimination as a criterion for identifying high water use efficiency wheat cultivars under water deficit conditions.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 429-439. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA--STI/PUB/947. English. (AGRIS 97-047793).

2920 Chen Ming (Academia Sinica, Beijing (China). Inst. of Geography) (1995) **Winter wheat's copper nutrition and response to Zn and Mn fertilizers.** *Chinese Journal of Soil Science (China) v. 26(5) p. 222-224.* 3 ill., 12 ref. Chinese. (AGRIS 97-047787).

2921 Dai Liangxiang (Hebei Coll. of Agrotechnology, Changli (China)) (1995) **A study on difference in P nutrition in winter wheat of various genotypes.** *Chinese Journal of Soil Science (China) v. 26(5) p. 213-215.* 3 tables; 9 ref. Chinese. (AGRIS 97-047788).

2922 Deleens, E. (Universite de Paris 11, Orsay (France). Institut de Biotechnologie des Plantes); Hannachi, L.; Genter, T. (1996) **[Natural isotopic abundance of 13 carbon in wheat seed: information about photosynthetical functioning of crops in the field]. L'abondance isotopique naturelle du carbone 13 des grains de ble: des informations sur le fonctionnement photosynthetique des cultures en champ.** Journee de l'ASF [Association des Selectionneurs Francais]. Gif sur Yvette (France). 1 Fev 1996. *Selectionneur Francais (France) (no 47) p. 71-80.* 23 ref. French. (AGRIS 97-047674).

2923 Delgado, JA.; Amacher, MC. (1997) **MODELING THE UPTAKE OF SULFUR BY CROPS ON THREE ALLUVIAL SOILS OF LOUISIANA - WHEAT.** *Communications in Soil Science & Plant Analysis. 28(3-5):225-236.* English. [USDA ARS SOIL PLANT NUTR RES UNIT FT COLLINS, CO 80522 USA].

The Cushman and Barber mechanistic model was used to help elucidate the mechanisms that govern the uptake of sulfur (S) by plants. Sulfur uptake predicted by the model was compared to measured S uptake by wheat (Triticum aestivum [L]) grown on Gallion very fine sandy loam (Typic Hapludalf), Mhoon silty clay loam (Typic Fluvaquent), and a Norwood silt loam (Typic Udifluvent) under glasshouse conditions. Predicted S uptake was significantly correlated with observed uptake r(2)=0.85. However, the model over predicted S uptake by a factor of 10.4. The assumption that the maximum ion Influx rate (I-max) for roots growing in soils is the same as the I-max measured in solution cultures experiments may not be appropriate. Better agreement between observed and predicted S uptake values was achieved by using an estimated I-max Obtained from soil studies (I-s). Using I-s, predicted vs observed S uptake had a slope of 1.5 and r(2)=0.93. The model predicted that when S concentration in soil solution (C-lo) at the root surface (r(o)) was about 2mM or higher, this high C-lo will trigger a higher ion Influx rate of about 2.6 nmol/m(2)sec. Plants grown on soils with C-lo less than 1 mM at r(o) will show a lower ion Influx rate of about 0.8 nmol/m(2)sec, suggesting that S uptake by wheat plants is biphasic and depends on C-lo at r(o). [References: 30].

2924 Fathi, G.; Mcdonald, GK.; Lance, RCM. (1997) **EFFECTS OF POST-ANTHESIS WATER STRESS ON THE YIELD AND GRAIN PROTEIN CONCENTRATION OF BARLEY GROWN AT TWO LEVELS OF NITROGEN (VOL 48, PG 67, 1997).** *Australian Journal of Agricultural Research. 48(3):U 6.* English.

2925 Gardiner, DT.; Christensen, NW. (1997) **A SIMPLE MODEL FOR PHOSPHORUS UPTAKE KINETICS OF WHEAT SEEDLINGS.** *Journal of Plant Nutrition. 20(2-3):271-277.* English. [TEXAS A&M UNIV DEPT AGRON & RESOURCE SCI KINGSVILLE, TX 78363 USA].

a simple model to compare and predict phosphorus (P) uptake behavior of plants may be useful to agronomists. A predictive equation based on Michaelis-Menten kinetics was developed for this purpose. Kinetic parameters for use in the model were determined in an experiment using two cultivars of winter wheat grown for 21 days in 14 soil treatments, including seven P levels, each in fumigated and unfumigated soil. In another experiment, the same wheat cultivars were grown for 7, 14, or 21 days at one soil P level in both fumigated and unfumigated soil. Using parameter values developed in the first experiment with multiple P levels

and one time period, the model closely (R(2) = 0.966, P < 0.001) predicted P uptake in the second experiment with one P level over multiple time periods. The model could be a useful agronomic tool because of its simplicity and because no data need be collected from artificial growing conditions. [References: 12].

2926 Gavi, F.; Raun, WR.; Basta, NT.; Johnson, GV. (1997) **EFFECT OF SEWAGE SLUDGE AND AMMONIUM NITRATE ON WHEAT YIELD AND SOIL PROFILE INORGANIC NITROGEN ACCUMULATION.** *Journal of Plant Nutrition. 20(2-3):203-218.* English. [OKLAHOMA STATE UNIV DEPT AGRON 044 N AGR HALL STILLWATER, OK 74078 USA].

The beneficial effect of sewage sludge in crop production has been demonstrated, but there is concern regarding its contribution to nitrate (NO3) leaching. The objectives of this study were to compare nitrogen (N) rates of sewage sludge and ammonium nitrate (NH4NO3) on soil profile (0-180 cm), inorganic N [ammonium nitrate (NH4-N) and nitrate nitrogen (NO3-N)] accumulation, yield, and N uptake in winter wheat (Triticum aestivum L.). One field experiment was established in 1993 that evaluated six N rates (0 to 540 kg . ha(-1). yr(-1)) as dry anaerobically digested sewage sludge and ammonium nitrate. Lime application in 1993 (4.48 Mg ha(-1)) with 540 kg N ha(-1). yr(-1) was also evaluated. A laboratory incubation study was included to simulate N mineralization from sewage sludge applied at rates of 45, 180, and 540 kg N ha(-1). yr(-1). Treatments did not affect surface soil (0-30 cm) pH, organic carbon (C), and total N following the first (1994) and second (1995) harvest. Soil profile inorganic N accumulation increased when greater than or equal to 270 kg N ha(-1) was applied as ammonium nitrate. Less soil profile inorganic N accumulation was detected when lime was applied. In general, wheat yields and N uptake increased linearly with applied N as sewage sludge, while wheat yields and N uptake peaked at 270 kg N ha(-1) when N was applied as ammonium nitrate. Lime did not affect yields or N uptake. Fertilizer N immobilization was expected to be high at this site where wheat was produced for the first time in over 10 years (previously in native bermudagrass). Estimated N use efficiency using sewage sludge in grain production was 20% (average of two harvests) compared to ammonium nitrate. Estimated plant N recovery was 17% for sewage sludge and 27% for ammonium nitrate. [References: 23].

2927 Halperin, SJ.; Kochian, LV.; Lynch, JP. (1997) **SALINITY STRESS INHIBITS CALCIUM LOADING INTO THE XYLEM OF EXCISED BARLEY (HORDEUM VULGARE) ROOTS.** *New Phytologist. 135(3):419-427.* English. [PENN STATE UNIV DEPT HORT 102 TYSON BLDG UNIVERSITY PK, PA 16802 USA].

Salinity stress inhibits Ca translocation to the shoot, leading to Ca deficiency. The objective of this study was to determine whether salt stress inhibits Ca translocation through effects on younger root regions, where radial Ca transport is largely apoplastic, or through effects on mature regions of the roots, where radial Ca transport is largely symplastic. Roots were excised from 4-d-old dark-grown barley seedlings. Calcium translocation was studied by application of Ca-45 3 or 6 cm from the root tip and measurement of its appearance in the root exudate. Calcium uptake along the axis of excised roots was studied with a vibrating Ca+2 microelectrode. Salt stress (60 mM NaCl) inhibited Ca translocation from the 6 cm region more than from the 3 cm region. Sodium sulphate treatments (30 and 36 mM) were more deleterious to Ca translocation than was NaCl in the 3 cm region, and 110 mM mannitol and 60 mM KCl affected Ca translocation similarly to Na2SO4. The salt and mannitol treatments were more deleterious to Ca translocation in the 6 cm region than in the 3 cm region, and mannitol and KCl inhibited Ca translocation more than the sodium treatments. Supplemental Ca could overcome the inhibition of Ca translocation by NaCl stress. Calcium uptake into the root at the 3 and 6 cm regions was not reduced by NaCl, but was retarded 0.05 cm from the apex. We conclude that symplastic Ca transport is more inhibited than apoplastic transport in salinized roots, and that the osmotic component of salt stress causes most of the inhibition. Since symplastic transport is inhibited, the possibility exists that research into the effects of salinity on the transport functions of endodermal cells will yield information that can be used to improve Ca translocation in salt-affected plants. [References: 36].

2928 Hausler, RE.; Bailey, KJ.; Lea, PJ.; Leegood, RC. (1996) **CONTROL OF PHOTOSYNTHESIS IN BARLEY MUTANTS WITH REDUCED ACTIVITIES OF GLUTAMINE SYNTHETASE AND GLUTAMATE SYNTHASE .3. ASPECTS OF GLYOXYLATE METABOLISM AND EFFECTS OF GLYOXYLATE ON THE ACTIVATION STATE OF RIBULOSE-1, 5-BISPHOSPHATE CARBOXYLASE-OXYGENASE.** *Planta. 200(4):388-396.* English. [UNIV SHEFFIELD ROBERT HILL INST SHEFFIELD S10 2TN S YORKSHIRE ENGLAND].

Heterozygous mutants of barley (Hordeum vulgare L. cv. Maris Mink) with decreased activities of chloroplastic glutamine synthetase (GS) between 97 and 47% of the wild type and ferredoxin-dependent glutamate synthase (Fd-GOGAT) down to 64% of the wild type have been used to study aspects of glyoxylate metabolism and the effect of glyoxylate on the activation state of ribulose-1, 5-bisphosphate carboxylase/oxygenase (Rubisco) in vivo. In the leaf, the extractable activities of serine:glyoxylate aminotransferase decreased with a decrease in GS whereas activities of glutamate and alanine:glyoxylate aminotransferase increased, pointing to a re-direction of amino donors from serine to glutamate and alanine. Under ambient conditions, the leaf contents of glutamate and alanine declined continuously with a decrease in GS, in parallel with the decrease in total amino acids. Glycine, serine and asparagine contents decreased with a decrease in GS to approximately 70% of the wild type, but increased again with a further decrease in GS. At high irradiances and at low CO2 concentrations, glyoxylate contents exhibited a pronounced minimum between 60% and 80% GS. With a further decrease in GS, glyoxylate contents recovered and approached values similar to the wild type. The activation state of Rubisco showed a negative correlation with glyoxylate contents, indicating that a decrease in GS feeds back on the first step of carbon assimilation and photorespiration. The activation state of stromal fructose-1, 6-bisphosphatase was unaffected by a decrease in GS or Fd-GOGAT, whereas the activation state of NADP-dependent malate dehydrogenase changed in a complex manner. The CO2-photocompensation point, Gamma*, was appreciably increased in mutants with 47% GS. 'Mitochondrial respiration' in the light (R(d)) was reduced with a decrease in GS. Relative rates of CO2 release into CO2-free air between the wild type and the 47%-GS mutant correlated with determinations of Gamma*. These data are consistent with the view that when GS is decreased there is an increased oxidative decarboxylation of glyoxylate resulting from a decreased availability of amino donors for the transamination of glyoxylate to glycine, and that when GS activities are lower than 70% of the wild type an additional mechanism operates to reduce the photorespiratory loss of ammonia. [References: 43].

2929 Havaux, M.; Tardy, F. (1997) **THERMOSTABILITY AND PHOTOSTABILITY OF PHOTOSYSTEM II IN LEAVES OF THE CHLORINA-F2 BARLEY MUTANT DEFICIENT IN LIGHT-HARVESTING CHLOROPHYLL A/B PROTEIN COMPLEXES.** *Plant Physiology. 113(3):913-923.* English. [CTR ETUD CADARACHE CEA DEPT ECOPHYSIOL VEGETALE & MICROBIOL F-13108 ST PAUL LES DURANCE FRANCE].

The chlorophyll-b-less chlorina-f2 barley mutant is deficient in the major as well as some minor light-harvesting chlorophyll-protein complexes of photosystem II (LHCII). Although the LHCII deficiency had relatively minor repercussions on the leaf photosynthetic performances, the responses of photosystem II (PSII) to elevated temperatures and to bright light were markedly modified. The chlorina-f2 mutation noticeably reduced the thermostability of PSII, with thermal denaturation of PSII starting at about 35 degrees C and 38.5 degrees C in chlorina-f2 and in the wild type, respectively. The increased susceptibility of PSII to heat stress in chlorina-f2 leaves was due to the weakness of its electron donor side, with moderate heat stress causing detachment of the 33-kD extrinsic PSII protein from the oxygen-evolving complex. Prolonged dark adaptation of chlorina-f2 leaves was also observed to inhibit the PSII donor side. However, weak illumination slowly reversed the dark-induced inhibition of PSII in chlorina-f2 and cancelled the difference in PSII thermostability observed between chlorina-f2 and wild-type leaves. The mutant was more sensitive to photoinhibition than the wild type, with strong light stress impairing the PSII donor side in chlorina-f2 but not in the wild type. This difference was not observed in anaerobiosis or in the presence of 3-(3, 4-dichlorophenyl)-1, 1-dimethylurea, diuron. The acceptor side of PSII was only slightly affected by the mutation and/or the aforementioned stress conditions. Taken together, our results indicate that LHCII stabilize the PSII complexes and maintain the water-oxidizing system in a functional state under varying environmental conditions. [References: 69].

2930 Herren, T.; Feller, U. (1997) **INFLUENCE OF INCREASED ZINC LEVELS ON PHLOEM TRANSPORT IN WHEAT SHOOTS.** *Journal of*

Plant Physiology. 150(1-2):228-231. English. [UNIV BERN INST PLANT PHYSIOL ALTENBERGRAIN 21 CH-3013 BERN SWITZERLAND].

Elevated zinc levels may cause various symptoms in plants by interfering with ion uptake in the roots, transport processes within the plant or metabolic activities. It has been reported previously that the symplastic transport via the phloem is inhibited under zinc toxicity In general, an increased zinc supply causes higher zinc contents in the vegetative plant parts of wheat, while the zinc content in the grains is not or only slightly affected. Zinc can be transferred from the xylem to the phloem in the peduncle. In the work reported here, the influence of high zinc levels on phloem transport in maturing wheat was investigated by feeding increasing zinc concentrations via a stem flap below the flag leaf node of field-grown plants. Simultaneously fed strontium and rubidium served as markers for xylem and phloem transport, respect ively. At the highest zinc quantities fed (above 1 mu mol per plant in 1 mt), dry matter accumulation in the grains was markedly, and rubidium redistribution to a lesser extent, affected in this system. Our results led to the conclusion that the phloem transport was strongly inhibited above a critical zinc level and that this effect was most likely due to interference with phloem loading or with the mass flow in the sieve tubes and not primarily by affecting phloem unloading or metabolism in the sinks. [References: 19].

2931 Hooda, PS.; Mcnulty, D.; Alloway, BJ.; Aitken, MN. (1997) **PLANT AVAILABILITY OF HEAVY METALS IN SOILS PREVIOUSLY AMENDED WITH HEAVY APPLICATIONS OF SEWAGE SLUDGE.** *Journal of the Science of Food & Agriculture. 73(4):446-454.* English. [UNIV LANCASTER INST ENVIRONM & BIOL SCI LANCASTER LA1 4YQ ENGLAND].

Plant uptake is one of the major pathways by which sludge-borne potentially toxic metals enter the food chain. This study examined the accumulation of Cd, Cu, Ni, Pb and Zn in wheat, carrots and spinach grown on soils from 13 sites previously amended with sewage sludge. Winter wheat, carrots and spinach were grown consecutively under field like conditions. The results showed that plant availability of heavy metals differed widely among the crop species. The accumulation of Cd, Ni and Zn in the plants showed the greatest increases compared to their background levels. The Cu and Pb accumulation in the plants grown on sludge-amended soils showed only small increases compared to those grown on uncontaminated soils. Multiple regression analysis of various soil properties showed that the surest way to control the accumulation of metals in food plants is by controlling their concentrations in the soils. Furthermore, soils with a non-acidic pH and a clayey texture tended to achieve better control of metal accumulation in food plants compared to those with an acidic reaction and a coarse texture. Metal concentrations in the plants generally correlated well with those extracted from soils in 0.005 M DTPA, 0.05 M EDTA-(Na)(2), 1 M NH4NO3 and 0.05 M CaCl2. The EDTA, however, proved to be a more reliable and consistent test in predicting the accumulation of metals in the plants. The results also showed that liming soils to pH 7 effectively reduced the metal contents in carrots and spinach, but liming to pH 6.5 had little effect on metal concentrations in wheat grain. [References: 28].

2932 Kastori, R.; Vapa, Lj. (Faculty of Agriculture, Novi Sad (Yugoslavia). Institute of Field and Vegetable Crops) (1994) **Effect of Zn, Cd and Pb on mineral elements concentration and accumulation in wheat (Triticum aestivum L.).** *Zbornik Matice srpske za prirodne nauke (Yugoslavia) (no. 87) p. 45-51.* 1 graph; 3 tables; 12 ref. English. (AGRIS 97-047792).

Excess concentration (10* (-3)M) of Zn, Cd and Pb was studied for its effect on the concentration and accumulation of N, P, K, Ca, Mg, Fe, Zn, Mn, and Cu in root and above-ground part and on growing and hydration of young wheat plants grown under conditions of water cultures. The results obtained showed that growing and hydration of the plants were most unfavourably affected by Cd, followed by Pb. The effect of Zn was less unfavourable. The studied heavy metals had specific effect on the concentration and accumulation of individual elements and it depended on plant part and studied element. The studied heavy metals showed to be most effective with respect to the concentration of alkali and alkaline earth metals, particularly Mg. However, the concentration and accumulation of the studied elements decreased in most cases.

2933 Katsuhara, M.; Yazaki, Y.; Sakano, K.; Kawasaki, T. (1997) **INTRACELLULAR PH AND PROTON-TRANSPORT IN BARLEY ROOT CELLS UNDER SALT STRESS - IN VIVO P-31-NMR STUDY.** *Plant & Cell Physiology. 38(2):155-160.* English. [OKAYAMA UNIV BIORESOURCES RES INST KURASHIKI OKAYAMA 710 JAPAN].

Salt stress-induced changes of intracellular pH and in levels of phosphorous compounds were monitored in intact root tips of barley seedlings (Hordeum vulgare cv. Akashinriki) by in vivo P-31-nuclear magnetic resonance (NMR) spectroscopy, Vacuolar alkalization was observed after treatment with both 300 and 500 mM NaCl. Much of the observed apparent alkalization of the cytoplasm was eliminated when the effect of Na+ ions on the titration curve was considered. Within 1 h after the initiation of salt stress levels of glucose-6-phosphate and UDP-glucose decreased markedly, and such decreases might lead directly or indirectly to cell death. Simultaneous measurements of the external and intracellular pH revealed the promotion of external acidification and infernal alkalization during salt stress. Possible mechanisms of Na+/H+ antiport at the tonoplast and the role of proton-pump in the plasma membrane are discussed. [References: 21].

2934 Lindberg, S.; Strid, H. (1997) **ALUMINIUM INDUCES RAPID CHANGES IN CYTOSOLIC PH AND FREE CALCIUM AND POTASSIUM CONCENTRATIONS IN ROOT PROTOPLASTS OF WHEAT (TRITICUM AESTIVUM).** *Physiologia Plantarum. 99(3):405-414.* English. [SWEDISH UNIV AGR SCI DEPT PLANT PHYSIOL BOX 7047 S-75007 UPPSALA SWEDEN].

Addition of aluminium chloride (50 mu M Al) caused different effects on the transmembrane electrical potential (PD) of root cells in Al-tolerant wheat (Triticum aestivum) cv Kadett and Al-sensitive cv. WW 20299. As changes in PD of plant cells may depend on transient fluxes of protons, potassium and/or calcium through cell membranes, the effect of Al was investigated on the cytosolic concentrations of these ions in protoplasts isolated from root tips of the same cultivars. The tetra[acetoxymethyl]esters of the fluorescent dyes bis-carboxyethyl-carboxyfluorescein, BCECF K+-binding benzofuran isophthalate, PBFI, and the stilbene chromophore Fura 2-AM were used to determine pH, K+ and Ca2+ respectively. Changes in fluorescence ratios, directly reflecting changes in [H+], [K+] and [Ca2+] in the cytosol, were determined by photometry fluorescence microscopy. Additions and removals of Al to and from both cultivars caused hyperpolarizations and depolarizations, respectively, but only in the sensitive cv. WW 20299 did the resting PD decrease gradually. Addition of Al to the protoplasts caused rapid changes in cytosolic pH, free [K+] and [Ca2+]. In both cultivars Al caused a transient oscillating increase in cytosolic [Ca2+] for 1 or 2 min and a rapid pa-dependent change in cytosolic [K+]. At pH 5 the presence of K+ in the medium diminished the Al-induced decrease in cytosolic [H+]. Aluminium (50 mu M) induced a transient increase in cytosolic [H+] (pH decreased) in both cultivars, but the cytosolic pH returned to its initial value only in the Al-tolerant cv. Kadett. In the Al-sensitive cv. WW 20299, repeated additions of Al caused a gradual decline in pH. Moreover, in the presence of 1 mM KCl, pH recovered completely in both cultivars. Since only the effect on pH differed in the two cultivars, the more toxic effect of Al on the cv. WW 20299 should be related to the change in pH. [References: 56].

2935 Martin, V.J. (Universidad de la Republica, Montevideo (Uruguay). Facultad de Ciencias); Veiga, L.; Mescia, A. (1995) **Photosynthesis and translocation patterns in wheat (Triticum aestivum L.) cultivars of the plant breeding programme in Uruguay.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 475-481. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA–STI/PUB/947. English. (AGRIS 97-047791).

2936 Mechergui, M. (Institut National Agronomique de Tunisie, Tunis (Tunisia). Dept. de Genie Rural et des Eaux et Forets); Snane, M.H. (1995) **Use of the 13C discrimination technique for identifying durum wheat cultivars efficient in uptake and use of water.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 519-528. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA–STI/PUB/947. English. (AGRIS 97-047794).

2937 Nooman, H.J.; Fuleky, G. (Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Godollo (Hungary)) (1995) **Evaluation of the potential availability of phosphorus by plant uptake.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 240-242.* Wye College Press. 3 ref. English. (AGRIS 97-047797).

2938 Oehlen, E. (Stockholm Univ. (Sweden). Botaniska Inst.) (1994) **Nitrate - specific and N-nutritional regulation of nitrate assimilation in barley.** Stockholm Univ. (Sweden). Stockholm Univ. Bibliography: p. 36-41. A dissertation bound with a collection of 4 reprints. 41 p. English. (AGRIS 97-047729).

2939 Penrose, LDJ.; Martin, RH. (1997) **COMPARISON OF WINTER HABIT AND PHOTOPERIOD SENSITIVITY IN DELAYING DEVELOPMENT IN EARLY-SOWN WHEAT AT A SITE IN NEW SOUTH WALES.** *Australian Journal of Experimental Agriculture. 37(2):181-190.* English. [TASMANIAN ALKALOIDS PTY LTD POB 130 WESTBURY TAS 7303 AUSTRALIA].

This study compared 2 mechanisms that delay the development of early-sown wheat, winter habit and sensitivity to photoperiod. To conduct this study, ear emergence dates were recorded for serial sowings of 15 wheats over 4 consecutive years at Temora, New South Wales, comprising 36 sowings in total. Ear emergence was measured as day of the year, and in both thermal and photothermal time from sowing. The timing of ear emergence was first considered in 3 wheats that were insensitive to photoperiod and vernalisation. In contrast to thermal time, the duration from sowing to ear emergence did not vary with sowing time when measured in photothermal units. Such a measurement is essential for the study of mechanisms whose effect in delaying development is a function of sowing time. These results were obtained using a more simply calculated measure of photothermal time than has been previously reported. For early-sown wheat, winter habit was found to more strongly delay ear emergence and provide greater flexibility in sowing time than responsiveness to photoperiod. Our study provided evidence that winter habit is a more attractive method of delaying ear emergence in early-sown wheat than photoperiod sensitivity. This finding supports the continued breeding of winter wheats for early sowings in the south-central wheat belt of New South Wales. [References: 20].

2940 Pukhalskaya, NV.; Romin, N.; Akanov, EN. (1997) **GROWTH AND CO2 EXCHANGE IN WHEAT SEEDLINGS GROWN AT AN ELEVATED CONCENTRATION OF CO2.** *Russian Journal of Plant Physiology. 44(2):147-151.* English. [RUSSIAN ACAD AGR SCI PRYANISHNIKOV RES INST FERTILIZERS & AGR SOIL SCI UL PRYANISHNIKOVA 31 MOSCOW 127550 RUSSIA].

The effect of an elevated concentration of CO2 (700 mu l/l) on the growth and gas exchange of wheat (Triticum aestivum L.) seedlings was studied on the 4th day (germination), the 8th day (etiolated seedlings), and the 13th day (2-leaf stage) after sowing. The elevated concentration of CO2 activated respiration of seeds germinating in the air but did not significantly affect their growth, gas exchange, and the time of shoot formation when the seeds were in soil. The increase in CO2 concentration lowered the rate of respiration in etiolated seedlings by 25-40% and in the 13-day-old seedlings-by 30-35%. In the 13-day-old seedlings, the elevated concentration of CO2 in the air increased the rate of photosynthesis and, as a result, augmented twofold the net (per day) assimilation of CO2 and activated growth processes. Thus, it was found that the CO2 concentration in the air significantly affected the growth and gas exchange of the seedlings before the formation of assimilating machinery. [References: 21].

2941 Rodriguez Caceres, E.A. (IMYZA, Castelar, Buenos Aires, Argentina.); Gonzalez Anta, G.; Lopez, J.R.; Di Ciocco, C.A.; Pacheco Basurco, J.C.; Parada, J.L. (1996) **Response of field-grown wheat to inoculation with Azospirillum brasilense and Bacillus polymyxa in the semiarid region of Argentina.** *Arid soil research and rehabilitation (USA) v. 10(1) p. 13-20.* references. English. (AGRIS 97-047685).

2942 Samuelson, M.E. (Stockholm Univ. (Sweden). Botaniska Inst.) (1994) **Responses of barley to environmental nitrate; root development, cytokinin levels and nitrate reductase.** Stockholm Univ. (Sweden). Stockholm Univ. Bibliography: p. 32-38. A dissertation bound with a collection of 4 reprints. 38 p. English. (AGRIS 97-047728).

2943 Savitch, LV.; Gray, GR.; Huner, NPA. (1997) **FEEDBACK-LIMITED PHOTOSYNTHESIS AND REGULATION OF SUCROSE-STARCH ACCUMULATION DURING COLD ACCLIMATION AND LOW-TEMPERATURE STRESS IN A SPRING AND WINTER WHEAT.** *Planta. 201(1):18-26.* English. [UNIV WESTERN ONTARIO DEPT PLANT SCI LONDON ON N6A 5B7 CANADA].

Regulation of sucrose-starch accumulation and its effect on CO2 gas exchange and electron transport were studied in low-temperature-stressed and cold-acclimated spring (Katepwa) and winter (Monopol) cultivars of wheat (Triticum aestivum L.). Low-temperature stress of either the spring or winter cultivar was associated with feedback-limited photosynthesis as indicated by a 50-60% reduction in CO2 assimilation rates, twofold lower ATP/ADP ratio, and threefold lower electron transport rate than 20 degrees C-grown control plants. However, no limitations were evident at the level of ribulose-1, 5-bisphosphate carboxylase-oxygenase (Rubisco) in low-temperature-stressed plants. Cold acclimation of the spring cultivar resulted in similar feedback-limited photosynthesis observed during low-temperature stress. In contrast, cold acclimation of the winter cultivar resulted in an adjustment of CO2 assimilation rates to that of control plants. However, we show, for the first time, that this capacity to adjust CO2 assimilation still appeared to be associated with limited triose phosphate utilisation, a twofold lower ATP/ADP ratio, a reduction in electron transport rates but no restriction at the level of Rubisco compared to controls grown at 20 degrees C. Thus, contrary to previous suggestions, we conclude that cold-acclimated Monopol appears to exhibit feedback limitations at the level of electron transport characteristic of cold-stressed plants despite the maintenance of high rates of CO2 assimilation. Furthermore, the differential capacity of the winter cultivar to adjust CO2 assimilation rates was associated with higher levels of sucrose accumulation and a threefold higher sucrose-phosphate synthase activity despite an apparent limitation in triose phosphate utilisation. [References: 28].

2944 Shetty, PK.; Magu, SP. (1997) **INFLUENCE OF METALAXYL ON GLOMUS FASCICULATUM ASSOCIATED WITH WHEAT (TRITICUM AESTIVUM L).** *Current Science. 72(4):275-277.* English. [NATL INST ADV STUDIES BIOREMEDIAT LAB INDIAN INST SCI CAMPUS BANGALORE 560012 KARNATAKA INDIA].

Soil incorporation of metalaxyl [methyl N-(2-methoxyacetyl)-N-(2, 6, xylyl)-DL-alaninate] significantly enhanced root colonization of the vesicular-arbuscular (VA) mycorrhizal fungi Glomus fasciculatum associated with wheat. The stimulatory response of VA mycorrhizal fungi to low concentration of metalaxyl resulted in increased plant biomass production, nutrient uptake and grain yield of wheat. However, higher concentrations of metalaxyl, particularly 2.5 ppm of metalaxyl affected the mycorrhizal infection and seed yield of wheat, Addition of urban compost to an extent ameliorated the toxic effect of fungicide on VA mycorrhizal colonization, plant growth and yield of wheat when compared to unamended soil. [References: 20].

2945 Song Zhiwei (Henan Agricultural School, Zhongmou (China)) (1995) **N, P and K accumulation, distribution and transfer patterns in K-type hybrid wheat.** *Chinese Journal of Soil Science (China) v. 26(6) p. 276-278.* 3 tables; 2 ill., 3 ref. Chinese. (AGRIS 97-047789).

2946 Yamashita, K.; Matsumoto, H. (1997) **EFFECT OF SODIUM CHLORIDE STRESS ON THE PLASMA MEMBRANE ATPASE OF BARLEY ROOTS - PROBABLE CAUSE FOR DECREASE IN ATPASE ACTIVITY.** *Journal of Plant Nutrition. 20(2-3):233-245.* English. [OKAYAMA UNIV BIORESOURCES RES INST KURASHIKI OKAYAMA 710 JAPAN].

The regulation of plasma membrane ATPase activity by salt stress was investigated in barley roots. The plasma membrane fractions were prepared from the roots treated with or without 200 mM sodium chloride (NaCl) for one day. After salt treatment, ATPase activity reduced by 20 to 30% as compared with that of control roots. No significant changes in the content of total phospholipid and sterol were detected in the plasma membrane fraction by salt stress. After extraction of most of the phospholipids in the plasma membrane vesicles with a solution containing 1% (W/V) octylglucoside and 1% (W/V) Triton X-100, the ATPase activity in salt-stressed roots was lower than that of control roots. After reconstitution of detergent-extracted protein into liposome, the reduction of ATPase activity by salt stress did not recover. Based on immunoblott

analysis, the relative amount of H+-ATPase in plasma membrane fraction prepared, from NaCl-stressed roots was smaller than that of control roots. These results indicate that the reduction of H+-ATPase activity by salt stress was caused by the decrease in the amount of H+-ATPase rather than the modification of ATPase. [References: 32].

2947 Zhang Huaiyu; Wang Huaxin; Guo Dazhi (Sichuan Agricultural Univ., Yaan (China). Lab. of Isotope) (1995) **Relationship between distribution and redistribution of the assimilates and grain yield in barley.** *Acta Agriculturae Nucleatae Sinica (China) v. 9(3) p. 168-174.* 4 tables; 7 ref. Chinese. (AGRIS 97-047727).

F62 PLANT PHYSIOLOGY-GROWTH AND DEVELOPMENT

2948 Banowetz, GM. (1997) **CULTIVARS OF HEXAPLOID WHEAT OF CONTRASTING STATURE AND CHLOROPHYLL RETENTION DIFFER IN CYTOKININ CONTENT AND RESPONSIVENESS.** *Annals of Botany. 79(2):185-190.* English. [USDA ARS 3450 SW CAMPUS WAY CORVALLIS, OR 97331 USA].

The work reported here compared cytokinin content and sensitivity in a selection of hexaploid wheat (Triticum aestivum L.) cultivars using the following measurements: leaf cytokinins at three time points during light-growth and at four 24 h intervals after light-grown plants were transferred to darkness; sensitivity of root growth to direct applications of isopentenyl adenosine ([9R]iP); and, sensitivity of germination and subsequent root and shoot growth to 18 h imbibition of seeds in benzyladenine (BA). Accumulation of zeatin riboside-type cultivars was greatest during light-growth in Tibet Dwarf a wheat with an extreme dwarf phenotype, intermediate in Omar standard and dwarf cultivars, and lowest in the standard and dwarf versions of ltana. Cytokinin levels were otherwise not directly correlated to plant stature in these wheats. There were no cultivar-associated qualitative differences in the types of cytokinins detected in this study. During the 16 h light period, the content of zeatin riboside-type cytokinins increased up to tenfold and then declined to basal levels during dark growth. Chlorophyll retention during dark-growth was correlated with leaf cytokinin content. Data collected at a restricted number of sampling points during dark-growth suggested a cyclic accumulation of [9R]iP-type cytokinins and the apparent cycle in Tibet Dwarf was offset by 24 h. Tibet Dwarf showed the greatest root growth inhibition after exposure of seedling roots to [9R]iP or imbibition of seeds in BA. Neither of these treatments affected shoot growth in any of the cultivars. (C) 1997 Annals of Botany Company. [References: 31].

2949 Blum, A.; Sullivan, CY. (1997) **THE EFFECT OF PLANT SIZE ON WHEAT RESPONSE TO AGENTS OF DROUGHT STRESS .1. ROOT DRYING.** *Australian Journal of Plant Physiology. 24(1):35-41.* English. [AGR RES ORG VOLCANI CTR INST FIELD CROPS POB 6 IL-50250 BET DAGAN ISRAEL].

Plant size has long been implicated in plant response to drought stress. This study is a first in a series of two intended to examine the effect of plant size on plant performance under the effect of various agents of drought stress. Variable plant size (in terms of plant height and shoot biomass) independent of genetic background effects was experimentally achieved using rht (tallest), Rht(1) and Rht(2) (medium) and Rht(3) (shortest) homozygous height isogenic lines of spring wheat (Triticum aestivum cv. Bersee). Top-root drying is a common stress condition when the top soil dries in the field. In this experiment wheat was grown in hydroponics system in long PVC tubes. Stress was applied by allowing the top (40 cm) roots to dry throughout most of the growing season while the remaining roots were immersed in the nutrient solution. Average seasonal top-root water potential was reduced from -0.097 MPa in the controls to -1.93 MPa under stress. This stress condition caused a reduction in shoot biomass while it increased total root length. There was a general progressive increase in leaf diffusive resistance under the treatment as plants became larger. This stomatal closure could not be accounted for by reduction in leaf water potential. In fact, leaf turgor increased as stomatal diffusive resistance increased with increasing plant size, leading us to conclude that stomatal closure was the primary response to top-root drying, followed by turgor maintenance possibly as a result of a non-hydraulic signal produced by the drying top-roots. Smaller plants were affected relatively less than were larger plants by this stress condition in terms of stomatal closure, plant height, tillering and shoot biomass reduction. Grain yield per plant was actually increased by stress in the smallest plants while it was unaffected by stress in the larger plants. It is concluded that the smallest plants were the most resistant to top-root drying but absolute biomass and yield under this stress condition was the greatest in the largest plants because of their relatively greater potential. [References: 21].

2950 Blum, A.; Sullivan, CY.; Nguyen, HT. (1997) **THE EFFECT OF PLANT SIZE ON WHEAT RESPONSE TO AGENTS OF DROUGHT STRESS .2. WATER DEFICIT, HEAT AND ABA.** *Australian Journal of Plant Physiology. 24(1):43-48.* English. [AGR RES ORG VOLCANI CTR INST FIELD CROPS POB 6 IL-50250 BET DAGAN ISRAEL].

Plant size has long been implicated in plant response to drought stress. This study is the second in a series of two intended to examine the effect of plant size on plant performance under the effect of various agents of drought stress. Variable plant size (in terms of plant height and shoot biomass) independent of genetic background effects was experimentally achieved using rht (tallest), Rht(1) and Rht(2) (medium) and Rht(3) (shortest) homozygous height isogenic lines of spring wheat (Triticum aestivum) cultivars Bersee and April-Bearded. Plants were grown in hydroponic culture in the growth chamber. In the first experiment, juvenile plants were challenged by osmotic stress using polyethylene glycol (PEG) in the nutrient solution giving a water potential of -0.55 MPa. The control nutrient solution was at -0.05 MPa. Plant growth, shoot biomass, leaf area, relative water content (RWC) and osmotic adjustment (OA) were measured. In the second experiment, effects on growth rate of chronic heat stress and abscisic acid (ABA) in the root medium of juvenile plants were evaluated. Potential plant size as determined by shoot biomass in the controls at 25 days after emergence was greatest in rht, medium in Rht(1) and Rht(2), and smallest in Rht(3) genotypes. Potential growth rate and leaf area were greater in plants of larger potential biomass (rht) than in plants of smaller potential biomass (Rht(3)). Growth reduction by osmotic stress was inversely related to plant size, while the extent of osmotic adjustment during osmotic stress was directly related to plant size. RWC did not vary with plant size. Relative growth reduction by heat stress and by ABA also decreased in smaller plants. ABA did not alleviate the depressing effect of heat on growth. Despite the greater stress tolerance of smaller (Rht(3)) plants, the absolute growth and biomass of large (rht) plants under stress conditions was always better than that of smaller plants. The results of these series of experiments suggest that greater stress tolerance of small plants is derived from their relatively smaller size and slower growth rate. Consequently, we conclude that growth under stress is sustained by potential growth rate and plant size of the genotype when stress is mild and by plant tolerance (even at the expense of potential growth rate and size) when stress is more severe. [References: 14].

2951 Box, J.E. Jr. (USDA Agricultural Research Service, Watkinsville, Ga. (USA)) (1996) **Use of minirhizotrons to study wheat rooting.** Plant Root Systems and Natural Vegetation. Almaty (Kazakstan). 5-11 Sep 1994. Plant root systems and natural vegetation. Persson, H.; Baitulin, I.O. (eds.). *Acta Phytogeographica Suecica (Sweden); no. 81 p. 109-112.* Svenska Vaextgeografiska Saellskapet. 18 ref. English. (AGRIS 97-047968).

2952 Burnett, VF.; Coventry, DR.; Newton, PJ. (1997) **EFFECT OF SEED SOURCE AND SEED PHOSPHORUS CONTENT ON THE GROWTH AND YIELD OF WHEAT IN NORTH-EASTERN VICTORIA.** *Australian Journal of Experimental Agriculture. 37(2):191-198.* English. [INST INTEGRATED AGR DEV RMB 1145 CHILTERN VALLEY RD RUTHERGLEN VIC 3685 AUSTRALIA].

Wheat (Triticum aestivum L.) seed was grown at 2 locations differing in phosphorus (P) status (low and high) in north-eastern Victoria (36 degrees S, 146 degrees E), with applied superphosphate (kg P/ha: 0, 12, 24, 100 and 200), to produce seed of different P content. This seed was used in field and glasshouse experiments in 1993 and 1994 to investigate the effects of seed source and P content on the growth and yield of wheat. Wheat seed grown at the low P status site was smaller than seed grown at the high P status site, irrespective of the amount of applied P. Seed from the low P status site produced less early dry matter in both field and glasshouse experiments in 1993, but there was no effect of seed source on grain yield in either experiment. High seed P content either had no effect or reduced seedling emergence in the field experiments. In the glasshouse, low P content in seed from the low P status site resulted in reduced emergence. Increases in dry matter production and grain yield with higher seed P content were only observed in the drought season of 1994, Application of P

resulted in increased emergence, dry matter production and grain yield at most seed P content levels but there were no significant interactions between seed P content and applied P. Application of N did not affect dry matter production in either year, but increased grain protein in both years and grain yield in 1993. Seed from low P status environments can affect early seedling growth but in average growing seasons, or in glasshouse conditions, wheat growth compensates so that differences in grain yield are not observed. However, in order to avoid risk of poor early seedling growth and possible yield penalties when the crop is stressed, wheat seed should be collected from adequate soil P status sites. [References: 18].

2953 Davenport, RJ.; Reid, RJ.; Smith, FA. (1997) **SODIUM-CALCIUM INTERACTIONS IN TWO WHEAT SPECIES DIFFERING IN SALINITY TOLERANCE.** *Physiologia Plantarum. 99(2):323-327.* English. [DEPT PLANT SCI CAMBRIDGE CB2 3EA ENGLAND].

Sodium/calcium interactions were compared in two species of wheat known to differ in sodium accumulation in the shoot and biomass reduction under saline conditions. Unidirectional uptake of Na-22 to the roots was measured in 5, 50, 100 and 150 mM NaCl with four levels of calcium activity. Translocation of sodium to the shoot was measured as Na-22 uptake over 7 days. The rate of sodium uptake into the roots did not vary between the salt-sensitive Triticum turgidum cv. Modoc and the tolerant Triticum aestivum cv. Kharchia, except at low calcium, when the rate of uptake was higher in Kharchia, and more sensitive to inhibition by additional calcium. The rate of translocation to the shoot was similar in both species, however the shoot:root ratio was higher in Kharchia and so the concentration of sodium, on a shoot fresh weight basis, was more dilute in Kharchia. There was no evidence for differences in sodium transport processes between the species which might confer differential salinity tolerance. Translocation of calcium to the shoot was measured as Ca-45 uptake in 5 and 150 mM NaCl with 4 levels of calcium activity. Translocation of calcium was more inhibited by sodium in the salt-sensitive Modoc, and this may reflect differences in calcium transport processes, which could account in part for the greater salt sensitivity of this species. [References: 18].

2954 Demchenko, K.N.; Demchenko, N.P. (Russian Academy of Sciences, St. Petersburg (Russian Federation). Komarov Botanical Inst.) (1996) **Early stages of lateral root development in Triticum aestivum L.** Plant Root Systems and Natural Vegetation. Almaty (Kazakstan). 5-11 Sep 1994. Plant root systems and natural vegetation. Persson, H.; Baitulin, I.O. (eds.). *Acta Phytogeographica Suecica (Sweden); no. 81 p. 71-75.* Svenska Vaextgeografiska Saellskapet. 16 ref. English. (AGRIS 97-047967).

2955 Dofing, SM. (1996) **TILLER INITIATION AND SURVIVAL IN BARLEY AS INFLUENCED BY CULTIVAR AND MANAGEMENT.** *Cereal Research Communications. 24(4):485-490.* English. [UNIV ALASKA FAIRBANKS 533 E FIREWEED PALMER, AK 99645 USA].

Minimizing the number of tillers in barley (Hordeum vulgare L.) that fail to produce grain may result in more rapid and efficient grain development, important considerations in many northern areas. The purpose of this research was to quantify effects of cultivar, seeding rate, and row spacing on the number of surviving tillers in barley. The barley cultivars 'Otal', 'Eero', and 'Jackson' were grown at seeding rates of 60, 170, and 280 kernels m(-2), and row spacings of 15 and 30 cm. Averaged across three years, Eero, the highest-tillering cultivar, had the highest percent tiller survival and Jackson, the lowest-tillering cultivar, had the lowest. The intermediate seeding rate of 170 kernels m(-2) had the highest percent tiller survival. There was no significant effect of row spacing on percent tiller survival. It was concluded that high-tillering cultivars are not necessarily less efficient in producing high percentages of grain-bearing spikes, and that row spacing would not be an effective management practice to enhance tiller survival. [References: 10].

2956 Flintham, JE.; Borner, A.; Worland, AJ.; Gale, MD. (1997) **OPTIMIZING WHEAT GRAIN YIELD - EFFECTS OF RHT (GIBBERELLIN-INSENSITIVE) DWARFING GENES.** *Journal of Agricultural Science. 128(Part 1):11-25.* English. [JOHN INNES CTR PLANT SCI RES NORWICH RES PK COLNEY NORWICH NR4 7UH NORFOLK ENGLAND].

Four sets of near-isogenic lines carrying different combinations of the alleles Rht-B1b, Rht-D1b and Rht-B1c for gibberellin-insensitive dwarfism in hexaploid wheat (Triticum aestivum L.) were compared with tall controls in a series of yield trials in eastern England and central Germany. In all four varietal backgrounds the effects of Rht-B1b and Rht-D1b were similar (plant height approximate to 86 and 83 % of tall controls respectively) and in combination reduced plant height to c. 58 %. The Rht-B1c allele caused more severe dwarfism (c. 50 %) and, when combined with Rht-D1b, reduced plant height still further to c. 41 %. Data from the trials were consistent with a model for height/yield relationships in which the pleiotropic effects of the Rht alleles on yield can be inferred from their primary function: insensitivity to gibberellin limits stem extension growth, decreasing assimilate demand for this organ and diverting it to the developing ear (which is not itself dwarfed). The net balance between the resulting increase in harvest index and the curvilinear relationship observed between plant height and total shoot yield results in optimum grain yields at intermediate plant heights. Yield advantages of shorter plants over tall controls were evident over several trials with mean grain yields ranging from 200 to 760 g m(-2). The optimum plant height for yield improvement in different genetic backgrounds was achieved by different Rht alleles according to the background varietal height, such that intrinsically taller genotypes required more potent Rht alleles to achieve maximum potential grain yield. Ear yield components showed increases in grain number due to Rht pleiotropy, from which it is inferred that the number of grains per ear is limited by supply of assimilates pre-anthesis. Increases in grain number were associated with decreases in mean weight per grain which varied according to severity of dwarfism and varietal background, so that the net effect on grain yield per ear was sometimes positive, sometimes negative, and sometimes neutral in different Rht/variety combinations. [References: 49].

2957 Gianoli, E.; Niemeyer, HM. (1997) **ENVIRONMENTAL EFFECTS ON THE ACCUMULATION OF HYDROXAMIC ACIDS IN WHEAT SEEDLINGS - THE IMPORTANCE OF PLANT GROWTH RATE.** *Journal of Chemical Ecology. 23(2):543-551.* English. [UNIV CHILE FAC CIENCIAS DEPT CIENCIAS ECOL CASILLA 653 SANTIAGO CHILE].

The effects of temperature and photoperiod on accumulation of hydroxamic acids (Hx) in wheat (Triticum aestivum L.) seedlings were evaluated under laboratory conditions. Hx concentrations were significantly higher at higher temperatures. No such clear trend was found for the photoperiod effect. The significant effect of temperature and photoperiod on growth rate of seedlings and the significant positive correlation between growth rate prior to analysis and levels of Hx, suggested that environmental effects on Hx accumulation were at least partially mediated through their effect on plant growth rate. After uncoupling the effect of environmental conditions from the effect of plant growth rate by statistical means the effect of temperature on Hx was no longer significant. Therefore, temperature effect was fully mediated by plant growth rate. Implications of the patterns found are discussed in issues of plant-defense general theories. [References: 28].

2958 Grant, RH. (1997) **PARTITIONING OF BIOLOGICALLY ACTIVE RADIATION IN PLANT CANOPIES [Review].** *International Journal of Biometeorology. 40(1):26-40.* English. [PURDUE UNIV DEPT AGRON W LAFAYETTE, IN 47907 USA].

Plant germination, growth, maturation, and productivity are heavily influenced by the quality and quantity of the light in its environment. The light environment has traditionally been quantified in terms of radiant heat energy and available photosynthetic radiation (PAR), but detailed spectral irradiance or photon flux distributions have rarely been studied. This information is needed to translate the research that plant photobiologist and phytochemists have been conducting with regard to understanding the light controls on plant physiology in the field environment of plant canopies. More interest has recently been generated as the potential impacts of global climate changes on intensively managed and natural terrestrial ecosystems are identified and evaluated. Linkages between the identified impacts of various wavelengths of light on plant physiology and the light environment of the plant canopy are identified, with detailed discussion concerning the impacts of plant canopy structure on the plant light response. Solar radiation in the ultraviolet-B (280-320 nm), ultraviolet-A and blue (350-500 nm), PAR (400-700 nm), blue (400-500 nm), green (500-600 nm) red (600-700 nm), far red (700-800 nm) and near infrared (800-1100 nm) is followed from the top of the plant canopy to the photoreceptor at the cellular level within the plant phytoelement. [References: 117].

2959 Guoping, Z. (1997) **GIBBERELLIC ACID(3) MODIFIES SOME GROWTH AND PHYSIOLOGIC EFFECTS OF PACLOBUTRAZOL**

(PP333) ON WHEAT. *Journal of Plant Growth Regulation. 16(1):21-25.* English. [ZHEJIANG AGR UNIV DEPT AGRON HANGZHOU 310029 PEOPLES REPUBLIC OF CHINA].

Gibberellic acid(3) (GA(3)) modification of some growth and physiologic effects of paclobutrazol (PP333) was studied by applying PP333 alone and in combination with GA(3) at the tillering stage of wheat. Results showed that GA(3) weakened the effect of PP333 on tillering and shortening the plant, increased the dry matter accumulation of different tillers, improved plant nitrogen metabolism by favoring nitrogen translocation into tillers at late growth stage, and stimulated tiller development. All of these reduced the difference in spike weight among tillers and the main stem. Compared with control, there were more spikes per plant and fewer grain per spike in the PP333 treatment, but all yield components developed positively in the treatment consisting of the mixture of GA(3) and PP333. [References: 5].

2960 Haberle, J.; Svoboda, P.; Matula, J. (1996) **A NONDESTRUCTIVE STUDY OF THE EFFECT OF SOIL AND FERTILIZATION ON THREE WINTER WHEATS.** *Cereal Research Communications. 24(4):477-483.* English. [RES INST CROP PROD PRAGUE 16106 CZECH REPUBLIC].

The growth of three winter wheats of different origin and habitus, Maris Marksman, Mironovskaya 808 and Mexique 50-B21 was studied nondestructively, on the basis of leaf growth and the rate of leaf development. The plants were grown in pots in growth chamber. Two soils were used, A and B, more and less fertile, resp. Both soils were either left unfertilized (F1) or fertilized according to agrochemical recommendation (F2). The plants were evaluated in intervals of 3-7 days; they were harvested destructively after 34 days, in the period of tillering. The effect of both soil origin and fertilization treatments and their interaction with genotype could be detected as early as from the changes in growth of the second leaf, and the effect became gradually more pronounced. Fertilization (F2) increased plant growth in soil B, and slightly depressed growth or left it unchanged in soil A. In all wheats, and irrespective of treatment, total and aboveground mass at harvest (day 34) was higher in soil A than B. Drought tolerant cv. Mexique 50-B21 was the least affected by soil origin; it had higher root/shoot ratio, higher total N content and pronouncedly lower N-total/N-NO3- ratio than cvs. Maris Marksman and Mironovskaya 808. [References: 13].

2961 Hotsonyame, GK.; Hunt, LA. (1997) **SOWING DATE AND PHOTOPERIOD EFFECTS ON LEAF APPEARANCE IN FIELD-GROWN WHEAT.** *Canadian Journal of Plant Science. 77(1):23-31.* English. [UNIV GUELPH DEPT CROP SCI GUELPH ON N1G 2W1 CANADA].

Rate of leaf appearance is a characteristic that can impact on the rate of development of a crop canopy. For wheat (Triticum aestivum L.), it is generally thought to be constant within a sowing date, but to vary among sowing dates. Such variation has been variously attributed to differences in the rate of change of photoperiod, the absolute photoperiod, or the mean air temperature. This study was undertaken to provide further information on the photoperiod and temperature effects on rate of leaf appearance in wheat. Field studies were conducted at flora, Ontario at five sowing dates under natural and extended (20 h) photoperiod conditions. Two genotypes each of spring and winter wheat were grown under 0 and 150 kg ha-1 nitrogen fertilization. The results indicated that variations in rate of leaf appearance were not due to rate of change in photoperiod or absolute photoperiod at emergence. The change in rate of leaf appearance during a growth cycle was constant when mean air temperature during growth varied in a narrow range (less than 10 degrees C), but varied when there were wider ranges (over 10 degrees C) of temperature variation. Rate of leaf appearance was lower for the September seeding, at which time temperatures were around 5 degrees C, but were quite similar for May, June, July and August seedings even though temperatures ranged from approximately 15 degrees C (May) to 23 degrees C (June). The results suggested that the leaf appearance rats-temperature response curve is curvilinear, as found in some growth room studies, and supported work indicating that the phyllochron would depend on the temperature at the time of measurement. [References: 38].

2962 Jing Yuanshu (Nanjing Coll. of Meteorology (China)); Wu Yunying (1996) **The influence of paulownia-wheat intercropping on physiological reaction and growth of wheat.** *Chinese Journal of Ecology (China) v. 15(2) p.* 21-24. 2 tables; 3 ill., 6 ref. Chinese. (AGRIS 97-047966).

2963 Linnestad, C. (Norges Landbrukshoegskole, Aas (Norway). Laboratorium for Molekylaer Plantebiologi (LMPB)) (1996) **[Barley grain development: Characterization of gene expression in gametophytic and sporophytic tissues by in situ hybridization]. Froeutvikling hos bygg: Karakterisering av gametofyttisk og sporofyttisk genekspresjon ved hjelp av in situ hybridiseringsteknikk.** Norges Landbrukshoegskole, Aas (Norway).. *Agricultural University of Norway. Doctor Scientiarum Theses (Norway); no. 96:2 vp.* Norges Landbrukshoegskole. Figures; ref. 5 papers are incl. in the thesis. English. (AGRIS 97-033305).

2964 Lu Jingxian; Sheng Chengshi (Hunan Agricultural Univ., Changsha (China)) (1996) **Ecological basis for the formation of larger wheat ear.** *Chinese Journal of Applied Ecology (China) v. 7(1) p. 27-32.* 7 tables. Chinese. (AGRIS 97-047964).

2965 Maciorowski, R.; Stankowski, S. (Akademia Rolnicza, Szczecin (Poland). Katedra Doswiadczalnictwa); Dijkstra, P. (Instituut voor Agrobiologisch en Bodenvruchtbaarheidsanderzoek AB DLO, Wageningen (Netherlands)) (1995) **[Description of growth of spring wheat (Triticum aestivum) plants, at different concentration of CO2, using logistic function]. Opis wzrostu roslin pszenicy jarej (Triticum aestivum), przy roznym stezeniu CO2 w powietrzu, za pomoca funkcji logistycznej.** *Hodowla Roslin Aklimatyzacja i Nasiennictwo (Poland) v. 39(6) p. 123-131.* 4 fig., 2 tables; 19 ref. Polish. (AGRIS 97-033346).

Higher CO2 concentration resulted in increased final dry matter of stem and whole parts, in average 20 percent, while dry matter and leaves area increased only about 11 percent. The maximal theoretical growth rates for each trait were about 20 percent higher for 7000 micro mols/mol. The green leaf area and the projected areas of other green parts were measured, and dry weights of all plant parts determined, every seven days. The notations were done until the moment in which the plants obtained maximal value of ivestigated traits.

2966 Martincic, J.; Guberac, V.; Maric, S. (1997) **INFLUENCE OF WINTER RYE SEED SIZE (SECALE CEREALE L) ON GERM AND ROOTLET LENGTH, AND GRAIN YIELD.** *Rostlinna Vyroba. 43(2):95-100.* English. [JOSIP JURAJ STROSSMAYER UNIV FAC AGR TRG SV TROJSTVA 3 OSIJEK 31000 CROATIA].

During 1994, some laboratory tests have been conducted to determine influence of seed size in winter rye (variety Hacada) on germination, germ length and rootlet length. During 1994/1995 growing season, a field trial has been conducted to determine influence of seed size on field germination and grain yield. Seed calibration has been performed and seed fractions were analysed (mm of diameter) as follows: 2.8; 2.5; 2.2; as well as unsieved seed as a control. The seed fractions of 2.8 mm and 2.5 mm have had the largest values of germinability (95.75%), whereas the lowest values were attained with the seed fraction of 2.2 mm (92.50%). Similar results were also achieved with the seed size influence on germ length and rootlet length. Seed fraction of 2.8 mm has had the largest values of germ length (62.7 mm) and rootlet length (144.1 mm), whereas the lowest values were attained with the seed fraction of 2.2 mm, respectively (germ length 33.0 mm and rootlet length 72.1 mm). The largest number of emerged plants/m(2) was attained with the seed fraction of 2.8 mm (527 plants/m(2)) and the lowest one with the seed fraction of 2.2 mm (498 plants/m(2)). The greatest grain yield of winter rye was attained with the seed fraction of 2.8 mm (6 200.25 kg/ha), and the smallest grain yield with the seed fraction of 2.2 mm (5 891.25 kg/ha). [References: 24].

2967 Mi Guohua; Li Wenxiong (Northeast Agricultural Univ., Harbin (China). Dept. of Agronomy) (1996) **Studies on the response of wheat spike differentiation to temperature and day length 1. Effect of vernalization on differentiation of wheat spike.** *Journal of Northeast Agricultural University (China) v. 27(2) p. 124-131.* 6 tables; 16 ref. Chinese. (AGRIS 97-047965).

2968 Penson, SP.; Schuurink, RC.; Fath, A.; Gubler, F.; Jacobsen, JV.; Jones, RL. (1997) **CGMP IS REQUIRED FOR GIBBERELLIC ACID-INDUCED GENE EXPRESSION IN BARLEY ALEURONE (VOL 8, PG 2325, 1996).** *Plant Cell. 9(2):271.* English.

2969 Querou, R.; Euvrard, M.; Gauvrit, C. (1997) **UPTAKE OF TRITICONAZOLE, DURING IMBIBITION, BY WHEAT CARYOPSES AFTER SEED TREATMENT.** *Pesticide Science. 49(3):284-290.* English. [INRA PHYTOPHARM LAB BV 1540 F-21034 DIJON FRANCE].

The uptake of C-14-labelled triticonazole by wheat caryopses during imbibition was investigated. The uptake from an aqueous solution appeared to be driven by mass flow rather than by accumulation in seed lipids. During treatment with a liquid seed-dressing preparation of triticonazole, c. 1 mu g triticonazole per caryopsis (2.4% of applied triticonazole) entered the seed. During germination in soil, another c. I mu g triticonazole per caryopsis entered the seed in 24 h. In killed seeds, no penetration was observed between 24 h and 72 h after the beginning of imbibition, After seed treatment and imbibition in soil, triticonazole appeared to be located in the seed coats and embryo, but not in endosperm; experiments suggested that the testa acted as a barrier. Under our conditions, the pathway from seed coats to shoots was not an important route for triticonazole uptake by the shoots. [References: 23].

2970 Rekoslavskaya, NI.; Yureva, OV.; Shibanova, LA.; Salyaev, RK. (1997) **SYNTHESIS AND PHYSIOLOGICAL FUNCTION OF D-TRYPTOPHAN DURING WHEAT GERMINATION.** *Russian Journal of Plant Physiology. 44(2):196-203.* English. [RUSSIAN ACAD SCI SIBERIAN INST PLANT PHYSIOL & BIOCHEM SIBERIAN DIV UL LERMONTOVA 132 IRKUTSK 664033 RUSSIA].

IAA content in primary leaves, coleoptiles, the intermediary zone (scutellum, epiblast, mesocotyl), and roots of 3- to 6-day-old wheat (Triticum aestivum L.) seedlings was determined to study growth regulation in the dark. IAA content in 3-day-old seedlings was high, particularly in the intermediary zone and roots. By the sixth day of growth, IAA content in primary leaves increased, whereas, in the seedlings as a whole, it decreased. In the seedling homogenate fraction enriched with etioplasts, tryptophan racemase operated in both L --> D and D --> L directions (on average, these conversions were 34 and 66%, respectively). The molar ratio of IAA/N-malonyl-D-tryptophan in the roots was 5-10 times higher than the IAA/tryptophan ratio. L-tryptophan aminotransferase (L-TAT) activity exceeded the activity of D-tryptophan aminotransferase (D-TAT) in both the upper and lower parts of the seedling. Activities of L-TAT and D-TAT increased drastically after cofactors (sodium pyruvate and NAD) were added to the incubation medium containing etioplast fraction and tryptophan stereoisomers. Activities of L-TAT and D-TAT in the intermediary zone of seedlings were similar. D-tryptophan was more active in stimulating root formation and primary leaf growth than IAA or L-tryptophan when added to the medium where the isolated embryos were cultured. A conclusion is drawn that D-tryptophan (or N-malonyl-D-tryptophan) and D-TAT are involved in IAA biosynthesis during wheat dark germination. [References: 18].

2971 Samuels, TD.; Kucukakyuz, K.; Rinconzachary, M. (1997) **AL PARTITIONING PATTERNS AND ROOT GROWTH AS RELATED TO AL SENSITIVITY AND AL TOLERANCE IN WHEAT.** *Plant Physiology. 113(2):527-534.* English. [MIDWESTERN STATE UNIV DEPT BIOL 3410 TAFT BLVD WICHITA FALLS, TX 76308 USA].

Studies of Al partitioning and accumulation and of the effect of Al on the growth of intact wheat (Triticum aestivum L.) roots of cultivars that show differential Al sensitivity were conducted. The effects of various Al concentrations on root growth and Al accumulation in the tissue were followed for 24 h. At low external Al concentrations, Al accumulation in the root tips was low and root growth was either unaffected or stimulated. Calculations based on regression analysis of growth and Al accumulation in the root tips predicted that 50% root growth inhibition in the Al-tolerant cv Atlas 66 would be attained when the Al concentrations were 105 mu M in the nutrient solution and 376.7 mu g Al g(-1) dry weight in the tissue. In contrast, in the Al-sensitive cv Tam 105, 50% root growth inhibition would be attained when the Al concentrations were 11 mu M in the nutrient solution and 546.2 mu g Al g(-1) dry weight in the tissue. The data support the hypotheses that differential Al sensitivity correlates with differential Al accumulation in the growing root tissue, and that mechanisms of Al tolerance may be based on strategies to exclude Al from the root meristems. [References: 32].

2972 Smiley, RW.; Patterson, LM.; Rhinhart, KEL. (1996) **FUNGICIDE SEED TREATMENT EFFECTS ON EMERGENCE OR DEEPLY PLANTED WINTER WHEAT.** *Journal of Production Agriculture. 9(4):564-570.* English. [OREGON STATE UNIV COLUMBIA BASIN AGR RES CENT POB 370 PENDLETON, OR 97801 USA].

Winter wheat (Triticum aestivum L.) seed is often planted deeply (>3 in.) into stubble-mulch fallow in the semi-arid Pacific Northwest (PNW). Stand establishment is affected by factors that influence the rate of seed germination and coleoptile growth. Systemically translocated triazole and imidazole fungicide seed treatments were compared for effects on seedling emergence under conditions of deep seed placement and variable seed-zone moisture in stubble-mulch fallow systems. Fungicides included RTU Vitavax Thiram (carbonin [2, 3-dihydro-5-carboxanilido-6-methyl-1, 4-oxathiin] + thiram [tetramethylthiuram disulfide]), Dividend (difenoconazole [1-(2-[4-(4-chlorophenoxy)-2-chlorophenyl]-4-methyl-1, 3-dioxolan-2-yl-meth l)-1H-1, 2, 4-triazole]), Raxil Thiram (tebuconazole [alpha[2-(4-chlorophenyl)ethyl]-alpha-(1, 1-dimethylethyl)-1H-1, 2, 4-triazol -1-ethanol] + thiram), NuZone and Flo-Pro IMZ (imazalil [1-(2(2, 4-dichlorophenyl)-2-(2-propenyloxy)ethyl)-1H-imidazole]), and Apron (metalaxyl [N-(2, 6--dimethylphenyl)-N-(methoxyacetyl)-alanine methyl ester)]). Gaucho (imidacloprid [1[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine]), a seed-treatment insecticide, was applied in some experiments. Seven field and three greenhouse experiments were performed from 1993 to 1995. Emergence in the field tended to be superior for seed treated with Dividend, alone or mixed with Apron, in plantings made from 1- to 5-in. deep into soil with 5 to 17% seed-zone water content and at 71 to 80 degrees F. RTU Vitavax Thiram had variable effects on seedling emergence. NuZone and Raxil Thiram, alone or mixed with Gaucho, generally delayed emergence when treated seed was planted at depths more than 2 in. In the greenhouse, treated seed was planted at 1-in. depth into moist (7, 10 or 15% w/w), warm (75 degrees F) silt loam overlain by 4-in. of dry silt loam, simulating a planting at 5-in. depth into stubble-mulch fallow during September. Emergence of Dividend-treated seed at each soil moisture content was usually more rapid than for other treatments, including seed planted without fungicide treatment. This research demonstrated that emergence of winter wheat planted deeply into stubble-mulch fallow is often improved when seed is treated with Dividend compared with RTU Vitavax Thiram and, among the systemically translocated triazole fungicides, Dividend is a better choice than Raxil when planting depths exceed 2 in. [References: 38].

2973 Smiley, RW.; Patterson, LM.; Shelton, CW. (1996) **FUNGICIDE SEED TREATMENTS INFLUENCE EMERGENCE OF WINTER WHEAT IN COLD SOIL.** *Journal of Production Agriculture. 9(4):559-563.* English. [OREGON STATE UNIV COLUMBIA BASIN AGR RES CENT POB 370 PENDLETON, OR 97801 USA].

Winter wheat (Triticum aestivum L.) in the Pacific Northwest (PNW) is typically planted when soils are warm (75 degrees F) to cool (50 degrees F). Drought during 1994 delayed planting in some fields until soils were cold (35-45 degrees F). Emergence in cold, wet soil was slow and often incomplete and, in some circumstances, appeared to differ for seed treated with different fungicides. Experiments were performed in the field and greenhouse to provide improved treatment guidelines for winter wheat planted into cold soil. Emphasis was on the fungicides Vitavax (carboxin [2, 3-dihydro-5-carboxanilido-6-methyl-1, 4-oxathiin]), Dividend 3FS (difenoconazole [1-(2-[4-(4-chlorophenoxy)-2-chlorophenyl]-4-methyl-methyl)-1H-1, 2, 4-triazole]). Thiram (tetramethylthiuram disulfide) and Apron (metalaxyl [N-(2, 6—dimethylphenyl)-N-(methoxyacetyl)-alanine methyl ester]). Emergence of winter wheat from cold (38 degrees F) soil was more complete when seed was treated with mixtures of Dividend + Apron, Dividend + Thiram, or RTU Vitavax Thiram than with Dividend alone or untreated. Differences in emergence were caused by Pythium root rot. Treatments including Thiram, Apron, or another fungicide toxic to Pythium species are recommended for winter wheat seed planted after about 15 October in the PNW. [References: 19].

2974 Volkmar, KM. (1997) **WATER STRESSED NODAL ROOTS OF WHEAT - EFFECTS ON LEAF GROWTH.** *Australian Journal of Plant Physiology. 24(1):49-56.* English. [AGR & AGRI FOOD CANADA SEMIARID PRAIRIE AGR RES CTR POB 1030 SWIFT CURRENT SK S9H 3X2 CANADA].

This experiment as undertaken to determine the effects of soil drying around the nodal and/or seminal root systems on the shoot growth of wheat (Triticum aestivum L.). Two split-root experiments were conducted, the first on newly emerged nodal roots of 18-day-old wheat plants, the second on 25-day-old plants. In both experiments, nodal and seminal roots were isolated from one another and water was withheld from either the nodal root chamber, the seminal root chamber, or both, over 6 days. In the first experiment, leaf growth was unaffected by withholding water from very short nodal roots, even though leaf relative water content of the droughted plants decreased. By comparison, both leaf elongation rate and relative water content decreased by withholding water from the seminal

roots. On plants that were 1 week older, leaf growth rate and leaf relative water content decreased when nodal roots were drought-stressed. Leaf growth rate of seminal root droughted plants was more impaired than their nodal root counterparts, even though leaf relative water contents of the two treatments were the same. In both experiments, drought stress applied to the nodal root system enhanced nodal root growth more than seminal roots. These results suggest that seminal and nodal roots perceive and respond to drought stress differently with respect to the nature of the message conveyed to the shoots. [References: 21].

2975 Vong, M.; Bakujzen, R.; Khejmovaara Diikstra, S.; Van Zejl, M.Dzh.; De Friz, M.A.; Van Bekam, E.M.; Sindzhorgo, K.M.S. (1994) **[Role of abscisic acid and gibberellin in dormancy duration of barley seeds. Comparison of dormancy state of germs and of aleuronic layer cells]. Rol' abstsizovoj kisloty i gibberellina v proyavlenii pokoya semyan yachmenya.Sravnenie sostoyaniya pokoya zarodyshej i kletok alejronovogo sloya.** *Fiziologiya rastenij (Russian Federation) v. 41(5) p. 659-667.* 43 ref. Russian. (AGRIS 97-033306).

2976 Zhang Yuwen; Zhang Ping; Yu Fangyi (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. for Application of Atomic Energy) (1995) **Diurnal changes in sink unloading of 14C-assimilates from flag leaves of spring wheat during grain filling stage.** *Acta Agriculturae Nucleatae Sinica (China) v. 9(4) p. 225-229.* 2 tables; 6 ill., 18 ref. Chinese. (AGRIS 97-047962).

F63 PLANT PHYSIOLOGY-REPRODUCTION

2977 Lalonde, S.; Beebe, DU.; Saini, HS. (1997) **EARLY SIGNS OF DISRUPTION OF WHEAT ANTHER DEVELOPMENT ASSOCIATED WITH THE INDUCTION OF MALE STERILITY BY MEIOTIC-STAGE WATER DEFICIT.** *Sexual Plant Reproduction. 10(1):40-48.* English. [UNIV MONTREAL INST RECH BIOL VEGETALE 4101 RUE SHERBROOKE EST MONTREAL PQ H1X 2B2 CANADA].

Water deficit during meiosis in microspore mother cells of wheat (Triticum aestivum L.) induces male sterility, which reduces grain yield. In plants stressed during meiosis and then re-watered, division of microspore mother cells seems to proceed normally, but subsequent pollen development is arrested. Stress-affected anthers generally lack starch. We employed light microscopy in conjunction with histochemistry to compare the developmental anatomy of water-stress-affected and normal anthers. The earliest effects of stress, detectable between meiosis and young microspore stages, were the degeneration of meiocytes, loss of orientation of the reproductive cells, and abnormal vacuolization of tapetal cells. Other effects observed during subsequent developmental stages were deposition of starch in the connective tissue where it is normally not present, hypertrophy of the middle layer or endothecial cells, and deposition of sporopollenin-like substances in the anther loculus, The resulting pollen grains lacked both starch and intine. These results suggest that abnormal degeneration of the tapetum in water-stressed anthers coupled with a loss of orientation of the reproductive cells could be part of early events leading to abortion of microspores. [References: 42].

F70 PLANT TAXONOMY AND GEOGRAPHY

2978 Barkworth, ME.; Burkhamer, RL.; Talbert, LE. (1996) **ELYMUS CALDERI - A NEW SPECIES IN THE TRITICEAE (POACEAE).** *Systematic Botany. 21(3):349-354.* English. [UTAH STATE UNIV DEPT BIOL INTERMT HERBARIUM LOGAN, UT 84322 USA].

Herbarium specimens identified as Agropyron yukonense or one of its synonyms consistently differ from the holotype and protologue of that name and resemble each other in their stiff, involute leaves, narrow, dark cauline nodal bands, and pilose paleas. This suggests that the non-holotype plants represent a new species. Cytogenetic analysis of root tip chromosomes from non-holotype plants revealed that they were tetraploids with 2n = 28. Analysis of genome-specific DNA suggested that it contained the St and H genomes, resembling Elymus s. str. in this regard, rather than the morphologically similar genus Roegneria which contains the St and Y genomes. Presence of the H genome and absence of the Y genome were supported by analysis of 70 low copy DNA sequences detected using sequence-tagged-site PCR analysis. Thus, morphological, cytogenetic, and molecular results support inclusion of the new species in Elymus. The name Elymus calderi is proposed, in honor of J.A. Calder, a taxonomist who worked extensively in western Canada. A description, illustration, and distribution map are presented. [References: 20].

H01 PROTECTION OF PLANTS-GENERAL ASPECTS

2979 Schreiber, L. (Kaiserslautern Univ. (Germany). Physiologische Oekologie) (1994) **A mechanistic approach towards effects of nonionic surfactants on mobility of pesticides in reconstituted cuticular wax of barley leaves.** 46th International Symposium on Crop Protection. Gent (Belgium). 3 May 1994. *Mededelingen - Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen Universiteit Gent (Belgium) v. 59(3b) p. 1409-1414.* 4 ill.; 1 table; 11 ref. English. (AGRIS 97-048164).

2980 Smeets, E.; Hendrickx, G.; Geypens, M. (Soil Service of Belgium, Leuven Heverlee (Belgium)) (1994) **EPIPRE, an up to date link between research and today's farming practice.** 46th International Symposium on Crop Protection. Gent (Belgium). 3 May 1994. *Mededelingen - Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen Universiteit Gent (Belgium) v. 59(3b) p. 1233-1239.* 5 ill.; 1 table. English. (AGRIS 97-048150).

H10 PESTS OF PLANTS

2981 Ahmadi, A.A. (1993) **Distribution and Natural enemies of Russian Wheat aphid, Diuraphis noxia (Mordvilko) (Homoptera:Aphididae) in the Fars province.** Shiraz Univ., Shiraz (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 3.* Persian. (AGRIS 97-033655).

2982 Akbari Noushad, S.D. (1993) **Bioecological study of "Porphyrophora tritici" (Homo:Margarodidae) a wheat root pest in East Azarbaidjan.** Plant Pests and Diseases Research Department Agricultural Center of East Azarbaidjan, Tabriz (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 4.* Persian. (AGRIS 97-034169).

2983 Al Taae, A.K.; Al Talib, N.Y.; Stephan, Z.A.; Nimer, S.N.; Al Din, S.S.; Ayoob, M.; Antoon, B.J.; Hassan, W. (State board for Agric. Res. (Iraq)) (1993) **[Studies on barley seed gall nematode Anguina tritici in Iraq]. Dira:sa:t h"awl di:da:n t" 'a:li:l al-s"a3i:r Anguina tritici fi: al-3ira:q.** *Mij"alat 'iba:' lil'abh"a:t" al-zira:3iyyat (Iraq). Ipa Journal of Agricultural Research v. 3(no.2) p. 202-216.* Arabic. (AGRIS 97-033852).

The effect of level of inoculum on barley infection indicated that percentage of infection increased by increasing the level of inoculum up to 20 galls per pot. Two races of A. tritici were identified, one attacking barley and the other attacking wheat only. Other results showed that the presence of A. tritici with the fungus, Dilophospors alopecuri as mixed inoculum in the soil increased the severity of the disease on barley. The effect of level of concentrations of the plant extract, cleome quinquenervia up to 20 significantly increased percentage of killing of barley juvenile nematode up to 85.5.

2984 Amare Andargie (Sinana Research Center, Robe (Ethiopia)); Beyech Mulatu; Wasie Haile; Adisu Birhan (1996) **Barley entomology research.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 128-137.* IAR/ICARDA. 7 tables; 15 ref. English. (AGRIS 97-048631).

The major insect pests on barley in Ethiopia are the barley shootfly (Delia arambourgi) and the Russian wheat aphid (Diuraphis noxia). Work on management of these pests has been carried out for years. Host preference, bionomics, crop resistance, effect of sowing date and chemical control have been studied. Results of these studies are reviewed in this paper.

2985 Anderson, P. (Swedish University of Agricultural Sciences, Alnarp, Sweden.); Lofqvist, J. (1996) **Oviposition deterrents from potato, wheat germ, larval frass, and artificial diet for Agrotis segetum (Lepidoptera: Noctuidae).** *Environmental entomology (USA) v. 25(3) p. 653-658.* references. English. (AGRIS 97-033570).

Methanol extracts of potato tubers and wheat germ acted as strong deterrents of oviposition for females of the moth Agrotis segetum Schiffermuller compared with pure solvent. Extracts of a semisynthetic

diet, based on potato and wheat germ, and extracts of frass from larvae reared on this diet also elicited oviposition deterrence. Extracts in water and chloroform were also oviposition deterring, but to a lower extent. Feral females showed the same response to the extracts as females of the laboratory strain reared on the semisynthetic diet for many generations. Frass extracts of A. segetum larvae also deterred oviposition by female A. exclamationis L., whereas female Mamestra brassicae L. did not respond to the extract.

2986 Bahrami, N. (1993) **Preliminary studies of the biology of syringopais temperatella Led. (Lep., Scythridae) in Bakhtaran Province.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 5.* Persian. (AGRIS 97-034170).

2987 Baker, G.H. (Division of Entomology, CSIRO, PMB 2, Glen Osmond (Australia)) (1996) **Population dynamics of the Mediterranean snail, Cernuella virgata, in a pasture-cereal rotation in South Australia.** *Slug and snail pests in agriculture. Proceedings of a Symposium, University of Kent, Canterbury, UK, 24-26 September 1996. p. 117-124.* British Crop Protection Council. 17 ref. English. (AGRIS 97-048893).

2988 Bandani, A.R. (1993) **Cereal aphids and their hymenopterous parasits in Sistan Province.** Tehran Univ., Karadj (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 6.* Persian. (AGRIS 97-033767).

2989 Bernal, J.; Gonzalez, D. (1997) **REPRODUCTION OF DIAERETIELLA RAPAE ON RUSSIAN WHEAT APHID HOSTS AT DIFFERENT TEMPERATURES.** *Entomologia Experimentalis et Applicata. 82(2):159-166.* English. [UNIV CALIF RIVERSIDE DEPT ENTOMOL RIVERSIDE, CA 92521 USA].

Diaeretiella rapae (M'Intosh), a polyphagous and cosmopolitan parasite of aphids, was imported from China to the USA for biological control of Diuraphis noxia (Mordwilko), a pest of small grains. We studied several aspects of its biology on D. noxia hosts in the laboratory at 3 constant temperatures, 10.0, 21.1, and 26.7 degrees C. Females lived significantly longer than males at all 3 temperatures, and longevity was greatest at 10 degrees C, followed by 21.1 and 26.7 degrees C. Fecundity (= number of mummies) did not differ significantly among the 3 temperatures studied. The ovarian egg-load was 129.1 +/- 9.3, and was significantly affected by the size of adult females. A pre-oviposition period (0.95 +/- 0.26 days) was detected at 10 degrees C, but not at the other temperatures. Pre-imaginal survivorship was similar among temperatures, while R(0) and T-c decreased with temperature, and r(m) increased with temperature. The offspring sex ratio (proportion females) was lowest at 26.7 degrees C, and similar between 10.0 and 21.1 degrees C. In addition, the offspring sex ratio significantly declined with the age of the female parent. The suitability of D. rapae for colonization against D. noxia in North America is discussed in relation to its responses to temperature and the climate of its home range. [References: 39].

2990 Bernal, JS.; Waggoner, M.; Gonzalez, D. (1997) **REPRODUCTION OF APHELINUS ALBIPODUS (HYMENOPTERA, APHELINIDAE) ON RUSSIAN WHEAT APHID (HEMIPTERA, APHIDIDAE) HOSTS.** *European Journal of Entomology. 94(1):83-96.* English. [UNIV CALIF RIVERSIDE DEPT ENTOMOL RIVERSIDE, CA 92521 USA].

Reproduction in Aphelinus aibipodus (Hayat & Fatima) from China on Diuraphis noxia (Mordvilko) hosts was studied in the laboratory. Studies were conducted at three constant temperatures, 10.0, 21.1, and 26.7 degrees C (+/-1.0 degrees C), 14L, : 10D photoperiod, and 50-70% R.H. The longevity of both males and females was greatest at 10.0 degrees C (26.0 and 41.5 d, respectively); differences in longevity were not significant ($p > 0.05$) between 21.1 and 26.7 degrees C in both sexes (males 13.1 vs. 10.0 d, females 20.9 vs. 16.4 d, respectively). Fecundity was greater at 26.7 (294.7 +/- 27.6 mummies) and 21.1 degrees C (214.8 +/- 33.5 mummies) than at 10.0 degrees C (569 +/- 11.7 mummies), but was not significantly different ($p > 0.05$) between the former two temperatures. Aphelinus albipodus did not successfully develop to adulthood at 10 degrees C, thus r(m) and R(o) values were zero, and T-c (generation time) could not be estimated. At 21.1 degrees C, r(m) = 0.188, R(o) = 68.9, and T-c = 23.9 d; those values were 0.288, 67.4, and 15.2 d, respectively, at 26.7 degrees C. The offspring sex ratio (females) was male-biased at all three temperatures: 0.364 +/- 0.061 at 10.0 degrees C, 0.437 +/- 0.029 at 21.1 degrees C, and 0.341 +/- 0.002 at 26.7 degrees C. Moreover, daily offspring sex ratio decreased with the age of the female parent at all three temperatures ($p < 0.05$). A pre-oviposition period of 1.5 d was observed in A. albipodus at 10 degrees C, and female offspring were not produced during the first 7.5 d of adult life of mated females. The limited number of ovarian eggs, 6.5 +/- 2.5, in newly emerged females (< 6 h old) together with their fecundity schedule indicated synovigeny in A. albipodus. Results are discussed in relation to the colonization in North America of A. albipodus for biological control of D. noxia. [References: 47].

2991 Bielza, P. (Servicio de Investigacion Agraria, Toledo (Espana). Laboratorio de Fitopatologia); Torres Vila, L.M.; Lacasa, A. (1996) **[Effects of cultivation on the survival of overwintering larvae of Haplothrips tritici Kurd. (Thysanoptera: Phlaeothripidae)]. Efecto del laboreo en la supervivencia de las larvas invernantes de Haplothrips tritici Kurd. (Thysanoptera: Phlaeothripidae).** *Boletin de Sanidad Vegetal. Plagas (Espana) v. 22(2) p. 289-295.* 6 fig., 1 cuadro; 15 ref. Spanish. (AGRIS 97-033487).

Durante la campana 1994/95 se realizo un estudio en Santa Olalla (Toledo) sobre la influencia de las labores en la mortalidad de las larvas invernantes de Haplothrips tritici, asi como de la pauta de emergencia de los adultos en primavera. Esta mostro una buena sincronizacion con la fenologia del trigo, produciendose desde el estado de hoja bandera hasta la formacion del grano, con un pico en torno a la emergencia de la espiga. El ratio sexual vario con el ciclo, apareciendo primero solo hembras, aumentando progresivamente la proporcion de machos. Aunque se observo una tendencia en la disminucion de las poblaciones de adultos que emergieron en primavera, en el sentido: barbecho quimico, no-laboreo, vertedera, cultivador, quema+cultivador, solo la labor de quema del rastrojo mas cultivador mostro diferencias significativas.

2992 Bielza, P. (Servicio de Investigacion Agraria, Toledo (Espana). Laboratorio de Fitopatologia); Torres Vila, L.M.; Lacasa, A. (1996) **[Quantitative and qualitative incidence of Haplothrips tritici Kurd. (Thysanoptera: Phlaeothripidae) on wheat production]. Incidencia cuantitativa y cualitativa de Haplothrips tritici Kurd. (Thysanoptera: Phlaeothripidae) en la produccion de trigo.** *Boletin de Sanidad Vegetal. Plagas (Espana) v. 22(2) p. 277-287.* 14 fig., 3 cuadros; 19 ref. Spanish. (AGRIS 97-033486).

Durante las campanas 1993/94 y 1994/95 se ha realizado un estudio en Santa Olalla (Toledo) sobre los danos que realiza Haplothrips tritici Kurd. en el trigo. Las infestaciones naturales registradas alcanzaron niveles muy altos, superiores a 200 larvas por espiga. La produccion disminuyo en mas de un 50 por cien respecto a las parcelas con densidades bajas, consecuencia de la reduccion del numero de granos por espiga y el peso de mil granos. Tanto la calidad fisica del grano (peso especifico) como la calidad harinera (porcentaje de degradacion de la fuerza panadera) se vieron afectados, reduciendo el valor comercial del grano.

2993 Brown Guedira, G.L. (Kansas State University, Manhattan.); Gill, B.S.; Bockus, W.W.; Cox, T.S.; Hatchett, J.H.; Leath, S.; Peterson, C.J.; Thomas, J.B.; Zwer, P.K. (1996) **Evaluation of a collection of wild timopheevi wheat for resistance to disease and arthropod pests.** *Plant disease (USA) v. 80(8) p. 928-933.* references. English. (AGRIS 97-034364).

Wild relatives of wheat (Triticum aestivum) are important sources of genes for resistance to disease and insect pests. A collection of the wild tetraploid wheat species Triticum timopheevii var. araraticum was evaluated for reaction to Hessian fly (Mayetiola destructor) wheat curl mite (Eriophyes tulipae) and six foliar diseases: leaf rust (caused by Puccinia recondita f. sp. tritici) stem rust (caused by Puccinia graminis f. sp. tritici) stripe rust (caused by Puccinia striiformis) powdery mildew (caused by Blumeria graminis f. sp. tritici) tan spot (caused by Pyrenophora tritici-repentis) and Septoria blotch (caused by Septoria tritici). All accessions tested were resistant to Septoria blotch and a very high percentage were resistant to tan spot. Resistance was detected to four obligate fungal pathogens, although accessions with leaf rust resistance were more frequent in the collection than those with resistance to stripe rust, stem rust, or powdery mildew. Resistance to Hessian fly biotype D and wheat curl mite was detected in 91 and 27 of the tested accessions, respectively. Variation was noted in reaction of a subset of accessions when tested with biotype L of Hessian fly. Thirty-one accessions with intermediate to high levels of resistance to at least five pests each were identified. Accessions from northern Iraq had the highest frequency of

resistances. This collection of wild timopheevi wheat represents a diverse gene pool that may be useful for improvement of common wheat.

2994 Burd, J.D. (USDA, ARS, Plant Science and Water Conservation Research Laboratory, Stillwater, OK.); Elliott, N.C.; Reed, D.K. (1996) **Effects of the aphicides 'Gaucho' and CGA-215944 on feeding behavior and tritrophic interactions of Russian wheat aphids.** *The Southwestern entomologist (USA) v. 21(2) p. 145-152.* references. English. (AGRIS 97-048538).

2995 Burd, J.D. (USDA, ARS, Plant Science Research Laboratory, Stillwater, OK.); Webster, J.A.; Puterka, G.J.; Hoxie, R.P.; Wellso, S.G. (1996) **Effect of Russian wheat aphid on constituent nonstructural carbohydrate content in wheat seedlings.** *The Southwestern entomologist (USA) v. 21(2) p. 167-172.* references. English. (AGRIS 97-048539).

2996 Chen Zhijie; Wu Guangjun; Zhang Meirong (Shaanxi Inst. of Zoology, Xian (China)) (1995) **Study on the efficacies of wheat-pepper interplantation to evade aphid damage and alleviate virus disease.** *Acta Phytophylacica Sinica (China) v. 22(4) p. 343-347.* 3 tables; 2 ill., 2 ref. Chinese. (AGRIS 97-048956).

2997 Chen Zhishen; Yang Zhimin; Yuan Guohui (Henan Agricultural Univ., Zhengzhou (China)) (1995) **Research on the application of Banzhongwei in preventing and controlling major wheat diseases and pests.** *Acta Agriculturae Universitatis Henanensis (China) v. 29(4) p. 388-395.* 10 tables; 4 ref. Chinese. (AGRIS 97-048955).

2998 Ciepiela, A.P.; Sempruch, C.; Kaszynski, W. (Agricultural and Pedagogic University, Siedlce (Poland). Dept. of Molecular Biology) (1995) **Participation of chosen nonprotein amino acids in constitutive resistance of winter triticale to grain aphid.** *Roczniki Nauk Rolniczych. Seria E - Ochrona Roslin (Poland). Polish Agricultural Annual. Series E - Plant Protection v. 24(1-2) p. 99-104.* 1 fig., 3 tables; 17 ref. English. (AGRIS 97-034357).

The participation of chosen nonprotein amino acids in constitutive resistance of winter triticale to grain aphid (Sitobion avenae (F.)) was studied. Authors found that Lasko cultivar (relatively resistant to S. avenae) ears contain more ornithine, beta-alanine, gamma-aminobutiric acid and all (taken as a sume) researched nonprotein amino-acids than analogical organs of Grado triticale (susceptible cultivar).

2999 Clement, S.L. (Western Regional Plant Introduction Station, USDA ARS, Pullman, WA.); Lester, D.G.; Wilson, A.D.; Johnson, R.C.; Bouton, J.H. (1996) **Expression of Russian wheat aphid (Homoptera: Aphididae) resistance in genotypes of tall fescue harboring different isolates of Acremonium endophyte.** *Journal of economic entomology (USA) v. 89(3) p. 766-770.* references. English. (AGRIS 97-033754).

Experiments were conducted to compare the expression of Russian wheat aphid, Diuraphis noxia (Mordvilko), resistance in 2 genotypes of tall fescue grass, Festuca arundinacea Schreb., harboring different isolates of the endophytic fungus Acremonium coenophialum Morgan-Jones and Gams. Aphids did not select endophyte-free over endophyte-infected tiller sections in laboratory tests. In a laboratory population growth test, aphid number declined for 2 d on all endophyte-free plants and then increased. Aphid mortality was 100 on all infected plants after 4 d. Thus, antibiosis resistance to D. noxia was not specific to tall fescue genotype or to Acremonium isolate. In a field plot, numbers of Russian wheat aphids were significantly higher on endophyte-free tall fescue. Using these results, and results of other studies involving Acremonium-enchanced resistance to D. noxia in tall fescue and other host grasses, the potential for using D. noxia to screen grass germplasm for Acremonium fungi is discussed.

3000 Cook, R.T.; Bailey, S.E.R.; McCrohan, C.R. (University of Manchester, School of Biological Sciences, Oxford Road, Manchester M13 9PT (United Kingdom)) (1996) **The potential for common weeds to reduce slug damage to winter wheat.** *Slug and snail pests in agriculture. Proceedings of a Symposium, University of Kent, Canterbury, UK, 24-26 September 1996. p. 297-304.* British Crop Protection Council. 12 ref. English. (AGRIS 97-048635).

3001 Dong Cixiang (Heze Prefectural Station of Plant Protection, Shandong (China)) (1995) **Studies on population dynamics of natural enemies and predatory function of main natural enemies to wheat aphids in the wheat fields.** *Entomological Journal of East China (China) v. 4(1) p. 56-60.* 4 tables; 4 ref. Chinese. (AGRIS 97-048957).

3002 Elberson, L.R. (University of Idaho, Moscow, ID.); Johnson, J.B. (1995) **Population trends and comparison of sampling methods for Diuraphis noxia and other cereal aphids (Homoptera: Aphididae) in northern Idaho.** *Environmental entomology (USA) v. 24(3) p. 538-549.* references. English. (AGRIS 97-033855).

Weekly sampling of Diuraphis noxia (Kurdjumov) infesting wheat and barley at four sites in northern Idaho was conducted during the growing seasons from 1989 to 1992. Infestations were higher in the spring-planted than in the fall-planted cereals. Populations of D. noxia began increasing during inflorescence emergence, Zadoks growth stage (ZGS) 50, and reached peak numbers during dough development and caryopsis ripening, ZGS 80-90. D. noxia infestations were highest during 1990 and lowest during 1992. Three survey methods were compared. These included collection of 100 seedlings or tillers per sample for Berlese extraction, an in-field examination of 500 tillers per sample, and an area wide suction trap sample. Results of the comparisons revealed higher mean numbers of D. noxia per tiller from the Berlese method than from the field count method. Comparison of field results with the suction trap collections revealed a definite temporal relationship, suggesting that suction trap counts reflect emigration following local field build up of cereal aphids infesting grain in northern Idaho rather than long distance immigration. Data collected over time from suction trap catches may be useful in predicting future field infestation rates, but will not eliminate the need for field surveys.

3003 Ester, A.; Darwinkel, A.; Floot, H.W.G.; Nijenstein, J.H. (Research Station for Arable Farming and Field Production of Vegetables (PAGV), PO Box 430, 8200 AK Lelystad (Netherlands)) (1996) **Control of field slugs (Deroceras reticulatum) in winter wheat using seeds treated with pesticides.** *Slug and snail pests in agriculture. Proceedings of a Symposium, University of Kent, Canterbury, UK, 24-26 September 1996. p. 165-172.* British Crop Protection Council. 16 ref. English. (AGRIS 97-048723).

3004 Frank, T. (Zoologisches Institut der Universitat, Baltzerstr. 3, CH 3012 Bern (Switzerland)) (1996) **Sown wildflower strips in arable land in relation to slug density and slug damage in rape and wheat.** *Slug and snail pests in agriculture. Proceedings of a Symposium, University of Kent, Canterbury, UK, 24-26 September 1996. p. 289-296.* British Crop Protection Council. 11 ref. English. (AGRIS 97-048725).

3005 Fuentescontreras, JE.; Powell, W.; Wadhams, LJ.; Pickett, JA.; Niemeyer, HM. (1996) **INFLUENCE OF WHEAT AND OAT CULTIVARS ON THE DEVELOPMENT OF THE CEREAL APHID PARASITOID APHIDIUS RHOPALOSIPHI AND THE GENERALIST APHID PARASITOID EPHEDRUS PLAGIATOR.** *Annals of Applied Biology. 129(2):181-187.* English. [UNIV CHILE FAC CIENCIAS DEPT CIENCIAS ECOL LAB QUIM ECOL CASILLA 653 SANTIAGO CHILE].

The effects of three wheat cultivars and two oat cultivars on the development of the cereal aphid parasitoid Aphidius rhopalosiphi De Steph. and the generalist aphid parasitoid Ephedrus plagiator (Nees) (Hymenoptera: Braconidae) were evaluated in the laboratory. The level of hydroxamic acids, a family of secondary metabolites that can affect the mean relative growth rate of cereal aphids in cereals, were measured in the different cultivars. The parasitoids were reared in Sitobion avenae (F.) (Homoptera: Aphididae), using plants grown under greenhouse conditions. A. rhopalosiphi showed a longer developmental time on wheat relative to oat cultivars. This effect was accounted for by a significant increase in the time from oviposition to pupation (mummy formation), while the duration of the pupal stage remained constant between treatments. No further effects were observed in other variables evaluating A. rhopalosiphi performance, such as adult longevity, adult body weight and secondary sex ratio. The generalist E. plagiator did not show significant differences in any of the variables analysed, both between cultivars and cereal species. Hydroxamic acids levels correlated negatively with mean relative growth rates of S. avenae, but positively with the observed developmental time of A. rhopalosiphi. The results are discussed in terms of tritrophic effects and the development of breeding programmes trying to improve plant resistance to aphids. [References: 20].

3006 Gaimari, S.D. (University of Illinois, Urbana, IL.); Turner, W.J. (1996) **Immature stages of Leucopis ninae Tanasijtshuk and two variant populations of Leucopis gaimarii Tanasijtshuk (Diptera: Chamaemyiidae) feeding on Russian wheat aphid, Diuraphis noxia**

(Mordvilko) (Homoptera: Aphididae). *Entomological Society of Washington (USA) v. 98(4) p. 647-666.* references. English. (AGRIS 97-048503).

3007 Gaimari, S.D. (University of Illinois, Urbana, IL.); Turner, W.J. (1996) **Larval feeding and development of Leucopis ninae Tanasijtshuk and two populations of Leucopis gaimarii Tanasijtshuk (Diptera: Chamaemyiidae) on Russian wheat aphid, Diuraphis noxia (Mordvilko) (Homoptera: Aphididae), in Washington.** *Entomological Society of Washington (USA) v. 98(4) p. 667-676.* references. English. (AGRIS 97-048991).

3008 Gallo, J. (Vysoka Skola Polnohospodarska, Nitra (Slovakia)) (1996) **[Occurrence of leaf miners (Agromyzidae) in winter barley in dependence on cultural practices]. Vyskyt mineriek (Agromyzidae) na jacmeni ozimnom v zavislosti od niektorych prvkov agrotechniky.** *Ochrana Rostlin - UZPI (Czech Republic) v. 32(3) p. 209-219.* 3 graphs, 2 tables; 19 ref. Slovak. (AGRIS 97-048630).

The occurrence of leaf miners (Agromyzidae) as influenced by cultural practices was investigated in two winter barley varieties (Borwina, Ermo). We found that the population growth of leaf miners started in 1986 and culminated in 1987. Since 1989 the occurrence of leaf miners has been in a latent state. Within year, maximum occurrence was during the period of the 16th and 17th of May. The imagoes of leaf miners inflicted higher damage to stands that were fertilized with higher rates of nitrogen than to unfertilized ones.

3009 Gash, A.F.; Carter, N.; Bale, J.S. (Writtle College, Lordship Road, Writtle, Essex, CM1 3RR (United Kingdom)) (1996) **The influence of nitrogen fertiliser applications on the cereal aphids Metopolophium dirhodum and Sitobion avenae.** *Brighton Crop Protection Conference: Pests and Diseases - 1996: Volume 1: Proceedings of an International Conference, Brighton, UK, 18-21 November 1996. p. 209-214.* British Crop Protection Council. 11 ref. English. (AGRIS 97-048809).

3010 Gillespie, R.L. (Washington State University, Ephrata, WA.); Kemp, W.P. (1996) **Sampling method assessment and quantification of temporal shifts in densities of grasshopper species (Orthoptera: Acrididae) between winter wheat, Triticum aestivum, and adjacent rangeland.** *Environmental entomology (USA) v. 25(3) p. 559-569.* references. English. (AGRIS 97-034003).

In this study, we determined that a sampling methods (D-Vac and sweep net) taken at weekly intervals could be used to sample grasshopper species across a adjacent habitats of winter wheat and rangeland. We also quantified temporal density estimate shifts between winter wheat, Triticum aestivum L., and rangeland by migratory grasshoppers, Melanoplus sanguinipes (F.), twostriped grasshopper, M. bivittatus (Say), and Packard grasshopper, M. packardii Scudder, all 3 species coinhabit these areas. Specifically, at 4 study sites with the highest grasshopper densities there were significant seasonal shifts in density estimates of these species between winter wheat and rangeland suggesting that these species dispersed between habitats. At a 5th site, sweep net sampling detected a shift in density estimates between habitats by M. sanguinipes and D-Vac sampling at this site suggested there was a similar trend. At 4 study sites such shifts in density estimates did not occur suggesting that no dispersal occurred or it was not detectable at these sites using our sampling methods. In all but 1 case the density of these species, were lower than those where density estimate shifts occurred.

3011 Golzar, H.; Nasrolla Nejhad, S. (1993) **New biotype of Anguina tritici on barley in Iran.** Agricultural Research Center of Gorgan and Gonbad, Gorgan (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.-2 Sep. 1993 Rasht (Iran Islamic Republic) p. 37.* Persian. (AGRIS 97-034180).

3012 Green, D.B. (ADAS, Woodthorne, Wergs Road, Wolverhampton, WV6 8TQ (United Kingdom)) (1996) **Managed applications of molluscicides for slug control in winter wheat.** *Brighton Crop Protection Conference: Pests and Diseases - 1996: Volume 1: Proceedings of an International Conference, Brighton, UK, 18-21 November 1996. p. 197-202.* British Crop Protection Council. 8 ref. English. (AGRIS 97-048829).

3013 Hatting, J. (Agricultural Research Council, Bethlehem (South Africa). Small Grain Inst.) (1996) **[Identify pests on wheat correctly]. Identifiseer plae korrek.** *SA Co-op (South Africa) v. 12(12) p. 12-13, 15.* Afrikaans. (AGRIS 97-048951).

3014 Havlickova, H. (1997) **CHARACTER AND EXTENT OF DAMAGE TO WINTER WHEAT CULTIVARS CAUSED BY CEREAL APHIDS.** *Rostlinna Vyroba. 43(3):113-116.* English. [RES INST CROP PROD CR-16106 PRAGUE 6 CZECH REPUBLIC].

Two winter wheat cultivars, Regina and Zdar, cultivated in greenhouse, were evaluated in relation to the changes in the leaf physiology, chlorophyll content and yield characteristics under cereal aphid stress. The significant reduction of leaf area, dry matter and chlorophyll content were determined in the leaves of plants infested by aphids Metapolophium dirhodum (MD) and Rhopalosiphum padi (RP). The damage to flag and 2nd leaves was obviously greater in MD infested plants, the bottom 3rd and 4th leaves were more damaged by RP. Both aphid species resulted in yield reduction. For greater part MP infestation resulted in seed weight losses, while RP feeding tended more to decrease in seed number per ear. The greatest losses in seed weight were observed in both cultivars in ears infested by Sitobion avenae (SA). Zdar was more sensitive to aphid feeding than Regina. [References: 19].

3015 Heydari, M. (1993) **An investigation of chemical norm control against "Eurygaster integriceps Put." in irrigated cereal farms of Varamin field.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 13.* Persian. (AGRIS 97-033713).

3016 Heydari, M. (1993) **The investigation of different infestation and damages of wheat with respect to ordinary wheat sunn pest and barley "Eurygaster integriceps Put." in irrigated cereal farms of Tehran Province.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 12.* Persian. (AGRIS 97-034173).

3017 Huang, XP.; Renwick, JAA. (1997) **FEEDING DETERRENTS AND SENSITIVITY SUPPRESSORS FOR PIERIS RAPAE LARVAE IN WHEAT GERM DIET.** *Journal of Chemical Ecology. 23(1):51-70.* English. [CORNELL UNIV BOYCE THOMPSON INST PLANT RES TOWER RD ITHACA, NY 14853 USA].

Rejection of wheat germ diet by cabbage-reared Pieris rapae larvae is explained by the fact that the diet contains strong feeding deterrents to the larvae. These deterrents were present mainly in hexane and butanol (BuOH) fractions of diet extracts, but the post-BuOH water fraction also showed some deterrent activity. Although minor diet components such as sorbic acid had a weak deterrent effect, wheat germ was primarily responsible for the activity. Seven compounds isolated from the BuOH extract of wheat germ were deterrent to the larvae. UV spectra suggested that most of these compounds are apigenin-based flavones. Fractionation of the hexane extracts showed that most of the active compounds were methanol-soluble, and HPLC of the MeOH fractions revealed the presence of active compounds that were absent in the BuOH extract of wheat germ, as well as other compounds that were common to both fractions. Acceptance of nasturtium by P. rapae larvae reared on wheat germ diet is explained by a type of "cross habituation" of the larvae to feeding deterrents. When larvae were reared on cabbage leaves treated with chemical fractions from wheat germ diet, they readily accepted nasturtium, which is normally refused by cabbage-reared P. rapae larvae, due to the presence of strong feeding deterrents in the plant. A high percentage of diet-reared larvae also fed on Erysimum cheiranthoides and Iberis amara, which are normally rejected. The chemical constituents encountered in wheat germ can almost completely account for the larval acceptance of nasturtium. The suitability of wheat germ diet for rearing phytophagous insects for behavioral assays must be questioned. [References: 50].

3018 Khan, A. (Crop Diseases Research Inst., PARC, Karachi (Pakistan)); Shaukat, S.S. (Karachi Univ. (Pakistan). Dept. of Botany) (1993) **Effect of neem and carbofuran against population of three nematodes associated with wheat varieties.** *Sarhad Journal of Agriculture (Pakistan) v. 9(2) p. 157-162.* 3 ills., 1 table, 16 ref. English. (AGRIS 97-034360).

The effects of carbofuran, single and double dose of neem leaves on population levels of Bitylenchus goffarti, Helicotylenchus indicus and Hoplolaimus seinhorsti and the growth parameters of 3 wheat varieties viz, Faisalabad-85m Khyber-87 and Sarhad-82 were examined. Whereas

population levels of B. goffarti and H. seinhorsti were greatly reduced by double dose of neem, the population level of H. indicus was most reduced by carbofuran. All the three nematicides resulted in increased root weight as well as the thousand seed weight.

3019 Krut', M.V.; Feshchin, D.M.; Didan, V.P. (Ukranian Academy of Agricultural Sciences, Kiev (Ukraine). Institute of Plant Protection) (1996) **[Peculiarities of development of harmful and useful fauna on winter wheat sowings]. Osobennosti razvitiya vrednoj i poleznoj fauny na posevakh ozimoj pshenitsy.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 31-32.* BRIPP. Russian. (AGRIS 97-034359).

3020 Lazar, M.D. (Texas AandM University System, Texas Agricultural Experiment Station, Amarillo, TX.); Michels, G.J. Jr.; Booker, J.D. (1995) **Reproductive and developmental rates of two greenbug biotypes in relation to two wheat host resistance genes.** *The Southwestern entomologist (USA) v. 20(4) p. 467-482.* references. English. (AGRIS 97-034362).

3021 Lhaloui, S. (National Institute for Agricultural Research, Settat, Morocco.); Hatchett, J.H.; Wilde, G.E. (1996) **Evaluation of New Zealand barleys for resistance to Mayetiola destructor and M. hordei (Diptera: Cecidomyiidae) and the effect of temperature on resistance expression to Hessian fly.** *Journal of economic entomology (USA) v. 89(2) p. 562-567.* references. English. (AGRIS 97-034025).

Six New Zealand barleys were evaluated for resistance to biotype L of the Hessian fly, Mayetiola destructor (Say), the most virulent biotype that infests wheat in the United States. Three of the barleys, 'Gwylan', 'WPBS 316/80', and 'Fleet', were found to be resistant to biotype L and were tested to Hessian fly and the stem gall midge M. hordei Keiffer in Morocco. Because high temperature may affect the expression of resistance to Hessian fly, the temperature sensitivity of resistance to biotype L also was assessed at constant temperatures of 18, 24, and 30 degrees C. Resistance tests demonstrated that Gwylan, WPBS 316/80, and Fleet were highly resistant to biotype L and Moroccan Hessian fly, but were susceptible to stem gall midge larvae. Resistance was expressed mainly as antibiosis, with 1st instars dying after feeding on resistant plants. Small numbers of larvae survived on resistant plants and appeared to develop normally, indicating that a tolerance mechanism also may be involved. Neither plant resistance nor the level of antibiosis expressed in the three cultivars was affected by increasing temperature up to 30 degrees C. The results indicate that the New Zealand barleys carry resistance genes different than those previously identified in barley and would be excellent sources for breeding Hessian fly-resistant cultivars in the United States and Morocco.

3022 Lovett, J.V. (University of New England, Armidale, New South Wales, Australia.); Hoult, A.H.C. (1995) **Allelopathy and self-defense in barley.** *Allelopathy : organisms, processes, and applications p. 170-183.* American Chemical Society. references. Developed from a meeting sponsored by the Botanical Society of America Section of the American Institute of Biological Sciences, August 1-5, 1993, Ames, Iowa. English. (AGRIS 97-048632).

Evidence for allelopathic activity in barley and the major temperate cereal crops is reviewed. We believe that the secondary metabolites, gramine and hordenine, produced by barley (Hordeum spp.) play a role in defending the producing plant against interference from other organisms. Our recent work has shown inhibitory effects on a fungus (Drechslera teres) and on armyworm (Mythimna convecta) larvae as well as on a number of plant species. This work and that of others showing activity against bacteria, aphids and mammals suggests a possible physiological resistance to these organisms which may be exploitable through plant breeding. A survey of 43 lines of barley including ancestral and modern types indicates that hordenine production by modern cultivars may already have been inadvertently favored by selection for agronomic traits while the ability to produce gramine may have been reduced or lost during this process.

3023 Mann, J.A.; Harrington, R.; Morgan, D.; Walters, K.F.A.; Barker, I.; Tones, S.J.; Foster, G.N. (IACR Rothamsted, Harpenden, Hertfordshire, AL5 2JQ (United Kingdom)) (1996) **Towards decision support for control of barley yellow dwarf vectors.** *Brighton Crop Protection Conference: Pests and Diseases - 1996: Volume 1: Proceedings of an International Conference, Brighton, UK, 18-21 November 1996. p. 179-184.* British Crop Protection Council. 17 ref. English. (AGRIS 97-048807).

3024 Mardokhi, W. (1993) **Biology and distribution of ground pearl (Porphyrophora tritici Bod) in Kordestan province.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 15.* Persian. (AGRIS 97-034174).

3025 Mardoukhi, V.; Heidari, M. (1993) **Study on variations of population density and damage of sunn pest (Eurygaster integriceps put) in dry rain-fed of Kurdestan.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Applied Entomology and Phytopathology Publication of Plant Pests and Diseases Research Institute (Iran Islamic Republic) v. 60(1-2) p. 7.* Persian. (AGRIS 97-034161).

3026 Mckillop, I.G.; Fox, S.M.; Pugh, B.D.; Langton, S.D.; Sylvester Bradley, R. (Central Science Laboratory, MAFF, Tangley Place, Guildford, Surrey, GU3 3LQ (United Kingdom)) (1996) **Developing a model to predict yield loss of winter wheat due to grazing by European wild rabbits.** *Brighton Crop Protection Conference: Pests and Diseases - 1996: Volume 1: Proceedings of an International Conference, Brighton, UK, 18-21 November 1996. p. 145-150.* British Crop Protection Council. 14 ref. English. (AGRIS 97-048892).

3027 Meredith, R.H. (Bayer plc, Crop Protection Business Group, Elm Farm Development Station, Great Green, Bury St Edmunds, Suffolk IP31 3SJ (United Kingdom)) (1996) **Testing bait treatments for slug control.** *Slug and snail pests in agriculture. Proceedings of a Symposium, University of Kent, Canterbury, UK, 24-26 September 1996. p. 157-164.* British Crop Protection Council. 9 ref. English. (AGRIS 97-048828).

3028 Michels, GJ.; Elliott, NC.; Romero, RL.; French, WB. (1997) **ESTIMATING POPULATIONS OF APHIDOPHAGOUS COCCINELLIDAE (COLEOPTERA) IN WINTER WHEAT.** *Environmental Entomology. 26(1):4-11.* English. [TEXAS A&M UNIV AGR EXPT STN PO DRAWER 10 BUSHLAND, TX 79012 USA].

Coccinellids are important natural enemies of aphid pests in wheat, Triticum aestivum em Thell, in the Great Plains of the United States. Coccinellid community development in wheat fields is unpredictable; therefore, precise, efficient sampling methods for coccinellids are needed for use in integrated pest management research and decision making. Our objectives were to compare removal sampling with quadrat sampling for estimating population density of adult and larval coccinellids in winter wheat, and to determine if timed count sampling and sweepnet sampling were useful for estimating adult and larval coccinellid densities. Removal sampling accurately estimated population density for adults of most species but consistently underestimated larval density. Timed count samples and sweepnet samples were significantly correlated with absolute density of both lan al and adult coccinellids. Regression models were developed to convert estimates of relative to estimates of absolute population density. Depending on sampling method and life stage, models included the number of tillers per 0.3 m, wheat plant growth stage, plant height, and the number of aphids per tiller as variables; R(2) values ranged from 0.89 to 0.93. Sweepnet sampling was more precise per unit of effort than timed count, quadrat, or removal sampling for estimating adult coccinellid density. Removal sampling (remoting all coccinellids seen during 2 successive 15-min searches from each of 9 plots (25 m(2)) was the least efficient method. [References: 27].

3029 Mohaghegh Neyshabouri, J. (1993) **A report on Eurygaster testudinaria Geoffr. and some of its biological properties.** Tehran Univ., Karadj (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 16.* Persian. (AGRIS 97-034175).

3030 Montazeri, M.M. (1993) **Comparisons on the population density of two major predators: Chrysopa carnea (Chrysopidae) and Coccinella 7-punctata (Coccinellidae) in wheat fields of Gonbad-kavus and studies on their efficacy under laboratory conditions.** Shahid Chamran Univ., Ahwaz (Iran Islamic Republic). College of Agriculture. *Proceedings of the*

11th Plant Protection Congress of Iran 28 Aug.-2 Sep. 1993 Rasht (Iran Islamic Republic) p. 17. Persian. (AGRIS 97-048837).

3031 Noorbakhsh, S.H. (1993) **Population dynamics of brown wheat mite Petrobia latens (Muller) in western Chahar-Mahal and Bakhtiari, Iran.** Shahid Chamran Univ., Ahwaz (Iran Islamic Republic). College of Agriculture. *Proceedings of the Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 18.* Persian. (AGRIS 97-034176).

3032 Oroumchi, S. (1995) **Evaluation of the efficiency of neem seed kernel powder against the storage pest Trogoderma granarium Everts.** Plant Pests and Diseases Research Dept., Oroumieh (Iran Islamic Republic). *Proceedings of the 12th Iranian Plant Protection Congress 2-7 September 1995 Karadj (Iran Islamic Republic) p. 302.* Persian. (AGRIS 97-034135).

3033 Oudejans, R.C.H.M. (Utrecht University, Utrecht, The Netherlands.); Vroemen, S.F.; Jansen, R.F.R.; Horst, D.J. van der (1996) **Locust adipokinetic hormones: carrier-independent transport and differential inactivation at physiological concentrations during rest and flight.** *Proceedings of the National Academy of Sciences of the United States of America (USA) v. 93(16) p. 8654-8659.* references. English. (AGRIS 97-033909).

Since concomitant release of structurally related peptide hormones with apparently similar functions seems to be a general concept in endocrinology, we have studied the dynamics of the lifetime of the three known adipokinetic hormones (AKHs) of the migratory locust, which control flight-directed mobilization of carbohydrate and lipid from fat body stores. Although the structure of the first member of the AKHs has been known for 20 years, until now, reliable data on their inactivation and removal from the hemolymph are lacking, because measurement requires AKHs with high specific radioactivity. Employing tritiated AKHs with high specific radioactivity, obtained by catalytic reduction with tritium gas of the dehydroLeu2 analogues of the AKHs synthesized by the solid-phase procedure, studies with physiological doses of as low as 1.0 pmol per locust could be conducted. The AKHs appear to be transported in the hemolymph in their free forms and not associated with a carrier protein, despite their strong hydrophobicity. Application of AKHs in their free form in in vivo and in vitro studies therefore now teas been justified. We have studied the degradation of the three AKHs during rest and flight. The first cleavage step by an endopeptidase is crucial, since the resulting degradation products lack any adipokinetic activity. Half-lives for AKH-I, -II and -III were 51, 40, and 5 min, respectively, for rest conditions and 35, 37, and 3 min, respectively, during flight. The rapid and differential degradation of structurally related hormones leads to changes in the ratio in which they are released and therefore will have important consequences for concerted hormone action at the level of the target organ or organs, suggesting that each of the known AKHs may play its own biological role in the overall syndrome of insect flight.

3034 Powell, A.L.; Bowen, I.D. (School of Pure and Applied Biology, University of Wales Cardiff, PO Box 915, Cardiff, CF1 3TL (United Kingdom)) (1996) **The screening of naturally occurring compounds for use as seed treatments for the protection of winter wheat against slug damage.** *Slug and snail pests in agriculture. Proceedings of a Symposium, University of Kent, Canterbury, UK, 24-26 September 1996. p. 231-236.* British Crop Protection Council. 26 ref. English. (AGRIS 97-048940).

3035 Prokhorova, S.V. (1996) **[To the entomofauna of winter triticale in Belarus]. K ehntomofaune ozimogo tritikale v Belarusi.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 54-55.* BRIPP. Russian. (AGRIS 97-034356).

3036 Radjabi, Gh. (1994) **Analysis of Sunn pest periodic outbreaks in Iran.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Applied Entomology and Phytopathology Publication of Plant Pests and Diseases Research Institute (Iran Islamic Republic) v. 61(1-2) p. 1.* Persian. (AGRIS 97-034150).

3037 Rastergari Nobandegani, N. (1993) **A preliminary faunistic survey of wheat aphids in Shahr-e-Kord area.** Shahid Chamran Univ., Ahwaz (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 20.* Persian. (AGRIS 97-033769).

3038 Rezabeigi, M.; Heydari, M. (1993) **Injurius scarab beetles on wheat and barley in Kermanshah region.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 21.* Persian. (AGRIS 97-034178).

3039 Rich, J.R. (University of Florida, Quincy, FL.); Rahi, G.S. (1995) **Suppression of Meloidogyne javanica and M. incognita on tomato with ground seed of castor, Crotalaria, hairy indigo, and wheat.** *Nematropica (USA) v. 25(2) p. 159-164.* references. English. (AGRIS 97-033921).

3040 Sadeghee, M.; Kholdebarin, B. (1993) **Effects of Metasystox insecticide on potassium uptake in barley plant.** Shiraz Univ., Shiraz (Iran Islamic Republic). Faculty of Science Biology Dept. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 22.* Persian. (AGRIS 97-033715).

3041 Salamun, M. (Domava (Slovenia)); Milevoj, L. (Ljubljana Univ. (Slovenia). Biotechnical Fac., Agronomy Dept.) (1996) **[Distribution of the red cereal leaf beetle (Oulema melanopus L.) and the blue cereal leaf beetle (Oulema lichenis Voet) in wheat crops]. Razsirjenost rdecega zitnega strgaca (Oulema melanopus L.) in modrega zitnega strgaca (Oulema lichenis Voet) v posevkih psenice.** Simpozij Novi izzivi v poljedelstvu (Symposium on New Challenges in Field Crop Production). Radenci (Slovenia). 9-10 Dec 1996. *Proceedings of the Symposium on New Challenges in Field Crop Production. Sesek, P. (ed.). Zbornik Simpozija Novi izzivi v poljedelstvuNew Challenges in Field Crop Production (Slovenia). University of Ljubljana, Biotechnical Faculty, Ljubljana (Slovenia). Agronomy Dept. p. 273-277.* 1 table; 4 ill., 6 ref. Slovenian. (AGRIS 97-034072).

The presence of red cereal leaf beetle (Oulema melanopus L.) and the blue cereal leaf beetle (Oulema lichenis Voet) was studied on the winter wheat at Jable. The following cultivars were included in the experiment: Olga, Justus, Hubertus, Ikarus, Pinka, Marija, Demetra, Zitarka and Ana. Observations were performed once a decade from the first ten-day period in May to the third ten-day period in June 1995. Beetles, larvae and eggs were counted and the damage caused by beetles and larvae was assessed. The Olga cv. proved to be the most susceptible and the Justus, Hubertus and Ikarus cvs. the least susceptible to the cereal leaf beetle (Oulema spp.). The beetles and larvae caused damage on winter wheat from late April to the second ten-day period of June. The red cereal leaf beetle (Oulema melanopus L.) was more numerous than the blue cereal leaf beetle (Oulema lichenis Voet) (34:1).

3042 Samersov, V.F.; Novokshonova, V.G. (1996) **[Peculiarities of changes of dynamics of greenbugs and entomophags population in spring barley sowings at different levels of anthropogenic influence]. Osobennosti izmenenij dinamiki chislennosti zlakovykh tlej i ehntomofagov v posevakh yarovogo yachmenya pri razlichnom urovne antropogennogo vozdejstviya.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 57-58.* BRIPP. Russian. (AGRIS 97-033851).

3043 Shayesteh, N. (1993) **Degradation of Phenitrothion in wheat and milling fractions.** Urmia Univ., Urmia (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 23.* Persian. (AGRIS 97-033716).

3044 Song Shuyun; Shi Lei; Yang Shizhang (Jilin Provincial Academy of Agricultural Sciences, Gongzhuling (China). Inst. of Plant Protection) (1996) **Evaluation of the influence of triflumuron and triflumuron + fenvalerate on the natural enemies of wheat armyworm in wheat field.** *Jilin Agricultural Sciences (China) (no. 2) p. 65-69.* 7 tables; 2 ref. Chinese. (AGRIS 97-048954).

3045 Tanasijtshuk, V.N. (Russian Academy of Sciences, St. Petersburg, Russia.) (1996) **Two species of Leucopis Meigen (Diptera: Chamaemyiidae) predacious on the Russian wheat aphid, Diuraphis noxia (Mordvilko) (Homoptera: Aphididae), in North America.** *Entomological Society of Washington (USA) v. 98(4) p. 640-646.* references. English. (AGRIS 97-048755).

3046 Toth, F.; Kiss, J.; Toth, I.; Kozma, E. (Godolloi Agrartud. Egyet., Godollo (Hungary). Novenyvedelemtani Tanszek); Samu, F. (Magyar Tud. Akad., Budapest (Hungary). Novenyved. Kutatoint) (1996) **[Dominant spider species (Araneae) of winter wheat in pitfall trap catches]. Az oszi buza fontosabb pokfajai (Araneae) talajcsapdas gyujtesre alapozva (Elozetes kozlemeny).** *Novenyvedelem (Hungary) v. 32(5) p. 235-239.* Hungarian. (AGRIS 97-048960).

Spiders were collected by pitfall trapping in winter wheat from late April until harvest, early July in 1992 and during the whole growing period from early November of 1992 to early July of 1993 in North Hungary. Traps were placed in the field margin and in the field at different distances from the margin. Our preliminary report is based on catches of traps placed in the middle of the field. Total of 1237 individuals (50 species of 13 families) were caught. 95 of these individuals were adults. Most of these were wolf spiders (Lycosidae, 49, 8, 9 species), followed by money spiders (Linyphiidae, 34, 9, 14 species) and gnaphosids (Gnaphosidae, 4, 7, 10 species). Dominant species were the lycosid Pardosa agrestis (Westring) and the linyphiid Oedothorax apicutas (Blackwall). Some preliminary details on differences between the spider fauna of Hungarian and Western European winter wheat fields are discussed.

3047 Trdan, S. (Ljubljana (Slovenia)); Milevoj, L. (Ljubljana Univ. (Slovenia). Biotechnical Fac., Agronomy Dept.) (1996) **[The cereal aphid (Sitobion avenae F.) in wheat crops in 1995]. Velika zitna us (Sitobion avenae F.) v posevkih psenice v letu 1995.** Simpozij Novi izzivi v poljedelstvu (Symposium on New Challenges in Field Crop Production). Radenci (Slovenia). 9-10 Dec 1996. *Proceedings of the Symposium on New Challenges in Field Crop Production. Sesek, P. (ed.). Zbornik Simpozija Novi izzivi v poljedelstvuNew Challenges in Field Crop Production (Slovenia). University of Ljubljana, Biotechnical Faculty, Ljubljana (Slovenia). Agronomy Dept. p. 287-291.* 4 tables; 6 ref. Slovenian. (AGRIS 97-034279).

The cereal aphid (Sitobion avenae F.) was examined at three geographically ecological areas. At Jable the presence of the cereal aphid was observed in nine cvs. of winter wheat (Olga, Justus, Hubertus, Ikarus, Pinka, Marija, Demetra, Zitarka and Ana) and at locations in the vicinity of Ptuj and the village of Dolenja vas in cvs. Marija and Ana. Winged and non-winged aphids were counted from the first ten-day period of May to the third ten-day period of June 1995. The largest number of winged and non-winged cereal aphids (Sitobion avenae F.) was found in the earliest cv. Pinka at Jable. The smallest number was registered on the Ikarus, which belongs to the late cvs. The highest number of winged aphids was found in the third ten-day period of May (EC 41-60), and the highest number of non-winged aphids in the first ten-day period of June (EC 58-68). On average, there were more aphids on each plant at Jable than at the other two locations. The level of susceptibility to the cereal aphid (Sitobion avenae F.) proved to be approximately the same in the Marija and Ana cvs. Strong rainfall in the second decade of June reduced the population density of the pest.

3048 Tuubel, E. (Estonian Agricultural Univ., Tartu (Estonia). Inst. of Plant Protection) (1996) **Influence of molluscicides on arthropod predators on winter wheat agrocoenosis.** Estonian Agricultural Univ., Tartu (Estonia). *Limatsiidide moju roeoevluelijalgsetele talinisu agrotsoenoosis 61 p.* 1 table; 19 ill., 108 ref. Estonian. (AGRIS 97-034358).

The influence of molluscicides (Mesurol, Larbate) on the number of predators - Carabidae, Staphylinidae and Araneidae was investigated in winter wheat agrocoenosis in Southern Sweden. The indirect influence of molluscicide application on predators' populations was established. Different predator groups were affected differently. In the treated plots the number of Carabidae and Araneidae was two times smaller compared to untreated plots. Of Carabidae specimens 15 general were found. The most common were Agonum, Trechus and Bembidion. The two first groups occurred in smaller numbers in treated plots. The indirect influence of molluscicide Larbate compared to Mesurol was more harmful to predators.

3049 Wang Yunbing; Wang Lianquan; jin Derui (Henan Vocation Technical Teachers Coll., Xinxiang (China). Dept. of Plant Protection) (1995) **A study on the damage and economic threshold of wheat aphid.** *Journal of Henan Vocation-Technical Teachers College (China) v. 23(3) p. 37-43.* 4 tables; 5 ref. Chinese. (AGRIS 97-048958).

3050 Zhang, NY.; Jones, BL.; Tao, HP. (1997) **PURIFICATION AND CHARACTERIZATION OF A NEW CLASS OF INSECT ALPHA-AMYLASE INHIBITORS FROM BARLEY.** *Cereal Chemistry. 74(2):119-122.* English. [USDA ARS CEREAL CROPS RES UNIT 501 N WALNUT ST MADISON, WI 53705 USA].

Barley seeds contain proteins that apparently protect them against attack by microorganisms and insects. Studies of these barley defensive proteins may lead to the development of barleys with improved natural resistance to pests. We have purified two low molecular weight proteins, designated BI alpha 1 and BI alpha 2, from barley grain, using ion-exchange chromatography and reversed-phase and gel-permeation high-performance liquid chromatography (HPLC). Both BI alpha 1 and BI alpha 2 inhibited insect (yellow meal worm, Tenebrio molitor) alpha-amylase activities. For the T. molitor alpha-amylase, the IC50 values of BI alpha 1 and BI alpha 2 were 80 mu g/mL (12.5 mu M) and 34 mu g/mL (6.8 mu M), respectively. Neither protein inhibited either human salivary alpha-amylase, barley alpha-amylase, or trypsin activities. N-terminal amino acid sequences of the inhibitors were highly homologous with those of the plant proteins called defensins. The first 20 N-terminal amino acids of BI alpha 2 were identical to those of gamma-hordothionin, but neither BI alpha 1 nor BI alpha 2 protein showed any homology with the chloroform-methanol (CM) soluble protein amino acid consensus sequence. The two inhibitors therefore apparently comprise another group of low molecular weight barley proteins that inhibit the alpha-amylase activities of some insects that attack cereal grains. [References: 26].

H20 PLANT DISEASES

3051 **[Triticum cultivar with resistance to eye-spot]. [Koring] Kultivar met weerstand teen oogvlek** (1996) Landbouweekblad, Cape Town (South Africa). *Landbouweekblad (South Africa) (no.974) p. 20-21.* Afrikaans. (AGRIS 97-034991).

3052 Adams, M.J.; Overthrow, R.; Carver, M.F.F. (IACR Rothamsted, Harpenden, Hertfordshire AL5 2JQ (United Kingdom)) (1996) **Soil-borne mosaic viruses in winter barley: effects of variety and management on BaYMV and BaMMV expression.** *HGCA Project Report (United Kingdom); no. 123 30 p.* HGCA. 13 ref. English. (AGRIS 97-049255).

3053 Adamski, T.; Chelkowski, J.; Kaczmarek, Z.; Surma, M.; Wisniewska, H. (1997) **EVALUATION OF SUSCEPTIBILITY OF AUTO- AND ALLOPLASMIC BARLEY DH LINES TO FUSARIUM SEEDLING BLIGHT.** *Euphytica. 93(2):169-172.* English. [POLISH ACAD SCI INST PLANT GENET PL-60479 POZNAN POLAND].

Auto- and alloplasmic doubled haploid (DH) lines of barley were examined for susceptibility to Fusarium culmorum (W.G.Sm.) Sacc. (isolate KF350) seedling blight. Inoculated kernels were incubated at 20 degrees C in a chamber saturated to 100% RH a with 12/12 h dark/light cycle. Germination capacity, disease score on a 5-degree scale and root length were evaluated. The data were analysed statistically using three-factor analysis of variance. It was observed that the infection score of roots of DH Lines with H. bulbosum cytoplasm was higher than that of their autoplasmic analogues. Length of infected seedling roots expressed as per cent of the control root length ranged from 81 to 56% in autoplasmic DH lines and from 60 to 48% in alloplasmic lines. These differences were statistically significant (at P=0.01). It was evident, that H. bulbosum cytoplasm increase susceptibility of barley genotypes to Fusarium seedling blight. [References: 11].

3054 Androsova, V.M.; Sadkovskij, V.E. (1995) **[Dry-air heating of winter wheat seed infected with Fusarium head blight]. Sukhovozdushnaya teplovaya obrabotka semyan ozimoj pshenitsy, porazhennykh fuzariozom.** *Doklady RASKhN (Russian Federation) (no.1) p. 19-20.* 6 ref. Russian. (AGRIS 97-035001).

3055 Anon. (1996) **Karnal bunt disrupts wheat marketing.** *California agriculture (USA) v. 50(3) p. 4-5.* English. (AGRIS 97-034525).

3056 Apsite, A.; Berzins, A.; Toma, M.; Steinberga, V. (Latvian University of Agriculture, Jelgava (Latvia)); Viesturs, U. (Latvian State Institute of Wood Chemistry, Riga (Latvia)) (1995) **Influence cultivation conditions on Trichoderma viride LL-333 growth.** *Latvijas Zinatnu Akademijas Vestis. B. (Latvia) (no.9/10) p. 121-126.* 12 ill. English. (AGRIS 97-034638).

Trichodermine, a microbial fungicide obtained from Trichoderma viride LL-333 in geometrically dissimilar bioreactors, was investigated both at the production and application stages. The growth of the producer was considerably better in the counterflow mixing system (CFMS) in comparison with the turbine mixing system. The efficiency of the fungicide Trichodermine produced by CFMS proved to be slightly higher for barley and sugar beet production. The morphological changes of the strain were studied during batch fermentation at different mixing regimes. The characteristic morphology was closer to normal when using CFMS.

3057 Assadi, P.; Behroozin, M. (1993) **Evaluation of certain new fungicides to control common bunt in East Azarbaijan.** Agricultural Research Center of East Azarbaidjan, Tabriz (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 26.* Persian. (AGRIS 97-034855).

3058 Babadoost, M. (1993) **Evaluation importance of barley seed-borne diseases in East Azarbaijan.** Tabriz Univ., Tabriz (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 28.* Persian. (AGRIS 97-034857).

3059 Babadoost, M. (1993) **Incidence of Fusarium spp. in wheat seeds and plants in East Azarbaijan.** Tabriz Univ., Tabriz (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 27.* Persian. (AGRIS 97-034856).

3060 Babadoost, M. (1995) **Incidence of seed- borne fungal diseases of Barley in east Azarbaidjan and Ardebil province.** Tabriz Univ., Tabriz (Iran Islamic Republic). College of Agriculture. *Iranian Journal of Plant Pathology official Journal of the Iranian Phythopathological Society (Iran Islamic Republic) v. 31(1-4) p. 31.* Persian. (AGRIS 97-034820).

3061 Bai, G.H. (Texas Tech University, Lubbock.); Shaner, G. (1996) **Variation in Fusarium graminearum and cultivar resistance to wheat scab.** *Plant disease (USA) v. 8(9) p. 975-979.* references. English. (AGRIS 97-035022).

Understanding variation in pathogen virulence and cultivar resistance is important for development of effective strategies for breeding wheat cultivars resistant to scab. Six isolates of Fusarium graminearum from China and the United States were compared for variation in cultural characteristics and virulence on nine wheat cultivars with different degrees of resistance to scab. The isolates varied in their cultural characteristics and ability to cause scab, but there was no consistent specificity of cultivar resistance or pathogen virulence. Therefore, a mixture of local isolates is an appropriate inoculum to screen for scab resistance. Subculturing the fungus on potato dextrose agar for eight generations did not reduce virulence. In the greenhouse, eight cultivars were tested five times over 3 years by inoculating one central floret in a spike with an Indiana isolate of the fungus. Cultivars Ning 7840, Sumai 49, Fu 5114, and Sumai 3 were consistently resistant. The fungus spread from the inoculated spikelet to noninoculated spikelets of resistant cultivars in less than 20 of the plants, and spread was not evident until 12 days after inoculation. All plants of susceptible cultivar Clark showed spread of infection, and symptoms appeared on noninoculated spikelets by 8 days after inoculation. Sudden blight on the top part of the spike may be an important characteristic of highly susceptible cultivars. Measurement of spread of scab within a spike is a stable and reliable estimate of cultivar resistance.

3062 Bartos, P.; Hanusova, R.; Stuchlikova, E. (Vyzkumny Ustav Rostlinne Vyroby, Prague Ruzyne (Czech Republic)) (1996) **[Physiologic specialization of wheat leaf rust (Puccinia persistens var. triticina) in the Czech Republic in 1994-1995]. Fyziologicka specializace rzi psenicne (Puccinia persistens var. triticina) v Ceske republice v letech 1994-1995.** *Ochrana Rostlin - UZPI (Czech Republic) v. 32(3) p. 187-200.* 6 tables; 10 ref. Czech. (AGRIS 97-049451).

In 1994 35 single pustule isolates of leaf rust from 14 locations and in 1995 91 isolates from 49 locations were analyzed. The obtained results confirmed that the large majority of isolates was avirulent on Lr1, Lr2 and mostly also on Lr2b. All isolates were avirulant on Lr9, Lr19, Lr24 and Lr28, but virulent on Lr11, Lr16, Lr17, Lr21, Lr23 and Lr30 (except one isolate).

3063 Bbadoost, M. (1995) **Fusarium species in wheat seeds and plants in east Azarbaidjan and Ardebil Provinces.** Tabriz Univ., Tabriz (Iran Islamic Republic). College of Agriculture. *Iranian Journal of Plant Pathology official Journal of the Iranian Phytophathological Society(Iran Islamic Republic) v. 31(1-4) p. 33.* Persian. (AGRIS 97-034821).

3064 Behroozin, M.; Assadi, P. (1993) **Evaluation of four new fungicides to control barley stripe disease in East Azarbaijan.** Agricultural Research Center of East Azarbaidjan, Tabriz (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 29.* Persian. (AGRIS 97-034858).

3065 Bekesi, P.; Jakabne Kondor, M. (Orsz. Mezogazd. Min. Int., Budapest (Hungary)) (1996) **[The behaviour of winter wheat varieties towards some fusarium species]. Oszibuza-fajtak magatartasa nehany fuzariumfajjal szemben.** *Novenyvedelem (Hungary) v. 32(8) p. 401-405.* Hungarian. (AGRIS 97-049538).

The disease of ear fusariosis of winter wheat is of exceptional economic significance in Hungary. From the early 1970s until the end of 1980s the species Fusarium culmorum and Fusarium graminearum have been prevalent, later an increasing incidence of Fusarium poae was noticed in Hungary. The authors studied the susceptibilities of winter wheat varieties and cultivar candidates towards Fusarium culmorum, Fusarium graminearum and Fusarium poae in field experiments on small plots of 1 m2. The inoculation of varieties have been carried out in the earing stage of plants by using conidial suspensions of all the three Fusarium species that originated from infected seed samples. The Fusarium infection of wheat kernels was studied with the filter paper-freezing method recommended by the ISTA. Fusarium poae infected the varieties inoculated only to a negligible extent; the F. culmorum infection of cultivars varied between 5 and 34 percent, while the one of F. graminearum varied between 4 and 40 percent. The correlations between the infections by F. culmorum and F. graminearum were investigated as well, with the following results: in early varieties r= +0, 38, in medium early ones r= +0, 32 and in medium late varieties r= +0, 63. This indicated that a successful breeding against one of the pathogens may hopefully result in an increasing resistance against the other.

3066 Bivol, S.V. (Academy of Sciences of the Republic of Moldova, Kishinev (Republic of Moldova). Institute of Biological Protection of Plants) (1996) **[Protection of winter wheat from root rots by biological means]. Zashchita ozimoj pshenitsy ot komevykh gnilej biologicheskimi sredstvami.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 93.* BRIPP. Russian. (AGRIS 97-034999).

3067 Bonde, M.R. (USDA, ARS, Foreign Disease Weed Science Research, Ft. Detrick, Frederick, MD.); Peterson, G.L.; Fuentes Davila, G.; Aujla, S.S.; Nanda, G.S.; Phillips, J.G. (1996) **Comparison of the virulence of isolates of Tilletia indica, causal agent of karnal bunt of wheat, from India, Pakistan, and Mexico.** *Plant disease (USA) v. 8(9) p. 1071-1074.* references. English. (AGRIS 97-034645).

Four Tilletia indica teliospore field populations, two from Mexico and one each from India and Pakistan, were tested for virulence on five Karnal bunt-resistant cultivars, one moderately susceptible, and two Karnal bunt highly susceptible wheat cultivars. The five resistant cultivars represented the most Karnal bunt-resistant germ plasm in the breeding programs at the International Maize and Wheat Improvement Center (Centro Internacional de Mejoramiento de Maiz y Trigo [CIMMYT]), Mexico, and the Department of Plant Breeding, Punjab Agricultural University, Ludhiana, India. Plants at the boot stage were inoculated by injecting into the boot 1 ml of a water suspension containing 10, 000 allantoid sporidia per ml,

incubated in a mist chamber for 3 days, then maintained until maturity in a greenhouse. All inoculated and control wheat spikes were harvested individually, and percentages of T. indica-infected seeds were determined. In addition, infected seeds from 10 randomly selected infected spikes per treatment were examined to estimate the proportion of each infected seed converted to a sorus. On the most resistant wheat cultivar (HD-29), percentage of seeds infected varied from 10 to 30, depending on pathogen aggressiveness. On the most susceptible cultivar (Bacanora), infection varied from 55 to 84. Although there were differences in pathogen aggressiveness, there was no evidence of the existence of races among the field populations. Wheat cultivars resistant to the Mexican fungal populations also were resistant to those from Asia, and vice versa; there was a significant correlation (P less than or equal to 0.05) between percentage of seeds infected and extent of fungal colonization of infected seeds with all but one pathogen population when comparing resistant versus other wheat cultivars.

3068 Bonsall, RF.; Weller, DM.; Thomashow, LS. (1997) **QUANTIFICATION OF 2, 4-DIACETYLPHLOROGLUCINOL PRODUCED BY FLUORESCENT PSEUDOMONAS SPP. IN VITRO AND IN THE RHIZOSPHERE OF WHEAT.** *Applied & Environmental Microbiology. 63(3):951-955.* English. [WASHINGTON STATE UNIV USDA ARS ROOT DIS & BIOL CONTROL RES UNIT POB 646430 PULLMAN, WA 99164 USA].

The broad-spectrum antibiotic 2, 4-diacetylphloroglucinol (Phl) is a major determinant in the biological control of a wide range of plant diseases by fluorescent Pseudomonas spp, A protocol was developed to readily isolate and quantify Phl from broth and agar cultures and from the rhizosphere environment of plants, Extraction, vith ethyl acetate at an acidic pH was suitable for both in vitro and in situ sources of Phl, For soil samples, the addition of an initial extraction step with 80% acetone at an acidic pH was highly effective in eliminating polar organic soil components, such as humic and fulvic acids, which can interfere with Phl detection by high-performance liquid chromotography. The efficiency of Phl recovery from soil by a single extraction averaged 54.6%, and a second extraction added another 6.1%. These yields were substantially greater than those achieved by several standard protocols commonly used to extract polar phenolic compounds from soil, For the first time Phl was isolated from the rhizosphere environment in raw soil, Following application of Pseudomonas fluorescens Q2-87 and the Phl-overproducing strain Q2-87(pPHL5122) to the seeds of wheat, 2.1 and 2.4 mu g of Phl/g of root plus rhizosphere soil, respectively, were isolated from wheat grown in a Ritzville silt loam; 0.37 and 1.3 mu g of Phl/g of root plus rhizosphere soil, respectively, were isolated from wheat grown in a Shano silt loam, However, when the amount of Phl was calculated on the basis of cell density, Q2-87(pPHL5122) produced seven and six times more antibiotic than Q2-87 in Ritzville silt loam, and Shano silt loam, respectively. [References: 24].

3069 Brashier, M. (SDSU.) (1995) **Latest wheat scab report has both good news and bad news.** *South Dakota farm and home research (USA) v. 46(4) p. 2-3.* English. (AGRIS 97-049487).

3070 Buga, S.F. (1996) **[Phytopathological state of cereal plantings and its peculiarities in actual conditions of agricultural activities]. Fitopatologicheskoe sostoyanie posevov zernovykh kul'tur i ego osobennosti v sovremennykh usloviyakh vedeniya sel'skogo khozyajstva.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 5-6.* BRIPP. Russian. (AGRIS 97-034956).

3071 Cao Keqiang; Zhu Zhiyu; Wang Shuanma (Hubei Agricultural Univ., Baoding (China). Dept. of Plant Protection) (1995) **The establishment of a mid-term forecast model for leaf rust of wheat.** *Acta Phytophylacica Sinica (China) v. 22(1) p. 57-61.* 2 tables; 1 ill., 4 ref. Chinese. (AGRIS 97-049515).

3072 Carrillo, A.; Mendoza Zamora, Cecilio; Ponce Gonzalez, Francisco (1994) **[Chemical control of yellow rust of barley (Puccinia striiformis West) in the states of Hidalgo, Mexico and Tlaxcala]. Control quimico de la roya lineal amarilla de la cebada (Puccinia striiformis West) en los estado de Hidalgo, Mexico y Tlaxcala.** *Revista Chapingo. Serie Proteccion Vegetal (Mexico) v. 1(1) p. 11-14.* 8 ref.; 3 cuadros. Spanish. (AGRIS 97-049034).

Se evaluaron tres fungicidas, tebuconazol, propiconazol y tetraconazol, en tres estados de la Republica Mexicana para el control de la roya lineal amarilla de la cebada. En Chapingo, Mexico, los tres productores quimicos en sus diferentes dosis se comportaron estadisticamente iguales pero diferentes al testigo. En Apan, Hgo., los mejores tratamientos fueron el tebuconazol y el tetraconazol, ambos a 0.125 gr de i.a./ha- En la Union, Tlax., solamente el tebuconazol a 0.125 gr de i.a./ha aparece como el mejor tratamiento resultando muy superior al mas proximo que es el propiconazol a 0.125 gr de i.a./ha.

3073 Chen Yanglin; Zhang Shuxiang; Wan Anmin (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. of Plant Protection) (1995) **Studies on Diniconazole for controlling powdery mildew of wheat.** *Acta Phytophylacica Sinica (China) v. 22(1) p. 51-56.* 5 tables; 3 ref. Chinese. (AGRIS 97-049514).

3074 Clear, RM.; Patrick, SK.; Nowicki, T.; Gaba, D.; Edney, M.; Babb, JC. (1997) **THE EFFECT OF HULL REMOVAL AND PEARLING ON FUSARIUM SPECIES AND TRICHOTHECENES IN HULLESS BARLEY.** *Canadian Journal of Plant Science. 77(1):161-166.* English. [CANADIAN GRAIN COMMISS GRAIN RES LAB 1404-303 MAIN ST WINNIPEG MB CANADA].

Fourteen samples consisting of three cultivars of hulless barley (Hordeum vulgare L.), grown commercially in southern Manitoba in 1994, were examined for levels of Fusarium species and seven fusarium trichothecene mycotoxins: deoxynivalenol (DON), diacetoxyscirpenol, 15-acetyldeoxynivalenol (15ADON), fusarenone-X, HT-2 toxin, neosolaniol and T-2 toxin. Four fractions from each sample were analysed. These consisted of kernels with the hulls still attached, kernels whose hulls had been removed at harvest, kernels that had been dehulled in the laboratory using a deawner, and kernels that had been pearled in the laboratory to 60% of their original weight. A composite sample of the hulls, obtained from the laboratory dehulling, was also tested. Mycotoxins were determined by gas chromatography-mass spectrometry. DON and 15ADON were the only trichothecenes detected in this study. The greatest numbers of propagules of Fusarium spp, and the highest concentrations of DON and 15ADON were found in the hulls. The average concentrations of F. graminearum Schwabe and DON in barley were reduced: 90 and 49%, respectively, as a consequence of laboratory dehulling; 95 and 59%, respectively, as a result of dehulling during harvest; and 99 and 86%, respectively, as a result of pearling. Results suggest that growing hulless cultivars shows promise for management of mycotoxin problems associated with FHB. [References: 28].

3075 Clear, RM.; Patrick, SK.; Platford, RG.; Desjardins, M. (1996) **OCCURRENCE AND DISTRIBUTION OF FUSARIUM SPECIES IN BARLEY AND OAT SEED FROM MANITOBA IN 1993 AND 1994.** *Canadian Journal of Plant Pathology-Revue Canadienne de Phytopathologie. 18(4):409-414.* English. [CANADIAN GRAIN COMMISS GRAIN RES LAB WINNIPEG MB R3C 3G8 CANADA].

A total of 136 seed samples of barley and 30 samples of oat grown in Manitoba in 1993 and 1994 were analyzed for the level and species of Fusarium infecting the kernels. Fusarium graminearum was the most commonly isolated of 11 Fusarium spp. In barley it ranged in mean frequency from 2% seed infection in samples from the northwestern (NW) region of Manitoba to 71% in samples from the central region of Manitoba. Oat had lower average levels of F. graminearum, ranging from nondetectable in the NW to 38% in central Manitoba. Definitive, reliable symptoms of fusarium head blight infection in harvested barley and oat were often absent. Due to the high frequency of F. graminearum in many samples, and this pathogen's known ability to produce deoxynivalenol, testing for this mycotoxin in these commodities appears warranted. This is especially true for barley grown in the central, eastern, or interlake regions of Manitoba in years when fusarium head blight is severe and the grain is destined for malting or pig feed. [References: 17].

3076 Colbach, N. (Institut National de la Recherche Agronomique, Dijon (France). Centre de Dijon, Agronomie) (1996) **[Influence of soil tillage on foot and root diseases in wheat]. Travail du sol: incidence sur les**

maladies du pied et des racines du ble. *Perspectives Agricoles (France) (no 218) p. 91-85.* 5 ref. French. (AGRIS 97-034454).

Le cycle de developpement des deux agents pathogenes majeurs responsables du pietin echaudage (Gaeumannomyces graminis var. tritici) et du pietin verse (Pseudocersporella herpotrichoides) est suffisament connu pour qu'il soit possible d'etudier les effets majeurs du travail du sol sur ces maladies. En effet, une phase importante du cycle de ces champignons se deroule dans le sol et le travail du sol agit directement sur la localisation des residus de cultures susceptibles de disseminer ces maladies. Les essais montrent que le choix des operations de preparation du travail du sol en vue de limiter le developpement de ces maladies doit necessairement integrer la succession culturale et, en particulier, la presence d'une culture hote les annees precedentes. Mais de nombreux autres facteurs sont aussi a prendre en compte pour la gestion des maladies et l'optimisation de l'itineraire technique.

3077 Conner, RL.; Hwang, SF.; Stevens, RR. (1996) **FUSARIUM PROLIFERATUM - A NEW CAUSAL AGENT OF BLACK POINT IN WHEAT.** *Canadian Journal of Plant Pathology-Revue Canadienne de Phytopathologie. 18(4):419-423.* English. [AGR & AGRI FOOD CANADA RES CTR POB 3000 LETHBRIDGE AB T1J 4B1 CANADA].

Fusarium proliferatum was shown to cause black point symptoms on kernels of Pavon wheat (Triticum aestivum) from California. Inoculation of the soft white spring wheat cv. Fielder with F. proliferatum produced black point symptoms on the grain that could not be distinguished from those caused by other agents of this disease. Infection of wheat spikes with F. proliferatum reduced kernel number, but had an inconsistent effect on seed weight. Germination of black point kernels at 10 degrees C was significantly reduced, and mycelial growth impaired development of the seedlings that germinated. [References: 17].

3078 Dai Fuming; Zhou Shiming (Shanghai Academy of Agricultural Sciences, Shanghai (China). Inst. of Plant Protection) (1995) **Isolation and utilization of microorganisms strains to control wheat scab.** *Acta Phytophylacica Sinica (China) v. 22(2) p. 112-116.* 3 tables; 3 ref. Chinese. (AGRIS 97-049516).

3079 Dreiseitl, A. (Vyzkumny Ustav Zemedelsky, Kromeriz (Czech Republic)); Jurecka, D. (1996) **[Disease occurrence in spring barley in the Czech Republic in 1989-1995]. Vyskyt chorob jecmene jarniho v Ceske republice v letech 1989-1995.** *Ochrana Rostlin - UZPI (Czech Republic) v. 32(3) p. 221-229.* 1 graph, 4 tables; 12 ref. Czech. (AGRIS 97-049252).

Disease infection of some registered varieties was evaluated at the Central Institute for Agriculture Supervision and Testing. All the varieties possessed at least one of specific resistance genes to powdery mildew with different effectiveness, and most varieties also contained a specific resistance gene to leaf rust. Infection by powdery mildew (Erysiphe graminis f. sp. hordei), leaf rust (Puccinia hordei), leaf blotch or scald (Rhynchosporium secalis) and net blotch (Pyrenophora teres) was assessed. Heavy infections were observed in 64 of 185 trials. Among them, 35 trials showed high occurrence of only one disease (27 by powdery mildew and 8 by leaf rust), 25 trials showed heavy infection by two and four trials by three diseases.

3080 Dushnicky, LG.; Ballance, GM.; Sumner, MJ.; Macgregor, AW. (1996) **PENETRATION AND INFECTION OF SUSCEPTIBLE AND RESISTANT WHEAT CULTIVARS BY A NECROSIS TOXIN-PRODUCING ISOLATE OF PYRENOPHORA TRITICI-REPENTIS.** *Canadian Journal of Plant Pathology-Revue Canadienne de Phytopathologie. 18(4):392-402.* English. [CANADIAN GRAIN COMMISS GRAIN RES LAB 1404-303 MAIN ST WINNIPEG MB R3C 3G8 CANADA].

Light microscopy and scanning electron microscopy were used to follow the infection process of a necrosis toxin-producing isolate (86-124) of the tan spot pathogen Pyrenophora tritici-repentis on leaves of susceptible and resistant wheat cultivars. Conidia germinated to produce germ tubes that gave rise to appressoria above epidermal cells or over the stomatal complex on both susceptible and resistant leaves. Germ tubes appeared to be attracted to stomatal complexes. The fungus penetrated the host leaf by direct invasion of the epidermal cells below the appressorium. If penetration did not occur below an appressorium, the germ tube grew further along the leaf surface to produce a secondary appressorium. Successful penetration of epidermal cells occurred with the formation of an intracellular vesicle which produced one or more secondary intracellular hyphae. The intracellular hyphae penetrated the lower wall of the infected epidermal cell prior to invasion of the mesophyll tissue. Penetration prior to invasion of mesophyll tissue occurred in a similar manner on leaves of susceptible and resistant wheat plants. [References: 34].

3081 Elahinia, S.A. (1993) **Effect of Wheat resistance to puccinia striiformis on colony growth rate of pathogen at seedling and adult-plant stage.** Guilan Univ., Rasht (Iran Islamic Republic). Faculty of Agricultural Science. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 31.* Persian. (AGRIS 97-034860).

3082 Elahinia, S.A. (1993) **Measurement of Spore production for detecting of Wheat resistance to Puccinia Striiformis.** Guilan Univ., Rasht (Iran Islamic Republic). Faculty of Agricultural Science. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.-2 Sep. 1993 Rasht (Iran Islamic Republic) p. 30.* Persian. (AGRIS 97-034859).

3083 Engel, RE.; Bruckner, PL.; Mathre, DE.; Brumfield, SKZ. (1997) **A CHLORIDE-DEFICIENT LEAF SPOT SYNDROME OF WHEAT.** *Soil Science Society of America Journal. 61(1):176-184.* English. [MONTANA STATE UNIV DEPT PLANT SOIL & ENVIRONM SCI BOZEMAN, MT 59717 USA].

A leaf spot complex that results in tissue necrosis and whose origin is unknown frequently damages selected winter wheat (Triticum aestivum L.) cultivars in Montana and neighboring regions. This study was undertaken to determine leaf spot origin (physiologic or pathogenic), cultivar susceptibility, and response to Cl nutrition. Winter wheat studies at seven sites (1993-1995) compared cultivars (Redwin, Tiber, CDC Kestrel, Manning, Stephens, Sierra, and Promontory), propiconazole (1-[[2-(2, 4-dichlorophenyl)-4-propyl-1, 3-dioxolan-2-yl]methyl]-1H-1, 2, 4-tr azole) fungicide treatments, and multiple Cl fertilizer rates (0-90 kg ha(-1)). Chlorotic or necrotic lesions developed at all sites, but not all cultivars were affected similarly. CDC Kestrel was the most susceptible cultivar. Flag leaf spot severity (portion of tissue area affected) was as great as 40% in this cultivar. Redwin, Sierra, and Promontory were the next most susceptible cultivars, followed by Stephens and Manning. Tiber, a variant line row selection of Redwin, was leaf spot tolerant. Multiple propiconazole applications had no effect on leaf spot severity, and infectious organism(s) could not be isolated from symptomatic tissue. Thus, leaf spot origin was probably physiologic and not infectious. Chloride fertilization (11-22 kg ha (-1)) greatly suppressed or eliminated leaf spotting, and increased yield in one or more cultivars at six of seven sites (up to 998 kg ha(-1)). Physiologic leaf spot occurrence and severity in affected cultivars was linked to inadequate Cl nutrition, and a possible osmotic imbalance in leaf mesophyll cells. Damage was usually minor when whole-plant Cl at head emergence was greater than or equal to 1.0 g kg(-1). Leaf spot damage increased exponentially as plant Cl dropped below this concentration. The name Cl-deficient leaf spot syndrome is proposed to describe this phenomenon in wheat. [References: 19].

3084 Ershad, A.; Dalili, A. (1993) **Out-break of wheat scab in Mazandaran.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 33.* Persian. (AGRIS 97-034861).

3085 Feng Chengyu; Zhang Guangwang (Haian County Station of Plant Protection and Quarantine, Jiangsu (China)) (1995) **Climatological zonation of wheat scab distribution in Jiangsu Province [China].** *Acta Phytopathologica Sinica (China) v. 25(2) p. 111-115.* 1 table; 1 ill., 6 ref. Chinese. (AGRIS 97-049530).

3086 Fernandez, M.R. (Agriculture and Agri Food Canada, Swift Current, Saskatchewan.); Clarke, J.M.; DePauw, R.M. (1996) **Comparison of durum and common wheat cultivars for reaction to leaf spotting fungi in the field.** *Plant disease (USA) v. 80(7) p. 793-797.* references. English. (AGRIS 97-034954).

Durum (Triticum turgidum var. durum) and common (T. aestivum) wheat cultivars (Canada Western Red Spring, Canada Prairie Spring, and Canada Western Soft White Spring), grown at two locations for 3 years, were assessed for severity of the leaf spot complex and relative proportion of leaf spotting fungi. The most prevalent fungi isolated were Pyrenophora tritici-repentis and Phaeosphaeria nodorum. Their percent isolation and leaf spot severity varied among years and between locations. The relative prevalence of the leaf spotting fungi in the individual cultivars, or cultivars

grouped by species, varied with year, whereas the leaf spot score varied with location. Cultivars and species differed in susceptibility to the leaf spotting fungi. The common wheat classes were mostly colonized by P. nodorum and the durum wheat by P. tritici-repentis Cultivars, but not cultivars grouped by species, also differed in the severity of the leaf spot complex. Within both durum and common wheat there were cultivars with low and high leaf spot scores.

3087 Foroutan, A. (1993) **Evaluation of selected wheat lines and cultivars from ICARDA'S rust nursery in Mazandaran.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 35.* Persian. (AGRIS 97-034863).

3088 Foroutan, A. (1993) **Preliminary screening of wheat lines and cultivars to Fusarium diseases in Mazandaran.** Agricultural Research Center of Mazandaran, Sari (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 34.* Persian. (AGRIS 97-034862).

3089 Getaneh Woldeab (IAR, Addis Abeba (Ethiopia)); Bekele Hunde; Yitbarek Semeane; Dereje Tadese (1996) **Barley disease management research.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 116-122.* IAR/ICARDA. 5 tables; 15 ref. English. (AGRIS 97-049254).

Different planting dates aimed at reducing the severity of scald and effect of seed sources on the incidence of barley stripe and loose smut were studied. Seed dressing fungicides such as Vitavax 200 WP, Thiram 25/BHC25, Vincit, Baytan universal and Prelude universal effectively reduced seed borne diseases, while Tilt 250 EC, Sportak sigma and Sportak 45 percent EC controlled foliar diseases. From disease screening trials on local and exotic barley germplasm/lines several lines were found resistant to scald.

3090 Ginkel, M. van (International Maize and Wheat Improvement Center, Mexico.); Schaar, W. van der; Zhuping, Y.; Rajaram, S. (1996) **Inheritance of resistance to scab in two wheat cultivars from Brazil and China.** *Plant disease (USA) v. 80(8) p. 863-867.* references. English. (AGRIS 97-034522).

One of the major diseases that reduces the quality of wheat is scab. Quality is reduced by the production of toxins in grain by the pathogen Fusarium graminearum. Various genetic sources of resistance have been identified, but the degree of resistance in most cultivars is insufficient. Although both South American and Chinese germ plasm are being used in breeding programs around the world, it is not known whether the resistance genes contributed by these sources are different. The purpose of this study was to determine the mode of inheritance and number of genes involved in the scab resistance of a wheat cultivar from Brazil and one from China, both known to possess intermediate to high resistance in regard to spread of the disease in the wheat head. The resistant Brazilian cultivar Frontana was compared to the highly resistant Chinese cultivar Ning 7840 in crosses with CNO79, a highly susceptible Mexican wheat, as the susceptible parent. Random F2-derived F7 lines from the six crosses possible (including reciprocals) among the parents were studied for their field response following inoculation with F. graminearum on two inoculation dates. Three methods of disease assessment were compared. The two resistant parents were shown to possess two unique dominant genes each, with all four genes being different. Combining their resistance genes may produce higher levels of resistance. The two inoculation dates provided the same gene postulations. The three disease assessment methods essentially measured the same basic process of disease spread within the head, based on the calculation of the genotypic correlations between the methods and the similarity in gene postulations. The easiest and most relevant method should therefore suffice for assessing the spread of scab through the wheat head.

3091 Glazek, M. (Institute of Plant Protection, Sosnicowice (Poland)) (1996) **[Effect of nitrogen fertilizers and chemical means of plant protection on the diseases of winter wheat in Poland]. Vliyanie azotnykh udobrenij i khimicheskikh sredstv zashchity rastenij na bolezni ozimoj pshenitsy v Pol'she.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 19.* BRIPP. Russian. (AGRIS 97-034997).

3092 Golzar, H. (1993) **Barley brown leaf spot-study on importance, distribution of species and its transmission in the Gorgan area.** Agricultural Research Center of Gorgan and Gonbad, Gorgan (Iran Islamic Republic). *Iranian Journal of Plant Pathology official Journal of the Iranian Phytopathological Society (Iran Islamic Republic) v. 29(1-2) p. 37.* Persian. (AGRIS 97-034830).

3093 Golzar, H. (1993) **Distribution of Fusarium head blight in Gorgan and Gonbad areas and response of commercial wheat cultivars to disease.** Agricultural Research Center, Gorgan (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 36.* Persian. (AGRIS 97-034864).

3094 Golzar, H.; Forotan, A.; Torabi, M. (1994) **Occurrence of take-all disease of Wheat in Gorgan and Mazandaran.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Applied Entomology and Phytopathology Publication of Plant Pests and Diseases Research Institute (Iran Islamic Republic) v. 61(1-2) p. 11.* Persian. (AGRIS 97-034823).

3095 Gonzalez, HHL.; Pacin, A.; Resnik, SL.; Martinez, EJ. (1996) **DEOXYNIVALENOL AND CONTAMINANT MYCOFLORA IN FRESHLY HARVESTED ARGENTINIAN WHEAT IN 1993.** *Mycopathologia. 135(2):129-134.* English. [UNIV BUENOS AIRES DEPT IND FAC CIENCIAS EXACTAS & NAT CIUDAD UNIV RA-1428 BUENOS AIRES DF ARGENTINA].

A mycological survey was carried out on wheat heads from the main production area of Argentina. The isolation frequency and relative density of species from genus Fusarium and dematiaceous fungi were calculated. F graminearum was the predominant Fusarium species; similar to that observed in the USA and Canada. An analysis of deoxynivalenol (DON) natural contamination also was performed on a limited number (44) of samples. DON contamination levels in positive samples ranged from 0.2 to 30 ppm. A stepwise regression procedure showed that, among the species analysed, F: graminearum relative density was related to the DON contamination level and that other prevalent fungi did not influence or modify that relationship. [References: 24].

3096 Goulart, A.C.P.; Paiva, F. de A.; Melo Filho, G.A. de; Richetti, A. (1996) **[Effect of timing and number of applications of the fungicides tebuconazole and mancozeb on the control of wheat blast disease (Pyricularia grisea) - economical and technical viability]. Efeito da epoca e do numero de aplicacoes dos fungicidas tebuconazole e mancozebe no controle da brusone (Pyricularia grisea) do trigo - viabilidade tecnica e economica.** *Fitopatologia Brasileira (Brazil) v. 21(3) p. 381-387.* 6 tables; 19 ref. Portuguese. (AGRIS 97-034996).

3097 Guo Mei (Heilongjiang Provincial Academy of Agricultural Sciences, Harbin (China). Inst. of Plant Protection) (1996) **A study on the effect of wheat kernel smudge on seedling growth.** *Heilongjiang Agricultural Sciences (China) (no. 4) p. 20-21.* 2 tables. Chinese. (AGRIS 97-049513).

3098 Harder, DE.; Dunsmore, KM.; Wilson, RG.; Salmeron, JJ. (1996) **STEM RUSTS ON WHEAT AND BARLEY IN CANADA, AND ON OAT IN CANADA AND MEXICO IN 1994.** *Canadian Journal of Plant Pathology-Revue Canadienne de Phytopathologie. 18(4):379-383.* English. [AGR & AGRI FOOD CANADA CEREAL RES CTR 195 DAFOE RD WINNIPEG MB R3T 2M9 CANADA].

In 1994, stem rusts of wheat and barley [Puccinia graminis f. sp; tritici] and of oat [P. graminis f. sp. avenae] were light in eastern Canada, and in western Canada were confined mainly to the Red River Valley of Manitoba. Maximum infections of 10% and 5%, respectively, that developed in lines of susceptible wheat in nurseries and in commercial barley fields in Manitoba were too low to cause significant damage. Infections of wild oat did not exceed 10% and were confined to Manitoba. In collections made from wheat in Canada, race QFCQ was the most common (43.1%), followed by races QCCG (40.3%), QCCJ (8.3%), QFCS (4.2%), TPMK (2.8%), and RKQQ (1.4%). From cultivated barley, race QCCG was the most common (77.6%), followed by QFCQ (12.3%), QCCJ (8.8%), and RKQQ (1.8%). Of all collections from wild barley, 68.9% were

P. g. secalis. All isolates of P. g. tritici collected from wheat, cultivated barley, and wild barley in Manitoba were virulent to genes Sr5, Sr21, Sr9g, Sr9d. All isolates were avirulent to genes Sr9e, Sr11, SrTmp, Sr13, Sr22, Sr24, Sr25, Sr26, Sr27, Sr29, Sr30, Sr31, Sr32, Sr33, Sr37, and Sr40; to the lines Mida-McMurachy-Exchange, Frontana-K58-Newthatch, CI8154/Frocor, Alpha 16, BW197, RL6076, RL6088, RL6172; to the cultivars Kenya Farmer, Agatha, Glenlea, Katepwa, Leader, Roblin, AC Taber, Grandin, and AC Domain; and to the durum cultivars AC Plenty, AC Melita, and Sceptre. Oat stem rust did not cause significant losses in Canada or Mexico in 1994. In Manitoba, race NA27 of P. g. avenae was the most common (58.3%), followed by race NA29 (39.5%), NA23 (1.6%), and NA68 (0.5%). In Mexico, race NA27 also was the most common (58.1%), followed by NA29 (40.3%) and NA30 (1.6%). [References: 16].

3099 Hare, MC.; Parry, DW. (1996) **OBSERVATIONS ON THE MAINTENANCE AND MEASUREMENT OF SOIL WATER IN SIMPLE POT EXPERIMENTS AND ITS EFFECTS ON SEED-BORNE FUSARIUM CULMORUM SEEDLING BLIGHT OF WINTER WHEAT.** *Annals of Applied Biology. 129(2):227-235.* English. [HARPER ADAMS AGR COLL CROP & ENVIRONM RES CTR NEWPORT TF10 8NB SHROPS ENGLAND].

A simple method for maintaining and measuring soil water and the relationship between soil water and seed-borne Fusarium culmorum seedling blight of wheat was investigated under controlled environmental conditions to develop reproducible assay conditions for epidemiological studies and the testing of fungicide seed treatments. For reproducibility, soil matric potential (Psi(m)) was used to define soil water, and a range of watering regimes were tested. Treatments were watered to either a maximum Psi(m) or to maintain a mean Psi(m) in order to establish which parameter best described the effect that soil water had on the incidence of disease symptoms. The severity of disease symptoms was closely related to the mean soil water status and not the maximum Psi(m) value. Watering intervals, ranging from three times a day to once every three days, did not affect this relationship. The percentage of seedlings showing symptoms after emergence (i.e. localised or extensive necrotic lesions) was inversely related to the mean Psi(m). With increasing soil dryness (mean Psi(m) from -0.14 MPa to -0.17 MPa) the percentage of seedlings with post-emergence symptoms decreased from 50% to 20%. However, as the mean Psi(m) changed from -0.14 MPa to -0.17 MPa the percentage of seedlings dying before emergence increased from 25% to 55% in direct proportion to Psi(m). Overall the incidence of infection as indicated by the total number of seedlings showing symptoms either before or after emergence remained relatively constant, and was not significantly related to mean Psi(m). [References: 18].

3100 Hause, B.; Kogel, KH.; Parthier, B.; Wasternack, C. (1997) **IN BARLEY LEAF CELLS, JASMONATES DO NOT ACT AS A SIGNAL DURING COMPATIBLE OR INCOMPATIBLE INTERACTIONS WITH THE POWDERY MILDEW FUNGUS (ERYSIPHE GRAMINIS F SP HORDEI).** *Journal of Plant Physiology. 150(1-2):127-132.* English. [INST PLANT BIOCHEM POB 110432 D-06018 HALLE GERMANY].

We have studied a possible function of jasmonates as mediators in the host-pathogen interaction of barley (Hordeum vulgare L.) with the powdery mildew fungus Egh (Erysiphe graminis f. sp. hordei). Previous findings from whole-leaf extracts demonstrated that (i) extracts from infected barley leaves did not contain enhanced levels of jasmonates, (ii) transcripts of jasmonate-inducible genes were not expressed upon infection, and (iii) exogenous application of jasmonates did not induce resistance to Egh (Kogel et al., 1995). Nevertheless, the question arises whether or not jasmonates are involved in the interaction of barley with the powdery mildew fungus at the local site of infection. Using an immunocytological approach the analysis of leaf cross-sections from a susceptible barley cultivar and its near-isogenic mlo(5)-resistant line revealed no accumulation of JIP-23, the most abundant jasmonate inducible protein, neither in epidermal cells attacked by the pathogen nor in adjacent mesophyll cells. As a positive control, cross-sections from methyl jasmonate-treated leaf segments showed a strong signal for JIP-23 accumulation. Because the presence of the jasmonate-inducible protein is highly indicative for an already low threshold level of endogenous jasmonate (Lehmann et al., 1995), the lack of JIP-23 accumulation at the sites of attempted fungal infection clearly demonstrates the absence of enhanced levels of jasmonates. This excludes even a local rise of jasmonate confined to those single cells penetrated (Mlo genotype) or attacked (mlo(5) genotype) by the fungus. [References: 29].

3101 Hole, D. (The Utah Agricultural Experiment Station.); Takemoto, J. (1995) **Promising biocontrol of wheat disease.** *Utah science (USA) v. 56(2) p. 6-7.* English. (AGRIS 97-034716).

3102 Irizar Garza, Martha Blanca Guadalupe; Cadena Hinojosa, Mateo A.; Ortega Delgado, Maria Luisa (1993) **[Effect of barley stripe mosaic virus in electrophoretic patterns of hordein]. Efecto del virus mosaico estriado de la cebada en patrones electroforeticos de hordeinas.** *Agrociencia (Mexico). Serie Proteccion Vegetal v. 4(3) p. 383-389.* 6 grafs., 7 ref. Spanish. (AGRIS 97-049071).

The Esperanza and Centinela varieties were, inoculated with BSMV. Hordein content was not affected by virus infection nevertheless total protein content was slightly increased. Changes in the electrophoretic patterns were observed in BSMV infected seeds. New bands were present or disapeared in the middle part of the pattern. The changes in the electrophoretic patterns of BSMV infected seed is a problem in the identification of barley varieties with this method. Se utilizaron las variedades de cebada Esperanza y Centinela, inoculadas con el virus. El contenido de hordeinas no se vio afectado por la presencia del virus; el porcentaje total de proteinas mostro un ligero incremento en las plantas infectadas en ambas variedades. Los patrones electroforeticos de las hordeinas observaron cambios cuando estas eran extraidas de semillas infectadas por el virus. La aparicion o desaparicion de bandas ocurrio en la zona intermedia del patron. Los cambios en los patrones electroforeticos de las hordeinas de semillas infectadas por VMEC son una limitante para la identificacion de las variedades de cebada por este metodo.

3103 Jevtic, R. (Institut za ratarstvo i povrtarstvo, Novi Sad (Yugoslavia)); Milosevic, M.; Pribakovic, M.; Draganic, M. (1996) **[The effect of fungicides used for seed treatment on diseases development and yield of some wheat varieties]. Uticaj fungicida za tretiranje semena na pojavu bolesti i prinos nekih sorti psenice.** *Zastita bilja (Yugoslavia) v. 47(1) p. 51-55.* 3 tables; 9 ref. Serbian. (AGRIS 97-049510).

The results of a two year investigation period of studying the effect of fungicides for seed treatment on diseases development and yield of five winter wheat varieties (Balkan, Jugoslavija, Rana niska, Zvezda, and Francuska) are presented. For seed disinfection the following fungicides were used: Benit universal, Vitavax 200 FF, Prelude SP and Baytan universal. The varieties Rana niska and Francuska achieved significantly higher yields than varieties Balkan and Jugoslavija at the level of significance of 5. However, at the level of significance 1 statistically approved differences between yield in 1991 and 1992, at the levels of significance of 5 and 1, respectively. In both years of investigation a very weak attack of parasites Erysiphe graminis tritici, Puccinia recondita and Fusarium spp. occured. A high correlation coefficient between years and hectolitre mass (r=0.97) was found.

3104 Jia Tingxiang; Liu Chuande; Wu Guiben (Yantai Inst. of Agricultural Sciences, Shandong (China)) (1995) **Studies on the pathogen of Fusarium root rot in wheat and its biology.** *Acta Phytophylacica Sinica (China) v. 22(3) p. 259-264.* 5 ref. Chinese. (AGRIS 97-049520).

3105 Karadzhova, J. (Institut za Zashchita na Rasteniyata, Kostinbrod (Bulgaria)) (1996) **[Fusarium sp. on barley]. Vidove Fusarium po echemika.** Institut za Zashchita na Rasteniyata, Kostinbrod (Bulgaria). Natsionalna Sluzhba za Rastitelna Zashchita, Karantina i Agrokhimiya k"m Ministerstvoto na Zemedelieto i Khranitelnata Promishlenost. *Rastitelna Zashchita (Bulgaria). Plant Protection v. 37(4) p. 18-19.* 1 table. Bulgarian. (AGRIS 97-034633).

3106 Lagerberg, C. (Swedish Univ. of Agricultural Sciences, Alnarp (Sweden). Dept. of Plant Protection Sciences) (1996) **Comparison of polyclonal ELISA with the seed-blotter, fluorescence and agar plate methods for detection and quantification of seed-borne Septoria nodorum in wheat.** Proceedings of the International Seed Testing Association. *Seed Science and Technology (Switzerland); v. 24(3) p. 585-588. International Seed Testing Association's Secretariat, Reckenholz (Switzerland).* International Seed Testing Association. 1 table, 1 graph, 6 ref. English. (AGRIS 97-049507).

Twelve naturally infected seed lots of winter wheat were analysed using the ELISA, seed blotter, fluorescence and agar plate methods to detect and quantify Septoria nodorum infection. Four replicates of 80 seeds per seed lot were tested withing each method.

3107 Latorre, I.; Darcy, CJ.; Domier, LL. (1996) **ULTRASONIC PURIFICATION OF TWO ILLINOIS ISOLATES OF BARLEY YELLOW DWARF VIRUSES.** *Canadian Journal of Plant Pathology-Revue Canadienne de Phytopathologie. 18(4):424-428.* English. [UNIV ILLINOIS DEPT CROP SCI URBANA, IL 61801 USA].

Ultrasonic disruption was used to purify two Illinois strains of barley yellow dwarf viruses (BYDV-RMV-IL and BYDV-PAV-IL). The relative efficiencies of ultrasonic disruption and repeated blending were compared in the purification of BYDV-RMV-IL. Ultrasonic disruption, repeated blending, and treatment with an industrial grade macerating enzyme (Extractase P20X) were compared in the purification of BYDV-PAV-IL. Sonication and repeated blending produced comparable yields of BYDV-RMV-IL. Use of sonication during extraction of BYDV-PAV-IL yielded an average of 1.5-fold more virus than did repeated blending. Yields from sonicated tissue were half of those obtained with Extractase P20X, but virus preparations were more pure, as determined by A(260)/A(280) ratios, and could be used directly as immunogens. Moreover, BYDV-PAV-IL could be purified one day faster by ultrasonic disruption than by enzyme extraction. [References: 11].

3108 Lavier, B. (Ecole Superieure d'Agriculture d'Angers (France)); Maumene, C. (1996) **[To manage frequent wheat crop. Cereal diseases: ten questions-answers about cereal take-all]. Gerer un assolement frequent de ble. Maladies des cereales: dix questions-reponses sur le pietin echaudage.** *Perspectives Agricoles (France) (no 216) p. 84-86.* French. (AGRIS 97-034435).

3109 LI Jinyu; Liu Xili (Beijing Agricultural Univ. (China). Inst. of Plant Preplanting and postharvest Technology) (1995) **Effects of seed coating formulation No. 17 on the development of Puccinia striiformis in host wheat.** *Acta Phytophylacica Sinica (China) v. 22(2) p. 176-180.* 4 tables; 5 ref. Chinese. (AGRIS 97-049517).

3110 Linhares, A.I.; Luz, W.C. da (1996) **[Occurrence of Drechslera tritici-repentis on wheat seeds in the state of Mato Grosso do Sul, Brazil]. Ocorrencia de Drechslera tritici-repentis em sementes de trigo no Mato Grosso do Sul.** *Fitopatologia Brasileira (Brazil) v. 21(1) p. 126.* Portuguese. (AGRIS 97-034992).

3111 Liu Qinchun (Shandong Academy of Agricultural Sciences, Jinan (China). Inst. of Plant Protection) (1995) **Distinguishing of wheat leaf rust races and analysis of toxic genes.** *Journal of Shandong Agricultural Sciences (China) (no. 4) p. 35-38.* 4 tables; 6 ref. Chinese. (AGRIS 97-049525).

3112 Lo, C.T. (Taiwan Agricultural Research Institute, Taiwan, Republic of China.); Nelson, E.B.; Harman, G.E. (1996) **Biological control of turfgrass diseases with a rhizosphere competent strain of Trichoderma harzianum.** *Plant disease (USA) v. 80(7) p. 736-741.* references. English. (AGRIS 97-034486).

Trichoderma harzianum strain 1295-22 is a commercially available biocontrol agent that is strongly rhizosphere competent and able to control several plant pathogenic fungi. Two formulations were tested for their ability to control brown patch caused by Rhizoctonia solani, dollar spot caused by Sclerotinia homoeocarpa, and Pythium root rot and blight caused by Pythium graminicola. In growth chamber trials, soils planted with creeping bentgrass were amended with the granular formulation to give 10(6) cfu/g. All three diseases were significantly reduced by this treatment. Populations of Pythium spp. were suppressed under laboratory conditions by strain 1295-22. In field trials conducted over 4 years, strain 1295-22 reduced dollar spot severity relative to untreated plots. Monthly applications of granular or peat-based formulations of T. harzianum 1295-22 reduced initial disease severity by as much as 71 and delayed disease development by up to 30 days. The persistence of strain 1295-22 in soil core samples from treated creeping bentgrass greens was also measured. After application of strain 1295-22, soil populations of Trichoderma spp. increased 100-fold relative to populations in untreated plots. Population levels remained at least an order of magnitude greater in treated than in untreated plots. Even after overwintering, population levels remained at or above 10(5) cfu/g of dry weight of the sample.

3113 Louw, J.P.J.; Crous, P.W.; Holz, G. (Stellenbosch Univ. (South Africa). Dept. of Plant Pathology) (1996) **Relative importance of the barley net blotch pathogens Pyrenophora teres f. teres (net-type) and P. teres f. maculata (spot-type) in South Africa.** *African Plant Protection (South Africa) v. 2(2) p. 89-95.* 2 tables; 1 fig., 36 ref. English. (AGRIS 97-049250).

3114 Lupej, A.Yu.; Voluevich, E.A. (Academy of Sciences of Belarus, Minsk (Belarus). Institute of Genetics and Cytology) (1996) **[Possibilities of introgression of strange cytoplasmic and nuclear genetical material for increasing the resistance of wheat to the septoriosis]. Vozmozhnosti introgressii chuzherodnogo tsitoplazmaticheskogo i yadernogo geneticheskogo materiala dlya povysheniya ustojchivosti pshenitsy k septoriozu.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 140-142.* BRIPP. Russian. (AGRIS 97-049511).

3115 Lyngkjaer, M.F. (Risoe National Lab., Roskilde (Denmark)) (1995) **Infection of barley by Erysiphe graminis: effect of Mlo-virulence and Mlo-resistance [E. graminis, including 3 manuscripts].** Kongelige Veterinaer- og Landbohoejskole, Copenhagen (Denmark). KVL. 104 ref. 87 p. English. (AGRIS 97-034637).

3116 Maes, M.; Garbeva, P.; Virgula, A.; Crepel, C. (Rijksstation voor Plantenziekten, Merelbeke (Belgium)) (1994) **Direct detection of bacterial phytopathogens in plant extracts.** 46th International Symposium on Crop Protection. Gent (Belgium). 3 May 1994. *Mededelingen - Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen Universiteit Gent (Belgium) v. 59(3b) p. 1193-1200.* 2 tables; 11 ref. English. (AGRIS 97-049506).

For the detection of the quarantine bacterial phytopathogens Xanthomonas campestris translucens and Erwinia amylovora, target specific rDNA oligonucleotide sequences were used as primers in PCR. The Xanthomonas campestris translucens primers recognized the phytobacteria belonging to the Xanthomonas translucens complex, producing a single 156 bp PCR fragment. The Erwinia amylovora primers were only complementary to the bacteria from the Erwinia amylovora species, initiating the amplification of a single 565 bp fragment in PCR. In both systems, taxonomically related or commonly present phytobacteria did not produce a PCR fragment and less than 4000 cfu target bacteria per n-d pure culture dilution were detected. Xanthomonas translucens infection was diagnosed in extracts of imported (Idaho, USA) wheat and barley seed. PCR mediated pathogen diagnosis was hindered when seeds were treated with fungicides. Erwinia amylovora bacteria could be detected when added to the epiphytical bacterial population present on the leafs, flowers and early fruit formations of pear. For Erwinia amylovora detection inside the shoots and branches of host plants, a PVPP treatment of the extract was required to eliminate PCR blocking agents.

3117 Mamluk, O.F. (International Center for Agricultural Research in the Dry Areas, Aleppo (Syria). Cereal Improvement Program) (1993) **Seed-borne diseases of wheat and barley.** Workshop on Quarantine for Seed in the Near East. Aleppo (Syria). 2-9 Nov 1991. Quarantine for seed. Proceedings. Mathur, S.B. (ed.); Manandhar, H.K. (ed.). *FAO Plant Production and Protection Paper (FAO); no. 119 p. 40-47. FAO, Rome (Italy). Plant Production and Protection Div.* FAO. English. (AGRIS 97-049508).

3118 Maumene, C. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Results 1996 of fungicides on cereal crops in France]. Fongicides: Bilan de la campagne 1996 France; cereales.** *Perspectives Agricoles (France) (no 219) p. 44-63.* 10 illus., 17 tableaux, 18 graph. French. (AGRIS 97-049030).

3119 McKirdy, S.J. (Agriculture Western Australia, South Perth, Australia.); Jones, R.A.C. (1996) **Use of imidacloprid and newer generation synthetic pyrethroids to control the spread of barley yellow dwarf luteovirus in cereals.** *Plant disease (USA) v. 80(8) p. 895-901.* references. English. (AGRIS 97-035035).

In seven field experiments with wheat and oats sown in autumn, insecticides were applied to control aphids and thereby diminish the spread of aphid-transmitted barley yellow dwarf luteovirus (BYDV). Disease progress was followed over time by enzyme-linked immunosorbent assay (ELISA) on leaf samples using antiserum specific to

BYDV serotype PAV. Two foliar applications of either of two newer generation synthetic pyrethroid insecticides, alpha-cypermethrin or beta-cyfluthrin, sprayed before flag leaf emergence and at rates as low as 12.5 g a.i./ha, decreased spread of BYDV by up to 75 and increased grain yields by up to 41. These pyrethroids were more effective in decreasing BYDV spread than foliar applications of pirimicarb (150 g a.i./ha) or dimethoate (320 g a.i./ha), two applications of which decreased BYDV spread by up to 45 and increased grain yield by up to 14. Seed treatment with imidacloprid (70 g a.i./ha) delayed BYDV spread in wheat and oats for up to 6 weeks after plant emergence. When imidacloprid seed dressing was followed by two foliar sprays of alpha-cypermethrin, BYDV incidence was decreased by up to 88, and grain yield was increased by up to 76. The predominant colonizing aphid species was Rhopalosiphum padi. Dressing seed with imidacloprid and/or foliar applications of the synthetic pyrethroids markedly decreased the numbers of aphids. Numbers colonizing plants were mostly lower than 10 per tiller on nontreated plots, suggesting the grain yield increases resulting from insecticide application were due to control of BYDV rather than to decreased aphid feeding damage. To minimize BYDV-induced grain yield losses in autumn-sown cereals, protection by insecticides should be provided from soon after plant emergence until the twelfth week of plant growth.

3120 Mckirdy, SJ.; Jones, RAC. (1997) **EFFECT OF SOWING TIME ON BARLEY YELLOW DWARF VIRUS INFECTION IN WHEAT - VIRUS INCIDENCE AND GRAIN YIELD LOSSES.** *Australian Journal of Agricultural Research. 48(2):199-206.* English. [WESTERN AUSTRALIA DEPT AGR PLANT PATHOL GRP BARON HAY COURT S PERTH WA 6151 AUSTRALIA].

In 4 field experiments at 2 sites in Western Australia, wheat was sown at different times in autumn and early winter. Within each sowing, incidence of barley yellow dwarf luteovirus (BYDV) was monitored by ELISA tests on leaf samples, using antiserum specific to BYDV serotype PAV. Delaying sowing decreased BYDV incidence in all 4 experiments. At the higher rainfall site, decreased BYDV incidence due to delayed sowing was associated with increased grain yield and size, and in 1 experiment also with a decrease in the proportion of shrivelled grain. In contrast, at the lower rainfall site, grain yield penalties derived from late sowing negated the yield increases associated with decreased BYDV levels. When imidacloprid seed-dressing followed by foliar sprays of alpha-cypermethrin were applied to control aphids at the lower rainfall site, within each sowing BYDV incidence and the proportion of shrivelled grain decreased and grain yield and size increased. Applications of pirimicarb at the higher rainfall site also decreased BYDV incidence and the proportion of shrivelled grain within each sowing, and grain yield and size were increased. In all experiments, the only, or predominant, colonising aphid species was Rhopalosiphum padi. At flag leaf emergence, delayed sowing decreased the number of aphids on plants. In high BYDV risk zones, when an appropriate insecticide is not applied to control aphid vectors in autumn-sown wheat, delaying sowing may be advisable to minimise BYDV-induced grain yield losses. However, the yield benefits from decreased BYDV infection need to be balanced against possible yield penalties due to late sowing. [References: 33].

3121 Milus, E.A. (University of Arkansas, Fayetteville.); Duveiller, E.; Kirkpatrick, T.L.; Chalkley, D.B. (1996) **Relationships between disease reactions under controlled conditions and severity of wheat bacterial streak in the field.** *Plant disease (USA) v. 80(7) p. 726-730.* references. English. (AGRIS 97-035003).

Bacterial streak of wheat is best controlled by resistant cultivars, but there are difficulties associated with screening for resistance under field conditions. Screening for resistance under controlled conditions could facilitate the development of resistant cultivars if there is a good relationship between disease reaction and disease severity. The objective of this study was to determine the relationships between bacterial streak reactions on primary leaves of seedlings or flag leaves of adult plants and bacterial streak severity on adult plants in the field. Fifty spring wheats and 24 winter wheats were evaluated. Except for spring wheat cultivar reactions on primary leaves, reactions (ranks) of greenhouse-grown cultivars were significantly and positively related (r ranged from 0.60 to 0.64 with P less than or equal to 0.0012) to ranks of cultivars evaluated for bacterial streak severity. However, selection for low percentages of water-soaking under controlled conditions would keep a few wheats that were susceptible in the field and discard several wheats that were resistant in the field. Because of these discrepancies we cannot recommend inoculation under controlled conditions as a reliable means of screening a random sample of wheats for bacterial streak resistance.

3122 Minarcic, P. (Slovenska Akademia Vied, Ivanka pri Dunaji (Slovakia). Ustav Experimentalnej Fytopatologie a Entomologie); Janitor, A. (1995) **Halo formation in epidermal cells of barley after powdery mildew (Erysiphe graminis DC.) infection.** *Biologia (Slovakia). Sect. Botany v. 50(1) p. 73-78.* 6 ill.; 15 ref. English. (AGRIS 97-034641).

Formation of haloes, their location and structure in the epidermal cell wall in barley cvs. of different susceptibility to powdery mildew, were studied by SEM, freeze etching and cytological methods. Results confirmed that differentiation of a halo occurs when the tip of the infection peg has enzymatically breached the cuticular layer of the epidermis. Haloes were formed in compatible cv. earlier (4-6 h after inoculation). The tip of the penetrating infection peg breaches the colored complex in the middle part of the halo and so enables gradual formation of a halo, with a ring-shaped circle at its periphery. On the basis of results, predictions are made about host-parasite relations at the epidermal cell level.

3123 Moeini, M.R.; Bamdadian, A. (1993) **Distribution of stripe and leaf rust in Zanjan dryland farming.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of the 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 38.* Persian. (AGRIS 97-034865).

3124 Mozhaeva, K.A.; Kastal'eva, T.B.; Vasil'eva, T.Ya. (VNIIF, Bol'shie Vyazemy (Russian Federation)) (1996) **[Detection of barley yellow dwarf virus in various regions of Russia using the immunoferment analysis]. Vyyavlenie virusa zheltoj karlikovosti yachmenya v razlichnykh regionakh Rossii s ispol'zovaniem immunofermentnogo analiza.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 48-50.* BRIPP. Russian. (AGRIS 97-034635).

3125 Nazari, K. (Seed and Plant improvement Institute, Karadj (Iran Islamic Republic)); Mamluk, O.F.; El Naimi, M. (The International Center for Agricultural Research in Dry Areas (ICARDA), Aleppo (Syria)) (1995) **Virulence investigations and race identification of wheat yellow rust (Puccinia striiformis f. sp. tritici) in Tel Hadya- Syria.** *Proceedings of the 12 th Iranian Plant Protection Congress 2-7 September 1995 Karadj (Iran Islamic Republic) p. 62.* Persian. (AGRIS 97-034743).

The objectives of this study were: 1) virulence investigation and 2) race identification of wheat yellow rust samples from wheat fields at Center's Principle Station, Tel Hadya. Yellow rust differential varieties were used. Two samples were collected over the cropping seasons 119/93 to 1993/94. Mass of vacuumed spores was used for virulence investigations in 1992/93 and four single spore cultures were used for race identification in 1993/94. After rehydration of vacuumed spores the first seedling leaves of susceptible cultivar were inoculated for resporulation of the fungus. Spores which were normally viable were inoculated to first seedling leaf of differential varieties. The inoculated plants were kept in 10C, 90 R. H. and in complete darkness for 48h in growth chamber and then were placed on greenhouse benches at 15C.

3126 Nazari, K.; Ershad, D. (1993) **Infection status dryland wheat fields by loose and covered smuts in Lorestan province.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug., 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 39.* Persian. (AGRIS 97-034579).

3127 Nejat Salari, A.; Ershad, D. (1993) **Isolation of six Fusarium species from barley-seeds in Iran.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 40.* Persian. (AGRIS 97-034866).

3128 Nielsen, P.; Sorensen, J. (1997) **MULTI-TARGET AND MEDIUM-INDEPENDENT FUNGAL ANTAGONISM BY HYDROLYTIC ENZYMES IN PAENIBACILLUS POLYMYXA AND BACILLUS**

PUMILUS STRAINS FROM BARLEY RHIZOSPHERE. *FEMS Microbiology Ecology. 22(3):183-192.* English. [ROYAL VET & AGR UNIV DEPT ECOL & MOL BIOL SECT GENET & MICROBIOL THORVALDSENSVEJ 40 DK-1871 FREDERIKSBERG C DENMARK].

Glucanolytic bacteria from barley rhizosphere soil were isolated by a procedure selecting for isolates with P-glucosidase activity. Almost all isolates were fast-growing, Gram-positive rods. Sixteen out of 100 isolates showed in vitro fungal antagonism against widely different plant-pathogenic microfungi (Aphanomyces cochleoides, Pythium ultimum and Rhizoctonia solani). The 16 isolates shared a characteristic profile of cell-wall-degrading enzymes, comprising glucanolytic (cellulase, mannanase and xylanase) and proteolytic enzymes. This enzyme profile was not observed in any of the non-antagonistic isolates and may thus be useful in selection protocols for fungal antagonists producing fungal cell-wall-degrading enzymes. The antagonistic isolates were identified as Paenibacillus (Bacillus) polymyxa (2 strains) and Bacillus pumilus (13 strains), Bacillus sp. (1 strain). Both P. polymyxa isolates and a subgroup of 4 B. pumilus isolates showed a medium-independent antagonism as tested against A. cochleoides in four different media. This was apparently related to constitutive production of cell-wall-degrading enzymes (P. polymyxa) or induction of a repertoire of enzymes substituting for each other in different media (B. pumilus). Despite different strategies of enzyme production in the media, both the P. polymyxa and B. pumilus strains demonstrate a multi-target and medium-independent type of fungal antagonism, which is promising for application in biological control. [References: 22].

3129 Paveley, ND.; Lockley, KD.; Sylvesterbradley, R.; Thomas, J. (1997) DETERMINANTS OF FUNGICIDE SPRAY DECISIONS FOR WHEAT. *Pesticide Science. 49(4):379-388.* English. [ADAS HIGH MOWTHORPE MALTON YO17 8BP N YORKSHIRE ENGLAND].

Yield responses to the application of foliar fungicides to wheat are highly variable. As the cost of treatment is known, some method of estimating future yield response is required if treatments are to be applied only when the value of the yield benefit will exceed the cost. Treatment decisions are often supported by disease thresholds, either formalised or developed by crop managers through practical experience. In farm practice, the proportion of yield that is due to fungicide treatment is not usually known, so the success of a spray decision is often judged by the level of disease later in the season. This paper presents data from field experiments in 1994 and 1995, showing that variation in the current level of visible disease (yellow rust and Septoria tritici) explains little of the variation in future effects of the disease on the host, and that the yield effect of a unit disease is not constant across sites and seasons. These findings suggest that traditional disease thresholds may be unreliable predictors of the need to spray and that estimating the success of a treatment decision by observing disease levels later in the season is prone to error. A 'negative threshold', defined as that level of disease below which an economically damaging epidemic cannot develop within a known time-period, may be more reliable. Below the negative threshold, treatment is not required. Above the negative threshold, other factors affecting the rate of epidemic development and sensitivity of the host to green leaf area loss need to be considered, in order to quantify the need for treatment. Measurements which reflect the crop's ability to intercept solar radiation may prove more reliable tools than percentage disease for judging the success of treatment decisions and, experimentally, for quantifying the effect of variation in risk determinants. [References: 31].

3130 Perkowski, J.; Kiecana, I.; Schumacher, U.; Muller, HM.; Chelkowski, J.; Golinski, P. (1997) HEAD INFECTION AND ACCUMULATION OF FUSARIUM TOXINS IN KERNELS OF 12 BARLEY GENOTYPES INOCULATED WITH FUSARIUM GRAMINEARUM ISOLATES OF TWO CHEMOTYPES. *European Journal of Plant Pathology. 103(1):85-90.* English. [ACAD AGR POZNAN DEPT CHEM UL WOJSKA POLSKIEGO 75 PL-60625 POZNAN POLAND].

Twelve barley genotypes were inoculated with two F. graminearum isolates of different chemotype I-1 #148 (producing nivalenol/deoxynivalenol) and I-2 #108 (deoxynivalenol/acetyldeoxynivalenol). For both I-1 and I-2 isolates, respectively, reductions (%) in number of kernels head(-1) 10.6 and 14.3; yield 39.6 and 35.7; weight of 1000 kernels 36.9 and 23.2 were observed in inoculated plants from control values. Chemical analysis revealed the presence (average concentration mg kg(-1)) of deoxynivalenol(1.3) and nivalenol (3.2) in kernels of all genotypes inoculated with the I-1 isolate, and zearalenone (0.2) in three samples. After inoculation with the I-2 isolate, deoxynivalenol (37.8) and zearalenone (0.4) were found in kernels of all genotypes, while 3-acetyldeoxynivalenol and 15-acetyldeoxynivalenol, respectively were determined in five and four samples only. No significant correlation between examined characteristics was found for either the I-1 or I-2 isolate. The results obtained contribute information on the accumulation of toxins in cereal grain inoculated with F. graminearum isolates of different chemotypes. [References: 29].

3131 Perondi, N.L.; Luz, W.C. da; Thomas, R. (1996) [Microbiological control of wheat scab]. Controle microbiologico da giberela do trigo. *Fitopatologia Brasileira (Brazil) v. 21(3) p. 243-249.* 26 ref. Portuguese. (AGRIS 97-034993).

3132 Picinini, E.C.; Fernandes, J.M.C.; Ignaczak, J.C.; Ambrosi, I. (1996) [Economic impact due to propiconazole use on wheat]. Impacto economico do uso do fungicida propiconazole na cultura de trigo. *Fitopatologia Brasileira (Brazil) v. 21(3) p. 362-368.* 14 ref. Portuguese. (AGRIS 97-034994).

3133 Poliksenova, V.D.; Piskun, S.G.; Anokhina, V.S.; Timoshenko, M.K.; Kunitskaya, M.P.; Nitievskaya, V.I. (Belarus State University, Minsk (Belarus)) (1996) [Diversity of species and polymorphism of agents of lupine and tomato fusariosis in connection with development of method of assessment of plants in terms of disease resistance]. Vidovoe raznoobrazie i polimorfizm vozbuditelej fuzarioza lyupina i tomata v svyazi s razrabotkoj metoda otsenki rastenij na bolezneustojchivost'. Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 52-54.* BRIPP. Russian. (AGRIS 97-034958).

3134 Pourmansouri, T.; Bamdadian, A. (1993) Evaluation of some advanced lines and cultivars of barley to Helminthosporium. Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 42.* Persian. (AGRIS 97-034868).

3135 Pourmansouri, T.; Bamdadian, A. (1993) Reaction of 43 lines of bread and durum wheat to Tilletia foetida in Karaj. Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 41.* Persian. (AGRIS 97-034867).

3136 Praslicka, J. (Vysoka Skola Polnohospodarska, Nitra (Slovakia)) (1996) [Effect of some factors on the infection of winter wheat by wheat dwarf virus (WDV)]. Vplyv niektorych faktorov na napadnutie psenice ozimnej virusovou zakrpatenostou psenice (WDV). *Ochrana Rostlin - UZPI (Czech Republic) v. 32(3) p. 181-186.* 2 tables; 12 ref. Slovak. (AGRIS 97-049536).

During 1991 to 1993 the differences in the infection of winter wheat by wheat dwarf virus (WDV) were evaluated. To determine whether an yield reduction was related to infection, the trials were conducted at two different sowing dates and with four varieties of winter wheat. The rate of infection and yield reduction were highly correlated with time of sowing. After the first date of sowing the average infection rate was 8.6 and the average yield 4.5 t/ha, while after the second sowing date the average infection rate was 4.5 and the average yield 5.6 t/ha.

3137 Praslicka, J. (1997) INFLUENCE OF OCCURRENCE OF PSAMMOTETTIX ALIENUS ON THE DEGREE OF ATTACK OF WINTER WHEAT WITH WHEAT DWARF VIRUS (WDV) [Slovak]. *Rostlinna Vyroba. 43(2):81-85.* Slovak. [UNIV AGR A HLINKU 2 NITRA 94976 SLOVAKIA].

In occurrence of Psammotettix alienus some differences among experimental years as well as among the sowing dates (Tab. I) were recorded. In all experimental years an occurrence of Psammotettix alienus was higher at the first sowing date as compared to the second one. The highest occurrence was recorded at the first sowing date in autumn of 1990 (50.7 cicadas) and in autumn 1992 (66.3 cicadas) within experimental plots

which were harvested in 1991 and/or 1993, respectively. The greatest differences in the occurrence of Psammotettix alienus in autumn season between the first and the second sowing dates were recorded within experimental plots which were also harvested in 1991 (24.7 cicadas) and 1993 (22.3 cicadas). When evaluated a degree of attack of winter wheat with the wheat dwarf virus, the differences among experimental years, varieties and sowing dates as well (Tab. II) were evident. The highest degree of attack of winter wheat with wheat dwarf virus was recorded at the first sowing date in 1991 (9.4%) and in 1993 (9.0%). When compared the results of the occurrence of Psammotettix alienus (Tab. I) and the attack of winter wheat with wheat dwarf virus (Tab. II), a certain relation is evident. The attack of winter wheat with wheat dwarf virus corresponded with the occurrence of Psammotettix alienus. The attack degree of winter wheat with wheat dwarf virus in relation to the occurrence of Psammotettix alienus was characterized by the values of regression coefficient (by = 0.101X); This relation was also confirmed by the calculated significant correlation coefficient (R = 0.51). Winter wheat variety Hana was the most attacked variety (6.4 to 17.2%) whilst the variety Blava was attacked least (1.5 to 8.6%). [References: 13].

3138 Proft, M. de; Mahaut, T.; Steyer, S. (Centre de Recherches Agronomiques de l'Etat, Gembloux (Belgium)) (1996) **[Yellow dwarf virus disease: consequences of an exceptional autumn [in Belgium in 1995]]. Jaunisse nanisante: les consequences d'un automne exceptionnel.** *Parasitica (Belgium) v. 52(1) p. 5-7.* French. (AGRIS 97-034634).

3139 Rabie, CJ.; Lubben, A.; Marais, GJ.; Vanvuuren, HJ. (1997) **ENUMERATION OF FUNGI IN BARLEY.** *International Journal of Food Microbiology. 35(2):117-127.* English. [CSIR POB 395 ZA-0001 PRETORIA SOUTH AFRICA].

Estimation of fungal contamination of barley grain is important as certain fungi can proliferate during the malting process. The following factors which may affect the enumeration of fungi were evaluated: dilution versus direct plating, presoaked versus unsoaked grain, five culture media: potato dextrose agar (PDA), acidified Czapek-Dox agar (ACA), pentachloronitrobenzene agar; (PCNB) dichloran rose bengal chloramphenicol agar (DRBC) and malt salt agar; two disinfectants' ethanol/water (80:20 v/v) and sodium hypochlorite (3.5% w/v in H2O). Two barley samples, one having a high incidence of storage fungi and one with a high incidence of field fungi were used and most fungi were identified to species level. Results showed that direct plating was superior to dilution plating for assessing the mycoflora of barley. Unsoaked grain gave significantly higher counts than presoaked grain in the case of Alternaria alternata, Rhizopus oryzae, Epicoccum nigrum and Mucor spp. Presoaked grain resulted in higher counts of Penicillium spp. Chlorine disinfection resulted in significantly higher counts of Aspergillus flavus, Eurotium spp. and Penicillium spp. Ethanol disinfection resulted in higher counts of Mucor spp., Phoma sorghina, Rhizopus oryzae and Aspergillus restrictus. PDA and ACA, in general gave some what better results than DRBC for both field and storage fungi. PCNB consistently gave the highest Fusarium counts. More than thirty fungal genera were found in the two samples. (C) 1997 Elsevier Science B.V. [References: 24].

3140 Rahimian, H. (1993) **Characteristic of the bacterium inciting gummy spike in Fars province.** Mazandaran Univ., Sari (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 43.* Persian. (AGRIS 97-034869).

3141 Reis, E.M.; Casa, R.T.; Forcelini, C.A. (1996) **[Relationship between severity and incidence of wheat leaf rust caused by Puccinia recondita f. sp. tritici]. Relacao entre a severidade e a incidencia da ferrugem da folha do trigo, causada por Puccinia recondita F. sp. Tritici.** *Fitopatologia Brasileira (Brazil) v. 21(3) p. 369-372.* 12 ref. Portuguese. (AGRIS 97-034995).

3142 Resnais, A.; Grigale, D. (Latvian State Plant Protection Centre (Latvia)) (1996) **[The most wide-spread diseases of winter grain crops]. Izplatitakas ziemaju slimibas.** *Latvijas Lauksaimnieks (Latvia) (no.12) p. 7-10.* Latvian. (AGRIS 97-049466).

The work of phytopathologists in ensuring normal phytosanitary conditions and successful disease control in grain crops is explained. The most wide-spread diseases observed in winter grain crops in Latvia during the year 1996 are described. The distribution of the diseases in different regions of Latvia, their harmful effect as well as their symptoms and diagnostics methods are discussed.

3143 Riede, C.R. (Instituto Agronomico do Parana, Londrina PR, Brazil.); Francl, L.J.; Anderson, J.A.; Jordahl, J.G.; Meinhardt, S.W. (1996) **Additional sources of resistance to tan spot of wheat.** *Crop science (USA) v. 36(3) p. 771-777.* references. English. (AGRIS 97-035005).

Tan spot, a foliar disease of wheat (Triticum aestivum L. em Thell) and durum (T. turgidum var. durum L.) caused by Pyrenophora tritici-repentis (Died.) Drechs., reduces yield in susceptible cultivars by 3 to 50. Additional sources for resistance to tan spot were sought in germplasm consisting of a collection of spring wheats previously screened for reaction to spot blotch [Cochliobolus sativus Ito and Kurib.) Drech. ex Dastur] in Brazil, wheat cultivars recommended for cultivation in the state of Parana, Brazil, and a collection of synthetic hexaploid wheat. Plants from each of the three groups were inoculated at the seedling stage with a composite of four fungal isolates and at the adult stage with one of the four isolates. A subset of germplasm was treated at the seedling stage with necrosis toxin, crude extract, and conidia produced by P. tritici-repentis isolate 86-124. Adult disease reactions did not always agree with seedling evaluations and some of the variation could be explained by sensitivity or a mixed reaction to necrosis toxin. Assay with purified necrosis toxin was a reliable way to detect a major factor involved in resistance. This work identifies diverse germplasm available for incorporation of tan spot resistance into cultivated wheats.

3144 Rodriguez Contreras, E.; Leyva Mir, S. Gerardo; Villasenor M, E. (1994) **[Incidence of fusarium head scab (Fusarium graminearum Schw.) on wheat (Triticum aestivum L.) and its chemical control in Juchitepec, Mexico]. Incidencia de rona de la espiga (Fusarium graminearum Schw.) en trigo (Triticum aestivum L.) y su combate quimico en Juchitepec, Mexico.** *Revista Chapingo. Serie Proteccion Vegetal (Mexico) v. 1(1) p. 15-18.* 11 ref.; 2 cuadros. Spanish. (AGRIS 97-049035).

Se aislo al hongo Fusarium graminearum Schw. De semillas con sintomas de rona de la espiga provenientes de Juchitepec, Mex., en donde se determino que la incidencia de la enfermedad fue de 54 a 70 en espigas de la variedad Salamanca. Posteriormente se probaron ocho fungicidas aplicandolos a la semilla en las variedades Salamanca S-75 y Temporalera M-87 para bajar la incidencia de la enfermedad, resultando los mejores productos el propiconazol, carbendazim y procloraz que disminuyeron la incidencia en un 100 en ambas variedades.

3145 Seguin, B. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Seed dressing sheets: barley net blotch]. Fiches traitement de semences: l'helminthosporiose de l'orge.** *Perspectives Agricoles (France) (no 218) p. 21-22.* French. (AGRIS 97-034452).

3146 Seguin, B. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[Smut of wheat and barley [Ustilago tritici, Ustilago nuda]]. Le charbon nu du ble et de l'orge [Ustilago tritici, Ustilago nuda].** *Perspectives Agricoles (France) (no 214) p. 4-5.* French. (AGRIS 97-034434).

3147 Shang Hongsheng; Zhang Hui; Li Zhenqi (Northwestern Agricultural Univ., Yangling, Shaanxi (China). Dept. of Plant Protection) (1995) **The effect of stripe rust infection on the synthesis of RNA and rRNA in wheat primary leaves.** *Acta Phytopathologica Sinica (China) v. 25(3) p. 215-220.* 3 tables; 9 ref. Chinese. (AGRIS 97-049532).

3148 Sharifi Tehrani, A. (1993) **A study susceptibicity of some barley cultivars to the fungus Ustilago hordei the agent of covered smut disease.** Tehran Univ., Tehran (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 45.* Persian. (AGRIS 97-034871).

3149 Sharifi Tehrani, M.; Okhovat, M. (1993) **Evaluation of some fungicides on Ustilago hordei.** Tehran Univ., Tehran (Iran Islamic Republic). College of Agriculture. *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 44.* Persian. (AGRIS 97-034870).

3150 Sheng Baoxin (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. of Plant Protection) (1995) **The study on the host range of**

wheat powdery mildew in the Northern China. *Scientia Agricultura Sinica (China) v. 28(6) p. 52-57.* 3 tables; 3 ref. Chinese. (AGRIS 97-049523).

3151 Simon, M.R.; Perello, A.E.; Cordo, C.A.; Arriaga, H.O. (1996) **[Influence of Septoria tritici Rob ex Desm. late infection on kernel weight and some quality parameters in wheat]. Influencia de la infeccion tardia de Septoria tritici Rob ex Desm. sobre el peso de mil granos y algunos parametros de calidad en Triticum aestivum L.** *Investigacion Agraria. Produccion y Proteccion Vegetales (Espana) v. 11(1) p. 161-171.* 6 tab.; 20 ref. Spanish. (AGRIS 97-049010).

3152 Smiley, R.W. (Oregon State University, Pendleton.); Patterson, L.M. (1996) **Pathogenic fungi associated with Fusarium foot rot of winter wheat in the semiarid Pacific Northwest.** *Plant disease (USA) v. 80(8) p. 944-949.* references. English. (AGRIS 97-034715).

Winter wheat plants and soil were collected from 288 nonirrigated fields in the semiarid Pacific Northwest during 1993 and 1994. Fungi associated with 5, 390 crown and subcrown internodes from 10 Oregon and nine Washington counties were identified. Fusarium graminearum Group 1 was most widespread and the dominant pathogen associated with a crown and root rot named Fusarium foot rot or dryland root rot. F. culmorum was widely distributed in soil but was detected in plants in only half as many locations as F. graminearum. Other pathogens included Bipolaris sorokiniana Microdochium nivale and F. avenaceum. Highly variable isolation frequencies for all five pathogens were presumed related to a very dry and a very wet survey year. Each pathogen was considered dominant or co-dominant at one or more sites during one or more years. All five species and F. acuminatum and F. oxysporum included isolates capable of killing wheat seedlings in the greenhouse.

3153 Stover, R.W. (North Dakota State University, Res. Cent., Langdon, ND.); Francl, L.J.; Jordahl, J.G. (1996) **Tillage and fungicide management of foliar diseases in a spring wheat monoculture.** *Journal of production agriculture (USA) v. 9(2) p. 261-265.* references. English. (AGRIS 97-049313).

Enthusiasm over conservation tillage in wheat (Triticum aestivum L.) monoculture has been tempered by concern about the carryover of foliar diseases on the surface residue. A 3-yr study evaluated the effects of foliar diseases on wheat production with different methods of primary tillage and with fungicide control treatments. Plots with chisel plowing (2x) as the primary tillage had higher surface residue and higher foliar severity in the early growth stages compared with moldboard plowing or with moldboard plowing preceded by burning. Early season differences in severity between moldboard plowing treatments with and without burning were mostly insignificant. The effect of chisel plowing on early season foliar disease did not consistently carry over to late season foliar ratings. In 1991, chisel plowing resulted in the highest late-season foliar disease as indicated by the area under disease progress curve (AUDPC). In 1992, there was no significant difference in AUDPC between tillage treatments, and in 1993, chisel plowed plots had the lowest AUDPC. In this study, yields were not significantly affected by any tillage-related foliar disease effect. Foliar fungicides consistently reduced foliar severity, but in all 3 yr, the fungicide treatments were not economical at 1991-1993 market prices.

3154 Sykora, M.; Krippel, E. (Komensky Univ., Bratislava (Slovakia). Katedra Genetiky) (1995) **Virulence genes frequency in barley powdery mildew population (Erysiphe graminis, f. sp. hordei) in Slovakia and neighbouring countries in 1993.** *Biologia (Slovakia). Sect. Botany v. 50(4) p. 427-430.* 1 table, 1 ill.; 10 ref. English. (AGRIS 97-034639).

In all observed regions a uniform presence of virulence genes Ml-a sub(6), Ml-a sub(12) and Ml-k resistance genes were found. However, among the other genes significant differences according to regions were found. It is supposed that differences are caused by different barley varieties in the different regions. In the Slovak pathogen population there are isolates with virulence genes which have at present no direct host variety. Their presence can be caused by migration of pathogen conidia from other regions and association with other virulence genes in complex pathotypes. A high frequency of virulence genes was found against Ml-a sub(6), Ml-a sub(7), Ml-a sub(12) and Ml-k and in Austria also Ml-g resistance genes. In Slovakia and the Czech Republic virulence is the highest against Ml-a sub(13) resistance gene. In Hungary there is considerably lower virulence. In Slovakia and Hungary a high virulence was found against Ml-La resistance gene. The lowest virulence was observed against Ml-a sub(3) resistance gene in all regions except Hungary. From 459 analyzed barley powdery mildew isolates no virulent was found against the ml-o resistance gene (the variety Alexis).

3155 Tang Borang; Zhu Wenzhen (Beijing Agricultural Univ. (China). Coll. of Plant Science and Technology) (1995) **Studies on the detached-leaf method for testing resistance of wheat to powdery mildew (Erysiphe graminis tritici).** *Acta Phytophylacica Sinica (China) v. 22(4) p. 309-314.* 7 tables; 2 ref. Chinese. (AGRIS 97-049522).

3156 Tang Yulan (Shandong Academy of Agricultural Sciences, Jinan (China). Inst. of Plant Protection) (1995) **Wheat powdery mildew types and gene analysis of population toxicity.** *Journal of Shandong Agricultural Sciences (China) (no. 3) p. 34-36.* 3 tables; 4 ref. Chinese. (AGRIS 97-049526).

3157 Todorova, M. (Institut za zastitu bilja, Sofija Kostinbrod (Bulgaria)); Jerkovic, Z. (Naucni institut za ratarstvo i povrtarstvo, Novi Sad (Yugoslavia)) (1996) **[Virulence of Puccinia recondita tritici in Serbia [Yugoslavia]]. Virulentnost Puccinia recondita tritici u Srbiji [Jugoslavija].** *Zbornik radova - Institut za ratarstvo i povrtarstvo (Yugoslavia) (no. 28) p. 95-97.* 2 tables; 6 ref. Serbian. (AGRIS 97-049509).

The purpose of this paper is the differentiation of the Puccinia recondita population in Yugoslavia on the basis of the virulence gene interactions with old host differential varieties as well as lines (carriers of known Lr (leaf rust) genes) that are most frequently used today. Leaf rust isolates were collected in 1995 on several localities. Cultures from the different localities expressed the differences in the virulence. Only Lr 9 and Lr 19 were resistant in all interactions with the pathogen. The high frequency of such reactions is also connected with Lr 1. Races 167 and 77 are most common nowadays. Of all the tested interactions between the Lr lines and parasite cultures, 80 were expressed as susceptibility. On the whole, resistance was based on 42 of the host genes.

3158 Torabi, M.; Jalalian, N. (1996) **First report on the occurrence of partial bunt on wheat in the Southern parts of Iran.** Seed and Plant Improvement Institute, Karadj (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research Seed and Plant Improvement Institute (Iran Islamic Republic) p. 8.* Persian. (AGRIS 97-034814).

3159 Toth, A. (Godolloi Agrartud. Egyet., Godollo (Hungary)) (1995) **[Effect of Fusarium isolates on winter wheat seedlings at different nutrient supply levels]. A Fusarium izolatumok hatasa oszi buza csiranovenyekre kulonbozo tapanyagellatas mellett.** *Novenytermeles (Hungary) v. 44(5-6) p. 449-459.* 4 Tables; 4 ill.; 35 ref. Hungarian. (AGRIS 97-049537).

The effect of Fusarium infections on winter wheat at seedling stage were studied in sandy experiments. The isolates of five Fusarium species F. avenaceum, F. culmorum, F. graminearum, F. moniliforme, F. sporotrichioides and five different fertilization treatment were applied. The data on plant decay, plant length, and dry matter content of roots were evaluated by analysis of variance. The affection with Fusarium decreased significantly (by 10-60 depending on the isolates) the parameters analysed. The rate of shoot/root dry matter contents changed in the function of the ability to cause disease, and the so-called "root cutting" effect of F. culmorum could be expressed even numerically.

3160 Valocka, B.; Sabova, M.; Liskova, M. (Slovenska Akademia Vied, Kosice (Slovakia). Parazitologicky Ustav) (1995) **The virulence of five different Heterodera avenae (Nematoda: Heteroderidae) populations.** *Biologia (Slovakia). Sect. Zoology v. 50(5) p. 457-459.* 2 tables; 5 ref. English. (AGRIS 97-034640).

The virulence of five geographically distant Heterodera avenae populations (from United Kingdom, Germany and Slovakia) are studied. Their effects on oat and spring barley cultivars with different degrees of susceptibility were compared. The importance of the relationships between the cereal cultivars' resistance and parasite pathotypes in Slovakia was also confirmed.

3161 Vanleur, JAG.; Alamdar, MZ.; Khawatmi, S. (1997) EFFECT OF COMMON ROOT ROT (COCHLIOBOLUS SATIVUS) ON YIELDS OF BARLEY UNDER EXPERIMENTAL CONDITIONS IN NORTHERN SYRIA. *Australian Journal of Agricultural Research. 48(3):351-357.* English. [TAMWORTH CTR CROP IMPROVEMENT TAMWORTH NSW 2340 AUSTRALIA].

The impact of Cochliobolus sativus on grain yield of different barley cultivars was studied for 3 seasons in northern Syria by comparing plots with and without artificial inoculation. Distributing oat kernels infested with C. sativus next to barley seed and inoculating seed with C. sativus conidia in a peat carrier resulted in an increase in common root rot symptoms on the subcrown internode. Subcrown internodes were shorter in inoculated than uninoculated plots. The effect of inoculation differed greatly among cultivars and years. Highest losses from the common root rot occurred under dry growing conditions, whereas a significant yield increase was noted on 2 susceptible lines grown under adequate moisture. As common root rot can reduce barley yield in unfavourable environments, the disease should be considered by crop improvement programs aimed at low-rainfall zones in Mediterranean environments. [References: 28].

3162 Wilkinson, R.E.; Roberts, J.J. (1993) **Methods for inhibiting rust infections of plants.** The Department. references. Copies of USDA patents are available for a fee from the Commissioner of Patents and Trademarks, U.S. Patents and Trademarks Office, Washington, D.C. 20231. vp. English. (AGRIS 97-035023).

Methods are provided for inhibition of leaf rust infections of plants, especially wheat, using inhibitors which disrupt sulfhydryl bonds of the enzymes used by the leaf rust germ tube to ingest and metabolize components of epicuticular waxes.

3163 Wu Xunzhi (Shandong Agricultural Univ., Tai'an (China). Dept. of Plant Protection) (1995) **Pathogen types of root rot disease in field infested by wheat take-all and pathogenicity.** *Journal of Shandong Agricultural Sciences (China) (no. 1) p. 30-32.* 2 tables; 5 ref. Chinese. (AGRIS 97-049527).

3164 Xie Shuixian; Chen Wanquan; Chen Yanglin (Chinese Academy of Agricultural Sciences, Beijing (China). Inst. of Plant Protection) (1995) **Technical system of integrated pest management on wheat in Tianshui [China].** *Acta Phytophylacica Sinica (China) v. 22(3) p. 251-255.* 3 tables; 7 ref. Chinese. (AGRIS 97-049518).

3165 Yang Yanjie; Wang Guisheng (Hebei Provincial General Station of Plant Protection, Shijiazhuang (China)) (1995) **Studies on the spatial distribution pattern and sampling technology of the loose smut of wheat in fields.** *Acta Phytophylacica Sinica (China) v. 22(3) p. 256-258.* 5 tables; 1 ref. Chinese. (AGRIS 97-049519).

3166 Yao Qingxiao; Guo Lijuan (Academia Sinica, Beijing (China). Inst. of Genetics) (1995) **On stability of resistance of mutants of wheat resistant to Helminthosporium sativum.** *Acta Phytopathologica Sinica (China) v. 25(2) p. 107-110.* 2 tables; 1 ill., 7 ref. Chinese. (AGRIS 97-049529).

The resistance was tested in offspring M1, M2 and M3 of mutants resistant to Helminthosporium sativum of wheat which was obtained by cell engineering. The experimental results demonstrated that the resistance was retained in the offspring of M1, M2 and M3 of mutants resistant to Helminthosporium sativum. In the meantime, as compared with standard control variety, the peroxidase activity of mutants increased remarkably. Two additional isoperoxidase bands appeared in the disease-resistant mutants.

3167 Yitbarek Semeane (IAR, Addis Abeba (Ethiopia)); Bekele Hunde; Getaneh Woldeab; Dereje Tadese (1996) **Disease surveys and loss assessment studies on barley.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hilu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 105-115.* IAR/ICARDA. 6 tables; 42 ref. English. (AGRIS 97-049253).

In Ethiopia 23 fungi, 2 bacteria, 2 viruses and 9 nematodes have been found on barley. Early surveys identified smuts and rusts as the most important barley diseases and blotches of potential importance. Currently blotches are the most threatening diseases of the crop. Viral diseases were less frequent, currently up to 5 serotypes of BYDV are reported. Host range studies are limited to leaf rust. Inoculation tests in glass house using uredospores from grass and broad leaf weeds resulted in a non pathogenic response. Therefore, the rust was pathogenic only on the reported host as observed in the field. Studies on pathogen variability are limited to rusts and scald. So far four races are reported for Puccinia graminis and two races for Phordei. In Rhychosporium secalis about 19 pathotypes are recognized. Scald and netblotch cause a yield loss of up to 67 percent and 34 percent, respectively.

3168 Zabozlaeva, L.D.; Maksimochkina, T.I. (1996) **[Efficiency of Trichodermin in the protection of barley from root rots]. Ehffektivnost' trikhodermina v zashchite yachmenya ot kornevykh gnilej.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 116-117.* BRIPP. Russian. (AGRIS 97-049251).

3169 Zamani Zadeh, H.R. (1993) **In vitro Zearalenone production by some Fusarium species and it's role in natural infection of wheat in Mazandaran Province.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 46.* Persian. (AGRIS 97-049410).

3170 Zamani Zadeh, H.R.; Khoursandi, H. (1995) **Occurrence of Fusarium species and their mycotoxins in wheat in Mazandaran Province.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Iranian Journal of Plant Pathology official Journal of the Iranian Phytopathological society (Iran Islamic Republic) v. 31(1-4) p. 12.* Persian. (AGRIS 97-034817).

3171 Zarea Nasr abadi, R.; Ershad, D. (1995) **Introducing five Fusarium species new to the mycoflora of Iran isolated from cereals.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 12th Iranian Plant Protection Congress 2-7 September 1995 Karadj (Iran Islamic Republic) p. 373.* Persian. (AGRIS 97-034801).

3172 Zhou Guoshun (Henan Vocation Technical Teachers Coll., Xinxiang (China). Dept. of Plant Protection) (1995) **[Study on the pathogen of leaf blight and occurrence trend in wheat].** *Journal of Henan Vocation-Technical Teachers College (China) v. 23(3) p. 44-48.* 2 tables; 3 ref. Chinese. (AGRIS 97-049534).

3173 Zuo Yuhu; Zheng Lianzhi; Zhang Yunhua (Heilongjiang August First Land Reclamation Univ., Mishan (China). Lab. of Plant Immunology) (1995) **Studies on the epidemic method of spring wheat scab in Heilongjiang Province [China].** *Acta Phytophylacica Sinica (China) v. 22(4) p. 297-302.* 4 tables; 3 ref. Chinese. (AGRIS 97-049492).

H50 MISCELLANEOUS PLANT DISORDERS

3174 Agrawal, M.; Verma, M. (1997) **AMELIORATION OF SULPHUR DIOXIDE PHYTOTOXICITY IN WHEAT CULTIVARS BY MODIFYING NPK NUTRIENTS.** *Journal of Environmental Management. 49(2):231-244.* English. [BANARAS HINDU UNIV DEPT BOT VARANASI 221005 UTTAR PRADESH INDIA].

Field experiments were conducted to examine the responses of two cultivars of wheat (Malviya 206 and Malviya 234) to sulphur dioxide when grown at six different nutrient levels. Thirty-day-old plants were exposed to 0.15 ppm SO2 for 4 hours per day, 5 days per week for 8 weeks. Total plant length was reduced significantly in SO2 treated plants, except those grown using recommended and twice the recommended fertilizer applications. Leaf area, however, was significantly reduced in SO2 treated plants. Total plant biomass and yield also decreased in plants exposed to SO2. Root:shoot ratio and leaf:weight ratio altered in plants grown at different nutrient levels and with different SO2 treatments. Total chlorophyll, ascorbic acid, starch and protein contents were reduced by SO2 exposure whereas total soluble sugar and reducing sugar levels were increased. The level of changes in different parameters due to SO2 exposure varied with different nutrient levels and cultivars of wheat. Soil mineral nutrient status has been found to modify the response of wheat plants. Yield data have suggested that Malviya 234 is more responsive to nutrient status and showed lower reductions due to SO2 exposure. (C) 1997 Academic Press Limited. [References: 45].

3175 Bozinovic, I.Z. (1996) **The effect of hormonal herbicides on quantitative traits in different wheat genotypes (Triticum aestivum L.).** Poljoprivredni fakultet, Novi Sad (Yugoslavia). *Dejstvo hormonalnih herbicida na kvantitativne osobine razlicitih genotipova psenice (Triticum aestivum L.) 98 p.* 9 ill.; 44 tables; 76 ref. Serbian. (AGRIS 97-049688).

The effects of hormonal herbicides MCPP+3, 6-D (Lontrel 418 C), MCPP (Morogal) and 2, 4-D+MCPA (Monosan S) on nine quantitative traits in wheat were studied. In the tillering phase and booting phase of wheat development, two doses, recommended and twice higher dose of herbicides were applied. After regular application, herbicides are not influenced on length of spike, number of kernels per spike, grain mass per spike. On contrary, after adequate application of three herbicides, the values of plant and stem height and 1000 kernels mass, also, are changed. The non adequate application of herbicides, in booting phase and twice higher dose than recommended, at the higher number of traits influenced changes. The changes of quantitative traits of wheat genotypes after herbicides application indicating specific reaction wheat cultivar-herbicide were established.

3176 Damania, AB.; Pecetti, L.; Qualset, CO.; Humeid, BO. (1997) **DIVERSITY AND GEOGRAPHIC DISTRIBUTION OF STEM SOLIDNESS AND ENVIRONMENTAL STRESS TOLERANCE IN A COLLECTION OF DURUM WHEAT LANDRACES FROM TURKEY.** *Genetic Resources & Crop Evolution. 44(2):101-108.* English. [IST SPERIMENTALE COLTURE FORAGGERE VIALE PIACENZA 29 I-20075 LODI ITALY].

Variation and geographic distribution of stem solidness and environmental stress tolerance were assessed under dryland conditions in a collection of 2420 durum wheat landrace morphotypes collected in 28 administrative provinces of Turkey. The former trait is known to confer resistance to wheat stem sawfly - a serious pest insect in West Asia and North Africa. Both characters were scored on a visual five-level scale. Score mean values and frequency distributions in the different provinces were significantly different for both traits according to analysis of variance and chi-square test, respectively. Two groups of provinces emerged with high frequency of solid-stemmed, and hollow-stemmed accessions, respectively. The former could be of interest in durum wheat breeding against the sawfly. The group of solid-stemmed province germplasms was collected at lower altitude than the other, being also different on average for higher temperatures and evapotranspiration, and shorter growing season at sites of origin. Overall frequency of morphotypes tolerant to stress conditions prevailing in the evaluation site was rather low (10%). This low frequency may be due to low adaptation of materials in this harsher environment than those of origin where rainfall is usually higher and temperatures markedly lower. Nonetheless, differences among provinces in frequency distribution of stress tolerant morphotypes were evidenced. The relatively more tolerant gene pools originated either along the western coast or in the southern part of the country, along the 'Fertile Crescent'. The least tolerant provence germplasms originated either in the North along the Black Sea or in the highlands of the eastern Anatolian Plateau. Germplasm from provinces Malatya and Izmir combined good levels of both stem solidness and stress tolerance. [References: 23].

3177 Darwent, AL.; Lefkovitch, LP.; Mills, PF. (1997) **EFFECT OF SOIL TEMPERATURE, SEEDING DEPTH AND CULTIVAR ON WHEAT TOLERANCE TO SIMULATED ETHALFLURALIN CARRYOVER.** *Canadian Journal of Plant Science. 77(1):181-188.* English. [AGR & AGRI FOOD CANADA NO AGR RES CTR BEAVERLODGE AB T0H 0C0 CANADA].

Field and controlled environment experiments were conducted at Beaverlodge, Alberta to determine the effect of soil temperature, seeding depth and cultivar on wheat (Triticum aestivum L.) tolerance to ethalfluralin. In one experiment, ethalfluralin was applied and incorporated, and wheat was seeded at several depths in late April/early May when soil temperatures were lowest or in late May when soil temperatures had increased. Mean 3-yr wheat yields decreased by 45% as the rate of ethalfluralin increased from 0 to 0.75 kg ha(-1) and by 21% as the depth of seeding increased from 4 to 12.5 cm but the effect of ethalfluralin on yields was similar regardless of the soil temperature (time of seeding). Mean plant density decreased by 55% as the rate of ethalfluralin increased and by 25% as the depth of seeding increased. Reductions in mean plant density from ethalfluralin were slightly greater when seeded into the warmer soils. In another experiment, the effect of ethalfluralin on the yields of three wheat cultivars, Laura, Conway and Biggar was similar, i.e. the cultivar x rate of ethalfluralin interaction was not significant. However, the mean plant density of Biggar, averaged over rates of ethalfluralin, was less than that of the other cultivars in 1 of 2 yr. In a controlled environment experiment, the oven-dry weight and percent emergence of wheat shoots of the cultivars, Katepwa, Laura and Conway, seeded at 1.5 or 4 cm into soils containing ethalfluralin at concentrations of 0 to 4 ppm and maintained at temperatures of 4.5 or 15 degrees C, were reduced by decreases in temperature and increases in the rate of herbicide and depth of seeding. However, the interaction of soil temperature x rate of ethalfluralin was not significant for the oven-dry weight of the wheat shoots and the reduction in percent emergence of the wheat shoots as the rate of ethalfluralin increased was only slightly greater at 4.5 degrees C than at 15 degrees C. These results indicate that soil temperature and cultivar selection have a minor effect on wheat tolerance to ethalfluralin while herbicide concentration and depth of seeding have a major impact. [References: 17].

3178 Domelles, A.L.C.; Carvalho, F.I.F. de; Federizzi, L.C.; Sereno, M.J.C. de M.; Amaral, A.; Langlois, P. (1996) **[Hexaploid wheat genotypes evaluation to toxic aluminium tolerance]. Avaliacao de genotipos de trigo hexaploide quanto a tolerancia a toxicidade do aluminio.** *Ciencia Rural (Brazil) v. 26(1) p. 19-22.* 11 ref. Portuguese. (AGRIS 97-035099).

3179 Foy, CD. (1997) **TOLERANCE OF DURUM WHEAT LINES TO AN ACID, ALUMINUM-TOXIC SUBSOIL (VOL 19, PG 1381, 1996).** *Journal of Plant Nutrition. 20(2-3):417-418.* English.

3180 Huang, J.W. (DuPont Central Research and Development, Newark, DE.); Pellet, D.M.; Papernik, L.A.; Kochian, L.V. (1996) **Aluminum interactions with voltage-dependent calcium transport in plasma membrane vesicles isolated from roots of aluminum-sensitive and -resistant wheat cultivars.** *Plant physiology (Lancaster, Pa.) (USA) v. 110(2) p. 561-569.* references. English. (AGRIS 97-035102).

The role of Al interactions with root-cell plasma membrane (PM) Ca2+ channels in Al toxicity and resistance was studied. The experimental approach involved the imposition of a transmembrane electrical potential (via K+ diffusion) in right-side-out PM vesicles derived from roots of two wheat (Triticum aestivum L.) cultivars (Al-sensitive Scout 66 and Al-resistant Atlas 66). We previously used this technique to characterize a voltage-dependent Ca2+ channel in the wheat root PM (J.W. Huang, D.L. Grunes, L.V. Kochian [1994] Proc Natl Acad Sci USA 91:3473-3477). We found that Al3+ effectively blocked this PM Ca2+ channel; however, Al3+ blocked this Ca2+ channel equally well in both the Al-sensitive and -resistant cultivars. It was found that the differential genotypic sensitivity of this Ca2+ transport system to Al in intact roots versus isolated PM vesicles was due to Al-induced malate exudation localized to the root apex in Al-resistant Atlas but not in Al-sensitive Scout. Because malate can effectively chelate Al3+ in the rhizosphere and exclude it from the root apex, the differential sensitivity of Ca2+ influx to Al in intact roots of Al-resistant versus Al-sensitive wheat cultivars is probably due to the maintenance of lower Al3+ activities in the root apical rhizosphere of the resistant cultivar.

3181 Jerkovic, Z.; Momcilovic, V.; Kovacevic, B. (Faculty of Agriculture, Novi Sad (Yugoslavia). Institute of Field and Vegetable Crops) (1994) **Resistance of winter barley to low temperatures.** *Zbornik Matice srpske za prirodne nauke (Yugoslavia) (no. 87) p. 73-78.* 2 tables; 9 ref. English. (AGRIS 97-049639).

Twenty varieties or lines of malting and forage winter barley were differentiated by the resistance to low temperatures in 1992/93 and 1993/94. Different treatments and scoring led to different conclusions about the range in series of studied genotypes according to the mentioned trait. Forage barley Novosadski 701 and 705 (Galeb) and new lines of malting barley NS 505 and 511 had higher level of resistance to low temperatures than the others.

3182 Khrustaleva, L.I.; Pogorilaya, E.V.; Golovnina, Yu.M.; Andreeva, G.N. (1995) **[Effect of brassinolide-55 on meiotic activity and number of chromosome disturbances in root meristeme cells of barley under salt stress]. Vliyanie ehpibrassinolida-55 na mitoticheskuyu aktivnost' i kolichestvo khromosomnykh narushenij v kletkakh kornevoj meristemy yachmenya pri solevom stresse.** *Sel'skokhozyajstvennaya biologiya. Seriya Biologiya rastenij (Russian Federation) (no.5) p. 69-73.* 23 ref. Russian. (AGRIS 97-035072).

In experiments with the seedlings of the Nosovsky 9 barley cultivar, performed under the chloride salinization, the anti-stress effect of the phytoregulator epibrassinolide-55 has been studied. It has been shown that the preparation relieved the inhibition effect of the salt ions surplus (0, 1 and 0, 2 M NaCl), stimulating the mitotic activity and reducing the mutation level in the cells of the root meristeme.

3183 Kobiljski, D.; Dencic, S. (Naucni institut za ratarstvo i povrtarstvo, Novi Sad (Yugoslavia)) (1996) **[Influence of drought stress on stem height and spike length of tall and semidwarf wheats]. Efekat stresa na visinu stabljike i duzinu klasa kod visokih i polupatuljastih psenica.** *Zbornik radova - Institut za ratarstvo i povrtarstvo (Yugoslavia) (no. 28) p. 39-46.* 2 tables; 15 ref. Serbian. (AGRIS 97-049683).

19 tall and 19 semidwarf wheat cultivars, originating from different countries were included in the study. The cultivars were grown under natural - field conditions and in drought stress. Drought stress had, in average, no significant effect on stem height and spike length neither in tall nor in semidwarf group of cultivars. But, inside each group, the differences between genotypes have been observed. In tall wheats only cv. Flamnik have had taller stem and longer spike in drought stress compared to field conditions. None of the analized semidwarf cultivars had taller stem in drought stress, but cv. S.Cerros and Kosuta have had the longer spike in drought stress than in field conditions. Those results indicate that the tall cv. Flamnik and semidwarf cv. S. Cerros and Kosuta could serve as donors of desirable genes in the process of wheat breeding for drought stress tolerance.

3184 Li Yanan; Chen Daqing; Ma Zichao (Hubei Agricultural Coll., Jingsha (China). Dept. of Agronomy) (1995) **Effect of mannitol on physiological properties of isolated wheat leaves under high temperature stress.** *Journal of Hubei Agricultural College (China) v. 15(4) p. 301-304.* 1 table; 3 ill., 14 ref. Chinese. (AGRIS 97-049686).

3185 Mulholland, BJ.; Craigon, J.; Black, CR.; Colls, JJ.; Atherton, J.; Landon, G. (1997) **EFFECTS OF ELEVATED CARBON DIOXIDE AND OZONE ON THE GROWTH AND YIELD OF SPRING WHEAT (TRITICUM AESTIVUM L).** *Journal of Experimental Botany. 48(306):113-122.* English. [UNIV NOTTINGHAM DEPT PHYSIOL & ENVIRONM SCI SUTTON BONINGTON CAMPUS LOUGHBOROUGH LE12 5RD LEICS ENGLAND].

Spring wheat cv. Minaret was grown under three carbon dioxide (CO2) and two ozone (O-3) concentrations from seedling emergence to maturity in open-top chambers. Under elevated CO2 concentrations, the green leaf area index of the main shoot was increased, largely due to an increase in green leaf area duration. Biomass increased linearly in response to increasing CO2 (ambient, 550 and 680 ppm). At anthesis, stem and ear dry weights and plant height were increased by up to 174%, 5% and 9 cm, respectively, and biomass at maturity was 23% greater in the 680 ppm treatment as compared to the ambient control. Grain numbers per spikelet and per ear were increased by 0.2 and 5 grains, respectively, and this, coupled with a higher number of ears bearing tillers, increased grain yield by up to 33%. Exposure to a 7 h daily mean O-3 concentration of 60 ppb induced premature leaf senescence during early vegetative growth (leaves 1-7) under ambient CO2 concentrations. Damage to the main shoot and possible seedling mortality during the first 3 weeks of exposure altered canopy structure and increased the proportion of tillers 1 and 2 which survived to produce ears at maturity was increased; as a result, grain yield was not significantly affected. In contrast to the older leaves, the flag leaf (leaf 8) sustained no visible O-3 damage, and mean grain yield per ear was not affected. Interactions between elevated CO2 and O-3 influenced the severity of visible leaf damage (leaves 1-7), with elevated CO2 apparently protecting against O-3-induced premature senescence during early vegetative growth. The data suggest that the flag leaf of Minaret, a major source of assimilate during grain fill, may be relatively insensitive to O-3 exposure. Possible mechanisms involved in damage and/or recovery are discussed. [References: 40].

3186 Nogales, R.; Gallardolara, F.; Benitez, E.; Soto, J.; Hervas, D.; Polo, A. (1997) **METAL EXTRACTABILITY AND AVAILABILITY IN A SOIL AFTER HEAVY APPLICATION OF EITHER NICKEL OR LEAD IN DIFFERENT FORMS.** *Water, Air, & Soil Pollution. 94(1-2):33-44.* English. [CSIC ESTAC EXPT ZAIDIN PROF ALBAREDA 1 POB 419 E-18080 GRANADA SPAIN].

A greenhouse experiment using soil was conducted to investigate the effects of the addition of different forms of either nickel or lead, together with an acidifying agent, on the distribution of Ni, Pb, Zn, Cu and Mn in wheat plants, and on the post-harvest extractability of these elements in the soil. Two treatments consisting of soil alone or soil mixed with sewage sludge at a rate of 200 Mg ha(-1) were used as controls. Nickel (400 mg kg(-1)) or lead (1600 mg kg(-1)) was added to the soil as an inorganic salt or mixed previously with sewage sludge. Six further treatments including an acidifying agent (wastewater from olive oil processing: alpechin) were also prepared. Wheat (Triticum aestivum L. var. Mesa) plants were harvested 75 d after germination. Dry matter yield of wheat was increased by the addition of sewage sludge. No reductions in yield were observed after the addition of nickel or lead. Nickel concentration and uptake by wheat, and extractability from soil, were higher when the sewage sludge enriched in nickel was added to soil. This effect was enhanced when the acidifying agent was also added. In contrast, lead availability was higher after the addition of inorganic Pb to soil. The addition of both forms of Ni enhanced Zn, Cu and Mn uptake by the plant, whereas the addition of lead increased Zn and Cu. After harvesting, increases in extractable Zn and Cu in the soil were observed only in treatments with sewage sludge, and not after the addition of Ni or Pb, or after the addition of the acidifying agent. Decreasing the pH of the soil with the acidifying agent tended to increase Mn uptake by wheat, and Mn extractability from the soil after harvesting. [References: 44].

3187 Ouzounidou, G.; Moustakas, M.; Eleftheriou, EP. (1997) **PHYSIOLOGICAL AND ULTRASTRUCTURAL EFFECTS OF CADMIUM ON WHEAT (TRITICUM AESTIVUM L) LEAVES.** *Archives of Environmental Contamination & Toxicology. 32(2):154-160.* English. [ARISTOTELIAN UNIV THESSALONIKI DEPT BOT GR-54006 THESSALONIKI GREECE].

The effects of a 7-day exposure of 3-day-old wheat plants to increasing Cd concentrations are described, with special attention being given to chloroplast ultrastructural changes, chlorophyll fluorescence responses, chlorophyll and nutrient concentration changes as well as growth changes of the whole plant. The plants treated with 1 mM Cd showed symptoms of heavy metal toxicity. The root, shoot-leaf length and the root, shoot-leaf biomass progressively decreased with increasing Cd in nutrient solution and in 1 mM of Cd an almost complete inhibition of growth was found. Shoot-leaf Cd accumulation increased under Cd-treatments, while a Fe, Mg, Ca, and K decline in the above ground parts was observed. The growth reduction and the inhibition of chlorophyll content and photosynthesis observed in the upper plant parts seemed principally due to indirect Cd effects on the content of essential nutrients. Cadmium treatment was shown to damage the structure of chloroplasts, as manifested by the disturbed shape and the dilation of the thylakoid membranes. These ultrastructural changes suggest that Cd probably induced premature senescence. [References: 54].

3188 Parker, DR. (1997) **RESPONSES OF SIX CROP SPECIES TO SOLUTION ZINC(2+) ACTIVITIES BUFFERED WITH HEDTA.** *Soil Science Society of America Journal. 61(1):167-176.* English. [UNIV CALIF RIVERSIDE DEPT SOIL & ENVIRONM SCI RIVERSIDE, CA 92521 USA].

Zinc contamination has long hampered the use of conventional nutrient solutions for attaining reproducible and severe Zn deficiencies. Chelator-buffered solutions show promise for precisely imposing micronutrient deficiencies, but further studies are needed to fully evaluate the method and to develop methods to avoid Zn-deficiency-induced P toxicity. In a greenhouse study, seedlings of maize (Zea mays L. 'Golden Cross Bantam'), wheat (Triticum aestivum L.'Yecora Rojo'), tall wheatgrass (Elytrigia pontica [Podp.] Holub 'Orbit'), alfalfa (Medicago saliva L.'Germain's WL-320'), soybean (Glycine max [L.] Merr.'Vinton 81'), and tomato (Lycopersicon esculentum L. 'Jackpot') were grown for 16 to 29 d in solutions containing 0.4 to 12 mu M total Zn. Computed Zn2+ activities were buffered at 4 to 123 pmol L(-1) by a 50-mu M excess of HEDTA, and solution P was maintained at 10 +/- 3 mu M. Zinc deficiencies ranged from mild to severe, dry matter yield minima ranged from 32 to 89% of controls, and critical Zn2+ activities for the onset of deficiency ranged from approximately 10 to 65 pmol L(-1). The relative sensitivity of the six species to low Zn was maize > tomato > wheat > alfalfa approximate to tall wheatgrass > soybean. Shoot Zn concentrations were consistent with the widely reported critical range of 15 to 20 mg kg(-1). Zinc deficiency in the three grass species led to hyperaccumulation of P to phytotoxic levels, and leaf symptoms largely reflected this toxicity. Leaf P concentrations in the

three dicots tended to be lower, but may have been within the phytotoxic range. Thus, even with P concentrations that approach soil solution values, the P toxicity that often accompanies Zn deficiency in solution-culture experiments was not eliminated. The effects of Zn deficiency on shoot concentrations of nutrients other than P were variable, although divalent cations tended to be elevated in Zn-deficient shoots. [References: 45].

3189 Pukhalskaya, NV. (1997) **GENERATIVE DEVELOPMENT OF BARLEY AT AN ELEVATED ATMOSPHERIC CONCENTRATION OF CO2 AND VARYING TEMPERATURE CONDITIONS.** *Russian Journal of Plant Physiology. 44(2):152-157.* English. [RUSSIAN ACAD AGR SCI PRYANISHNIKOV RES INST FERTILIZERS & AGR SOIL SCI UL PRYANISHNIKOVA 31 MOSCOW 127550 RUSSIA].

Ear development in barley (Hordeum vulgare L.) was studied at normal (350 mu l/l) and elevated (700 mu l/l) atmospheric CO2 concentrations and two temperature regimes. Plant productivity was found to increase by 63 and 47% at temperatures of 20/14 and 23/17 degrees C (day/night), respectively. Analysis of production showed that elevated CO2 may induce an increase in the number of spikelets in the inflorescence primordium and in the size of the primordium beginning from the early stages of development. At 20/14 degrees C, a high level of CO2 significantly elevated the yield of the main ear, increasing the number of caryopses by 18-28% and the grain weight in the main ear by 42-49%. At 23/17 degrees C, a double concentration of CO2 increased plant production due to increased tiller formation (by 75-106%). It was found that the CO2 concentration did not affect pollen fertility in barley at low temperature, but at elevated temperature, the number of sterile pollen grains increased. Thus, the experiments showed that an elevated CO2 concentration affected the development of the barley ear during its whole ontogeny, including the early stages. [References: 25].

3190 Qin Suichu; Chen Jun (Zhejiang Agricultural Univ., Hangzhou (China). Dept. of Soil and Agrochemistry); Liang Qizhi (1995) **Investigation on Mg deficiency in wheat.** *Journal of Zhejiang Agricultural Sciences (China) (no. 6) p. 273-275.* 1 table; 4 ref. Chinese. (AGRIS 97-049684).

3191 Semenov, MA.; Wolf, J.; Evans, LG.; Eckersten, H.; Iglesias, A. (1996) **COMPARISON OF WHEAT SIMULATION MODELS UNDER CLIMATE CHANGE .2. APPLICATION OF CLIMATE CHANGE SCENARIOS.** *Climate Research. 7(3):271-281.* English. [UNIV BRISTOL LONG ASHTON RES STN DEPT AGR SCI ICAR BRISTOL BS18 9AF AVON ENGLAND].

A comparison of the performance of 5 wheat models (AFRCWHEAT2, CERES, NWHEAT, SIRIUS and SOILN) was carried out for 2 sites in Europe: Rothamsted, UK, and Seville, Spain. The aims of this study were (1) to compare predictions of wheat models for climate change scenarios, and (2) to investigate the effects of changes in climatic variability in climate-change scenarios on model predictions. Simulations were run for climate change scenarios derived from a number of 2 x CO2 equilibrium and transient GCM (global circulation model) experiments. For most climate change scenarios the model results were broadly similar. Where results differed, much of the difference could be explained by model sensitivity to climate and differences in initial conditions. Transient scenarios without changes in climatic variability usually resulted in large yield increases for Rothamsted and in nil to large yield increases for Seville. Incorporation of changed climatic variability in the transient scenario had a more profound effect on grain yield and resulted in a substantial decrease in mean yield with a strong increase in yield variation at Seville. This was associated with the changes in the duration of dry spells and a redistribution of precipitation over the vegetation period. The results show that future studies of the effect of climate change on crop yields must consider changes in climatic variability as well as changes in mean climate. [References: 28].

3192 Vankovaradeva, RV.; Yaneva, IA.; Baidanova, VD.; Lvov, NP.; Karasev, GS.; Trunova, TI. (1997) **MOLYBDENUM-INDUCED INCREASE IN FROST TOLERANCE OF WINTER WHEAT GROWN ON ACIDIC SOIL.** *Russian Journal of Plant Physiology. 44(2):204-209.* English. [BULGARIAN ACAD SCI M POPOV INST PLANT PHYSIOL AKAD G BONCHEV STR BLOCK 21 BU-1113 SOFIA BULGARIA].

Winter wheat Triticum aestivum L. plants were grown to the tillering stage outdoors on forest-chestnut soil, pH 4.2, then hardened for seven days at 2 degrees C, and frozen under controlled conditions at -5 to -16 degrees C. Before seeding, 1 mg/kg (NH4)(6)Mo7O24. 4H(2)O, had been added to the soil. The treatment with molybdenum led to an enhancement of frost tolerance and significantly increased soluble protein content and nitrate reductase and Mo-cofactor activities. The results are considered as evidence for the "quantitative adaptation strategy" of plants to low-temperature stress. [References: 22].

3193 Vanvuuren, MMI.; Robinson, D.; Fitter, AH.; Chasalow, SD.; Williamson, L.; Raven, JA. (1997) **EFFECTS OF ELEVATED ATMOSPHERIC CO2 AND SOIL WATER AVAILABILITY ON ROOT BIOMASS, ROOT LENGTH, AND N, P AND K UPTAKE BY WHEAT.** *New Phytologist. 135(3):455-465.* English. [SCOTTISH CROP RES INST DEPT CELLULAR & ENVIRONM PHYSIOL DUNDEE DD2 5DA SCOTLAND].

We investigated interactions between the effects of elevated atmospheric carbon dioxide concentrations ([CO2]) and soil water availability on root biomass, root length and nutrient uptake by spring wheat (Triticum aestivum cv. Tonic). We grew plants at 350 and 700 mu mol mol(-1) CO2 and with frequent and infrequent watering ('wet' and 'dry' treatments, respectively). Water use per plant was 1.25 times greater at 350 than at 700 mu mol CO2 mol(-1), and 1.4 times greater in the 'wet' than in the 'dry' treatment. Root biomass increased with [CO2] and with watering frequency. Elevated [CO2] changed the vertical distribution of the roots, with a greater stimulation of root growth in the top layers of the soil. These data were confirmed by the video data of root lengths in the 'dry' treatment, which showed a delayed root development at depth under elevated [CO2]. The apparent amount of N mineralized appeared to be equal for all treatments. Nutrient uptake was affected by [CO2] and by watering frequency, and there were interactions between these treatments. These interactions were different for N, K and P, which appeared to be related to differences in nutrient availability and mobility in the soil. Moreover, these interactions changed with time as the root system became larger with [CO2] and with watering frequency, and as fluctuations in soil moisture contents increased. Elevated [CO2] affected nutrient uptake in contrasting ways. Potassium uptake appeared to be reduced by the smaller mass how of water reaching the root surface. However, this might be countered with time by the greater root biomass at elevated [CO2], by the greater soil moisture contents at elevated [CO2], enabling faster diffusion, or both. Phosphorus uptake appeared to be increased by the greater root biomass at elevated [CO2]. We conclude that plant nutrient uptake at elevated [CO2] is affected by interactions with water availability, though differences between nutrients preclude generalizations of the response. [References: 34].

3194 Vapa, Lj. (Faculty of Sciences, Novi Sad (Yugoslavia)); Kastori, R.; Radovic, D. (1995) **Effect of heavy metals on isozyme polymorphism in wheat.** *Zbornik Matice srpske za prirodne nauke (Yugoslavia) (no. 89) p. 37-43.* 4 graphs; 1 table; 17 ref. English. (AGRIS 97-049687).

The influence of excess concentrations (10* (-3)M) of lead, cadmium and zinc on wheat seedlings was studied. Lead was found to be the most unfavourable for plant growth. The accumulation of lead was considerably higher in root than in shoot. Electrophoretic analysis of GOT-2, GOT-3, SOD, ADH-1, AADH-1, ACO-1, ACO-2, SKDH-1, and cPx in shoot and root of wheat seedlings showed that number of bands and staining intensity varied in the material grown in Pb, Cd and Zn solutions.

3195 Wang Yunhua (Centerchina Agricultural Univ., Wuhan (China). Lab. of Trace Elements) (1995) **Study on the Mo deficiency of winter wheat and Mo application in the yellow-brown earths of Hubei, China.** *Soils and Fertilizers (China) (no. 3) p. 24-27.* 6 tables. Chinese. (AGRIS 97-049682).

3196 Wolf, J.; Evans, LG.; Semenov, MA.; Eckersten, H.; Iglesias, A. (1996) **COMPARISON OF WHEAT SIMULATION MODELS UNDER CLIMATE CHANGE .1. MODEL CALIBRATION AND SENSITIVITY ANALYSES.** *Climate Research. 7(3):253-270.* English. [WAGENINGEN UNIV AGR DEPT THEORET PROD ECOL POB 430 NL-6700 AK WAGENINGEN NETHERLANDS].

A comparison of the performance of 5 wheat models was carried out for 2 sites in Europe with considerably different agroclimatic conditions: Rothamsted, UK, and Seville, Spain. The models were calibrated against field data sets from both sites. For Rothamsted the measured time courses of crop growth, evapo-transpiration and nitrogen uptake were reproduced reasonably well by the different models, except for leaf area index. For Seville, the experimental data set was insufficient for such a detailed

comparison and mainly simulated results were compared. The sensitivity of the model results to stepwise changes in individual weather variables was then determined. In the different model runs a temperature rise generally resulted in lower yields, an increase in precipitation and atmospheric CO2 concentration resulted in higher yields, and increased variability of weather variables often resulted in lower yields with increased yield variability. [References: 26].

3197 Yoshida, M.; Abe, J.; Moriyama, M.; Shimokawa, S.; Nakamura, Y. (1997) **SEASONAL CHANGES IN THE PHYSICAL STATE OF CROWN WATER ASSOCIATED WITH FREEZING TOLERANCE IN WINTER WHEAT.** *Physiologia Plantarum. 99(3):363-370.* English. [HOKKAIDO NATL AGR EXPT STN SAPPORO HOKKAIDO 062 JAPAN].

The relationship between freezing tolerance (expressed as LTS, , the lethal freezing temperature for 50% of plants) and the amount and physical state (as determined by spin-lattice [T-1] and spin-spin [T-2] relaxation times of protons) of water in crown tis sue was examined in contrasting winter wheat (Triticum aestivum L.) varieties grown under field conditions from 1992 to 1994. During acclimation, the LT(50) Values decreased from around -7 to -17, -20 and -27 degrees C in PI 173438, Chihokukomugi and Valuevskitya, respectively. Tissue water content decreased continuously through autumn to reach a plateau around 3 g H2O (g dry weight)(-1) in early winter when LT(50) was still decreasing, and then gradually increased under snow cover. A significant negative correlation was found between mean minimum air temperatures and freezing tolerance prior to the establishment of continuous snow cover. Tn contrast, a positive association between mean minimum temperatures and crown tissue water content was significant only when air temperatures were above 0 degrees C, as water content did not decrease further at sub-zero temperatures. Seasonal changes in T-1 were closely related to changes in freezing tolerance. T-1 decreased until January even though water content stopped decreasing. Further tests on 15 field-grown varieties confirmed a strong negative association between freezing tolerance and T-1. The results suggest that cold hardening is comprised of two stages, with the transition occurring at ca 0 degrees C. Development of hardiness was related to (1) a reduction in water content in the first stage (at minimum temperatures >0 degrees C), and (2) a change in physical state of water without much reduction in water content in the second stage. Varietal differences in hardiness thus arise due to changes in both water content and physical state of water. [References: 32].

3198 Zhang Aimin (China Agricultural Univ., Beijing (China). Dept. of Plant Genetics and Breeding) (1996) **Relations between endogenous hormones and male sterility in wheat (Triticum aestivum): preliminary results.** *Journal of Agricultural Biotechnology (China) v. 4(1) p. 56-61.* 2 tables; 11 ref. Chinese. (AGRIS 97-049685).

3199 Zhang, GC.; Slaski, JJ.; Archambault, DJ.; Taylor, GJ. (1997) **ALTERATION OF PLASMA MEMBRANE LIPIDS IN ALUMINUM-RESISTANT AND ALUMINUM-SENSITIVE WHEAT GENOTYPES IN RESPONSE TO ALUMINUM STRESS.** *Physiologia Plantarum. 99(2):302-308.* English. [UNIV ALBERTA DEPT BIOL SCI EDMONTON AB T6G 2E9 CANADA].

We have studied the effect of aluminum (Al) on lipid composition of plasma membranes from roots of an Al-resistant (PT741) and an Al-sensitive (Katepwa) cultivar of Triticum aestivum L. Several genotype-specific changes were observed in phospholipids and steryl lipids. While exposure to 20 mu M AlCl3 for 3 days had no effect on total phospholipids in either genotype, the most abundant phospholipid, phosphatidylcholine, increased significantly in the Al-resistant PT741 with corresponding decreases in other phospholipids. In comparison, no change in phosphatidylcholine was observed in the Al-sensitive Katepwa. Aluminum also decreased steryl lipids (mainly free sterols) in PT741. Such changes were not observed in Katepwa. As a result of differential changes in lipid composition, the relative abundance of one lipid class to another changed. The ratio of steryl lipids to phospholipids decreased in PT741, with no change in Katepwa. While limited information on the relationship between membrane function and lipid composition makes it difficult to relate these changes to Al toxicity and resistance, changes observed only in the Al-resistant genotype could contribute to continued plant growth in the face of Al stress. [References: 38].

H60 WEEDS

3200 Adamczewski, K.; Urban, M. (1996) **Enhancing the herbicidal spectrum and activity of sulfosulfuron by tank-mixing with adjuvants.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 813-818.* SP. 4 tables; 5 ref. English. (AGRIS 97-049990).

3201 Bahrami, N.; Mirkamali, H. (1993) **Weeds in rainfed Wheat fields in the Kermanshah Province.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28Aug.- 2 Sep , 1993 Rasht (Iran Islamic Republic) p. 48.* Persian. (AGRIS 97-035274).

3202 Bublik, L.I.; Tsiren', V.F. (Ukranian Academy of Agricultural Sciences, Kiev (Ukraine). Institute of Plant Protection) (1996) **[Dynamics of chlortoluron content in winter wheat and soil]. Dinamika soderzhaniya khlortolurona v ozimoj pshenitse i pochve.** Abstracts of reports of science-production conference dedicated to the 25th anniversary of BRIPP (Minsk-Priluki, 14-16 February of 1996). Part 1. Minsk (Belarus). 14-16 Feb 1996. *[Ecological and economical bases for perfecting the integrated systems of protection of plants from pests, diseases and weeds]. Samersov, V.F.; Sorochinskij, L.V. (eds.). Ehkologo-ehkonomicheskie osnovy usovershenstvovaniya integrirovannykh sistem zashchity rastenij ot vreditelej, boleznej i sornyakov. Belarus Research Institute of Plant Protection, Minsk (Belarus) p. 10-11.* BRIPP. Russian. (AGRIS 97-035243).

3203 Christensen, S.; Heisel, T.; Walter, A.M. (1996) **Patch spraying in cereals.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 963-968.* SP. 3 ill., 17 ref. English. (AGRIS 97-049877).

3204 Christensen, S.; Rasmussen, G.; Olesen, J.E.; Joergensen, L.N. (1996) **Weed management for integrated winter wheat production.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 1003-1008.* SP. 2 tables; 17 ref. English. (AGRIS 97-050000).

3205 Citron, G. (Institut Technique des Cereales et des Fourrages, Paris (France)) (1996) **[A new herbicide for cereal crops: "Laureat" (chlortoluron + diflufenicanil)]. Herbicides cereales, gros plan sur une nouvelle specialite ["Laureat" (chlortoluron + diflufenicanil)].** *Perspectives Agricoles (France) (no 215) p. 37-39.* French. (AGRIS 97-035119).

3206 Cosser, N.D.; Gooding, M.J.; Davies, W.P.; Froud Williams, R.J. (1996) **Effects of wheat dwarfing genes on grain yield and quality of wheat in competition with Alopecurus myosuroides.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 1089-1094.* SP. 2 tables; 20 ref. English. (AGRIS 97-050002).

3207 Cussans, J.W.; Lutman, P.J.W.; Storkey, J.; Blair, A.M.; Corbett, S.J.; Green, M.; Hill, A.L.; McDonald, H. (1996) **Inter-site variability in crop-weed interference in winter wheat.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 1. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 203-208.* SP. 3 tables; 7 ref. English. (AGRIS 97-049995).

3208 Dellow, J.J.; Incerti, M.; Britton, R.; Bishop, A. (1996) **Herbicide resistance extension strategy for the south eastern wheat belt of New**

South Wales, Australia. 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 2. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 487-492.* SP. 1 ref. English. (AGRIS 97-049987).

3209 Faghih, H.; Radje, M.E. (1993) **Effect of several herbicides on the weeds and yield of Wheat.** Fars Agricultural Research Center, Zarghan (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 50.* Persian. (AGRIS 97-035260).

3210 Fasil Reda (IAR, Addis Abeba (Ethiopia)) (1996) **Weed control research in barley.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 100-104.* IAR/ICARDA. 1 table; 12 ref. English. (AGRIS 97-049879).

Multi-locational testing on yield loss assessment revealed that weeds can cause about 17 percent yield reduction in barley. Weed competition was most critical during the first 30 days of crop establishment. Timing of manual weeding was found important and the proper time for this operation being 30-35 days after planting. Barley gave highest yield when weeded early compared to mid and late season weeding. Among the herbicides tested 2, 4-D and Linron (both at the rate of 1 liter product ha-1), Mecoprop (3 liter product ha-1), Brittox 2.5 liter) and Chlorsulfuron (20 g) were effective on broad leaf weeds. Carbyne 2(1 liter product ha-1) performed better against wild oat. Dichlofop methyl (3.5 liter prod. ha-1) and fenoxapro-p ethyl (1 liter ha-1) were similarly effective on important grass weeds such as Snowdenia polystachia, Setaria pumila and Phalaris paradoxa. Dichlofop methyl, however, showed weaker performance against Phalaris paradoxa. It has been shown that there is a considerable advantage of using weed free seeds during planting. A yield difference of 17 percent was observed between clean and unclean seed treatments.

3211 Fatemi, H. (1993) **Weed control in Wheat fields in Esfahan.** Agricultural Research Center, Esfahan (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 51.* Persian. (AGRIS 97-035275).

3212 Fenni, M. (Setif Univ. (Algerie). Lab. d'Ecologie Vegetale) (1994) **[Effects of weeds on the yield of durum wheat (Variety: Waha) and the efficacy of some herbicides [in Algeria]]. Effet de mauvaises herbes sur le rendement du ble dur (Variete: Waha) et efficacite de quelques herbicides.** 46th International Symposium on Crop Protection. Gent (Belgium). 3 May 1994. *Mededelingen - Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen Universiteit Gent (Belgium) v. 59(3b) p. 1299-1303.* 4 tables; 4 ref. French. (AGRIS 97-050005).

3213 Gu Kun (Yixing Municipal Bureau of Agriculture, Jiangsu (China)) (1995) **Experiment of weed control and weed population shift in wheat field.** *Journal of Weed Science (China) v. 9(2) p. 63-64.* 2 tables. Chinese. (AGRIS 97-049992).

3214 Hamidi, R.; Ghadiri, H. (Shiraz Univ. (Iran Islamic Republic)) (1996) **Turgenia latifolia competition with winter wheat at various soil moisture levels.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 1. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 79-84.* SP. 2 ill., 2 tables; 6 ref. English. (AGRIS 97-049993).

3215 Karczmarczyk, S.J.; Devlin, R.M.; Bhowmik, P.C.; Zbiec, I.I. (1996) **Effect of CGA-152005 on growth and enzyme activity in wheat, radish, and pea.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 845-849.* SP. 5 tables; 4 ref. English. (AGRIS 97-049997).

3216 Legere, A. (1997) **CEREAL PLANTING DATES AS A TOOL IN THE MANAGEMENT OF GALEOPSIS TETRAHIT AND ASSOCIATED WEED SPECIES IN SPRING BARLEY AND OAT.** *Crop Protection. 16(2):117-125.* English. [AGR CANADA SOILS & CROPS RES & DEV CTR 107 SCI CRESCENT SASKATOON SK S7N 0X2 CANADA].

The effects of delayed planting and herbicide treatments on populations of Galeopsis tetrahit and associated weed species, and on mid-season above-ground dry weight and grain yield of spring barley and oat were measured in field experiments conducted from 1989 to 1991, in La Pocatiere, Quebec, Canada. Two crop planting dates were compared in 1989 and three dates in 1990-1991. The weed control factor included two post-emergence herbicide treatments (cyanazine/MCPA, thifensulfuron-methyl) and a weedy control treatment. By mid-season, post-planting cohorts of G. tetrahit generally had comparable densities and above-ground dry weight, regardless of crop planting date. Delayed planting reduced density but had no effect on dry weight of associated weeds. Both herbicide treatments effectively suppressed G. tetrahit and associated weeds. However, effects of weed control treatments were generally the same, regardless of planting date. Delayed planting most often did not compensate for the benefits from chemical weed control and affected both crops at mid-season by reducing crop height and dry weight. This effect carried over to oat but not to barley grain yields. Herbicide applications were beneficial to barley grain yields in two out of three years but not to oat yields. Overall, delayed planting was generally not favourable to early barley and oat growth and oat yields, and did not provide the expected suppression of G. tetrahit and associated weeds which could have alleviated the need for chemical weed control. (C) 1997 Elsevier Science Ltd. [References: 25].

3217 Levy, O.; Benyamini, Y.; Rubin, B.; Krugman, T.; Nevo, E. (1996) **Chlorotoluron resistance identification and genetic analysis in wild emmer wheat (Triticum dicoccoides).** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 2. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 523-528.* SP. 2 tables; 14 ref. English. (AGRIS 97-050004).

3218 Lopez F, Saul; Medina Pitalua, J.L.; Tasistro Souto, A. (1994) **[Systematic sampling of Oxalis spp. in wheat (Triticum spp.) at El Batan Experiment Station (CIMMYT)]. Muestreo sistematico de Oxalis spp. en trigo (Triticum spp.) en la estacion Experimental El Batan (CIMMYT).** *Revista Chapingo. Serie Proteccion Vegetal (Mexico) v. 1(1) p. 109-112.* 12 ref.; 3 cuadros. Spanish. (AGRIS 97-049732).

En los bosques pinoneros de El Cardonal, Hidalgo, se evaluaron dos disenos experimentales para definir la efectividad de los insecticidas malation y carbaril en la prevencion del ataque a conillos por Conophthorus cembroides Wood y Leptoglossus occidentalis Heidemann, las dos plagas mas importantes de los conos del pino pinonero Pinus cembroides Zucc. en el area de estudio. Se planeo un diseno experimental para utilizar a los arboles individuales como las unidades experimentales, en el otro diseno se usaron los arboles individuales como bloques experimentales. En ambos disenos no se encontraron diferencias significativas entre los insecticidas y el testigo. Sin embargo, el diseno que utilizo cada arbol como bloque tuvo un coeficiente de variacion de 19.1 menos que en el otro diseno, ademas fue mas practico y mas barato.

3219 Loubser, J. (Western Cape Department of Agriculture, Elsenburg (South Africa). Elsenburg Agricultural Developement Inst.) (1996) **[Chemical weed control in wheat (low dosages)]. Chemiese onkruidbeheer in koring met laer dosisse.** *Elsenburg Journal (South Africa) (no.1) p. 50-55.* 8 tables; 6 ref. Afrikaans. (AGRIS 97-049991).

3220 Mallory Smith, C.A.; Hansen, J.; Zemetra, R.S. (1996) **Gene transfer between wheat and Aegilops cylindrica.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 2. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 441-445.* SP. 5 ref. English. (AGRIS 97-049996).

3221 Marshall, G.; Gemmell, J.; Kirkwood, R.C.; Leach, G.E.; Bryan, I.B.; Hadfield, S.T.; Jutsum, A.R. (1996) **Possible mechanisms conferring selectivity to tralkoxydim.** 2. International Weed Control Congress.

Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 833-838.* SP. 6 ref. English. (AGRIS 97-049875).

3222 Mathiassen, S.K.; Kudsk, P. (1996) **Influence of climate scenarios on herbicide performance.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 905-910.* SP. 2 ill., 13 ref. English. (AGRIS 97-049876).

3223 Miklaszewska, K.; Paradowski, A. (Poznan Univ. (Poland). Inst. of Plant Protection) (1996) **Influence of field pansy (Viola arvensis Murr.) density on the yield of winter barley.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 1015-1018.* SP. 2 ill., 2 tables; 4 ref. English. (AGRIS 97-049878).

3224 Mirkamali, H. (1993) **Bromus commutatus in Wheat in the Systan- and Bluchestan (SB) province.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep., 1993 Rasht (Iran Islamic Republic) p. 52.* Persian. (AGRIS 97-035276).

3225 Montazeri, M.; Saberi, H.K. (1993) **Control of Lolium persicum and Parapholis incurva in Barley.** Seed and Plant Improvement Institute, Tehran (Iran Islamic Republic). *Proceedings of the 11th Plant Protection Congress of Iran 28 Aug.- 2 Sep. 1993 Rasht (Iran Islamic Republic) p. 53.* Persian. (AGRIS 97-035277).

3226 Nietschke, B.S.; Reeves, T.G.; Matthews, J.M.; Powles, S.B. (Adelaide Univ., Roseworthy (Australia)) (1996) **Components of an integrated weed management strategy to control herbicide-resistant Avena spp.: an Australian perspective.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 2. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 493-498.* SP. 4 tables; 10 ref. English. (AGRIS 97-049874).

3227 Orr, J.P. (UCCE.); Canevari, M.; Jackson, L.; Wennig, R.; Carner, R.; Nishimoto, G. (1996) **Postemergence herbicides and application time affect wheat yields.** *California agriculture (USA) v. 50(4) p. 32-36.* English. (AGRIS 97-049769).

3228 Parker, L.; Murdoch, A.J. (1996) **Mathematical modelling of multispecies weed competition in spring wheat.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 1. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 153-158.* SP. 2 ill., 2 tables; 7 ref. English. (AGRIS 97-049994).

3229 Pawlowska, J.; Dietrych Szostak, D. (1996) **Evaluation of some herbicides in winter cereals infested with Galium aparine L.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 1041-1042.* SP. 2 tables; 1 ref. English. (AGRIS 97-050001).

3230 Podsiadlo, C.; Koszanski, Z. (Akademia Rolnicza, Szczecin (Poland). Zaklad Podstaw Produkcji Roslinnej i Nawadniania Roslin) (1995) **[Effect of irrigation and mineral fertilization on weeds in spring wheat]. Wplyw deszczowania i nawozenia mineralnego na zachwaszczenie pszenicy jarej.** *Zeszyty Naukowe. Akademia Rolnicza w Szczecinie. Rolnictwo (Poland) (no.165) p. 99-103.* 4 tables; 7 ref. Polish. (AGRIS 97-035244).

In four year field experiments on a sandy soil, the effects of sprinkling irrigation and various doses of mineral fertilizers on spring wheat weed infestation were estimated. The weeds were typical for sandy soils, the prevailing species being: Chenopodium album, Viola arvensis and Agropyron repens. The number of weeds on irrigated plot exceeded by 14 percent that of the nonirrigated ones., but their dry weight had been reduced by 38 percent. Weed control caused by high doses of NPK was more pronounced on irrigated wheat plots.

3231 Razavi, M.; Mirkamali, H. (1994) **Weeds in rainfed wheat fields in Maraghe and Hashtrood.** Plant Pests and Diseases Research Institute, Tehran (Iran Islamic Republic). *Applied Entemology and PhytoPathology Publication of Plant Pests and Diseases Research Institute (Iran Islamic Republic) v. 61(1-2) p. 27.* Persian. (AGRIS 97-035271).

In this study, carried out during 1991 and 1992 in rainfed wheat fields in Maraghe and Hashtrood (easter Azarbaidjan), Lisaea heterocarpa was found to be the most distributed and dominant weed in those areas, while four other species namely Scandix iberica, Galium tricornutum, Ranunculus arvensis and Cirsium aduncum were also dominant, but not in all the areas investigated.

3232 Riechers, D.E. (Washington State University, Pullman, WA.); Fuerst, E.P.; Miller, K.D. (1996) **Initial metabolism of dimethenamid in safened and unsafened wheat shoots.** *Journal of agricultural and food chemistry (USA) v. 44(6) p. 1558-1564.* references. English. (AGRIS 97-035245).

The metabolic fate of the chloroacetamide herbicide dimethenamid was examined in excised shoots of unsafened and safened wheat seedlings. Compared to unsafened controls, fluxofenim treatment increased the rate of metabolism of dimethenamid to water-soluble compounds. Thin layer chromatography revealed that similar dimethenamid metabolites were present in extracts from both safened and unsafened wheat shoots. However, three metabolites were more abundant in extracts from fluxofenim-treated wheat relative to unsafened wheat. Reversed-phase high-performance liquid chromatography and mass spectrometry were used to isolate and confirm the identity of dimethenamid metabolites extracted from safened wheat shoots 1 h after treatment with dimethenamid. In addition to the presence of the glutathione conjugate of dimethenamid, gamma-glutamylcysteine and cysteinylglycine dipeptide conjugates, as well as a cysteine conjugate and an oxygenated glutathione conjugate of dimethenamid, were detected. On the basis of time course analysis of dimethenamid metabolites by thin layer chromatography and structural identification by mass spectrometry, it appears that from 5 to 100 min after treatment with dimethenamid metabolism occurs exclusively via the glutathione conjugation pathway in wheat. Thus, the protection conferred to wheat by fluxofenim treatment is most likely due to increased glutathione-mediated detoxification of dimethenamid.

3233 Riechers, DE.; Yang, K.; Irzyk, GP.; Jones, SS.; Fuerst, EP. (1996) **VARIABILITY OF GLUTATHIONE S-TRANSFERASE LEVELS AND DIMETHENAMID TOLERANCE IN SAFENER-TREATED WHEAT AND WHEAT RELATIVES.** *Pesticide Biochemistry & Physiology. 56(2):88-101.* English. [WASHINGTON STATE UNIV DEPT CROP & SOIL SCI PULLMAN, WA 99164 USA].

Glutathione S-transferase (GST) levels were quantified in shoots of wheat and wheat relatives to determine if variation existed for GST levels, with or without treatment with herbicide safeners, and if GST levels could be used as an accurate biochemical marker for wheat seedling tolerance to the herbicide dimethenamid. Wheat lines and relatives were either unsafened or treated with the safeners fluxofenim (CGA-133205) or cloquintocet-mexyl (CGA-185072). GST levels were assayed using an enzyme-linked immunosorbent assay utilizing a maize GST antibody (GST-ELISA) and an enzyme activity assay using dimethenamid as a substrate (GST-D). In general, the GST-ELISA indicated that significant GST was present constitutively (in untreated plants) and that the two safeners increased GST levels to a similar extent. In contrast to the GST-ELISA, the GST-D assay generally detected little or no constitutive GST-D activity; fluxofenim increased GST-D activity more than cloquintocet-mexyl. Tolerance to dimethenamid in fluxofenim-safened wheat seedlings in the greenhouse was correlated with GST-D activity ($r(2) = 0.51$) but not with GST-ELISA ($r(2) = 0.03$). These data suggest that screening wheat and wheat relatives for safener-increased GST-D activity can be used as a biochemical marker to predict and select for increased wheat seedling tolerance to dimethenamid. (C) 1996 Academic Press. [References: 27].

3234 Seefeldt, S.S.; Fuerst, E.P.; Irzyk, G.P.; Gealy, D.R.; Shukla, A.; Hoffman, D.; Brewster, B.D. (1996) **Diclofop-resistant Avena fatua from the Willamette Valley of Oregon.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 2. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 511-516.* SP. 18 ref. English. (AGRIS 97-049988).

3235 Singh, S.; Kirkwood, R.C.; Marshall, G. (1996) **Uptake, translocation and metabolism of 14C isoproturon in wheat, susceptible and resistant biotypes of Phalaris minor.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 2. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 529-534.* SP. 2 tables; 16 ref. English. (AGRIS 97-049989).

3236 Stupnicka Rodzynkiewicz, E. (1996) **Changes in population sizes of weeds in cereals grown in five-year rotation.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 1. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 185-190.* SP. 3 ill., 10 ref. English. (AGRIS 97-050045).

3237 Tereshchuk, V.S. (Plant Protection Inst., Priluki Minsk (Belarus)) (1996) **Occurrence of weeds in barley depending on the preceding crop.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 1. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 259-264.* SP. 2 tables; 16 ref. English. (AGRIS 97-049873).

3238 Tiebas, M.A.; Esparza, M.; Biurrun, R.; Perez de Ciriza, J.J. (Instituto Tecnico y de Gestion Agricola, Pamplona (Espana)) (1996) **[Specific herbicides against wild oat, in addition to adjuvants]. Herbicidas especificos contra ballueca, mas coadyuvantes.** *Navarra Agraria (Espana) (no.99) p. 10-18.* Tab., graf. Spanish. (AGRIS 97-035118).

3239 Tokes, G. (Budapest Fovarosi Novenyegeszsegugyi es Talajvedelmi Allomas, Budapest (Hungary)); Bagyinka, T. (Bekes Megyei Novenyegeszsegugyi es Talajvedelmi Allomas, Bekescsaba (Hungary)) (1996) **[Sensitivity to etephon-ccc regulators of cereal varieties grown in Hungary II. Winter barley, rye, triticale, oats]. Magyarorszagon termesztett kalaszos gabonafajtak erzekenysege az etefon-ccc alapu regulatoros beavatkozasra II. Oszi arpa, rozs, tritikale, zab.** *Novenyvedelem (Hungary) v. 32(3) p. 119-127.* 6 Tables; 3 ill. Hungarian. (AGRIS 97-049880).

In a three-year-study about 50-60 varieties of barley, rye, triticale and oats, were evaluated for their response to treatment with Flordimex T.Extra (660 g/l etephon) + Bercema CCC (500 g/l chloromequat) at rates of 0, 8 + 0, 4 l/ha, respectively, found the best for the purpose. The weather in the years of the trial were very different from each other, so during 1990 with favourable, 1991 with average rainfall conditions, and in the very draught year of 1992 the response of varieties could be compared under different ecological conditions. A new assessment system was worked out for the determination of efficacy and sensitivity, taking changes in plant height, lodging and yield into consideration: the "regulator effect index" and the "relative sensitivity". Values in points of each variety are shown in the tables, from which responses observed in the particular years can be seen.

3240 Tumans, V.; Vanags, I. (Latvian State Plant Protection Centre (Latvia)) (1996) **[The influence of the herbicide DUPLOZAN SUPER 60 solution on dicotyledonous weeds and spring barley]. Herbicida DUPLOZANS SUPER 60 s.u. ietekme uz divdigllapju nezalem un vasaras mieziem.** *Raziba (Latvia) (no.11) p. 7-10.* Latvian. (AGRIS 97-049867).

The article deals with the effect of the herbicide duplozan super 60 solution on weeds, which has the best effect in their early phases of development. It is emphasized that the best results can be obtained if weeds are in a shoot phase. The decreasing of the total number of dicotyledonous weeds under the influence of herbicides in barley cornfields in 1994 and 1995 are analysed. The yields of barley corn in 1994 and 1995 are compared. The usage of duplozan super 60 solution at definite rations in spring barley, winter rye, winter wheat and spring wheat cornfields is recommended.

3241 Welsh, J.P.; Bulson, H.A.J.; Stopes, C.E.; Froud Williams, R.J.; Murdoch, A.J. (1996) **Weed control in organic winter wheat using a spring-time weeder.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 3. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 1127-1132.* SP. 5 tables; 8 ref. English. (AGRIS 97-050003).

3242 Yaduraju, N.T.; Ahuja, K.N. (Indian Agricultural Research Inst., New Delhi (India)) (1996) **Effects of soil solarization with or without weed control on weeds and productivity in soybean-wheat system.** 2. International Weed Control Congress. Copenhagen (Denmark). 25-28 Jun 1996. *Proceedings: Second international weed control congress, 2. Brown, H.; Cussans, G.W.; Devine, M.D.; Duke, S.O.; Fernandez-Quintanilla, C.; Helweg, A.; Labrada, R.E.; Landes, M.; Kudsk, P.; Streibig, J.C. (eds.). Statens Planteavlsforsoeg, Flakkebjerg (Denmark) p. 721-727.* SP. 6 tables; 10 ref. English. (AGRIS 97-049858).

3243 Yenish, JP.; Durgan, BR.; Miller, DW.; Wyse, DL. (1997) **WHEAT (TRITICUM AESTIVUM) YIELD REDUCTION FROM COMMON MILKWEED (ASCLEPIAS SYRIACA) COMPETITION.** *Weed Science. 45(1):127-131.* English. [WASHINGTON STATE UNIV DEPT CROP & SOIL SCI PULLMAN, WA 99164 USA].

Yield loss of hard red spring wheat due to competition from common milkweed was measured in grower fields in Minnesota. Wheat yield loss was measured using the area of influence and additive competitive methods. Simple linear regression of wheat yield and percentage wheat yield loss against distance from a common milkweed shoot gave r(2) values of 0.013 and 0.015, respectively, indicating limited value of the area of influence model for common milkweed in spring wheat. In an additive competition model, wheat yield was reduced 47% at the highest density of 12 common milkweed shoots m(-2). Coefficients of determination for percentage yield loss regressed against common milkweed shoot density were 0.548, 0.547, and 0.529 for simple linear, nonlinear rectangular hyperbolic, and linear square root function models, respectively. Regression of percentage yield loss against common milkweed biomass resulted in r(2) values of 0.566, 0.645, and 0.658 for simple linear, nonlinear rectangular hyperbolic, and linear square root function models, respectively Restrictions of common milkweed density due to factors other than competition limited yield loss response to the simple linear phase of both the nonlinear rectangular hyperbolic and the linear square root function models previously described. [References: 17].

3244 Yenish, JP.; Fry, TA.; Durgan, BR.; Wyse, DL. (1997) **ESTABLISHMENT OF COMMON MILKWEED (ASCLEPIAS SYRIACA) IN CORN, SOYBEAN, AND WHEAT.** *Weed Science. 45(1):44-53.* English. [WASHINGTON STATE UNIV DEPT CROP & SOIL SCI PULLMAN, WA 99164 USA].

The establishment of common milkweed in corn, soybean, and wheat and rotations of corn-soybean and soybean-wheat was determined in field studies at Rosemount and Morris, MN. Common milkweed seedling density 115 d after initial seedling emergence was 500, 15, 000, and 31, 300 seedlings ha(-1) in corn, soybean, and wheat, respectively, in 1990; 500, 7, 300, and 15, 600 in 1991 at Rosemount and 2, 900, 26, 500, and 37, 000 in 1990; and 2, 200, 6, 700, and 8, 100 in 1991 at Morris in the year of seedling establishment. Common milkweed seedling defoliation by monarch butterfly larva was 1, 31, and 0% at Rosemount and 20, 78, and 0% at Morris for corn, soybean, and wheat, respectively. In the 2nd and 3rd rotational years, corn-soybean rotations had fewer shoots ha(-1) 115 d after shoot emergence than soybean-wheat rotations. Seedling densities 115 d after initial seedling emergence were greater in corn-soybean rotations where soybean rather than corn was the rotational crop and in soybean-wheat rotations where wheat rather than soybean was the rotational crop immediately following common milkweed seeding. Conventional tillage treatments had lower common milkweed shoot density than conservation tillage in all years of all rotations except in the initial count, when soybean was the first rotational crop in which shoot density was greater in conventional than in conservation tillage treatments. Cyanazine,

imazethapyr, or bromoxynil applications in corn, soybean, or wheat rotational crops, respectively reduced common milkweed shoot density. [References: 20].

J11 HANDLING, TRANSPORT, STORAGE AND PROTECTION OF PLANT PRODUCT

3245 Anon. (1995) **Integrated pest management in Kansas farm-stored wheat using aeration controllers.** *Report of progress (Kansas Agricultural Experiment Station) (USA); no. SRP 737 8 p.* English. (AGRIS 97-050117).

3246 Audsley, E.; Sells, J.; Boon, A. (1995) **The Whole Crop Biorefinery Project: Task 6: Final report: Economic assessment of the Whole Crop Biorefinery System.** The Bioraf Denmark Foundation, Aakirkeby (Denmark). Bioraf Danmark Fonden. 3 ill., 45 tables; 12 ref. 134 p. English. (AGRIS 97-035414).

3247 Bagger, C.L.; Olsen, H.S.; Steiger, W.; Persson, L.I.; Ingvardsen, L.; Soerensen, H. (1995) **The Whole Crop Biorefinery Project: Task 5: Final report: Aqueous enzymatic extraction of rapeseed oil, protein, starch and syrup.** The Bioraf Denmark Foundation, Aakirkeby (Denmark). Bioraf Danmark Fonden. 17 ill., 45 tables; 71 ref. 148 p. English. (AGRIS 97-035393).

3248 Bolano, A.; Pujola, M.; Monleon, T.; Gordun, E. (Escuela Superior de Agricultura de Barcelona (Espana)) (1996) **[Application of gluten index for determining wheat degradation]. Aplicacion del gluten index para la determinacion de la degradacion del trigo.** *Alimentacion. Equipos y Tecnologia (Espana) (no.9) p. 37-42.* 3 tab., 4 fig.; 14 ref. Spanish. (AGRIS 97-050070).

3249 Chen, X. (King's College London, London, UK.); Schofield, J.D. (1996) **Changes in the glutathione content and breadmaking performance of white wheat flour during short-term storage.** *Cereal chemistry (USA) v. 73(1) p. 1-4.* references. English. (AGRIS 97-035361).

White flour milled from grain of the hard bread wheat cv. Mercia was stored at 20 degrees C and used to monitor changes in the contents of free reduced glutathione (GSH), free oxidized glutathione (GSSG), and protein-glutathione mixed disulphides (PSSG). GSH levels fell from 149 to 85 nmol/g of flour during the first 10 days of storage, and they remained constant thereafter up to 40 days of storage. The breadmaking performance of the flour increased concomitantly with the fall in GSH content during the first 10 days of storage and again remained constant up to 40 days. The fall in GSH levels could not be accounted for in terms of either simple oxidation to GSSG or the formation of PSSG because glutathione levels in these two pools also fell during the initial 10-day period. The results indicate that the changes in glutathione levels in all three pools are closely related temporally to changes in breadmaking performance during the short-term storage of white flour. The nature of the reactions that lead to the drop in glutathione levels remains to be elucidated.

3250 Coksoyler, N.; Boncuk, H.; Ozkaya, S. (Provincial Control Laboratory, Ankara (Turkey)) (1994) **Analyzing the formation of moisture content and mycotoxin in post-harvest and storage periods of wheat samples.** General Directorate of Agricultural Research, Ankara (Turkey). *Bugdaylarda hasat sonrasi ve depolama donemlerinde kuf gelisimi ve mikotoksin olusumunun incelenmesi 31 p.* Provincial Control Laboratory. 30 ref.; 12 tables. Turkish. (AGRIS 97-035416).

3251 Flinn, P.W. (U.S. Grain Marketing Research Laboratory, USDA, ARS, Manhattan, KS.); Hagstrum, D.W.; McGaughey, W.H. (1996) **Suppression of beetles in stored wheat by augmentative releases of parasitic wasps.** *Environmental entomology (USA) v. 25(2) p. 505-511.* references. English. (AGRIS 97-035368).

Field studies were conducted to assess the effectiveness of the parasitoid wasps, Cephalonomia waterstoni (Gahan), and Choetospila elegans (Westwood), for controlling Cryptolestes ferrugineus (Stephens), rusty grain beetle and Rhyzopertha dominica (F.), lesser grain borer. On 6 July 1993 and 7 July 1994, adults of both C. ferrugineus and R. dominica were released at monthly intervals into 6 steel grain bins each containing 27.2 t of hard red winter wheat, Triticum aestivum L. Adults of both parasitoid species were released into 3 of the bins 21 d after the 1st beetle release. The amount of suppression of C. ferrugineus by C. waterstoni could not be measured in either year of this study because C. waterstoni infested the control bins. However, C. elegans was effective in suppressing R. dominica populations. In 1993 and 1994, R. dominica populations were suppressed by 98 and 91 compared with the control bins. After 198 d from initial beetle release in 1993, the treatment bins averaged 0.05 R. dominica per kilogram and the control bins averaged 2.06 R. dominica per kilogram. After 131 d from initial beetle release in 1994, the treatment bins averaged 6.94 R. dominica per kilogram and the control bins averaged 81.03 R. dominica per kilogram.

3252 Gobin, P. (INRA, Montpellier, France.); Duviau, M.P.; Wong, J.H.; Buchanan, B.B.; Kobrehel, K. (1996) **Change in sulfhydryl-disulfide status of wheat proteins during conditioning and milling.** *Cereal chemistry (USA) v. 73(4) p. 495-498.* references. English. (AGRIS 97-050164).

The sulfhydryl-disulfide status of wheat kernel proteins underwent modifications during the conditioning process performed before milling. Wheat conditioned 12 hr to a moisture content of 16 at room temperature resulted in a significant increase of available sulfhydryls in the proteins of all parts of the kernel: endosperm, embryo, and bran, including both metabolic and storage proteins of the endosperm. The sulfhydryl groups generated during conditioning remained reduced even after lengthy storage of the flour at 4 degrees C. The results imply that the technological quality of wheat flour may be considerably influenced by the conditioning process used before milling, as well as by subsequent storage conditions.

3253 Illerup, J.B.; Rathmann, O. (1996) **CO2 gasification of wheat straw, barley straw, willow and Giganteus.** Risoe National Lab., Roskilde (Denmark). *Risoe-R (Denmark); no. 873 32 p.* RNL. 27 ill., 15 tables; 5 ref. English. (AGRIS 97-035403).

3254 Jood, S. (CCS Haryana Agricultural University, Hisar, India.); Kapoor, A.C.; Singh, R. (1996) **Effect of insect infestation and storage on lipids of cereal grains.** *Journal of agricultural and food chemistry (USA) v. 44(6) p. 1502-1506.* references. English. (AGRIS 97-035364).

Insect infestation of wheat, maize, and sorghum grains caused by Trogoderma granarium Everts and Rhyzopertha dominica Fabricius singly or in mixed populations resulted in substantial reductions in the contents of total lipids, phospholipids, galactolipids, and polar and nonpolar lipids. The reduction was significant ($P < 0.05$) at 50 and 75 infestations. Phospholipids in wheat and galactolipids in maize and sorghum were more affected as compared to other lipid classes. Losses of lipids showed significant ($P < 0.05$) and negative correlations with the levels of insect infestations. T. granarium was comparatively more destructive than R. dominica because of variation in the distribution pattern of lipids in seed components and feeding habits of insects. Storage of three cereal grains for 1, 2, and 4 months had no significant effect on total lipids and other classes of lipids.

3255 Jood, S. (CCS Haryana Agricultural University, Hisar, India.); Kapoor, A.C.; Singh, R. (1995) **Polyphenol and phytic acid contents of cereal grains as affected by insect infestation.** *Journal of agricultural and food chemistry (USA) v. 43(2) p. 435-438.* references. English. (AGRIS 97-035417).

Polyphenol and phytic acid contents of wheat, maize and sorghum varied significantly and increased progressively with the levels of grain infestation (25, 50 and 75) caused by Trogoderma granarium Everts and Rhizopertha dominica Fabricius separately and mixed population. Higher insect infestation (50 and 75) of wheat and sorghum led to substantial increase (by weight) in polyphenol and phytic acid due to the selective feeding activities of the beetles. Feeding of both insect species on maize caused proportional increase in polyphenol but decrease in physic acid due to variation in the distribution of these compounds in seed components and also selective feeding habit of insects. Storage of uninfested cereal grains for up to 4 months did not cause appreciable change in the levels of these antinutrients.

3256 Kristensen, E.F.; Soegaard, H.T. (Forskningscenter Bygholm (Denmark). Sektion for Maskinteknik) (1995) **[Production of quality flour of Danish grown cereals]. Fremstilling af kvalitetsmel af danskavlet korn.** Statens Husdyrbrugsforsoeg, Foulum (Denmark).. *Intern Rapport. Statens Husdyrbrugsforsoeg (Denmark); no. 52 55 p.* SH. 12 ill., 19 tables. Danish. (AGRIS 97-050163).

3257 Loefqvist, B.; Schade, J.R.; Hoehndorf, T.; Jelsted, M. (1995) **The Whole Crop Biorefinery Project: Task 3: Final report: Upgrading wheat and barley to starch and feed ingredients.** The Bioraf Denmark Foundation, Aakirkeby (Denmark). Bioraf Danmark Fonden. 25 ill., 23 tables; 4 ref. 118 p. English. (AGRIS 97-035415).

3258 Nemeth, LJ.; Paulley, FG.; Preston, KR. (1996) **EFFECTS OF INGREDIENTS AND PROCESSING CONDITIONS ON THE FROZEN DOUGH BREAD QUALITY OF A CANADA WESTERN RED SPRING WHEAT FLOUR DURING PROLONGED STORAGE.** *Food Research International. 29(7):609-616.* English. [CANADIAN GRAIN COMMISS GRAIN RES LAB WINNIPEG MB R3C 3G8 CANADA].

A laboratory scale no-time frozen dough procedure that approximates Canadian commercial practice has been developed and used to study the effects of ingredients and processing conditions on the bread quality of a straight grade Canada Western Red Spring (CWRS) wheat flour during prolonged storage (2 days to 26 weeks). All treatments (baking absorption level, mixing energy input, mixer type, fermentation and intermediate proof times, removal of oxidant and/or dough strengthening conditioners and partial freeze-thaw cycles) had significant effects (P less than or equal to 0.05) upon bread quality (loaf volume and/or bread score). In general, these effects were more pronounced with extended frozen storage time. High baking absorption, undermixing, bulk fermentation (>1 h) and removal of oxidant and/or surfactants had the most dramatic effects. Addition of a very strong flour at 30% to strengthen the CWRS wheat flour had no significant effect (p greater than or equal to 0.05) upon bread quality under optimum conditions. (C) 1997 Published by Elsevier Science Ltd on behalf of the Canadian Institute of Food Science and Technology. [References: 37].

3259 Svihus, B.; Herstad, O.; Newman, CW. (1997) **EFFECT OF HIGH-MOISTURE STORAGE OF BARLEY, OATS, AND WHEAT ON CHEMICAL CONTENT AND NUTRITIONAL VALUE FOR BROILER CHICKENS.** *Acta Agriculturae Scandinavica Section A-Animal Science. 47(1):39-47.* English. [AGR UNIV NORWAY DEPT ANIM SCI POB 5025 N-1432 AS NORWAY].

Barley, oats, and wheat were stored anaerobically for three months after adjusting the dry matter content to 60%. The content of true protein was reduced when grains were high-moisture stored, but the amino acid content was not affected to the same extent. High-moisture storage decreased the soluble dietary fibre and soluble beta-glucan content in barley and oats, and simultaneously the extract viscosity of the grain was reduced to the same level as for wheat. In two experiments with two to five week old broiler chickens given diets with 70% dried or high-moisture stored grain, feed:gain ratio was reduced ($P < 0.05$) to the same level as for the wheat diets when high-moisture stored barley instead of dried barley was fed, and digestibility of dry matter, organic matter, fat, and minerals increased ($P < 0.05$). Weight gain and cleanness of cages also increased ($P < 0.05$), and the relative size of the digestive tract was reduced ($P < 0.05$). Digestibility of dry matter, organic matter, and minerals increased ($P < 0.05$) when high-moisture stored oats compared to dried oats were fed, and high-moisture storage of wheat increased ($P < 0.05$) P and Ca digestibility. [References: 42].

J15 HANDLING, TRANSPORT, STORAGE AND PROTECTION OF NON-FOOD OR NON-FEED AGRICULTURAL PRODUCTS

3260 Reffstrup, T. (1995) **[Fibre qualities: harvest methods and processing: mechanical defibration]. Fiberkvaliteter, hoestmetoder og forarbejdning, herunder mekanisk defibrering.** [Research in Industrial Use of Non-Food Crops, 1: Plant Fibres]. Lyngby (Denmark). 17 May 1995. *[Research in industrial use of non-food crops]. Olesen, P.O.; Rexen, F.; Larsen, J.; Bro, S. (eds.). Forskning i industriel anvendelse af non-food-afgroeder. Akademiet for de Tekniske Videnskaber, Lyngby (Denmark) p. 99-111.* ATV. 5 ill., 8 ref. Danish. (AGRIS 97-050182).

L02 ANIMAL FEEDING

3261 Bowman, JGP.; Sowell, BF. (1997) **DELIVERY METHOD AND SUPPLEMENT CONSUMPTION BY GRAZING RUMINANTS - A REVIEW.** *Journal of Animal Science. 75(2):543-550.* English. [MONTANA STATE UNIV DEPT ANIM & RANGE SCI BOZEMAN, MT 59717 USA].

The effectiveness of supplementation programs is affected by the ability to reduce intake variation and to meet target supplement consumption. A review was made of factors affecting variation in individual animal consumption of supplement by grazing cattle and sheep, including supplement type and feeding method, animal dominance and social interactions, and forage availability. The effects of palatability were not included. The proportion of animals not consuming supplement is increased by Limited trough space, small supplement allowance, self-fed supplements, neophobia to feed or feed delivery devices, and group feeding situations. Variation in individual animal supplement intake is increased by excessive trough space, limited supplement allowance, self-fed supplements, feed and feed delivery equipment neophobia, and individual feeding of supplements. Factors influencing the percentage of animals consuming the target amount of supplement need to be more clearly identified. There seems to be an optimum level of feeding competition that reduces intake variation and improves the proportion of animals consuming adequate amounts of supplement, but this optimum varies with the feeding situation. [References: 44].

3262 Christen, S.D. (University of Maine, Orono.); Hill, T.M.; Williams, M.S. (1996) **Effects of tempered barley on milk yield, intake, and digestion kinetics of lactating Holstein cows.** *Journal of dairy science (USA) v. 79(8) p. 1394-1395.* references. English. (AGRIS 97-036235).

The effects on milk yield and digestion kinetics were compared when tempered (10 water added 24 h prior to processing and feeding), rolled barley and dry, rolled barley were fed in trial 1, or tempered, whole barley, and dry, rolled barley were fed in trial 2. In trial 1, the diet based on tempered, rolled barley resulted in increased milk yield (5), efficiency (10), and apparent digestibility of dietary DM (6), NDF (15), ADF (12), CP (10), and starch (4). Mean fractional rate of passage was slower for tempered (7.8/h) than for dry (8.6/h) barley particles. Mean fractional rate of passage of forage particles and rates of digestion of forage and concentrate did not differ. The percentage of particle washout from an in situ bag (pore size, 53 microns) was 21 for dry barley and 6 for tempered barley, indicating that tempering reduced the pool size of small particles in rolled barley. In trial 2, the diet based on tempered, whole barley resulted in decreased daily milk yield (5), efficiency (11), and apparent digestibility of dietary DM (16), CP (10), and starch (8). The results indicated that tempered, rolled barley can be effectively used in diets for high yielding dairy cows to increase yield and efficiency; however, tempered barley must be rolled to achieve these effects.

3263 Hess, B.W. (University of Missouri, Columbia.); Krysl, L.J.; Judkins, M.B.; Holcombe, D.W.; Hess, J.D.; Hanks, D.R.; Huber, S.A. (1996) **Supplemental cracked corn or wheat bran for steers grazing endophyte-free fescue pasture: effects on live weight gain, nutrient quality, forage intake, particulate and fluid kinetics, ruminal fermentation, and digestion.** *Journal of animal science (USA) v. 74(5) p. 1116-1125.* references. English. (AGRIS 97-036158).

Two experiments were conducted with beef steers (Exp. 1, average BW of 580 kg; Exp. 2, average BW of 247 kg) to evaluate the use of no supplements (CON) or daily supplementation with (OM basis) 0.34 of BW of cracked corn (CORN), 0.34 of BW of wheat bran (WBBW), or 0.48 of BW of wheat bran (WBISO; calculated to be isocaloric to CORN) on digestive responses (Exp. 1) and live weight gain (Exp. 2). In Exp. 1, type of supplement did not affect ($P > 0.10$) the dietary fiber or N constituents, but in vitro OM disappearance of the forage differed ($P < 0.10$) with supplementation and type of supplement fed. Supplemented steers consumed less ($P < 0.05$) forage and total OM. Particulate passage, fluid passage, and ruminal pH were not affected ($P > 0.10$) by supplementation. Ruminal NH3 N concentration showed ($P < 0.05$) a treatment X sampling time interaction and, in general, WBBW and WBISO steers had greater ruminal NH3 N than CORN and CON steers. Total VFA concentrations and molar proportions of propionate were lower ($P < 0.10$) in CON steers than in supplemented steers; no differences were noted ($P > 0.10$) among supplemented steers. Molar proportions of acetate were lower ($P = 0.01$) in supplemented steers than in CON steers and were greater ($P = 0.03$) in WBBW steers than in WBISO steers. Butyrate molar proportions were lower ($P < 0.05$) in CON steers than in supplemented steers and differed ($P < 0.10$) with type and quantity of supplement supplied. In situ forage NDF disappearance at 6, 9, and 24 h after feeding and rate of disappearance were greater ($P < 0.05$) in CON steers than in supplemented steers. In Exp.

2, CON steers weighed less (P = 0.01) than supplemented steers, CORN steers weighed more (P = 0.08) than wheat bran-supplemented steers, and WBISO steers weighed more (P = 0.02) than WBBW steers; ADG for 90 d followed a similar response. Results suggest that supplementation of wheat bran rather than corn did not seem to stop the reduction in forage intake or OM digestion.

3264 Hill, T.M. (C. S. Akey, Inc., Lewisburg, OH.); Christen, S.D.; Davis Dentici, K. (1996) **The efficiency of protein utilization from various sources of crude protein fed to lambs consuming a barley-based feedlot diet.** *Journal of sustainable agriculture (USA) v. 7(4) p. 35-44.* references. English. (AGRIS 97-051111).

3265 Omara, FP.; Murphy, JJ.; Rath, M. (1997) **THE EFFECT OF REPLACING DIETARY BEET PULP WITH WHEAT TREATED WITH SODIUM HYDROXIDE, GROUND WHEAT, OR GROUND CORN IN LACTATING COWS.** *Journal of Dairy Science. 80(3):530-540.* English. [NATL UNIV IRELAND UNIV COLL DUBLIN DEPT ANIM SCI & PROD DUBLIN 4 IRELAND].

This experiment examined the effect of complete diets composed of 60% grass silage and 40% concentrate based mainly on beet pulp, ground wheat, wheat treated with NaOH, or ground corn on milk production and ruminal fermentation of dairy cows. Milk production and fat yield were 19.8, 20.7, 20.1, and 21.2 kg/d and 0.71, 0.76, 0.72, and 0.78 kg/d, respectively (18 cows per treatment). Cows fed the diet based on ground corn had higher milk production and fat yield, but lower milk protein concentration, than did cows fed the diet based on beet pulp. Cows fed the diet based on ground corn also had higher fat yields than did cows fed the diet based on wheat treated with NaOH. Cows fed the diet based on ground wheat had lower ruminal pH than did cows fed the diet based on beet pulp (6.34 vs. 6.59) and higher ruminal NH3 concentrations (6.2 vs. 5.2 mmol/L) than did cows fed the diet based on ground corn. These results showed little difference in milk production based on wheat processing method and little advantage to replacing beet pulp with either wheat type in a high forage diet. However, milk production and fat yield were increased by replacing beet pulp with ground corn. [References: 43].

3266 Pinchak, W.E. (Texas Agricultural Experiment Station, Vernon, TX.); Worrall, W.D.; Caldwell, S.P.; Hunt, L.J.; Worrall, N.J.; Conoly, M. (1996) **Interrelationships of forage and steer growth dynamics on wheat pasture.** *Journal of range management (USA) v. 49(2) p. 126-130.* references. English. (AGRIS 97-051160).

Little information is available comparing animal performance or stocking stability for different wheat (Triticum aestivum L.) cultivars. Wheat is annually planted on 10 million ha in the Southern Great Plains. Our objective was to determine the effects of wheat cultivars with different forage production potentials on the seasonal and total productivity of steers. 'Lancota' and 'NK Pro 812'(NK 812) were planted in September 1987 and October 1988 at the W.T. Waggoner Ranch in north Texas. Hereford steers (Bos taurus L.), 220 to 233 kg. were grazed from November 1987 to May 1988 and December 1988 to April 1989. Seasonal and total forage production and disappearance were affected ($p<0.05$) by season and year. Cultivar did not affect forage production and disappearance. Steer average daily gain (ADG), gain head-1, and gain ha-1 were significantly affected by year, season, year X season, and cultivar X season interactions. Steer gain ha-1 was lower ($P<0.10$) in year 2 than year 1 for both cultivars. Both gain head-1 and gain ha-1 were lower ($P<0.10$) on NK 812 than Lancota in year 2. Season long gain ha-1 followed similar trends to gain head-1. A season X year interaction ($P<0.05$) occurred because NK 812 matured earlier and was less winter hardy than Lancota. Across years steer ADG increased with herbage allowance up to 27.3 kg 100 kg BW-1 Day-1 and further increases in herbage allowance had limited effect on steer ADG. Yearly variation in environmental conditions had greater effects on steer performance and forage production than cultivar.

3267 Steenfeldt, S. (Forskningscenter, Foulum (Denmark)) (1996) **[Enzyme supply to feed high in wheat content: effect on production parametres and viscosity in broilers]. Enzymtilsaetning til foder med et hoejt hvedeindhold: effekt paa produktionsparametre og viscositet hos slagtekyllinger.** *Dansk Erhvervsfjerkrae (Denmark) v. 25(4) p. 96-98.* 3 tables; 5 ref. Danish. (AGRIS 97-036168).

3268 Terui, H. (Kansas State University, Manhattan.); Morrill, J.L.; Higgins, J.J. (1996) **Evaluation of wheat gluten in milk replacers and calf starters.** *Journal of dairy science (USA) v. 79(7) p. 1261-1266.* references. English. (AGRIS 97-036192).

Two trials were conducted to evaluate wheat gluten as an ingredient in calf feeds. In one trial, Holstein bull calves (n = 120) were assigned for 6 wk to one of five milk replacers, which contained different percentages of CP and different percentages of protein furnished from soluble wheat gluten. Within a given protein percentage, BW gains of calves were not affected by the percentage of protein that was supplied as wheat gluten. Calves fed milk replacer containing 18 CP with 33 wheat gluten gained as much as calves fed replacers containing 20 CP. In another trial, newborn Holstein calves (n = 62) were used. Protein supplements of the calf starters used until 7 wk of age were either soybean meal or spray-dried wheat gluten and soybean meal. No significant differences were observed between the two treatments. Also, no significant carry-over effect occurred when all calves received a common diet from 7 to 10 wk of age.

3269 Villalba, JJ.; Provenza, FD. (1997) **PREFERENCE FOR WHEAT STRAW BY LAMBS CONDITIONED WITH INTRARUMINAL INFUSIONS OF STARCH.** *British Journal of Nutrition. 77(2):287-297.* English. [UTAH STATE UNIV DEPT RANGELAND RESOURCES LOGAN, UT 84322 USA].

We hypothesized that feed preference depends on the interplay between flavour and postingestive effects, and we tested two predictions based on this hypothesis: (1) lambs acquire preferences for poorly nutritious feeds paired with starch; and (2) preferences persist when starch is no longer administered. Twenty lambs were randomly allocated to two groups and conditioned as follows: on odd-numbered days, lambs in group 1 received onion-flavoured wheat straw and lambs in group 2 received oregano-flavoured wheat straw. On even-numbered days, the flavours were switched and starch (2.5-9.4 % of the digestible energy received/d) was infused into the rumen of all animals during straw consumption. Four periods of 8 d of conditioning were performed and on the 9th day of each period all animals were offered a choice between onion- and oregano-flavoured straw. After conditioning, starch administration was suspended and lambs were offered onion- and oregano-flavoured straw at weekly intervals for 8 weeks (extinction). Lambs strongly preferred the flavoured straw paired with starch, and this preference persisted during extinction. Thus, these results suggest that the postingestive effects of energy play an important role in the development of feed preferences of ruminants. [References: 43].

L51 ANIMAL PHYSIOLOGY-NUTRITION

3270 Bergero, D. (Turin Univ. (Italy). Dipartimento di Produzioni Animali, Epidemiologia ed Ecologia); Nardi, S. (1996) **[Eating time of some feeds for saddle horses reared in Italy]. Tempi di consumo di alcuni alimenti in cavalli da sella allevati in Italia.** *O con DV Obiettivi e Documenti Veterinari (Italy) v. 17(1) p. 63-67.* 2 tables; 1 graph; 16 ref. Italian. (AGRIS 97-051853).

Eating time required for 1 kg oats, wet oats, crushed oats, oats pellets, barley, wet barley, crushed barley, barley flakes, maize, broken maize, maize flakes, maize pellets, hay and wet hay have been measured. For hay, 33' have been required as an average, and differences were found between normal and wet presentation. For all cereals, eating mean time was about 10'; differences were found for oats, barley and maize among the treatments. Daily eating time was found to be variable depending on the diet composition; this could involve possible effects on the arise of behaviour troubles Sono stati controllati i tempi di assunzione di 1 kg dei seguenti alimenti: avena (intera asciutta, intera bagnata, schiacciata, pellettata); orzo (intero asciutto, intero bagnato, schiacciato, pellettato); mais (intero, frantumato, fioccato, pellettato); fieno (asciutto, bagnato). Il tempo medio di assunzione del foraggio e' risultato di 33 minuti circa, con differenze dovute al trattamento. Il tempo medio di assunzione dei cereali e' risultato prossimo ai dieci minuti, senza differenze significative tra gli alimenti, ma con differenze dovute al trattamento subito. Il tempo di assunzione dell'intera razione e' risultato considerevolmente variabile in dipendenza dalla sua composizione, con possibili riflessi sulla insorgenza di turbe comportamentali.

3271 Cilliers, SC.; Hayes, JP.; Chwalibog, A.; Dupreez, JJ.; Sales, J. (1997) **A COMPARATIVE STUDY BETWEEN MATURE OSTRICHES (STRUTHIO CAMELUS) AND ADULT COCKERELS WITH RESPECT TO TRUE AND APPARENT METABOLISABLE ENERGY VALUES**

FOR MAIZE, BARLEY, OATS AND TRITICALE. *British Poultry Science. 38(1):96-100.* English. [LITTLE KAROO AGR CTR POB 313 ZA-6620 OUDTSHOORN SOUTH AFRICA].

1. In three successive trials with cockerels and mature ostrich males the apparent and true metabolisable energy values, corrected for nitrogen retention (AME(n) and TME(n)) were determined by a balance method for malting barley, oats, triticale and yellow maize. AU these ingredients were used as sole dietary components with the exception of triticale for ostriches which was diluted with 440 g/kg; lucerne meal. The balance trial lasted for 5 d after an adaption period of 7 d for ostriches, and 3 d after an adaption period of one day for cockerels. 2. AME(n) values for cockerels of malting barley, oats, triticale and maize were 11.6, 10.48, 11.44 and 14.42 MJ/kg respectively. Significantly higher values of 14.21, 12.65, 12.60 and 14.89 MJ/kg were determined for malting barley, oats, triticale and maize for ostriches. 3. TME(n) values determined by regression yielded values in ostriches of 13.92, 12.27, 13.21 and 15.22 MJ/kg for malting barley, oats, triticale and maize respectively. The corresponding TME(n) values in cockerels were 11.33, 10.63, 11.82 and 14.07 MJ/kg. 4. The ostrich is capable of utilising fibre more efficiently than poultry. The higher energy values observed for the various ingredients also indicated that the non-starch polysaccharides such as beta-glucans and arabinoxylans in the more fibrous energy sources had little if any effect on the available energy of these ingredients as found with poultry. 5. The potential of ostriches to utilise the more fibrous energy sources like barley, oats and triticale allows for their economical use in diet formulation. This possibility may result in markedly lower food costs for ostriches. [References: 19].

3272 Huntington, GB. (1997) STARCH UTILIZATION BY RUMINANTS - FROM BASICS TO THE BUNK. *Journal of Animal Science. 75(3):852-867.* English. [104 TROTTERS RIDGE DR RALEIGH, NC 27614 USA].

Starch is the major energy component of grains. Wheat contains 77% of DM as starch, corn and sorghum contain 72%, and barley and oats contain 57 to 58%. In vitro systems have provided valuable data on kinetic aspects of starch digestion. Molecular biological techniques have provided a clearer picture of the ruminal microbial milieu. Proportions of starch fermented in the rumen can be predicted satisfactorily for a variety of grains and processing methods. Compared with dry rolling, steam processing (flaking or rolling) increases ruminal digestibility of starch (percentage of intake) from 52 to 78% for sorghum, from 75 to 85% for corn, and six percentage units or less for other grains. Recent research provides new insight into pancreatic function and intestinal glucose transport systems. The capacity to digest starch in the intestine ranges from 45 to 85% of starch entering the duodenum, with that capacity apparently limited by the supply of pancreatic amylase. There is evidence that amylase secretion may be enhanced by increasing duodenal entry of protein. Capacity for active transport of glucose across the gut wall does not seem to limit the amount of starch digested that is absorbed as glucose. For ruminants eating medium- to high-concentrate diets, about 30% of their total glucose need comes from glucose absorption, 50% from organic acid absorption (substrates for hepatic gluconeogenesis), and 20% from other sources. When glucose absorption from the gut increases, ruminants generally adjust (decrease) gluconeogenesis to meet their need; that need is directly linked to DE intake. In terms of overall ME yield, grain starch is best used when it is fermented in the rumen. However, close coordination of protein and starch supply to the duodenum may improve capture of starch in the form of glucose. [References: 116].

3273 Kadim, IT.; Moughan, PJ. (1997) DEVELOPMENT OF AN ILEAL AMINO ACID DIGESTIBILITY ASSAY FOR THE GROWING CHICKEN - EFFECTS OF TIME AFTER FEEDING AND SITE OF SAMPLING. *British Poultry Science. 38(1):89-95.* English. [MASSEY UNIV DEPT ANIM SCI MONOGASTR RES CTR PALMERSTON NORTH NEW ZEALAND].

1. The study aimed to establish the optimum time after ingestion and optimum sampling site for the development of an ileal amino acid digestibility assay for broiler chickens. 2. To establish the optimal sampling time, 4-week-old broiler chickens were given one of 6 protein sources (meat-and-bone, soyabean, cottonseed, fish, maize and wheat meals) as the sole source of protein in a test diet. The diets contained chromic oxide as an indigestible marker. The birds were starved for 24 h, fed and subsequently killed for sampling of ileal digesta (terminal 15 cm) at 2, 3, 4, 5 and 6 h after the start of feeding. 3. For the soyabean, fish, wheat and maize meal diets, sampling time had no significant effect on apparent ileal nitrogen digestibility, whereas for the meat-and-bone and cottonseed meal diets there was a significant quadratic effect of sampling time. The amount of digesta collected was maximised and the mean apparent ileal nitrogen digestibility had the lowest variation around the 4 h sampling time. 4. To establish the optimum sampling site, 4-week-old chickens were given either a meat-and-bone, a soyabean or a wheat bran meal-based diet. The birds were killed 4 h after the start of feeding and digesta were sampled from 0-10, 0-15, 0-20 or 0-25 cm of terminal ileum. 5. There was no significant effect of sampling site on the apparent ileal digestibility of dietary nitrogen. The terminal 15 cm of ileum was considered a preferred site for sampling ileal digesta from broiler chickens. [References: 25].

3274 Kanauchi, O.; Agata, K.; Fushiki, T. (1997) MECHANISM FOR THE INCREASED DEFECATION AND JEJUNUM MUCOSAL PROTEIN CONTENT IN RATS BY FEEDING GERMINATED BARLEY FOODSTUFF. *Bioscience Biotechnology & Biochemistry. 61(3):443-448.* English. [KIRIN BREWERY CO LTD CORP RES & DEV DIV APPL BIORES CTR 3 MIYAHARACHO TAKASAKISHI GUNMA 37012 JAPAN].

We investigated the effects of germinated barley foodstuff (GBF) on the fecal excretion and jejunum mucosal protein content in male Sprague-Dawley rats fed on various diets with the same protein and dietary fiber levels, Under these experimental conditions, GBF was confirmed to induce greater fecal output compared with commercial water-soluble or -insoluble dietary fibers, While the dietary fiber extracted from CBF increased the fecal output and mucosal protein content, the protein fraction of GBF degraded to the peptide form did not increase the fecal output or mucosal protein content, Increased mucosal protein and fecal output were thus found to require the presence of the dietary fiber fraction or possibly the protein fraction bound tightly to the dietary fiber of GBF, GBF feeding increased the volatile fatty acids concentration in the cecum, indicating that GBF may be efficiently fermented in the intestinal tract. [References: 38].

3275 Kanauchi, O.; Nakamura, T.; Agata, K.; Fushiki, T. (1997) PREVENTIVE EFFECT OF GERMINATED BARLEY FOODSTUFF ON DIARRHEA INDUCED BY WATER-SOLUBLE DIETARY FIBER IN RATS. *Bioscience Biotechnology & Biochemistry. 61(3):449-454.* English. [KIRIN BREWERY CO LTD CORP RES & DEV DIV APPL BIORES CTR 3 MIYAHARACHO TAKASAKISHI GUNMA 37012 JAPAN].

We investigated the preventive effect of germinated barley foodstuff (GBF) added to the diet on diarrhea induced by the dietary water-soluble dietary fibers, polydextrose, hemicellulose, and poly-acrylic acid sodium salt, in Sprague-Dawley rats, The minimum content of GBF necessary for blocking diarrhea was 3% (by weight) of the diet, Since GBF is mainly derived from the aleurone and scutellum of malted barley, we assessed the physiological effects of the aleurone and scutellum fractions derived from barley grains before and after germination, The addition of fractions containing only germinated barley, and not barley collected before germination, increased the fecal output and jejunal mucosal protein content, The effects of malted barley were very similar to those of GBF, It was concluded that germination was necessary to bring about the physiological effects of GBF, Since non-lignified hemicellulose and Gln-rich protein were newly synthesized during germination, these might have contributed to the increased fecal output and jejunal mucosal protein content. [References: 31].

3276 Makinen, M.; Siljanderrasi, H. (1996) APPARENT ILEAL DIGESTIBILITY OF AMINO ACIDS IN WET WHEAT PROTEIN AND SOYA BEAN MEAL FOR GROWING PIGS. *Agricultural & Food Science in Finland. 5(6):547-555.* English. [AGR RES CTR FINLAND SWINE RES STN TERVAMAENTIE 179 FIN-05840 HYVINKAA FINLAND].

A study was conducted on four castrated male pigs to determine the apparent ileal digestibility (AID) of crude protein (CP) and amino acids in wheat protein (WP), a wet by-product of the starch and gluten industry, and in soya bean meal (SBM). The pigs were fitted with a steered ileo-caecal valve cannula at a liveweight of 35 kg. They were assigned to two semi-purified wheat starch based diets, with either WP or SBM as a sole protein source, and fed according to a three-period reversal design. The diets were formulated to contain 140 g CP/kg DM, 11.3 MJ net energy/kg DM and similar amounts of lysine, methionine and threonine. The CP control and the lysine and threonine contents in CP were lower in WP than in SBM. Nearly half of the DM in WP was starch, and the crude fibre content of the product was very low. The apparent ileal and total tract digestibilities of CP were very similar in both the WP and SBM diets. The

AID of methionine was higher in WP (88.2%) than in SBM (84.6%) diets (P<0.01) but no differences were found in the AID of the other amino acids. The results show that the AID values of CP and amino acids in WP in growing pigs are comparable to those in SBM. [References: 31].

3277 Martin, C. (INRA Theix, Saint Genes Champanelle, France.); Bernard, L.; Michalet Doreau, B. (1996) **Influence of sampling time and diet on amino acid composition of protozoal and bacterial fractions from bovine ruminal contents.** *Journal of animal science (USA) v. 74(5) p. 1157-1163.* references. English. (AGRIS 97-036981).

Four ruminally cannulated cows were used to compare amino acid (AA) composition of protozoal and bacterial fractions as affected by sampling time and diet. Cows were given once a day restricted feed (80 of ad libitum intake) of 7 kg DM with two successive diets. Diet HB was 65 Cocksfoot hay and 35 pelleted ground barley, and Diet H was 100 Cocksfoot hay. Samples of whole ruminal contents were taken 2, 5, 8, 11, and 23 h after feeding for Diet HB and 2 h after feeding for Diet H to isolate the liquid-associated protozoa and bacteria (LAP, LAB) and particle-associated bacteria (PAB). At each sampling time, the AA compositions of the different microbial populations were determined. The AA profiles of the LAP were different from those of the bacteria for 13 AA out of 17 studied. Difference between AA compositions of LAB and PAB were also observed for 10 AA out of 17 studied. Irrespective the microbial population, AA composition did not vary with sampling time after feeding diet HB (P > 0.05; except for arginine, glutamate, and glycine). The A contents of none of the three microbial population were affected (P > 0.05) by the diet except for leucine and glutamate (P < 0.01). The differences in AA profiles between LAP and bacteria and between LAB and PAB confirm the importance of the representativeness of the microbial reference sample for correctly estimating microbial AA flow into the small intestine.

3278 Noziere, P.; Michaletdoreau, B. (1997) **EFFECTS OF AMOUNT AND AVAILABILITY OF STARCH ON AMYLOLYTIC ACTIVITY OF RUMINAL SOLID-ASSOCIATED MICROORGANISMS.** *Journal of the Science of Food & Agriculture. 73(4):471-476.* English. [INRA STN RECH NUTR HERBIVORES F-63122 ST GENES CHAMPANELLE FRANCE].

Three ruminally cannulated dry cows were used in an experiment designed as a Latin square to investigate the effects of amount and availability of starch on the amylolytic activity of ruminal solid-associated microorganisms (SAM). Animals were fed twice daily a diet (7 kg DM day(-1)) consisting of wheat straw, cocksfoot hay and ground barley in the ratios 10:90:0, 10:60:30 and 10:30:60. Nylon bags containing rapidly (barley) or slowly (maize) degradable cereal grains were incubated in the rumen. Enzymes of the SAM were extracted from rumen contents and bag residues, and amylolytic (amylase and alpha-D-glucosidase) activities were measured. The in situ degradation of starch was determined. Increasing the level of barley in the diet induced a linear increase in amylase activity of SAM in the rumen contents. In the bags, amylase activity and starch degradation rate were not modified by supplementation. High activity was observed more rapidly in bags containing barley, where starch is rapidly available, than in bags containing maize, where starch is protected by a resistant endosperm. These results suggest that amylolytic activity of SAM may depend on the amount of starch available to microorganisms. [References: 35].

3279 Peterson, DM.; Qureshi, AA. (1997) **EFFECTS OF TOCOLS AND BETA-GLUCAN ON SERUM LIPID PARAMETERS IN CHICKENS.** *Journal of the Science of Food & Agriculture. 73(4):417-424.* English. [ARS USDA CEREAL CROPS RES UNIT 501 WALNUT ST MADISON, WI 53705 USA].

Cereal grain diets affect serum lipids by their soluble fibre and tocotrienols. Chickens were fed diets containing an oat bran fraction or waxy hulless barley that were enriched or depleted in beta-glucan and/or tocotrienols. Serum cholesterol and triacylglycerides and enzymes of cholesterol metabolism were measured. Weight gains appeared to be lower in birds on oat bran fraction-containing diets and higher in those on barley-containing diets supplemented with beta-glucanase. All diets containing oat bran fraction or barley lowered serum total cholesterol and low-density-lipoprotein (LDL) cholesterol relative to the corn control diet. LDL cholesterol was reduced more by oat bran fraction supplemented with tocotrienols than by either oat bran fraction or tocotrienols alone. LDL cholesterol levels were the same for all barley-based diets. Activities of beta-hydroxy-beta-methylglutaryl coenzyme A (HMG CoA) reductase and cholesterol 7 alpha-hydroxylase were inversely affected by the diets. Oat bran fraction plus tocotrienols, barley and solvent-extracted barley decreased HMG CoA reductase by 50% and increased cholesterol 7 alpha-hydroxylase by 100%; other diets caused lesser effects. It was concluded that both beta-glucan and tocotrienols affected cholesterol levels and metabolism, and the effects were additive or less. Removal of beta-glucan from barley diets abolished or diminished effects on enzyme activities but did not alter effects on cholesterol levels, indicating the possibility of another component in barley that affected cholesterol levels. [References: 54].

3280 Scott, TA.; Boldaji, F. (1997) **COMPARISON OF INERT MARKERS [CHROMIC OXIDE OR INSOLUBLE ASH (CELITE(TM))] FOR DETERMINING APPARENT METABOLIZABLE ENERGY OF WHEAT- OR BARLEY-BASED BROILER DIETS WITH OR WITHOUT ENZYMES.** *Poultry Science. 76(4):594-598.* English. [AGR & AGRI FOOD CANADA POB 1000 AGASSIZ BC V0M 1A0 CANADA].

A broiler chick bioassay was used to measure the effect of two inert digestibility markers on the determination of dietary AME. Diets contained 80% of either wheat or barley (with or without enzyme) and either chromic oxide at 0.5% or one of three levels of insoluble ash (0.5, 1.0, or 1.5%) as markers. The various cereal and marker diet combinations were consumed ad libitum (0 to 21 d) by two groups of 10 male broilers in each of two trials. The AME of each diet was determined by measuring the respective marker ratios between diet and excreta (collected for 24 h at 7 or 21 d) or ileal digesta collected at 21 d. Growth and feed conversion were measured on each group of birds between 0 and 21 d. There was no effect of marker on growth or feed efficiency. However, determination of AME of wheat- or barley-based diets with or without enzymes were affected by choice of marker and whether markers were measured in excreta (7 or 21 d) or ileal digesta. Chromic oxide was viewed as the least accurate method for determining AME, based on chromic oxide's inability to define AME differences between barley-based diets with and without enzymes, whereas insoluble ash clearly demonstrated improved AME of wheat- and barley-based diets with an enzyme. The optimum levels of insoluble ash for accuracy and repeatability were between 0.5 and 1.0%. The AME of the diets were, on average, 5% lower when determined with 7 vs 21 d excreta and 2.5% lower for ileal digesta than excreta collected at 21 d. It was concluded that identification of components that result in variability in AME levels of diets will be improved if a bioassay uses insoluble ash as a marker. [References: 18].

3281 Valaja, J.; Siljanderrasi, H.; Makinen, M. (1996) **EFFECTS OF FEED PROCESSING ON THE APPARENT ILEAL DIGESTIBILITY OF AMINO ACIDS IN PIG DIETS CONTAINING WHEAT BRAN OR WHEAT MIDDLINGS.** *Agricultural & Food Science in Finland. 5(6):557-565.* English. [AGR RES CTR FINLAND INST ANIM PROD FIN-31600 JOKIOINEN FINLAND].

The effects of feed processing on the apparent ileal digestibility of amino acid and the utilisation of nitrogen (N) in diets containing wheat by-products were studied in five castrated male pigs (live weight 40-109 kg). A T-cannula was surgically fitted into the caecum of the pigs at a live weight of 27 kg using the steered ileo-caecal valve technique. The experiment was conducted with a 6 x 5 cyclic change-over design in which six diets were arranged 2 x 3 factorially. The corresponding factors were type of wheat by-product in the diets: wheat bran (152 g/kg) or wheat middlings (328 g/kg), and method of feed processing: steam pelleting, expanding or extrusion. The other dietary feed ingredients were barley and soya bean meal. The feed-processing method or dietary wheat by-product had no effect on the apparent ileal digestibility of amino acids and crude protein. The pigs on diets containing wheat middlings tended to retain more N per intake (p<0.10) than did those on wheat bran diets. The wheat middlings diets also tended to have higher biological values than did the wheat bran diets (p<0.10). Further, daily N retention tended to be better with expanding than with pelleting (p<0.10). The N retention differences were mainly caused by the differences in N intakes of the treatments. In conclusion, feed processing at a moderate temperature or wheat by-product in the diets had no influence on the apparent ileal digestibility of amino acids. [References: 28].

L74 MISCELLANEOUS ANIMAL DISORDERS

3282 Harvey, R.B. (USDA, ARS, Food Animal Protection Research Laboratory, College Station, TX.); Edrington, T.S.; Kubena, L.F.; Elissalde,

M.H.; Casper, H.H.; Rottinghaus, G.E.; Turk, J.R. (1996) **Effects of dietary fumonisin B1-containing culture material, deoxynivalenol-contaminated wheat, or their combination on growing barrows.** *American journal of veterinary research (USA) v. 57(12) p. 1790-1794.* references. English. (AGRIS 97-038966).

N10 AGRICULTURAL STRUCTURES

3283 Schwab, C.V. (Iowa State University, Ames, IA.); Ross, I.J.; White, G.M.; Colliver, D.G. (1996) **Wheat loads and vertical pressure distribution in a full-scale bin. II. Detention.** *Transactions of the ASAE (USA) v. 39(3) p. 1145-1149.* references. English. (AGRIS 97-039266).

The vertical loads imposed on a full-scale bin floor by wheat were measured during a storage time of 6 h. The floor loads were determined to be dependent on the length of storage time. A linear regression model was developed to predict this change in loads in relation to detention time. The linear regression equation had coefficient of determination values ranging from 0.230 to 0.817. Analysis of the model slopes also indicated that fill height and radial location affect the vertical floor loads with a statistical significance level of 0.05. The radial distribution of vertical pressure during detention was measured. The vertical pressure distribution is dependent on radial location and is not uniformly distributed. Radial location significantly influenced the vertical pressure at the 0.05 significance level. The distribution pattern is similar to the filling condition.

N20 AGRICULTURAL MACHINERY AND EQUIPMENT

3284 Boisgontier, D. (Institut Technique des Cereales et des Fourrages, Paris (France)); Lajoux, P. (1996) **[Technical sheet: the Huard drills SD 3000 and SD 4000]. Fiche technique: les semoirs Huard SD 3000 et SD 4000.** *Perspectives Agricoles (France) (no 214) p. 31-32.* French. (AGRIS 97-039277).

Le semoir pour semis direct SD 3000 a ete concu pour implanter un ble derriere mais.Il a garde les principales caracteristiques de son predecesseur. La principale evolution concerne le chassis. Il est maintenant compose de deux modules articules autour d'un pivot central. Le principe de travail est toujours de type triple disques.

P33 SOIL CHEMISTRY AND PHYSICS

3285 Berner, A.; Scherrer, D.; Niggli, U. (Research Institute of Organic Agriculture, Bernhardsberg, CH 4104 Oberwil (Switzerland)) (1995) **Effect of different organic manures and garden waste compost on the nitrate dynamics in soil, N uptake and yield of winter wheat.** *Nitrogen leaching in ecological agriculture. Proceedings of an International Workshop, Royal Veterinary and Agricultural University, Copenhagen, Denmark. Kristensen, L.; Stopes, C.; Kolster, P.; Granstedt, A.; Hodges, D. (eds.) p. 289-300.* AB Academic Publishers. 6 ref. English. (AGRIS 97-055186).

3286 Carman, K. (1997) **EFFECT OF DIFFERENT TILLAGE SYSTEMS ON SOIL PROPERTIES AND WHEAT YIELD IN MIDDLE ANATOLIA.** *Soil & Tillage Research. 40(3-4):201-207.* English. [UNIV SELCUK FAC AGR DEPT AGR MACHINERY TR-42031 KONYA TURKEY].

Field experiments were conducted on a clay soil in entisol to determine the effect of different tillage tools on soil properties, emergence rate index and yield of wheat in Middle Anatolia. There were four different tillage treatments: mouldboard ploughing followed by disc harrowing twice; rotary tillage twice; stubble cultivator followed by a disc harrowing; heavy globe disc twice. The smallest aggregate mean weight diameters and surface roughness were produced by rotary tillage. Decreasing mean weight diameter decreased the surface roughness. There was a significant ($P < 0.01$) effect of the four different tillage systems on moisture content, bulk density, penetration resistance, aggregate mean weight diameter and surface roughness. Tillage systems had a significant effect on emergence rate and yield of wheat. Emergence rate index and yield of wheat varied from 15.24 to 18.88 and from 3065 kg ha(-1) to 4265 kg ha(-1), respectively. The greatest emergence rate index and yield were obtained with stubble cultivator followed by disc harrowing treatment. [References: 14].

3287 Castrignano, A.; Colucci, R.; Degiorgio, D.; Rizzo, V.; Stelluti, M. (1997) **TILLAGE EFFECTS ON PLANT EXTRACTABLE SOIL WATER IN A SILTY CLAY VERTISOL IN SOUTHERN ITALY.** *Soil & Tillage Research. 40(3-4):227-237.* English. [IST SPERIMENTALE AGRONOM AGRONOM RES INST VIA CELSO ULPIANI 5 I-70125 BARI ITALY].

This paper describes how the CERES-Wheat simulation model can be used to estimate tillage effects on soil water regimes of a silty clay soil in Foggia, Southern Italy. The four tillage treatments compared are traditional mouldboard ploughing, ripper subsoiling, surface disc-harrowing and minimum tillage with rotary hoeing under continuous durum wheat cropping. For each tillage treatment the CERES-Wheat model was used to calculate the water balance for several layers in the root zone. The water balance routine of the model estimates the water content within saturation and the lower limit at any time, Inputs required by the model are some basic information about the site, weather, genetic parameters and management practices as well as some soil properties, such as albedo, bulk density, organic matter and N contents, The model was calibrated by estimating the genetic parameters for the minimum tillage treatment in the season 1984-85. The same set of parameters was used for the subsequent validation procedure, Statistical tests proved that the match between measured and simulated soil water content values was quite good, The simulation results also showed some differences among different tillage treatments. The model predicted the lowest plant extractable soil water values and a different water content distribution along the soil profile of the ripper subsoiling in comparison with the other tillage treatments. The soil water content was lower until 20-40 cm depth and higher at 40-60 cm depth in the ripper treatment as compared with the others. In deeper layers differences became non-significant, This might be due to the cracks produced by the ripper through which rainfall infiltrated in deep layers. [References: 14].

3288 Cheng Jianping (Sichuan Agricultural Univ., Ya'an (China)) (1995) **Study on content of available silicon and effect of silicon fertilizer on wheat growth in paddy soil of Sichuan, China.** *Resource Development and Market (China) v. 11(5) p. 220-223.* 6 tables; 10 ref. Chinese. (AGRIS 97-055182).

3289 Holford, ICR. (1997) **SOIL PHOSPHORUS - ITS MEASUREMENT, AND ITS UPTAKE BY PLANTS.** *Australian Journal of Soil Research. 35(2):227-239.* English. [8 RUTHNING AVE TAMWORTH NSW 2340 AUSTRALIA].

Phosphorus (P) is the most important nutrient element (after nitrogen) limiting agricultural production in most regions of the world. It is extremely chemically reactive, and more than 170 phosphate minerals have been identified. In all its natural forms, including organic forms, P is very stable or insoluble, and only a very small proportion exists in the soil solution at any one time. Plant-available P may be considered in either its quantitative or intensive dimension. The quantity of available P is time-specific and crop-specific, because it is the amount of P that will come into the soil solution and be taken up by the crop during its life cycle. The intensity of available P (availability) is most easily identified with its concentration in the soil solution. The soil property controlling the relationship between the solid phase P and its concentration in solution is known as the buffering capacity. The solid phase P involved in this relationship is only a small proportion of the total P, and is known as labile P. It is usually measured by isotopic exchange, but this exchangeable P component does not include the sparingly soluble compounds that also replenish the soil solution as its concentration is depleted by plant uptake. The buffering capacity is the ability of the soil solution to resist a change in its P concentration as P is removed by plant uptake or added in fertilisers or organic materials. Buffering capacity is synonymous with sorptivity, which is a preferable term in the context of the reactivity of P fertiliser with soil. It is usually measured from an adsorption isotherm. By fitting a suitable equation, such as the Langmuir, the total sorption capacity as well as the sorption strength can be determined. Both parameters are important in understanding P availability in soils. Buffering capacity has a major effect on the uptake of labile P because it is inversely related to the ease of desorption of solid phase P and its diffusion. available P therefore is a direct function of the quantity of labile P and an inverse function of buffering capacity. This has been demonstrated in plant uptake studies. Similarly, the most effective methods of measuring available P (soil tests) are those which remove a proportion of labile P that is inversely related to buffer capacity. Soil tests which measure the concentration of P in solution actually measure availability rather than available P, and their efficacy on a

range of soils will depend on the uniformity of the soils' buffer capacities. The most effective soil test usually consists of an anionic extractant. Acidic lactate or fluoride have been found most effective in New South Wales, on a wide range of soils, except calcareous soils which neutralise the acidic component (usually hydrochloric or acetic acid) of the extractant. Sodium bicarbonate (pH 8.5) has been found effective on calcareous soils and is widely used throughout the world. It has proved unreliable on NSW soils, and may need more thorough evaluation on non-calcareous soils in other parts of Australia. [References: 33].

3290 Jensen, ES. (1997) **NITROGEN IMMOBILIZATION AND MINERALIZATION DURING INITIAL DECOMPOSITION OF N-15-LABELLED PEA AND BARLEY RESIDUES.** *Biology & Fertility of Soils. 24(1):39-44.* English. [RISO NATL LAB PLANT NUTR ENVIRONM SCI & TECHNOL DEPT DK-4000 ROSKILDE DENMARK].

The immobilization and mineralization of N following plant residue incorporation were studied in a sandy loam soil using N-15-labelled field pea (Pisum sativum L.) and spring barley (Hordeum vulgare L.) straw. Both crop residues caused a net immobilization of soil-derived inorganic N during the complete incubation period of 84 days. The maximum rate of N immobilization was found to 12 and 18 mg soil-derived N g(-1) added C after incorporation of pea and barley residues, respectively. After 7 days of incubation, 21% of the pea and 17% of the barley residue N were assimilated by the soil microbial biomass. A comparison of the N-15 enrichments of the soil organic N and the newly formed biomass N pools indicated that either residue N may have been assimilated directly by the microbial biomass without entering the soil inorganic N pool or the biomass had a higher preference for mineralized ammonium than for soil-derived nitrate already present in the soil. In the barley residue treatment, the microbial biomass N was apparently stabilized to a higher degree than the biomass N in the pea residue treatment, which declined during the incubation period. This was probably due to N-deficiency delaying the decomposition of the barley residue. The net mineralization of residue-derived N was 2% in the barley and 22% in the pea residue treatment after 84 days of incubation. The results demonstrated that even if crop residues have a relative low C/N ratio (15), transient immobilization of soil N in the microbial biomass may contribute to improved conservation of soil N sources. [References: 28].

3291 Leclerc, B.; Georges, P.; Cauwel, B.; Lairon, D. (Orgaterre, Rue Costa Cauda, 84160 Cucuron (France)) (1995) **A five year study on nitrate leaching under crops fertilised with mineral and organic fertilisers in lysimeters.** *Nitrogen leaching in ecological agriculture. Proceedings of an International Workshop, Royal Veterinary and Agricultural University, Copenhagen, Denmark. Kristensen, L.; Stopes, C.; Kolster, P.; Granstedt, A.; Hodges, D. (eds.) p. 301-308.* AB Academic Publishers. 12 ref. English. (AGRIS 97-055132).

3292 Li Kaiyang (Academia Sinica, Yangling, Shaanxi (China). Northwest Inst. of Soil and Water Conservation) (1996) **Quantitative evaluation of moisture condition and yield responses in crop fields on rain-fed eroded loess farmland in Shaanxi, China.** *Chinese Journal of Soil Science (China) v. 27(2) p. 58-60.* 6 tables; 4 ref. Chinese. (AGRIS 97-055180).

3293 Li Xiaolin (Beijing Agricultural Univ. (China). Dept. of Plant Nutrition) (1995) **Uptake of nutrients from subsoil by wheat as affected P supply under different soil moistures.** *Plant Nutrition and Fertilizer Sciences (China) v. 1(2) p. 40-46.* 6 tables; 16 ref. Chinese. (AGRIS 97-055181).

3294 Matula, J. (Research Institute of Crop Production, Prague, Czech Republic.) (1996) **Determination of potassium, magnesium, phosphorus, manganese and cation exchange capacity for fertilizer recommendations used by Czech Union of rapeseed growers.** *Communications in soil science and plant analysis (USA) v. 27(5/8) p. 1679-1691.* references. Paper presented at the 1995 International Symposium on Soil Testing and Plant Analysis: Quality of Soil and Plant Analysis in View of Sustainable Agriculture and the Environment held August 5-10, 1995, Wageningen, The Netherlands. English. (AGRIS 97-040151).

The Union of Rapeseed Growers began to use a method of soil testing (KVK-UF), with a subsequent system of fertilizing, because this approach helped to re-establish a good level and balance of soil nutrients. The soil nutrients were extracted using neutral 0.5M ammonium acetate containing 0.015M NH4F. Exchangeable cations were determined by atomic absorption and phosphorus as a phosphomolybdate complex. Excess NH4OAc was washed from the soil with ethanol, then the determined exchangeable ammonium ions were related to the CEC of the soil. The relationship between the amount of extractable P and availability for the plant was evaluated in short-term experiments in plant growth chambers. The best correlation was found in tests using Fe(OH)3-impregnated paper, followed by the methods: KVK-UF, 0.01M CaCl2, EUF, Mehlich 2 and Egner (in descending order). The correction determined phosphorus values in KVK-UF extractant by CEC of soils improved the degree of correlation. This method, therefore, was the most suitable of those tested.

3295 Petersen, J.; Kjellerup, V. (1996) **[Poultry manure: production, content of nutrients and fertilizing effect]. Fjerkraegoedning: produktion, naeringsstofindhold og goedningsvirkning.** Statens Planteavlsforsoeg, Foulum (Denmark).. *Groen Viden. Landbrug (Denmark); no. 174 8 p.* SP. 5 ill., 3 tables. Danish. (AGRIS 97-040148).

3296 Schnug, E. (Federal Agricultural Research Centre, Braunschweig, Germany.); Fleckenstein, J.; Haneklaus, S. (1996) **Coca Cola is it! The ubiquitous extractant for micronutrients in soil.** *Communications in soil science and plant analysis (USA) v. 27(5/8) p. 1721-1730.* references. Paper presented at the 1995 International Symposium on Soil Testing and Plant Analysis: Quality of Soil and Plant Analysis in View of Sustainable Agriculture and the Environment held August 5-10, 1995, Wageningen, The Netherlands. English. (AGRIS 97-040160).

Coca Cola has been found to be an excellent extractant for micronutrients in soils, particular for manganese (Mn). The main ingredients of Coca Cola, phosphoric acid, reducing sugar and carbon dioxide are well proven in common extraction recipes. The overall extraction force of Coca Cola was similar to that of commonly used phosphoric acid methods. Compared to DTPA, Coca Cola extracted only 27 of iron (Fe), 38 of copper (Cu), and 86 of zinc (Zn), but 165 of Mn. Correlation coefficients for the relationship between Coca Cola-extractable Fe, Zn, and Cu in soils and element concentrations in plants were the same as by means of the DTPA method. For Mn 49 of the variability in Mn concentrations observed in field grown winter wheat plants could be explained by Coca Cola-extractable soil Mn, but only 39 when employing DTPA. The critical value for available Mn and Zn on the investigated inceptisols was 17.8 mg/kg Mn and 1.3 mg/cg Zn for Coca Cola and 9.4 mg/kg Mn and 1.8 mg/kg Zn for DTPA. Tentative critical values for Fe and Cu are 19.3 mg/kg Fe and 0.38 mg/kg Cu for Coca Cola and 73 mg/kg Fe and 0.96 mg/kg Cu for the DTPA method. Besides the better results in extracting available micronutrient fractions from soils, further advantages of Coca Cola as an extractant are its ubiquitous availability and readiness for use but also its easy and safe handling and the fact that the procedure has no harmful impacts on environment.

3297 Simard, R.R. (Agriculture and Agri Food Canada, Sainte Foy, Quebec, Canada.); Charron, G.; Pageau, D. (1996) **Field calibration of boron soil tests for barley.** *Communications in soil science and plant analysis (USA) v. 27(5/8) p. 1631-1646.* references. Paper presented at the 1995 International Symposium on Soil Testing and Plant Analysis: Quality of Soil and Plant Analysis in View of Sustainable Agriculture and the Environment held August 5-10, 1995, Wageningen, The Netherlands. English. (AGRIS 97-040208).

Boron (B) deficiencies limit crop yields on clay soils rich in organic matter in eastern Canada The objective of this study was to calibrate a B soil test for barley on Humic Cryaquepts of the Lac Saint-Jean area, province of Quebec, Canada. Two barley (Hordeum vulgare L.) cultivars were grown on 12 sites over three cropping seasons. On average, the Mehlich 3 solution extracted less B (2.8 mg/kg) than Sr-Citrate (3.2 mg/kg), but more than hot water (1.3 mg/kg), mannitol-CaCl2 (0.8 mg/kg), CaCl2 (0.6 mg/kg), and cold water (0.5 mg/kg). The response to B fertilizer was cultivar specific. The 0.01M CaCl2 solution was most closely related to barley B uptake ($r = 0.65^{**}$), whereas Mehlich 3 ($r = 0.61^{*}$) best predicted fertilizer response. The relationship between fertilizer B responsiveness by barley and amounts of soil B extracted was most improved when soil pH was included in the equation. Higher critical levels of Mehlich 3-extractable B than proposed in the literature were determined. This may be due to the large clay and ammonium oxalate-extractable aluminum (Al) contents which increase soil B sorption capacity and decrease B intensity. The results of this study suggest that soil pH should be included in a Mehlich 3-based soil test for B to predict fertilizer B needs of barley growing on these clay soils.

3298 Bevilaqua, GAP.; Broch, DL.; Possenti, JC.; Villela, FA. (1997) **EFFECT OF FERTILIZER AND SOIL MOISTURE NUTRIENT UPTAKE AND WHEAT SEEDLING ESTABLISHMENT.** *Pesquisa Agropecuaria Brasileira. 32(3):249-255.* Portuguese. [UNIV FED PELOTAS DEPT FITOTECN FAC AGRON ELISEU MACIEL CAIXA POSTAL 354 BR-96001970 PELOTAS RS BRAZIL].

The purpose of this study was to evaluate the effect of fertilizer placement and soil moisture on seedling establishment and nitrogen, phosphorus and potash uptake of wheat (Triticum aestivum L.), cv. BR-23. Ten and 20% of soil gravimetric moisture and six fertilizer placements in relation to the seeds were used: nearby the seed; 1.5 cm; 3.0 cm; 4.5 cm; 6.0 cm and 7.5 cm beside and below the seed. The experiment was conducted in plastic trays in a greenhouse. The soil used was red-yellow podzolic. The following parameters were evaluated: emergence, percentage, emergence speed, dry matter weight of aerial parts and root system, electric condutivity of soil, and nitrogen, phosphorus and potash uptake by the seedlings. The results allowed to conclude that: a) the placement that gives the best results in terms of percentage and speed of emergence is 6.3 and 7.4 cm beside and below the seeds for 20% soil moisture, and 6.7 cm for 10% soil moisture; b) 10% gravimetric moisture does not affect the emergence percentage but affects the emergence speed and dry-matter of aerial parts, and roots; c) the fertilizer applied closer to the seeds decreases the emergence percentage and the emergence speed; d) N, P and K uptake are greater where the fertilizer is closer to the seeds. [References: 15].

3299 Govedarica, M.; Milosevic, N.; Jarak, M.; Marinkovic, B.; Hadzic, V.; Ubavic, M. (Faculty of Agriculture, Novi Sad (Yugoslavia)) (1995) **Microbiological activity in soil under the conditions of growing winter wheat after sugar beet.** *Zbornik Matice srpske za prirodne nauke (Yugoslavia) (no. 88) p. 73-80.* 11 tables; 20 ref. English. (AGRIS 97-055322).

Soil samples were taken from plots under winter wheat grown after sugar beet and were analyzed for total number of microorganisms, number of ammonifiers, fungi, actinomycetes, azotobacter, oligonitrophilic bacteria, ureolitic organisms, denitrifiers and the activity of dehydrogenase, protease and urease. The number and enzymic activity of microorganisms depended on soil compaction, depth and date of sampling. The number of almost all studied groups of microorganisms, as well as enzymic activity in the compacted soil was lower than in loose soils. In the compacted soil the number of denitrifiers increased in all sampling periods. The number and enzymic activity of microorganisms decreased with depth, both in the loose and compacted soil. On average, the number and enzymic activity was the highest in the first sampling date, and the lowest in the last.

3300 Grego, S.; Colombo, L.; De Cesare, F.; Vettraino, A.M.; Badalucco, L.; Campiglia, E.; Caporali, F. (Department of Agricultural Biology and Chemistry, University of Tuscia, Viterbo (Italy)) (1995) **Examining the rhizosphere soil of wheat and barley intercropped with pea.** *Soil management in sustainable agriculture. Proceedings Third International Conference on Sustainable Agriculture, Wye College, University of London, UK, 31 August to 4 September 1993. Cook, H.F.; Lee, H.C. (eds.) p. 319-324.* Wye College Press. 8 ref. English. (AGRIS 97-055307).

3301 Marchetti, R.; Donatelli, M.; Spallacci, P. (1997) **TESTING DENITRIFICATION FUNCTIONS OF DYNAMIC CROP MODELS.** *Journal of Environmental Quality. 26(2):394-401.* English. [IST SPERIMENTALE AGRON VIALE CADUTI GUERRA I-41100 MODENA ITALY].

Denitrification (DN) has an important role in models simulating soil nitrate leaching, because denitrification losses influence the soil N budget, hence the amount of nitrate available for leaching. In spite of the importance of DN estimate, the behavior of submodels simulating DN losses is not well known. The aim of this study was to improve the knowledge of the behavior of submodels simulating DN losses in selected crop growth/N-leaching models. To remove the interference of the other processes on the results, we isolated the algorithms predicting the denitrification rate (DNR) and applied them to three data sets selected from the available literature. Denitrification subroutines were taken from the models EPIC, CropSyst, CREAMS, GLEAMS, CERES-N, and NLEAP. A preliminary sensitivity analysis emphasized how quite similar algorithms can give rise to considerably different predictions. The measured vs. predicted values comparison confirmed DNR to be remarkably affected by the soil water content (SW) relationship with soil water values at field capacity and/or at saturation. CERES-N, CREAMS, GLEAMS, and EPIC submodels underestimated even up to 100% the number of occasions where DNR > 0, since they simulated the DN process only when SW values were higher than SW at field capacity, whereas in real systems DN occurs even at lower SW values. Results suggest that DN modeling should take into greater account the contribution to DN losses during aerobic conditions. The large natural variation of DNR measurements invalidates the use of statistical criteria for the comparison of measured vs. estimated DN values in deterministic models. [References: 38].

3302 Meeus Verdinne, K. (Ministere Federal de l'Agriculture, Gembloux (Belgique). Centre de Recherches Agronomiques); Ninane, V.; Goffart, J.P.; Destain, J.P.; Francois, E. (1995) **[Rational management of nitrogen: replenishment through mineralization of three labelled green manure crops]. Gestion raisonnee de l'azote: restitution par la mineralisation de trois engrais verts marques.** International Symposium on Nuclear and Related Techniques in Soil-Plant Studies on Sustainable Agriculture and Environmental Preservation. Vienna (Austria). 17-21 Oct 1994. Nuclear techniques in soil-plant studies for sustainable agriculture and environmental preservation. Proceedings. *Proceedings Series (IAEA) p. 353-362. IAEA, Vienna (Austria); FAO, Rome (Italy).* IAEA. IAEA--STI/PUB/947. French. (AGRIS 97-055306).

3303 Mench, M.; Baize, D.; Mocquot, B. (1997) **CADMIUM AVAILABILITY TO WHEAT IN FIVE SOIL SERIES FROM THE YONNE DISTRICT, BURGUNDY, FRANCE.** *Environmental Pollution. 95(1):93-103.* English. [INRA UNITE AGRON CTR RECH BORDEAUX BP 81 F-33883 VILLENAVE DORNON FRANCE].

Preliminary results from the French ASPITET programme demonstrated that Cd background levels in agricultural soils can vary greatly (0.02-6.9 mg Cd kg(-1)) depending on parent material and pedogenic processes (Baize, 1997). However, the total Cd content in soil is often not significantly related to the Cd concentration in edible plant parts. A field case study was undertaken across the southern part of the Yonne district, Burgundy, France. This area has various soil series with either low or high geochemical Cd content in the topsoil. Cd availability in soils sampled at 16 sites belonging to five soil series was investigated using single extractions. In addition, shoots (at stem elongation) and grains (at harvest) of field-grown wheat were collected at the same sites and analysed for macronutrients and trace elements. Cd concentrations in grain varied from 0.015 to 0.146mg Cd kg(-1) DM depending on soil characteristics, soil series, and plant mineral composition. Cd grain concentrations did not reflect total Cd content in the surface soil layer, however, they were correlated with Cd extracted by a 0.1 M calcium nitrate unbuffered solution, and to a lesser extent with either soil pH or CEC. These three parameters may be useful guides to predict Cd in wheat grain harvested in the Yonne district. An inverse relationship was found between Cd and Cu contents in grain. The highest Cd concentrations in wheat grain occurred in plants grown on Aubues soils which had marginal Cu and Zn deficiencies in shoots. In order of Cd accumulation in wheat grain, soil series may be ranked as follows. DomCrien < Carixien, Terres Noires < Sols Marron < Aubues. (C) 1997 Elsevier Science Ltd. [References: 42].

3304 Murphy, PJ.; Langridge, P.; Smith, SE. (1997) **CLONING PLANT GENES DIFFERENTIALLY EXPRESSED DURING COLONIZATION OF ROOTS OF HORDEUM VULGARE BY THE VESICULAR-ARBUSCULAR MYCORRHIZAL FUNGUS GLOMUS INTRARADICES.** *New Phytologist. 135(2):291-301.* English. [UNIV LONDON WYE COLL DEPT BIOCHEM & BIOL SCI ASHFORD TW25 5AH KENT ENGLAND].

A model system was developed for the molecular analysis of plant-mycorrhizal fungus interactions using Hordeum vulgare cv. Galleon and Glomus intraradices Schenk and Smith. High levels of early-colonization stage mycorrhizas (20-35 % of the total root length) were routinely obtained in the roots of 12-14-d-old barley seedlings. Detailed colonization studies showed that most colonization occurred in the first 5-10 lateral roots, and that colonization in primary roots and younger lateral roots was low. Differential screening of a cDNA library prepared from the highly colonized region of the root system and subsequent northern analyses

identified four differentially expressed cDNA clones. Two clones, BMR6 and BMR78, detect RNA transcripts that accumulate to much higher levels in mycorrhizal roots than in non-mycorrhizal root tissues. DNA hybridization analysis confirmed that both of the clones were of plant rather than fungal origin. Hybridization and sequence analysis strongly suggests that BMR78 represents a partial cDNA of a low copy proton-ATPase gene. This finding is consistent with the extensive proliferation of the periarbuscular membrane and high ATPase activity associated with it. BM6 detects a low copy gene whose function is unknown. [References: 47].

3305 Sharma, P.; Swarup, A. (1997) **COMPARISON OF PYRITES VARYING IN WATER-SOLUBLE SULFUR WITH GYPSUM FOR THE RECLAMATION OF ALKALI SOILS UNDER A RICE-WHEAT ROTATION.** *Biology & Fertility of Soils. 24(1):96-101.* English. [CENT SOIL SALIN RES INST KARNAL 132001 HARYANA INDIA].

We evaluated the effect of agricultural-grade (AG) pyrites (total sulfur 22%) varying in water-soluble sulfur (1-8%) and gypsum on the soil properties and yields of rice and wheat in alkali soils during the years 1993-1995 at the Gudha and Saraswati experimental farms at the Central Soil Salinity Research Institute, Karnal, India. Gypsum and pyrites were applied on the basis of gypsum requirement (GR) of the soils. Results showed that the efficiency of AG pyrites in decreasing soil pH and exchangeable sodium percentage (ESP) and increasing crop yields was dependent on their water-soluble sulfur content at the time of application to the field. Pyrites with 5.5% and 8% soluble sulfur were as effective as gypsum. The freshly mined pyrite (water-soluble S 1%) was found to be inefficient in reclaiming alkali soils. We also explored the possibility of increasing the water-soluble sulfur content of pyrite by optimizing its storage conditions. When pyrite (1% water-soluble S) was stored under moist conditions by sprinkling water over the bags under a rain shelter, there was an enrichment of indigenous iron- and sulfur-oxidizing bacteria of pyrite, and the water-soluble sulfur increased to 5% within a period of 6 months. However no such increase occurred when pyrite was stored dry. We conclude that the soluble sulfur content of pyrite increased during its storage under moist conditions and should be between 6% and 8% at the time of its application to the field. [References: 21].

3306 Smit, E. (Research Institute for Plant Protection, Wageningen, The Netherlands.); Wolters, A.C.; Lee, H.; Trevors, J.T.; Elsas, J.D. van (1996) **Interactions between a genetically marked Pseudomonas fluorescens strain and bacteriophage phi R2f in soil: effects of nutrients, alginate encapsulation, and the wheat rhizosphere.** *Microbial ecology (USA) v. 31(2) p. 125-140.* references. English. (AGRIS 97-040423).

The introduction of bacteriophages could potentially be used as a control method to limit the population size of engineered bacteria that have been introduced into soil. Hence, the ability of a species-specific phage, phi R2f, to infect and lyse its host, a Pseudomonas fluorescens R2f transposon TnS derivative, in soil, was studied Control experiments in liquid media revealed that productive lysis of host cells by phage phi R2f occurred when cells were freely suspended, whereas cells present in alginate beads resisted lysis. The presence of nutrients enhanced the degree of lysis as well as the production of phage progeny, both with the suspended cells and with cells escaped from the alginate beads. Experiments in which host cells and phage phi R2f were introduced into two soils of different texture revealed that host cells were primarily lysed in the presence of added nutrients; and phage reached highest titres in these nutrient-amended soils. Encapsulation of the host cells in alginate beads inhibited lysis by the phage in soil. Populations of free host cells introduced into soil that colonized the rhizosphere of wheat were not substantially lysed by phage phi R2f. However, P. fluorescens R2f populations colonizing the rhizosphere after introduction in alginate beads were reduced in size by a factor of 1, 000. Cells migrating from the alginate beads towards the roots may have been in a state of enhanced metabolic activity, allowing for phage phi R2f infection and cell lysis.

3307 Steppuhn, H.; Wall, K.; Rasiah, V.; Jame, YW. (1996) **RESPONSE FUNCTIONS FOR GRAIN YIELD FROM SPRING-SOWN WHEATS GROWN IN SALINE ROOTING MEDIA.** *Canadian Agricultural Engineering. 38(4):249-256.* English. [AGR & AGRI FOOD CANADA SEMIARID PRAIRIE AGR RES CTR RES BRANCH POB 1030 SWIFT CURRENT SK S9H 3X2 CANADA].

Farmers often request information about the salt tolerances of their crops. Field tests in saline soils can provide qualitative assessments; but because of natural variability, these tests cannot define the functional relationships required for modelling growth responses to root-zone salinity. These require tests under more controlled conditions. Two control tests were conducted in the Swift Current Salt Tolerance Testing Laboratory with five spring-sown Canadian wheat varieties (Katepwa, Neepawa, Biggar, Fielder, and Kyle). The first test followed the standard procedure (U.S. Salinity Laboratory) of increasing root-zone salinity gradually after plant emergence; the second treated root zones with full complements of salts before seeding. The plants were irrigated four times daily with hydroponic solutions containing a range of salt concentrations between 1 and 14 dS/m equivalent electrical conductivity for saturated soil paste extracts (EC(e)). Responses were measured by the number of plants surviving to harvest time, the grain yield, and the number of fertile spikes per plant. Three functions were evaluated for their suitability in describing grain yield response mathematically: (1) the conventional two-piece linear model; (2) a sigmoid-shape response; and (3) an exponential non-linear function. The sigmoid function proved the most fitting in both tests and indicated that significant declines in grain production began at EC(e)-values of 1 to 2 dS/m, which are considerably lower than that reported ir. the literature for wheats in general (6 dS/m). The number of harvested plants was not significantly affected by salinity, but the number of fertile spikes per plant, in linear association with grain yield, decreased with increasing EC(e). [References: 24].

3308 Svircev, Z.; Gantar, M.; Gajin, S. (University of Novi Sad (Yugoslavia). Institute of Biology) (1995) **Nitrogenase activity of Nostoc and Anabaena strains in association with wheat roots.** *Zbornik Matice srpske za prirodne nauke (Yugoslavia) (no. 88) p. 65-71.* 2 graphs; 2 tables; 14 ref. English. (AGRIS 97-055323).

In this paper we describe dark and light nitrogenase activity of Nostoc (2S9B) and Anabaena (C5) strains: 1) associated with the wheat roots, 2) in free-living cultures and 3) free-living cultures enriched with fructose. The results suggest that growth and nitrogenase activity of the Nostoc strain was supported in darkness when the cyanobacteria were associated with wheat roots or when grown free-living in the presence of fructose, whereas the Anabaena strain did not show nitrogenase activity when incubated in the dark under the same conditions.

3309 Unkovich, MJ.; Pate, JS.; Sanford, P. (1997) **NITROGEN FIXATION BY ANNUAL LEGUMES IN AUSTRALIAN MEDITERRANEAN AGRICULTURE [Review].** *Australian Journal of Agricultural Research. 48(3):267-293.* English. [UNIV WESTERN AUSTRALIA DEPT BOT NEDLANDS WA 6907 AUSTRALIA].

3310 Wang, XJ.; Douglas, LA. (1996) **EFFECT OF PHOSPHOROAMIDES ON SOIL UREASE ACTIVITY, AND PLANT DRY MATTER PRODUCTION AND UREA-N UPTAKE BY WHEAT PLANTS.** *Agrochimica. 40(5-6):209-215.* English. [UNIV MELBOURNE DEPT AGR PARKVILLE VIC 3052 AUSTRALIA].

Experiments in our laboratory showed that phenylphosporo diamidate (PPD), N-(n-butyl) thiophosphoric triamide (NBTET) and cyclohexylphosphoric triamide (CHPT) inhibited soil urease activity. The effects of the inhibitors on dry matter production and urea-N uptake by wheat plants grown in pots in a glasshouse (23C day temperature, no wind) were studied. Under conditions that minimised ammonia loss from the soil surface, urease inhibitors applied at 0.5 - 1.0% of the urea application rate did not influence plant dry matter or N uptake. Recovery of 15N from the soil-plant systems was less at the higher rate of 15N-urea (200 mg urea-N per pot), as compared with a lower rate (50 mg urea-N per pot). [References: 21].

3311 Whitelaw, MA.; Harden, TJ.; Bender, GL. (1997) **PLANT GROWTH PROMOTION OF WHEAT INOCULATED WITH PENICILLIUM RADICUM SP. NOV.** *Australian Journal of Soil Research. 35(2):291-300.* English. [CHARLES STURT UNIV SCH SCI & TECHNOL WAGGA WAGGA NSW 2650 AUSTRALIA].

A phosphate-solubilising isolate of Penicillium radicum (sp. nov.) was used to inoculate wheat (Triticum aestivum cv. Dollarbird), in a glasshouse experiment and a field trial, using low pH soils at 5 levels of phosphate application. When data for all phosphate application levels were combined, inoculation by, P. radicum resulted in 14% increases in wheat yield in the field trial and increases in both phosphate uptake (10%) and yield (9%) in the glasshouse. In the glasshouse, the response to inoculation was higher at the nil phosphate application level (17%) than for the combined phosphate application levels (9%). This negative interaction

indicates that growth promotion could be partially due to soil phosphate solubilisation by the fungus, with a greater response for soils with lower available P. However, other plant-growth promotion mechanisms may also be involved. [References: 26].

P35 SOIL FERTILITY

3312 Abu Dahi, Y.M. (Baghdad Univ. Coll. of Agric. (Iraq)) (1994) **[Effect of nitrogen and copper on yield quality, nitrogen and copper contents of wheat (Triticum aestivum L.) cultiver (Abu-Ghraib-3)]. T'at"i:r al-nitru:j"i:n wa al-nuh"a:s fi: h"as*l al-h"unt*at wa nu:3i:tha: wa muh"twa:huma: lil-s*inf ('abu:-g"ri:b-3) (Triticum aestivum L.).** *Mij"alat al-3ulu:m al-zira:3iyyat al-3ira:qiyyat (Iraq). The Iraqi Journal of Agricultural Sciences v. 25(no.1) p. 173-182.* Arabic. (AGRIS 97-040509).

This study was conducted to evalute the effects of various levels of N and Cu concentrations and their uptake in shoots and roots of wheat cultivar (Abu-Ghrib-3). Results indicated that the application of 0, 120, 180 and 240 kg N / ha as urea had significantly increased the dry matter of shoot, root and the grain yield / pot, weight of 1000 seeds, seed protein percentage, N content and its uptake in shoots, roots and seeds.

3313 Jansson, H. (1995) **Status of sulphur in soils and plants of thirty countries.** FAO, Rome (Italy). Land and Water Development Div.; Agricultural Research Centre, Jokioinen (Finland). Inst. of Soils and Environment. *World Soil Resources Reports (FAO); no. 79 101 p.* FAO. Diagrs., illus., tables. English. (AGRIS 97-055392).

3314 Patwary, S.U. (Bangladesh Inst. of Nuclear Agriculture, Mymensingh (Bangladesh)) (1995) **Fate of fertilizer nitrogen in soil under different cultivation, irrigation and fertilizer management practices.** Nuclear methods in soil-plant aspects of sustainable agriculture. Proceedings of an FAO/IAEA Regional Seminar for Asia and the Pacific, Colombo, Sri Lanka, 5-9 April 1993. *Technical Document (IAEA); no. 785 p. 61-66. Joint FAO/IAEA Div. of Nuclear Techniques in Food and Agriculture, Vienna (Austria).* IAEA. IAEA–TECDOC-785. English. (AGRIS 97-055374).

3315 Rouchaud, J.; Neus, O.; Callens, D.; Bulcke, R. (1997) **ENHANCED SOIL BIODEGRADATION OF PROSULFOCARB HERBICIDE IN BARLEY CROP.** *Bulletin of Environmental Contamination & Toxicology. 58(5):752-757.* English. [UNIV CATHOLIQUE LOUVAIN PHYTOPHARM LAB 3 PL CROIX SUD B-1348 LOUVAIN BELGIUM].

3316 Strong, WM.; Best, EK.; Cooper, JE. (1997) **PHOSPHATE FERTILISER RESIDUES IN WHEAT-GROWING SOILS OF THE WESTERN DOWNS, QUEENSLAND.** *Australian Journal of Soil Research. 35(2):341-354.* English. [QUEENSLAND WHEAT RES INST DEPT PRIMARY IND POB 2282 TOOWOOMBA QLD 4350 AUSTRALIA].

Effects of repeated annual application and residual effects of past phosphorus (P) applications were studied at Billa Billa and The Gums, Queensland, on 2 Vertisols representative of a large cropping area in this region. Phosphorus was applied annually at 0, 4, 8, 12, and 25 kg/ha at sowing to each wheat crop between 1978 and 1988. Phosphorus was also applied at 25, 50, 100, 200, or 400 kg/ha as a once-only application, before wheat was sown in 1978, and was incorporated by tillage. Pot experiments were conducted each year with soil (6 kg/pot) gathered from field plots in May before wheat sowing to determine the residual value (RV) of previously applied P fertiliser under standard conditions of frequent watering. In 1979 the RV was determined in a second series of pots with a water deficit to simulate conditions of plant moisture stress that were to dominate the field experiments. The RV of P fertiliser was reduced to one-third that determined under well-watered conditions. Low residual values (8-47%) determined in the field in 1979 for P rates 25 and 50 kg/ha applied in 1978 were probably due to reduced P uptake from dry topsoil throughout which P residues were incorporated by tillage. By contrast, P applied annually at a low rate (4 or 8 kg/ha) in a band close to seeds created profitable responses when evaluated over the sequence of successive wheat crops. The bicarbonate-extractable soil test value (Pbi) on either soil fertilised annually for n years with P at a rate R (kg/ha . year) was described by the model P-bf = P-bu + 0.29R Sigma 5{5 + (n - 1)}(-1) where P-bu is the soil test value (mg/kg) of unfertilised soil. [References: 21].

P36 SOIL EROSION, CONSERVATION AND RECLAMATION

3317 Giasson, E.; Cassol, E.A. (1996) **[Rill erosion related to inflow rates and amounts of incorporated wheat straw in a sandy clay loam paleudult soil]. Relacoes da erosao em sulcos com vazoes aplicadas e doses de residuos de trigo incorporados a um plintossolo franco-argiloarenoso.** *Revista Brasileira de Ciencia do Solo (Brazil) v. 20(1) p. 117-125.* 5 illus.; 17 ref. Portuguese. (AGRIS 97-040582).

3318 Staben, ML.; Bezdicek, DF.; Smith, JL.; Fauci, MF. (1997) **ASSESSMENT OF SOIL QUALITY IN CONSERVATION RESERVE PROGRAM AND WHEAT-FALLOW SOILS.** *Soil Science Society of America Journal. 61(1):124-130.* English. [WASHINGTON STATE UNIV DEPT CROP & SOIL SCI PULLMAN, WA 99164 USA].

Chemical and microbial aspects of soil quality are an important consideration when evaluating the benefits of soil conservation efforts such as the Conservation Reserve Program (CRP). The objective of this study was to evaluate the quality of CRP and wheat-fallow (W-F) soils using soil biological and chemical parameters and C and N mineralization processes. The study was conducted on 20 CRP/W-F paired sites in eastern Washington, on Ritzville silt loam (coarse-silty, mixed, mesic Calciorthidic Haploxerolls). Soils collected from the paired fields were analyzed for chemical and biological parameters that have been suggested as indicators of soil quality. Potential enzyme activities and soil N were higher in the CRP soil than the W-F soil. Although there were no significant differences in total organic carbon (TOC) or microbial biomass carbon (MBC) the C mineralization potentials and C pools mere significantly different between the CRP and W-F soils. Soil biota measurements showed there was greater active bacterial biomass in the CRP soil but greater fungal-feeding nematodes, flagellates, and amoebae in the W-F soil. The C mineralization study suggests that there is a significant increase in the secondary C pool of the CRP soil, which may indicate a buildup of higher quality soil organic matter and the potential for higher enzyme levels. When grass or straw was added to each soil type, the W-F soil produced more CO2 with either substrate than the CRP soil, indicating C limiting conditions in the W-F soil. Since it is unknown what constitutes good soil quality, these shifts in chemical and biological parameters may seem subtle. However, in general, trends in the data indicated that soil quality in the CRP was improved after 4 to 7 yr, compared with its previous management in W-F cropland. [References: 42].

3319 Zrubec, F.; Svicek, F. (Vyskumny Ustav Podnej Urodnosti, Bratislava (Slovakia)) (1994) **[Conservation soil tillage elements application in the crop system of winter wheat with Amazone Company technique]. Uplatnenie prvkov ochranneho obrabania pody v pestovatelskom systeme ozimnej psenice s vyuzitim techniky FY Amazone.** *Vedecke prace Vyskumneho Ustavu Podnej Urodnosti(Slovakia) p. 247-257.* 3 tables, 1 ill.; 8 ref. Slovak. (AGRIS 97-040564).

The problem of choosing soil conservation tillage systems in growing winter wheat (after spring barley) was solved by field trials on Chernozems with detailed soil and crop monitoring, including economic evaluation for the period 1992-93. Field trials were implemented at two levels: A, conventional soil tillage, and B, reduced soil tillage, with reduction of mechanical tillage operations, including zero tillage, with shallow topsoil tillage by disc instruments, and with leaving after-harvest remnants above ground. The results showed that soils under the B variants keep comparable, or even more favourable parameters of volume soil conditions, than A soils. In the A variant there were more markedly negative elements connected with more intensive soil surface crusting and formation of crust with compaction tendencies in all of the surface topsoil zone. Also negative was an overloose condition in the bed zone and in all of the lower part of the topsoil, with bulk density values of 1.17 Mg m** (-3), porosity at 55-56 , and high aeration (15-16). These vertical topsoil zones, more compact in the B variants with bulk density values of 1.25-1.33 Mg m** (-3) under given weather conditions, obviously formed more suitable conditions for field forming processes and winter wheat. Winter wheat yield increase in B variants was 0.09-1.08 t ha** (-1), i.e. 2.5-30.8 , with a parallel reduction in grower's costs per ha of 935-1111 Sk. To this could be also added ecological contributions resulting from more effective soil conservation and stabilization of soil fertility.

P40 METEOROLOGY AND CLIMATOLOGY

3320 Gate, P. (Institut Technique des Cereales et des Fourrages, Paris (France)); Vignier, L.; Vadon, B.; Souici, D.; Minkov, D.; Lafarga, A.; Zairi, M. (1996) **[Cereal crops in Mediterranean area. A model for limiting climate hazards]. Cereales en milieu mediterraneen. Un modele pour limiter les risques climatiques.** *Perspectives Agricoles (France) (no 217) p. 59-66.* 8 graph. French. (AGRIS 97-040590).

Une meilleure connaissance de l'ecophysiologie des cereales permet aujourd'hui d'envisager la mise en oeuvre d'une strategie pour limiter les risques encourus par la plante a l'aide d'un calage du cycle cultural d'une variete donnee sur une date de semis appropriee. L'etude de plusieurs sites a revele une grande variabilite climatique qui doit inciter au classement des varietes en fonction des conditions limitantes specifiques. Les travaux entrepris par les partenaires du Reseau Cerealier Mediterraneen ont permis de definir un langage commun pour quantifier ces risques et l'elaboration de modeles de developpement.

3321 Landau, S.; Barnett, V. (University of Nottingham, Department of Physiology and Environmental Science, Sutton Bonington, Leicestershire LE12 5RD (United Kingdom)) (1996) **A comparison of methods for climate data interpolation, in the context of yield predictions from winter wheat simulation models.** *Aspects of Applied Biology (United Kingdom) (no.46) p. 13-22.* 21 ref. Modelling in applied biology: spatial aspects, 25-27 June 1996, Brunel University, London, UK. English. (AGRIS 97-040632).

Q01 FOOD SCIENCE AND TECHNOLOGY

3322 Guerrieri, N. (Universita di Milano, Milano, Italy.); Alberti, E.; Lavelli, V.; Cerletti, P. (1996) **Use of spectroscopic and fluorescence techniques to assess heat-induced molecular modifications of gluten.** *Cereal chemistry (USA) v. 73(3) p. 368-374.* references. English. (AGRIS 97-040661).

Fresh gluten isolated from soft wheat flour was heated at varying temperatures for different times: from 45 degrees C for 1 hr. to 110 degrees C for 18 hr; it was then freeze-dried. The solubility of the untreated and heated glutens in different solvents under nonreducing and reducing conditions was determined, and the extracts were analyzed for protein composition by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) and acid PAGE. The intrinsic fluorescence, the fluorescence developed on titration with 8-aniline-1-naphthalene sulfonate (ANS), the UV spectra with second derivatives and solution stability were measured on acetic acid extracts of the glutens. Titration with ANS revealed sites with high and low probe affinity (high and low hydrophobicity). The results show: 1) a hydrophobic modification at 45 degrees C, this in no way affected the electrophoretic patterns; 2) moderate changes at 65 degrees C ascribable to conformational modifications: 3) heating at 90 degrees C or above strongly affected protein solubility in acetic acid and produced disulfide supported aggregates. Conformational modifications were also evident. In these changes gliadins, except omega-gliadins, and low molecular weight albumins and globulins were the most involved. 4) Heating at 110 degrees C for 18 hr produced insolubilization not reversed by dithiothreitol.

3323 Satyanarayana, V. (1996) **World malt and malting barley: competition, marketing, and trade.** *Agricultural economics report (USA); no. 359 112 p.* Dept. of Agricultural Economics, Agricultural Experiment Station, North Dakota State University. ill. bibliographical ref. (p. [87]-91). Cover title. "August 1996.". English. (AGRIS 97-040648).

3324 Wannerberger, L. (University of Lund, Lund, Sweden.); Wahlgren, M.; Eliasson, A.C. (1996) **Adsorption of protein fractions from wheat onto methylated silica surfaces.** *Cereal chemistry (USA) v. 73(4) p. 499-505.* references. English. (AGRIS 97-055555).

The kinetics of the sequential adsorption of gliadins and water-soluble fraction (WSF) from the wheat variety Kosack onto hydrophobic silica (methylated silica) surfaces were studied by in situ ellipsometry. The measurements were made in water and in 0.01M acetate buffer, pH 4.0 and 5.0, with and without 0.1M NaCl. The concentration of gliadins and WSF was 1.7 microgram/ml. The adsorption of gliadins in water was investigated at three different protein concentrations (0.17, 1.7, and 17 microgram/ml), and the adsorption was found to be very high with regard to the low concentrations of protein in solution. The results of the sequential adsorption in water indicated that the WSF adsorbed to preadsorbed gliadins. When proteins of the WSF were adsorbed first, they blocked further adsorption of gliadins. Measurements in acetate buffer at different pH values showed that the effect of pH was larger in the experiments where the gliadins were adsorbed first, both for the initial adsorption and for the sequential addition of WSF. An increase in ionic strength also increased the amount of WSF adsorbed to preadsorbed gliadins. These results indicate that the sequential adsorption of WSF to gliadins is strongly affected by electrostatic interactions.

Q02 FOOD PROCESSING AND PRESERVATION

3325 Ashour, S.A.; El Shora, H.M.; Metwally, M.; Habib, S.A. (Faculty of Science, Mansoura University, Mansoura (Egypt)) (1996) **Fungal fermentation of whey incorporated with certain supplements for the production of proteases.** *Microbios (United Kingdom) v. 86(346) p. 59-69.* 34 ref. English. (AGRIS 97-040728).

3326 Bhatty, R.S. (University of Saskatchewan, Saskatoon.) (1996) **Production of food malt from hull-less barley.** *Cereal chemistry (USA) v. 73(1) p. 75-80.* references. English. (AGRIS 97-040909).

Four cultivars of hull-less barley and, for comparison, two cultivars of malting barley and one cultivar of soft wheat, all having germination capacity >95, were steeped to about 42 moisture and malted in an automatic micromalting system. Hull-less barleys had a 16-hr shorter steep time than the malting barleys or wheat and produced malts that were comparable in composition and enzyme activities (alpha-amylase, diastatic power, beta-glucanase, and proteolytic) to the malting barley malts but superior to the wheat malt. One cultivar each of hull-less barley, malting barley, and wheat, steeped to about 43 moisture, were malted in a pilot plant. Again, hull-less barley malt was, except for cultivar differences, more like malting barley malt than wheat malt in composition and enzyme activities. Nondiastatic malts having reduced enzyme activities were prepared by heating the green malt at 85 degrees C; the heating temperature may be adjusted to prepare malts of desired color, flavor, and enzyme activities. Hull-less barley malt was milled in a flour mill to produce malted bran and flour. Hull-less barley malt and its products can be added directly to a variety of foods without the need to prepare extracts and syrups, as is the case with most brewer's and distiller's malts. However, malt extracts and syrups may be prepared from hull-less barley malt without the problem of residual hull disposal. It is proposed that hull-less barley malt be called "food malt" to distinguish it from brewer's and distiller's malts, which are prepared from select grades of malting (hulled) barleys.

3327 Blumenthal, C. (CSIRO, North Ryde, NSW, Australia.); Bekes, F.; Gras, P.W.; Barlow, E.W.R.; Wrigley, C.W. (1995) **Identification of wheat genotypes tolerant to the effects of heat stress on grain quality.** *Cereal chemistry (USA) v. 72(6) p. 539-544.* references. English. (AGRIS 97-041029).

High-temperature stress (> 35 degrees C) during the grain-filling period has the potential to modify grain quality. A consequent weakening of dough properties has been reported for many wheat genotypes. The experiment described in this article was designed to identify wheat genotypes that might be tolerant to the effects of heat stress on grain quality and to further assess the molecular basis of these changes. A diverse set of 45 wheat genotypes was exposed to 10 hr of 40 degrees C on each of three consecutive days in a phytotron. Mean values for all genotypes (with unheated control samples, all in duplicate) showed highly significant changes ($P < 0.001$) in 1, 000 kernel weight (-17 difference for heat stressed minus control), protein content (17 increase), dough mixing time in a 2-g Mixograph (-13), and resistance breakdown (17). The general weakening of dough due to heat was accompanied by a decrease in glutenin-to-gliadin ratio and in the percentage of very large glutenin polymers. Bound lipid content increased, and there was a general reduction (-9) in the proportion of small (B-type) starch granules. For all these attributes, reactions for individual genotypes ranged from little change (tolerance to heat stress) to considerable change (susceptible to heat stress). A group of genotypes was thus identified that should be useful in breeding attempts to stabilize wheats against heat-related variations in grain quality. Markers identified as potentially useful in breeding for tolerance include the presence of the Glu-D1d allele (glutenin subunits 5

and 10), and increases in glutenin-to-gliadin ratio and in the percentage of very large glutenin polymers.

3328 Bregitzer, P. (USDA, ARS, National Small Grains Germplasm Research Facility, Aberdeen, ID.); Poulson, M.; Jones, B.L. (1995) **Malting quality of barley lines derived from tissue culture.** *Cereal chemistry (USA) v. 72(5) p. 433-435.* references. English. (AGRIS 97-040733).

The occurrence of somaclonal (tissue culture-derived) variation in plants regenerated from tissue culture will influence the efficiency with which techniques such as genetic transformation can be used in the development of new barley cultivars. To assess the effect of somaclonal variation on malting quality, 12 families of tissue culture-derived lines from three barley cultivars were analyzed using standard micromalting techniques. Each family was derived from a single regenerated plant that, in turn, was derived from an immature embryo callus culture. five to six plants from each family were selected in the R2 generation based on phenotypic similarity to their uncultured parental controls, and advanced to the R4 and R5 generations for replicated field tests. The malting quality of the majority of these lines was altered by passage through tissue culture, and most alterations were undesirable. These results suggest that efforts should be made to delineate in vitro (tissue culture) conditions that are less mutagenic to cultured barley calls.

3329 Campos, D.T. (Michigan State University East Lansing, MI.); Steffe, J.F.; Ng, P.K.W. (1996) **Mixing wheat flour and ice to form undeveloped dough.** *Cereal chemistry (USA) v. 73(1) p. 105-107.* references. English. (AGRIS 97-041033).

3330 Ciaffi, M. (University of Tuscia, Viterbo, Italy.); Lafiandra, D.; Turchetta, T.; Ravaglia, S.; Bariana, H.; Gupta, R.; MacRitchie, F. (1995) **Breadbaking potential of durum wheat lines expressing both X- and Y-type subunits at the Glu-A1 locus.** *Cereal chemistry (USA) v. 72(5) p. 465-469.* references. English. (AGRIS 97-041036).

Functionality and protein composition data were obtained for 13 F7 lines derived by a four-way cross, involving two different Italian cultivars (Creso and Lira), a tetraploid breeding line (A327), and an accession of Triticum dicoccoides. Three bread wheat cultivars currently grown in Italy and two durum parental cultivars were used as controls. These lines possessed one or two subunits at the Glu-A1 locus, derived from the uncommon allelic variant at the same locus of both A327 and Triticum dicoccoides. Functional quality was assessed by the sodium dodecyl sulfate (SDS) sedimentation test, rheological dough tests (mixograph and alveograph), and an optimized microbaking test. Protein composition was measured by near infrared reflectance (protein content), size-exclusion HPLC, and SDS-PAGE. Rheological and baking properties were strongly associated with the allelic type of proteins encoded by the Glu-B3 and Glu-A1 loci. Lines with the best technological performances contained the Clu-A1 allele from T. dicoccoides and the allelic type LMW-2 at the Glu-B3 locus from the parental durum wheat cultivars. Results indicated that some lines had exceptionally high dough strength and approached acceptable levels for baking, with one possessing dough rheological properties and baking performance as good as those of the bread wheat cultivars used as controls.

3331 Cierniewska, A.; Gasiorowski, H.; Kawka, A.; Kaczkowski, J.; Kedzior, Z.; Kiryluk, J.; Kowalczyk, C.; Kowalewski, W.; Michniewicz, J.; Ratajczak, P. (1995) **[Oat. Chemistry and technology].** *Owies. Chemia i technologia 180 p.* Panstwowe Wydawnictwo Rolnicze i Lesne. fig., tables; ref.; Distributed 1996. Polish. (AGRIS 97-040857).

3332 Duviau, M.P. (INRA, Montpellier, France.); Yamamoto, H.; Ng, P.K.W.; Kobrehel, K. (1996) **Modifications of wheat proteins due to flour chlorination.** *Cereal chemistry (USA) v. 73(4) p. 490-494.* references. English. (AGRIS 97-055900).

The extractability of wheat flour proteins underwent considerable changes as the result of chlorination, especially as detected under different conditions for sequential protein extraction. Compared to controls, changes in protein extractability were greater when flours were chlorinated to pH 4.3 than to pH 4.8. Gliadins seemed to be more affected than glutenins. Low molecular weight proteins, whose molecular mass ranged between 9 and 15 kDa, were also considerably affected, but to a varying extent. While free -SH groups decreased slightly in treated samples, results suggested that SS bonds did not seem to be affected under chlorination, and their accessibility to thioredoxin and to dithiothreitol also remained unchanged.

3333 El Haddad, L. (ESA Purpan, Toulouse, France.); Aussenac, T.; Fabre, J.L.; Sarrafi, A. (1995) **Relationships between polymeric glutenin and the quality characteristics for seven common wheats (Triticum aestivum) grown in the field and greenhouse.** *Cereal chemistry (USA) v. 72(6) p. 598-601.* references. English. (AGRIS 97-041038).

Seven common wheat cultivars were grown under greenhouse and field conditions. Sodium dodecyl sulfate (SDS) extraction and size exclusion high-performance liquid chromatography (SE-HPLC) were used to separate proteins according to size (pF1-pF5 and pFi). The technological parameters such as alveograph index (W, P, G) and Zeleny volume (Z) of each genotype for each agronomic condition were measured. A high genetic variability was observed for all parameters. Differences between the two agronomic conditions were significant for most parameters, however, the interactions between genotype and agronomic conditions were significant only for a few protein fractions. The amount of certain polymeric glutenin classifies the genotypes in the same way a quality criteria (Zeleny and alveograph) does. The ratio of the amount of soluble polymeric glutenin excluded by column of SE-HPLC (pF1) to the amount of non-excluded ones (pF2) divides genotypes into two groups, one with HMW-glutenin subunits 5+10 and the other with HMW-glutenin subunits 2+12 (Clu-D1 allelic composition).

3334 Eynard, L. (Universita di Milano, Milano, Italy.); Guerrieri, N.; Cerletti, P. (1995) **Modifications of starch during baking: studied through reactivity with amyloglucosidase.** *Cereal chemistry (USA) v. 72(6) p. 594-597.* references. English. (AGRIS 97-041007).

Conditions that ensure starch hydrolysis by amyloglucosidase in a limited substrate system were worked out. Using these conditions, we evaluated the degree of access of the enzyme to starch molecules in different starchy materials. Raw starches of different botanical origins are hydrolyzed at different rates, but starches with limited branching hydrolyze more rapidly. A good example of this is a limit dextrin, which is more susceptible than its parent amylopectin. We also studied the effect of gelatinization on the enzymatic availability of starch. It was observed that damaged granules undergo amylolysis much more rapidly than do undamaged ones. Therefore, the extent of amylolysis in a given starch is governed by the degree of granule damage. Starch in bread is hydrolyzed more rapidly and extensively than is that in flour and dough but no significant differences were found in conventional yeast fermentation between soft and durum wheat. On the other hand, bread obtained by acid fermentation initially undergoes slow amylolysis, although the final level reached is the same as in bread made from the same flour by conventional yeast fermentation.

3335 Fares, C. (Istituto Sperimentale per la Cerealicoltura, Foggia, Italy.); Troccoli, A.; Di Fonzo, N. (1996) **Use of friction debranning to evaluate ash distribution in Italian durum wheat cultivars.** *Cereal chemistry (USA) v. 73(2) p. 232-234.* references. English. (AGRIS 97-041041).

A new method to evaluate ash distribution patterns in durum wheat is proposed. Durum wheat samples (198) collected during two years from three locations in southern Italy were debranned by a friction debranning machine (Satake) at five successive time intervals (level1, 2, 3, 4, 5). Ash content of debranned samples (DAL1, 2, 3, 4, 5) and of whole kernel (WKA) was determined. Calculations indicated the percentage of ash removal (RAL) from the WKA after each debranning level. The weight of the material removed (WMR) during each debranning stage was also calculated. Statistical analysis showed the significant effect of debranning levels, years, locations, and cultivars. Differences among cultivars for ash distributions and WMR were noted. No association between DAL and WMR was found, showing that DAL could be a suitable measure of kernel ash gradient. In general, a diminishing ash trend was observed as debranning level increased. Almost all of the correlation coefficients between WKA and DAL1, 2, 3 4, 5 were high, both in general and for each cultivar. In general they were significant, showing DAL1 as the most correlated.

3336 Guerrieri, N. (Universita degli Studi di Milano, Milano, Italy.); Cerletti, P. (1996) **Effect of high-temperature short-time treatment of wheat flour on gluten vitality and structure.** *Cereal chemistry (USA) v. 73(3) p. 375-378.* references. English. (AGRIS 97-041028).

The effect of high-temperature short-time (HTST) applications on gluten in its natural flour environment was investigated. Changes occurring in HTST-treated samples during storage and in samples subjected to severe thermal denaturation were studied. Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) profiles of the gluten polypeptides, and the intrinsic fluorescence, were modified only in the heat-denatured preparation. On the other hand. after HTST treatment changes in the extrinsic fluorescence (8-aniline-1-naphthalene sulfonate [ANS] binding) revealed enhanced surface hydrophobicity, which however, regressed on storage. Consistent with these observations was the amount of the associated water. It appears that it is the gluten surface that is mainly affected by HTST treatment, and this could represent a very early stage of heat damage of gluten.

3337 Koh, B.K. (Keimyung University, Taegu (Korea Republic). Department of Foods and Nutrition); Hoseney, R.C. (Kansas State University, Manhattan (USA). Department of Grain Science and Industry) (1996) **Investigation on the water soluble fraction causing rapid dough breakdown of wheat flour.** *Foods and Biotechnology (Korea Republic) v. 5(4) p. 287-290.* 6 illus.; 17 ref. English. (AGRIS 97-055899).

3338 Koh, B.K. (Keimyung University, Daegue, Korea.); Karwe, M.V.; Schaich, K.M. (1996) **Effects of cysteine on free radical production and protein modification in extruded wheat flour.** *Cereal chemistry (USA) v. 73(1) p. 115-122.* references. English. (AGRIS 97-041034).

Addition of cysteine as a free radical scavenger during extrusion markedly affected physical and chemical properties of wheat flour extrudates. Radial expansion at the die decreased in linear extrudates and longitudinal expansion through surfaces cut at the die increased, reflecting weakened dough strength. Cell size decreased, cell walls thinned, and cells became more evenly distributed and densely packed. Cysteine decreased electron paramagnetic resonance (EPR) free radical signal intensity but increased free radical density of the extrudates, preferentially quenching nitrogen-centered radicals. Nonprotein thiols decreased and disulfides increased in samples with added cysteine, whereas the opposite occurred with protein SH-SS groups. Protein solubility in 1.5 sodium dodecyl sulfate (SDS) without beta-mercapto ethanol decreased markedly with extrusion but increased with each increment of cysteine. Addition of cysteine slightly increased protein solubility in SDS plus beta-mercaptoethanol compared to that of unextruded flour. Polyacrylamide gel electrophoresis (PAGE) patterns of extracted proteins showed increasing amounts of high molecular weight material solubilized from previously insoluble aggregates. Glycoproteins, probably starch-protein complexes, were detected in the highest molecular weight material. PAGE patterns after reduction of disulfide bonds showed shifts in molecular weight distributions from high to low molecular weight products with added cysteine. All together, data indicates that cysteine acts predominantly by free radical quenching. Little or no thiol-disulfide interchange or sulfur radical addition was detected.

3339 Koksel, H. (Hacettepe University, Ankara, Turkey.); Celik, S.; Tuncer, T. (1996) **Effects of gamma irradiation on durum wheats and spaghetti quality.** *Cereal chemistry (USA) v. 73(4) p. 506-509.* references. English. (AGRIS 97-055890).

3340 Kollengode, A.N. (Univ. of Nebraska, Lincoln, NE.); Sokhey, A.S.; Hanna, M.A. (1996) **Physical and molecular properties of re-extruded starches as affected by extruder screw configuration.** *Journal of food science (USA) v. 61(3) p. 596-599, 603.* references. English. (AGRIS 97-040807).

Amylomaize V, amylomaize VII, wheat and rice starches were extrusion cooked in a single-screw extruder at 140 degrees C barrel temperature and 140 rpm screw speed. Extrudates were ground and re-extruded through a 3 mm cylindrical die nozzle using screws with no mixing (NM), 1 mixing (1M) or two mixing (2M) elements. Overall expansions were the highest and bulk densities were lowest with 1M. Radial expansions for amylomaize V, amylomaize VII, and wheat starches were the highest with 1M and lowest with 2M. Amylopectin contents of starches decreased with corresponding increases of gel permeation chromatograph peak II fractions when number of mixing elements was increased. lambda values of peak I and peak II decreased upon re-extrusion of starches with increasing number of mixing elements.

3341 Kweon, MR.; Sosulski, FW.; Bhirud, PR. (1997) **CATIONIZATION OF WAXY AND NORMAL CORN AND BARLEY STARCHES BY AN AQUEOUS ALCOHOL PROCESS.** *Starch-Starke. 49(2):59-66.* English. [NABISCO INC 200 DEFOREST AVE E HANOVER, NJ 07936 USA].

When an aqueous alcoholic-alkaline solvent was used, cationization of normal and waxy corn and barley starches was achieved with high degrees of substitution (DS) and reaction efficiency (RE) in the absence of gelatinization inhibitor salts. Ethanol was a more effective solvent than methanol or 2-propanol, and alcohol concentrations could vary between 35-65%. Maintaining a starch to water ratio of 1:1 (w/w) was critical, but DS values were proportional to the concentration of cationic reagent, 3-chloro-2-hydroxypropyltrimethylammonium chloride. At 50 degrees C, cationization was essentially complete within 6h but nearly the same DS could be achieved in 1h at 70 degrees C. [References: 19].

3342 Larsson, H. (University of Lund, Lund, Sweden.); Eliasson, A.C. (1996) **Phase separation of wheat flour dough studied by ultracentrifugation and stress relaxation. I. Influence of water content.** *Cereal chemistry (USA) v. 73(1) p. 18-24.* references. English. (AGRIS 97-041031).

Separation of starch and gluten into two aqueous phases is an important aspect of wheat flour dough development. The fact that starch can easily be washed from dough, leaving behind a gluten gel, illustrates the phase separation of dough very well. To study this phase separation, dough was subjected to high centrifugal forces of 100, 000 X g. The tendency of starch and gluten to separate into two phases is reported for six wheat cultivars at water contents ranging from 38 to 50. At high water contents, a separation of the dough into liquid, gel, gluten, and starch phases was observed. When the water content was reduced, unseparated dough was found at the bottom of the test-tube. At low water contents no separation was observed. The influence of dough water content on the stress-relaxation modulus was considerable at water contents where no separation took place. For doughs prepared with increasing water contents, where separation occurred, the modulus was less affected. This was interpreted as being the region where gluten development was complete. Separation properties varied for cultivars of wheat. Three cultivars with the same relative amounts of separated phases produced roughly the same stress-relaxation modulus.

3343 Larsson, H. (University of Lund, Lund, Sweden.); Eliasson, A.C. (1996) **Phase separation of wheat flour dough studied by ultracentrifugation and stress relaxation. II. Influence of mixing time, ascorbic acid, and lipids.** *Cereal chemistry (USA) v. 73(1) p. 25-31.* references. English. (AGRIS 97-041032).

Separation by ultracentrifugation provides a simple tool for studies a the aqueous phases of wheat flour dough. A separation into liquid, gel gluten and starch, phases was maintained. More or less unseparated dough was also found at the bottom of the test tube. In the present study, the separation behavior was studied for three wheat cultivars when influenced of factors known to affect the baking behavior. The separation properties differ among cultivars. Increased mixing time caused an approximately linear increase for incorporation of water into the gluten phase. For winter wheat, the amount of unseparated dough decreased with increased mixing time, while the separation of spring wheats was not influenced. The general effect of adding ascorbic acid to dough or using defatted flour was improved separation. Lecithin impaired separation. An advantage of this technique is that the phases could be studied without disturbing the composite system. This resulted in valuable information for the interpretation of rheological measurements on dough. It was possible to relate effects on the modulus to either gluten strength, the liquid phase, or interactions between starch and gluten.

3344 Laukevics, J.; Bekers, M.; Danilevics, A.; Kaminska, E.; Lisovska, A.; Upite, D.; Vigants, A. (Institute of Microbiology and Biotechnology, Riga (Latvia)) (1996) **Suitability of some sorts of grain for ethanol fermentation in Latvia.** *Proceedings of the Latvian Academy of Sciences, Section B (Latvia) v. 50(3) p. 137-139.* 4 tables. English. (AGRIS 97-055601).

3345 Lee, Y.T. (Sunmoon University, Asan (Korea Republic). Department of Food Resources and Technology); Seog, H.M.; Cho, M.K.; Kim, S.S. (Korea Food Research Institute, Sungnam (Korea Republic)) (1996) **Physicochemical properties of hull-less barley flours prepared with different grinding mills.** *Korean Journal of Food Science and Technology (Korea Republic) v. 28(6) p. 1078-1083.* 1 illus.; 6 tables; 22 ref. Korean. (AGRIS 97-055594).

3346 Li Changyou (South China Agricultural Univ., Guangzhou (China). Coll. of Polytechnic) (1995) **Measuring the drying characteristics of wheat in a deep-bed from continuous drying air dyanmics.** *Journal of South China Agricultural University (China) v. 17(1) p. 102-107.* 8 ill., 3 ref. Chinese. (AGRIS 97-055901).

3347 Liu, C.Y. (University of Adelaide, Glen Osmond, S.A., Australia.); Shepherd, K.W.; Rathjen, A.J. (1996) **Improvement of durum wheat pastamaking and breadmaking qualities.** *Cereal chemistry (USA) v. 73(2) p. 155-166.* references. English. (AGRIS 97-041023).

3348 Maza Kersie (IAR, Addis Abeba (Ethiopia)); Lakech Goitom (1996) **Barley utilization. 1.** Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van leur, Joop (eds.) p. 167-170.* IAR/ICARDA. 3 tables; 6 ref. English. (AGRIS 97-055592).

An Experiment on barley composity flour for five types of Ethiopian traditional food showed that a mixture of 10-50 percent barley with tef and wheat is satisfactory for injera, dabo and anebabero. A mixture of 10-90 percent barley with wheat and sorghum is satisfactory for kita and genfo. When the mixture of barley flour to wheat flour exceeds 50 percent, the bread quality is affected.

3349 Morita, N. (University of Osaka Prefecture, Sakai, Osaka, Japan.); Nakata, K.; Hamauzu, Z.; Toyosawa, I. (1996) **Effect of alpha-glucosyl rutin as improvers for wheat dough and breadmaking.** *Cereal chemistry (USA) v. 73(1) p. 99-104.* references. English. (AGRIS 97-041040).

The effect of water-soluble alpha-glucosyl rutin (G-rutin) on some rheological properties of wheat flour dough, on interaction between gluten and starch in dough, and on loaf volume were studied. Addition of G-rutin (200 ppm) increased the loaf volume significantly. Farinograph tests showed that G-rutin decreased the development and stability times. Dough containing a higher amount (1, 000 ppm) of G-rutin increased the modulus of elasticity, viscosity coefficient, and relaxation time over that of the control and over that of dough with a lower amount (50 ppm). Combined additions of G-rutin and L-ascorbic acid (AsA, 50 ppm) gave higher values in all parameters tested. Scanning electron microphotography of doughs showed that G-rutin-treated doughs changed somewhat in viscous appearance when compared with the control. There were no changes in the gelatinization temperature or starch enthalpy with the addition of G-rutin to dough. The sulfhydryl content in dough treated with G-rutin was higher than that of the control. The size of gas cells of crumb baked with G-rutin and AsA decreased slightly.

3350 Muenzing, K. (1995) **[Studies in wheat drying with particularly consideration of important influence variables for practice].** Bundesanstalt fuer Getreide-, Kartoffel- und Fettforschung in Detmold und Muenster, Detmold (Germany); Technische Univ. Berlin (Germany). Inst. fuer Lebensmitteltechnologie II, Getreidetechnologie. *Studien zur Weizentrocknung unter besonderer Beruecksichtigung wichtiger Einflussvariablen fuer die Praxis 108 p.* TUB. 2 ill., 32 graphs, 29 tables; 88 ref. German. (AGRIS 97-055902).

Es war Ziel dieser Arbeit, die Wirkung von bislang wenig beachteten Variablen der Warmluftrocknung auf Qualitaetsmerkmale von Weizen zu beschreiben. Dazu wurden die fuer die Wasserbindung relevanten stofflichen Merkmale anhand von Erklaerungsmodellen systematisiert und der Trocknungsvorgang nach thermodynamischen Gesichtspunkten differenziert. Als Hauptmerkmale wurden die Bindungseigenschaften und der Zustand des Trocknungsgutes, die Energiezufuhr, der Fluessigkeitsentzug sowie die Betriebsweise der Trockner behandelt. Der Versuchsansatz bestand darin, die Eintrittstemperatur und Eintrittsfeuchtigkeit der Trocknungsluft sowie die beteiligten Waerme- und Massenstroeme als Prozessparameter fuer das Trocknungsgeschehen unter Einbeziehung der resultierenden Getreidequalitaet zu bewerten. Die Ergebnisse von Warmluftrocknungsversuchen, die mit erntefrischem, naturfeuchtem Weizen unter konstanten Zuluftbedingungen in einem Labortrockner durchgefuehrt wurden, werden beschrieben. Dabei wurden unterschiedlich feuchte Getreidepartien mit abweichendem Grad der Ab- oder Nachreife herangezogen. Die Trocknungsbedingungen wurden jeweils so variiert, dass sie den praktischen Verhaeltnissen bei der Weizentrocknung weitgehend entsprachen.

3351 Rasanen, J. (Technical Research Center of Finland.); Harkonen, H.; Autio, K. (1995) **Freeze-thaw stability of prefermented frozen lean wheat doughs: effect of flour quality and fermentation time.** *Cereal chemistry (USA) v. 72(6) p. 637-642.* references. English. (AGRIS 97-041039).

The effects of fermentation time and flour quality on the baking quality of prefermented frozen wheat doughs were studied. The doughs were baked from six different flours and fermented optimally (40 min) and less than optimally (25 min) before freezing. After frozen storage (1-14 days), the baking quality was evaluated and the structure of the doughs was studied by microscopic and rheological methods. Fermentation time had a dramatic effect on the freezing and thawing stability of the doughs. With one-day storage, the loaf volumes were, on average, 20 greater after shorter than after longer fermentation time. Moreover, with interrupted fermentation the change in loaf volume due to freezing was almost independent of flour quality. Microstructural and rheological studies showed that the reason for these improvements was a thicker gluten network and greater amount of small gas bubbles. However, the interrupted fermentation did not reduce the deterioration of loaf volumes during longer storage times. The most significant decrease (11 of the fresh volume) occurred during the first week but continued during the second week of frozen storage (up to 15 of the fresh volume).

3352 Rhee, C.O. (Chonnam National University, Kwangju (Korea Republic). Department of Food Science and Technology); Sugimoto, T.; Kawamura, Y. (National Food Research Institute, Tsukuba (Japan). Protein Science Laboratory) (1993) **Distribution of lipoxygenase activity among flours from different milling of wheat.** *Foods and Biotechnology (Korea Republic) v. 2(1) p. 44-45.* 1 illus.; 1 table; 10 ref. English. (AGRIS 97-041035).

3353 Roach, R.R. (Keebler Company, Elmhurst, IL.); Hoseney, R.C. (1995) **Effect of certain surfactants on the starch in bread.** *Cereal chemistry (USA) v. 72(6) p. 578-582.* references. English. (AGRIS 97-040746).

Addition of Tristearin (C18TG) improved loaf volume in a manner similar to that of shortening. Triolein (C18'TG), when used to replace shortening in the breadmaking formula, improved volume only slightly, probably because less solid fat was present. Using the hydrated form of monoglycerides (MG) was more effective than blending the MG with the flour in a high-speed mixer or adding them as is. Light micrographs of starch isolated from bread showed that MG or sodium stearoyl lactylate (SSL) added to the formula reduced the swelling of starch, whereas shortening did not. If the effect of MG on crumb firmness relates to their effect on starch swelling, then the mechanism of softening for MG different than that for shortening. The SSL had a somewhat different effect in this limited water system than it had in an excess water system. The effect appeared to be similar to that in the excess water system heated to a lower temperature. Studies with bread made from defatted flour showed that MG reduced crumb firmness, whereas shortening did not. This supports the idea that the mechanisms by which these two lipids reduce crumb firmness are different.

3354 Roach, R.R. (Keebler Company, Elmhurst, AL.); Hoseney, R.C. (1995) **Effect of certain surfactants on the swelling, solubility and amylograph consistency of starch.** *Cereal chemistry (USA) v. 72(6) p. 571-577.* references. English. (AGRIS 97-041037).

The effects of certain mono- and triglycerides and other surfactants on unmodified wheat and corn starch slurries were examined by the Viskograph E. All emulsifiers and surfactants tested caused a lower consistency than the control during the first stage of consistency increase and reduced consistency throughout most of the second stage of consistency increase. Certain monoglycerides went through apparent phase changes, which may have caused them to interact more fully with the starch and reduce consistency below that of the control. When carboxymethylcellulose (CMC) was used to create a background consistency, its consistency could not be deducted from the consistency of a starch plus CMC slurry to obtain the consistency of a starch-only slurry. All monoglycerides tested reduced starch swelling when compared to the control at temperatures of 60-80 degrees C. Monoglycerides with 18 carbons, both saturated and monounsaturated, reduced swelling at 90 degrees C. However, a 10 monoglyceride increased swelling at 90 and 95 degrees C. The increased swelling was also shown by light micrographs and consistency measurements. In general, triglycerides did not affect swelling. All monoglycerides reduced starch solubility compared to that of the control. No triglycerides had an effect on starch solubility. Swelling

occurred in two stages, but solubility showed a relatively smooth increase as temperature increased. This suggests that swelling is related to the two stages consistency increase found with such instruments as the amylograph or viskograph.

3355 Rumbo, M.; Chirdo, F.G.; Fossati, C.A.; Anon, M.C. (Centro de Investigacion y Desarrollo en Criotecnologia de Alimentos (CIDCA), Universidad Nacional de La Plata, 47 y 116 (1900) La Plata (Argentina)) (1996) **Influence of thermal treatment of food on the immunochemical quantification of gliadin.** *Food and Agricultural Immunology (United Kingdom) v. 8(3) p. 195-203.* 22 ref. English. (AGRIS 97-055711).

3356 Smits, JP.; Rinzema, A.; Tramper, J.; Vansonsbeek, HM.; Knol, W. (1996) **SOLID-STATE FERMENTATION OF WHEAT BRAN BY TRICHODERMA REESEI QM9414 - SUBSTRATE COMPOSITION CHANGES, C BALANCE, ENZYME PRODUCTION, GROWTH AND KINETICS.** *Applied Microbiology & Biotechnology. 46(5-6):489-496.* English. [TNO NUTR & FOOD RES INST DIV AGROTECHNOL & MICROBIOL POB 360 NL-3700 AJ ZEIST NETHERLANDS].

A description is given of the solid-state fermentation of wheat bran by Trichoderma reesei QM9414 at constant temperature and relative humidity. Glucosamine: the oxygen consumption rate (OCR), the carbon dioxide production rate (CPR), changes in wheat bran composition and the production of four enzymes were measured during 125 h of fermentation. A C balance was set up between CO2 production, based on CPR measurements, CO2 production as expected on the basis of substrate composition changes and substrate elemental composition in combination with dry-matter weight loss. Glucosamine was used as the measure of biomass. The results indicate that the glucosamine content of fungi in liquid culture cannot be used to estimate the biomass content in solid-state fermentations. Using glucosamine. correlations between fungal growth and respiration kinetics could only partly be described with the linear-growth model of Pirt. A decline in OCR and CPR started the moment the glucosamine level was 50% of its maximum value. After the glucosamine level had reached its maximum OCR and CPR continued to decline. The activities of xylanase and protease are linearly related to the glucosamine level. No clear correlations between glucosamine and carboxylmethyl-cellulose-hydrolysing enzyme activity and amylase activity were found. [References: 19].

3357 Terebiznik, M.R. (Ciudad Universitaria, Buenos Aires, Argentina.); Pilosof, A.M.R.; Moreno, S. (1996) **Effective purification procedure of Aspergillus oryzae alpha-amylase from solid state fermentation cultures including concanavalin A-sepharose.** *Journal of food biochemistry (USA) v. 19(5) p. 341-354.* references. English. (AGRIS 97-040729).

Solid state fermentation cultures of Aspergillus oryzae NRRL 3485 on moistened wheat bran produced high levels of alpha-amylase as judged by the specific activity of water extracts (500-700 units/mg protein) and by the enzyme concentration (around 0.15 g/L) in those extracts. The purification of alpha-amylase by affinity chromatography on Concanavalin A-Sepharose is described. A first DEAE-Sepharose chromatography step (binding of the enzyme contained in the water extract and further elution with 0.2 M NaCl, pH 5) was necessary in order to remove contaminants that hinder the binding of the glycoprotein alpha-amylase to the lectin. Elution was performed with 7.5 mM alpha-D-methylmannoside. The enzyme was obtained highly concentrated and purified with a specific activity of 2000 units/mg protein and a recovery of around 60, free of alpha-glucosidase, amyloglucosidase and color contaminants. The purity of the enzyme preparation was assessed through nondenaturing gel electrophoresis and sucrose gradient centrifugation. An improvement of the performance of the purification procedure is presented in which the maximum capacities of both the anion exchanger and the lectin matrices were exploited.

3358 Vadlamani, K.R. (Kansas State University, Manhattan, KS.); Seib, P.A. (1996) **Reduced browning in raw oriental noodles by heat and moisture treatment of wheat.** *Cereal chemistry (USA) v. 73(1) p. 88-95.* references. English. (AGRIS 97-040949).

Flours milled from heat- and moisture-treated hard white wheat (KS-196) contained reduced levels of polyphenol oxidase (PPO), but not peroxidase (PO). With a 12-min heating period, the PPO activity decreased with increasing moisture content (MC) from 13 to 15, whereas with 4- and 8-min heating periods, the PPO activity was insensitive to moisture level. When the tempering period was increased from 1 to 4 hr at 19 MC, PPO activity in the heat-treated wheat was unaffected. Three other wheat cultivars, tempered to 15 MC for 1 hr and then heat-treated for 8 min at 100 degrees C, yielded flours with =50 reduction in PPO activity. Heating the KS-196 wheat for 12 min at 100 degrees C reduced PPO activity in flour by as much as 76, but destroyed the elasticity of gluten as determined by mixograms. White noodles and yellow alkaline noodles, made from heat-treated (15 MC, 8 min, 100 degrees C) KS-196 wheat, had improved brightness in the raw state and showed little change in cooking quality and cooked texture, except for reduced firmness. When KS-196 wheat was pearled to remove 28 of its weight, and the pearled kernels were heat- and moisture-treated at 15 MC for 8 min at 100 degrees C, the straight-grade flour contained 75 less PPO activity than the untreated wheat flour. White noodles made from pearled, heat- and moisture-treated wheat were brighter than those made from pearled untreated wheat. A white noodle dough, made from heat- and moisture-treated wheat with aminoguanidine bicarbonate added, had the brightest dough (L* = 75) after 24 hr at 25 degrees C.

3359 Wang, L. (Kansas State University, Manhattan, KS.); Seib, P.A. (1996) **Australian salt-noodle flours and their starches compared to U.S. wheat flours and their starches.** *Cereal chemistry (USA) v. 73(2) p. 167-175.* references. English. (AGRIS 97-040730).

The properties of flours and starches from three soft wheats segregated in Western Australia for noodlemaking were compared with those of 12 wheats from the United States representing six classes. Also included were seven Korean noodle flours and their starches. Wheat starches were isolated from the flours in approximately 65 recovery by dough washing and in approximately 90 yield by protease digestion. Compared to the Australian flour, three U.S. soft red wheat flours had approximately 10 more total lipids and nonstarch lipids, whereas Western White wheat flour had less. Total lipids were low in the Australian flours, but nonstarch lipids were average. The swelling powers (SP) of the three Australian flours at 92.5 degrees C ranged from 20.0 to 21.1 g/g, whereas those of the 12 U.S. flours ranged from 14.8 to 19.0 g/g. Multiple regression analysis showed that the SP of the 22 flours were positively correlated (r2 = 0.93, P = 0.001) with the SP of the starches and negatively correlated with flour protein levels. The high SP (92.5) of an Australian noodle-segregate flour was attributed to its low protein level and to its starch's low amylose and lipid levels. Gels prepared at 6 from Gamenya starch, one of the high-swelling Australian wheat starches, gave a high storage modulus (G') in dynamic rheological tests when compared to the gels of low-swelling wheat starches. When the starch concentrations in gels were increased to 10.5, the G' increased less for Gamenya than for the low-swelling starches, especially one from a soft wheat (Geneva). Low-swelling starch from the hard red winter wheat Karl gave gels at 8.0-10.5 solids with G' values that almost matched those of Gamenya. The size distributions of starch granules from Karl and Geneva wheats were the lowest and highest, respectively, among the starches tested.

Q03 FOOD CONTAMINATION AND TOXICOLOGY

3360 Dupuis, B. (1997) **THE CHEMISTRY AND TOXICOLOGY OF POTASSIUM BROMATE [Review].** *Cereal Foods World. 42(3):171-183.* English. [UNIV MANITOBA DEPT FOOD SCI WINNIPEG MB R3T 2N2 CANADA].

3361 Lopezdiaz, TM.; Flannigan, B. (1997) **PRODUCTION OF PATULIN AND CYTOCHALASIN E BY ASPERGILLUS CLAVATUS DURING MALTING OF BARLEY AND WHEAT.** *International Journal of Food Microbiology. 35(2):129-136.* English. [HERIOT WATT UNIV INT CTR BREWING & DISTILLING RICCARTON EDINBURGH EH14 4AS MIDLOTHIAN SCOTLAND].

Production of patulin and cytochalasin E by four strains of Aspergillus clavatus during small-scale laboratory malting of barley at 16 and 25 degrees C was investigated. Fungal biomass, measured as ergosterol, appeared to be greater at 25 than at 16 degrees C, but marked differences were observed between the degree of colonization by the different strains. Patulin was detected in extracts by HPLC. Net production was greater at 16 degrees C, but amounts were strain dependent. Except for one strain, cytochalasin E was detected only in barley malted at 25 degrees C. In experiments with wheat inoculated with two A. clavatus strains, ergosterol levels in the green malts were generally greater than in corresponding

barley malts. Patulin was again detected in all samples, with the equivalent of 22.4 mg/kg being detected in one sample at 16 degrees C, but cytochalasin E was only found at 25 degrees C, the highest level detected being 13.8 mg/kg. In samples of barley spiked with toxin and kilned at 80 degrees C for 24 h, only about one-fifth of the amount of toxin recovered from corresponding unkilned controls was detected. It is indicated that differences in both contaminant strains and temperature in different maltings may account for disparities between symptoms reported for individual outbreaks of mycotoxicosis associated with malting by-products. (C) 1997 Elsevier Science B.V. [References: 21].

3362 Moore, A. (MAFF, Food Contaminants Division, London SW1P 3JR (United Kingdom)) (1996) **Ochratoxin A in cereals and flour, and carry-over into retail processed foods.** *Food Surveillance Information Sheet (United Kingdom); no. 95 7 p.* MAFF. 8 ref. English. (AGRIS 97-056061).

3363 Mossoba, M.M. (U.S. Food and Drug Administration, Washington, DC.); Adams, S.; Roach, J.A.G.; Trucksess, M.W. (1996) **Analysis of trichothecene mycotoxins in contaminated grains by gas chromatography/matrix isolation/Fourier transform infrared spectroscopy and gas chromatography/mass spectrometry.** *Journal of AOAC International (USA) v. 79(5) p. 1116-1123.* references. English. (AGRIS 97-041283).

Gas chromatography/matrix isolation/Fourier transform infrared (GC/MI/FTIR) spectroscopy and GC/mass spectrometry (MS) were used to confirm the identities of trimethylsilyl (TMS) derivatives of trichothecene mycotoxins in naturally contaminated grains. Infrared spectral bands observed in the fingerprint region were unique for 10 trichothecene standards. Characteristic absorption bands were observed for the ester (near 1750 cm-1) and ketone (near 1700 cm-1) carbonyl stretching vibrations, the acetate CH3 symmetric bend (1370 cm-1), the epoxide ring (1262 cm-1), the trimethylsilyl CH3 in-plane deformation (1253 cm-1), the ester (O)C-O asymmetric stretching vibration (near 1244 cm-1), and several other bands including intense features due to the TMS function. Infrared bands observed under cryogenic matrix isolation conditions were compared with those found at room temperature in a potassium bromide matrix for 5 of these standards. Identities of deoxynivalenol (DON) from barley and mixed feed, nivalenol from wheat and barley, and DON and fusarenon-x from sweet corn were confirmed by comparison of their infrared spectral bands with those of standards. The identity of DON in the same test samples of sweet corn was confirmed further by GC/MS. GC/MS was also used to quantitate the levels of DON (67-455 ppm) in sweet corn test samples.

3364 Murkovic, M.; Gailhofer, M.; Steiner, W.; Pfannhauser, W. (1997) **FORMATION OF ZEARALENONE ON WHEAT CONTAMINATED WITH FUSARIUM GRAMINEARUM UNDER CONTROLLED CONDITIONS.** *Zeitschrift fur Lebensmittel-Untersuchung und-Forschung A-Food Research & Technology. 204(1):39-42.* English. [GRAZ UNIV TECHNOL DEPT BIO & FOOD CHEM PETERSGASSE 12-2 A-8010 GRAZ AUSTRIA].

The contamination of cereals with field-growing Fusarium species can be a health hazard since Fusarium are known for their ability to produce mycotoxins like zearalenone (ZON) and deoxynivalenol (DON). For this study the formation of ZON was investigated under controlled growth conditions. Ergosterol, as an indicator of fungal growth, and ZON were analysed by HPLC with UV and fluorescence detection respectively. It is shown that ZON is synthesised in the late growth phase of the fungi, which is typical for secondary metabolites. Milling of contaminated wheat shows a reduced content of ZON in fractions of low ash content. Consequently the concentration of ZON in bran, which has a high ash content, was much higher. [References: 17].

3365 Trigo Stockli, D.M. (Kansas State University, Manhattan.); Curran, S.P.; Pedersen, J.R. (1995) **Distribution and occurrence of mycotoxins in 1993 Kansas wheat.** *Cereal chemistry (USA) v. 72(5) p. 470-474.* references. English. (AGRIS 97-041268).

Wheat samples from various locations in Kansas were tested for mold invasion by plating on agar medium and then analyzing for the presence of deoxynivalenol, zearalenone, and aflatoxin B1 using thin-layer chromatography. In eastern Kansas, 29 of 30 samples (96) were invaded with Fusarium graminearum and the mean percentage of invaded kernels was 33 in northeast, 16 in east central, and 15 in southeast districts. The highest level of invasion observed was 75 on a sample from northeast Kansas. Deoxynivalenol was detected in 23 of 116 samples analyzed (20) and was correlated highly ($r = 0.839$, $P < 0.001$) with the level of invasion by F. graminearum. Zearalenone was detected only in one sample from northeast Kansas. Cool, wet weather during 1993 was an important factor affecting invasion and toxin formation by F. graminearum. The level of mycotoxin in 1993 Kansas wheat was relatively low.

3366 Trigo Stockli, D.M. (Kansas State University, Manhattan.); Deyoe, C.W.; Satumbaga, R.F.; Pedersen, J.R. (1996) **Distribution of deoxynivalenol and zearalenone in milled fractions of wheat.** *Cereal chemistry (USA) v. 73(3) p. 388-391.* references. English. (AGRIS 97-041269).

Wheat samples collected from various locations in Kansas were milled at 16 moisture content using a Buhler mill. Wheat bran, shorts, and flour from samples invaded with Fusarium graminearum and several noninvaded samples were analyzed for deoxynivalenol and zearalenone using thin-layer chromatography. The presence of deoxynivalenol and zearalenone on random samples was confirmed using gas chromatography. When present in milled fractions, the levels of deoxynivalenol and zearalenone were generally highest in the bran and lowest in the flour. Ten of 27 bran samples (37) and six of 27 shorts samples (22) contained deoxynivalenol levels that exceeded 1 ppm. Three of 27 samples (11) yielded flour with deoxynivalenol levels that exceeded 1 ppm. Zearalenone levels exceeded 1 ppm in five of 27 bran samples (19) and four of 27 shorts samples (15). None of the flour fractions contained > 1 ppm zearalenone.

3367 Trucksess, M.W. (U.S. Food and Drug Administration, Washington, DC.); Ready, D.E.; Pender, M.K.; Ligmond, C.A.; Wood, G.E.; Page, S.W. (1996) **Determination and survey of deoxynivalenol in white flour, whole wheat flour, and bran.** *Journal of AOAC International (USA) v. 79(4) p. 883-887.* references. English. (AGRIS 97-041404).

A liquid chromatographic (LC) method for determining deoxynivalenol (DON) in white flour, whole wheat flour, and bran was developed. A 25 g test portion was extracted with acetonitrile-water (84 + 16), and the extract was filtered and applied to a column containing a combination of charcoal, Celite, and other adsorbents. The eluate was then chromatographed on a silica-based, reversed-phase LC column by using a gradient of water and methanol. DON was measured at 220 nm. Average recoveries of DON from white flour, whole wheat flour, and bran spiked at 1 microgram/g were 88, 86, and 85, respectively. The limit of determination of the method was <0.5 microgram/g. A total of 562 wheat-based products from the 1993 crop year were collected by 21 U.S. Food and Drug Administration District Offices and analyzed by this method in Kansas City, Seattle, and New Orleans District Laboratories. The numbers of samples with DON contamination greater than or equal to 1 microgram/g from 163 bran, 272 white flour, 90 whole wheat flour, and 37 miscellaneous test samples were 20, 28, 14, and 2, respectively. About 52, 50, 40, and 27 of the same test samples were contaminated with DON at levels >0.1 microgram/g.

3368 Wood, GM.; Patel, S.; Entwisle, AC.; Williams, AC.; Boenke, A.; Farnell, PJ. (1997) **OCHRATOXIN A IN WHEAT - CERTIFICATION OF TWO REFERENCE MATERIALS.** *Food Additives & Contaminants. 14(3):237-248.* English. [LEATHERHEAD FOOD RES ASSOC RANDALLS RD LEATHERHEAD KT22 7RY SURREY ENGLAND].

The preparation of two wheat reference materials and the certification of their ochratoxin A content is described. The materials were prepared and certified within the European Commission, Measurements and Testing Programme (M&T). The first and second phases of this project, two intercomparisons of procedures for the determination of ochratoxin A in wheat, at levels of approximately 13 mu g/kg, and 7 mu g/kg, respectively have already been reported. This paper describes the work carried out in certification of the ochratoxin A content (mass fraction) of two wheat reference materials: a blank wheat CRM 471, and a contaminated wheat, CRM 472. These materials were prepared for use in the second intercomparison referred to above and reported previously. Reference material CRM 472 was prepared from naturally-contaminated wheat blended with the blank wheat (CRM 471). Details are given of the milling, blending and packaging procedure, and the checks to ensure homogeneity and stability of the material. The certification exercise was carried out by 15 laboratories using a variety of extraction and clean-up procedures, and the certified ochratoxin A content (mass fraction) of CRM 471 was <0.6 mu g/kg. The value for CRM 472 was 8.2 mu g/kg with an uncertainty of 1.0 mu g/kg. [References: 12].

3369 Abdel All, E.S.M. (University of Saskatchewan, Saskatoon, SK, Canada.); Hucl, P.; Sosulski, F.W. (1995) **Compositional and nutritional characteristics of spring einkorn and spelt wheats.** *Cereal chemistry (USA) v. 72(6) p. 621-624.* references. English. (AGRIS 97-041836).

One einkorn and five spring spelt accessions were grown at five and four locations in 1992 and 1993, respectively, and evaluated for their compositional and nutritional properties compared to common hard red spring (HRS) and durum wheats. Einkorn and two spelt accessions, SK0021 and PGR8801, were higher in soluble sugars, protein, and ash, whereas spelt accessions SK0505, SK0263, and RL5407 were higher in starch and fat. The accessions contained less total and insoluble dietary fiber than did common HRS, while soluble fiber was similar among the wheat species. Einkorn was significantly higher in phosphorus level, and all accessions exceeded the HRS wheat in potassium level. Einkorn tended to be high in riboflavin and pyridoxine compared with wheats, whereas einkorn and spelt SK0263 and RL5407 were richer in beta-carotene and retinol equivalent than was common HRS wheat. Einkorn and spelt SK0021 and PGR8801 flours had higher protein content did common HRS flour. The gluten content of all wheat species similar and constituted about 77 of total flour protein. The gliadin to glutenin ratios were 2:1 for einkorn; 1:1 for spelt SK0021 and PGR8801 and common HRS; and 0.8:1 for durum and spelt SK0505, SK0263, and RL5407 wheat flour proteins.

3370 Addo, K. (1997) **EFFECTS OF HONEY TYPE AND LEVEL ON THE BAKING PROPERTIES OF FROZEN WHEAT FLOUR DOUGHS.** *Cereal Foods World. 42(1):36-40.* English. [UNIV KENTUCKY DEPT NUTR & FOOD SCI LEXINGTON, KY 40506 USA].

Effects of honey type and level on the baking and sensory properties of frozen doughs were investigated. The types of honey used included a liquid variety containing 81.4% honey solids and a dry variety with 70% honey solids. The two types tested at levels ranging from 4 to 12% (flour basis) and compared with control nonfrozen and frozen doughs containing 6% sugar. Doughs were prepared by a modified short-time dough procedure and frozen at -18 degrees C. After two weeks of frozen storage, the doughs were thawed, and replicate samples were baked. Addition of higher amounts of liquid honey (greater than or equal to 8%) improved the baking properties of frozen doughs. Dry honey was most effective in lowering crumb firmness of breads baked from frozen doughs. Neither honey variety nor sugar could adequately protect the doughs from the adverse effects of repeated freeze-thaw cycles. Sensory panelists scored breads baked from frozen doughs containing 10% liquid honey and the nonfrozen control with 6% sugar the highest in overall product acceptability. [References: 15].

3371 Araujo, W.M.C.; Ciacco, C.F.; Esteves, W.; Camargo, C.R. de O. (1996) **[The effect of adding deffated soybean flour to wheat flour dough]. Efeito da adicao de farinha de soja desengordurada na massa de farinha de trigo.** *Ciencia e Tecnologia de Alimentos (Brazil) v. 16(1) p. 26-31.* 26 ref. Portuguese. (AGRIS 97-041823).

3372 Armero, E.; Collar, C. (1997) **TEXTURE PROPERTIES OF FORMULATED WHEAT DOUGHS - RELATIONSHIPS WITH DOUGH AND BREAD TECHNOLOGICAL QUALITY.** *Zeitschrift fur Lebensmittel-Untersuchung und-Forschung A-Food Research & Technology. 204(2):136-145.* English. [INST AGROQUIM LAB CEREALES POB 73 E-46100 BURJASSOT VALENCIA SPAIN].

Texture properties of wheat doughs were determined with a texturometer by using texture profile analysis (TPA) as well as Chen and Hoseney methodologies. The time elapsed between two compressions and strain were optimized so that meaningful values were obtained for TPA. Single effects and interactions between flour type, the breadmaking process and anti-staling additives (i.e. monoglycerides, diacetyl tartaric ester of monoglycerides, sodium stearoyl lactylate, carboxymethylcellulose and hydroxypropylmethylcellulose) on dough texture properties (i.e. springiness, resilience, hardness, cohesiveness, adhesiveness, chewiness, gumminess and stickiness) were estimated. The breadmaking process and addition of hydrocolloids had the most important effects and interactions on TPA. Hydrocolloids and a-amylase increased dough stickiness. Dough cohesiveness was a good predictive parameter of bread quality. Water content, acidity values and gluten quality were the main factors determining the texture properties of dough. [References: 24].

3373 Arvanitoyannis, I.; Psomiadou, E.; Nakayama, A. (1996) **EDIBLE FILMS MADE FROM SODIUM CASEINATE, STARCHES, SUGARS OR GLYCEROL .1.** *Carbohydrate Polymers. 31(4):179-192.* English. [ARISTOTELIAN UNIV THESSALONIKI SCH AGR LAB FOOD CHEM & BIOCHEM GR-54006 THESSALONIKI GREECE].

The physical properties of edible films, based on blends of sodium caseinate with starches of different origin (corn and wheat) plasticized with water, glycerol or sugars, were studied. An increase in water or sugar/glycerol content resulted in a considerable decrease in the modulus of elasticity and in the tensile strength of films. The tensile strength and the water vapor permeability decreased with an increase in sodium caseinate contents (> 10% w/w). The development of crystallinity caused a reduction in as and water permeabilities. Semi-empirical models for calculation of gas permeability and tensile strength and tensile moduli were applied with limited success and the obtained values were compared to those experimentally determined. (C) 1997 Published by Elsevier Science Ltd. [References: 83].

3374 Berman, M. (Macquarie University, NSW, Australia.); Bason, M.L.; Ellison, F.; Peden, G.; Wrigley, C.W. (1996) **Image analysis of whole grains to screen for flour-milling yield in wheat breeding.** *Cereal chemistry (USA) v. 73(3) p. 323-327.* references. English. (AGRIS 97-041833).

Image analysis of whole-grain samples was used to predict milling quality in wheat breeding to select for this aspect of quality, while preserving the seed intact for sowing. About 66 of the variation in flour yield for 38 grain samples could be explained by four factors computed from the images of 100 grains for each sample (mean of grain area, lengths of minor and major axes, and ellipsoidal volume), plus test weight. Test weight alone accounted for only 17 of the variation. The set of grain samples consisted of eight genotypes (three cultivars and five breeders' lines) grown at up to six sites. The method devised is suitable for a breeding program, being relatively low in labor requirement, not requiring time consuming positioning of the grains, and having low cost (less than $3, 000 plus personal computer and software). The results of this preliminary study should provide direction for further development of noninvasive analysis of milling quality.

3375 Bhatty, RS.; Rossnagel, BG. (1997) **ZERO AMYLOSE LINES OF HULL-LESS BARLEY.** *Cereal Chemistry. 74(2):190-191.* English. [UNIV SASKATCHEWAN CTR CROP DEV 51 CAMPUS DR SASKATOON SK S7N 5A8 CANADA].

3376 Bietz, JA.; Lookhart, GL. (1997) **WHEAT VARIETAL IDENTIFICATION BY CAPILLARY ELECTROPHORESIS - AN INTER-LABORATORY COMPARISON OF METHODS.** *Food Science & Technology-Lebensmittel-Wissenschaft & Technologie. 30(2):210-213.* English. [USDA ARS NATL CTR AGR UTILIZAT RES 1815 N UNIV ST PEORIA, IL 61604 USA].

Capillary electrophoresis (CE) is a rapid automated method for wheat protein analysis It is sensitive, reproducible, and gives high resolution separation of gliadins, differentiating most genotypes. Optimal CE conditions have not yet been established, however, nor methods compared between laboratories. We therefore analysed gliadins from several varieties by two methods in two laboratories using comparable CE systems. A commercial 0.1 mol/L phosphate buffer, pH 2.5, containing a linear hydrophilic polymer, was used with uncoated 27 cm silica capillaries (20 cm from inlet to detector) of 50 and 20 mu m i.d. Separations with 50 mu m capillaries were performed at 7 kV and required 30-40 min; those with 20 mu m capillaries were performed at 22 kV, and separations took about 10 min. In each laboratory, both methods gave excellent separations with comparable selectivity and resolution. For some analyses (especially those using 50 mu m capillaries), however, elution times and operating currents varied with different batches of commercial buffers, giving unacceptable reproducibility. Thus, while CE is a useful alternative to slab gel electrophoresis or high performance liquid chromatography for wheat varietal identification, CE buffer compositions must be carefully controlled to ensure acceptable reproducibility. [References: 8].

3377 Booth, C.K. (Royal Brisbane Hospital, Herston, QLD, Australia.); Reilly, C.; Farmakalidis, E. (1996) **Mineral composition of Australian ready-to-eat breakfast cereals.** *Journal of food composition and analysis : an*

official publication of the United Nations University, International Network of Food Data Systems (USA) v. 9(2) p. 135-147. references. English. (AGRIS 97-056137).

The consumption of fortified ready-to-eat breakfast cereals contributes significantly to the Australian population's dietary intake of a number of nutrients. However, our knowledge of the mineral content of cereals is limited The present study aimed to describe the mineral content of these important breakfast foods. Twelve different ready-to-eat breakfast cereals and 21 of the raw ingredients, which were used in their manufacture, were sampled and analyzed for their aluminium, calcium, manganese, iron, magnesium, zinc, and copper contents The ready-to-eat breakfast cereals and ingredients were representative of one year's production, namely 1993. The processing of whole cereal grains to the final product results in losses of all the minerals tested. However, ready-to-eat breakfast cereals still contribute significant amounts of these important minerals, particularly iron, manganese and magnesium, to the Australian diet.

3378 Borghi, B. (Istituto Sperimentale per la Cerealicoltura, Lodigiano, Italy.); Castagna, R.; Corbellini, M.; Heun, M.; Salamini, F. (1996) **Breadmaking quality of Einkorn wheat (Triticum monococcum ssp. monococcum).** *Cereal chemistry (USA) v. 73(2) p. 208-214.* references. English. (AGRIS 97-041622).

Twenty-five Einkorn lines (Triticum monococcum ssp. monococcum) were evaluated for their agronomic performance in Italy and Germany. Seeds produced in 1993 in the two locations were used for breadmaking quality tests. Flour was produced (after dehulling) with an experimental mill. Flour yield and the percentage of fine particles of all Einkorn lines were similar to the bread wheat standard. The protein content (N X 5.7) of Einkorn lines ranged from 13.2 to 22.8, values higher than those found for bread wheat (10.8-13.3). SDS sedimentation volume of Einkorn genotypes ranged from 11 to 93 ml. Seven Einkorn lines had acceptable gluten strength that yielded alveograph values and farino-graph stability indices similar to those of bread wheat. Most Einkorn flours produced sticky dough; however, about one-third gave an acceptable dough and produced breads with a bright yellow color with volumes similar to, or better than, bread wheat. Rheological parameters and bread volume correlated positively with SDS sedimentation volume. About 16 of the 1, 099 accessions screened for SDS sedimentation volume gave values above 60 ml, the threshold value for considering a genotype potentially suitable for breadmaking. Einkorn could become an important crop for the production of baked foods rich in carotenoids and proteins.

3379 Caballero Barrigon, A. (1996) **[Effects of damaged starch on amylographic properties of spring vitreous wheats]. Efectos del almidon danado sobre las propiedades amilograficas de trigos vitreos de primavera.** *Alimentacion. Equipos y Tecnologia (Espana) (no.9) p. 45-52.* 9 tab., 6 fig.; 33 ref. Spanish. (AGRIS 97-056112).

Se ha investigado la influencia del almidon danado sobre las propiedades amilograficas de trigos vitreos de primavera, selecionando para ello diferentes variedades de estos trigos, algunas de las cuales, como Rinconada y Yecora, son muy utilizadas por la industria harinera. Con cada una de ellas, se ha determinado el Amilograma e Indice de Maltosa.

3380 Campsolinas Dresaire, J. (1996) **[Chemical-rheological analysis of wheat flour: interpretation of analytical data in improved design]. Analisis quimico-reologico de la harina de trigo: interpretacion de los datos analiticos en el diseno de mejorantes.** *Alimentacion. Equipos y Tecnologia (Espana) (no.9) p. 31-35.* 4 fig. Spanish. (AGRIS 97-056111).

El diseno de un mejorante panario depende basicamente de dos factores: caracteristicas del proceso y calidad de la harina empleada. En este articulo se describen brevemente los principales metodos de analisis para harinas de trigo.

3381 Chiue, H.; Kusano, T.; Iwami, K. (1997) **ANTIOXIDATIVE ACTIVITY OF BARLEY HORDEIN AND ITS LOSS BY DEAMIDATION.** *Journal of Nutritional Science & Vitaminology. 43(1):145-154.* English. [KOBE GAKUIN UNIV DEPT NUTR KOBE 65121 JAPAN].

Barley hordein was comparable to maize zein in antioxidation under a powder model system. Various deamidated "hordein" preparations were obtained and examined for their molecular-size distribution (by Sephacryl S-100 gel filtration), hydrophobicity (by fluorescence measurement using fluorescent probes) and antioxidative activity (by the ferric thiocyanate method). Deamidation caused fragmentation of the hordein molecule and simultaneously lowered its fatty acid-binding capacity rather than its surface hydrophobicity. Then, the antioxidative activity diminished with increasing deamidation. When the fatty acid-binding capacity was plotted against the antioxidative activity, a high correlation (r(2)=0.92) was observed between these two events. [References: 27].

3382 Christophersen, C.; Andersen, E.; Jakobsen, TS.; Wagner, P. (1997) **XYLANASES IN WHEAT SEPARATION.** *Starch-Starke. 49(1):5-12.* English. [NOVO NORDISK AS NOVO ALLE DK-2880 BAGSVAERD DENMARK].

Hemicellulases used in the wheat separation process have resulted in better separation, purer fractions, increased plant capacity, reduced processing time etc. In order to further improve enzyme-treatment in the wheat separation process, monocomponent xylanases were evaluated. A laboratory viscosity model has been set up to evaluate the xylanases. The model showed good correlation (for a commercial hemicellulase preparation used for wheat separation) between viscosity of the wheat flour slurry and the sludge/supernatant ratio after centrifugation of the slurry. A xylanase (Novozyme 867) with excellent performance in the wheat separation process has been found. The xylanase has high activity towards soluble arabinoxylan and gives a rapid viscosity reduction of wheat flour slurries. The enzyme also has a moderate activity towards insoluble arabinoxylan, but due to the low molecular weight of the solubilized material this was not was found to contribute negatively to the enzymes' performance. The pH and temperature conditions in the wheat separation process were well within the active range of the enzyme. A pilot plant experiment showed improved yield of gluten and A-starch, with no apparent negative effect on the gluten quality. [References: 5].

3383 Ciaffi, M. (University of Tuscia, Viterbo, Italy.); Tozzi, L.; Lafiandra, D. (1996) **Relationship between flour protein composition determined by size-exclusion high-performance liquid chromatography and dough rheological parameters.** *Cereal chemistry (USA) v. 73(3) p. 346-351.* references. English. (AGRIS 97-041621).

The relationship between protein composition, measured by size-exclusion high-performance liquid chromatography (SE-HPLC), and rheological dough properties, evaluated by alveographic test, were investigated in bread wheat cultivars grown at two locations in North and Central Italy. Total polymeric proteins were separated into two size groups on the basis of their solubility in 2 sodium dodecyl sulfate-phosphate buffer with and without reducing agents. Relative and absolute amounts of total polymeric proteins, determined by SE-HPLC after sonication, showed variable (nonsignificant to significant) relationships with rheological properties, particularly dough tenacity (alveographic index P) and strength (alveographic index W). On the other hand, absolute or relative amounts of insoluble polymeric proteins correlated positively with dough strength and tenacity and accounted for up to 30-40 more variation in these parameters than did total polymeric proteins. Correlations of both absolute and relative amounts of soluble polymeric proteins with dough strength and tenacity were not significant and significantly negative, respectively, whereas the correlation with dough extensibility (alveographic index L) was significantly positive.

3384 Cleemput, G.; Hessing, M.; Vanoort, M.; Deconynck, M.; Delcour, JA. (1997) **PURIFICATION AND CHARACTERIZATION OF A BETA-D-XYLOSIDASE AND AN ENDO-XYLANASE FROM WHEAT FLOUR.** *Plant Physiology. 113(2):377-386.* English. [KATHOLIEKE UNIV LEUVEN LAB LEVENSMIDDELENCHEM KARDINAAL MERCIERLAAN 92 B-3001 HEVERLEE BELGIUM].

A beta-D-xylosidase and an endo-xylanase were purified from European wheat (Triticum aestivum) flour. The beta-D-xylosidase had a molecular weight of approximately 64, 000 and an isoelectric point of 5.5. It hydrolyzed p-nitrophenyl-beta-D-xylopyranoside and xylooligosaccharides and released D-xylose units from wheat arabinoxylan and oat spelts xylan. An endo-xylanase with a molecular weight of approximately 55, 000 was also obtained and it consisted of a number of isoforms with isoelectric points between 4.0 and 5.0. The action of the isolated endo-xylanase depended on the degree of substitution of the polysaccharide. Unbranched polymers were preferentially hydrolyzed. Since xylo-oligosaccharides were not hydrolyzed, the enzyme appeared to need at least five or more consecutive unsubstituted xylose units. Finally, an alpha-L-arabinofuranosidase that hydrolyzed p-nitrophenyl-alpha-L-arabinofuranoside was partially purified. [References: 34].

3385 Czuchajowska, Z. (Washington State University, Pullman, WA.); Lin, P.Y.; Smolinski, S. (1996) **Role in dough rheology of high molecular weight glutenin subunits of soft white winter and club wheats.** *Cereal chemistry (USA) v. 73(3) p. 338-345.* references. English. (AGRIS 97-041716).

The effect of high molecular weight glutenin subunit (HMW-GS) composition of seven soft white winter (SWW) and four club wheat cultivars from the Pacific Northwest region on dough rheology was investigated. All samples were harvested in 1988, 1990, and 1993 (in Walla Walla, WA). Three selected SWW and three club wheats were grown in 1990, in seven locations covering broad growing conditions. The SWW and club wheats grown under the same conditions showed similar protein content (11.70 and 11.65, respectively) but distinctly different values of total area of HMW-GS (0.9-1.9 for SWW, and 0.7-1.3 for club wheat. excluding Hyak). The quality score of HMW-GS multiplied by area showed much better correlation with dough rheology (alveograph W: r = 0.905; mixograph mixing time: r = 0.743) and SDS sedimentation volume (r = 0.883) than for each of these parameters separately. The increase in protein content of SWW, (from 8.5 to 12.5) and of club wheats (from 7.5 to 11) resulting from growing conditions accompanies the increase of total area of HMW-GS, from 0.85 to 1.3 and from 0.7 to 0.95, respectively. However, that increase better matched the increase in protein content of SWW wheats (r = 0.662) than club wheats (r = 0.352). If the increase in protein content is substantial for the cultivars with high quality score HMW-GS, it might cause an increase of gluten strength as measured by dough rheology and SDS sedimentation value. The cultivar Hyak, containing the subunits 7+8 in Glu-1B locus and 5+10 in Glu-1D locus, is a good example of the latter. The club wheats (not Hyak), having a generally low quality score of HMW-GS, preserve unique properties of weak gluten, even with the increase of protein content.

3386 Danielson, AD.; Newman, RK.; Newman, CW. (1996) **PROXIMATE ANALYSES, BETA-GLUCAN, FIBER AND VISCOSITY OF SELECT BARLEY MILLING FRACTIONS.** *Cereal Research Communications. 24(4):461-468.* English. [MONTANA STATE UNIV DEPT PLANT SOIL & ENVIRONM SCI BOZEMAN, MT 59717 USA].

Four barley genotypes, Azhul (waxy), Azhul sister-line (non-waxy), Waxbar (waxy) and Shonkin (waxy) were milled through an g-roller dry mill following tempering to 10% moisture for 12 h. Fractions obtained were first break flour, flour, fifth middlings, red dog, break shorts, reduction shorts and bran. The fractions were analyzed for protein, ether extract, ash, starch, beta-glucans, neutral and acid detergent fiber (NDF and ADF, respectively), and acid viscosity. Protein was higher ($P < 0.05$) in fifth middlings, red dog, break shorts, reduction shorts and bran when compared to first break flour and flour. First break flour and flour contained the greatest ($P < 0.05$) concentration of starch and the least ($P < 0.05$) fiber while beta-glucan and fiber was concentrated ($P < 0.05$) in red dog, break and reduction shorts and bran. Acid viscosity was the greatest ($P < 0.05$) in the red dog fraction. Results of this experiment indicate that certain components of barley can be isolated in relatively high concentration in select milling fractions obtained roller-milling in a mill designed for wheat. [References: 20].

3387 Dormaar, JF.; Lukow, OM.; Lindwall, CW.; Kozub, GC. (1997) **EFFECT OF ARTIFICIALLY ERODED DARK BROWN CHERNOZEMIC SOIL AND SUBSEQUENT AMENDMENTS ON THE MILLING AND BAKING QUALITY OF WHEAT UNDER DRYLAND CONDITIONS.** *Canadian Journal of Soil Science. 77(1):27-32.* English. [AGR CANADA RES CTR LETHBRIDGE AB T1J 4B1 CANADA].

A field was artificially eroded by levelling in 1957. It was continuously cropped to barley for 7 yr. Subsequently, the field was cropped to a wheat-fallow rotation up to but not including 1986. Two major restoring productivity experiments were conducted over that time period. After 30 yr and 19 crops, a third experiment was established to determine the effect of artificial soil erosion and four restorative amendments on 13 wheat quality characteristics. Year, erosion level, and amendment all had significant effects on many wheat quality parameters. Erosion decreased overall quality, mainly by decreasing protein content which in turn affected other quality characteristics. Applications of manure, fertilizer, and straw + fertilizer increased protein content and related characteristics substantially compared to the check. Since high-quality bread wheat is central to its worldwide demand, prevention of soil erosion is essential. Conversely, eroded soil can be ameliorated with amendments but at a cost of the amendment and its application. [References: 23].

3388 Douzals, J.P. (ENSBANA, Dijon, France.); Marechal, P.A.; Coquille, J.C.; Gervais, P. (1996) **Microscopic study of starch gelatinization under high hydrostatic pressure.** *Journal of agricultural and food chemistry (USA) v. 44(6) p. 1403-1408.* references. English. (AGRIS 97-041831).

Starch gelatinization corresponds to a melting phase transition in aqueous medium. Such a transition involves important mass transfer of water. Using a high-pressure bomb including optical ports, the volume variation of starch granules in suspension was related to gelatinization during a high-pressure treatment up to 420 MPa. Microscopic observations of wheat and potato starch granules were compared with macroscopic measurements of compressibility up to 600 MPa and gelatinization intensity using differential scanning calorimetry on treated suspensions. Wheat starch gelatinization started below 300 MPa and was completely achieved at 600 MPa. Potato starch was not altered under 600 MPa. The behavior of the volume variation of starch granules under pressure compared with starch suspensions compressibility could be explained by simultaneous compression and hydration mechanisms.

3389 Dupuis, B. (University of Manitoba, Winnipeg.); Bushuk, W.; Sapirstein, H.D. (1996) **Characterization of acetic acid soluble and insoluble fractions of glutenin of bread wheat.** *Cereal chemistry (USA) v. 73(1) p. 131-135.* references. English. (AGRIS 97-041837).

The breadmaking potential of wheat flour depends strongly on its protein content and quality. Research has shown that for bread wheat varieties of diverse breadmaking potential, loaf volume is inversely related to the amount of acetic acid soluble (AAS) glutenin fraction and directly related to the amount of acetic acid insoluble (AAI) glutenin fraction. The objective of the present research was to identify the molecular properties of glutenin controlling its solubility in acetic acid, which in turn might explain the significant correlations with loaf volume. Two wheat cultivars of diverse breadmaking quality (Glenlea and Katepwa) contained different proportions of AAS and AAI fractions. The AAS fractions contained similar amounts of glutenin but that of Katepwa contained significantly more gliadin. Both fractions of Glenlea contained significantly more high molecular weight glutenin subunit (HMW-GS) 7. Quantitative differences in individual HMW-GS and the ratio of HMW-GS to (low molecular weight) LMW-GS could not explain differences in solubility of glutenin. The higher content of the AAI fraction in the stronger cultivar Glenlea appears to be related to its higher content of HMW-GS 7 and weaker interaction with gliadin. Interaction of glutenin with gliadin appears to be related to the solubility of glutenin in acetic acid solution; the greater the interaction the higher the solubility and vice versa. The same phenomenon may be involved in dough development during mixing.

3390 El Hady, E.A. (Suez Canal University, Ismailia, Egypt.); El Samahy, S.K.; Seibel, W.; Brummer, J.M. (1996) **Changes in gas production and retention in non-prefermented frozen wheat doughs.** *Cereal chemistry (USA) v. 73(4) p. 472-477.* references. English. (AGRIS 97-056176).

The effect of freezing conditions, flour protein content, yeast type, water amount, and freeze-thaw cycles during storage on rheological properties and gas production in non-prefermented frozen wheat doughs were examined. Freezing the dough with high air velocity (3 m/see) at-20 degrees C, and after one week storage at the same temperature, gave the highest yeast activity and the best bread quality, while the least activity was in case of freezing with high air velocity (3 m/sec) at -30 degrees C and storage at -20 degrees C for the same period. The risograph total gas production was decreased by 33.4 for frozen dough after four weeks storage. Moreover, the reduction was 49.7 as a result of subjecting the dough to three freeze-thaw cycles. The rheological behaviors measured by rheofermentometer changed during storage. The activity of compressed yeast was less than that of instant active dry yeast in frozen dough. The decrease of added water from 58.8 to 56.8 improved the bread characteristics.

3391 Eladawy, TA. (1997) **EFFECT OF SESAME SEED PROTEIN SUPPLEMENTATION ON THE NUTRITIONAL, PHYSICAL, CHEMICAL AND SENSORY PROPERTIES OF WHEAT FLOUR BREAD.** *Food Chemistry. 59(1):7-14.* English. [MENOUFIA UNIV FAC AGR DEPT FOOD SCI & TECHNOL SHIBIN AL KAWM EGYPT].

Sesame products (sesame meal, roasted and autoclaved sesame meals, sesame protein isolate and concentrate) were added to red wheat flour to produce blends at protein levels of 14, 16, 18 and 20%. Dough properties were studied using a Brabender Farinograph. Leaves were prepared from

the various blends using the straight dough procedure and then evaluated for volume, crust and crumb colour, crumb texture, flavour and overall quality. The water absorption, development time and dough weakening were increased ($P < 0.05$) as the protein level increased in all blends; however, dough stability decreased. Sesame products could be added to wheat flour up to 18% protein level (sesame protein isolate) and up to 16% protein level (for other sesame products) without any observed detrimental effects on bread sensory properties. No significant differences ($P > 0.05$) were recorded in loaf volume between control and breads containing sesame protein isolate (up to 18% protein level) and either autoclaved sesame meal or sesame protein concentrate (up to 14% protein level). Also, addition of these products increased the contents of protein, minerals, total essential amino acids, especially lysine, and also improved the in vitro protein digestibility and computed biological value. (C) 1997 Published by Elsevier Science Ltd. All rights reserved. [References: 33].

3392 Elhaddad, L.; Aussenac, T.; Fabre, JL.; Sarrafi, A. (1997) **RP-HPLC DETERMINATION OF THE SDS-UNEXTRACTABLE PROTEIN FRACTION COMPOSITION DURING THE RIPENING PERIOD FOR THE COMMON WHEAT CULTIVAR SOISSONS.** *Journal of the Science of Food & Agriculture. 73(4):477-484.* English. [ESA PURPAN LAB PHYSIOL VEGETALE 75 VOIE TOEC F-31076 TOULOUSE FRANCE].

The quantity of the SDS-unextractable protein fraction (Fi) is known to be correlated with the baking performance. In this study, by reversed-phase high-performance liquid chromatography (RP-HPLC), we followed the evolution of the Fi composition. The percentage of each high molecular weight glutenin subunit (%HMW-GS) in relation with the all HMW-GS, the percentage of the total high molecular weight glutenin in relation with the total Fi proteins, the percentage of each peak among the non-HMW-GS proteins (P1 to P17) of the Fi fraction as well as the evolution of the ground kernels protein composition (the same types of % were investigated) from the 10th day after anthesis (DAA) to the maturity of the kernel (55th DAA) were determined. After the 25th DAA the Fi and the ground kernels compositions were stable with only a gain in quantity per kernel. Small but significative differences existed for the %HMW-GS between the Fi and the ground kernels. The P6, P11 and P13 of the kernel were in proportion twice as big as the ones in the Fi whereas the % P1 was roughly 1.5 times bigger in the Fi than in the ground kernels. [References: 19].

3393 Fjell, K.M.; Seibel, W.; Gerstenkorn, P. (1996) **Method for ash determination by conductivity.** *Cereal chemistry (USA) v. 73(4) p. 510-511.* references. English. (AGRIS 97-056134).

3394 Fu, B.X. (University of Manitoba, Winnipeg, MB, Canada.); Sapirstein, H.D. (1996) **Procedure for isolating monomeric proteins and polymeric glutenin of wheat flour.** *Cereal chemistry (USA) v. 73(1) p. 143-152.* references. English. (AGRIS 97-041828).

A new method for fractionation of monomeric (albumins, globulins, and gliadins) and polymeric (native unreduced) glutenin proteins of wheat flour has been developed. Proteins were first separated into 50 (v/v) 1-propanol soluble (50PS) and insoluble (50PI) fractions. The 50PI protein was essentially free of monomeric proteins and comprised mainly glutenin; 50PS protein was a mixture of monomeric proteins and polymeric glutenin. Polymeric glutenin in 50PS protein was isolated under nonreducing conditions by precipitation with 1-propanol to a concentration of 70. Polyacrylamide gel electrophoresis at pH 3.1 showed that the precipitated glutenin fraction (70PI) contained some monomeric proteins, mainly omega-gliadins. Sodium dodecyl sulfate polyacrylamide gel electrophoresis showed that no polymeric glutenin remained soluble in aqueous 70 1-propanol. The fractionation procedure was therefore highly selective. This fractionation procedure, in conjunction with reversed-phase high-performance liquid chromatography was then used to examine the flour proteins of two Canadian wheat cultivars (Glenlea and Katepwa) of diverse dough strength. While the amounts of total polymeric glutenin (approximately 50 of flour protein) and the proportions of omega-gliadins in 70PI glutenin (approximately 30) were comparable for both cultivars, flour of the very strong mixing Glenlea contained 21 more insoluble (50PI) glutenin and 30 less soluble (70PI) glutenin as determined by Kjeldahl analysis. The ratios of 50PI to 70PI glutenin (4.5 and 2.8 for Glenlea and Katepwa, respectively) were directly proportional to the mixograph dough development times. Results showed that 50PI and 70PI glutenins had the same subunit composition and similar high molecular weight to low molecular weight subunit ratios. The difference in solubility of the polymeric glutenin in 1-propanol is probably due to a difference in molecular size. The results obtained in this study confirmed the importance of both.

3395 Gaido, ZA.; Manera, GA.; Dubois, ME. (1996) **INFLUENCE OF PROTEIN-BASED SELECTION IN EARLY GENERATIONS ON YIELDS AND QUALITY OF WHEAT CROPS (TRITICUM AESTIVUM L).** *Phyton-International Journal of Experimental Botany. 59(1-2):95-101.* Spanish. [CONSEJO INVEST CIENTIFICAS & TECNOL PROV CORDOBA CORDOBA ARGENTINA].

A disruptive selection for protein on F-3 wheat lines was carried out in three different environments. They were evaluated on F-5 for grain yield and bread-making quality in the semiarid region. The protein classes established in F-3 were not maintained in F-5. This lack of reponse for protein selection could be due to the contrasting pluviometric conditions during the multiplication and evaluation cycles which may have disguised the genetic differences and the effect of seed origin. Although the bread-making parameters showed no significant differences in F-3, either for environment or for protein class, they showed values indicative of good quality for the three environments under study. A positive correlation between the measured parameters was observed. On the other brand, a correlation between protein content and grain yield was not found. This lack of correlation added to the good bread-making quality obtained in all lines opens up the possibility of simultaneous selection for both parameters. [References: 16].

3396 Gaines, C.S. (USDA, ARS, Soft Wheat Quality Laboratory, Ohio Agricultural Research and Development Center, Wooster.); Finney, P.F.; Fleege, L.M.; Andrews, L.C. (1996) **Predicting a hardness measurement using the single-kernel characterization system.** *Cereal chemistry (USA) v. 73(2) p. 278-279.* references. English. (AGRIS 97-041838).

The single-kernel characterization system (SKCS) crushes individual kernels and uses algorithms based on the force-deformation profile data to classify wheat samples into soft, hard, or mixed market classes. Those, data were utilized to produce a predictive equation for softness equivalent (SE), a direct measure of wheat kernel texture obtained from milling wheat on a modified Brabender Quadrumat Jr. mill and sieving system. Predicted SE values had a high correlation ($r2 = 0.996$) with actual SE milling values. In contrast to SKCS hardness index values, predicted SE values accurately responded to varying kernel moisture content and kernel size, within the ranges examined. Therefore, using the SKCS data to predict an independent measure of kernel texture (e.g., SE) may be a valuable augmentation to or replacement for using SKCS algorithms to classify wheat.

3397 Gan, Z. (University of Reading, Whiteknights, Reading, UK.); Schofield, J.D. (1996) **Production and characterization of monoclonal antibodies against wheat flour diacylgalactosylglycerols.** *Journal of agricultural and food chemistry (USA) v. 44(6) p. 1609-1615.* references. English. (AGRIS 97-041827).

Seven immunoglobulin M (IgM)-type monoclonal antibodies were developed against wheat diacylgalactosylglycerols (MGDG). That with the highest titer, MG405, was characterized in detail using a solid phase enzyme-linked immunosorbent assay (ELISA). Inhibition experiments with galactose, glycerol, galactosylglycerol, and lipid standards containing fatty acids typical of those in MGDG indicated that MG405 was directed against the whole MGDG molecule rather than parts of its structure. Six other monoclonal antibodies, also IgM type, had similar specificities. Antibody binding was reduced by 30 when fetal bovine serum, used as antibody diluent and blocking agent, was replaced with gelatin in an ELISA carried out with purified MG405. The plasma cofactor beta 2-glycoprotein I (beta 2GPI) increased binding only slightly, suggesting that some other plasma cofactor may potentiate antibody binding to MGDG. MG405 also appeared not to be an intrinsically low affinity antibody to beta 2GPI. Availability of antibodies such as MG405 could provide a valuable means of investigating polar liquid functionality in foods.

3398 Gawalko, EJ.; Nowicki, TW.; Babb, J.; Tkachuk, R.; Wu, SL. (1997) **COMPARISON OF CLOSED-VESSEL AND FOCUSED OPEN-VESSEL MICROWAVE DISSOLUTION FOR DETERMINATION OF CADMIUM, COPPER, LEAD, AND SELENIUM IN WHEAT, WHEAT PRODUCTS, CORN BRAN, AND RICE FLOUR BY TRANSVERSE-HEATED GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY.** *Journal of AOAC International. 80(2):379-387.* English.

[CANADIAN GRAIN COMMISS GRAIN RES LAB 1404-303 MAIN ST WINNIPEG MB R3C 3G8 CANADA].

A method is described for the determination of Pb, Cd, Cu, and Se in cereal samples, An atomic absorption spectrometer equipped with a transverse-heated graphite furnace with Zeeman background correction was used for all determinations, Sample preparation was performed by closed-vessel microwave digestion using nitric acid and focused open-vessel microwave digestion using nitric acid-hydrogen peroxide, Both techniques were evaluated by using 15 cereal reference materials and comparing results with certified or reference values for each element, Cereal reference standards obtained from the Community Bureau of Reference (Europe), the National Institute of Standards and Technology (USA), the National Institute for Environmental Studies (Japan), the National Research Centre for Certified Reference Materials (People's Republic of China), and the Canadian Grain Commission were used, Application of a series of t-tests, conducted according to Sidak's modified Bonerroni t-procedure, showed that both techniques yielded accurate results for cereal reference materials, Some differences from certified and reference values, however, were found for each element. [References: 52].

3399 Grosch, W.; Schieberle, P. (1997) **FLAVOR OF CEREAL PRODUCTS - A REVIEW [Review].** *Cereal Chemistry. 74(2):91-97.* English. [DEUTSCH FORSCH ANSTALT LEBENSMITTELCHEM LICHTENBERGSTR 4 D-85748 GARCHING GERMANY].

The review is focused on studies presenting quantitative data and odor activity values (ratio of concentration to odor threshold) of key odorants in bread (wheat and rye), toasted bread, puff pastries made with different fats, fragrant and nonfragant rices, sweet corn, popcorn, and tortillas. The influence of raw materials, processing parameters, and storage conditions on the concentrations of key odorants and some data on flavor precursors and formation pathways of these compounds are discussed. [References: 50].

3400 Herrman, T.J. (Kansas State University, Manhattan, KS.); Bowden, R.L.; Loughin, T.; Bequette, R.K. (1996) **Quality response to the control of leaf rust in Karl hard red winter wheat.** *Cereal chemistry (USA) v. 73(2) p. 235-238.* references. English. (AGRIS 97-041624).

Samples of Karl hard red winter wheat from Kansas fungicide trials in 1992 and 1993 were used to evaluate the impact of leaf rust on physical grain quality, milling properties, flour protein content, absorption, and peak mixing time. Leaf rust was allowed to develop naturally on control plots and was prevented from developing on plots treated with systemic fungicides. Changes in kernel characteristics and flour properties were observed for the fungicide in both years, whereas flour extraction percentage and test weight did not respond significantly ($P > 0.05$) Differences between control and fungicide-treated wheat were consistent between years, except for single kernel size standard deviation. Increases in grain and flour protein content related to fungicide were 0.7 in both studies. Using protein premiums for 1992 and 1993 marketing years, an economic comparison between fungicide and control treatments revealed that the added value of increased protein exceeded 50 of the fungicide treatment cost.

3401 Hettiarachchy, N.S. (University of Arkansas, Fayetteville, AR.); Griffin, V.K.; Gnanasambandam, R. (1996) **Preparation and functional properties of a protein isolate from defatted wheat germ.** *Cereal chemistry (USA) v. 73(3) p. 364-367.* references. English. (AGRIS 97-041834).

A protein isolate (90 protein) was prepared from defatted wheat germ by alkaline extraction at pH 9.5 and isoelectric precipitation at pH 4 0. Nitrogen solubility of wheat germ protein isolate (WGPI) was 72 at pH 6.0. WGPI compared well with bovine serum albumin (BSA) in its emulsifying properties. Foaming capacity of WGPI was similar to that of egg white standard while the foam stability was significantly lower ($P < 0.05$). Surface hydrophobicity of WGPI as measured by a fluorescence method followed the same trend as that of emulsifying properties (WGPI < BSA). Electrophoresis of WGPI revealed a wide band at approximately 55 kDa range and another one at 35 kDa. Several polypeptides were observed at >21 kDa MW. Wheat germ offers as a potential source of functional protein isolate for possible food applications.

3402 Hofvendahl, K.; Hahnhagerdal, B. (1997) **L-LACTIC ACID PRODUCTION FROM WHOLE WHEAT FLOUR HYDROLYSATE USING STRAINS OF LACTOBACILLI AND LACTOCOCCI.** *Enzyme & Microbial Technology. 20(4):301-307.* English. [LUND UNIV LUND INST TECHNOL DEPT APPL MICROBIOL POB 124 S-22100 LUND SWEDEN].

A whole wheat flour containing bran and gluten was hydrolyzed by a commercial mixed-amylase preparation and fermented to lactic acid by two Lactococcus lactis strains and two Lactobacillus delbrueckii strains. All fermentations were kept at a constant pH of 6.0 except for one case in which the initial pH was 5.85 and then was not controlled further, thereby resulting in only 3.3 g l(-1) of lactate produced. The yield of lactate based on total sugar was 80-90% for three of the strains whereas the yield for L. delbrueckii ssp. bulgaricus was much lower. The productivities and yields increased with the addition of yeast extract for all strains, but the effect varied. Lactococcus lactis ssp. lactis ATCC 19435 showed almost the same productivity (3.0 and 3.3 g l(-1) h(-1)) without and with yeast extract, respectively. All four organisms produced mainly L-lactate. The Lactococci produced 100% L-lactate in the presence of yeast extract and Lactococcus lactis ssp. lactis ATCC 19435 produced exclusively L-lactate also in the absence of yeast extract. (C) 1997 by Elsevier Science Inc. [References: 39].

3403 Hou, G. (Wheat Marketing Center, Inc., Portland, OR.); Yamamoto, H.; Ng, P.K.W. (1996) **Relationships of quantity of gliadin subgroups of selected U.S. soft wheat flours to rheological and baking properties.** *Cereal chemistry (USA) v. 73(3) p. 352-357.* references. English. (AGRIS 97-041825).

The gliadin subgroups (omega, gamma, beta, and alpha-gliadins) in 17 soft wheat patent flours from four wheat classes and seven straight-grade flours were identified and quantified by acid polyacrylamide gel electrophoresis (A-PAGE) coupled with densitometry using a known quantity of modified Osborne gliadins as a quantitative standard. Flour rheological properties were evaluated by alveograph, farinograph, and mixograph tests. Japanese-type sponge cakes (JSC) and AACC sugar-snap cookies (SSC) were made to evaluate the flours' baking performances. The results showed that the quantity of alpha-gliadins was wheat class related. The percentages of individual gliadin subgroups in flour protein were significantly lower in the patent flours than in counterpart straight-grade flours. The quantities of certain gliadin subgroups and total gliadins have various associations with flour rheological properties, and JSC and SSC end-use quality for each class of wheat.

3404 Hou, G. (Wheat Marketing Center, Inc., Portland, OR.); Yamamoto, H.; Ng, P.K.W. (1996) **Relationships of quantity of glutenin subunits of selected U.S. soft wheat flours to rheological and baking properties.** *Cereal chemistry (USA) v. 73(3) p. 358-363.* references. English. (AGRIS 97-041826).

The high molecular weight glutenin subunits (HMW-GS) and low molecular weight (LMW) glutenin subunit groups (B and C subunits) in 17 soft wheat patent flows (four wheat classes) and seven straight-grade flours were identified and quantified by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) coupled with densitometry using a known quantity of glutenins as a quantitative standard. Flour rheological properties were evaluated and Japanese-type sponge cakes (JSC) and sugar-snap cookies (SSC) were made to evaluate the flours' baking performances. The quantity of B subunits and the ratio of the quantities of B subunits to C subunits were statistically significantly different among four classes of soft wheat patent flours. Patent flours containing subunit 1 showed significantly smaller alveograph P and P/L values and farinograph water absorption values, and larger alveograph L containing subunit 2*. The quantities of subunits 2*, 6, 8, and 9 were each correlated with some flour rheological and baking properties. The quantity of A subunits had a significantly negative correlation with JSC volume in club wheat patent flours and the quantity of B subunits was strongly associated with larger JSC volume per unit flour protein in western soft white winter (WSWW) wheat flours. The ratio of the quantities of B subunits to C subunits in flour protein may be an important parameter in relation to the SSC diameter for WSWW wheat flours and to the SSC diameter per unit flour protein for club wheat flours. The quantity of total LMW-GS correlated negatively with JSC volume per unit flour protein for eastern soft white winter (ESWW) wheat flours, and the total glutenin subunits associated negatively with SSC diameter per unit flour protein for ESWW wheat flours and with JSC volume for club wheat flours.

3405 Huebner, F.R. (Food Physical Chemistry National Center for Agricultural Utilization Research Agricultural Research Service, USDA, Peoria, IL.); Bietz, J.A. (1995) **Rapid and sensitive wheat protein fractionation and varietal identification by narrow-bore reversed-phase**

high-performance liquid chromatography. *Cereal chemistry (USA) v. 72(5) p. 504-507.* references. English. (AGRIS 97-041830).

For wheat varietal identification by reversed-phase high-performance liquid chromatography (RP-HPLC), gliadins are typically extracted from approximately 50 mg of flour with 70 ethanol. Aliquots 10-15 microliter are analyzed on 15- or 25-cm X 4.6 mm (i.d.) columns at 1.0 ml/min for approximately 1 hr. A gradient of increasing acetonitrile concentration, containing trifluoroacetic acid, is commonly used to elute proteins. However, such solvents are expensive, and present a disposal problem. Smaller RP-HPLC columns offer shorter analysis times, reduced flow rates, decreased disposal problems, and lower cost per analysis. The ability of such columns to fractionate gliadins and to differentiate cultivars was investigated. Using a 3.2-mm X 15-cm C4 column, flow rate, sample size, analysis time, and solvent consumption were reduced by half, while preserving excellent resolution of extracted proteins. Gliadins can also be extracted from as little as 1-2 mg of flour or ground endosperm. With a 2.1-mm X 15-cm C4 column (Vydac), further reductions of flow rates and analysis time (about fourth that of a standard column) are possible, while maintain excellent resolution. Under these conditions, solvent use is about one eighth that of standard RP-HPLC analyses. To further reduce analysis time and sample consumption, gradient times can be reduced to as little as one tenth that of standard columns, and separations can be done in only 9-10 min. Some resolution is sacrificed for such rapid analyses; while this is often acceptable, it may sometimes prevent differentiation of genetically similar cultivars that are otherwise identifiable. Similar RP-HPLC procedures can be used to analyze reduced subunits of glutenins. The ability to perform such rapid, high-resolution analyses of small samples, with low solvent consumption, suggests that narrow-bore RP-HPLC may become especially useful for selection and identification during wheat breeding.

3406 Huebner, FR.; Nelsen, TC.; Chung, OK.; Bietz, JA. (1997) **PROTEIN DISTRIBUTIONS AMONG HARD RED WINTER WHEAT VARIETIES AS RELATED TO ENVIRONMENT AND BAKING QUALITY.** *Cereal Chemistry. 74(2):123-128.* English. [USDA ARS NATL CTR AGR UTILIZAT RES 1815 N UNIV ST PEORIA, IL 61604 USA].

Previous size-exclusion high-performance liquid chromatography (SE-HPLC) studies of hard red spring (HRS) wheat proteins reported correlations of amounts of certain gliadin and glutenin fractions with general score, a quality descriptor based on loaf volume, mixing time, and other parameters. We now extended these studies to 12 hard red winter (HRW) wheats, each grown at six Midwestern locations. Gliadin and reduced glutenin fractions were isolated and fractionated by SE-HPLC. Amounts of fractions corresponding to specific molecular weight (MW) ranges, determined by integrating peaks from SE-HPLC elution profiles, were statistically correlated with various baking quality parameters. Amounts of one fraction rich in gamma-gliadins correlated well with loaf volume; correlations were better than found previously for HRS wheats. Correlations adjusted for overall protein (partial correlations) were >0.5 for 10 of the 12 samples, and >0.84 for six samples when estimated among samples, among locations, among samples at each location, and among locations for each sample. Because gamma-gliadins appeared well correlated to loaf volume, the gliadin fraction was also analyzed by reversed-phase high-performance liquid chromatography (RP-HPLC), which provides better separations. Correlations of gamma-gliadin peak areas from RP-HPLC with loaf volume were then 0.93-0.99 for different varieties grown in different locations. Narrow-bore columns with shorter run times gave slightly higher correlations than did standard RP-HPLC columns. It is evident that both genetics and environment affect the relationship of quantitative protein distribution to loaf volume. [References: 31].

3407 Irani, P. (1994) **Macaroni quality survey of durum Wheat varieties.** Seed and Plant Improvement Institute, Karadj (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research (Iran Islamic Republic) v. 9(3-4) p. 3.* Persian. (AGRIS 97-041718).

3408 Iyer, L.; Singh, U. (1997) **FUNCTIONAL PROPERTIES OF WHEAT AND CHICKPEA COMPOSITE FLOURS.** *Food Australia. 49(1):27-31.* English. [ACAD GRAIN TECHNOL WERRIBEE VIC 3030 AUSTRALIA].

Hard and soft wheat flours, each supplemented at 10, 30 and 50% (w/w) levels with desi and kabuli chickpea flours, were evaluated for protein, fat and moisture contents and functional properties: water absorption, oil absorption, solubility and swelling power, gelation capacity, gel consistency, nitrogen solubility and Brabender viscoamylographic properties. Emulsification capacity, flour solubility and nitrogen solubility were considerably increased in all composite flours, whereas water absorption and oil absorption of wheat flours supplemented with desi chickpea flour did not change noticeably. Oil absorption was much higher in kabuli than in desi chickpea flour and this resulted in higher oil absorption in hard and soft wheat composite flours. Increased levels of desi chickpea flour increased the peak viscosity value of hard wheat composite flour but not of soft wheat composite flour. The gelatinisation temperature of desi and Kabuli chickpea flours was higher than that of the wheat flours and this slightly increased the initial pasting temperatures of the composite flours. [References: 14].

3409 Johansen, H.N. (Danish Institute of Animal Science, Tjele, Denmark.); Glitso, V.; Bach Knudsen, K.E. (1996) **Influence of extraction solvent and temperature on the quantitative determination of oligosaccharides from plant materials by high-performance liquid chromatography.** *Journal of agricultural and food chemistry (USA) v. 44(6) p. 1470-1474.* references. English. (AGRIS 97-041766).

The effect of extraction solvents and temperatures on extraction yields of monosaccharides, sucrose, and raffinose oligosaccharides from plant materials was investigated. Toasted soybean meal, cotton seed meal, field peas, and a feed mixture were extracted in either water, 50 (v/v), or 80 (v/v) aqueous methanol or ethanol at 20 or 50 degrees C or at the boiling point of the solvent. Extraction in 80 (v/v) alcohol was strongly influenced by the extraction temperature and maximum extraction was only achieved at the boiling point. Extraction in water and 50 (v/v) methanol or ethanol was less heat sensitive and gave comparable results. Aqueous ethanol (50, v/v) was as effective as 50 (v/v) methanol, whereas lower yields were seen at higher alcohol strength. There was no consistent difference in the extraction yield when comparing reflux with constant stirring and water bath with occasional mixing for any of the extraction solvents used.

3410 Jones, B.L. (USDA, ARS, Cereal Crops Research Unit, Madison, WI.) (1995) **A comparison of barley and malt polypeptides that inhibit green malt endoproteinases.** *American Society of Brewing Chemists (USA) v. 53(4) p. 160-166.* references. English. (AGRIS 97-041641).

3411 Kahlon, TS.; Chow, FI. (1997) **HYPOCHOLESTEROLEMIC EFFECTS OF OAT, RICE, AND BARLEY DIETARY FIBERS AND FRACTIONS [Review].** *Cereal Foods World. 42(2):86-92.* English. [ARS WESTERN REG RES CTR USDA ALBANY, CA 94710 USA].

3412 Keller, RCA.; Orsel, R.; Hamer, RJ. (1997) **COMPETITIVE ADSORPTION BEHAVIOUR OF WHEAT FLOUR COMPONENTS AND EMULSIFIERS AT AN AIR-WATER INTERFACE.** *Journal of Cereal Science. 25(2):175-183.* English. [TNO NUTR & FOOD RES DEPT CEREALS & FOOD INGREDIENTS POB 360 NL-3700 AJ ZEIST NETHERLANDS].

This study aimed to characterise the competitive adsorption behaviour of the different components present in wheat flour and emulsifiers used in breadmaking at an air-water interface using surface balance measurements. It was found that the proteins could be arranged in increasing order of surface activity: albumin < globulin < glutenin < gliadin. Furthermore, the ability of the proteins to interact with and/or to insert into lipid monolayers was found to correlate with their surface activities. The ability of gliadin to insert into emulsifier monolayers was comparable to its ability to insert into lipid monolayers. Competition experiments with pure protein monolayers, and the subsequent addition of different lipid or emulsifier suspensions, revealed that non-bilayer forming lipids were more effective at adsorbing to and competing at the air-water interface than bilayer forming lipids. It was found that proteins could not insert into lipid or emulsifier monolayers above a surface pressure of 37 mN/m, whereas a wheat lipid mixture could reach a surface pressure of approximately 50 mN/m. If sufficient amounts of lipids are available to reach the gas cell interface in dough, it is likely that lipids will expel the proteins from the interface and that lipids and/or emulsifiers will be the only constituents left in the gas cell film. This study indicates that future studies addressing the issue of gas-cell stability in a wheat flour dough should focus on the behaviour of lipid and emulsifier monolayers. (C) 1997 Academic Press Limited. [References: 23].

3413 Kim, H.R. (University of Manitoba, Winnipeg, Canada.); Bushuk, W. (1995) **Changes in some physicochemical properties of flour proteins due**

to partial reduction with dithiothreitol. *Cereal chemistry (USA) v. 72(5) p. 450-456.* references. English. (AGRIS 97-041824).

Changes in protein solubility, patterns of sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE), and weight of SDS-insoluble gel protein and its rheological properties during reduction of wheat flour proteins by dithiothreitol (DTT) were investigated for two Canadian hard red spring wheats of diverse strength. SDS-PAGE results for the water-soluble protein fraction showed that changes in solubility and gel protein properties with gradually increasing reduction resulted from increasing differential release of water-soluble glutenin oligomers (fragments of polymeric glutenin comprising several subunits). Oligomers contained mainly y-type high Mr glutenin subunits (8 and 10 for Glenlea and 9 and 10 for Katepwa) or B-type low Mr glutenin subunits. The protein of Katepwa flour (strong) released water-soluble oligomers at a lower DTT concentration than did the protein of Glenlea (extra strong). With increasing DTT concentration, the amount of the y-type subunits (indicated by SDS-PAGE band intensity) and the solubility of total protein in SDS solution increased, whereas the gel protein weight and its elasticity decreased. The results showed that the proteins of the extra strong Glenlea flour were more resistant to reduction by DTT than were the proteins of the weaker Katepwa flour. The implication of these results in the molecular basis of wheat flour strength for breadmaking is discussed.

3414 Knuckles, BE.; Hudson, CA.; Chiu, MM.; Sayre, RN. (1997) **EFFECT OF BETA-GLUCAN BARLEY FRACTIONS IN HIGH-FIBER BREAD AND PASTA.** *Cereal Foods World. 42(2):94 ff.* English. [ARS WESTERN REG RES CTR CEREAL PROD UTILIZAT RES UNIT USDA ALBANY, CA 94710 USA].

High-fiber, high-complex carbohydrate diets have been useful in regulating blood lipids, blood glucose, and insulin response-factors that are significant in the prevention and treatment of coronary heart disease and diabetes. Breads and pastas with increased levels of dietary fiber (including beta-glucans) were produced by substituting barley flour fractions enriched with beta-glucan for 5, 20, or 40% of the standard flours. The dry milled/sieved and water-extracted barley fractions contained 42 and 51% total dietary fiber (TDF) and 19 and 33% beta-glucans, respectively. Bread, in which the dry milled/sieved barley flour fraction replaced 20% of the standard flour, contained 4.2 times the TDF, 7.6 times the total beta-glucans, and 0.8 times kcal per serving compared to the control. This bread was judged acceptable in laboratory acceptance tests although loaf volume was reduced and color was slightly darker than the control. Pastas in which barley fractions replaced 20 or 40% of the wheat semolina provided 5.4 to 10.4 g TDF per serving (compared with 2 g in the control). These pastas, which could be labeled as good or high-fiber sources, respectively, had acceptable sensory quality although they were darker in color than the control. Kilocalories in a serving of these pastas with 20 and 40% flour substitution were 11 and 16%, respectively, lower than in the control. When the water-extracted barley fraction was substituted in breads and pastas, color scores and acceptability improved over those containing the dry milled/sieved barley fraction. [References: 40].

3415 Larre, C.; Nicolas, Y.; Desserme, C.; Courcoux, C.; Popineau, Y. (1997) **PREPARATIVE SEPARATION OF HIGH AND LOW MOLECULAR WEIGHT SUBUNITS OF GLUTENIN FROM WHEAT.** *Journal of Cereal Science. 25(2):143-150.* English. [INRA LAB BIOCHIM & TECHNOL PROT RUE GERAUDIERE BP 1627 F-44316 NANTES 03 FRANCE].

Wheat flour was washed with Tris-HCl buffer containing 4% Triton X114 before extracting the residual gluten with 70% ethanol. The glutenin extraction with 50% ethanol was performed at various ratios of DTT/protein; a minimum ratio of 0.1 g/g was needed to solubilise the maximum amount of glutenin. An experimental design was used to optimise the extraction conditions to obtain the best yield and purity of low M(r) and high M(r) glutenin subunits. The purity of each glutenin subunit fraction was measured by RP-HPLC analysis after reduction and alkylation. Both temperature and protein concentration had an effect on the preparation of these fractions. An increase in the protein concentration enhanced the yield of the high M(r) glutenin fraction and simultaneously decreased that of the low M(r) glutenin. Using the Deringer desirability function, conditions giving the optimum separation were determined. The procedure was scaled up and permitted the preparation of 0.96 g of high M(r) and 1.64 g of low M(r) glutenin subunits from 5 g of gluten. The purities of these fractions, determined by RP-HPLC, were 90% and 95%, respectively, and their amino acid compositions were similar to those of high and low M(r) subunits separated by RP-HPLC. (C) 1997 Academic Press Limited. [References: 22].

3416 Lempereur, I.; Rouau, X.; Abecassis, J. (1997) **GENETIC AND AGRONOMIC VARIATION IN ARABINOXYLAN AND FERULIC ACID CONTENTS OF DURUM WHEAT (TRITICUM DURUM L.) GRAIN AND ITS MILLING FRACTIONS.** *Journal of Cereal Science. 25(2):103-110.* English. [INRA UNITE TECHNOL CEREALES 2 PL VIALA F-34060 MONTPELLIER 01 FRANCE].

Total arabinoxylan (AXt), water-extractable arabinoxylan (WeAX) and ferulic acid (FA) from five cultivars of durum wheat (Triticum durum L.), grown under four different agronomic conditions, were measured. Among the varieties analysed, AXt, WeAX and FA contents ranged between 4.07%-6.02%, 0.37%-0.56% and 0.784 mg/g-7.98 mg/g, respectively. High genetic and agronomic variability was detected for AXt, WeAX and FA. AXt and FA increased sharply in milling products for extraction rates above 60%. FA was quantified in durum wheat milling fractions. High concentrations of FX esterified to cell-wall arabinoxylans were found in the aleurone layer (69% of total FA), germ and seedcoat (26.6% of total FA). Only trace amounts were detected in the starchy endosperm (1.4% of total FA). A highly significant correlation appeared between AXt and FA contents. (C) 1997 Academic Press Limited. [References: 29].

3417 Lookhart, G. (USDA/ARS, U.S. Grain Marketing Research Laboratory, Manhattan, KS.); Bean, S. (1995) **Separation and characterization of wheat protein fractions by high-performance capillary electrophoresis.** *Cereal chemistry (USA) v. 72(6) p. 527-532.* references. English. (AGRIS 97-041804).

Wheat protein fractions, separated by the Osborne Solvent Fractionation Procedure, were characterized by high-performance capillary electrophoresis (HPCE). Each fraction was separated on a 27-cm fused-glass capillary (20 micromoles, i.d.) using 0.1 M phosphate buffer (pH 2.5) containing hydroxypropylmethylcellulose, a polymer additive, at 45 degrees C and 22 kV constant voltage. Albumins and globulins migrated in the first 4 min, whereas gliadins and glutenins migrated after 4 min. Individual alpha, beta, gamma, and omega gliadin proteins, which were collected from reversed-phase high-performance liquid chromatography (RP-HPLC) separations were also separated by HPCE. Combined results of this study and our previous studies provide a catalog of individual gliadin information from HPCE, HPLC, acid-polyacrylamide gel electrophoresis (A-PAGE) and sodium dodecyl sulfate (SDS)-PAGE, relating class, relative molecular size, hydrophobicity, relative charge, and separation times of each gliadin subclass by HPLC and HPCE. The main advantages of HPCE are: 1) the complementing of other electrophoretic and chromatographic protein separation methods, and 2) safety because no toxic acrylamides and only minute amounts of organic solvents and buffers are used.

3418 Lookhart, G.L. (USDA, ARS, Grain Marketing Research Laboratory, Manhattan, KS.); Bean, S.R. (1996) **Improvements in cereal protein separations by capillary electrophoresis: resolution and reproducibility.** *Cereal chemistry (USA) v. 73(1) p. 81-87.* references. English. (AGRIS 97-041506).

Capillary electrophoresis rinsing protocols and buffer compositions were optimized to improve the resolution and reproducibility of cereal prolamin separations. Capillary cleaning protocols were varied to improve reproducibility. Four cleaning regimes were tested; the optimum was a 4-min rinse with 1M phosphoric acid. Several buffer modifiers were tested for use with 100 mM phosphate buffer (pH 2.5) containing 0.05 hydroxypropylmethylcellulose. Twenty percent acetonitrile provided optimal resolution, while maintaining excellent reproducibility. That buffer provided high resolution of wheat and oat prolamins. Resolution of rice prolamins also improved using that buffer, but best resolution of rice prolamins was found when lauryl-sulfobetain at its critical micelle concentration (26 mM) was also added.

3419 Mendes Da Silva, C.E. (Universidade Federal do Ceara, Fortaleza, CE, Brazil.); Ciacco, C.F.; Barberis, G.E.; Solano, W.M.R.; Rettori, C. (1996) **Starch gelatinization measured by pulsed nuclear magnetic resonance.** *Cereal chemistry (USA) v. 73(3) p. 297-301.* references. English. (AGRIS 97-041832).

The extent of starch gelatinization was quantified by pulsed-proton nuclear magnetic resonance (NMR) analysis. To quantify the gelatinization of starch, a relative liquefying index (RLI), calculated from the ratio of liquid to solid phases determined by pulsed NMR, was defined. A

correlation coefficient > 0.94, at 5 significance level, was found between the RLI and the degree of gelatinization determined by a method of enzymatic susceptibility. Studies on the kinetics of gelatinization of wheat starch in starch-water systems by the NMR method showed a first-order reaction until the degree of gelatinization reached a fixed and constant value which increased with the temperature and with the amount of water in the system. The minimum activation energy occurred 45.0 water. The similarity between the activation energies found at 55.0 and at 65.0 water indicated that 55.0 water is the minimum water content for the complete gelatination of wheat starch.

3420 Moll, M. (1997) **AN UPDATE OF ANALYTICAL PROCEDURES FOR THE DETERMINATION OF MALT MODIFICATION AND MALT HOMOGENEITY .4. [Review].** *Monatsschrift fur Brauwissenschaft. 50(1-2):12 ff.* English. [MOLL INT 1 ALLEE CHAPTAL F-54630 RICHARDMENIL FRANCE].

More than 40 different methods of analysis allowing the evaluation of malt modification and 4 methods for homogeneity have been described (part 1 to 4) with their strengths and weaknesses and their limits. A perspicacious brewer should be able to make the best choice from these methods of analysis with the objective of predicting malt behaviour during the brewing process. Ancestral methods, nearly centenarian, must be revised at an international level. The accumulation of analytical methods in malt specifications should be avoided for economical reasons and to avoid overlapping. [References: 293].

3421 Morris, CF.; King, GE.; Rubenthaler, GL. (1997) **CONTRIBUTION OF WHEAT FLOUR FRACTIONS TO BEAK HOT PASTE VISCOSITY.** *Cereal Chemistry. 74(2):147-153.* English. [WASHINGTON STATE UNIV USDA ARS WESTERN WHEAT QUAL LAB E-202 FOOD SCI & HUMAN NUTR FACIL E PULLMAN, WA 99164 USA].

The quality of many baked products, noodles, gravies, and thickeners is related to the pasting properties of wheat (Triticum aestivum L.) flour, yet different flours vary markedly in their pasting performance. The objective of the present research was to assess the role of the wheat flour fractions, gluten, water solubles, prime and tailing starches, in the contribution to peak hot paste viscosity among three selected wheat cultivars. Straight-grade flours were fractionated and reconstituted. Fractions were examined independently and were deleted in otherwise fully reconstituted flours. Fractions were exchanged between cultivars for reconstituting flours, and fractions were substituted individually into a common starch base. The flours from the cultivars Klasic, McKay, and Madsen differed markedly in their peak hot paste viscosities, and were fractionated and reconstituted with only a small effect on paste viscosity. Results clearly showed that prime starch was the primary determinate of flour paste viscosity, but the other fractions all exerted a significant effect. Tailing starch increased paste viscosity directly due to pasting capacity of starch or indirectly through competition for water. Gluten also increased paste viscosity through competition for water. The water-soluble fraction from different cultivar flours was more variable in effect. [References: 25].

3422 Nagel Held, B. (1995) **[Production of barley fractions with high nutritive value and their utilization in bakery products].** Technische Univ. Berlin (Germany). Inst. fuer Gaerungs- und Getraenketechnologie; Technische Univ. Berlin (Germany). Fachber. Lebensmittelwissenschaft und Biotechnologie. *Herstellung ernaehrungsphysiologisch wertvoller Fraktionen aus Gerste und deren Verarbeitung in Backwaren 169 p.* TUB. 5 ill., 10 graphs, 75 tables; 129 ref. German. (AGRIS 97-056138).

Gerstensorten und -staemme wurden fraktioniert geschaelt. Dabei wurden keine gravierenden Unterschiede im Beta-Glucangehalt zwischen den Schaelfraktionen festgestellt. Die Beta-Glucane der Geste kommen gleichmaessig im Korn verteilt vor. Durch Vermahlung und Sichtung gelang es jedoch, betaglucanreiche und -arme Fraktionen zu trennen. Die Mehlfraktion (etwa 2/3) enthielt durchschnittlich 1, 8 bis 2, 5 Beta-Glucane, waehrend die Kleiefraktion (etwa 1/3) 4, 6 bis 4, 8 , teilweise auch 6, 0 Beta-Glucane enthielt. Es konnten erhebliche Unterschiede zwischen einzelnen Sorten hinsichtlich ihrer Backeignung, unabhaengig vom Beta-Glucangehalt, festgestellt werden. Bei der Brotherstellung war es sowohl mit Hefe als auch mit Sauerteigen moeglich, unter Verwendung von bis zu 40 Gerstenmehl optische und sensorisch einwandfreie und gleichzeitig b allaststoffhaltige Brote herzustellen. Gerstenbrote enthielten bei Verwendung von 40 Teilen Gerstenmehl 0, 8 , bei Verwendung von 40 Teilen Gerstengriesskleie ca. 1, 3 Beta-Glucane, bezogen auf Frischsubstanz, und damit vier- bzw. sechsmal hoehere Werte als reine Weissbrote. Muerbkekse aus 100 Teilen Gerstenkleie waren sensorisch einwandfrei und besassen ebenfalls gute Gebaeckeigenschaften. Sie konnten als ballaststoffreich deklariert werden. Muerbkekse aus 100 Teilen Gerstengriesskleie enthielten im Durchschnitt 2, 2 Beta-Glucane.

3423 Nicolas, Y.; Larre, C.; Popineau, Y. (1997) **A METHOD FOR THE ISOLATION OF HIGH M(R) SUBUNITS OF WHEAT GLUTENIN.** *Journal of Cereal Science. 25(2):151-154.* English. [INRA LAB BIOCHIM & TECHNOL PROT RUE GERAUDIERE BP 1627 F-44316 NANTES 03 FRANCE].

3424 Obanni, M. (Purdue Univ., West Lafayette, IN.); BeMiller, J.N. (1996) **Ghost microstructures of starch from different botanical sources.** *Cereal chemistry (USA) v. 73(3) p. 333-337.* references. English. (AGRIS 97-041785).

A technique applied to characterize the cooking and paste properties of various maize endosperm mutant starches was applied to potato, mung bean, and other cereal starches. This technique, which is based on cooking very dilute starch suspensions without shear and examination of the particulate products by light microscopy, confirmed that the pasting behavior of each starch and the nature of the discontinuous phase of the pastes formed under the conditions employed in the method are unique. Some groupings based on similar appearances of granule remnants were found to parallel the genetic background of the source plant. These groupings (wheat and barley; oats; rice; waxy rice; common maize, sorghum, popcorn, and millet; waxy maize and waxy sorghum), with respect to the cereal starches, are similar to those based on granule size and shape and the presence or absence of surface pores visible by scanning electron microscopy.

3425 Pedersen, J.F. (USDA, ARS, Wheat, Sorghum, and Forage Research, Lincoln, NE.); Martin, C.R.; Felker, F.C.; Steele, J.L. (1996) **Application of the single kernel wheat characterization technology to sorghum grain.** *Cereal chemistry (USA) v. 73(4) p. 421-423.* references. English. (AGRIS 97-056297).

A single kernel wheat characterization system (SKWCS) was recently developed by the USDA, ARS Grain Marketing Research Laboratory and is currently being marketed by Perten Instruments North America, Inc. This device has been shown to accurately measure individual seed hardness, moisture, and size of wheat. The objective of this study was to determine if the SKWCS technology could be applied to the measurement of sorghum grain. Grains from 64 sorghum plots grown at Mead, NE in 1992 were characterized using a prototype SKWCS at the USDA, ARS Grain Marketing Research Laboratory. Problems encountered were primarily associated with the single kernel feeder mechanism. Occasion ally, two sorghum seeds were fed to the crushing device instead of a single kernel. These double sampling events were easily detected by examination of the size data, and software limits could be set to exclude such double sampling events from the data set. If broken seeds were not removed prior to measurement of the grain, errors in hardness and size values also occurred. These errors could usually be detected by examination of the data, and eliminated by adjustment of software limits. Inspection and hand cleaning of samples is highly recommended prior to characterization. Based on our results, SKWCS technology can be successfully applied to sorghum seed.

3426 Porter, L.L. (Kansas State University.); Barkley, A.P. (1995) **Selection of wheat varieties in Kansas: does quality matter?** *Report of progress (Kansas Agricultural Experiment Station) (USA); no. 730 7 p.* references. English. (AGRIS 97-056241).

3427 Ramkumar, DHS.; Bhattacharya, M.; Menjivar, JA.; Huang, TA. (1996) **RELAXATION BEHAVIOR AND THE APPLICATION OF INTEGRAL CONSTITUTIVE EQUATIONS TO WHEAT DOUGH.** *Journal of Texture Studies. 27(5):517-544.* English. [UNIV MINNESOTA DEPT AGR & BIOSYST ENGN 1390 ECKLES AVE ST PAUL, MN 55108 USA].

The small amplitude rheological properties of doughs of different compositions were measured using a dynamic rheometer. In the first study, the effect of water, flour, and added gluten on the dynamic properties was investigated. Frequency sweep was carried out in the range of 0.1 to 100 s(-1) at an applied strain of 0.1%. Storage (G') and loss (G '') moduli for each composition were recorded. The storage modulus versus frequency plots were a series of parallel curves indicating that the moisture-to-flour ratio was the most important parameter. The loss

modulus versus frequency plot showed a falling-off after a frequency of 40 s(-1). A plot of tan delta versus frequency indicated a more elastic dough at shorter time scales (or higher frequencies). Data from the dynamic shear experiment were used to determine the parameters of the generalized Maxwell model. Depending on composition, the doughs exhibited unimodal or bimodal distributions. Stresses relaxed faster when the flour-to-water ratio was high. In the second study, the dynamic and transient properties of three commercial doughs were investigated. Stress-strain behavior of a short cookie dough showed strain softening at higher stains. Dough samples did not exhibit initial stress overshoot at the shear rates investigated. A time-strain separability, valid for many polymer melts, was observed for cracker doughs, which encouraged the use of the factorable KBKZ model. The integral constitutive Wagner equation was applied to the transient data and was found to give a reasonably good fit except at short times where stress maximum occurred. The Yamamoto model, on the other hand, gave a poor fit to the shear viscosity data. [References: 42].

3428 Ranhotra, G.S. (American Institute of Baking, Manhattan, KS.); Gelroth, J.A.; Glaser, B.K.; Lorenz, K.J. (1996) **Nutrient composition of spelt wheat.** *Journal of food composition and analysis : an official publication of the United Nations University, International Network of Food Data Systems (USA) v. 9(1) p. 81-84.* references. English. (AGRIS 97-041806).

Eight samples of spelt wheat from the 1994 crop year were analyzed for macrocomponents (proximates), selected vitamins and minerals, and the first limiting amino acid lysine. They were also immunoassayed for gluten. All spelt samples differed minimally in the content of various nutrients analyzed except lysine; lysine values differed widely and ranged between 1.96 and 3.96 g/100 g protein. All assayed spelt wheat samples contained gluten.

3429 Redaelli, R.; Pogna, NE.; Ng, PKW. (1997) **EFFECTS OF PROLAMINS ENCODED BY CHROMOSOMES IB AND 1D ON THE RHEOLOGICAL PROPERTIES OF DOUGH IN NEAR-ISOGENIC LINES OF BREAD WHEAT.** *Cereal Chemistry. 74(2):102-107.* English. [IST SPERIMENTALE CEREALICOLTURA VIA MULINO 3 I-20079 S ANGELO L LO ITALY].

Fourteen bread wheat near-isogenic lines (NILs) with different alleles at 1B- and 1D-chromosome loci Glu-1, Glu-3 and Gli-1 coding for high molecular weight glutenin subunits (HMW-GS), low molecular weight-GS, and gliadins, respectively, were grown in replicated plots to investigate the individual and combined effects of glutenin and gliadin components on the rheological properties of dough as determined by the Chopin alveograph. NILs did not reveal significant differences in seed yield, protein content, kernel weight, test weight, flour yield, and starch damage. On the contrary, they had a large variation in alveograph dough tenacity P (55-93 mm), swelling G (17-26 mt) and strength W (140-252 J x 10(-4)). The null alleles at the Gli-D1/Glu-D3 loci, and allele Glu-D1d (HMW-GS 5+10) were found to have a strong positive influence on dough tenacity and a remarkable negative influence on dough swelling (extensibility) when compared to alleles Gli-D1/Glu-D3b and Glu-Dla (HMW-GS 2+12), respectively. On the other hand, alleles Glu-B1c (HMW-GS 7+9) and Gli-B1/Glu-B3k gave greater G values than alleles Glu-B1u (HMW-GS 7*+8) and Gli-B1/Glu-B3b. The effects of individual Glu-1, Gli-1, or Glu-3 alleles on P and G values were largely additive. The impact of the null allele at Gli-D1/Glu-D3 on gluten strength was highly positive in NILs possessing HMW-GS 2+12, and negligible or negative in NILs containing HMW-GS 5+10, suggesting that there is scope for improving dough quality by utilizing this allele in combination with HMW-GS 2+12. Gli-D1/Glu-D3-encoded prolamins were shown to play a major role in conferring extensibility to dough, and could account for the superior breadmaking characteristics of bread wheat as compared to durum wheat. [References: 23].

3430 Saulnier, L.; Andersson, R.; Aman, P. (1997) **A STUDY OF THE POLYSACCHARIDE COMPONENTS IN GLUTEN.** *Journal of Cereal Science. 25(2):121-127.* English. [INRA BIOCHIM & TECHNOL GLUCIDES LAB BP 71627 F-44316 NANTES FRANCE].

The polysaccharide contents of glutens from 13 wheat flours were studied. Arabinoxylans (estimated as the sum of arabinose and xylose) represented similar to 0.4% by weight of the gluten. Enzymic degradation by Alcalase solubilised 90% of the gluten, but only 45% and 23% of arabinose and xylose, respectively. These polysaccharide components were found mainly in the Alcalase-treated residue as cell-wall fragments. A correlation was found between starch and arabinoxylan content of gluten, suggesting that the amount of these components was mainly related to the water washing efficiency during the preparation of the gluten. H-1-nmr study of the high molecular weight polysaccharide solubilised From gluten by Alcalase treatment showed that wheat arabinoxylan (AX) and arabinogalactan (AG) structural features were present, although the proportion of AG was higher than that usually found in wheal flour. A minor AX population, representing 0.1-0.2% of total AX in flour (similar to 8% of AX in gluten), with a highly disubstituted xylan backbone was also isolated. (C) 1997 Academic Press Limited. [References: 19].

3431 Schropp, P. (Deutsche Forschungsanstalt fur Lebensmittelchemie, Garching, Germany.); Wieser, H. (1996) **Effects of high molecular weight subunits of glutenin on the rheological properties of wheat gluten.** *Cereal chemistry (USA) v. 73(3) p. 410-413.* references. English. (AGRIS 97-041602).

High molecular weight (HMW) glutenin subunits of different chemical state (reduced, S-alkylated, reoxidized with KBrO3 or KIO3)and of different compositions (cv Rektor [HMW subunits 5, 7, 9, 10]. cv. Apollo [HMW subunits 2, 6, 8, 12]) were added, mostly in 1 amounts. to base flours of Rektor and Apollo. The corresponding glutens were then characterized by microscale extension tests and compared to glutens from the flours without additives. The extensibility of gluten was increased by monomeric proteins (gliadin, reduced HMW subunits) and was decreased by reoxidized HMW subunits. The maximum resistance of gluten was increased by reoxidized HMW subunits, when the major portion of the product was in an aggregated state (reoxidation with KBrO3). A maximum level of resistance was reached with the addition of 1.5-2.0 of reoxidized HMW subunits. HMW subunits reoxidized with KIO3 had an decreasing effect on gluten resistances. Main differences to HMW subunits reoxidized with KBrO3 were the lower portion of polymerized proteins and the absence of free thiol groups. Monomeric proteins (reduced or S-alkylated HMW subunits, gliadin) generally decreased maximum resistance. The effect of reoxidized HMW subunits on gluten properties did not seem to depend on the HMW subunit composition.

3432 Seguchi, M. (Kobe Women's University, Kobe, Japan.) (1995) **Surface staining of wheat starch granules with Remazolbrilliant blue R dye and their extraction with aqueous sodium dodecyl sulfate and mercaptoethanol.** *Cereal chemistry (USA) v. 72(6) p. 602-608.* references. English. (AGRIS 97-041835).

Wheat starch granules were stained with Remazolbrilliant blue R (RBB) dye. The RBB-stained starch granules (RBB-starch) were successively extracted with 1 sodium dodecyl sulfate (SDS) solution containing 1 2-mercaptoethanol (2-ME) at room temperature for 1 day (extraction 1), 5 days (extraction 2), and 15 days (extraction 3). The stained molecules were solubilized first, an indication that the RBB dye was bound to the granule surface. After each extraction with 1 SDS solution containing 1 2-ME, granules were examined by scanning electron microscopy. The appearance of the residual starch structure changed greatly between extraction 2 and 3. After extraction 3, only a shell-like structure was present. X-ray diffraction analysis of this sample indicated an absence of crystallinity. The SDS extracts were subjected to Sepharose CL-2B gel-filtration chromatography. Two blue peaks were observed for extraction 1: one high and one low molecular size. The low molecular weight peak decreased for extraction 2 and was absent for extraction 3. The high molecular weight blue peak did not disappear although the ratio of unstained carbohydrate to RBB-stained carbohydrate increased with time. The low molecular weight blue peak was further subjected to the Sephadex G-50 gel-filtration chromatography, and the resulting single peak was analyzed for sugars, proteins and peptides, and lipids. Only lipids were found. The main TLC spot was RBB stained and indicated lysophosphatidylglycerol by Dittmer and periodate spray reagents.

3433 Shewry, PR.; Tatham, AS.; Lazzeri, P. (1997) **BIOTECHNOLOGY OF WHEAT QUALITY [Review].** *Journal of the Science of Food & Agriculture. 73(4):397-406.* English. [UNIV BRISTOL LONG ASHTON RES STN DEPT AGR SCI IACR BRISTOL BS18 9AF AVON ENGLAND].

Wheat gluten proteins are largely responsible for the viscoelastic properties that allow doughs to be processed into bread and various other food products including cakes, biscuits (cookies), pasta and noodles. Detailed biochemical and biophysical studies are revealing details of the molecular structures and interactions of the individual gluten proteins, and their roles in determining the functional properties of gluten. In particular, one group of gluten proteins, the high molecular weight

(HMW) subunits of glutenin, have been studied in detail because of their role in determining the strength (elasticity) of doughs. The development of robust transformation systems for bread wheat is now allowing the role of the HMW subunits to be explored experimentally, by manipulating their amount and composition in transgenic plants. Such studies should lead to improvement of the processing properties of wheat for traditional end uses and the development of novel end uses in food processing or as raw material for other industries. [References: 58].

3434 Stone, PJ.; Gras, PW.; Nicolas, ME. (1997) **THE INFLUENCE OF RECOVERY TEMPERATURE ON THE EFFECTS OF A BRIEF HEAT SHOCK ON WHEAT .3. GRAIN PROTEIN COMPOSITION AND DOUGH PROPERTIES.** *Journal of Cereal Science. 25(2):129-141.* English. [UNIV MELBOURNE DEPT AGR & RESOURCE MANAGEMENT JOINT CTR CROP IMPROVEMENT PARKVILLE VIC 3052 AUSTRALIA].

In this study; controlled-environment conditions were used to examine the main effects and possible interactions of moderately high (20-32 degrees C) and very high (>32 degrees C) temperature treatments, during grain filling, on wheat protein composition and dough mixing behaviour at maturity. In particular, we wished to examine whether the deleterious effects of a short exposure to very high temperature (40 degrees C) could be compensated by the expected benefits of moderately high temperature. To this end, wheat cv. Oxley was exposed to either 21/16 or 40/16 degrees C from 15-19 days after anthesis and subsequently grown under one of three moderately high temperature regimes until maturity: 21/16, 27/22 or 30/25 degrees C. Flour from each treatment was tested for protein composition using size-exclusion high-performance liquid chromatography (SE-HPLC) and dough mixing behaviour using the 2-g mixograph. We conclude that in the heat-sensitive cultivar Oxley: (a) moderately high temperatures increased flour protein percentage; but (b) significantly decreased dough strength: measured as mixing time and resistance breakdown; (c) a short exposure to very high temperature also increased flour protein percentage and reduced dough strength, regardless of the following moderately high temperature; (d) the effects of moderately high and very high temperature on dough strength tended to be additive; (e) protein monomer content (r = -0.83 to -0.93) and SDS sedimentation volume (r = 0.80 to 0.96) were highly correlated with the response of dough strength to elevated temperatures. (C) 1997 Academic Press Limited. [References: 25].

3435 Sumathi, A.; Vishwanatha, S.; Malleshi, NG.; Rao, SV. (1997) **GLYCEMIC RESPONSE TO MALTED, POPPED AND ROLLER DRIED WHEAT-LEGUME BASED FOODS IN NORMAL SUBJECTS.** *International Journal of Food Sciences & Nutrition. 48(2):103-107.* English. [CENT FOOD TECHNOL RES INST DEPT GRAIN SCI & TECHNOL MYSORE 570013 KARNATAKA INDIA].

A blend consisting of 75% malted and debranned wheat flour, toasted flours of 10% green gram, 5% Bengal gram, 5% moth bean and 5% skim milk powder, consumed by seven healthy adult subjects in the form of 'chapati' (unleavened bread), showed higher blood glucose response after 30 min, as compared with blends of similar composition prepared by adopting popping or roller drying technique. No significant differences were observed in blood glucose response between the three foods at any other time intervals up to 120 min. However, significantly slower response to the popped product was observed in peak blood glucose, area under the curve (AUC) and slope from 0 time to maximal increase in glycemia. All the three foods were digested fast, as blood glucose reached fasting levels after 120 min. [References: 33].

3436 Suzuki, Y.; Esumi, Y.; Uramoto, M.; Kono, Y.; Sakurai, A. (1997) **STRUCTURAL ANALYSES OF CARBON CHAINS IN 5-ALK(EN)YLRESORCINOLS OF RYE AND WHEAT WHOLE FLOUR BY TANDEM MASS SPECTROMETRY.** *Bioscience Biotechnology & Biochemistry. 61(3):480-486.* English. [RIKEN INST PHYS & CHEM RES HIROSAWA 2-1 WAKO SAITAMA 35101 JAPAN].

The locations of double bonds and the linearity of each carbon chain in 5-alk(en)ylresorcinols present in rye and wheat whole flour were determined from collision-activated dissociation (CAD) spectra by tandem mass spectrometry. Among the determined alk(en)ylresorcinols, eleven alkenylresorcinols (C-17 to C-23) and four alkadienylresorcinols (C-19 to C-25) had not been previously identified. In this study, we found that identification of a radical-anion fragment peak due to a simple allylic cleavage on the methyl side was essential for determining the locations of double bonds in positionally isomeric alkenylresorcinols. In addition, an analysis of the CAD spectra of lithium-adduct cations as precursor ions was useful for determining the locations of the homoconjugated (Z, Z)-diene group in alkadienylresorcinols. [References: 13].

3437 Uno, K. (Kyowa Hakko Kogyo Co., Ltd., Ibaraki, Japan.); Imai, T.; Ogata, N.; Kohyama, K. (1996) **New viscograph for rheological analysis of a small quantity of wheat flour.** *Cereal chemistry (USA) v. 73(4) p. 452-456.* references. English. (AGRIS 97-056333).

A cone-plate viscometer was developed to analyze viscosity changes during heating of a small quantity of wheat flour suspension. The instrument consists of a cone, a plate, a temperature-control heater, and a water trap to prevent water evaporation from a sample. With this apparatus it is possible to record a viscogram using only approximately 100 mg of wheat flour. Although the flour concentration was low, the temperature at which the viscosity began to rise in this cone-plate viscometer was closer to the gelatinization temperature determined by differential scanning calorimetry than that determined with other viscographs. It suggests that the new apparatus was more sensitive to initial swelling of gelatinized starch. The maximum viscosity in viscograms of wheat starch measured by the new instrument decreased with the alpha-amylase activity. Depending on the heating rate, viscogram parameters obtained with this instrument were well correlated with those obtained with other viscometers.

3438 Vasanthan, T. (University of Saskatchewan, Saskatoon, Canada.); Bhatty, R.S. (1996) **Physicochemical properties of small- and large-granule starches of waxy, regular, and high-amylose barleys.** *Cereal chemistry (USA) v. 73(2) p. 199-207.* references. English. (AGRIS 97-041456).

Small- and large-granule starches were isolated from pin-milled and air-classified fractions of waxy (SB 89528), regular (Condor), and high-amylose (Glacier) barleys, and their physicochemical properties were investigated. The isolations contained 95-97 starch, 0.1-0.3 protein, and 0.1-0.2 ash. Scanning electron microscopy showed that the starch granules were oval to round in shape with diameter ranges of 2-10 micrometer for small and 12-26 micrometer for large granules. The starches had A-type X-ray diffraction patterns, typical of cereal starches. The differences in the physicochemical properties such as X-ray diffraction relative intensities, swelling factor, amylose leaching, Brabender pasting, differential scanning calorimetry thermal characteristics, and resistance to acid and alpha-amylase hydrolysis were greater among the three genotypes than between the small- and large-granule starches from the same genotype. The large-granule barley starches may be substituted for corn starch because their physicochemical properties are generally similar.

3439 Weegels, PL.; Hamer, RJ.; Schofield, JD. (1997) **DEPOLYMERISATION AND RE-POLYMERISATION OF WHEAT GLUTENIN DURING DOUGH PROCESSING .2. CHANGES IN COMPOSITION.** *Journal of Cereal Science. 25(2):155-163.* English. [TNO NUTR & FOOD RES BIOCHEM & GENE TECHNOL DIV POB 360 NL-3700 AJ ZEIST NETHERLANDS].

In view of the importance of the glutenin macropolymer (GMP) for dough properties and bread-making quality, the changes of composition of glutenin subunits in GMP were investigated for flours and doughs from three cultivars (Rektor, Camp Remy, Obelisk) and from a blend of two of those cultivars (Camp Remy/Obelisk). After mixing, the content of GMP, and the contents of high M(r) and low M(r) glutenin subunits in GMP, decreased. The two subunit classes, and the individual subunits, decreased to different extents, however. This resulted in large changes in their proportions in GMP. After mixing, high M(r) glutenin subunits accounted for 8-17% of the GMP of dough, whereas in flour they accounted for 29-31%. During dough resting, the amounts of all glutenin subunit classes increased as the amount of GMP increased, but in most cases to lower final levels than those present in the flour. The proportions of high M(r) glutenin subunits in the GMP of dough increased to levels similar to those present in the GMP of flour (22-31%). The x-type/y-type high M(r) glutenin subunit molar ratio decreased significantly from 2.42 in the GMP from flour or 2.38 in the GMP from dough directly after mixing, to 1.78-1.83 after 90 min dough resting or longer. This indicates that the GMP became more enriched in y-type subunits during re-polymerisation. In contrast, the high M(r) glutenin subunit 12/subunit 9 molar ratio in GMP fell significantly from 1.79 for GMP from flour to 1.13 for dough directly after mixing, and increased upon resting to a level similar to that in the GMP from flour. The changes in composition during dough mixing and

resting indicate that specific reactions involving glutenin subunits occur during depolymerisation of GMP and during re-polymerisation of the SDS-extractable glutenin polymers. (C) 1997 Academic Press Limited. [References: 21].

3440 Weegels, PL.; Hamer, RJ.; Schofield, JD. (1997) **FUNCTIONAL PROPERTIES OF LOW M(R) WHEAT PROTEINS .3. EFFECTS ON COMPOSITION OF THE GLUTENIN MACROPOLYMER DURING DOUGH MIXING AND RESTING.** *Journal of Cereal Science. 25(2):165-173.* English. [TNO NUTR & FOOD RES BIOCHEM & GENE TECHNOL DIV POB 360 NL-3700 AJ ZEIST NETHERLANDS].

The effect of low M(r) wheat protein addition on the amount and composition of the glutenin macropolymer (GMP) of dough was investigated for the three wheat cultivars Obelisk (weak), Camp Remy (medium strong) and Rektor (strong). During mixing, the amounts of high and low M(r) glutenin subunit classes, and of the individual subunits decreased. The proportion of high M(r) glutenin subunits decreased and that of low M(r) glutenin subunits increased, indicating an inhomogeneous distribution of the two subunit classes within the polymers present in GMP. During resting, the amounts of the glutenin subunit classes and of individual subunits increased. Meanwhile, the proportion of high M(r) glutenin subunits in GMP increased. Low M(r) wheat protein addition retarded re-polymerisation in that the amounts of glutenin subunit classes and of individual high M(r) glutenin subunits in GMP increased less than without addition. The proportion of high M(r) glutenin subunits in GMP directly after mixing was also decreased by low M(r) wheat protein addition, and the proportion increased faster during dough resting, compared with the GMP in dough without low M(r) wheat protein addition. Eventually, after 90 or 135 min resting, no differences existed in the proportions in GMP from doughs with and without low M(r) wheat protein addition. Low M(r) wheat protein addition had no specific effect on individual high M(r) glutenin subunits, nor on the x-type/y-type subunit ratio in the GMP. In contrast, with increasing low M(r) wheat protein addition, a highly significant reduction in the subunit 10 or 12/subunit 9 ratio in GMP was observed. This finding is in line with the decrease in this ratio directly after mixing in GMP of the dough without low M(r) wheat protein addition. Since no specific effects were observed, it can be concluded that the low M(r) wheat protein acts rather unspecifically on the GMP of dough. (C) 1997 Academic Press Limited. [References: 17].

3441 Yamamoto, H. (Yamazaki Baking Co., Ltd., Tokyo, Japan.); Worthington, S.T.; Hou, G.; Ng, P.K.W. (1996) **Rheological properties and baking qualities of selected soft wheats grown in the United States.** *Cereal chemistry (USA) v. 73(2) p. 215-221.* references. English. (AGRIS 97-041819).

Seventeen soft wheat cultivars from four classes of U.S. soft wheats, eastern soft white winter (ESWW), western soft white winter (WSWW), club, and soft red winter (SRW) wheats, were selected for evaluation of their milling, physicochemical, and rheological properties and their suitability for making Japanese-type sponge cakes (JSC) and AACC sugar-snap cookies (SSC). The texture characteristics of JSC were determined with texture profile analysis (TPA). Results indicated that some SRW and ESWW wheats could be potential substitutes for WSWW and club wheats for JSC end-use. Both ESWW and SRW wheat short patent flours produced relatively larger diameter cookies than did WSWW and club wheel short patent flours. Correlation analyses indicated that decreasing flour particle size was a very important parameter related to improving quality of both JSC and SSC, while starch damage was more detrimental to SSC quality. Results from the present study also showed that the alveograph and mixograph were useful tools for evaluation of soft wheat quality for cake and cookie baking.

3442 Yang, G. (Kellogg Company, Battle Creek, MI.); Wehling, R.L.; Zeece, M.G.; Patridge, J.E.; Shelton, D.R. (1995) **Characterization of hard red winter wheat storage proteins by two-dimensional electrophoresis and their correlations with selected quality parameters.** *Cereal chemistry (USA) v. 72(6) p. 568-570.* references. English. (AGRIS 97-041805).

3443 Zayas, I.Y. (U.S. Grain Marketing Research Laboratory, USDA, ARS, Manhattan, KS.); Steele, J.L. (1996) **Image texture analysis for discrimination of mill fractions of hard and soft wheat.** *Cereal chemistry (USA) v. 73(1) p. 136-142.* references. English. (AGRIS 97-041611).

Digital image texture analysis was utilized to identify mill fractions from different mill streams and to assess wheat hardness differences. The study was conducted using a soft red winter wheat (Terra SR-87) and a hard red winter wheat (Thunderbird). Black and white images were acquired in a 256 X 256 pixel format to examine samples of coarse and fine mill fractions. Sixteen 64 X 64 pixel subimages per image were evaluated using texture analysis. Software was developed to calculate the image textural features used to develop the mill stream and hardness classification models. Several models based on image textural features were computed for different sets of subimages belonging to wheat of different hardness or mill stream. Recognition of hard wheat vs. soft wheat was achieved with 100 correct recognition rate for each mill fraction when a three-feature model was used for pairwise analysis. Different mill fractions of the same wheat, coarse vs. fine, were similarly discriminated with 100 accuracy for each pairwise comparison. All four mill fractions were successfully recognized with 100 correct recognition rate when a three feature model was used for four class analysis. The wheat class and mill fraction discrimination was achieved with <3 g (approximately 0.2 g/subimage) of material.

Q52 FEED PROCESSING AND PRESERVATION

3444 Ashbell, G.; Weinberg, ZG.; Bruckental, I.; Tabori, K.; Sharet, N. (1997) **WHEAT SILAGE - EFFECT OF CULTIVAR AND STAGE OF MATURITY ON YIELD AND DEGRADABILITY IN SITU.** *Journal of Agricultural & Food Chemistry. 45(3):709-712.* English. [AGR RES ORG VOLCANI CTR FORAGE PRESERVAT & BY PROD RES UNIT IL-50250 BET DAGAN ISRAEL].

Dry matter (DM) yields and degradability in situ of two wheat cultivars--an early-maturing, Bet Hashita (BH), and a late-maturing, Ariel (A), harvested and ensiled at four maturity stages, shooting, flowering, milk, and dough--were evaluated. The wheat was ensiled in minisilos for 90 days. The DM yields (t ha(-1)) of A tended to be higher than those of BH at all maturity stages. Average neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents of both cultivars were lowest at the shooting stage and highest at flowering stage. Average NDF and ADF contents of A silages were higher than those of BH: 631 vs 582 g kg(-1) DM and 378 vs 338 g kg(-1) DM ($P < 0.05$), respectively. In situ DM degradability of BH was higher than that of A at all stages of maturity ($P < 0.05$). (average 27.1 vs 20.1%; $P < 0.05$), and it decreased significantly with maturity. In situ NDF degradability during 24 h of incubation decreased with maturity in both cultivars ($P < 0.05$) and was higher for BH than for A at the milk stage. Total degradable NDF yields tended to increase with maturity and to be higher in cultivar A. Therefore, A, harvested at a later ripening stage, is preferable to BH as a roughage crop for dairy cattle. [References: 12].

3445 Girma Getachew (IAR, Addis Abeba (Ethiopia)); Abate Tedla; Seyoum Bediye; Amaha Sebsibe; Aschalew Tsegahun; Kahsay Berhe (1996) **Improvement and utilization of barley straw.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. Hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 171-181.* IAR/ICARDA. 11 tables; 27 ref. English. (AGRIS 97-056371).

Out of 6.5 million tons of crop residues produced each year in the country over a million tons of straw comes from barley there is substantial under-utilization of barley straw as animal feed. The major constraints on the use of barley straw as animal feed are low nutrient content, low voluntary intake, poor digestibility use of straw for other purposes and unavailability of storage facility. The low nutritive value could be upgraded to support increased animal production. There are several factors that affect the quality of barley straw. This paper presents review of previous research work on barley straw quality improvement and utilization in the country.

3446 Lee, S.K.; Lee, B.D.; Chee, S.H. (Chungnam National University, Taejon (Korea Republic). Department of Animal Science); Jung, K.K. (Yeungnam University, Kyungsan (Korea Republic). Department of Animal Science) (1996) **Effects of addition of wheat bran or rice straw to air-tightly stored ginseng meal on storage, and palatability and dry matter digestibility in goat.** *Korean Journal of Animal Nutrition and Feedstuffs (Korea Republic) v. 20(6) p. 536-542.* 6 tables; 15 ref. Korean. (AGRIS 97-056376).

3447 Negovanovic, D. (Institut za stocarstvo Zemun Polje, Beograd Zemun (Yugoslavia)); Djordjevic Milosevic, S.; Zakonovic, M.; Zujovic, M.; Trenkovski, S.; Stojanovic, Lj.; Ruzic, D. (1996) **[Effect of hybrid and additives on chemical composition and quality of silages of corn sowed after wheat harvesting]. Uticaj hibrida i aditiva na kvalitet i hemijski sastav silaze postrno sejanog kukuruza.** 8. jugoslovenski simpozijum o krmnom bilju sa medjunarodnim ucescem. Novi Sad (Yugoslavia). 28-31 May 1996. *Zbornik radova - Institut za ratarstvo i povrtarstvo (Yugoslavia) (no. 26) p. 525-531.* 2 tables; 8 ref. Serbian. (AGRIS 97-041914).

In the examination of chemical composition and quality of silages of three early maize hybrids, ZPTC 111, ZPTC 125/9 and ZPTC 113, sown after wheat harvesting, and produced in conditions of dry summer with minimal irrigation. The silages are made without or with addition of probiotic Microsil. The highest content of dry matter was in the silages of ZPTC 111 hybrid - 26.78. The other two hybrids had dry matter content lower then 25. The protein content was high in silages of all hybrids and hybrid ZPTC 113 had the highest content (12.51 in dry matter). The best quality had the silages of hybrid ZPTC 111 (Flieg mark 96 points) and the worst silages of hybrid ZPTC 113 (84.67 points) which had higher percentage of acetic acid in total acids.

3448 Pettersson, T.; Martinsson, K.; Lingvall, P. (1996) **ENSILING OF BARLEY GRAIN - OPTIMUM HARVEST TIME.** *Swedish Journal of Agricultural Research. 26(4):189-197.* English. [SWEDISH UNIV AGR SCI DEPT AGR RES NO SWEDEN ROBACKSDALEN 4097 S-90403 UMEA SWEDEN].

Barley, combine-harvested at different ripening stages during 4 consecutive seasons, was ensiled rolled, with propionic acid as an additive, and with a DM content below 600 g per kg, in an attempt to find the harvest stage that would ensure the highest amount of nutrients per hectare after ensiling. The highest DM content of starch including maltodextrins, both before and after ensiling, was achieved when the grain DM content at harvest exceeded 50%. Harvesting when the grain DM exceeded 60% was accompanied by the most effective fermentation. The lowest loss of starch plus sugars and the largest DM content per m(3) of the silo was achieved at a harvest DM exceeding 70%. The mean DM loss was 1.6%. Harvesting under cold weather conditions or at low DM content may lead to poor stability of the silage after exposure to air. To ensure high hygienic quality, the DM content at harvest should be between 60 and 75%. The best harvest time for barley grain to be stored rolled and ensiled is when the DM content is 65 to 70%. [References: 25].

Q53 FEED CONTAMINATION AND TOXICOLOGY

3449 Sundheim, L. (The Norweigian Crop Research Inst., As (Norway). Plant Protection Centre) (1995) **[Mycotoxins in marginal cereal farming]. Mykotoxiny pri hospodareni v marginalnich podminkach.** *Sbornik Jihoceske Univerzity. Zemedelska Fakulta Ceske Budejovice. Fytotechnicka Rada (Czech Republic) v. 12(Spec.no.) p. 69-76.* 6 tables; 16 ref. English. (AGRIS 97-041927).

Q54 FEED COMPOSITION

3450 Asrat Wondimu (ENI, Addis abeba (Ethiopia)) (1996) **Utilization of barley for development of low cost suplementary and weaning foods.** 1. Proceedings of the Barley Research Review Workshop. Addis Abeba (Ethiopia) 16-19 Oct 1993. *Barley research in Ethiopia: Past work and future prospect. hailu Gebre (IAR, Addis Abeba (Ethiopia)); Van Leur, Joop (eds.) p. 158-a166.* IAR/ICARDA. 3 tables; 5 fig., 14 ref. English. (AGRIS 97-056417).

Optimal conditions for malted barley were standardized and different trials were also carried out on popping of barley, which was used in the formulation of the weaning food. The blend consists of barley and chickpea in a ratio of 2:1 Barley and chickpea have been germinated for 48 and 24 hrs to produce a weaning food of good nutritive value, low paste viscosity and high calorie density. Popped and roller dried weaning foods were also formulated on the same basic ration and 5 percent malted barley flour was added to reduce the paste viscosity and enhance the calorie density of the foods. Nutritional qualities of all the formulations fall within the recommended levels given by ISI. The protein content ranged from 14.8 to 15.6 percent, fat 1.85 to 3.8 percent carbohydrates 60.5 to 66.7 percent and calorie 338.6 to 344.2. The essential amino acid contents were also satisfactory, protein efficiency ratio was 2.59.

3451 Garcia, J. (Universidad Politecnica de Madrid (Espagne). Departamento Produccion Animal); Villamide, M.J.; De Blas, J.C. (1996) **[Energy, protein and fibre digestibility of sunflower hulls, olive leaves and NaOH treated barley straw for rabbits]. Digestibilite chez le lapin de l'energie, des proteines et des fibres contenues dans des coques de tournesol, des feuilles d'olivier et de la paille d'orge traitee a la soude.** *World Rabbit Science (France) v. 4(4) p. 205-209.* 14 ref. English. (AGRIS 97-041936).

3452 Goihl, J. (Agri Nutrition Services, Inc., Shakopee, MN.) (1996) **Soft red winter wheat or triticale may be viable substitute for corn.** *Feedstuffs (USA) v. 68(26) p. 11, 30.* references. English. (AGRIS 97-041972).

3453 Jobim, C.C.; Reis, R.A.; Rosa, B.; Rodrigues, L.R. de A. (1996) **[Evaluation of triticale (X Triticosecale wittimack) for silage]. Avaliacao do triticale (X Triticosecale wittimack) para silagem.** *Revista da Sociedade Brasileira de Zootecnia (Brazil) v. 25(3) p. 404-413.* 25 ref. Portuguese. (AGRIS 97-041971).

3454 Jorgensen, H.; Gabert, VM.; Eggum, BO. (1997) **THE NUTRITIONAL VALUE OF HIGH-LYSINE BARLEY DETERMINED IN RATS, YOUNG PIGS AND GROWING PIGS.** *Journal of the Science of Food & Agriculture. 73(3):287-295.* English. [DANISH INST ANIM SCI DEPT NUTR RES CTR FOULUM POB 39 DK-8830 TJELE DENMARK].

Three experiments, the first with rats, the second with young pigs and the third with growing pigs, were carried out to compare the nutritional value of cv Lysimax, a newly developed high-lysine barley, to cv Lami, a conventional barley grown in Denmark. In the diets for rats and growing pigs the barleys were the sole protein source while in the experiment with young pigs the barleys made up to 649 g kg(-1) of the respective diets. The lysine content of cv Lysimax was 52.6% higher than that of cv Lami; 4.99 g 16 g N-1 compared to 3.27 g 16 g N-1. The contents of threonine, tryptophane, methionine and cystine of cv Lysimax were 3.80, 1.41, 1.80 and 2.27 g 16 g N-1, respectively; being 18.4, 8.5, 9.8 and 5.1% higher than in cv Lami. Conversely, the contents of glutamic acid and proline in cv Lysimax were 15.79 and 7.40 g 16 g N-1, respectively, being 36.1 and 40.0% lower than in cv Lami. In the experiment with rats, the higher lysine content and the lower content of glutamic acid and proline in cv Lysimax resulted in a 34.8% increase ($P < 0.05$) in biological value (BV); 0.867 for cv Lysimax compared to 0.643 for cv Lami. True protein digestibilities and energy digestibilities in rats fed cv Lysimax were 0.019 and 0.010 units lower ($P < 0.05$) than for cv Lami. For young pigs the increased lysine content and the lower content of glutamic acid and proline of cv Lysimax increased ($P < 0.05$) nitrogen (N) retention from 10.9 to 12.4 g day(-1), respectively, and increased ($P < 0.05$) apparent BV from 0.690 to 0.734, respectively. The digestibility of energy was 0.030 units lower ($P < 0.05$) for the diets with cv Lysimax than for the diets with cv Lami. Likewise, with growing pigs the increased lysine content and the lower content of glutamic acid and proline increased ($P < 0.05$) N retention from 6.4 to 10.8 g day(-1) and apparent BV from 0.271 to 0.495, respectively. The apparent ileal digestibilities of lysine, threonine, tryptophane, methionine and cystine were similar ($P > 0.05$) between the barleys. It is concluded that the development of high-lysine barley varieties could be beneficial for meeting the requirements of essential amino acids for monogastrics. Moreover, N excretion into the environment was substantially reduced due a reduction in the prolamine fraction which is rich in glutamic acid and proline. [References: 44].

3455 Kandala, C.V.K. (University of Georgia, Athens.); Nelson, S.O.; Lawrence, K.C. (1996) **Determining moisture content in small wheat samples by dual-frequency RF impedance sensing.** *Transactions of the ASAE (USA) v. 39(3) p. 1185-1188.* references. English. (AGRIS 97-041973).

A technique is described for estimating moisture content of small samples of hard red winter wheat (10 to 30 kernels) by impedance measurements at 1 and 4.5 MHz on a parallel-plate capacitor holding the sample between the plates. The measurement system was calibrated by measurements on samples, ranging from 9 to 20 moisture content, wet basis, from three wheat cultivars grown in 1991 and 1992. Validation measurements were taken for prediction of moisture content of small wheat sample from three different cultivars harvested in 1992. Moisture contents of the small samples were predicted with a five-variable equation involving differences in the real and imaginary components of the complex impedance at the two frequencies. The standard error was 0.9 moisture

content. The study established a basis for further development of the rapid, nondestructive method for estimating moisture content of small wheat samples.

3456 Sun, R.; Lawther, JM.; Banks, WB. (1997) **A TENTATIVE CHEMICAL STRUCTURE OF WHEAT STRAW LIGNIN.** *Industrial Crops & Products. 6(1):1-8.* English. [UNIV COLL N WALES BIOCOMPOSITE CTR BANGOR LL57 2UW GWYNEDD WALES].

Based on the chemical and structural characterizations of over 200 fractions of polysaccharides and lignins, respectively, from wheat straw, the linkages between lignin and polysaccharides are discussed and a tentative chemical structure of wheat straw lignin is proposed. (C) 1997 Elsevier Science B.V. [References: 42].

Q55 FEED ADDITIVES

3457 Partridge, G. (Finnfeeds International Ltd. (United Kingdom)) (1995) **[Practical application of feed enzymes in wheat-based pig feeds]. Prakticke pouzitie novych enzymov v krmnych zmesiach pre osipane na baze psenice.** Najnovsie biotechnologicke a technicke hladiska na vyrobu a vyuzitie krmiv, krmnych zmesi a krmnych aditiv vo vyzive zvierat. Ivanka pri Dunaji (Slovakia). 14-15 Nov 1995. *Up-to-date biotechnological and technical views on the manufacture and utilization of feeds, feed mixtures and feed additives in animal nutrition. Proceedings of the 15th scientific conference of the Feedstuffs Research Institute in Ivanka pri Dunaji. November 14-15, 1995, Ivanka pri Dunaji (Slovakia). Najnovsie biotechnologicke a technicke hladiska na vyrobu a vyuzitie krmiv, krmnych zmesi a krmnych aditiv vo vyzive zvierat. Zbornik prac z 15. vedeckej konferencie Vyskumneho ustavu krmivarskeho. 14.-15. 11. 1995, Ivanka pri Dunaji (Slovenska republika). Vyskumny Ustav Krmovinarsky, Ivanka pri Dunaji (Slovakia) p. 123-131.* OFPRINT. 5 tables; 10 ref. Slovak. (AGRIS 97-041993).

New feed enzymes used in wheat-based pig feeds developed by Finnfeeds International Ltd. open up new possibilities in feed formulations. Use of appropriate feed-enzymes allows the use of maximum levels of wheat and wheat by-products and to upgrade the feeding value of these raw materials without impairing the health and performance of animals. Feed-enzymes decrease viscosity of digesta, but improve nutrient digestibility brought about by the breakdown of insoluble cell wall material, e.g. insoluble arabinoxylans and beta-glucans. Appropriate feeding enzymes could therefore allow greater access for the pigs' endogenous enzyme secretions, leading to improved overall digestibility of nutrients.

Q60 PROCESSING OF NON-FOOD OR NON-FEED AGRICULTURAL PRODUCTS

3458 Kubikova, J. (Leopold Franzens University of Innsbruck, Innsbruck, Austria.); Zemann, A.; Krkoska, P.; Bobleter, O. (1996) **Hydrothermal pretreatment of wheat straw for the production of pulp and paper.** *Tappi journal (USA) v. 79(7) p. 163-169.* references. English. (AGRIS 97-042124).

3459 Lawther, J.M. (University of Wales, Bangor, UK.); Sun, R.; Banks, W.B. (1996) **Fractional characterization of wheat straw lignin components by alkaline nitrobenzene oxidation and FT-IR spectroscopy.** *Journal of agricultural and food chemistry (USA) v. 44(5) p. 1241-1247.* references. English. (AGRIS 97-042125).

A method was developed for the isolation and fractional characterization of phenolic monomers in wheat straw lignin using (a) methanol/toluene, ethanol/toluene, or chloroform extraction for isolation of free phenolic monomers; (b) treatments with various alkalis and hydrogen peroxide for different lengths of time to extract loosely bound phenolic acids and aldehydes; and (c) alkaline nitrobenzene oxidation of lignin in the residue of alkali-treated wheat straw, extracted hemicellulose, and cellulose for determination of tightly bound phenolics. The yield of free phenolic monomers ranged from 0.007 to 0.031 of dry straw. The predominant components of the alkali-labile free monomers were found to be ferulic and p-coumaric acid, which together comprised 65-82 of the total. The results of alkaline nitrobenzene oxidation indicated a high guaiacyl content in the original wheat straw and a high relative syringyl content in treated wheat straw. A comparison of FT-IR spectroscopic data of untreated and treated wheat straw illustrated that the most obvious features in the spectra of alkaline treated wheat straw were the disappearance of the ester linkage absorption and reduced lignin content in treated wheat straw.

S01 HUMAN NUTRITION-GENERAL ASPECTS

3460 Jones, J.M. (College of St. Catherine, St. Paul, MN.) (1996) **Changing grain and fiber consumption in the United States.** *Cereal foods world (USA) v. 41(8) p. 703-704.* references. English. (AGRIS 97-042297).

S20 PHYSIOLOGY OF HUMAN NUTRITION

3461 Hosig, K.B. (University of Arkansas for Medical Sciences, Little Rock, AR.); Shinnick, F.L.; Johnson, M.D.; Story, J.A.; Marlett, J.A. (1996) **Comparison of large bowel function and calcium balance during soft wheat bran and oat bran consumption.** *Cereal chemistry (USA) v. 73(3) p. 392-398.* references. English. (AGRIS 97-042467).

This study evaluated the generally accepted concept that dietary fiber from oat bran would have less effect on stool weight than wheat bran fiber. Nine healthy young men participated in two studies, each consisting of 28 days of a low fiber diet and 28 days of a bran diet. Incorporation of 14-16 g of wheat bran or oat bran fiber into basal diets of 14-18 g of fiber increased wet and dry stool weights to the same extent and decreased fecal pH ($P < 0.05$). Neither bran changed stool moisture. gastrointestinal transit time, calcium balance, or defecation frequency. Most changes were first detected during the period from day 8 to days 12-14 of the study. Incorporation of oat bran only increased the proportion of soluble fiber in the diet from 24 to 33 of the total fiber. We conclude: 1) fiber in oat and wheat brans increases stool weight to the same extent; 2) some measures of bowel function may not change with added fiber if they are within the normal range during low fiber intakes: 3) wheat and oat brans do not adversely affect calcium balance when calcium intake is generous (greater than or equal to 1, 200 mg/day); and 4) changes in bowel function may be detected by the second week of a dietary change if intake is rigorously controlled.

S30 DIET AND DIET-RELATED DISEASES

3462 Kroon, PA.; Faulds, CB.; Ryden, P.; Robertson, JA.; Williamson, G. (1997) **RELEASE OF COVALENTLY BOUND FERULIC ACID FROM FIBER IN THE HUMAN COLON.** *Journal of Agricultural & Food Chemistry. 45(3):661-667.* English. [AFRC INST FOOD RES DEPT FOOD MOL BIOCHEM NORWICH RES PK NORWICH NR4 7UA NORFOLK ENGLAND].

The action of wheat bran as a potential colon anticarcinogen is related partly to its low fermentability in the large intestine. Phenolic acids are highly bioactive components and also limit degradability of wheat bran in ruminants. Therefore, the solubilization of covalently bound phenolic acids during the fermentation of wheat bran in a human model colon was examined. Phenolics were only partially and relatively slowly solubilized from wheat bran, but were rapidly and fully solubilized from sugarbeet fiber; the levels of free ferulic acid in fermentation liquors remained very low and did not reflect the amounts solubilized from fiber sources. Xylanase and ferulic acid esterase activities were shown to be present. The released ferulic acid did not appear to bind noncovalently to the residual wheat bran fiber. Thus: fermentation in the gut alters the partition of esterified phenolic acids from the insoluble residue and the soluble fraction, where microbial ferulic acid esterase(s) can potentially yield free ferulic acid. [References: 42].

3463 Murphy, P.A. (Iowa State University, Ames, IA.) (1996) **Technology of vitamin A fortification of foods in developing countries.** *Food technology (USA) v. 50(9) p. 69-74.* references. English. (AGRIS 97-056823).

3464 Nakaji, S. (Hirosaki University School of Medicine, Hirosaki, Japan.); Sugawara, K.; Ohta, M.; Iwane, S.; Aisawa, T.; Munakata, A. (1996) **Endoscopic evaluation of the preventive effect of wheat bran against 1, 2-dimethylhydrazine induced large bowel carcinogenesis in rats.** *Nutrition research (New York, N.Y.) (USA) v. 16(9) p. 1521-1527.* references. English. (AGRIS 97-056993).

We evaluated the preventive effects of wheat bran (40, weight percent of diet) on the development of large bowel carcinoma induced by weekly intraperitoneal administration of 25 mg/kg (body weight) of 1, 2-dimethylhydrazine over 19 weeks in the rat. Feces number and volume per pellet in wheat bran diet group were significantly greater than those in

basal diet group, and the induction rates of tumor in the wheat bran diet group was found to be significantly lower than that in the basal diet group. These results suggested that wheat bran was effective in inhibiting large bowel carcinogenesis, and that the increased fecal weight and volume from wheat bran may be involved in such an inhibitory effect.

T01 POLLUTION

3465 Barbarick, K.A. (Colorado State University, Fort Collins, CO.); Ippolito, J.A.; Westfall, D.G. (1995) **Biosolids effect on phosphorus, copper, zinc, nickel, and molybdenum concentrations in dryland wheat.** *Journal of environmental quality (USA) v. 24(4) p. 608-611.* references. English. (AGRIS 97-042872).

When biosolids that are low in trace elements are applied on cropland, the tissue concentrations of trace elements may approach a concentration plateau as cumulative quantity of the element added increases. If the plateau concentration is less than that of safe threshold, the application may continue indefinitely. We found that wheat (Triticum aestivum L. 'Vona' or 'TAM107') grain concentrations of P, Cu, Zn, and Ni from an 11-yr field study of biosolids kind application follow a plateau model. The grain concentrations of P, Cu, and Zn approach the calculated plateau maximum after 11 applications (in fallow rotation, we completed six applications to one set of plots plus five applications to a second set). Grain Ni levels show a linear response to cumulative inputs of biosolids Ni. Possibly, the biosolids are providing a labile source of Ni. The Mo concentrations did not change significantly as cumulative inputs of biosolids Mo increased. Our results indicate that plateau modeling can describe the changes in wheat grain concentrations associated with biosolids application.

3466 Lichtfouse, E.; Eglinton, T.I. (Laboratoire de Biogeochimie Isotopique, associe a l'Institut National de la Recherche Agronomique, Universite Pierre et Marie Curie, Case 120, 75252, Paris Cx 05 (France)) (1995) **13C and 14C evidence of pollution of a soil by fossil fuel and reconstruction of the composition of the pollutant.** *Organic Geochemistry (United Kingdom) v. 23(10) p. 969-973.* 28 ref. English. (AGRIS 97-043059).

3467 Mortensen, L. (Danmarks Miljoeundersoegelser, Copenhagen (Denmark)) (1996) **[Ozone reduces the harvest]. Ozon reducerer udbyttet.** *Landbonyt. Erhvervsjordbruget (Denmark) v. 3(7) p. 12-14.* Danish. (AGRIS 97-043173).

3468 Vizarova, G.; Zatkalikova, T.; Zelenakova, E. (Slovenska Akademia Vied, Bratislava (Slovakia). Ustav Ekobiologie) (1995) **Effect of mercury on some physiological processes in barley.** *Biologia (Slovakia). Sect. General Biology v. 50(6) p. 573-576.* 1 table, 3 ill.; 13 ref. English. (AGRIS 97-042957).

Mercury at various soil concentrations (10, 100, 250, and 500.10E2 mol per cubic dm had negative effects on young barley plant growth. The growth of roots was inhibited more than the growth of the above-ground parts. Inhibition of these processes correlated with mercury concentration. Bioaccumulation of mercury in the plants correlated with Hg sup(2+) ions in soil. Mercury decreased or increased chlorophyll content, possibly as a defense against Hg sup(2+) concentration. In general it decreased chlorophyll content. Only the concentration of 100 micro mol resulted in an increase of chlorophyll.

3469 Yagodin, B.A.; Govorina, V.V.; Vinogradova, S.B.; Zamaraev, A.G.; Chapovskaya, G.V. (1995) **[Accumulation of cadmium and plumbum by some farm crops on soddy-podzolic soils with different level of cultivation]. Nakoplenie kadmiya i svintsa nekotorymi sel'skokhozyajstvennymi kul'turami na dernovo-podzolistykh pochvakh raznoj stepeni okul'turennosti.** *Izvestiya Timiryazevskoj sel'skokhozyajstvennoj akademii (Russian Federation) (no.2) p. 85-100.* 75 ref. Russian. (AGRIS 97-043140).

Data about cadmium and plumbum content in main farm crops from different countries of the world, specific features of their accumulation by plants under conditions of technogenic pollution are discussed. Information about cadmium and plumbum content in yield of winter wheat, barley, oats, potatoes, perennial and annual grasses, as well as in natural vegetation from training farm "Mikhailovskoje" (Moscow region) is presented. It is noted that concentration of cadmium is usially lower or within permissible limit, while that of plumbum corresponds to average concentrations peculiar to plants which are not polluted by this metal.

U10 MATHEMATICAL AND STATISTICAL METHODS

3470 Hossaini, K. (1993) **Study of the effects of seeding rates on grain yield of Wheat variety Azadi in Gachsaran.** Agricultural Research Station, Gachsaran Kohgilloyeh and Boyer-Ahmad (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research (Iran Islamic Republic) v. 8(3-4) p. 8.* Persian. (AGRIS 97-043265).

3471 Khabaz Saberi, H. (1993) **A survey on Barley genotypes for dual-purpose uses.** Seed and Plant Improvement Institute, Karadj (Iran Islamic Republic). *Seed and Plant Journal of Agricultural Research (Iran Islamic Republic) v. 8(3-4) p. 6.* Persian. (AGRIS 97-043238).

One of the several uses of barley is growing it for grazing or cutting at certain Growth Stage and later harvesting the grain. As some high yielding barley cultivars are confronted with drastic yield reduction after being grazed or cut, there is a demand for genotypes to justify the above-mentioned requirment. In addition to one barley, one bread wheat and one triticale used as checks in this trial, preliminary screening of 32 barley genotypes led to the selection of ten promising entries which were under investigation for three consecutive years (1988-1991) using a Spilit-Plot design with four replications under rainfed condition in Gorgan. Thirteen enteries and citting vs noncutting at tillering stage were respectively studied in the main and subplots. Combined results of the 3 years study led to the nomination of two varieties (C.63 and Lignee 527) with highest grain yield and least yield fluctuation after cutting, as dual- purpose barley varieties.

3472 Zhu Dehui (Beijing Academy of Agriculture and Forestry (China). Inst. of Crops) (1995) **Study on development and application of "Wheat Management Expert System".** *Crops (China) (no. 6) p. 1-3.* 2 tables. Chinese. (AGRIS 97-057435).

U30 RESEARCH METHODS

3473 Zuev, E.V.; Serbin, A.A. (1995) **Computer-aided work with initial material for plant breeding.** 4. Regional Conference on Mechanization of Field Experiments (IAMFE/BALTIC '95). Kaunas (Lithuania). 8-10 Aug 1995. *Proceedings of the fourth regional conference on mechanization of field experiments (IAMFE/BALTIC '95) Kaunas/Dotnuva, Lithuania, August 8-10, 1995. Leuchovius, T.; Hallerstroem, B.; Lazauskas, S. (eds.) p. 138-140.* Sveriges Lantbruksuniv. 4 ref. English. (AGRIS 97-057460).

Abad, M.S. 2635
Abate Tedla 3445
Abdalla, O. 2695
Abdel All, E.S.M. 3369
Abe, J. 3197
Abebe Demissie 2636
Abecassis, J. 3416
Abrams, S.R. 2875
Abu Dahi, Y.M. 2541, 3312
Adalsteins, AE. 2803
Adam, B.D. 2439
Adamczewski, K. 3200
Adams, M.J. 3052
Adams, S. 3363
Adamski, T. 2637, 3053
Adamu Mola 2454, 2456
Adary, A.H. 2575
Addo, K. 3370
Adisie Nuramo 2692
Adisu Birhan 2984
Agata, K. 3274, 3275
Agrawal, M. 3174
Ahmad, H. 2729
Ahmad, R. 2617
Ahmadi, A.A. 2981
Ahuja, K.N. 3242
Aisawa, T. 3464
Aitken, MN. 2931
Akanov, EN. 2940
Akbari Noushad, S.D. 2982
Akkal, N. 2843
Al Babrawi, R. 2542
Al Din, S.S. 2983
Al Taae, A.K. 2983
Al Talib, N.Y. 2983
Al Zubaidi, A.H. 2542
Alamdar, MZ. 3161
Albani, D. 2638
Alberti, E. 3322
Albrechtsen, R.S. 2773
Aleixo, A.L. 2601
Aleksakhin, R.M. 2841
Alemayehu Asefa 2703
Alemayehu, F. 2742
Alewijnse, D. 2910
Alfoldi, T. 2610
Allen, E. 2440
Allen, F.L. 2639
Alloway, BJ. 2931
Alpi, A. 2868
Alston, AM. 2563
Altom, W. 2455
Altpeter, F. 2640
Amacher, MC. 2923
Amaha Sebsibe 3445
Aman, P. 3430
Amanuel Gorfu 2454, 2456
Amaral, A. 3178
Amare Andargie 2984
Ambrosi, I. 2438, 3132
Amri, A. 2425
Amsal Tarekegn 2456
An, LZ. 2917
Anamthawatjonsson, K. 2641
Andersen, E. 3382
Andersen, M.D. 2642
Andersen, SB. 2522
Anderson, A. 2849
Anderson, J.A. 3143
Anderson, JA. 2691
Anderson, O. 2643
Anderson, P. 2985
Anderson, WK. 2457
Andersson, R. 3430
Andreeva, G.N. 3182
Andrews, L.C. 3396
Androsova, V.M. 3054
Aniszewski, T. 2552
Anokhina, V.S. 3133
Anon, M.C. 3355
Anon. 2644, 3055, 3245
Antikainen, M. 2850
Antonielli, M. 2898
Antoon, B.J. 2983
Appels, R. 2741
Apsite, A. 3056
Araji, A.A. 2424
Araujo, W.M.C. 3371
Archambault, DJ. 3199
Armero, E. 3372
Arriaga, H.O. 3151
Artemov, E.M. 2573
Artemov, V.M. 2573
Arvanitoyannis, I. 3373
Aschalew Tsegahun 3445
Ashbell, G. 3444
Ashour, S.A. 3325
Ashraf, M. 2918
Aslam, M. 2851
Asmare Yalew 2434, 2436
Asrat Wondimu 3450
Assadi, P. 3057, 3064
Atherton, J. 3185
Atkins, C.A. 2611
Atkinson, D. 2612
Atkinson, P.M. 2458
Aude, M.I. da S. 2852
Audsley, E. 3246
Aujla, S.S. 3067
Ausmane, M. 2603
Aussenac, T. 2479, 3333, 3392
Autio, K. 3351
Autrique, E. 2645
Ayoob, M. 2983
Azzam, A. 2425
Azzam, S. 2425
Baba, K. 2781
Babadoost, M. 3058, 3059, 3060
Babb, J. 3398
Babb, JC. 3074
Bach Knudsen, K.E. 3409
Badalucco, L. 3300
Baenziger, P.S. 2646, 2704
Baga, M. 2768
Bagger, C.L. 3247
Bagyinka, T. 3239
Bahraei, S. 2647
Bahrami, N. 2986, 3201
Bai, G.H. 3061
Baidanova, VD. 3192
Bailey, KJ. 2928
Bailey, S.E.R. 3000
Baize, D. 3303
Baker, G.H. 2987
Baker, R.H. 2459
Bakujzen, R. 2975
Bale, J.S. 3009
Balesh Tulema 2579
Ballance, GM. 3080
Baltensperger, D.D. 2646, 2704
Bamdadian, A. 3123, 3134, 3135
Bandani, A.R. 2988
Banks, W.B. 3459
Banks, WB. 3456
Banowetz, GM. 2948
Barbarick, K.A. 3465
Barberis, G.E. 3419
Barcelo, P. 2787
Bariana, H. 3330
Barker, I. 3023
Barkley, A.P. 3426
Barkworth, ME. 2978
Barlow, E.W.R. 3327
Barnett, V. 3321
Barro, F. 2787
Bartos, P. 3062
Basford, K.E. 2648, 2672
Bason, M.L. 3374
Basta, NT. 2926
Batini, P. 2898
Bauer, A. 2864
Baum, BR. 2649
Baxter, ES. 2838
Bazza, M. 2919
Bbadoost, M. 3063
Beach, E.D. 2450
Bean, S. 3417
Bean, S.R. 3418
Beckwith, C.P. 2569
Bede, M. 2460
Beebe, DU. 2977
Behroozin, M. 3057, 3064
Beiles, A. 2649
Bekele Hunde 3089, 3167
Bekers, M. 3344
Bekes, F. 3327
Bekesi, P. 3065
Belicka, I. 2461
BeMiller, J.N. 3424
Ben, J.R. 2543
Benbi, DK. 2592
Bender, GL. 3311
Benitez, E. 3186
Benyamini, Y. 3217
Bequette, R.K. 3400
Berecz, K. 2853
Beres, I. 2902
Berg, WA. 2544
Bergero, D. 3270
Bergkvist, G. 2496
Berhane Lakew 2462, 2703
Berhanu Bekele 2692, 2703
Berman, M. 3374
Berna, A. 2650
Bernal, J. 2989
Bernal, JS. 2990
Bernard, L. 3277
Bernard, M. 2661
Bernard, S. 2661
Berner, A. 3285
Bernicot, M.H. 2651, 2652, 2653, 2654, 2658, 2761
Bernier, F. 2650
Berzins, A. 3056
Besson, J.M. 2610
Best, EK. 3316
Bethke, P.C. 2854
Betts, S. 2439
Bevan, MW. 2638
Bevilaqua, GAP. 3298
Beyech Mulatu 2984
Bezant, J. 2655
Bezdicek, DF. 3318
Bhalkar, D.V. 2598
Bhatnagar, V.K. 2499
Bhattacharya, M. 3427
Bhatty, R.S. 3326, 3438
Bhatty, RS. 3375
Bhirud, PR. 3341
Bhowmik, P.C. 3215
Bielza, P. 2991, 2992
Bietz, J.A. 3405
Bietz, JA. 3376, 3406
Birkmose, T. 2556
Bishop, A. 3208
Bisht, S.S. 2760
Bisognin, D.A. 2852
Biswas, CR. 2592
Biurrun, R. 3238
Bivol, S.V. 3066
Biyashev, RM. 2656
Bjornstad, A. 2683, 2842
Black, CR. 3185
Black, K.E. 2612
Blair, A.M. 3207
Blake, T. 2706, 2745
Blake, T.K. 2657
Blake, TK. 2743
Bland, D.E. 2724, 2725
Blum, A. 2949, 2950
Blum, U. 2855
Blumenthal, C. 3327
Bobleter, O. 3458
Bockus, W.W. 2993
Bodvarsdottir, SK. 2641
Boenke, A. 3368
Boeuf, C. 2661
Bogdanovic, D. 2564
Boisgontier, D. 3284
Boissard, P. 2843
Bokan, N. 2546
Bolano, A. 3248
Boldaji, F. 3280
Boller, T. 2766
Boncuk, H. 3250
Bonde, M.R. 3067
Bonnefoy, M. 2593
Bonnifet, J.P. 2593
Bonsall, RF. 3068
Booker, J.D. 3020
Boon, A. 3246
Booth, C.K. 3377
Bordaloi, P.K. 2431
Borghi, B. 3378
Borner, A. 2956
Boschi, E. 2868
Boskovic, Lj. 2545, 2546
Botha, CEJ. 2856
Bothmer, R. von 2748
Botrel, T.A. 2594
Bottomley, P. 2798
Bouthier, A. 2593
Bouton, J.H. 2999
Bouzaher, A. 2428
Bowden, R.L. 3400
Bowen, I.D. 3034
Bowerman, P. 2463
Bowman, H.F. 2657
Bowman, JGP. 3261
Box, J.E. Jr. 2951
Boxus, P. 2669
Boyko, E.V. 2698
Bozinovic, I.Z. 3175
Bragason, BT. 2641
Brandt, SA. 2465, 2466
Bransteitter, R. 2687
Brashier, M. 3069
Braun, P. 2658
Bregitzer, P. 2659, 3328
Breland, TA. 2547
Brennan, P.S. 2671
Brennan, PS. 2746
Brewster, B.D. 3234
Brisibe, EA. 2522
Briski, L. 2548
Britton, R. 3208
Broch, DL. 3298
Brodl, M.R. 2867
Brorsen, B.W. 2439
Brown Guedira, G.L. 2993
Brown, C.S. 2908
Brown, G.A. 2699
Bruckental, I. 3444
Bruckner, PL. 2743, 3083
Bruins, MBM. 2523
Brumfield, SKZ. 3083
Brummer, J.M. 3390
Bryan, G. 2745
Bryan, I.B. 3221
Bublik, L.I. 3202
Buchanan, B.B. 3252
Buerstmayr, H. 2660
Buga, S.F. 3070
Bulcke, R. 3315
Bulson, H.A.J. 3241
Bulson, HAJ. 2464
Buntin, G.D. 2724, 2725
Burd, J.D. 2994, 2995
Burkhamer, RL. 2978
Burnett, VF. 2952
Busch, W. 2762
Bushuk, W. 3389, 3413
Butterfield, RE. 2835
Caballero Barrigon, A. 3379
Cadalen, T. 2661
Cadena Hinojosa, Mateo A. 3102
Cai Hong 2889
Caldwell, S.P. 3266
Callens, D. 3315
Camargo, C.R. de O. 3371
Cambron, S. 2688
Campbell, CA. 2465, 2466

Campiglia, E. 3300
Campos, D.T. 3329
Campsolinas Dresaire, J. 3380
Canevari, M. 3227
Cao Keqiang 3071
Cao Yuanyin 2819
Caporali, F. 3300
Carlson, G.A. 2657
Carlson, P. 2446
Carman, K. 3286
Carner, R. 3227
Carrillo, A. 3072
Carter, N. 3009
Carter, TR. 2839
Carvalho, F.I.F. de 3178
Carvalho, LJCB. 2600
Carver, M.F.F. 3052
Casa, R.T. 3141
Cashman, MM. 2883
Casper, H.H. 3282
Cassol, E.A. 3317
Castagna, R. 2662, 3378
Castilho, A. 2663
Castrignano, A. 3287
Cauwel, B. 3291
Ceccarelli, S. 2664, 2665, 2742, 2802
Celik, S. 3339
Ceoloni, C. 2674
Cerletti, P. 3322, 3334, 3336
Cerny, J. 2903
Chajka, M.T. 2480
Chalkley, D.B. 3121
Chambers, P.A. 2442
Chanda, SV. 2857
Chandani, M. 2677
Chapovskaya, G.V. 2573, 3469
Charron, G. 3297
Chasalow, SD. 3193
Chaubey, A.K. 2788
Chawla, D.V. 2677
Chee, S.H. 3446
Chelkowski, J. 3053, 3130
Chen Daqing 3184
Chen Gang 2848
Chen Jun 3190
Chen Lijun 2549
Chen Ming 2834, 2920
Chen Shilin 2467
Chen Wanquan 2666, 3164
Chen Yanglin 3073, 3164
Chen Yichun 2795
Chen Yukui 2817
Chen Zhijie 2996
Chen Zhishen 2997
Chen, X. 3249
Cheng Jianping 3288
Cheong, J.I. 2602
Chi Yongqin 2767
Chibbar, RN. 2768
Chilot Yirga 2432, 2434, 2436
Chirdo, F.G. 3355
Chiu, MM. 3414
Chiue, H. 3381
Chizhova, S.I. 2503
Cho, M.K. 3345
Choi, M.G. 2602
Chojecki, J. 2655
Chomo, G.V. 2444
Chow, FI. 3411
Christen, S.D. 3262, 3264
Christensen, G. 2430
Christensen, NW. 2925
Christensen, S. 3203, 3204
Christie, BR. 2559
Christophersen, C. 3382
Christou, P. 2667
Chung, OK. 3406
Chwalibog, A. 3271
Ciacco, C.F. 3371, 3419
Ciaffi, M. 2858, 3330, 3383
Ciepiela, A.P. 2998
Cierniewska, A. 3331
Cilliers, SC. 3271
Citron, G. 3205
Ciuffetti, LM. 2668
Clamot, G. 2669
Clarke, J.M. 3086
Clear, RM. 3074, 3075
Cleemput, G. 3384
Clement, S.L. 2999
Coelho, J.C. 2601
Coksoyler, N. 3250
Colbach, N. 3076
Collado, L.S. 2670
Collar, C. 3372
Collinge, D.B. 2916
Colliver, D.G. 3283
Colls, JJ. 3185
Colombo, L. 3300
Colot, V. 2638
Colucci, R. 3287
Comeau, A. 2706
Condon, A.G. 2881
Conger, B.V. 2639
Conlan, S. 2638
Conner, RL. 3077
Conoly, M. 3266
Cook, R.T. 3000
Cooper, JE. 3316
Cooper, M. 2648, 2671, 2672, 2673, 2746
Coquille, J.C. 3388
Corbellini, M. 3378
Corbett, S.J. 3207
Cordo, C.A. 3151
Corke, H. 2670
Cortez, J. 2707
Cortez, M.J. 2708, 2709, 2710
Cosser, N.D. 3206
Courcoux, C. 3415
Couvreur, F. 2468
Coventry, DR. 2952
Cox, T.S. 2993
Coy, A.E. 2680
Craigon, J. 3185
Crepel, C. 3116
Crocker, GJ. 2616
Cross, J.W. 2859
Cross, RHM. 2856
Crous, P.W. 3113
Cuadrado, A. 2674
Cui Dangqun 2823
Cunfer, B.M. 2724, 2725
Curran, S.P. 3365
Currie, RS. 2495
Cussans, J.W. 3207
Cwojdzinski, W. 2552
Cygankiewicz, A. 2791
Cyran, M. 2675
Czuchajowska, Z. 3385
D'Avignon, A. 2553
D'Ovidio, R. 2676
Dahiya, M. 2677
Dahlin, C. 2860
Dai Fuming 3078
Dai Liangxiang 2921
Dakheel, A.J. 2861
Dalili, A. 3084
Damania, AB. 3176
Dang Zengchun 2560
Daniel Shamebo 2421
Danielson, AD. 3386
Danilevics, A. 3344
Dapkus, R. 2533
Darcy, CJ. 3107
Darwent, AL. 3177
Darwinkel, A. 3003
Das, K. 2431
Dasilva, WR. 2894
Davenport, RJ. 2953
Davies, D.B. 2463
Davies, W.P. 3206
Davies, WP. 2473
Davis Dentici, K. 3264
Davoyan, R.O. 2678
Dawit Tadese 2679
Day, J.L. 2680
De Blas, J.C. 3451
De Cesare, F. 3300
De Friz, M.A. 2975
Debaeke, P. 2479
Debuyser, J. 2896
Dechen, A.R. 2543
Dechev, D. 2681
Deconynck, M. 3384
Deffune, G. 2550
Degiorgio, D. 3287
DeGregorio, R. 2509
Dejene Abesha 2421
DeLacy, I.H. 2672, 2682
Delcour, JA. 3384
Deleens, E. 2922
Delgado, JA. 2923
Dell'Aquila, A. 2534
Dellow, J.J. 3208
Delwiche, S.R. 2443
Demchenko, K.N. 2954
Demchenko, N.P. 2954
Demissie, A. 2683, 2842
Demorenko, I.F. 2684
Dencic, S. 2685, 2844, 3183
Deoliveria, MCN. 2486
DePauw, R.M. 3086
Dereje Tadese 3089, 3167
Desai, A. 2687
Desjardins, M. 3075
Desserme, C. 3415
Destain, J.P. 3302
Deumier, J.M. 2593
Devlin, R.M. 3215
Deyoe, C.W. 3366
Dhari, R. 2726
Dhuyvetter, K.C. 2613
Di Ciocco, C.A. 2941
Di Fonzo, N. 3335
Di Turi, M. 2534
Didan, V.P. 3019
Dietrych Szostak, D. 3229
Dijkstra, P. 2965
Dimitrova, A. 2847
Djordjevic Milosevic, S. 3447
Djurhuus, J. 2475
Dofing, SM. 2955
Domier, LL. 3107
Dominici, L. 2858
Dominiece, I. 2507
Donatelli, M. 3301
Dong Cixiang 3001
Dorffling, H. 2686
Dorffling, K. 2686
Dormaar, JF. 3387
Dornelles, A.L.C. 3178
Douglas, LA. 3310
Douzals, J.P. 3388
Draganic, M. 3103
Dreiseitl, A. 3079
Drozdowicz, Y.M. 2862
Dubcovsky, J. 2687
Dubois, ME. 3395
Dubovoj, V.I. 2830
Duck, B.N. 2639
Ducreux, G. 2896
Dudhe, Y.H. 2539
Duncan, SR. 2614
Dunsmore, KM. 3098
Dupreez, JJ. 3271
Dupuis, B. 3360, 3389
Durgan, BR. 3243, 3244
Durnin, D. 2875
Dushnicky, LG. 3080
Duveiller, E. 3121
Duviau, M.P. 3252, 3332
Dvorak, J. 2687
Dweikat, I. 2688
Dyck, FB. 2491
Dyer, W. 2745
Eckersten, H. 3191, 3196
Eckes, P. 2777
Eckhoff, J. 2657
Ederli, L. 2898
Edney, M. 3074
Edrington, T.S. 3282
Edwards, LM. 2469
Eggum, BO. 3454
Eglinton, T.I. 3466
Ehl' Khal'favi, K.A. 2689
El Haddad, L. 3333
El Hady, E.A. 3390
El Naimi, M. 3125
El Samahy, S.K. 3390
El Shora, H.M. 3325
Eladawy, TA. 3391
Elahinia, S.A. 3081, 3082
Elberson, L.R. 3002
Elbouhssini, M. 2425
Elder, P. 2509
Eleftheriou, EP. 3187
Elhaddad, L. 3392
Eliasson, A.C. 3324, 3342, 3343
Elissalde, M.H. 3282
Elliott, N.C. 2994
Elliott, NC. 3028
Ellis, RP. 2870
Ellison, F. 3374
Elmore, CD. 2426
Elsas, J.D. van 3306
Endo, T.R. 2698
Engel, RE. 3083
Entwisle, AC. 3368
Epplin, F.M. 2470
Ershad, A. 3084
Ershad, D. 3126, 3127, 3171
Esparza, M. 3238
Ester, A. 3003
Esteves, W. 3371
Esumi, Y. 3436
Euvrard, M. 2969
Evans, LG. 3191, 3196
Evers, A.D. 2690
Eynard, L. 3334
Fabre, J.L. 2479, 3333
Fabre, JL. 3392
Faghih, H. 3209
Falih, T.K. 2471
Fan Zheru 2817
Fares, C. 3335
Faris, JD. 2691
Farkhutdinov, RG. 2863
Farmakalidis, E. 3377
Farnell, PJ. 3368
FAROOQEAZAM. 2918
Fasil Reda 3210
Fatemi, H. 3211
Fath, A. 2968
Fathi, G. 2551, 2924
Fauci, MF. 3318
Faulds, CB. 3462
Faure, JP. 2896
Favati, A. 2868
Fedadu Tufa 2692
Federizzi, L.C. 3178
Fedulov, Y. 2845
Fekadu Alemayehu 2462, 2692
Fekadu Fufa 2703
Felker, F.C. 3425
Feller, U. 2930
Feng Chengyu 3085
Fenni, M. 3212
Fernandes, J.M.C. 3132
Fernandez, M.R. 3086
Feshchin, D.M. 3019
Feuillet, C. 2782
Fielding, L.A. 2867
Fillery, IRP. 2892
Finney, P.F. 3396
Fischbeck, G. 2578
Fitter, AH. 3193
Fjell, K.M. 3393
Flannigan, B. 3361
Fleckenstein, J. 3296
Fleege, L.M. 3396
Flinn, P.W. 3251
Flintham, J.E. 2690
Flintham, JE. 2956
Floot, H.W.G. 3003
Fofana, N.F. 2470
Folegatti, M.V. 2594
Follet, R.F. 2615
Foltz, J.C. 2437
Forcelini, C.A. 3141
Forotan, A. 3094
Foroutan, A. 3087, 3088
Forster, BP. 2870
Fossati, C.A. 3355
Foster, G.N. 3023
Fox, P.N. 2673, 2693, 2694
Fox, S.M. 3026
Foy, CD. 3179
Francl, L.J. 3143, 3153
Francl, LJ. 2691
Francois, E. 3302
Frank, A.B. 2864
Frank, J. 2804
Frank, T. 3004

Franzen, LG. 2860
Freeze, B. 2427
Freitas, J.G. de 2789
French, WB. 3028
Fricke, W. 2865
Fridman, Sh.D. 2573
Friedt, W. 2770
Frizzone, J.A. 2594
Froud Williams, R.J. 3206, 3241
Fry, TA. 3244
Fu, B.X. 3394
Fuentes Davila, G. 3067
Fuentescontreras, JE. 3005
Fuentesdavila, G. 2695
Fuerst, E.P. 3232, 3234
Fuerst, EP. 3233
Fuleky, G. 2937
Fushiki, T. 3274, 3275
Gaba, D. 3074
Gabert, VM. 3454
Gagro, M. 2472
Gaido, ZA. 3395
Gailhofer, M. 3364
Gaimari, S.D. 3006, 3007
Gaina, L. 2801
Gaines, C.S. 3396
Gajin, S. 3308
Gale, MD. 2956
Gallardolara, F. 3186
Gallo, J. 3008
Gambhir, P.N. 2897
Gan, Y. 2866
Gan, Z. 3397
Gantar, M. 3308
Gao Mingjun 2696
Garbeva, P. 3116
Garcia, J. 3451
Gardiner, DT. 2925
Gash, A.F. 3009
Gasiorowski, H. 3331
Gassman, PW. 2428
Gate, P. 3320
Gauvrit, C. 2969
Gaventa, JM. 2668
Gavi, F. 2926
Gavian Sarah 2433
Gawalko, EJ. 3398
Gealy, D.R. 3234
Gebre, H. 2742
Gebrehiwot Hailemariam 2421
Gecheff, K.I. 2847
Gelroth, J.A. 3428
Gemechu Degefa 2433
Gemmell, J. 3221
Genter, T. 2922
Georges, P. 3291
Gerstenkorn, P. 3393
Gervais, P. 3388
Getaneh Woldeab 3089, 3167
Geypens, M. 2980
Ghadiri, H. 3214
Ghazal, H. 2728
Ghomi, S. 2482
Gianoli, E. 2957
Giasson, E. 3317
Gielo, S. 2791
Gill, B.S. 2697, 2698, 2993
Gill, K.S. 2697, 2698
Gillespie, R.L. 3010
Gilmour, R.F. 2699, 2700
Ginkel, M. van 3090
Girma Gebrekidan 2436, 2579
Girma Getachew 3445
Glaser, B.K. 3428
Glazek, M. 3091
Glitso, V. 3409
Gnanasambandam, R. 3401
Gnocchi, S. 2662
Gobin, P. 3252
Godwin, ID. 2746
Goffart, J.P. 3302
Goihl, J. 3452
Golinski, P. 3130
Golovatyuk, L.A. 2830
Golovnina, Yu.M. 3182
Golzar, H. 3011, 3092, 3093, 3094
Goncharova, L.I. 2841
Gonzalez Anta, G. 2941
Gonzalez, D. 2989, 2990
Gonzalez, HHL. 3095
Gooding, M.J. 2907, 3206
Gooding, MJ. 2473
Gordon, DC. 2870
Gordun, E. 3248
Goulart, A.C.P. 3096
Govedarica, M. 3299
Govorina, V.V. 3469
Granatstein, D.M. 2623
Grando, S. 2665, 2742, 2802
Grant, RH. 2958
Gras, P.W. 3327
Gras, PW. 3434
Grassucci, R. 2804
Grausgruber, H. 2660
Gray, GR. 2943
Green, D.B. 3012
Green, M. 3207
Greenfield, J. 2787
Grego, S. 3300
Gregorcic, A. 2548
Griffin, M. 2535
Griffin, V.K. 3401
Griffith, M. 2850
Grigale, D. 3142
Grimm, B. 2873
Grindstaff, K.K. 2867
Grosch, W. 3399
Grossardt, T. 2441
Grzywa, M. 2811
Gu Kun 3213
Guberac, V. 2966
Gubler, F. 2701, 2968
Gudmundsson, J. 2641
Guerrieri, N. 3322, 3334, 3336
Guglielminetti, L. 2868
Guilford, W.L. 2859
Gulewicz, K. 2552
Gunther, T. 2872
Guntherborstel, O. 2576
Guo Cunrong 2915
Guo Dazhi 2947
Guo Lijuan 3166
Guo Mei 3097
Guoping, Z. 2959
Gupta, R. 3330
Gupta, UC. 2559
Gusta, LV. 2702
Haberle, J. 2960
Habib, S.A. 3325
Hadfield, S.T. 3221
Hadzic, V. 3299
Hagstrum, D.W. 3251
Hahnhagerdal, B. 3402
Hailu Beyene 2434
Hailu Gebre 2462, 2474, 2703
Hailu Mekbeb 2679
Haley, S.D. 2704
Halford, N.G. 2787
Halperin, SJ. 2927
Halvorson, A.D. 2613, 2615
Hamauzu, Z. 3349
Hamberg, G. 2869
Hamberg, M. 2869
Hamer, RJ. 3412, 3439, 3440
Hamidi, R. 3214
Hammer, GL. 2429
Hammondkosack, MCU. 2638
Han, F. 2705
Handley, LL. 2870
Haneklaus, S. 3296
Hanks, D.R. 3263
Hanna, M.A. 3340
Hannachi, L. 2922
Hansen, E.M. 2475
Hansen, J. 3220
Hanus, H. 2576
Hanusova, R. 3062
Harasymow, S.E. 2700
Harden, TJ. 3311
Harder, DE. 3098
Hare, MC. 3099
Harkonen, H. 3351
Harman, G.E. 3112
Harrigan, KA. 2871
Harrington, R. 3023
Harrison, PA. 2835
Harsch, S. 2872
Hartel, H. 2873
Hartvig, P. 2422
Harvey, R.B. 3282
Harwood, J.L. 2901
Hassan, W. 2983
Hatchett, J.H. 2646, 2993, 3021
Hatting, J. 3013
Hause, B. 3100
Hausler, RE. 2928
Havaux, M. 2929
Havlickova, H. 3014
Havlin, J.L. 2584
Hayes, JP. 3271
Hayes, P. 2706
Hayes, P.M. 2718, 2719
Heatherly, LG. 2426
Heidari, M. 3025
Heimovaara Dijkstra, S. 2885
Heisel, T. 3203
Helbert, J. 2843
Helm, J.H. 2707, 2708, 2709, 2710
Hendrickx, G. 2980
Henry, I. 2706
Henry, R.J. 2711, 2712
Henry, RJ. 2713
Henry, Y. 2896
Henselova, M. 2476
Hensleigh, P.F. 2657
Hera, C. 2580
Hergert, G.W. 2584
Herren, T. 2930
Herrman, T.J. 3400
Herrmann, R.G. 2762
Herstad, O. 3259
Hervas, D. 3186
Herzmark, P. 2859
Hesemann, CU. 2872
Heslopharrison, JS. 2663, 2783
Hess, B.W. 3263
Hess, J.D. 3263
Hessing, M. 3384
Hettiarachchy, N.S. 3401
Heun, M. 2662, 3378
Heydari, M. 3015, 3016, 3038
Hicks, G.R. 2874
Higgins, J.J. 3268
Hill, A.L. 3207
Hill, R.D. 2875
Hill, T.M. 3262, 3264
Hillmer, S. 2854
Hiner, A.N.P. 2876
Hirai, T. 2882
Ho, T.H.D. 2786
Hockett, E.A. 2657
Hoehndorf, T. 3257
Hoffman, D. 3234
Hoffman, L.A. 2444
Hofvendahl, K. 3402
Holcombe, D.W. 3263
Holdsworth, M. 2638
Hole, D. 3101
Holford, ICR. 2616, 3289
Holt, LM. 2779
Holz, G. 3113
Hood, B. 2849
Hooda, PS. 2931
Hooker, J.E. 2612
Horiuchi, T. 2558
Horst, D.J. van der 3033
Hoseney, R.C. 3337, 3353, 3354
Hosig, K.B. 3461
Hoson, T. 2911, 2912
Hossaini, K. 3470
Hotsonyame, GK. 2961
Hou, G. 3403, 3404, 3441
Hoult, A.H.C. 3022
Housley, T.L. 2878
Howell, TA. 2572
Howes, B. 2900
Hoxie, R.P. 2995
Hraska, S. 2714
Hrivna, L. 2626
Hronec, O. 2836
Hu Changcheng 2666
Hu Shanglian 2524, 2530
Hu Yunlin 2715
Huang, D.Y. 2716
Huang, J.W. 3180
Huang, TA. 3427
Huang, XP. 3017
Huber, S.A. 3263
Hucl, P. 3369
Hudson, CA. 3414
Huebner, F.R. 3405
Huebner, FR. 3406
Huffaker, R.C. 2851
Humeid, BO. 3176
Huner, NPA. 2943
Hunt, L.J. 3266
Hunt, L.A. 2961
Hunter, R.A. 2699
Huntington, GB. 3272
Hurkman, W.J. 2717
Hussain, T. 2617
Hvid, S.K. 2477
Hwang, SF. 3077
Ibraheem, K. 2459
Ichikawa, N. 2891
Iglesias, A. 3191, 3196
Ignaczak, J.C. 2438, 3132
Illerup, J.B. 3253
Imai, T. 2895, 3437
Incerti, M. 3208
Ingvardsen, L. 3247
Ippolito, J.A. 3465
Iragavarapu, TK. 2478
Irani, P. 3407
Irizar Garza, Martha Blanca Guadalupe 3102
Irzyk, G.P. 3234
Irzyk, GP. 3233
Isfan, D. 2553
Ishida, N. 2877
Ishigami, M. 2882
Ishii, R. 2600
Ivezic, J. 2846
Iwami, K. 3381
Iwane, S. 3464
Iyamabo, O.E. 2718, 2719
Iyer, L. 3408
Izaurralde, RC. 2428
Jaama, E. 2488
Jaaska, V. 2720
Jaber, A.S. 2554
Jackson, L. 3227
Jacobsen, JV. 2701, 2968
Jacobsen, N. 2748
Jacquemin, JM. 2792
Jain, PK. 2904, 2905
Jakabne Kondor, M. 3065
Jakobsen, TS. 3382
Jalalian, N. 3158
Jalil, S. 2542
Jame, YW. 3307
Janitor, A. 3122
Jansen, R.F.R. 3033
Jansson, H. 3313
Jarak, M. 3299
Javornik, B. 2737
Jean, C. 2896
Jedel, P.E. 2707, 2708, 2709, 2710
Jelic, M. 2536, 2763
Jelsted, M. 3257
Jensen, ES. 3290
Jensen, P.E. 2422
Jensen, R.B. 2721
Jeong, B.R. 2878
Jerkovic, Z. 3157, 3181
Jesko, J. 2435
Jevtic, R. 3103
Jezowski, S. 2637
Ji Fenggao 2722
Jia Gaofeng 2723
Jia Tingxiang 3104
Jia, Y.Q. 2479
Jiang Jianping 2618
Jiang Xiuyong 2879
Jilani, G. 2617
Jin Derui 3049

Jin Zhengxun 2723
Jin Ziyu 2515
Jing Yuanshu 2962
Jobim, C.C. 3453
Joergensen, L.N. 3204
Johansen, H.N. 3409
Johnson, DA. 2649
Johnson, GV. 2455, 2555, 2926
Johnson, J.B. 3002
Johnson, J.W. 2724, 2725
Johnson, M.D. 3461
Johnson, P.A. 2442
Johnson, R.C. 2999
Johnston, M. 2706
Jones, A.E. 2463
Jones, B. 2706
Jones, B.L. 2659, 2880, 3328, 3410
Jones, BL. 3050
Jones, J.M. 3460
Jones, J.R. 2446
Jones, R.A.C. 3119
Jones, R.L. 2854, 2862
Jones, RAC. 3120
Jones, RL. 2968
Jones, SS. 3233
Jood, S. 3254, 3255
Jordahl, J.G. 3143, 3153
Jordahl, JG. 2691
Jorgensen, H. 3454
Joshi, A.K. 2726
Jouve, N. 2674
Judkins, M.B. 3263
Jung, C.S. 2884
Jung, K.K. 3446
Jurecka, D. 3079
Jurgens, HU. 2686
Jutsum, A.R. 3221
Kabashnikova, L.F. 2480
Kaczkowski, J. 3331
Kaczmarek, Z. 3053
Kadim, IT. 3273
Kaerner, E. 2481
Kaerner, M. 2481
Kahlon, TS. 3411
Kahsay Berhe 3445
Kale, V.B. 2598
Kalla, R. 2701
Kameya, T. 2731
Kaminska, E. 3344
Kamisaka, S. 2911, 2912
Kanampiu, FK. 2555
Kanauchi, O. 3274, 3275
Kandala, C.V.K. 3455
Kanehisa, K. 2764
Kang, Y.K. 2881
Kangasjarvi, J. 2727
Kannangara, C.G. 2810
Kanno, A. 2731
Kano, H. 2877
Kant, T. 2529
Kapashi, S.B. 2906
Kapoor, A.C. 3254, 3255
Karadzhova, J. 3105
Karanja, DD. 2420
Karasev, GS. 3192
Karczmarczyk, S. 2483, 2484, 2557, 2595, 2596
Karczmarczyk, S.J. 3215
Karjalainen, R. 2727
Kartha, KK. 2768
Karwe, M.V. 3338
Kasarda, D.D. 2676
Kasarda, DD. 2803
Kastal'eva, T.B. 3124
Kastori, R. 2844, 2932, 3194
Kaszynski, W. 2998
Katsuhara, M. 2933
Kawai, S. 2882
Kawamura, Y. 3352
Kawasaki, T. 2933
Kawka, A. 3331
Kearsey, M. 2655
Kedzior, Z. 3331
Keller, B. 2782
Keller, RCA. 3412
Kelley, C.R. 2423
Kemmerling, B. 2766
Kemp, W.P. 3010
Kervinen, T. 2727
Ketata, H. 2728
Kettlewell, P.S. 2569, 2712
Kettlewell, PS. 2473, 2883
Keys, M. 2701
Khabaz Saberi, H. 2482, 3471
Khan, A. 3018
Khan, I.M. 2729
Khan, K. 2716
Khan, S.I. 2729
Khawatmi, S. 3161
Khejmovaara Diikstra, S. 2975
Khetata, H. 2861
Kholdebarin, B. 3040
Khorgade, P.W. 2776
Khoursandi, H. 3170
Khripach, V.A. 2503
Khrustaleva, L.I. 3182
Khurana, JP. 2904, 2905
Khurshid Hussain, S. 2566
Kiecana, I. 3130
Kilian, A. 2687, 2705, 2842
Kim, B.J. 2884
Kim, H.R. 3413
Kim, HS. 2730
Kim, S.S. 3345
Kimpinski, J. 2469
King, GE. 3421
Kirkpatrick, T.L. 3121
Kirkwood, R.C. 3221, 3235
Kiryluk, J. 3331
Kisaka, H. 2731
Kisaka, M. 2731
Kishka, M.N. 2732
Kiss, J. 3046
Kissimon, J. 2853
Kjaerulff, S. 2733
Kjellerup, V. 3295
Klein, KK. 2427
Kleinhofs, A. 2687, 2705, 2842
Klimovich, A.S. 2480
Kling, CI. 2872
Kmecl, V. 2548
Knetsch, M.L.W. 2885
Knol, W. 3356
Knuckles, BE. 3414
Knudsen, L. 2556
Ko, HL. 2713
Kobiljski, B. 2685
Kobiljski, D. 3183
Kobrehel, K. 3252, 3332
Kochian, L.V. 3180
Kochian, LV. 2927
Kocjan Acko, D. 2886
Koebner, RMD. 2641
Kogel, KH. 2766, 3100
Koh, B.K. 3337, 3338
Kohyama, K. 3437
Koizumi, M. 2877
Koksel, H. 3339
Kollengode, A.N. 3340
Koncz, C. 2777
Konecny, V. 2476
Kono, Y. 3436
Koo, B.C. 2734
Kopus', M.M. 2735
Kopus', N.G. 2735
Korol, A. 2736
Kosulina, L.G. 2525
Koszanski, Z. 2483, 2484, 2557, 2595, 2596, 2599, 3230
Kotake, T. 2887
Kothari, SL. 2529
Kovacevic, B. 3181
Kovalik, U.K. 2797
Kowalczyk, C. 3331
Kowalewski, W. 3331
Koz'min, G.V. 2841
Kozma, E. 3046
Kozub, GC. 3387
Kpakpo, ADF. 2558
Kraljevicbalalic, M. 2846
Kratochvil, R.J. 2780
Kreita, D. 2508
Krenzer, EG. 2512
Krikorian, A.D. 2908
Krippel, E. 3154
Kristensen, E.F. 3256
Kristensen, H. 2500, 2501
Krkoska, P. 3458
Krogere, R. 2603
Kroon, PA. 3462
Kroonenberg, P.M. 2648
Krstic, M. 2538
Krugman, T. 2736, 3217
Krut', M.V. 3019
Krysiak, H. 2791
Krysl, L.J. 3263
Kubena, L.F. 3282
Kubikova, J. 3458
Kucukakyuz, K. 2971
Kudoyarova, GR. 2863
Kudsk, P. 3222
Kueuets, H. 2796
Kuht, J. 2485
Kumarasinghe, K.S. 2919
Kump, B. 2737
Kunitskaya, M.P. 3133
Kunzel, G. 2738
Kusano, T. 3381
Kushalappa, A.C. 2540
Kushnak, G. 2657
Kuwajima, K. 2882
Kuz'min, N.A. 2739
Kvist, M. 2496
Kweon, MR. 3341
Kwon, T.O. 2602
Labovitz, J.N. 2859
Lacasa, A. 2991, 2992
Lafarga, A. 3320
Lafiandra, D. 2740, 2858, 3330, 3383
Lagerberg, C. 3106
Lagudah, E.S. 2741
Laine, S. 2528
Lairon, D. 3291
Lajoux, P. 3284
Lakatos, L. 2837
Lakech Goitom 3348
Lakew, B. 2742
Lakshminarayan, PG. 2428
Lalonde, S. 2977
Lamarre, M. 2553
Lamb, N. 2875
Lambers, H. 2910
Lance, RCM. 2551, 2924
Landau, S. 3321
Landon, G. 3185
Langenkemper, K. 2777
Langlois, P. 3178
Langridge, P. 3304
Langton, S.D. 3026
Lanning, SP. 2743
Lantmann, AF. 2486
Lapinski, B. 2675
Lark, R.M. 2487
Laroche, G. 2744
Larre, C. 3415, 3423
Larson, S. 2745
Larsson, H. 3342, 3343
Latorre, I. 3107
Lauk, E. 2488
Laukevics, J. 3344
Laurie, D. 2655
Lavelli, V. 3322
Lavergne, D. 2896
Lavier, B. 2619, 3108
Law, CN. 2779
Lawrence, K.C. 3455
Lawson, WR. 2746
Lawther, J.M. 3459
Lawther, JM. 3456
Lazar, M.D. 3020
Lazzeri, P. 2787, 3433
Lea, PJ. 2928
Leach, G.E. 3221
Leath, S. 2993
Leaver, C.J. 2901
Leblanc, PV. 2559
Leclerc, B. 3291
Lee, B.D. 3446
Lee, H. 3306
Lee, J.H. 2602
Lee, S.K. 3446
Lee, Y.T. 3345
Leech, R.M. 2901
Leegood, RC. 2928
Lefkovitch, LP. 3177
Legere, A. 3216
Leigh, R.A. 2913
Leitch, AR. 2783
Lemmens, M. 2660
Lempereur, I. 3416
Lesselich, G. 2686
Lester, D.G. 2999
Leviminzi, R. 2571
Levine, H.G. 2908
Levy, O. 2736, 3217
Lewis, P. 2843
Leyva Mir, S. Gerardo 3144
Lhaloui, S. 2425, 3021
Li Changyou 3346
Li Dingxin 2560
Li Guibao 2561, 2562
Li Guifang 2723
Li Hongen 2747
LI Jinyu 3109
Li Kaiyang 3292
Li Kewu 2848
Li Wenxiong 2524, 2888, 2967
Li Wenze 2526
Li Xiaobing 2888
Li Xiaolin 3293
Li Yanan 3184
Li Yizhen 2489
Li Youchun 2537
Li Zhenqi 3147
Liang Hui 2527
Liang Qizhi 3190
Lichtfouse, E. 3466
Liepins, J. 2603
Ligmond, C.A. 3367
Lin Xiaoxia 2829
Lin, P.Y. 3385
Lindberg, S. 2934
Linde Laursen, I. 2748
Lindsay, J.G. 2901
Lindwall, CW. 3387
Ling Beibei 2829
Lingvall, P. 3448
Linhares, A.I. 3110
Linnestad, C. 2963
Liskova, M. 3160
Lisovska, A. 3344
Liu Chuande 3104
Liu Dongqing 2606
Liu Guojiang 2620
Liu Hong 2767
Liu Jianjun 2749
Liu Jinjiang 2530
Liu Jintong 2889
Liu Qinchun 3111
Liu Siheng 2750
Liu Tingzhi 2618
Liu Xili 3109
Liu, C.Y. 3347
Liu, J.H. 2875
Lo, C.T. 3112
Lobreaux, S. 2874
Lockley, KD. 3129
Loefqvist, B. 3257
Lofqvist, J. 2985
Loganathan, P. 2565
Lokstein, H. 2873
Lomovic, S. 2536
Lookhart, G. 3417
Lookhart, G.L. 3418
Lookhart, GL. 3376
Lopez F, Saul 3218
Lopez, J.R. 2941
Lopezdiaz, TM. 3361
Lorenz, K.J. 3428
Lotfali Aeineh, G. 2504
Lotfollahi, M. 2563
Loubser, J. 3219
Loughin, T. 3400
Louw, J.P.J. 3113
Lovett, J.V. 3022
Loy, JP. 2451
Lu Jingxian 2964
Lu Shihua 2751
Lu Tiegang 2752
Lu Weizhong 2785
Lu, ZJ. 2778
Lubben, A. 3139

Luck, E. 2686
Ludwig, A. 2578
Lukaszewski, AJ. 2753
Lukow, OM. 3387
Luo, M.C. 2687
Lupej, A.Yu. 3114
Luthar, Z. 2754
Luthra, J.K. 2755
Lutman, P.J.W. 3207
Luz, W.C. da 3110, 3131
Lvov, NP. 3192
Lynch, JP. 2927
Lyngkjaer, M.F. 3115
Lyon, M.K. 2890
Ma Quanhua 2467
Ma Ruikun 2756
Ma Zichao 3184
Maas, C. 2777
Macewicz, J.B. 2757, 2758
Macgregor, AW. 3080
Machado, N. 2759
Machutcheon, MG. 2702
Maciorowski, R. 2965
MacRitchie, F. 3330
Maes, M. 3116
Magan, N. 2838
Magu, SP. 2944
Mahaut, T. 3138
Maheshwari, SC. 2904, 2905
Mahmood Shah, S. 2566
Maidl, FX. 2578
Maikhuri, R.K. 2621
Makdis, F. 2861
Makinen, M. 3276, 3281
Makke, A. 2490
Maksimochkina, T.I. 3168
Maksimovic, D. 2538
Malasky, A.R. 2423
Malesevic, M. 2564, 2685
Malik, B.S. 2760
Malik, MK. 2905
Malleshi, NG. 3435
Mallory Smith, C.A. 3220
Malokostova, E.I. 2739
Malorod, V.I. 2739
Maluszynski, M. 2734
Mamluk, O.F. 3117, 3125
Man Huimin 2622
Manera, GA. 3395
Manjaya, J.G. 2776
Mann, J.A. 3023
Manoharan, V. 2565
Marais, GJ. 3139
Marchetti, R. 3301
Mardokhi, W. 3024
Mardoukhi, V. 3025
Marechal, P.A. 3388
Marencik, A. 2714
Margiotta, B. 2740
Maric, S. 2966
Marinac, L.A. 2880
Marinkovic, B. 3299
Marinova, E. 2792
Marlett, J.A. 3461
Maroof, MAS. 2656
Marr, K.M. 2890
Marrs, R.H. 2577
Marshall, G. 3221, 3235
Marshall, GR. 2429
Marthe, F. 2738
Martin, C. 3277
Martin, C.R. 3425
Martin, G. 2761
Martin, JM. 2743
Martin, PK. 2641
Martin, R. 2762
Martin, RH. 2939
Martin, V.J. 2935
Martincic, J. 2966
Martinez, EJ. 3095
Martinsson, K. 3448
Masarova, K. 2714
Masbou, V. 2479
Masci, S. 2676
Massie, D.R. 2443
Matejovic, I. 2714
Mather, D.E. 2799
Mathiassen, S.K. 3222
Mathre, DE. 3083
Mathur, J. 2777
Matsumoto, H. 2946
Matsunaka, T. 2891
Matsuoka, Y. 2800
Matthews, J.M. 3226
Matthews, P. 2701
Matula, J. 2960, 3294
Maughan, PJ. 2656
Maumene, C. 3108, 3118
May, M.J. 2604
Maza Kersie 3348
Mcconkey, BG. 2465, 2466, 2491
McCrohan, C.R. 3000
Mcdonald, GK. 2551, 2563, 2924
McDonald, H. 3207
McFeeters, R.L. 2890
McGaughey, W.H. 3251
Mcintosh, RA. 2778
Mckenzie, RC. 2465, 2466
Mckillop, I.G. 3026
McKirdy, S.J. 3119
Mckirdy, SJ. 3120
McNeil, D. 2741
Mcneill, AM. 2892
Mcnulty, D. 2931
McVey, D.V. 2646, 2704
Mdadila, J.M. 2445
Mechergui, M. 2936
Medina Pitalua, J.L. 3218
Meeus Verdinne, K. 3302
Meinhardt, S.W. 3143
Mello Junior, A.V. 2594
Melo Filho, G.A. de 3096
Melz, G. 2686
Mench, M. 3303
Mendes Da Silva, C.E. 3419
Mendoza Zamora, Cecilio 3072
Menjivar, JA. 3427
Meredith, R.H. 3027
Merkulov, L. 2846
Mescia, A. 2935
Metodiev, M.V. 2893
Metwally, M. 3325
Meyer, N.L. 2437
Mi Guohua 2967
Michalet Doreau, B. 3277
Michaletdoreau, B. 3278
Michels, G.J. Jr. 3020
Michels, GJ. 3028
Michniewicz, J. 3331
Mikhajlova, S.A. 2480
Mikkelsen, M. 2494
Miklaszewska, K. 3223
Milevoj, L. 3041, 3047
Miller, A.J. 2913, 2914
Miller, DW. 3243
Miller, K.D. 3232
Miller, N. 2783
Miller, R.D. 2639
Miller, TE. 2663, 2779
Mills, BF. 2420
Mills, PF. 3177
Milosevic, M. 3103
Milosevic, N. 3299
Milovanovic, M. 2536, 2538, 2763
Milus, E.A. 3121
Minarcic, P. 3122
Mingeot, D. 2792
Minkov, D. 3320
Mirkamali, H. 3201, 3224, 3231
Mirkova, V.N. 2847
Mirshahi, A. 2896
Mirshahi, M. 2896
Mirzawan, P.D.N. 2682
Miyagawa, S. 2558
Miyashita, NT. 2769
Miyawaki, T. 2891
Mocquot, B. 3303
Moeini, M.R. 3123
Mohaghegh Neyshabouri, J. 3029
Mohanty, S. 2447, 2448
Moharramipour, S. 2764
Mohsin Iqbal, M. 2566
Moll, M. 3420
Molnarova, J. 2492
Momcilovic, V. 3181
Monleon, T. 3248
Monneveux, P. 2645
Montazeri, M. 3225
Montazeri, M.M. 3030
Moore, A. 3362
Moore, G. 2783
Moreno Galvez, Rodolfo 2807
Moreno Sevilla, B. 2646, 2704
Moreno, S. 3357
Morgan, D. 3023
Mori, S. 2765
Morita, N. 3349
Moriyama, M. 3197
Morrill, J.L. 3268
Morris, C.F. 2815
Morris, CF. 3421
Mortensen, L. 3467
Mossoba, M.M. 3363
Motta, CAP. 2894
Moughan, PJ. 3273
Moussaoui, M. 2425
Moustakas, M. 3187
Mozhaeva, K.A. 3124
Muenzing, K. 3350
Mujeebkazi, A. 2695
Mulat Demeke 2432
Mulholland, BJ. 3185
Mulla, D.J. 2623
Muller, HM. 3130
Munakata, A. 3464
Munchgarthoff, S. 2766
Munoz Orozco, Abel 2497
Murakami, T. 2882
Murata, S. 2764
Murdoch, A.J. 3228, 3241
Murkovic, M. 3364
Murphy, JJ. 3265
Murphy, P.A. 3463
Murphy, PJ. 3304
My Yiquan 2767
Nachit, M.M. 2645
Nadassky, S. 2435
Nagarajan, S. 2897
Nagel Held, B. 3422
Nair, RB. 2768
Nakagawa, N. 2887
Nakahira, Y. 2781
Nakaji, S. 3464
Nakamura, T. 3275
Nakamura, Y. 3197
Nakata, K. 3349
Nakatsu, S. 2895
Nakayama, A. 3373
Nanda, G.S. 3067
Nardi, S. 3270
Nasrolla Nejhad, S. 3011
Nato, A. 2896
Nauseh, Gh.H. 2728
Navvabi, A.R. 2493
Nazari, K. 3125, 3126
Negovanovic, D. 3447
Nejat Salari, A. 3127
Nelsen, TC. 3406
Nelson, E.B. 3112
Nelson, L.A. 2646, 2704
Nelson, S.O. 3455
Nemeth, LJ. 3258
Nenajdenko, G.N. 2567
Neuhaus, JM. 2766
Neus, O. 3315
Nevo, E. 2649, 2736, 2870, 3217
Newman, CW. 3259, 3386
Newman, RK. 3386
Newton, PJ. 2952
Ng, P.K.W. 3329, 3332, 3403, 3404, 3441
Ng, PKW. 3429
Nguyen, HT. 2950
Nicolas, ME. 3434
Nicolas, Y. 3415, 3423
Nielsen, G.C. 2500
Nielsen, G.C.N. 2501
Nielsen, K.A. 2494
Nielsen, K.V. 2477
Nielsen, P. 3128
Niemeyer, HM. 2957, 3005
Nietschke, B.S. 3226
Niggli, U. 2610, 3285
Nijenstein, J.H. 3003
Nikolov, G. 2597
Nimer, S.N. 2983
Ninane, V. 3302
Nishimoto, G. 3227
Nissila, E. 2805
Nitievskaya, V.I. 3133
Nogales, R. 3186
Noh, T.H. 2602
Nomura, T. 2895
Nooman, H.J. 2937
Noorbakhsh, S.H. 3031
Norwood, C.A. 2613
Norwood, CA. 2495
Novokhatka, V.G. 2830
Novokshonova, V.G. 3042
Nowicki, T. 3074
Nowicki, TW. 3398
Noye, G. 2422
Noziere, P. 3278
Obanni, M. 3424
Oberthur, L.E. 2657
Oconnor, BJ. 2702
Oehlen, E. 2938
Oestergaard, H.S. 2556
Ogata, N. 3437
Ognjanovic, R. 2538, 2763
Ohlander, L. 2496
Ohm, H. 2688
Ohsako, T. 2769
Ohta, M. 3464
Okhovat, M. 3149
Olesen, A. 2522
Olesen, J.E. 3204
Olsen, H.S. 3247
Omara, FP. 3265
Ordon, F. 2770
Oroumchi, S. 3032
Orr, J.P. 3227
Orsel, R. 3412
Ortega Delgado, Maria Luisa 3102
Osorio Alcala, Leodegario 2497
Oudejans, R.C.H.M. 3033
Ouyang Xirong 2771
Ouzounidou, G. 3187
Overthrow, R. 3052
Ozkaya, S. 3250
Pacheco Basurco, J.C. 2941
Pacheco, C.A. 2601
Pacin, A. 3095
Padole, V.R. 2598
Page, S.W. 3367
Pageau, D. 2498, 3297
Painter, K.M. 2623
Paiva, F. de A. 3096
Palladino, P. 2798
Pan Xuebiao 2624
Panara, F. 2898
Pande, P.C. 2897, 2906
Pandey, A.K. 2499
Panwar, J.D.S. 2906
Papastylianou, I. 2625
Papernik, L.A. 3180
Parada, J.L. 2941
Paradowski, A. 3223
Parfitt, R.L. 2565
Park, E.H. 2884
Parker, DR. 3188
Parker, L. 3228
Parr, J.F. 2617
Parry, DW. 3099
Parthier, B. 3100
Parton, KA. 2429
Partridge, G. 3457
Pasqualini, S. 2898
Pate, JS. 3309
Patel, S. 3368
Patil, M.N. 2539
Patrick, SK. 3074, 3075
Patridge, J.E. 3442
Patschka, G. 2660
Patterson, F. 2688
Patterson, L.M. 3152
Patterson, LM. 2972, 2973
Patterson, T.G. 2859
Patwary, S.U. 3314
Pauk, J. 2528

Paulin, J. 2899
Paulley, FG. 3258
Paveley, ND. 3129
Pavlovic, M. 2763
Pavoni, A. 2740
Pawlowska, J. 3229
Payne, PI. 2779
Payton, ME. 2512
Pecetti, L. 3176
Peden, G. 3374
Pedersen, J.B. 2500, 2501
Pedersen, J.F. 3425
Pedersen, J.R. 3365, 3366
Peeper, T.F. 2470
Pelikan, M. 2626
Pellet, D.M. 3180
Peltonen, S. 2727
Pender, M.K. 3367
Penrose, LDJ. 2939
Penson, SP. 2968
Perata, P. 2868
Perello, A.E. 3151
Perenzin, M. 2662
Perez de Ciriza, J.J. 3238
Perkowski, J. 3130
Perondi, N.L. 3131
Persson, L.I. 3247
Petersen, J. 2568, 3295
Petersen, P.H. 2500
Peterson, C.J. 2646, 2704, 2993
Peterson, DM. 3279
Peterson, EWF. 2447, 2448
Peterson, G.L. 3067
Petkolicheva, K. 2808
Pettersson, T. 3448
Pfannhauser, W. 3364
Phillips, J.G. 3067
Phirke, P.S. 2539
Picinini, E.C. 3132
Pickett, JA. 3005
Pilosof, A.M.R. 3357
Pinchak, W.E. 3266
Pinto, P.A. 2601
Piskun, S.G. 3133
Platford, RG. 3075
Podsiadlo, C. 2483, 2484, 2557, 2595, 2596, 2599, 3230
Pogna, NE. 3429
Pogorilaya, E.V. 3182
Poliksenova, V.D. 3133
Polo, A. 3186
Ponce Gonzalez, Francisco 3072
Popineau, Y. 3415, 3423
Popova, L.P. 2893
Popovic, A. 2763
Porceddu, E. 2676
Porter, L.K. 2615
Porter, L.L. 3426
Portmann, P.A. 2699
Possenti, JC. 3298
Postolatii, A. 2801
Postolatii, A.A. 2797
Poulson, M. 3328
Pourmansouri, T. 3134, 3135
Powell, A.L. 3034
Powell, W. 3005
Powles, S.B. 3226
Prabhu, K.V. 2755
Prakash, V. 2499
Prasad, K. 2499, 2502
Praslicka, J. 3136, 3137
Pratchett, N. 2655
Prehn, D. 2706
Preston, KR. 3258
Pribakovic, M. 3103
Proft, M. de 3138
Prokhorova, S.V. 3035
Provenza, FD. 3269
Prusakova, L.D. 2503
Przulj, N. 2564
Psomiadou, E. 3373
Pugh, B.D. 3026
Pujola, M. 3248
Pukhalskaya, NV. 2940, 3189
Puolimatka, M. 2528
Puterka, G.J. 2995
Qi Shiyu 2772
Qin Suichu 3190
Qualset, CO. 3176
Que Daoming 2606
Querou, R. 2969
Quick, J.S. 2773
Qureshi, AA. 3279
Rabie, CJ. 3139
Radjabi, Gh. 3036
Radje, M.E. 3209
Radmehr, M. 2504
Radovic, D. 3194
Ragab, RA. 2656
Ragasits, I. 2853
Raghavan, G.S.V. 2540
Rahi, G.S. 3039
Rahimian, H. 3140
Rai, B. 2726
Raikhel, N.V. 2874
Rajaram, S. 2695, 3090
Rakoczytrojanowska, M. 2523
Rakowska, M. 2675
Ram, D. 2502
Ramkumar, DHS. 3427
Ramon Lopez, J. 2774
Rana, R.K. 2775
Randall, GW. 2478
Ranhotra, G.S. 3428
Rank, B. 2873
Rao, A. 2529
Rao, K.S. 2621
Rao, SV. 3435
Rasanen, J. 3351
Rasiah, V. 3307
Rasmussen, C.B. 2876, 2900
Rasmussen, G. 3204
Rasmussen, J. 2568
Rasmussen, K. 2568
Rasmussen, K.J. 2475
Rastergari Nobandegani, N. 3037
Ratajczak, P. 3331
Rath, M. 3265
Rathjen, A.J. 3347
Rathmann, O. 3253
Ratnasiri, W.G.A. 2682
Raun, W.R. 2584
Raun, WR. 2455, 2555, 2926
Raut, S.K. 2776
Ravaglia, S. 3330
Raven, JA. 2588, 2870, 3193
Raymer, P.L. 2680
Razavi, M. 3231
Readman, R.J. 2569
Ready, D.E. 3367
Redaelli, R. 3429
Reed, D.K. 2994
Reeves, T.G. 3226
Reffstrup, T. 3260
Regasa Ensermu 2436
Reich, V.H. 2639
Reichel, C. 2777
Reid, RJ. 2953
Reilly, C. 3377
Reis, E.M. 3141
Reis, R.A. 3453
Reiss, B. 2777
Rekoslavskaya, NI. 2970
Ren Yongxing 2467
Ren, SX. 2778
Renwick, JAA. 3017
Resnais, A. 3142
Resnik, SL. 3095
Rettori, C. 3419
Rezabeigi, M. 3038
Rhee, C.O. 3352
Rhinhart, KEL. 2972
Rich, J.R. 3039
Richards, R.A. 2881
Richetti, A. 3096
Riechers, D.E. 3232
Riechers, DE. 3233
Riede, C.R. 3143
Riffaldi, R. 2571
Rimar, J. 2505
Rinconzachary, M. 2971
Rinzema, A. 3356
Rizzo, V. 3287
Roach, J.A.G. 3363
Roach, R.R. 3353, 3354
Roberts, J.J. 2724, 2725, 3162
Robertson, E.J. 2901
Robertson, JA. 3462
Robinson, D. 2870, 3193
Robison, M.H. 2437
Rodrigues, GC. 2600
Rodrigues, L.R. de A. 3453
Rodriguez Caceres, E.A. 2941
Rodriguez Contreras, E. 3144
Rodriguez Perez, Juan Enrique 2497
Rodriguez, A. 2506
Rodriguezramos, R. 2695
Roessing, AC. 2486
Rogers, JL. 2455
Rogers, WJ. 2779
Romero, RL. 3028
Romin, N. 2940
Rosa, B. 3453
Rosenberger, C.A. 2635
Ross, I.J. 3283
Rossnagel, BG. 3375
Rottinghaus, G.E. 3282
Rouau, X. 3416
Rouchaud, J. 3315
Roy, M. 2484
Rozynek, B. 2872
Rubenis, J. 2603
Rubenthaler, GL. 3421
Rubin, B. 2736, 3217
Rubow, T. 2422
Ruckenbauer, P. 2660
Rumbo, M. 3355
Ruza, A. 2507, 2508
Ruzgas, V. 2533
Ruzic, D. 3447
Ryden, P. 3462
Saarikko, RA. 2839
Saberi, H.K. 3225
Sabova, M. 3160
Sadeghee, M. 3040
Sadkovskij, V.E. 3054
Saini, HS. 2977
Sakano, K. 2933
Sakurai, A. 3436
Sakurai, N. 2887, 2909
Salamini, F. 3378
Salamun, M. 3041
Sales, J. 3271
Salmeron, JJ. 3098
Salmon, D.F. 2707, 2708, 2709, 2710
Salomonsson, AC. 2585
Salomonsson, L. 2585
Salyaev, RK. 2970
Samardjieva, K. 2792
Samersov, V.F. 3042
Sammons, D.J. 2780
Samofalova, N.E. 2735
Samu, F. 3046
Samuels, TD. 2971
Samuelson, M.E. 2942
Sandini, I. 2438
Sanford, P. 3309
Santos, H.P. dos 2438, 2627
Sapirstein, H.D. 3389, 3394
Sardi, K. 2902
Sarkar, A. 2570
Sarrafi, A. 3333, 3392
Sasek, A. 2903
Sato, K. 2764
Satoh, J. 2781
Satumbaga, R.F. 3366
Satyanarayana, V. 3323
Saulnier, L. 3430
Saviozzi, A. 2571
Savitch, LV. 2943
Sawkins, D. 2457
Saxena, K.G. 2621
Sayers, EJ. 2779
Sayre, RN. 3414
Schaar, W. van der 3090
Schachermayr, G. 2782
Schachtman, D.P. 2741
Schade, J.R. 3257
Schaich, K.M. 3338
Schapaugh, WT. 2614
Schell, J. 2777
Scherrer, D. 3285
Schieberle, P. 3399
Schiemann, A. 2770
Schimmelpfennig, D. 2798
Schmidt, J.W. 2646, 2704
Schneider, AD. 2572
Schneider, S.A. 2423
Schnug, E. 3296
Schofield, J.D. 3249, 3397
Schofield, JD. 3439, 3440
Schonbeck, M. 2509
Schreiber, L. 2979
Schropp, P. 3431
Schumacher, U. 3130
Schuurink, RC. 2968
Schwab, C.V. 3283
Schwartz, S.J. 2444
Schwarzacher, T. 2783
Sciazko, D. 2596
Scofield, A.M. 2550
Scoles, GJ. 2768
Scott, TA. 3280
Scrimgeour, CM. 2870
Sechkin, A.D. 2513
Seefeldt, S.S. 3234
Seekings, JA. 2779
Seguchi, M. 3432
Seguin, B. 3145, 3146
Seib, P.A. 3358, 3359
Seibel, W. 3390, 3393
Selles, F. 2465, 2466
Sells, J. 3246
Semeane, Y. 2742
Semenov, MA. 3191, 3196
Sempruch, C. 2998
Seog, H.M. 3345
Sepahvand, N. 2809
Serbin, A.A. 3473
Sereno, M.J.C. de M. 3178
Sesek, P. 2510
Seyoum Bediye 3445
Sfredo, GJ. 2486
Shah, D.M. 2635
Shahmoradi, S.J. 2784
Shamsi, SRA. 2918
Shan Yushan 2628
Shanbanovich, N.N. 2480
Shaner, G. 3061
Shang Hongsheng 3147
Shapiro, B.I. 2432
Sharet, N. 3444
Sharifi Tehrani, A. 3148
Sharifi Tehrani, M. 3149
Sharma, P. 3305
Sharma, S.K. 2629
Sharma, VK. 2529, 2904, 2905
Shashi Madan 2775
Shatilov, I.S. 2573
Shaukat, S.S. 3018
Shaw, A. 2875
Shayesteh, N. 3043
Shelton, CW. 2973
Shelton, D.R. 2646, 2704, 3442
Shen A'lin 2574
Shen Xiaorong 2785
Shen, Q. 2786
Sheng Baoxin 3150
Sheng Chengshi 2964
Shepherd, K.W. 3347
Shepherd, M.A. 2604
Sheppard, J.A. 2671
Shetty, PK. 2944
Shevchenko, V.A. 2513
Shewry, P.R. 2787
Shewry, PR. 3433
Shi Lei 3044
Shibanova, L.A. 2970
Shideed, K.H. 2575
Shiina, T. 2781
Shimokawa, S. 3197
Shinnick, F.L. 3461
Shukla, A. 3234
Shukla, D.S. 2906

Shukle, RH. 2821
Sibiryakova, T.V. 2567
Siddiqui, S.H. 2566
Sieling, K. 2576
Siljanderrasi, H. 3276, 3281
Simard, R.R. 3297
Simeone, M. 2676
Simon, M.R. 3151
Sindzhorgo, K.M.S. 2975
Singh Cundy, A. 2849
Singh, J.P. 2629
Singh, P. 2499, 2502
Singh, R. 3254, 3255
Singh, S. 3235
Singh, S.B. 2788
Singh, U. 3408
Singh, YD. 2857
Sinkovic, T. 2737
Siqueira, O.J.W. de 2627
Skovmand, B. 2694
Skriver, K. 2642
Slaski, JJ. 3199
Smathers, R.L. 2437
Smeets, E. 2980
Smiley, R.W. 3152
Smiley, RW. 2972, 2973
Smit, E. 3306
Smith, C. 2638
Smith, DB. 2448
Smith, FA. 2953
Smith, G. 2473
Smith, G.P. 2907
Smith, H.M.S. 2874
Smith, JL. 3318
Smith, P.N. 2442
Smith, S.J. 2914
Smith, SE. 3304
Smits, JP. 3356
Smolinski, S. 3385
Smulewich, G. 2900
Snaar Jagalska, B.E. 2885
Snane, M.H. 2936
Snape, JW. 2736
Snaydon, RW. 2464
Snijders, CHA. 2523
Snow, C.S.R. 2577
Soave, D. 2789
Soegaard, H.T. 3256
Soerensen, H. 3247
Sokhey, A.S. 3340
Solano, W.M.R. 3419
Solie, J. 2512
Solie, J.B. 2470
Song Shuyun 3044
Song Zhihong 2790
Song Zhiwei 2945
Sorensen, J. 3128
Sorokin, A. 2738
Sorrells, M.E. 2645
Sosulski, F.W. 3369
Sosulski, FW. 3341
Soto, J. 3186
Souici, D. 3320
Sowa, W. 2791
Sowell, BF. 3261
Spallacci, P. 3301
Spetsov, P. 2792
Spiess, E. 2610
Spurlock, SR. 2426
Srivastava, S. 2804
Srivastava, V. 2640
St Pierre, C.A. 2706
Staben, ML. 3318
Stack, M. 2773
Stafford, J.V. 2487
Stankov, L 2793
Stankowski, S. 2965
Starcevic, Lj. 2564
Staver, L.P. 2794
Steele, J.L. 3425, 3443
Steenfeldt, S. 3267
Steffe, J.F. 3329
Steffenson, B. 2706
Steiger, W. 3247
Steinberga, V. 3056
Steiner, W. 3364
Stelluti, M. 3287
Stendahl, F. 2496
Stephan, Z.A. 2983
Stephenson, M.M.P. 2540
Steppuhn, H. 2511, 3307
Stevens, RR. 3077
Stewart, W.M. 2707, 2708, 2709, 2710
Steyer, S. 3138
Sticksel, E. 2578
Stobbe, E.H. 2866
Stockton, RD. 2512
Stoilov, L.M. 2847
Stojanovic, Lj. 3447
Stojanovic, S. 2763
Stone, PJ. 3434
Stopes, C.E. 3241
Stopes, CE. 2464
Storkey, J. 3207
Story, J.A. 3461
Stover, R.W. 3153
Strid, H. 2934
Strong, WM. 3316
Stuchlikova, E. 3062
Stupnicka Rodzynkiewicz, E. 3236
Subhadra Madan 2775
Sugawara, K. 3464
Sugimoto, T. 3352
Sullivan, CY. 2949, 2950
Sumathi, A. 3435
Sumner, MJ. 3080
Sun Benpu 2630
Sun Guangzu 2795
Sun, R. 3456, 3459
Sundheim, L. 3449
Suominen, M. 2805
Surma, M. 2637, 3053
Suzuki, Y. 3436
Svicek, F. 3319
Svihus, B. 3259
Svircev, Z. 3308
Svoboda, P. 2960
Swarup, A. 3305
Sykora, M. 3154
Sylvester Bradley, R. 3026
Sylvesterbradley, R. 3129
Szabova, T. 2836
Tabori, K. 3444
Tajnsek, A. 2899
Takeda, K. 2887, 2909
Takemoto, J. 3101
Talbert, LE. 2743, 2978
Tamm, Ue. 2796
Tan Jianan 2834
Tanaka, C.K. 2717
Tanasijtshuk, V.N. 3045
Tandon, J.P. 2760
Tang Borang 3155
Tang Yulan 3156
Tanksley, S.D. 2645
Tao, HP. 3050
Taran, M.G. 2797
Tardy, F. 2929
Tarr, A.W. 2700
Tasistro Souto, A. 3218
Tatham, A.S. 2787
Tatham, AS. 3433
Taye Bekele 2579
Taylor, GJ. 3199
Taylor, SL. 2455
Teeri, TH. 2727
Terebiznik, M.R. 3357
Tereshchuk, V.S. 3237
Tersboel, M. 2631
Terui, H. 3268
Tesfaye Getachew 2692, 2703
Thirtle, C. 2798
Thomas, J. 3129
Thomas, J.B. 2993
Thomas, R. 3131
Thomashow, LS. 3068
Thompson, C.R. 2613
Thordal Christensen, H. 2916
Tichtinsky, G. 2896
Tiebas, M.A. 3238
Tillman, R.W. 2565
Timoshenko, M.K. 3133
Tinker, N.A. 2799
Tkachuk, R. 3398
Todorova, M. 3157
Tokes, G. 3239
Toma, M. 3056
Tones, S.J. 3023
Torabi, M. 3094, 3158
Torres Vila, L.M. 2991, 2992
Toth, A. 3159
Toth, F. 3046
Toth, I. 3046
Toyosawa, I. 3349
Toyoshima, Y. 2781
Tozzi, L. 3383
Tramper, J. 3356
Travis, R.L. 2851
Trdan, S. 3047
Tremblay, GF. 2498
Trenkovski, S. 3447
Tret'yakov, N.N. 2513
Trevors, J.T. 3306
Trigo Stockli, D.M. 3365, 3366
Tripathy, B.C. 2908
Troccoli, A. 3335
Trucksess, M.W. 3363, 3367
Trunova, TI. 3192
Tsiren', V.F. 3202
Tsonev, T.D. 2893
Tsumuki, H. 2764
Tsunewaki, K. 2800
Tsurusaki, K. 2909
Tucci, GF. 2740
Tumans, V. 3240
Tuncer, T. 3339
Tuori, RP. 2668
Turchetta, T. 2740, 3330
Turk, J.R. 3282
Turner, W.J. 3006, 3007
Tuubel, E. 3048
Ubavic, M. 3299
Ullrich, SE. 2705
Ulrich, DJ. 2491
Umbarkar, S.P. 2539
Unger, P.W. 2514
Unkovich, MJ. 3309
Uno, K. 3437
Untila, I. 2801
Upite, D. 3344
Uppal, S. 2677
Uramoto, M. 3436
Urban, M. 3200
Uri, N.D. 2449, 2450
Utriainen, M. 2727
Uzunova, V. 2847
Vadlamani, K.R. 3358
Vadon, B. 3320
Valaja, J. 3281
Valcke, R. 2863
Valery, P. 2843
Valocka, B. 3160
Van Bekam, E.M. 2975
Van Cleemput, O. 2580
Van Leur, Joop 2474, 2802
Van Zejl, M.Dzh. 2975
Vanags, I. 3240
Vandenboogaard, R. 2910
Vanginkel, M. 2695
Vankovaradeva, RV. 3192
Vanleur, JAG. 2742, 3161
Vanni, G. 2571
Vanoort, M. 3384
Vansonsbeek, HM. 3356
Vanvuuren, HJ. 3139
Vanvuuren, MMI. 3193
Vapa, Lj. 2932, 3194
Varshney, A. 2529
Vasanthan, T. 3438
Vasil'eva, T.Ya. 3124
Vasil, I.K. 2640
Vasil, V. 2640
Veiga, L. 2935
Veneklaas, EJ. 2910
Vensel, WH. 2803
Vergara, M. 2868
Verjux, N. 2619, 2632, 2633
Verma, M. 3174
Verma, R.P.S. 2755
Verschoor, A. 2804
Veselov, SU. 2863
Vetelainen, M. 2805
Vettraino, A.M. 3300
Viesturs, U. 3056
Vigants, A. 3344
Vignier, L. 3320
Villalba, JJ. 3269
Villamide, M.J. 3451
Villand, P. 2806
Villasenor M, E. 3144
Villasenor Mir, Hector E. 2807
Villela, FA. 3298
Vinogradova, S.B. 3469
Virgula, A. 3116
Vishwanatha, S. 3435
Vitellozzi, F. 2674
Vivar, H. 2706
Vizarova, G. 3468
Vladova, R. 2808
Vojdani, P. 2809
Volkmar, KM. 2974
Voluevich, E.A. 3114
Voncramontaubadel, S. 2451
Vong, M. 2975
Vothknecht, U.C. 2810
Vroemen, S.F. 3033
Wada, M. 2600
Wadhams, LJ. 3005
Waga, J. 2811
Waggoner, M. 2990
Wagner, GM. 2581
Wagner, P. 3382
Wahlgren, M. 3324
Wakabayashi, K. 2911, 2912
Walburger, AM. 2427
Walker, D.J. 2913, 2914
Wall, K. 3307
Wall, KG. 2511
Walter, A.M. 3203
Walters, K.F.A. 3023
Wan Anmin 3073
Wang Bingkui 2515
Wang Caibin 2582
Wang Fahong 2516
Wang Futing 2823
Wang Guangjin 2795
Wang Guisheng 3165
Wang Guixue 2812
Wang Heqing 2583
Wang Huaxin 2947
Wang Jinsheng 2915
Wang Lianquan 3049
Wang Shi'en 2772
Wang Shuanma 3071
Wang Wenmei 2813
Wang Yong 2630
Wang Yunbing 3049
Wang Yunhua 3195
Wang Zhenlin 2517
Wang Zhong 2848
Wang, GZ. 2769, 2800
Wang, L. 3359
Wang, M. 2885
Wang, ML. 2783
Wang, XJ. 3310
Wang, XL. 2917
Wanner, G. 2762
Wannerberger, L. 3324
Ward, RW. 2730
Wasie Haile 2984
Wasternack, C. 3100
Watanabe, Y. 2891
Watson, C.A. 2612
Watts, RJ. 2701
Webster, J.A. 2995
Weegels, PL. 3439, 3440
Wehling, R.L. 3442
Weinberg, ZG. 3444
Weining, S. 2713
Welinder, K.G. 2721, 2876, 2900
Weller, DM. 3068
Wellso, S.G. 2995
Welsh, J.P. 3241
Wennig, R. 3227
Wesenberg, D.M. 2659
Wesley, RA. 2426
West, D.R. 2639
Westfall, D.G. 2584, 3465
Wettstein, D. von 2810, 2814
White, F.C. 2424
White, G.M. 3283

Whitelaw, MA. 3311
Wichman, D. 2657
Wiese, M.V. 2446
Wieser, H. 3431
Wilde, G.E. 3021
Wilkinson, R.E. 3162
Williams, AC. 3368
Williams, M. 2901
Williams, M.S. 3262
Williamson, G. 3462
Williamson, L. 3193
Wilson, A.D. 2999
Wilson, RG. 3098
Wisniewska, H. 3053
Wivstad, M. 2585
Wlodek, S. 2605
Wolf, J. 3191, 3196
Wolf, S.A. 2437
Wolters, A.C. 3306
Wondimagegnehu Seyoum 2421
Wong, J.H. 3252
Wood, G.E. 3367
Wood, GM. 3368
Worland, AJ. 2956
Worrall, N.J. 3266
Worrall, W.D. 3266
Worthington, S.T. 3441
Wrigley, C.W. 2815, 3327, 3374
Wu Guangjun 2996
Wu Guiben 3104
Wu Xidong 2816
Wu Xunzhi 3163
Wu Yunying 2962
Wu Zhenlu 2817
Wu, SL. 3398
Wu, Y. 2868
Wyse, DL. 3243, 3244
Xia Peizhen 2586
Xiao Zhimin 2772
Xie Fenggen 2518
Xie Shuixian 3164
Xu Budong 2840
Xu Renlin 2785
Xu Xuexuan 2560
Xue Xi 2818
Yaduraju, N.T. 3242
Yagodin, B.A. 3469
Yamaguchi, J. 2868
Yamamoto, H. 3332, 3403, 3404, 3441
Yamashita, K. 2946
Yan Huijun 2587
Yan Sibai 2666
Yaneva, IA. 3192
Yang Jiashu 2819
Yang Li 2820
Yang Shizhang 3044
Yang Yanjie 3165
Yang Zhimin 2997
Yang, G. 3442
Yang, J. 2916
Yang, K. 3233
Yao Qingxiao 3166
Yau, SK. 2519
Yazaki, Y. 2933
Yenish, JP. 3243, 3244
Yeshanew Ashagrie 2454, 2579
Yin, ZH. 2588
Yitbarek Semeane 3089, 3167
Yoshida, M. 3197
Young, D.L. 2623
Yu Fangyi 2976
Yu Guuohua 2622
Yu Quanlin 2819
Yuan Guohui 2997
Yuan Xiaoliang 2889
Yuan Zhenge 2589
Yunis, S. 2689
Yureva, OV. 2970
Zabozlaeva, L.D. 3168
Zairi, M. 3320
Zakonovic, M. 3447
Zamani Zadeh, H.R. 3169, 3170
Zamaraev, A.G. 2573, 3469
Zanini, W. 2852
Zantoko, L. 2821
Zarea Nasr abadi, R. 3171
Zatkalikova, T. 3468
Zayas, I.Y. 3443
Zbiec, I.I. 3215
Zecevic, V. 2822
Zeece, M.G. 3442
Zejnalov, A.A. 2841
Zelenakova, E. 3468
Zemann, A. 3458
Zemede Asfaw 2520
Zemetra, R.S. 3220
Zeng Hanbing 2524, 2530
Zentner, RP. 2465, 2466
Zewdu Yilma 2454, 2456
Zhan Kekui 2823
Zhan Shumin 2622
Zhang Aimin 2824, 3198
Zhang Baomin 2630
Zhang Caomei 2532
Zhang Chaomei 2531
Zhang Guangwang 3085
Zhang Guoping 2521
Zhang Huaiyu 2947
Zhang Hui 3147
Zhang Meirong 2996
Zhang Mingkui 2590
Zhang Ping 2976
Zhang Qinghui 2840
Zhang Shaonan 2825
Zhang Shigui 2606
Zhang Shuming 2634
Zhang Shuxiang 3073
Zhang Wenjun 2826, 2827
Zhang Wumin 2591
Zhang Xiangqi 2828
Zhang Xingzi 2532
Zhang Xiurong 2618
Zhang Yunhua 3173
Zhang Yuwen 2976
Zhang Zaijun 2531, 2532
Zhang Zhitian 2607
Zhang, GC. 3199
Zhang, NY. 3050
Zhang, P. 2786
Zhang, Z. 2916
Zhao Miaozhen 2515
Zhao Yufang 2829
Zheng Lianzhi 3173
Zhirov, E.G. 2678
Zhivotkov, L.A. 2830
Zhogin, A.F. 2831
Zhong, G.Y. 2687
Zhou Guoshun 3172
Zhou Peng 2888
Zhou Shiming 3078
Zhu Dehui 3472
Zhu Jinbao 2832
Zhu Muyuan 2833
Zhu Peili 2608
Zhu Wenzhen 3155
Zhu Xiaoda 2812
Zhu Zhiyu 3071
Zhu, CY. 2892
Zhuping, Y. 3090
Zimmermann, C. 2686
Znidarsic Pongrac, V. 2548
Zolghadr, M. 2493
Zrubec, F. 3319
Zuev, E.V. 3473
Zujovic, M. 3447
Zuo Yuhu 3173
Zwer, P.K. 2993
Zyablitskaya, E.Ya. 2841

1,3/1,4 BETA D GLUCAN 2887
15 ACETYLDEOXYNIVALENOL 3074
2 ACETYL 1 PYRROLINE 3399
2 LUTEOVIRUSES 3107
2' DEOXYMUGINEIC ACID 2882
2,4 D 3212, 3227
3 HYDROXY 3 METHYLGLUTARYL COENZYME 3279
4X TRITICALE FORMS 2808
5 (12 HEPTADECENYL) RESORCINOL 3436
5 ALK(EN)YLRESORCINOL 3436
5' FLANKING REGION 2638
5S 2663
7 ALPHA HYDROXYLASE 3279
A GENOME 2662, 2858
ABA 2527, 2717, 2786, 2862, 2875, 2885, 2975
ABDOMINALIS 2990
ABILITY 2821
ABSCISIC ACID 2911, 2949
ABSCISIC ACID CONTENT 2974
ABSOLUTE 3028
ABSORPTION 2717, 2829, 2862, 3272, 3273, 3276
ABUTILON THEOPHRASTI 2902
ACCELERATED DEGRADATION 3315
ACCEPTANCE 3261
ACCUMULATION 2727, 2781, 2949, 2953, 3100, 3188
ACERIA TULIPAE 2993
ACETATE 3269
ACETIC ACID 2571, 3389
ACETYLENE INHIBITION 3301
ACETYLENE REDUCTION 2581
ACID 2686, 2971, 3100
ACID BASE BALANCE 2588
ACID HYDROGEN PEROXIDE 3398
ACID PHOSPHATASE 2898
ACID SOILS 3309
ACIDIC SOIL 3192
ACIDIFICATION 2862
ACIDIFYING AGENT (WASTEWATER FROM OLIVE OIL PROCESSING) 3186
ACREMONIUM 2999
ADAPTATION 2665, 2728, 2867
ADDITION AND SUBSTITUTION LINES 2792
ADDITIVE MODEL 3243
ADENOSINE DIPHOSPHATE 2806
ADIPOKINETIC HORMONES 3033
ADJUSTMENT 2950
ADJUVANTS 3200, 3238
ADONIS 3201
ADSORPTION 3289, 3324, 3412
ADULTS 3461
AEGILOPS 2858
AEGILOPS CYLINDRICA 3220
AEGILOPS SPELTOIDES 2678
AEGILOPS UMBELLULATA 2663, 2792
AEGILOPS VARIABILIS 2792
AELIA 3248
AERATION 2485, 3245
AERIAL PARTS 2546
AESTIVUM 2641
AETIOLOGY 2680, 3055, 3086, 3153, 3158
AFGHANISTAN 2535
AFLATOXINS 3365
AFRICA 3313
AGAR 3106
AGE 3273
AGING 2534
AGRICULTURAL DEVELOPMENT 2621
AGRICULTURAL ECONOMICS 2430
AGRICULTURAL POLICIES 2623
AGRICULTURAL PRODUCTS 2423
AGRICULTURAL RESEARCH 2420
AGRICULTURAL RESOURCES 2636
AGRICULTURE 2431
AGROBACTERIUM 2522
AGROBACTERIUM TUMEFACIENS 2754
AGROECOSYSTEMS 3318
AGROFORESTRY 2962
AGROMYZIDAE 3008
AGRONOMIC CHARACTERS 2461, 2504, 2524, 2644, 2645, 2646, 2651, 2652, 2653, 2654, 2657, 2658, 2659, 2680, 2704, 2706, 2707, 2708, 2709, 2710, 2718, 2724, 2725, 2735, 2739, 2744, 2761, 2773, 2780, 2784, 2785, 2795, 2817, 2830, 2831
AGRONOMIC COMPARISONS 2956
AGRONOMIC PERFORMANCE 2805
AGRONOMY 2454, 2456, 2712
AGROPYRON 2641, 2695
AGROSTIS STOLONIFERA 3112
AGROTIS SEGETUM 2985
AIR 3174, 3350
AIR FLOW 3245, 3346
AIR TEMPERATURE 2534, 2848, 2864
AL 3+ 3199
ALANINE 3325
ALBANIA 2430
ALBERTA 2707, 2708, 2709, 2710
ALBINISM 2522
ALBUMINS 2875, 3325, 3394, 3417
ALCOHOL DEHYDROGENASE 2868
ALCOHOLS 3409
ALDEHYDES 2810
ALDICARB 2469
ALEURONE 2701
ALEURONE CELLS 2714, 2786, 2854, 2862, 2867, 2875, 2885, 2963
ALFALFA 2544
ALGAE 2733
ALGERIA 3212
ALGINATES 3306
ALKALI SOIL 3305
ALKALI TREATMENT 3265, 3451
ALKALINITY 3459
ALKALOIDS 3022
ALKYLRESORCINOLS 3436
ALLELIC VARIATION 2740, 3415, 3429, 3433
ALLELOCHEMICALS 3022
ALLELOPATHY 3022
ALLIUM CEPA 2505
ALLIUM PORRUM 3304
ALLOPLASMIC LINES 3053
ALNUS GLUTINOSA 2669
ALOPECURUS MYOSUROIDES 3206, 3207
ALPHA AMYLASE 2701, 2875, 2907, 2975, 3357, 3437
ALPHA AMYLASE ACTIVITY 2895
ALPHA AMYLASE GENE 2701
ALPHA SUBUNIT 2896
ALTERNARIA 3095
ALTERNARIA ALTERNATA 3172
ALTERNATIVE AGRICULTURE 2617, 2623
ALTITUDE 2621
ALUMINIUM 2565, 2590, 2934, 3178, 3180, 3190
ALUMINUM 3199
ALUMINUM TOLERANCE 2971
AMARANTHUS 2902
AMERICA 2691
AMIDES 3232, 3325
AMINO ACID DIGESTIBILITY 3454
AMINO ACIDS 2531, 2586, 2747, 2862, 2928, 2998, 3277, 3326, 3454
AMINOTRANSFERASE 2928
AMMONIA 2573, 2588
AMMONIA LYASE 2727
AMMONIA VOLATILIZATION 2892, 3310
AMMONIUM 2588
AMMONIUM COMPOUNDS 3263
AMMONIUM FIXATION 2573
AMMONIUM NITRATE 2488, 2577, 2588, 2902
AMMONIUM SULPHATE 2902
AMYLASE 3402
AMYLASE ACTIVITY 3278
AMYLASES 2670, 2907
AMYLOLYTIC ACTIVITY 3278
AMYLOLYTIC ENZYMES 2768
AMYLOPECTIN 3334
AMYLOSE 2768, 3334, 3341, 3354, 3359, 3438
AMYLOVORUS 3402
ANABAENA 3308
ANABAENA SYMBIOSIS 2581
ANABOLISM 2947, 2976
ANAEROBIOSIS 2868
ANALYSIS FIA METHOD 3420
ANALYTICAL METHODS 2443, 2741, 2890, 3248, 3294, 3324, 3345, 3363, 3379, 3380, 3393, 3419, 3425
ANALYZER 3421
ANATOMY 2846, 2977
ANCESTRY 2645
ANDROGENESIS 2528
ANEUPLOIDY 2783
ANGUINA TRITICI 2983, 3011
ANIMAL ECOLOGY 2982, 2986, 3024, 3029, 3038
ANIMAL FEEDING 3264, 3267, 3268, 3270, 3452
ANIMAL HUSBANDRY 3270
ANIMAL MORPHOLOGY 2986, 3038
ANIMAL NUTRITION 3267
ANIMAL PERFORMANCE 3266
ANIMAL TISSUES 3398
ANOXIA 2868
ANTAGONISM 3021
ANTENNA SIZE 2929
ANTHER 2523, 2977
ANTHER CULTURE 2526, 2528, 2530, 2531, 2532, 2661, 2771
ANTHERS 2531, 2771
ANTHROPOGENIC SOILS 3112
ANTIBODIES 2874, 3107
ANTIDOTES 3233
ANTIFEEDANTS 2994
ANTIFREEZE PROTEINS 2850
ANTIFUNGAL ACTIVITY 2766, 3128
ANTIFUNGAL PROPERTIES 3101
ANTIFUNGAL PROTEINS 3050
ANTIGEN ANTIBODY REACTIONS 3397
ANTINUTRITIONAL FACTORS 3255
ANTIOXIDATION 3381
APHELINIDAE 2989, 2990
APHELINUS 2981
APHELINUS ALBIPODUS 2990
APHID SCHIZAPHIS GRAMINUM 2957

APHIDIDAE 2988, 2990, 3002, 3009, 3023, 3028
APHIDIUS 3005
APHIDOIDEA 2996, 3001, 3037
APHIDOPHAGOUS 3028
APHIDS 3120
APICAL MERISTEMS 3182
APICES 2971
APOPLAST 2650, 2850
APPARENT METABOLIZABLE ENERGY 3280
APPLICATION METHOD 2568
APPLICATION METHODS 2560, 2573, 3195, 3203, 3465
APPLICATION RATES 2483, 2484, 2536, 2538, 2546, 2553, 2557, 2562, 2573, 2574, 2583, 2584, 2595, 2596, 2599, 2864, 2902, 3018, 3039, 3119, 3203, 3223, 3227, 3230, 3235, 3465
APPRESSORIUM FORMATION 3080
ARABIDOPSIS 2656
ARABIDOPSIS THALIANA 2777, 2806, 2896, 2904, 2909, 3304
ARABINOGALACTAN 3430
ARABINOXYLAN 3430
ARABINOXYLANS 2850, 3384, 3416
ARACHIS HYPOGAEA 2467, 2582, 2620
ARANEAE 3048
ARBUSCULAR MYCORRHIZAE 2944
ARBUSCULAR MYCORRHIZAL FUNGI 3311
AREA OF INFLUENCE 3243
ARENARIUS 2641
ARGENTINA 2759, 2774, 2941, 3151
ARGININE DECARBOXYLASE (ADC) 2917
ARID SOILS 2615
ARM 2691
ARMENIA 2993
ARRESTIN 2896
ARTHROPODA 3019, 3031
ARTIFICIAL DIETS 3017
ASCORBIC ACID 2670, 3343
ASCSY 3243, 3244
ASHES 3335, 3366, 3393
ASIA 3313
ASPARTIC ACID 3325
ASPERGILLUS CLAVATUS 3361
ASPERGILLUS NIGER 3325, 3462
ASPERGILLUS ORYZAE 3357
ASPERGILLUS TERREUS 3325
ASSIMILATION 2943
ASSOCIATIONS 2683
ATMOSPHERE 2573, 3467
ATMOSPHERIC AMMONIA 2588, 2918
ATPASES 3304
ATTRACTANTS 3027
AUREOFACIENS 3068
AUSTRALIA 2429, 2551, 2892, 2987, 3359, 3377
AUSTRIA 2660
AUTO ANALYZER 2895
AUTOHYDROLYSIS 2887
AUXIN 2650
AUXIN BIOSYNTHESIS 2909
AVAILABILITY 3289
AVAILABLE WATER 2466
AVENA 2656, 3209, 3211, 3224, 3226, 3239
AVENA COLEOPTILES 2911
AVENA FATUA 3221, 3234, 3238
AVENA SATIVA 2501, 2533, 2556, 2603, 2631, 2639, 2669, 2680, 2699, 2815, 2869, 3070, 3124, 3133, 3160, 3228, 3236, 3469
AVENA STERILIS 3212
AZADIRACHTA 3032
AZADIRACHTA INDICA 3018
AZERBAIJAN 2993
AZOSPIRILLUM BRASILENSE 2941
B GENOME 2858
B LESS BARLEY 2929
BACILLUS POLYMYXA 2941, 3128
BACILLUS PUMILUS 3128
BACILLUS THURINGIENSIS 2522
BACKCROSSING 2678, 2745
BACTERIA 2733, 3140, 3277, 3278, 3306, 3311, 3402
BACTERIOPHAGES 3306
BACTERIOSES 3121, 3140, 3167
BAKERS' YEAST 3390, 3422
BAKERY INDUSTRY 3407
BAKERY PRODUCTS 3403, 3404, 3422
BAKING 3258, 3334, 3349, 3412, 3430
BAKING CHARACTERISTICS 2479, 2716, 2761, 2787, 2791, 3249, 3330, 3333, 3351, 3353, 3378, 3390, 3403, 3404, 3426, 3441, 3442
BAKING PROPERTIES 3391
BAKING QUALITY 3433
BALANCE 3281
BANGLADESH 3314
BARLEY CARBOHYDRATES 2868
BARLEY FEED FRACTIONS 3276
BARLEY HORDEIN 3381
BARLEY HORDEUM VULGARE 2661, 2766, 3420
BARLEY LEAF EPIDERMIS 2865
BARLEY RESISTANCE 2764
BARLEY RHIZOSPHERE 3128
BARLEY ROOT 2933
BARLEY STRAW 2602, 3451
BARLEY SUPPLEMENT 3278
BARLEY YELLOW DWARF LUTEOVIRUS 2706, 3023, 3119, 3124, 3138
BARLEY YELLOW MOSAIC DISEASE 2770
BARLEY YELLOW MOSAIC VIRUS 2833
BARRIER PROPERTIES 3373
BEEF CATTLE 2435, 3263, 3266
BEERS 2796
BEET BETA VULGARIS 3187
BEHAVIOUR 3000
BEIJING 2834
BELARUS 2480, 3035, 3042, 3070, 3133, 3168, 3237
BELGIUM 2980, 3138, 3302
BENEFITS 2957
BENOXACOR 3233
BENZYLADENINE 2948
BETA 3422
BETA D GLUCANASE 2887
BETA GLUCAN 3259, 3279
BETA GLUCAN SOLUBILASE 3420
BETA GLUCANASE SUPPLEMENTATION 3259
BETA GLUCANS 3411
BETA VULGARIS 2477, 2494, 2556, 3056, 3299
BETHYLIDAE 3251
BILAJI 3311
BINDING 2701, 2850, 3197
BINDING PROTEINS 2786, 2874, 2929
BINS 3283
BIOASSAYS 2565
BIOAVAILABILITY 2565, 2931
BIOCHEMICAL BASIS 3434, 3439
BIOCHEMICAL ENGINEERING 2810
BIOCHEMICAL PATHWAYS 2765, 2869
BIOCHEMICAL POLYMORPHISM 3194
BIOCONTROL 3005
BIOCONTROL AGENT 3068
BIODETERIORATION 3159
BIODIVERSITY 2636
BIOGENIC AMINES 3022
BIOLOGICAL COMPETITION 3204, 3206, 3214, 3228
BIOLOGICAL CONTROL 2981, 2989, 2990, 3030, 3032, 3039, 3066, 3078, 3101, 3112, 3128, 3131, 3168, 3251
BIOLOGICAL CONTROL ORGANISMS 3006, 3007, 3045, 3101, 3251
BIOLOGICAL DEVELOPMENT 2513, 2901, 3007, 3020, 3320
BIOLOGICAL DIFFERENCES 2687, 2941, 3007, 3067, 3086, 3326, 3328, 3358, 3369, 3374, 3378, 3389, 3425, 3443
BIOLOGICAL SAMPLES 3398
BIOLOGY 2520, 3216, 3244
BIOMASS 2458, 2590, 3174, 3246, 3247, 3253, 3257, 3260, 3266, 3318
BIOMASS ALLOCATION 2910
BIOPHYSICS 2841
BIOPREPARATIONS 2552
BIOREACTORS 3056
BIOSYNTHESIS 2765, 2806, 2867, 2882, 2909, 2970
BIOTECHNOLOGY 2696, 2712, 3344
BIOTYPE 2821
BIOTYPES 3011, 3020, 3021, 3156, 3234, 3235
BIPOLARIS SOROKINIANA 2727
BISCUITS 3422, 3441
BLIGHT 3130
BLIGHTS 2825, 3084, 3088, 3172
BLOOD CHOLESTEROL 3411
BLOOD COMPOSITION 3282
BLOOD GLUCOSE RESPONSE 3435
BLOOD MEAL 3264
BLOOD PLASMA 3460
BLUE GREEN ALGAE 2581
BLUE LIGHT 2904, 2958
BODY PARTS 3282
BOEOTICUM 2720
BOLLWORM 3017
BORON 3297
BOSTRICHIDAE 3255
BOTANICAL COMPOSITION 2636, 3230
BOTANY 2520
BRACONIDAE 2989, 2990
BRAN 3112, 3263, 3325, 3326, 3335, 3357, 3362, 3366, 3367, 3377, 3386, 3422, 3460, 3461, 3464
BRAN OIL 3411
BRANCHED POLYETHYLENE MELT 3427
BRASSICA 3294
BRASSICA JUNCEA 2621, 2937
BRASSICA NAPUS 2442, 2452, 2477, 2556, 2699, 3004, 3027, 3246
BRAZIL 3090
BREAD 2430, 3334, 3353, 3412, 3422, 3442
BREAD MAKING QUALITY 3384, 3415, 3433
BREAD QUALITY 3372
BREAD WHEAT 2662, 2858
BREAD WHEATS 3392, 3434, 3439
BREADMAKING 2479, 2716, 2773, 3249, 3329, 3330, 3333, 3334, 3347, 3349, 3353, 3360, 3371, 3378, 3380, 3383, 3385, 3389, 3390, 3413, 3414, 3431, 3442
BREADMAKING QUALITY 2473, 2779, 3429
BREAKFAST CEREALS 3377
BREEDING 2742
BREEDING MATERIALS 2522
BREEDING METHODS 2537, 2664, 2665, 2692, 2703, 2741, 2752, 2784, 2802, 2993, 3061, 3067
BREWING 2659, 2706, 2711, 3326, 3328, 3410
BROADCASTING 2604
BROILER CHICKENS 3267
BROILER CHICKS 3279
BROMOXYNIL 3003, 3227
BROMUS 2463, 2470, 2509, 3224
BROWNING 3358
BUCKWHEAT 2558, 2621

BULBOSUM METHOD 3053
BULGARIA 2681
BULK 3274
BULLOCKS 3263, 3266
C 3 TRITICUM AESTIVUM L 2588
C 4 ZEA MAYS L 2588
C3 2856
CA2+ 2927
CADMIUM 2931, 3186, 3303, 3469
CAESIUM 2812
CAKES 3441
CALCAREOUS SOILS 2554, 2571
CALCIUM 2484, 2565, 2851, 2905, 2927, 2934, 3180, 3325, 3460, 3461
CALCIUM CARBONATE 2590
CALCIUM CHLORIDE 2862
CALCOFLUOR COMPLEX FORMATION 3420
CALIFORNIA 3055, 3227
CALLOGENESIS 2525
CALLUS 2522, 2525, 2526, 2532, 2686, 2771, 2859
CALMODULIN 2905
CALVES 3268
CANADA 2450
CANADIAN WEEDS 3216
CANNULATION 3276
CAPILLARY 3376
CAPITAL TAXATION 2901
CAPSICUM ANNUUM 2476
CAPSICUM FRUTESCENS 2996
CARABIDAE 3035, 3048
CARBOFURAN 3018
CARBOHYDRATE 3174, 3269, 3414
CARBOHYDRATE ESTERS 2911
CARBOHYDRATES 2531, 2712, 2878, 2995, 3460
CARBON 2881, 2892, 2922, 3104, 3290, 3466
CARBON DIOXIDE 2588, 2864, 2893, 2901, 2965, 3185, 3193, 3253
CARBON ISOTOPE DISCRIMINATION 2910
CARBON METABOLISM 2943
CARBOXYLASE 2860
CARCINOGENESIS 3464
CARCINOMAS 3464
CAROTENOIDS 2873
CARROT 2931
CARROTS 3291
CARTOGRAPHY 2458
CASEIN 3325
CATALYTIC ACTIVITY 2642, 2869
CATECHOL OXIDASE 3358
CATIONS 2590, 3190, 3294, 3325
CATTLE 3261, 3265
CD 2931
CDNA 2768, 2896
CDNA CLONES 2727
CECIDOMYIIDAE 2688
CELL CULTURE 2524, 2783, 3306
CELL DIVISION 2847
CELL ELONGATION 2887
CELL LINES 2686
CELL MEMBRANES 2874, 2913, 2914
CELL SHAPE 2850
CELL STRUCTURE 2854, 2874, 2890, 2901, 2906, 2913, 3180
CELL SUSPENSIONS 2522
CELL TURGOR 2865
CELL WALL 2650
CELL WALLS 2650, 2766, 2857, 2887, 3122
CELLULASE PRODUCTION 3356
CELLULOSE ETHERS 3373
CELLULOSES 3260, 3325, 3459
CENTRAL GOVERNMENT 2423, 2441
CENTRIFUGING 3342, 3343
CEREAL 3259, 3416
CEREAL APHIDS 2764, 3014, 3120
CEREAL BYPRODUCTS 3446
CEREAL CONTAMINATION 3364
CEREAL CROPS 2468, 2533, 2557, 2593, 2605, 2611, 2619, 2632, 2633, 2651, 2652, 2653, 2654, 2658, 2716, 2744, 2761, 2922, 3076, 3108, 3118, 3145, 3146, 3171, 3205, 3320, 3469
CEREAL FLOURS 3326, 3362
CEREAL GERMS 2804, 2874, 3401
CEREAL GRAINS 3265
CEREAL PRODUCTS 3331, 3362, 3407, 3460
CEREAL PROTEIN 3418
CEREAL STARCHES 3341
CEREALS 2422, 2430, 2464, 2473, 2496, 2702, 2712, 2815, 2957, 2987, 3000, 3023, 3074, 3120, 3130, 3185, 3197, 3252, 3300, 3324, 3332, 3362, 3368, 3442
CERES MODEL 3287
CEREUS 3128
CERTIFICATION 3368
CHAIN FATTY ACIDS 3274
CHAMAEMYIIDAE 3006, 3007, 3045
CHARA CORALLINA 2953
CHARGE REMOTE FRAGMENTATION 3436
CHEAT BROMUS SECALINUS 2498
CHELATING AGENTS 3180
CHEMICAL AND PHYSICAL ANALYSIS METHOD 3420
CHEMICAL COMPOSITION 2479, 2510, 2602, 2635, 2640, 2659, 2676, 2712, 2735, 2854, 2867, 2873, 2874, 2880, 2884, 2886, 2899, 2901, 2907, 2913, 2916, 2995, 3022, 3205, 3255, 3268, 3276, 3288, 3294, 3296, 3322, 3330, 3363, 3369, 3380, 3383, 3386, 3389, 3394, 3403, 3404, 3453, 3459, 3461
CHEMICAL CONTAMINATION 3469
CHEMICAL CONTROL 2984, 3000, 3003, 3012, 3015, 3023, 3027, 3030, 3040, 3043, 3057, 3064, 3096, 3119, 3132, 3149, 3153, 3209, 3211, 3224, 3225, 3227
CHEMICAL PRECIPITATION 2749
CHEMICAL REACTIONS 2873
CHEMICAL STRUCTURE 3232, 3456
CHEMICAL SYNTHESIS 2829, 3147
CHEMICOPHYSICAL PROPERTIES 2878, 3345, 3393, 3424, 3441
CHEMISTRY 2874, 2901
CHEMORECEPTORS 2874
CHICKENS 3279, 3280, 3295
CHICKPEAS 2699
CHIMAERAS 2875
CHINA 2446, 2666, 2747, 3061, 3090, 3150, 3164
CHITINASE 2642, 2766
CHITINASES 3100
CHLAMYDOMONAS REINHARDTII 2860
CHLORINE 3332
CHLORMEQUAT 3239
CHLOROPHYLL CONTENT 3014
CHLOROPHYLL FLUORESCENCE 2781
CHLOROPHYLL METER 2891
CHLOROPHYLLS 2622, 2873, 3184, 3468
CHLOROPLAST 2731, 2781
CHLOROPLAST DEVELOPMENT 2860
CHLOROPLAST DNA 2769
CHLOROPLASTS 2860, 2879, 3147, 3187
CHLORTOLURON 2736
CHOLESTEROL 3259, 3279, 3460
CHROMATOGRAPHY 3432, 3440
CHROMIC OXIDE 3280
CHROMOSOME 2800
CHROMOSOME 1R 2778
CHROMOSOME ABERRATIONS 2847, 3182
CHROMOSOME ADDITION LINES 2792
CHROMOSOME BANDING 2737
CHROMOSOME MARKERS 2808
CHROMOSOME PAIRING 2674, 2697
CHROMOSOME TRANSLOCATION 2643, 2666, 2687, 2722, 2737, 2826, 2827
CHROMOSOMES 2696, 2698, 2729, 2730, 2736, 2737, 2753, 2783, 2828, 2847
CICER ARIETINUM 2699, 2857
CITRATE 2855
CITRIC ACID 2862
CLASSIFICATION 2443, 2487, 3327
CLAVIBACTER 3140
CLAY SOIL 2563
CLAY SOILS 3297
CLEANING 3418
CLIMATE 2434, 3321
CLIMATE CHANGE 2835, 3191, 3196
CLIMATIC CHANGE 2864
CLIMATIC FACTORS 2434, 3138, 3222, 3351, 3385, 3390
CLIMATIC RISK 2429
CLIMATIC VARIABILITY 3191, 3196
CLIMATIC ZONES 3085
CLONES 2635, 2676, 2806
CLONING 2668, 2721, 2733, 2736, 2768, 2963
CLOVER 2585
CO2 2839
CO2 CONCENTRATION 2835, 2940, 3189
CO2 ENRICHMENT 3185
COBALT 2812, 3325
COCCINELLIDAE 3028
COCHLIOBOLUS HETEROSTROPHUS 2668
COCHLIOBOLUS SATIVUS 3086, 3152
COEFFICIENT OF PARENTAGE 2730
COENZYME A REDUCTASE 3279
COENZYMES 2810
COINTEGRATION 2451
COLD 2531, 3181, 3320
COLD ACCLIMATION 2850, 2943, 3199
COLD HARDINESS 2686
COLEOPTILE 2898, 2909, 2912
COLEOPTILES 2887, 2904, 2970
COLLECTION 2683, 2742, 2842
COLLISION ACTIVATED DISSOCIATION 3436
COLLOIDS 3342, 3343, 3359, 3413
COLON FERMENTATION 3462
COLONIC FUNCTION 3274
COLONIZATION 3304
COLORADO 2773, 3465
COLORECTAL CANCER 3462
COLOUR 2690, 2807, 3345, 3358
COMBINE HARVESTERS 2605
COMBINING ABILITY 2700, 2723, 2749, 2809
COMMINUTION 3270
COMMON MILKWEED, ASCLEPIAS SYRIACA L ASCSY 3243
COMMON ROOT ROT 2972
COMMON SALT 3463
COMMON WHEAT 2641, 2674, 2736, 2769, 2778, 2872
COMMON WHEATS 2858, 3415, 3429
COMPACTION 2469
COMPARATIVE FEEDING VALUE 3272
COMPARATIVE MAPPING 2655
COMPENSATION 2442
COMPETITION 2464, 2496, 2498, 2568, 3216
COMPLEX MODULI 3427
COMPONENTS 2855, 2872, 3161, 3281
COMPOSTS 3285, 3291
COMPOUND FEEDS 3457
COMPUTER APPLICATIONS 2560, 2799, 2980, 3473

COMPUTER SOFTWARE 2694, 2706, 2799, 3443, 3472
CONCENTRATE 3265
CONDUCTANCE 2865
CONSERVATION 2491
CONSERVATION TILLAGE 2613, 3244, 3319
CONSISTENCY 3354
CONSTRUCTION 2768
CONSUMER PRICES 2445
CONSUMPTION 3007
CONTAMINATION 2836, 3055, 3362, 3363, 3367
CONTROL 3120
CONTROLLED BURNING 3153, 3226
CONTROLLED ENVIRONMENTS 3197
CONVOLVULUS 3201, 3209
COOKED RICE 3399
COOKIES 3391
COOKING 2670, 3339, 3358, 3435
COPPER 2920, 3186, 3296, 3303, 3312, 3465
CORN 2478, 2918, 2923, 3095, 3298
CORN STARCH 3340, 3354
CORN TORTILLAS 3399
COST BENEFIT ANALYSIS 2446, 2583, 3164
COSTS 2623, 2957, 2980, 3245, 3246
COTTON 2423, 2667, 2923, 2944, 2953, 3028
COTYLEDONS 2862, 2898
COUMAROYL ESTERASE 3462
COVER CROP 2547
COVER PLANTS 2509, 2604
COWPEA 2464
CRIMSON CLOVER 2558
CRITERIA 3368
CROP 2428
CROP GROWTH MODELLING 2511
CROP LOSSES 3117, 3119, 3161, 3167, 3210, 3227
CROP MANAGEMENT 2482, 2509, 2584, 2633, 2680, 3331, 3472
CROP PHENOLOGY MODELS 2839
CROP PLANTING DATES 3216
CROP RESIDUE 2570
CROP RESIDUES 2463, 2514, 2615, 3076, 3153
CROP RESPONSE 2511
CROP ROTATION 3318
CROP YIELD 2431, 2459, 2460, 2467, 2470, 2471, 2472, 2475, 2479, 2481, 2483, 2485, 2488, 2490, 2492, 2493, 2494, 2500, 2501, 2502, 2503, 2506, 2507, 2508, 2510, 2513, 2514, 2518, 2536, 2539, 2541, 2545, 2554, 2556, 2557, 2560, 2561, 2562, 2564, 2567, 2574, 2575, 2584, 2589, 2591, 2593, 2597, 2599, 2607, 2608, 2617, 2620, 2622, 2626, 2632, 2634, 2644, 2646, 2651, 2653, 2657, 2658, 2680, 2685, 2704, 2706, 2728, 2735, 2744, 2756, 2772, 2773, 2780, 2791, 2796, 2799,2812,22844, 2861, 2864, 2866, 2886,2889, 2941, 2947, 3018, 3049, 3091, 3103, 3119, 3136, 3151, 3153, 3172, 3195, 3207, 3209, 3212, 3214, 3223, 3227, 3239, 3242, 3297, 3400, 3467
CROPPING HISTORIES 2469
CROPPING PATTERNS 2739
CROPPING SEQUENCE 2592
CROPPING SYSTEM 2495
CROPPING SYSTEMS 2442, 2454, 2456, 2584, 2608, 2613, 2621, 2623, 2628, 2634, 3291, 3300
CROPS 2442, 2577, 2585, 2601, 2621, 2931, 2937, 3004, 3027, 3247, 3257, 3292, 3303, 3313
CROSS BREEDS 2872
CROSS LINKING 2911
CROSSBREDS 2509, 2680
CROSSBREEDING 3090
CROTALARIA 3039
CRUDE FIBRE 2596, 3451
CRUDE PROTEIN 2488, 2789, 2907, 3262, 3264, 3268
CRYPTOLESTES FERRUGINEUS 3251
CSFR 3294
CULMORUM 3130
CULTIVAR 3177
CULTIVAR DIFFERENCE 2600
CULTIVAR IDENTIFICATION 2713
CULTIVARS 2529, 2730, 2743, 2778, 2960, 2971, 3083
CULTIVATED BARLEY 2683
CULTIVATION 2454, 2456, 2477, 2491, 2500, 2516, 2520, 2601, 2604, 2991, 3236
CULTURAL BEHAVIOUR 2670
CULTURAL METHODS 2499, 2520, 2629, 3348
CULTURE 3311, 3356, 3402
CULTURE MEDIA 2525, 2526, 2531, 2532, 2820, 2862, 3106
CULTURE PLATE INSERTS 2523
CYANOPHYTA 3308
CYCLIC PEPTIDE 2705
CYCLING 2834
CYFLUTHRIN 3119
CYPRUS 2625
CYSTEINE 2676, 3338
CYSTINE PEPTIDES 2803, 3406
CYTOCHALASIN E 3361
CYTOCHROME OXIDASE 2769
CYTOGENETIC ANALYSIS 2783
CYTOGENETICS 2641, 2663, 2821
CYTOKININ 2948
CYTOKININS 2942
CYTOLOGY 2748
CYTOPLASM 2537, 2637, 2800, 2913, 3114, 3147
CYTOPLASMIC CALCIUM 2934
CYTOPLASMIC INHERITANCE 2745
CYTOPLASMIC MALE STERILITY 2818
CYTOPLASMIC PH 2933
CYTOSOLIC IONS 2934
CYTOTAXONOMY 2748
CZECH REPUBLIC 2435, 3062, 3079, 3154
D GENOME 2661
D TRYPTOPHAN 2970
D TRYPTOPHAN AMINOTRANSFERASE 2970
DACTYLIS GLOMERATA 3277
DAIRY COWS 3262, 3265, 3277
DAMAGE 2894, 2992, 3004, 3008, 3119, 3441
DARKNESS 2908
DATA ANALYSIS 2728
DATA COLLECTION 3313, 3473
DATABASES 2694
DAUCUS CAROTA L 2731
DAYLIGHT 3173, 3321
DEAMIDATION 3381
DECIMAL CODE 2496
DECISION 3129
DECISION MAKING 2429, 3426
DECOMPOSITION 2571, 2585, 2855, 3318
DEFAECATION 3461
DEFENSE 2957, 3050
DEFICIENCY 2559, 3188
DEFICIENCY DISEASES 3190
DEFICIT 2572
DEGRADABILITY 3278
DEGRADATION 3033, 3248
DEGREE DAYS 2465, 2466
DEHYDRATION TOLERANCE 2894
DELAYED FLUORESCENCE (DF) 2845
DELAYED PLANTING 3216
DELIA 2984
DELTA C 13 2870
DEMAND 2440
DENATURATION 3336
DENITRIFICATION 2547
DENMARK 2422, 2475, 2477, 2494, 2500, 2501, 2556, 2631, 3203, 3204, 3222, 3246, 3256, 3257, 3295, 3467
DENSITY 3425
DENSITY LIPOPROTEIN CHOLESTEROL 3411
DENSO 2655
DEOXYNIVALENOL 3074, 3095, 3130
DEPENDENCE 2904
DEPENDENT PH CHANGES 2588
DEPTH 2513, 2601, 2633, 2972
DERIVATIVES 2641, 2674
DESICCATION 2702
DESIGN 2506, 2699, 3284
DEVELOPING COUNTRIES 3463
DEVELOPMENTAL STAGES 2717, 2866, 2901
DEXTRINS 3334
DIAERETIELLA 2994
DIAERETIELLA RAPAE 2989
DIAGNOSIS 3116, 3464
DIALLEL CROSSING 2809
DIAMETER 3425
DIARRHEA 3275
DICAMBA 2522, 3227
DICLOFOP 3234
DICOTYLEDON 2850
DIET 3268, 3377, 3460, 3464
DIETARY 3273
DIETARY FIBER 3274, 3275, 3414, 3462
DIETARY FIBERS 3274
DIETARY FIBRES 2675, 3263, 3369, 3422, 3460, 3461
DIETARY STARCH 3265
DIETS 3259, 3271, 3276
DIFFERENT PROTEIN 3454
DIFFERENT RELATIVE HUMIDITIES 3373
DIFFERENT SENSITIVITY 2934
DIFFERENT TEMPERATURES 2990
DIFFUSE LIGHT 2958
DIFFUSION 2979
DIGESTIBILITY 3262, 3263, 3264, 3280, 3446, 3451, 3454, 3457
DIGESTIBILITY MARKERS 3280
DIGESTION 3262, 3263, 3272, 3278, 3461
DIGESTION METHODS 3398
DIGESTIVE DISORDERS 3355
DIGESTIVE SYSTEM 2754
DIGITAL IMAGING MICROSCOPY 2934
DIMBOA 3005
DIMENSIONS 2897, 3268, 3396, 3437, 3438
DIMETHOATE 3119
DINICONAZOLE 3073
DINUCLEOTIDE BINDING FOLD 2705
DIOXIDE CONCENTRATION 2910
DIPLOID WHEATS 2858
DIPTERA 2688
DIPTERA CECIDOMYIIDAE 2821
DIRECT SOWING 2475, 2604, 3284
DISCRIMINATION 2871
DISEASE 3080, 3129
DISEASE CONTROL 2446, 2452, 2480, 2500, 2501, 2980, 2996, 2997, 3069, 3073, 3085, 3089, 3091, 3103, 3108, 3112, 3118, 3119, 3140, 3145, 3149, 3153, 3162, 3165, 3204, 3400, 3464
DISEASE RESISTANCE 2583, 2646, 2666, 2678, 2689, 2691, 2704, 2706, 2759, 2760, 2763, 2774, 2785, 2795, 2811, 2819, 2825, 2828, 2833, 2993, 3051, 3052, 3061, 3062, 3067, 3081, 3082, 3086, 3087, 3089, 3090, 3114, 3115, 3121, 3135, 3143, 3148, 3150, 3153, 3154, 3155, 3160, 3166, 3172
DISEASE SURVEYS 3055, 3152, 3167
DISEASE THRESHOLD 3129
DISPERSIONS 3388

DISTILLERS 3391
DISTORTION SEGREGATION 2661
DISULFIDE BONDS 2803, 3406, 3433
DITHIOERYTHRITOL 3440
DIURAPHIS NOXIA 2981, 2984, 2989, 2990, 2994, 2995, 2999, 3002, 3006, 3007, 3045
DIURAPHIS NOXIA MORDWILKO 2989
DIVERSITY 2662, 2769, 2770
DNA 2522, 2647, 2663, 2687, 2697, 2701, 2762, 2777, 2783, 2785, 2786, 2806, 2829, 2874, 3116
DOMESTIC GARDENS 2509
DOMINANT GENES 2666, 2722
DORMANCY 2745, 2975
DORMANCY BREAKING 2975, 2991
DOSE RESPONSE RELATIONS 3187
DOUBLE BOND LOCATION 3436
DOUBLED HAPLOID LINES 2522
DOUBLED HAPLOIDS 2661, 3053
DOUGH 2779, 3360
DOUGH FUNCTIONALITY 3372
DOUGH PROPERTIES 3415
DOUGH QUALITY 2779
DOUGH RESTING 3439, 3440
DOUGHS 2716, 3327, 3329, 3334, 3337, 3338, 3342, 3343, 3349, 3351, 3371, 3380, 3383, 3385, 3390, 3397, 3412, 3422, 3431
DRAUGHT ANIMALS 2434
DRECHSLERA 3092, 3110, 3172
DRILLING EQUIPMENT 2514
DROUGHT 2600, 2974, 3183
DROUGHT RESISTANCE 2497, 2600, 2794, 2831
DROUGHT STRESS 2648
DRUGS 3027, 3178
DRY 3386
DRY ENVIRONMENTS 2956
DRY FARMING 2514, 2584, 2607, 2613, 2622, 3123, 3126, 3201, 3231, 3465, 3470
DRY MATTER 2959
DRY MATTER CONTENT 2510, 2521, 2554, 2626, 2790, 2834, 2841, 2852, 2864, 2888, 2947, 3119, 3159, 3260, 3262, 3446
DRY MULCHES 2606
DRY ROLLED CORN 3272
DRY WEIGHT 3185
DRYING 3350
DRYLAND WHEAT 2551
DURATION 2848, 2976, 3249, 3258, 3322, 3336, 3343, 3351, 3358
DURATION EFFECTS 2702
DURUM WHEAT 2555, 2803, 3287, 3406, 3416
DWARFISM 3206
DWARFS 2820, 3136
DYE COUPLING 2856
DYNAMIC RHEOLOGICAL PROPERTIES 3372, 3427
DYNAMICS 2576, 3318
EARLY EXPERIENCE 3261
EARLY MATURITY 2955
EASTERN SOUTH DAKOTA 3028
EBC MALT, MALT (ANALYSIS METHOD FOR) 3420
ECOLOGY 2987, 3004
ECONOMETRIC MODELS 2437, 2446
ECONOMIC ANALYSIS 2438, 2574, 2613, 2623, 2824, 3319
ECONOMIC BEHAVIOUR 2424, 2437, 3069, 3400
ECONOMIC COMPETITION 2449
ECONOMIC RETURNS 2425
ECONOMIC SITUATION 2430
ECONOMIC THRESHOLDS 3049
ECONOMIC VIABILITY 2506, 2617
EDTA 2855
EDTA, ETHYLENEDIAMINETETRAACETIC ACID 3303
EDUCATION 3460
EFFICIENCY 2597, 2617, 2864, 2922, 3118, 3205, 3212, 3264
EGGS 2435
ELASTICITY 3358, 3413
ELECTRIC FIELD 2841
ELECTRIC POTENTIAL 2914, 3180
ELECTRODES 2913, 2914
ELECTRODIALYSIS FERMENTATION 3402
ELECTRON TRANSPORT 2929, 2943
ELECTROPHORESIS 2779, 2808, 2811, 2853, 2858, 2872, 3102, 3333, 3355, 3376, 3394, 3413, 3417, 3418, 3439, 3440, 3442
ELECTROPHORESIS (SGE, SDS PAGE) 2903
ELECTROPORATION 2777
ELEMENT 2638
ELEMENTS 2650, 2701, 3303
ELEVATED CO2 2838, 3193
ELICITOR 2766
ELISA 3106, 3355, 3397
ELONGATION 2857, 2912, 2974
ELYMUS 2623, 2641
EMBRYO CULTURE 2525, 2527, 2637, 2775
EMBRYONIC DEVELOPMENT 2894, 2963
EMBRYOS 2650
EMERGENCE 2512, 2514, 2866, 2902, 2961, 2966, 3216
EMMER WHEAT 2736
EMULSIFIERS 3354
EMULSIFYING 3401
ENCAPSULATION 3306
ENDOPHYTES 2999
ENDOPLASMIC RETICULUM 2867
ENDOSCOPY 3464
ENDOSPERM 2757, 2758, 2806, 2848, 2963, 3050, 3347, 3416
ENDOSPERM CELL WALLS 3420
ENDOSPERM PROTEINS 2872
ENDOSPERM STORAGE PROTEIN 2779
ENERGY 2570, 2610, 3074, 3280
ENERGY BALANCE 2610
ENERGY VALUE 3369, 3451
ENGLAND 2442, 3228
ENRICHMENT 2940, 3189, 3193
ENSILING 3259
ENSILING WHOLE WHEAT 3444
ENTOMOLOGY 2984
ENUMERATION 3139
ENVIRONMENTAL FACTORS 2492, 2587, 2717, 2964, 2965, 3333
ENVIRONMENTAL IMPACT 2584, 2623
ENVIRONMENTAL POLICIES 2442
ENVIRONMENTAL TEMPERATURE 3007, 3021, 3320
ENVIRONMENTS 2742
ENZYMATIC HYDROLYSIS 3246
ENZYME 3384
ENZYME ACTIVITIES 3318
ENZYME INHIBITORS 2754, 2880, 3162, 3358, 3410
ENZYME PREPARATION 3259
ENZYMES 2705, 2806, 2878, 2907, 2943, 2963, 3267, 3325, 3344, 3457
ENZYMIC ACTIVITY 2670, 2810, 2854, 2875, 2885, 2893, 2907, 2916, 2938, 2942, 3215, 3299, \3308, 3325, 3326, 3334, 3352, 3357, 3358, 3410, 3437
EPICOTYLS 2857
EPICUTICULAR WAX 2764
EPIDEMICS 2980, 3071, 3093, 3172, 3173
EPIDEMIOLOGY 3086, 3108, 3120
EPIDERMIS 2913, 2914, 3122
EQUIPMENT 2824, 3340
EQUIPMENT PERFORMANCE 3284
ERGOSTEROL 3364
ERODED SOIL 2590
EROSION 2491, 2623
EROSION CONTROL 2509
ERWINIA AMYLOVORA 3116
ERYSIPHE GRAMINIS 2678, 2689, 2811, 2993, 3079, 3100, 3115, 3118, 3122, 3150, 3154, 3155
ERYSIPHE GRAMINIS F SP TRITICI 2778
ESCHERICHIA COLI 2642, 2768, 2804, 2810, 2905
ESTABLISHMENT 2496
ESTER LINKAGES 3456
ESTERASE ACTIVITIES 2857
ESTERASE FAE III 3462
ESTERASE ISOZYMES 2808
ESTERASES 2885, 3462
ESTONIA 2481, 2485, 2488, 2490, 2796, 3048
ETHAFLURALIN 3177
ETHANOL 2916, 3344, 3432
ETHEPHON 3239
ETHIOPIA 2421, 2432, 2433, 2434, 2436, 2454, 2462, 2474, 2520, 2579, 2636, 2665, 2679, 2683, 2692, 2703, 2742, 2984, 3089, 3167, 3210, 3348, 3445, 3450
ETIOLATION 2879
ETIOPLASTS 2860
EUROPE 3313
EURYGASTER 3029, 3036, 3248
EURYGASTER INTEGRICEPS 3015, 3016, 3025
EVALUATION 2580, 3151, 3248, 3262, 3302, 3319
EVOLUTION 2663, 2720, 2748
EXCISED ROOTS 2971
EXOGLUCANASE 2887
EXOTIC GERMPLASM 2805
EXPANDING 3281
EXPENDITURE 2437
EXPERIMENTATION 2506, 2565, 2579, 2697, 2699, 2729, 2916, 2965, 3143, 3210, 3220, 3234, 3235, 3464, 3467
EXPLANTS 2667
EXPORTS 2424, 2446, 2449, 2450, 3055
EXPRESSION 2656, 2701, 2727, 2868
EXTENSIBILITY 2911, 2912
EXTENSION ACTIVITIES 2431, 3208
EXTENSION ZONE 2956
EXTENSIVE CHLOROSIS 2691
EXTRACT DILUTION ANALYSIS 3399
EXTRACT FRACTIONATION 2552
EXTRACTION 3456
EXTRACTS 3259, 3337
EXTRUSION 3281, 3338, 3340
EXTRUSION COOKING 3281
F SP HORDEI 2727
F SP TRITICI 2766, 3098, 3129
F1 HYBRIDS 2714, 2723, 2823
F2 HYBRIDS 2817
F344 RATS 3360
FABA BEANS 2452
FAECES 3461, 3464
FAGOPYRUM 2754
FALLOW 2495, 2613, 2616
FALLOW SYSTEMS 2615
FALLOWING 2616
FAMILY 2656, 3304
FAO 2535
FAR RED 2958
FARM AREA 2435, 2440, 3426
FARM INCOME 2423, 2439
FARM INPUTS 2433, 2438, 3246
FARM MANAGEMENT 2429, 3426
FARM RESULTS 3246

FARM STORAGE 3245
FARM SURVEYS 3471
FARM YARD MANURE 2592
FARMERS 3208
FARMING SYSTEMS 2510, 2610, 2612, 2621
FARMLAND 2434, 3292
FARMYARD MANURE 2556, 2617, 2631, 3295
FAST FOOD 3460
FATE 2547
FATS 3460
FATTY ACID BINDING CAPACITY 3381
FATTY ACIDS 2869, 3275, 3381, 3436
FAUNA 2988, 3011, 3037
FEATHER MEAL 3264, 3273
FECAL DIGESTIBILITIES 3281
FECES 3454
FED RATS 3411
FEED 3261, 3368
FEED ADDITIVES 3446, 3447
FEED CONVERSION EFFICIENCY 3262, 3264, 3268
FEED CROPS 2639, 2680, 3469
FEED INTAKE 3262, 3263, 3264, 3268, 3270, 3282
FEED LEGUMES 2639, 2699
FEED MEALS 3446
FEED PREFERENCE 3269
FEED PROCESSING 3270
FEED UTILISATION 3259
FEEDING BEHAVIOR 3261
FEEDING DETERRENT 3017
FEEDING HABITS 2670, 2994, 3007
FEEDING VALUE 3259
FEEDS 3055, 3105, 3257, 3262, 3263, 3277
FEEDSTUFFS 3276
FENITROTHION 3043
FERMENTATION 2716, 3259, 3325, 3344, 3351, 3357, 3379, 3390, 3448
FERTILE 2977
FERTILE TRANSGENIC WHEAT 2529, 3433
FERTILITY 2530, 2750
FERTILITY AMENDMENT 3387
FERTILIZATION 2486, 2544, 2559, 2960
FERTILIZER 2465, 2547, 2570, 2616, 3434
FERTILIZER APPLICATION 2421, 2434, 2436, 2472, 2492, 2501, 2548, 2549, 2553, 2556, 2566, 2574, 2579, 2582, 2586, 2594, 2628, 2634, 2834, 2920, 3008, 3091, 3195, 3204, 3230, 3288, 3314
FERTILIZER COMBINATIONS 2589
FERTILIZER N 2465, 2466
FERTILIZER NITROGEN 2558
FERTILIZER REQUIREMENTS 3289
FERTILIZERS 2556, 2569, 2575, 2584, 2592, 2610, 2902, 3009, 3285, 3291, 3294, 3295, 3297
FERULIC ACID 2855, 3416, 3456, 3462
FERULOYLATED OLIGOSACCHARIDES 3462
FESTUCA ARUNDINACEA 2999
FIBER 3273, 3462
FIBRE 3259
FIBRE CROPS 3260
FIELD 2585, 2702, 2892, 3193
FIELD CONDITIONS 2558
FIELD EXPERIMENTATION 2422, 2433, 2442, 2475, 2477, 2483, 2484, 2494, 2500, 2501, 2508, 2556, 2557, 2595, 2596, 2599, 2605, 2631, 2667, 2922, 3065, 3121, 3159, 3200, 3203, 3204, 3206, 3207, 3214, 3223, 3226, 3228, 3229, 3230, 3236, 3237, 3241, 3242, 3295, 3333
FIELD PEA CROP 3309
FIELDS 2718, 3028
FIRMNESS 3349, 3353
FISH MEAL 3264
FISHING NETS 2893
FIXATION 2870
FLAG LEAF 2846
FLAG LEAVES 2838
FLANKING MARKERS 2655
FLAVONOIDS 2659
FLAVOR 3269
FLAVOUR 3269, 3377
FLAVOUR ENHANCERS 3463
FLOODED RICE 2581
FLOUR 2871, 3360, 3386, 3430
FLOUR BEETLE 3017
FLOUR DOUGHS 3372, 3427
FLOUR PROPERTIES 3434, 3439
FLOUR PROTEINS 3392
FLOUR QUALITY CHARACTERISTICS 3429
FLOUR REFINEMENT 3416
FLOURS 3326, 3345, 3352, 3362, 3422
FLOW INJECTION ANALYSIS 3420
FLOW KARYOTYPE 2783
FLOWERING 2906
FLUID 3278
FLUORESCENCE 2736, 2777, 2873, 3416
FLUORESCENCE IN SITU HYBRIDIZATION 2674
FLUORESCENCE RATIO MICROSCOPY 2934
FLUORIDES 2565, 2876
FOAMING 3401
FOAMS 3412
FOLIAR ABSORPTION 2892
FOLIAR APPLICATION 2569, 2979, 3119
FOOD 3381, 3398
FOOD CONSUMPTION 3460
FOOD INDUSTRY 3407
FOOD SAFETY 3367
FOOD SUPPLY 2434
FOOD TECHNOLOGY 2773, 3249, 3327, 3335, 3338, 3340, 3347, 3348, 3358, 3359, 3377, 3385, 3431, 3463
FOODS 3055, 3252, 3336, 3339, 3347, 3349, 3351, 3362, 3367, 3374, 3377, 3396, 3408, 3414, 3417, 3419, 3432, 3437, 3443
FOOT ROT 3152
FORAGING 3000
FORCED AIR DRYING 3256
FORECASTING 2866, 2980, 3023, 3026, 3071, 3085, 3165, 3173, 3283, 3321, 3347, 3374, 3396, 3455
FOREIGN TRADE 2445
FOREST SOILS 2567, 2853
FORMALDEHYDE TREATED BARLEY 3272
FORMS 2808
FORMULATIONS 3003, 3027, 3112, 3262, 3359, 3441
FOUR PHASES 2857
FRACTIONATION 3247, 3324, 3337, 3366, 3394, 3405, 3417, 3422, 3430, 3443
FRACTIONS 3281, 3456
FRAGARIA 2669
FRAGMENT LENGTH POLYMORPHISM 2661
FRAGMENT LENGTH POLYMORPHISMS 2730
FRANCE 2468, 2619, 2651, 2652, 2653, 2654, 2658, 2761, 3118, 3466
FREE METAL 3188
FREE RADICALS 3338
FREEZE TOLERANT YEAST 3258
FREEZING 3390
FREEZING TOLERANCE 2702, 2850, 3197, 3199
FRICTION 3335
FROST 2434, 3320
FROST RESISTANCE 2845
FROST TOLERANCE 2686, 3192
FROZEN DOUGH 3258
FROZEN FOODS 3351
FROZEN STORAGE 3390
FRUIT 2467
FUMIGANTS 3245
FUMIGATION 3174
FUNCTIONAL PROPERTIES 3439
FUNGAL ANTAGONISM 3128
FUNGAL DISEASES 2480, 2633, 2706, 2993, 3022, 3054, 3055, 3057, 3059, 3060, 3061, 3063, 3064, 3067, 3069, 3070, 3076, 3081, 3082, 3084, 3087, 3088, 3090, 3091, 3092, 3093, 3094, 3101, 3106, 3112, 3114, 3118, 3123, 3125, 3126, 3127, 3133, 3134, 3135, 3143, 3145, 3146, 3148, 3149, 3151, 3152, 3158, 3169, 3170
FUNGAL GROWTH 3364
FUNGI 2838, 2983, 3056, 3057, 3063, 3081, 3082, 3084, 3087, 3088, 3092, 3093, 3094, 3123, 3125, 3126, 3127, 3134, 3135, 3139, 3148, 3149, 3158, 3167, 3169, 3170, 3171, 3250, 3325, 3365
FUNGICIDE 3129
FUNGICIDES 2452, 2479, 2508, 2997, 3056, 3057, 3064, 3072, 3073, 3083, 3091, 3096, 3103, 3118, 3132, 3144, 3145, 3146, 3149, 3153, 3400
FUNGUS COCHLIOBOLUS CARBONUM 2705
FUSARIUM 2480, 2660, 3054, 3059, 3063, 3066, 3078, 3084, 3088, 3093, 3095, 3104, 3105, 3127, 3131, 3133, 3152, 3168, 3169, 3170, 3171, 3449
FUSARIUM AVENACEUM 3074
FUSARIUM CULMORUM 3053, 3065, 3099, 3152, 3159, 3449
FUSARIUM GRAMINEARUM 3074, 3095, 3364
FUSARIUM HEAD BLIGHT 3074, 3130
FUSARIUM OXYSPORUM 3449
FUSARIUM POAE 3074
GA 2521, 2820, 2854, 2862, 2867, 2875, 2975
GAEUMANNOMYCES 3094
GAEUMANNOMYCES GRAMINIS 2633, 3076, 3108
GALACTOSE 3325, 3397
GALEOPSIS TETRAHIT 3216
GALIUM 2902, 3201, 3207, 3229
GAMETOCIDAL GENES 2800
GAMMA GLIADINS 2803
GAMMA IRRADIATION 2812, 2817, 2829
GAMMA RADIATION 2734, 2775, 3339
GAS CELL STABILITY 3412
GAS CHROMATOGRAPHY 2675, 3130, 3363
GAS EXCHANGE 2908, 2940, 2956
GASEOUS AMMONIA 2588, 2918
GASES 3390
GASTROPODA 2987, 3000, 3003, 3004, 3012, 3027, 3034
GELATIN 3325
GELATINIZATION 3341
GENE 2522, 2705, 2766
GENE BANKS 2636, 2694
GENE EXPRESSION 2640, 2643, 2717, 2768, 2777, 2786, 2810, 2875, 2963, 2975, 3100, 3304
GENE FAMILY 2727
GENE LOCATION 2696
GENE POOL 2730
GENE TRANSFER 2640, 2667, 2731, 2754, 2777, 2786, 2810, 3220, 3347
GENE TRANSPOSITION 2678
GENES 2640, 2643, 2674, 2676, 2687, 2689, 2690, 2691, 2698, 2735, 2738, 2786, 2806, 2810, 2811, 2813, 2814, 2818, 2820, 2826, 2875, 3020, 3062, 3090, 3111, 3154, 3156, 3157, 3330
GENETIC ANALYSIS 2872
GENETIC CODE 2635
GENETIC CONTROL 2808
GENETIC CORRELATION 2812

GENETIC DISTANCE 2645
GENETIC DIVERGENCE 2720
GENETIC DIVERSITY 2683, 2720, 2730, 2842
GENETIC ENGINEERING 2667, 2733, 3306
GENETIC INHERITANCE 2640, 2706, 2750, 2809, 2826, 3090, 3217
GENETIC MAP COMPARISON 2661
GENETIC MAPS 2661, 2687, 2698, 2706, 2741, 2745, 2799
GENETIC MARKERS 2647, 2687, 2690, 2698, 2706, 2735, 2745, 2754, 2799, 2811, 2815, 2827, 2842
GENETIC PARAMETERS 2700, 2822, 2823
GENETIC POLYMORPHISM 2647, 2649
GENETIC RESOURCES 2679, 2694, 2742, 2805, 2842, 2993, 3090, 3176, 3473
GENETIC SIMILARITY 2770
GENETIC SOIL TYPES 2562, 3296, 3297
GENETIC TRANSFORMATION 2640, 2643, 2733, 2777, 2786, 2814
GENETIC VARIABILITY 2662
GENETIC VARIATION 2647, 2757, 2758, 2795, 2809, 2817, 2822, 2870, 2873, 3180, 3424
GENETICS 2460, 2504, 2639, 2647, 2697, 2698, 2706, 2745, 2779, 2786, 2799, 2875, 2993, 3067, 3090, 3115, 3143, 3234, 3333, 3471
GENOME 2656, 2720, 2730, 2740
GENOME DONOR 2662, 2858
GENOME ORGANIZATION 2663, 2783
GENOME SYNTENY 2705
GENOMES 2741, 2799, 2978, 3347
GENOMIC DNA 2713
GENOMIC SEQUENCE 3304
GENOTYPE ENVIRONMENT INTERACTION 2648, 2664, 2665, 2671, 2672, 2673, 2682, 2699, 2745, 2771, 2799, 2815
GENOTYPES 2543, 2636, 2670, 2756, 2789, 2844, 2921, 2946, 2999, 3020, 3121, 3175, 3178, 3327, 3333, 3374, 3378, 3438, 3471
GENOTYPIC VARIATION 2910
GEOCHEMISTRY 3466
GEOGRAPHIC INFORMATION SYSTEMS 2458
GEOGRAPHICAL DISTRIBUTION 2458, 2748, 2981, 2995, 3045, 3085, 3152, 3165, 3218, 3352, 3365
GEORGIA (USA) 2680, 2724, 2725
GERM LENGTH 2966
GERMANY 3378
GERMIN 2650
GERMINABILITY 2534, 2540, 2886, 3168
GERMINATION 2485, 2701, 2717, 2745, 2862, 2894, 2902, 2966, 2975, 3099, 3109, 3244, 3274, 3275, 3410
GERMPLASM 2636, 2644, 2649, 2679, 2693, 2741, 2747, 2759, 2770, 2805, 2842, 2993, 3061, 3067, 3121, 3143
GERMPLASM CONSERVATION 2636, 2683
GIBBERELLA AVENACEA 3152
GIBBERELLA ZEAE 3061, 3090, 3130, 3144, 3152, 3365, 3366
GIBBERELLIN 2701
GIBBERELLIN RESPONSE COMPLEX 2701
GLASS TRANSITION 3373
GLI 1 3415
GLIADIN 2858, 3376, 3406
GLIADIN LOCI 3415, 3429
GLIADINS 2808, 2872, 2903
GLOBULINS 3394, 3417
GLU 1 3415
GLU A1 LOCUS 2740
GLUCANASE 2766
GLUCANS 3422
GLUCOSE 2806, 2882, 3272, 3402, 3414
GLUMES 2861
GLUTAMIC ACID 2810, 3325, 3463
GLUTAMINE SYNTHETASE 2928
GLUTATHIONE 3232, 3249
GLUTELIN 3440
GLUTEN 2507, 2626, 2787, 2791, 3248, 3268, 3322, 3327, 3336, 3342, 3343, 3347, 3349, 3358, 3371, 3423, 3428, 3430, 3431
GLUTEN PROTEINS 3412
GLUTEN STARCH DOUGHS 3372, 3427
GLUTEN STRENGTH 2779
GLUTENIN 3392, 3415, 3423
GLUTENIN COMPOSITION 3439, 3440
GLUTENIN LOCI 2663
GLUTENIN MACROPOLYMER 3439, 3440
GLUTENIN SUBUNITS 2662, 3429
GLUTENINS 2479, 2640, 2832, 3327, 3330, 3333, 3371, 3385, 3389, 3394, 3404, 3413, 3417, 3418, 3431
GLYCERIDES 3353, 3354, 3397
GLYCEROL 2867, 2882
GLYCINE MAX 2426, 2539, 2639, 2667, 3242
GLYCOLATE 2928
GLYCOSIDASES 2786, 2875
GLYCOSIDES 2859, 3409
GLYOXYLATE 2928
GLYOXYLATE METABOLISM 2928
GOATS 3446
GOLDEN DELICIOUS APPLES 3373
GOSSYPII 2990
GOSSYPIUM 2539, 2606, 2609, 2624, 2630, 2667
GRADING 2449
GRADUAL CHANGES 2835
GRAIN 2481, 2506, 2507, 2508, 2514, 2586, 2587, 2646, 2657, 2681, 2704, 2712, 2763, 2773, 2780, 2797, 2832, 2852, 2864, 2866, 2897, 2900, 2906, 2907, 3074, 3119, 3245, 3246, 3251, 3254, 3255, 3261, 3283, 3303, 3327, 3350, 3363, 3374, 3377, 3424, 3454, 3460, 3465
GRAIN APHID 3014
GRAIN CROPS 2500, 2501, 2603, 2680
GRAIN DEVELOPMENT 2857
GRAIN FEED 2423
GRAIN PROTEIN 2585
GRAIN PROTEIN CONTENT 2891
GRAIN QUALITY 3120, 3185
GRAIN SORGHUM 3028
GRAIN YIELD 2568, 2600, 2655, 2966
GRAINS 3356
GRAMINE 2764
GRAMINEAE 2904, 2905, 2957, 3031, 3344
GRAMINEARUM GROUP 1 3099
GRANULES 2617, 2871, 3112, 3424
GRASS LIGNINS 3456
GRASSES 2477, 2494, 2556, 2631, 2960, 3120, 3291, 3295
GRASSLAND SOILS 2565
GRASSLANDS 2458
GRAVITY 2908
GRAZING 3263, 3266
GRAZING INTENSITY 2453
GREEN MALT 3420
GREEN MANURES 2617, 2623, 3302
GREENHOUSES 2543, 2861, 3121, 3333
GROUNDWATER 2548
GROUP 7 CHROMOSOMES 2661
GROWING PIGS 3281
GROWTH 2464, 2471, 2478, 2513, 2515, 2518, 2541, 2549, 2550, 2551, 2558, 2561, 2565, 2576, 2589, 2702, 2734, 2835, 2838, 2841, 2843, 2857, 2863, 2887, 2908, 2911, 2927, 2939, 2943, 2944, 2949, 2953, 2954, 2956, 2957, 2960, 2965, 2972, 3097, 3174, 3186, 3187, 3188, 3189, 3193, 3196, 3288, 3293, 3321, 3434, 3467, 3468
GROWTH CHAMBERS 2830
GROWTH DISORDERS 2849
GROWTH INHIBITORS 2481, 2515, 2717, 2893
GROWTH PERIOD 2622, 2889, 2947
GROWTH RATE 2480, 2942
GROWTH STAGES 2496
GTP BINDING PROTEIN 2896
GYPSUM 3305
GYPSY MOTH 3017
H 1 NMR 3197
H+ TRANSLOCATING ATPASES 2946
HABITATS 3004, 3010
HABITUATION 3017
HAEMOGLOBIN 2810
HAEMOLYMPH 3033
HALOPHYTE 2933, 2946
HAPLOID 2528
HAPLOID PRODUCTION 2641, 3053
HAPLOIDY 2637, 2718, 2719, 2752, 2799, 2828
HAPLOMETHODS 2637
HAPLOTHRIPS 2991, 2992
HARD 2871
HARD RED SPRING WHEAT, TRITICUM AESTIVUM L 3243
HARD WHEAT 2597, 2681, 3358, 3407, 3443
HARDINESS 3197
HARROWING 2631
HARVEST INDEX 2514
HARVESTERS 3250
HARVESTING 2441, 2577, 2605, 3260
HARVESTING DATE 3256, 3385
HAY 3270, 3277
HC TOXIN SYNTHETASE 2705
HEAD BLIGHT 3074
HEADING 2812
HEALTHY SUBJECTS 3414
HEART 3268
HEART DISEASES 3460
HEAT 2864, 2866, 2906, 3320, 3327, 3388
HEAT STRESS 2504, 2534, 2867, 3184, 3327, 3434
HEAT THERAPY 3054
HEAT TREATMENT 3322, 3336, 3355, 3458
HEAVY METALS 2836, 3187, 3194, 3303, 3465
HEDONIC SHIFT 3269
HEIGHT 2467, 2521, 2750, 2763, 2812, 2844, 2864, 3119, 3175, 3183, 3268, 3467
HEILONGJIANG 3173
HELIANTHUS 2584
HELIANTHUS ANNUUS 2601, 2613, 2974
HELICOTYLENCHUS 3018
HELICOVERPA ARMIGERA 3013
HELMINTHOSPORIUM 3064, 3097, 3118, 3134, 3166
HELMINTHOSPORIUM CARBONUM 2668
HEMICELLULOSE 3458, 3459
HEMIPTERA 3035
HEMP NETTLE 3216
HERBAGE CROPS 3266
HERBICIDE RESISTANCE 2736
HERBICIDE SAFENERS 3232, 3233
HERBICIDES 2422, 2494, 3175, 3200, 3202, 3203, 3205, 3208, 3209, 3210, 3211, 3212, 3213, 3215, 3217, 3219, 3220, 3221, 3222, 3223, 3225, 3226, 3227, 3229, 3232, 3234, 3235, 3236, 3238, 3239, 3240
HERITABILITY 2757, 2758, 2813, 2822
HESSIAN FLY 2688
HESSIAN FLY RESISTANT WHEAT 2425
HETERODERA AVENAE 3160
HETEROGENEITY 2865
HETEROSIS 2685, 2723, 2749, 2823
HEXAPLOID WHEAT 2661, 2808
HEXAPLOIDY 2722, 2791, 2793, 3143

HIDALGO 3072
HIGH CONCENTRATE DIETS 3272
HIGH IRRADIANCE 2958
HIGH M(R) GLUTENIN GENES 2740
HIGH WATER ACTIVITY 3381
HIGH YIELDING VARIETIES 2535, 2646, 2657, 2704, 2755, 2760, 2773, 2774, 2780
HIGHER PLANTS 2904
HIGHLANDS 2499, 2502, 2755
HISTOCYTOLOGICAL ANALYSIS 3115
HISTOPATHOLOGY 3282, 3464
HISTORICAL TRENDS 2427
HISTORY 2639
HMG COA REDUCTASE 3279
HMW GLUTENIN SUBUNITS 2740, 3392
HMW GLUTENINS 2903
HOM 2989
HOMEOSTASIS 2717, 2913
HOMOEOLOGOUS GROUP 2 2661
HOMOLOGIES 3050
HOMOPTERA 2989, 2990, 3014, 3028
HOPLOLAIMUS 3018
HORDEINS 2683
HORDEUM 2452, 2458, 2481, 2485, 2490, 2493, 2506, 2518, 2540, 2604, 2612, 2625, 2642, 2664, 2700, 2712, 2738, 2748, 2754, 2762, 2784, 2796, 2814, 2815, 2836, 2847, 2870, 2928, 3105, 3113, 3117, 3300
HORDEUM BULBOSUM 2637, 2748, 3053
HORDEUM SPONTANEUM 2649, 2805
HORDEUM VULGARE L 2523, 2528, 2731, 2868, 2882, 2898, 2929, 3053
HORDEUM VULGARE SL 2770
HORTICULTURE 2422
HOST PARASITE RELATIONS 3061
HOST PATHOGEN RELATIONS 3122
HOST PLANT 3017
HOST SPECIFIC TOXIN 2668
HOST SPECIFICITY 3080
HOSTS 2999, 3000, 3020, 3150
HOT AIR DRYING 3346, 3350
HPLC 3383, 3394, 3405, 3409
HUBEI 3195
HUMAN NUTRITION 3460
HUMIC ACIDS 2550
HUMIDITY 2894, 3350
HUNGARY 2435, 2853, 3046, 3065, 3154, 3159, 3239
HUSKING 3326
HYBRIDIZATION 2731, 2732, 2801, 2807, 2830, 2963, 3330
HYBRIDS 2537, 2659, 2674, 2685, 2759, 2790, 2801, 2830, 2945, 3053
HYDRATION 3329, 3353
HYDRAZIDES 3464
HYDROCARBONS 3466
HYDROGEN FLUORIDE (HF) 2917
HYDROGEN PEROXIDE 2876
HYDROLASES 2869
HYDROLYSIS 3310, 3334, 3438
HYDROLYTIC ENZYMES 3128
HYDROPHOBICITY 3322, 3324, 3336, 3381, 3401
HYDROXAMIC ACIDS 2957, 3005
HYDROXYPROLINE (HYP) RESISTANCE 2686
HYM 2989, 2990
HYPERTENSION 3460
IAA 2550, 2717, 2909
IAA BIOSYNTHESIS 2970
IAA OXIDASE 2857
ICE 2850, 3329
IDAHO 2437, 3002
IDENTIFICATION 2740, 2751, 2770, 2778, 2782, 2900, 2909, 3041, 3047, 3102, 3155, 3304, 3399, 3406, 3429, 3436
II REACTION CENTER 2781
ILEAL 3454
ILEUM 3454
ILLUMINATED BARLEY 2781
IMAZALIL 2972
IMBIBITION 2969
IMMATURE EMBRYO 2529
IMMOBILIZATION 3290
IMMOBILIZED CELLS 3402
IMMUNE RESPONSE 3282
IMMUNOCYTOCHEMISTRY 3100
IMMUNOFLUORESCENCE 3106
IMMUNOLOGY 2854, 2874, 2901
IMPACTS 3185
IMPORT 2860
IMPORT CONTROLS 2446
IMPORTS 2450
IMPROVEMENT 3259
IMPROVER 3360
IN SITU DEGRADABILITY 3444
IN SITU HYBRIDIZATION 2641
IN VITRO ANDROGENESIS 2523
IN VITRO CULTURE 2669
IN VITRO EXPERIMENTATION 2637, 2721, 3263
IN VITRO REGENERATION 2525
IN VITRO SELECTION 2686
IN VITRO TRANSCRIPTION 2781
IN VIVO P 31 NMR 2933
INBRED LINES 2807, 2828
INCOME 2437
INCOMPLETE BLOCK DESIGNS 2519
INCORPORATION 2463
INCREASES YIELD 2972
INCREASING CARBON DIOXIDE 2835
INCUBATION 3278
INDEX 3435
INDIA 2621, 3067, 3235, 3242
INDICATOR 3364
INDIGENOUS ORGANISMS 2636
INDIGOFERA 3039
INDOLE 3 ACETALDEHYDE 2909
INDOLE 3 ETHANOL 2909
INDOLEACETIC ACID 2857
INDUCED CELL ELONGATION 2887
INDUCED MUTATION 2775, 2831
INDUCED PROTEINS 3100
INDUCTION 2868, 3233
INDUSTRY 2437
INFECTION 2944, 2983, 3099, 3109, 3115, 3129, 3147, 3306
INFECTION STRUCTURES 2766
INFERTILITY 2825
INFESTATION 2470, 2680, 2992, 2995, 3002, 3079, 3117, 3151, 3248, 3254, 3255
INFLORESCENCE PRIMORDIUM 3189
INFLORESCENCES 2529
INFLUX 2953
INFORMATION 2429
INFORMATION SYSTEMS 2458
INFRARED SPECTROPHOTOMETRY 2884, 3363
INGREDIENTS 3258, 3377
INHERITANCE 2668, 2691, 2821
INHIBITION 2867, 3358, 3381, 3397, 3410
INHIBITORS 3310
INITIATION 2961
INJURY 2702
INNOVATION ADOPTION 2432, 2433, 2436
INOCULATION 2695
INOCULATION METHODS 2941, 3065
INOCULUM DENSITY 3161
INORGANIC ACIDS 2862
INORGANIC SALTS 3186
INSECT CONTROL 2994, 2997, 3245
INSECT NEMATODES 3042
INSECTA 2981, 2982, 2986
INSECTICIDES 2994, 2997, 3023, 3044, 3119, 3120, 3245, 3315
INSITU 3265
INSOLUBLE ASH 3280
INSULIN 3460
INSULIN RESPONSES 3435
INTACT 2860
INTEGRATED CONTROL 2902, 3164, 3204
INTEGRATED PEST MANAGEMENT 2980, 3245
INTEGRATED PLANT PRODUCTION 2472
INTEGRATION 2451
INTENSIVE FARMING 2584, 2613
INTER MODEL COMPARISON 3191, 3196
INTERCELLULAR CANALS 2914
INTERCOMPARISON 3368
INTERCROPPING 2467, 2618, 2620, 2624, 2629, 2630, 2996, 3300
INTERFACES 3304
INTERFACIAL PROPERTIES 3412
INTERFAMILIAL SOMATIC HYBRID 2731
INTERFERENCE 3216
INTERGENERIC HYBRIDIZATION 2503, 2675, 2678, 2714
INTERGENERIC HYBRIDS 2641
INTERSPECIFIC HYBRIDIZATION 2637, 2793
INTERVARIETAL MAP 2661
INTESTINE 3275
INTESTINES 3464
INTRACELLULAR PH 2588
INTRASPECIFIC HYBRIDIZATION 3114
INTRINSIC RATE 2990
INTRODUCED VARIETIES 3045
INVIVO 3435
ION CHANNELS 2934
ION EXCHANGE 2851, 2914
ION EXCHANGE CAPACITY 3294
ION TRANSPORT 2953, 2971
IONIC STRENGTH 2588
IONS 2565, 2913, 3180, 3324
IONTOPHORESIS 2856
IOXYNIL 3003
IPOMOEA BATATAS 2670
IPT GENE 2948
IRAN ISLAMIC REPUBLIC 2482, 2493, 2504, 2647, 2784, 2809, 2981, 2982, 2986, 2988, 2993, 3011, 3015, 3016, 3024, 3025, 3029, 3030, 3031, 3032, 3036, 3037, 3038, 3040, 3043, 3057, 3058, 3059, 3060, 3063, 3064, 3081, 3082, 3084, 3087, 3088, 3092, 3093, 3094, 3123, 3125, 3126, 3127, 3134, 3135, 3140, 3148, 3149, 3158, 3169, 3170, 3171, 3201, 3209, 3211, 3214, 3224, 3225, 3231, 3407, 3470, 3471
IRAQ 2575, 2983, 2993
IRON 2765, 3296
IRON DEFICIENCY 2882, 3187
IRRADIATION 3339, 3383
IRRIGATED FARMING 3314
IRRIGATED WHEAT 2455
IRRIGATION 2477, 2495, 2572, 2593, 2594, 2597, 2600, 2628
IRRIGATION RATES 2557, 2595, 2596, 3230
IRRIGATION SYSTEMS 2889
IRRIGATION WATER 2598
ISODITYROSINE 2857
ISOENZYMES 2687, 2696, 2720, 3166, 3194
ISOGENIC LINES 2956
ISOLATION TECHNIQUES 2854, 2890

ISOPROTURON 3235
ISOTOPES 2881, 2922, 3466
ISOZYME 2656, 2683
ISOZYMES 2770, 2808
ISRAEL 2736
ITALY 3270, 3378, 3383
JASMONATE INDUCED PROTEINS 3100
JASMONATES 3100
JEJUNUM MUCOSA 3274
JELLIFICATION 2670, 3334, 3349, 3359, 3388, 3419, 3438
JIANGSU 3085
JUGLANS 2669
KANSAS 3245, 3251, 3365, 3366, 3400, 3426
KARNAL BUNT 2695
KARYOTYPES 2748, 2783
KEEPING QUALITY 3446, 3455
KERNEL MORPHOLOGICAL VARIATION 2871
KERNELS 2443, 2490, 2757, 2758, 3074, 3252, 3335, 3378, 3396, 3400, 3425
KINASE 2736, 2905
KINETICS 2923, 2971, 3402
KOREA REPUBLIC 3359
L CV HERTA 3188
L LEAVES 2911
L TRYPTOPHAN 2909
LABILE PHOSPHATE 3289
LABORATORY EXPERIMENTATION 3350, 3425
LACTATING COWS 3265
LACTATING DAIRY COWS 3272
LACTIC ACID 2862
LACTIC ACID PRODUCTION 3402
LACTOBACILLUS DELBRUECKII 3402
LACTOCOCCUS LACTIS 3402
LAMBS 3264
LAND DIVERSION 2423
LAND PLANTS 2588
LAND RACES 2802
LAND VARIETIES 2636, 2645
LANDRACE BARLEYS 2683
LANDRACES 2742, 2842, 3176
LANDSCAPE 2491
LARVAE 2991, 3006, 3007
LATE SEASON APPLICATION 2455
LATHYRUS 3201
LATIN AMERICA 3313
LATVIA 2461, 2507, 2508, 2603, 3056, 3142, 3240, 3344
LAW 2423
LEACHING 2475, 2556, 2569, 2584, 2623, 3291, 3438
LEAD 3186, 3303, 3469
LEAF 2511, 2856, 2956, 2960, 3307
LEAF APPEARANCE RATE 2961
LEAF AREA INDEX 2843
LEAF COLOR 2764, 2891
LEAF DAMAGE 3185
LEAF EATING INSECTS 2831
LEAF EXPANSION 2949
LEAF GAS EXCHANGE 2910
LEAF GROWTH 2974
LEAF PHYSIOLOGY 3014
LEAF RUST 2782
LEAVES 2573, 2622, 2686, 2756, 2766, 2786, 2831, 2843, 2859, 2864, 2866, 2873, 2891, 2893, 2901, 2908, 2916, 2918, 2922, 2927, 2943, 2957, 2960, 2974, 2976, 2979, 2986, 2995, 3008, 3018, 3080, 3111, 3121, 3141, 3147, 3153, 3162, 3174, 3184, 3400, 3451
LECITHINS 2867
LECTINS 2874, 3357
LEGISLATION 2423
LEGUME RESIDUES 2558, 2585
LEGUMES 2435
LENGTH POLYMORPHISMS 2656
LEPA 2572
LEPIDOPTERA 3017
LEPTINOTARSA DECEMLINEATA 2754
LEPTOSPHAERIA NODORUM 3086
LETTUCES 3291
LEUCINE 2534
LIFE CYCLE 3020
LIFE TABLES 2989, 2990
LIGHT 2781, 2873, 2905, 2908, 2977, 3104
LIGNIN 3456
LIGNINS 2849, 3458, 3459
LILIUM 2977
LIMESTONE 2902
LIMING 2543, 2556, 2579
LIMIT DEXTRINASE 3420
LIMITATION 2943
LINEAR MODELS 3283
LINEAR PROGRAMMING 2623
LINES 2691, 2764, 2779, 3080, 3100
LINKAGE MAPS 2661
LINOLEATE PEROXIDATION 3381
LINOLEIC ACID 2869
LINSEED 2452, 2699
LINUM USITATISSIMUM 2452, 2577, 2631, 2699
LINYPHIIDAE 3046
LIPID COMPOSITION 2946, 3199
LIPID CONTENT 2596, 3262
LIPID METABOLISM 3414
LIPIDS 2867, 3254, 3327, 3353, 3359, 3371, 3397, 3412
LIPOXYGENASE 2869, 3352
LIQUID CHROMATOGRAPHIC DETERMINATION 3368
LIQUID MANURE 2585
LIQUIDS 3342
LITHUANIA 2533
LITTER 3318
LIVER 3269
LIVER CHOLESTEROL 3279
LMW SUBUNITS 2803, 3429
LOAM SOILS 3302
LOCATION 2808, 3436
LOCI 2687, 2706, 2745, 2779, 2799, 3020
LOCOMOTION 3033
LOCUS 2674
LOCUSTA MIGRATORIA 3033
LODGING 2763
LODGING RESISTANCE 2515, 2583
LOESS SOILS 3285
LOLIUM 2937, 3221, 3225, 3302
LOLIUM MULTIFLORUM 2509
LOLIUM MULTIFLORUM LAM 2496
LOLIUM PERENNE 2577, 2588, 2680
LOLIUM PERENNE L 2496
LONG TERM EXPERIMENT 2592
LONG TERM TOXICITY 3360
LONGEVITY 3020
LOSSES 2442, 2576, 2580, 2623, 2992, 3026, 3119, 3161, 3227, 3301, 3314
LOW FAT DIET 3411
LOW INPUT 2742
LOW INPUT AGRICULTURE 2610, 2623
LOW M(R) 3439
LOW M(R) WHEAT PROTEINS 3440
LOW TEMPERATURE 2731, 2943
LOW WATER POTENTIALS 2912
LUCERNE 2616
LUPIN EXTRACTS 2552
LUPINS LUPINUS ANGUSTIFOLIUS 3309
LUPINUS 2699
LUPINUS ANGUSTIFOLIUS 2611
LYCOPERSICON ESCULENTUM 2476, 2505, 2509, 2667, 3039
LYCOSIDAE 3046
LYMANTRIA DISPAR 3017
LYMEGRASS 2641
LYSIMETERS 3291
LYSINE 2747
M(R) GLUTENIN SUBUNITS 3433
MACROECONOMIC ANALYSIS 2437
MACROTYLOMA UNIFLORUM 2621
MAGNESIUM 2484, 2554, 3190, 3294
MAGNETIC FIELD 2539
MAILLARD REACTION 3358
MAIN SHOOT 2955
MAIZE 2424, 2435, 2445, 2464, 2522, 2578, 2592, 2638, 2667, 2705, 2712, 2753, 2815, 2843, 2868, 2912, 2937, 3233, 3254, 3255, 3263, 3270, 3363, 3452
MAIZE ENDOSPERM 2768
MAIZE PLANTS 3187
MAIZE ROOTS 2865
MAIZE SEEDLINGS 2868
MAIZE ZEIN 3381
MAJOR FACTOR 2702
MAJOR GENES 2655
MAKING QUALITY 3429
MALATE DEHYDROGENASE ISOZYMES 2808
MALE INFERTILITY 2722, 3198
MALE STERILITY 2977
MALIC ACID 2862, 3180
MALONYL D TRYPTOPHAN 2970
MALT 2626, 2880, 3323, 3326, 3410
MALT MODIFICATION 3420
MALTING (ANALYSIS METHOD FOR) 3420
MALTING BARLEY 2456, 2579, 2593, 2654, 2659, 2692, 2700, 2711, 2796, 2880, 3326, 3410
MALUS 2669
MAMMALS 3022, 3269
MANAGEMENT 2465
MANCOZEB 3096
MANGANESE 2556, 2751, 2920, 2931, 3186, 3294, 3296
MANGANESE SULPHATE 2834
MANITOBA 2866, 3074, 3095
MANKIND 3461
MANNITOL 3184
MANPOWER 2441
MAP 2656, 2705
MAPPING 2663, 2839
MAPS 2655, 2663, 2730
MARGINAL FARMS 3449
MARGINAL LAND 2665, 2802
MARKER ASSISTED SELECTION 2688
MARKERS 2713, 2740, 2770, 2978
MARKET PRICES 2440, 2449
MARKETING 2439, 2445, 3055
MARYLAND 2780
MASS SPECTROMETRY 3363
MASSACHUSETTS 2509
MATHEMATICAL MODELS 2424, 2439, 2487, 2560, 2623, 2843, 2889, 2893, 2965, 2980, 3228, 3317, 3321, 3323
MATHEMATICS 2439, 2449, 2893, 3396
MATO GROSSO DO SUL 3110
MATRICARIA 2902, 3222
MATRICARIA PERFORATA 2902
MATURATION 2479, 2583, 2813, 2930
MATURED SOYBEAN 2558
MATURITY 2509, 3444
MAXIMA DUCH HYPOCOTYLS 2911, 2912
MAXIMUM AMYLOGRAPH VISCOSITY 2895
MAYETIOLA 3021

MAYETIOLA DESTRUCTOR 2821, 2993, 3021
MCPA 3227
MEAL PATTERNS 3460
MEASUREMENT 2565, 2914, 3294, 3296, 3367, 3455
MEASURING INSTRUMENTS 3437
MEAT BONE MEAL 2585
MECHANICAL PROPERTIES 2899, 2911, 2912, 3373, 3388
MECHANICAL PROPERTIES OF CELL WALLS 2912
MECHANISM 2977
MECHANISMS 2641, 2933, 2971
MEDIA 2523
MEDICAGO SATIVA 2623, 2836
MEDITERRANEAN CLIMATE 3320
MEDITERRANEAN COUNTRIES 3320
MEDITERRANEAN ZONE 3320
MEIOSIS 2674, 2729, 3182
MELANOPLUS 3010
MELANOPLUS SANGUINIPES 3010
MELOIDOGYNE INCOGNITA 3039
MELOIDOGYNE JAVANICA 3039
MEMBRANE 2905
MEMBRANE H+ ATPASE 3304
MEMBRANE POTENTIAL (ELECTRICAL) 2934
MEN 3461
MERCAPTOETHANOL 3440
MERCURIC CHLORIDE 2727
MERCURY 3468
MERISTEMS 2901
MESOPHYLL 2865
MESSENGER RNA 2650, 2717, 2781
METABOLISM 2549, 2736, 2859, 2868, 2909, 2972, 3162, 3221, 3232, 3233, 3235, 3272, 3274, 3360, 3402, 3461
METABOLITES 2859, 2869, 2875, 3232
METABOLIZABLE ENERGY 3271
METAL AVAILABILITY 3303
METAL CONTENTS 2931
METALDEHYDE 3000, 3003, 3004, 3012
METAPHASE CHROMOSOMES 2783
METEOROLOGICAL ELEMENTS 3086
METHANOL 3337
METHIOCARB 3003, 3027
METHIONINE 2765, 2882
METHODOLOGY 3139
METHODS 2487, 2667, 2729, 2854, 2916, 2951, 3002, 3069, 3090, 3155, 3260, 3329, 3390, 3425, 3432, 3455
METHYL LINOLEATE 3381
METOLACHLOR 3233
METOPOLOPHIUM DIRHODUM 3009, 3013, 3014
MEXICO 3067
MEXICO (PROVINCE) 3072, 3144, 3218
MICROBIAL ACTIVITY 3318
MICROBIAL BIOMASS 2892
MICROBIAL FLORA 3140
MICROBIAL POPULATIONS 3278
MICROBIOLOGICAL ANALYSIS 3078, 3127
MICROCLIMATE 2624, 2630
MICRODISSECTION 2783
MICROFLORA 3139
MICRONUTRIENT FERTILIZERS 2591
MICROORGANISMS 3299
MICROPROJECTILE BOMBARDMENT 2522, 2529, 3433
MICROSATELLITES 2713
MICROSCOPY 2762, 3388
MICROSPORE CULTURE 2528
MICROSPOROGENESIS 2977
MICROWAVE TREATMENT 2540
MIDDLE EAST 3313
MILDEWS 2689, 2811, 2819, 2828, 3073, 3155, 3156
MILDLY HYPERCHOLESTEROLEMIC MEN 3411
MILK FAT 3262
MILK PRODUCTION 3265
MILK PROTEIN 3262
MILK REPLACERS 3268
MILK YIELD 3262
MILLETS 2712
MILLING 3043, 3252, 3257, 3326, 3331, 3345, 3352, 3366, 3374, 3378, 3400, 3416, 3426, 3443
MILLING INDUSTRY 3043
MILLING PRODUCTS 3398
MILLS 3345
MINERAL CONTENT 2484, 2596, 2932, 3369, 3377
MINERAL DEFICIENCIES 2765, 3297
MINERAL NITROGEN 2563
MINERAL NUTRIENTS 2937, 3188, 3285, 3377
MINERALIZATION 2584, 2926, 3290
MINIMUM TILLAGE 2477, 2485, 2584
MINNESOTA 3077
MISCANTHUS 3253
MITOCHONDRIA 2901
MITOSIS 2848, 2901
MIXING 2463, 3056, 3327, 3329, 3343, 3349, 3442
MIXING BEHAVIOUR 3434
MIXTURES 2464
MO COFACTOR 3192
MODEL 2429, 3189, 3427
MODEL COMPOUNDS 3456
MODELS 2428, 2443, 2448, 2487, 2574, 2628, 2676, 2843, 2907, 3023, 3026, 3071, 3173, 3207, 3321, 3359, 3396, 3443
MOIST STORAGE 3259
MOISTURE 2491
MOISTURE CONTENT 2534, 2540, 3250, 3252, 3262, 3329, 3340, 3342, 3343, 3357, 3358, 3396, 3461
MOLASSES 3261
MOLECULAR BASIS 2769
MOLECULAR BIOLOGY 2669, 2806
MOLECULAR CLONING 2765, 2833, 2896, 3304
MOLECULAR GENETICS 2643, 2787, 2815
MOLECULAR MAPPING 2691
MOLECULAR MARKER 2782
MOLECULAR WEIGHT 2479, 2832, 3332, 3333, 3338, 3347, 3389, 3401, 3420, 3431, 3432
MOLECULAR WEIGHT GLUTENIN 2638, 2872
MOLECULAR WEIGHT SUBUNITS 2740, 3423, 3433
MOLLUSCA 3003, 3004, 3012, 3034
MOLLUSCICIDES 3000, 3003, 3004, 3012, 3027, 3034, 3048
MOLYBDENUM 3192, 3195, 3465
MONARCH BUTTERFLY (DANAUS SPP.) 3244
MONITORING 3374
MONOCLONAL ANTIBODIES 2948, 3397
MONOCOCCUM 2779
MONOCOTYLEDON 2850
MONOCULTURE 2619, 2625, 2632, 2633, 3108, 3153
MONOGRAPHELLA NIVALIS 3152
MONOSACCHARIDES 2995
MONOTERPENOIDS 3034
MONTANA 2657, 3010
MORBIDITY 3124
MOROCCO 2425, 2919
MORPHOLOGY 3274
MORTALITY 2999
MUGINEIC ACID 2882
MULCHES 2607
MULTIPLE CROPPING 2620
MULTIPLE FORMS 2766
MULTIPLE PROBES 2674
MULTIPLE REGRESSION 2465
MULTIPURPOSE BREEDS 3471
MUNG BEANS 3424
MUSTARD 2937
MUTAGENS 2734, 2775
MUTANT 2674
MUTANTS 2659, 2697, 2777, 2795, 2831, 2873, 2890, 3166, 3454
MUTATION 2642, 2732, 2734, 2777, 2795, 3234
MYB 2701
MYCELIUM 3109
MYCORRHIZAL FUNGI 2944
MYCOSPHAERELLA GRAMINICOLA 2993, 3086
MYCOTOXICOSIS 3361
MYCOTOXINS 3130, 3143, 3170, 3250, 3282, 3362
MYTHIMNA SEPARATA 3044
N 15 LABELLED CROP RESIDUES 3290
N 15 LEAF FEEDING 2892
N 15 NATURAL ABUNDANCE 2870, 3309
N 15 UTILIZATION EFFICIENCY 2558
N 2 FIXATION 3309
N MALONYL D TRYPTOPHAN 2970
NA+/H+ ANTIPORT 2933
NACL 2927
NACL STRESS 2865
NATURAL ABUNDANCE 2870
NATURAL ENEMIES 2981, 3001, 3044
NEAR ISOGENIC LINE 2779
NEAR ISOGENIC LINES 2688
NEBRASKA 2646, 2704
NECROSIS 2691
NEMATODE CONTROL 2754, 3018, 3039
NEOPLASMS 3460
NET ASSIMILATION OF CO2 2940
NEW SOUTH WALES 3208
NEW SPECIES 3011, 3029, 3045
NEW ZEALAND 3021
NH3 2918
NICKEL 3186, 3465
NICOTIANA TABACUM 2639, 2731, 2777, 2874
NICOTIANAMINE 2882
NICOTINAMIDE 3325
NINGXIA (HUI) 2560
NITOSOLS 2590
NITRATE 2563, 2588, 3301
NITRATE REDUCTASE 2938, 2942, 3192
NITRATES 2442, 2475, 2484, 2548, 2569, 2584, 2596, 2623, 2851, 2914, 2915, 2938, 2942, 3291
NITROBENZENE OXIDATION 3456
NITROGEN 2464, 2466, 2484, 2487, 2494, 2556, 2566, 2569, 2571, 2584, 2615, 2616, 2617, 2789, 2834, 2881, 2888, 2899, 2918, 2938, 2942, 2960, 2961, 3104, 3174, 3185, 3193, 3276, 3285, 3291, 3295, 3298, 3301, 3312, 3314, 3318, 3333, 3401
NITROGEN CONTENT 2546, 2626
NITROGEN CYCLE 2584
NITROGEN FERTILIZER 2578
NITROGEN FERTILIZERS 2461, 2479, 2481, 2483, 2484, 2490, 2507, 2508, 2510, 2536, 2538, 2541, 2545, 2546, 2548, 2553, 2557, 2560, 2562, 2564, 2566, 2569, 2573, 2577, 2579, 2580, 2583, 2584, 2594, 2595, 2596, 2599, 2602, 2615, 2617, 2843, 2853, 2864, 2907, 2941, 3009, 3091, 3314
NITROGEN FIXATION 2581, 3302

NITROGEN FIXING BACTERIA 2941
NITROGEN IMMOBILIZATION 2547
NITROGEN ISOTOPE FRACTIONATION 2870
NITROGEN METABOLISM 2521
NITROGEN MINERALIZATION 2547, 2585
NITROGEN NUTRITION 2891
NITROGEN UPTAKE 2547
NITROGEN USE EFFICIENCY 2910
NITROGEN UTILISATION 3281
NITROGENASE 3308
NIVALENOL 3130
NMR SPECTROSCOPY 2933, 3419
NOCTUIDAE 3017
NODAL ROOTS 2974
NOMENCLATURE 3098
NON FOOD PRODUCTS 3260
NONCEREAL FLOURS 2670
NONDESTRUCTIVE METHODS 2960
NONGOVERNMENTAL ORGANIZATIONS 2535
NONHOST 3080
NONSTARCH POLYSACCHARIDES 3430
NORFLURAZON 2860
NORTH AFRICA 3117
NORTH AMERICA 3045
NORTH DAKOTA 3153
NORTH EASTERN VICTORIA 3309
NORWAY 3449
NOSTOC 3308
NOXIOUS ANIMALS 3026
NPK FERTILIZERS 2586, 2790, 3291
NUCLEAR 2731
NUCLEAR DNA 2662
NUCLEAR MAGNETIC RESONANCE 3197
NUCLEASES 2847
NUCLEIC PROBES 2697, 2762
NUCLEOLUS 2818
NUCLEOSIDE DIPHOSPHATE KINASE 2896
NUCLEOTIDE SEQUENCE 2635, 2643, 2650, 2676, 2733, 2786, 2803, 2833, 2874, 3116
NUCLEOTIDE SEQUENCES 2769
NUCLEOTIDES 2810
NUCLEUS 2874
NUMBER 2961
NUTRIENT AVAILABILITY 2566, 2615, 2942, 3293, 3294, 3296, 3297
NUTRIENT IMPROVEMENT 3445
NUTRIENT MEDIA 2588
NUTRIENT SOLUTION TECHNIQUE 3188
NUTRIENT SOLUTIONS 3178
NUTRIENT TRANSPORT 2790, 2819, 2851, 2888, 2935, 2945
NUTRIENT UPTAKE 2553, 2566, 2573, 2592, 2617, 2790, 2920, 2921, 2937, 2938, 2945, 3040, 3285, 3293, 3297
NUTRIENTS 2577, 2584, 2617, 2627, 3174, 3267, 3295, 3306
NUTRITION PHYSIOLOGY 3461
NUTRITIONAL REQUIREMENTS 2920, 2921, 3159
NUTRITIONAL STATUS 3313
NUTRITIVE VALUE 2621, 3281, 3294, 3331, 3377, 3428, 3445, 3450
O 3 3185
OAK HICKORY FOREST 2958
OAT 3216
OAT BRAN 3279, 3414
OATS 2621, 2699, 2712, 2815, 3186, 3270, 3291, 3362, 3418, 3461
OAXACA 2497
OCEAN ATMOSPHERE MODEL 2835, 2839
OCEANIA 3313
OCHRATOXIN 3362, 3364
OCHRATOXIN A 3368
OIL CROPS 2601
OKLAHOMA 2470
OLEA EUROPAEA 3451
OLIGOSACCHARIDES 3409
OPAQUE 2 2638
OPEN AIR FUMIGATION 2838
OPHIOBOLUS 3142
OPTIMIZATION METHODS 2470
OREGANO ORIGANUM VULGARE 3269
OREGON 3234
ORGANIC ACIDS 2862, 2901
ORGANIC AGRICULTURE 2610, 2612, 2626, 2631
ORGANIC AMENDMENTS 2550
ORGANIC CARBON BUILD UP 2592
ORGANIC FARMING 2585
ORGANIC FERTILIZERS 2560, 2587, 2590, 3190, 3285, 3291
ORGANIC MATERIALS 2571
ORGANIC MATTER 2458, 2487, 3297
ORGANIC NITROGEN COMPOUNDS 3459
ORGANIZATION 2663, 2783
ORGANOLEPTIC ANALYSIS 2670, 3339, 3358
ORGANOLEPTIC PROPERTIES 2453
ORYZA 2617, 3314
ORYZA SATIVA 2489, 2591, 2608, 2667, 2701, 2712, 2815, 2848
ORYZA SATIVA L 2868
OSMOTIC ADJUSTMENT 2949
OSMOTIC POTENTIAL 2912
OSMOTIC PRESSURE 2865
OSMOTIC STRESS 2912
OTHER METALS 3186
OULEMA 3041
OULEMA MELANOPUS 3041
OVA 3006
OVARY CO CULTIVATION 2528
OVARY CO CULTURE 2523
OVEN 3398
OVENS 3396
OVERWEIGHT 3460
OVINE GASTROINTESTINAL TRACT 3272
OVIPOSITION 2985
OXALATE OXIDASE 2650
OXALATES 2717, 2916
OXALIS 3218
OXIDATION 2857, 2869, 3431, 3459
OXIDOREDUCTASES 2717, 2810, 2869, 2901, 2916
OXIDOREDUCTIONS 2908
OXYGEN 2875
OXYGEN EVOLVING COMPLEX 2929
OXYGEN PERMEABILITY 3373
OZONE 2838, 3185, 3467
OZONE (O 3) 2917
P 31 NUCLEAR MAGNETIC RESONANCE 2933
P COUMARIC ACID 3456
P SOIL TEST 3316
P UPTAKE 3316
PACIFIC NORTHWEST 2973
PACIFIC STATES (USA) 2446, 3101, 3152, 3385
PACLOBUTRAZOL 2467, 2521
PADDY SOIL 3288
PAENIBACILLUS POLYMYXA 3128
PAKISTAN 2506, 2566, 2617, 3067
PAL TRANSCRIPTS 2727
PALATABILITY 3269, 3446
PANAX PSEUDOGINSENG 3446
PANCREATIC EXOCRINE SECRETION 3272
PANICUM MILIACEUM 2621
PAPER STRENGTH 3341
PARASITES 2994, 3251
PARASITIC NEMATODES 2469
PARASITOID 2990
PARASITOIDS 2994, 3251
PARASITOIDS HYMENOPTERA 2989, 2990
PARENTS 2723, 2795, 2817
PARTIAL REDUCTION 3440
PARTICLE SIZE 3262, 3327, 3378, 3441
PASSAGE 3273, 3281
PASTA 2670, 3339, 3347, 3358, 3359, 3407
PASTA INDUSTRY 3407
PASTURE LEGUMES 3309
PASTURES 2987
PATENTS 3162
PATHOGENESIS 3061, 3067, 3119, 3152
PATHOGENESIS RELATED (PR) PROTEINS 3100
PATHOGENESIS RELATED PROTEIN 2850
PATHOGENESIS RELATED PROTEINS 2766, 2850
PATHOGENICITY 2973, 3061, 3067, 3104, 3115, 3154, 3157, 3160, 3163
PATHOGENS 3022, 3023, 3052, 3104, 3116, 3146, 3152, 3153, 3163, 3172
PATHOTYPES 3160
PATHWAY 2909
PATTERNS 2683
PATULIN 3361
PAULOWNIA 2618, 2962
PCR 2697, 2713, 2738, 2806, 2833, 3116
PEA LECTIN PROMOTER 2638
PEA NUCLEI 2905
PEANUT CULTIVARS 2910
PEAS 2442, 2699, 3300, 3409
PEAT 3112
PEDIGREE 2842
PEDIGREE ANALYSIS 2730
PELLETING 3270, 3281
PELLETS 3277
PENTOSANS 3259, 3416
PEPTIDES 2890, 3101, 3347, 3442
PERENNIAL WEEDS 3244
PERENNIALS 2603
PERFORMANCE 2742
PERFORMANCE LIQUID CHROMATOGRAPHY 2803, 3392, 3406, 3415, 3423, 3439
PERFORMANCE TESTING 2514
PERILLA FRUTESCENS 2621
PERMEABILITY 2874
PEROXIDASE 2857
PEROXIDASES 2721, 2849, 2876, 2900, 3166, 3184, 3358
PEST CONTROL 2494, 3015, 3016, 3024, 3029, 3030, 3031, 3037, 3038, 3040, 3048
PEST INSECTS 2434, 2591, 2680, 2984, 2994, 2996, 3006, 3007, 3009, 3022, 3023, 3045, 3049, 3164, 3251
PEST RESISTANCE 2646, 2669, 2673, 2704, 2831, 2993, 2998, 2999, 3020
PEST SURVEYS 3041, 3047
PESTICIDE ACTIONS 3238
PESTICIDE PERSISTENCE 3202
PESTICIDE SYNERGISTS 3238
PESTICIDES 2472, 2610, 2623, 2979, 3015
PESTS OF PLANTS 2500, 2501, 2633, 2981, 2982, 2986, 2988, 2999, 3000, 3003, 3004, 3009, 3011, 3012, 3013, 3015, 3016, 3019, 3023, 3024, 3025, 3027, 3029, 3030, 3031, 3032, 3034, 3036, 3037, 3038
PETROBIA 3031
PETROLEUM 3466
PH 2577, 2590, 2670, 2851, 2862, 2913, 2914, 2931, 3104, 3190, 3263, 3324, 3332, 3352
PH DEPENDENCE 2898
PHACELIA 2604

PHACELIA TANACETIFOLIA 3302
PHALARIS 3211, 3224, 3235
PHASEOLUS 2667
PHASEOLUS VULGARIS L 3187
PHENOLIC ACIDS 2855, 3068, 3416, 3456, 3462
PHENOLIC ACIDS AND ALDEHYDES 3456
PHENOLIC ANTIOXIDANTS 3462
PHENOLIC COMPOUNDS 3459
PHENOLOGY 2835, 2991
PHENOTYPES 2807
PHENYL PHOSPHORODIAMIDATE 3310
PHENYLPROPANOID METABOLISM 2727
PHLOEM 2930
PHLOEM LOADING PATHWAY 2856
PHOSPHATE 2923, 2971, 3311
PHOSPHATE BUFFER CAPACITY 3289
PHOSPHATE FERTILIZERS 2543, 2560, 2565, 2567, 2579, 2634, 3293
PHOSPHATE SOLUBILISATION 3311
PHOSPHATE SYNTHASE ACTIVITY 2943
PHOSPHOLIPIDS 2635, 2901
PHOSPHORUS 2484, 2486, 2577, 2581, 2834, 2921, 2923, 2937, 2944, 3294, 3298, 3311, 3316, 3465
PHOSPHORUS TOXICITY 3188
PHOSPHORYLASE 2806
PHOSPHORYLATION 2885, 2905
PHOTOASSIMILATE 2955
PHOTOINHIBITION 2845
PHOTOPERIOD 2957, 2961
PHOTOPERIODICITY 2517
PHOTORECEPTOR 2904
PHOTORESPIRATION 2928
PHOTOSYNTHESIS 2587, 2618, 2819, 2845, 2873, 2879, 2891, 2893, 2908, 2910, 2918, 2922, 2935, 2947, 2962, 3174, 3185, 3193, 3467
PHOTOSYNTHETIC ACTIVITIES 3187
PHOTOSYNTHETIC APPARATUS 2929
PHOTOSYNTHETIC DIFFERENCES 2910
PHOTOSYSTEM I 2860
PHOTOSYSTEM II 2781
PHOTOSYSTEMS 2733, 2890
PHOTOTROPISM 2904
PHYLLOCHRON 2961
PHYLLOSPHERE FUNGI 2838
PHYLOGENY 2720
PHYSICAL CONTROL 2601
PHYSIOLOGICAL FUNCTIONS 2756
PHYSIOLOGICAL RACES 3111, 3125
PHYSIOLOGY 2917, 3199
PHYTIC ACID 3255
PHYTOCHROME 2905, 2948
PHYTOSIDEROPHORE 2882
PHYTOSTEROLS 3182
PHYTOTOXICITY 2565, 2571, 3034, 3178, 3180, 3205, 3221
PHYTOTOXIN 2705
PIERIDAE 3017
PIERIS RAPAE 3017
PIG SLURRY 2571
PIGMENT 3174
PIGS 3454
PILOT FARMS 2421, 2433
PINNATA 2581
PISUM 2699
PISUM SATIVUM 2623, 2631, 2841, 3187, 3215
PISUM SATIVUM L 2904
PLACEMENT 2584
PLAINS 2572, 2760
PLANNING 3472
PLANT 2850, 2910, 3398
PLANT ANATOMY 2843, 2854, 2901, 3159
PLANT AVAILABILITY 2931
PLANT AVAILABLE WATER CAPACITY 2578
PLANT BIOTECHNOLOGY 2809, 2814
PLANT BREEDING 2460, 2639, 2664, 2669, 2672, 2693, 2712, 2719, 2732, 2741, 2758, 2759, 2774, 2794, 2797, 2798, 2801, 2814, 2824, 2825, 2993, 3061, 3067, 3090, 3130, 3328, 3347, 3473
PLANT CELL 2933
PLANT CELL WALLS 2912, 3462
PLANT CHROMOSOMES 2783
PLANT COLLECTIONS 2679
PLANT COMPETITION 2843
PLANT CONDITION 2575
PLANT CUTICLE 2979
PLANT DEVELOPMENTAL STAGES 2549, 2573, 2593, 2717, 2843, 2864, 2962, 2967, 3002, 3150, 3227, 3320
PLANT DISEASE RESISTANCE 2782
PLANT DISEASES 2434, 2591, 2680, 2706, 3023, 3052, 3057, 3058, 3059, 3060, 3063, 3064, 3081, 3082, 3084, 3087, 3088, 3091, 3092, 3093, 3094, 3105, 3117, 3123, 3126, 3127, 3134, 3135, 3140, 3142, 3148, 3149, 3153, 3158, 3164, 3169, 3170, 3171
PLANT ECOLOGY 2463
PLANT EMBRYOS 2534, 2640, 2677, 2829
PLANT ESTABLISHMENT 2514
PLANT EXTRACTS 3034, 3325, 3326
PLANT GALLS 3011
PLANT GROWTH REGULATOR 2959
PLANT GROWTH SUBSTANCES 2476, 2480, 2503, 2859, 3182, 3198
PLANT HABIT 2772, 2843
PLANT MATERIALS 2547
PLANT NEMATODES 2673, 3018, 3039
PLANT NUTRITION 3294, 3295
PLANT OILS 3353
PLANT PHYSIOLOGY 2745, 2897
PLANT POPULATION 2452, 2513, 2840, 2843, 3207, 3213, 3223, 3237
PLANT PRODUCTION 2432, 2434, 2440, 2462, 2474, 2487, 2505, 2506, 2509, 2575, 2621
PLANT PROPAGATION 2669
PLANT PROTECTION 2472
PLANT PROTEIN 2479, 3327, 3338, 3347, 3369, 3383, 3389, 3403, 3404, 3405, 3413
PLANT REGENERATION 2523, 2528, 2529
PLANT REQUIREMENTS 2584, 3294, 3297
PLANT RESISTANCE 3005
PLANT RESOURCES 2669
PLANT RESPONSE 2543, 2789, 3091
PLANT RESPONSES 3185, 3193
PLANT TISSUES 2806, 2963
PLANT VIRUSES 3023, 3052, 3136
PLANT WATER RELATIONS 2497, 2853
PLANTING DATE 2436, 3089
PLANTS 2650, 2663, 2686, 2727, 2882, 2917, 2928, 2930, 2943, 2946, 2948, 3005, 3174, 3188
PLASMA CHOLESTEROL 3279, 3411
PLASMA MEMBRANE 2904, 2934, 2953, 3199
PLASMODESMATAL FREQUENCY 2856
PLASTIC FILM 2606
PLASTID GENE EXPRESSION 2781
PLOUGHING 2603, 3153
PLUMBAGINIFOLIA 2731
PLUMULE 2540
POA 2509
POA PRATENSIS 2623
POACEAE 2720, 2850
PODZOLS 3469
POISONING 3282
POLAND 2435, 2483, 2484, 2557, 2595, 2596, 2599, 2605, 2791, 3091, 3200, 3223, 3229, 3230, 3236, 3331
POLLEN 2531, 2859, 2977
POLLEN DEVELOPMENT 2977
POLLEN STERILITY 3189
POLLUTED SOIL 3466
POLYACRYLAMIDE GEL ELECTROPHORESIS 2803, 2858, 3406
POLYAMINE 2917
POLYMERASE CHAIN REACTION 2713, 2740
POLYMERIC PROTEIN 3434
POLYMERS 2855, 3327, 3333, 3383, 3394
POLYMORPHISM 2740, 2782
POLYMORPHISM RFLP 2662
POLYPEPTIDES 2781, 2872, 3304
POLYPHENOLS 3255
POLYPLOID WHEATS 2858
POLYSACCHARIDE 3430
POLYSACCHARIDE DEGRADATION 2887
POLYSACCHARIDE DEGRADING ENZYMES 3278
POLYSACCHARIDES 2675, 2912, 2995, 3416, 3456
POPCORN 3399
POPULATION 2464, 2656
POPULATION DENSITY 2463, 2482, 2840, 2899, 2999, 3002, 3009, 3010, 3025, 3030
POPULATION DISTRIBUTION 3036, 3152
POPULATION DYNAMICS 2987, 3001, 3002, 3031, 3042, 3112, 3164, 3213, 3236
POPULATION GROWTH 2999
POPULATION STRUCTURE 3036
POPULATIONS 2469, 2736, 2742, 2821, 2989, 3244
POROSITY 3351
PORTUGAL 2601
PORTULACACEAE 3227
POSTHARVEST LOSSES 3055
POSTHARVEST TECHNOLOGY 2439, 2712, 3246, 3247, 3257
POSTPRANDIAL GLYCEMIA 3435
POSTPRANDIAL VARIATIONS 3278
POT EXPERIMENTATION 2513, 2861, 3215, 3221, 3222
POTASH 3298
POTASH FERTILIZERS 2518, 2542, 2561, 2577, 2582
POTASSIUM 2484, 2486, 2542, 2554, 2596, 2631, 2834, 2913, 2914, 2927, 3040, 3294
POTASSIUM CHLORIDE 2902
POTASSIUM SULPHATE 2902
POTASSIUM UPTAKE 2923
POTATO 2552
POTATO STARCH 3388, 3424
POTATOES 2435, 2621
POTENT ODORANTS 3399
POTENTIAL BREADMAKING QUALITY 3406
POULTRY 2435, 3259
POWDER MODEL SYSTEMS 3381
POWDERY MILDEW 2464, 2778
POWDERY MILDEW RESISTANCE 2683, 2778, 2792
PPSAF 2860
PRATYLENCHUS 2673
PRATYLENCHUS PENETRANS 2469
PRE HARVEST SPROUTING 2895
PRECIPITATION 2514, 2907, 3239, 3321, 3365
PRECOCITY 2653, 2813
PREDATION 3001
PREDATORS 3006, 3007, 3028, 3045
PREDICTING SOIL TEST 3316
PREDICTION 3392
PREPARED FOODS 3377
PREPLANT 2455
PRESSURE 3283, 3388
PRICE FORMATION 3426

PRICE POLICIES 2430
PRICE SUPPORT 2423
PRICES 2450
PRIESKE FES 2860
PRIMERS 2688
PRIORITY SETTING 2420
PROBE 2865
PROBIOTICS 3447
PROCESSED PLANT PRODUCTS 3407
PROCESSED PRODUCTS 3407
PROCESSING 2963, 3257, 3260, 3262, 3331, 3337, 3345, 3362, 3463
PROCESSING CONDITIONS 3258
PROCESSING QUALITY 3331
PRODUCER PRICES 2445
PRODUCTION 2450, 3189
PRODUCTION COSTS 2438, 2613, 3257
PRODUCTION DATA 2435, 2445
PRODUCTION ECONOMICS 2433, 2436
PRODUCTION FACTORS 2432, 2433, 2434, 2454, 2456
PRODUCTION POSSIBILITIES 2516
PRODUCTIVITY 2491, 2594
PRODUCTS 3276, 3281, 3355, 3414, 3416, 3435
PROFIT 2470
PROFITABILITY 2439, 2442, 2613, 2617, 2623, 2798, 3246
PROGENY 2757, 2758, 2791, 2811, 3134, 3429
PROLAMINES 2479, 2676, 2735, 2811, 3102, 3324, 3327, 3347, 3355, 3371, 3389, 3394, 3403, 3417, 3418
PROLINE 2531, 2622, 2686, 3184
PROMOTER 2650, 2701, 2781
PROPAGATION MATERIALS 2482
PROPIONATE 3269
PROTEASES 2854, 2880, 3410
PROTECTED CULTIVATION 3121, 3333
PROTECTIVE COATINGS 2869
PROTEIN 2616, 3192, 3261, 3273, 3281, 3304, 3430
PROTEIN COMPOSITION 3434
PROTEIN CONTENT 2466, 2479, 2488, 2490, 2507, 2551, 2564, 2593, 2596, 2622, 2640, 2711, 2714, 2723, 2757, 2758, 2791, 2811, 2901, 2907, 3184, 3262, 3324, 3327, 3332, 3333, 3336, 3347, 3366, 3369, 3383, 3385, 3390
PROTEIN IMPORT 2860
PROTEIN ISOLATES 3401
PROTEIN KINASE 2885
PROTEIN KINASE C 2668
PROTEIN METABOLISM 2635, 2874, 3264
PROTEIN PHOSPHORYLATION 2904
PROTEIN QUALITY 3347
PROTEIN SOURCE 3265
PROTEIN SYNTHESIS 2867, 2875
PROTEINOUS BY PRODUCTS 3276
PROTEINS 2479, 2640, 2712, 2716, 2747, 2777, 2803, 2853, 2873, 2887, 2901, 3247, 3252, 3257, 3264, 3268, 3322, 3324, 3325, 3330, 3332, 3366, 3376, 3381, 3383, 3389, 3394, 3403, 3404, 3415, 3418, 3423, 3433, 3439, 3442, 3451
PROTEOLYSIS 2854
PROTONS 3197
PROTOPLAST FUSION 2731
PROTOPLASTS 2522, 2777, 2783, 2854, 2874, 2875, 2885, 2905, 2927
PROTOZOA 3277
PROVENANCE 2645, 2993, 3021, 3062, 3090
PROXIMATE COMPOSITION 2484, 2510, 2567, 2596, 2676, 2716, 2763, 2886, 3249, 3252, 3254, 3326, 3327, 3331, 3333, 3335, 3339, 3349, 3359, 3369, 3377, 3378, 3393, 3400, 3428, 3438, 3447, 3450
PRUNING 2459
PRUNUS 2669
PRUNUS CERASUS 2669
PSAMMOTETTIX ALIENUS 3137
PSBA 2781
PSBD/C OPERON 2781
PSEUDOCERCOSPORELLA HERPOTRICHOIDES 2633, 3076, 3118
PSEUDOMONAS FLUORESCENS 3306
PSEUDOMONAS SYRINGAE 3101
PSS 2860
PTEROMALIDAE 3251
PUBLIC SECTOR 2798
PUCCINIA 2766, 3087, 3118, 3123
PUCCINIA GRAMINIS 2766, 2993, 3098
PUCCINIA HORDEI 2706, 3079
PUCCINIA RECONDITA 2666, 2678, 2775, 2993, 3062, 3141, 3157, 3162
PUCCINIA STRIIFORMIS 2706, 2993, 3072, 3081, 3082, 3109, 3125, 3129, 3147
PULP 3260
PULPING 3458
PULPWOOD 3458
PUPAE 3006
PURIFICATION 2668, 2766, 2878, 2880, 2898, 2905, 3128, 3232, 3247, 3257, 3357, 3410, 3415, 3423, 3462
PUROTHIONINS 3050
PYRALIDAE 3017
PYRENOPHORA 2993
PYRENOPHORA GRAMINEA 3145
PYRENOPHORA TERES 3079, 3113
PYRENOPHORA TRITICI REPENTIS 2668, 2691, 2993, 3086, 3143
PYRETHRINS 3138
PYRICULARIA 3096
PYRITE OXIDATION 3305
PYRITES 3305
PYROPHOSPHATE 2898
PYTHIUM 2973
PYTHIUM GRAMINICOLA 3112
PYTHIUM ULTIMUM 3128
QUALITY 2449, 2450, 2455, 2460, 2490, 2507, 2567, 2587, 2598, 2643, 2659, 2669, 2670, 2675, 2681, 2684, 2700, 2706, 2711, 2712, 2723, 2735, 2739, 2772, 2773, 2775, 2787, 2793, 2796, 2797, 2815, 2823, 2832, 2907, 3151, 3248, 3256, 3261, 3327, 3328, 3339, 3347, 3349, 3350, 3351, 3358, 3359, 3374, 3383, 3385, 3392, 3400, 3408, 3410, 3421, 3426, 3434, 3447, 3453
QUANTITATIVE ANALYSIS 2717, 2718, 2851, 2862, 2867, 2869, 2873, 2893, 3363, 3409
QUANTITATIVE GENETICS 2799
QUANTITATIVE TRAIT LOCI 2655, 2691
QUANTITATIVE TRAIT LOCI (QTL) 2655
QUANTITIES 3050
QUANTITY 3434, 3439
QUARANTINE 3055
QUEBEC 3297
QUEENSLAND 3161
QUERCUS 2669
QUERCUS ROBUR 2669
RABBITS 3026, 3451
RACES 3098
RADIAL TURGOR 2865
RADIATION 2917, 3455
RADIOCARBON DATING 3466
RADIOISOTOPES 2867
RAFFINOSE 3409
RAIN 2434, 2622, 2680, 2987, 3071, 3173, 3266
RAINFED FARMING 2502, 2625, 2728, 2807, 2919, 3201
RANGELANDS 3010
RANUNCULUS 3201, 3231
RAPD 2662, 2688
RAPDS 2770
RAPESEED 2435
RAPESEED MEAL 3409
RAPESEED OIL 3247
RAPHANUS SATIVUS 3215
RAPID METHOD 2713
RAPID PRODUCTION 3433
RARE EARTH ELEMENTS 2915
RAT 3274
RATES 2961
RATS 3435, 3454, 3464
RATS FED DIETS 3279
RB 86 UPTAKE 2934
RECEPTOR LIKE KINASE 2782
RECESSIVE GENES 2811
RECLAIMED SOIL 2542
RECLAMATION 3305
RECOMBINANT DNA 2777, 2786, 2810
RECOMBINATION 2674, 2698, 2719, 2731, 2736, 2831
RECTIFYING K+ CHANNELS 2934
RED LIGHT 2905
RED SPRING WHEAT 3360
RED WINTER WHEAT 3083
REDUCED GLUTENIN 3423
REDUCTASE 2909
REDUCTION 2810, 2928, 3413, 3432
REFERENCE MATERIALS 3368
REFLECTANCE 2443
REFLECTION COEFFICIENTS 2865
REGENERATION 2528, 2677, 2686, 2731
REGINA 3014
REGISTRATION 2646, 2652, 2657, 2704, 2707, 2708, 2709, 2710, 2724, 2725, 2773, 2780, 3083
REGULATIONS 2422
RELATION PARAMETERS 2865
RELATIVE GROWTH RATE 2910
RELATIVE HUMIDITY 3071, 3173
RELATIVES 2800
RELAXATION 2912
RELAXATION TIMES 3197
RELEASE 2547
REMOTE SENSING 2458
REMUNERATION 2439
RENAL CARCINOGEN 3360
REPEATED NUCLEOTIDE SEQUENCES 2978
REPELLENTS 2985, 3034
REPRODUCTION 2989, 2990
REPRODUCTIVE PERFORMANCE 3020
REPUBLIC OF MOLDOVA 2732, 2794, 2797, 2801, 3066
REQUIREMENTS 2668, 2989
RESEARCH 2424, 2462, 2474, 2639, 2669, 2692, 2703, 2798, 2849, 2984, 3089, 3210, 3347
RESEARCH INSTITUTIONS 2611
RESEARCH PROJECTS 2611
RESIDUAL EFFECTS 2617
RESIDUE 2966
RESIDUE QUALITY 3290
RESIDUES 2547, 2553, 2571, 3043, 3314
RESISTANCE 2695, 2764, 2770, 2778, 2933, 3005, 3014, 3077, 3098, 3100, 3129, 3130
RESISTANCE BREEDING 2660, 2782
RESISTANCE GENE 2782
RESISTANCE TO CHEMICALS 3178, 3205, 3208, 3217, 3220, 3226, 3234, 3235
RESISTANCE TO INJURIOUS FACTORS 2651, 2653, 2658, 2715, 2744, 2751, 2759, 2765, 2774
RESISTANT 2522
RESISTANT STARCH 3435
RESPONSE CURVATURE 3289, 3316
RESPONSES 2457, 2727, 2839, 3174
RESPONSIVENESS 3316
REST 3033

RESTORATION 2800
RESTRICTED FEEDING 3277
RESTRICTION ENDONUCLEASE ANALYSIS 2769
RESTRICTION FRAGMENT LENGTH 2662
RETINAL S ANTIGEN 2896
RETINOL 3463
REVEALS 2674
RFLP 2645, 2662, 2687, 2730, 2736, 2738, 2770, 2827, 2842
RFLP ANALYSIS 2522
RFLP MAPPING 2655
RFLP MAPS 2661
RHEOLOGICAL PROPERTIES 3258, 3339, 3342, 3343, 3347, 3349, 3351, 3370, 3378, 3379, 3380, 3383, 3385, 3390, 3403, 3404, 3431, 3441
RHIZOCTONIA 2633
RHIZOCTONIA SOLANI 3112
RHIZOSPHERE 2580, 2892, 3300, 3306
RHOPALOSIPHUM PADI 3013, 3049, 3119
RHOPALOSIPHUM PADI L 3014
RHYNCHOSPORIUM 3118
RHYNCHOSPORIUM SECALIS 2706, 3079
RHYZOPERTHA DOMINICA 3251, 3254
RIBOSOMAL RNA 2687, 3147
RIBOSOMAL RNA GENES 2663
RIBOSOMES 2687, 2804
RIBULOSE 1, 5 BISPHOSPHATE CARBOXYLASE OXYGENASE 2928
RICE 2423, 2445, 2558, 2570, 2621, 2667, 2701, 2705, 2712, 2815, 2868, 2969, 3310, 3418, 3463
RICE AROMA 3399
RICE BRAN 3414
RICE CULTURE 2581
RICE ENDOSPERM 2768
RICE FIELDS 2602
RICE PLANTS 2891
RICE SEEDLINGS 2868
RICE STRAW 2617, 3446
RICINUS COMMUNIS 3039
RIPENING PERIOD 3392
RISK 2439, 2613, 3208, 3227
RNA 3147
ROD OUTER SEGMENTS 2896
ROLLER MILLING 3386
ROOT 2478, 2650
ROOT EATING INSECTS 2982, 3024
ROOT GROWTH 2491, 3298
ROOT INHIBITION 2948
ROOT LESION NEMATODE DENSITY 2469
ROOT MORPHOLOGY 2923
ROOT ROT 2469
ROOT ROTS 3066, 3142, 3163, 3168
ROOT SYSTEMS 2549, 2633, 2951
ROOTING 2951, 2954
ROOTLET LENGTH 2966
ROOTS 2513, 2565, 2612, 2717, 2851, 2892, 2913, 2914, 2942, 2953, 2954, 2995, 3022, 3040, 3076, 3159, 3180, 3182, 3193, 3199, 3312
ROTATION 2495
ROTATIONAL CROPPING 2438, 2442, 2454, 2456, 2489, 2582, 2601, 2603, 2605, 2609, 2611, 2613, 2615, 2617, 2619, 2620, 2623, 2625, 2627, 2632, 2987, 3076, 3236, 3237, 3291, 3299, 3302
ROTATIONS 2428, 2616
ROTS 3104
RP HPLC 3392
RUBIDIUM 2930
RUBISCO 2893
RUMEN 3265, 3278
RUMEN DIGESTION 3262, 3263
RUMEN FLUID 3277
RUMEN MICROORGANISMS 3277
RUMINANTS 3272
RUSSIAN FEDERATION 2567, 2684, 2739, 3124, 3469, 3473
RUST FUNGI 3080
RUSTS 2706, 2760, 3071, 3111, 3125, 3141, 3142, 3162, 3400
RUTIN 3349
RYE 2577, 2655, 2674, 2675, 2712, 2753, 2778, 2808, 2815, 2845, 2943, 3256, 3259, 3344, 3416
RYE ADDITION LINES 2783
RYE FLOUR 3256
RYEGRASS 2918, 3186
SACCHARUM OFFICINARUM 2629, 2682
SADDLE HORSES 3270
SALICYLATES 2717
SALINITY 2511, 2598, 2717, 2933, 3182
SALIX 3253
SALT 3186
SALT RESISTANCE 2511
SALT STRESS 2870, 2927, 2933, 2946
SALT STRESSED WHEAT 2511, 3307
SALT TOLERANCE 2511, 2927, 2953, 3182
SALTS 2902
SAMPLES 3074, 3075, 3095
SAMPLING 2458, 2584, 3002, 3010, 3028, 3165, 3277, 3394, 3437, 3443
SAMPLING METHODS 3028
SANDY SOILS 3230, 3291
SASKATCHEWAN 2428, 2491, 3086
SATIETY 3269
SATURATED FATTY ACIDS 2867
SCAB 2660, 3074
SCABS 2785, 2795, 3078, 3085, 3173
SCARABAEIDAE 3038
SCENARIOS 2839
SCHISTOSOMA JAPONICUM 2810
SCHIZAPHIS GRAMINUM 3020
SCLEROTINIA HOMOEOCARPA 3112
SCREENING METHOD 2702
SDS PAGE 2860
SDS UNEXTRACTABLE PROTEIN 3392
SEASONAL DEVELOPMENT 3042
SEASONAL LABOUR 2434
SEASONAL VARIATION 3002, 3086, 3152, 3266, 3321
SEASONS 3241
SECALE 2422, 2509, 2680, 2712, 2815
SECALE CEREALE 2494, 2500, 2509, 2533, 2556, 2631, 2639, 2674, 2675, 2680, 2778, 2815, 2826, 2827, 2828, 2869, 3070, 3133, 3142, 3239, 3256
SECALE CEREALE L 2966
SECALE CEREALE L WRENS ABRUZZI 2855
SECONDARY METABOLITES 2957
SEDIMENTATION 2747
SEED 2482, 2485, 2537, 2540, 2806, 2886, 2941, 3054, 3097, 3103, 3119, 3425
SEED DRESSING 2480, 3054, 3079, 3089, 3119, 3144, 3145, 3146, 3168
SEED DRILLS 3284
SEED FILLING 2479, 2515, 2517, 2852, 2897, 2976
SEED GERMINATION 2571, 2940
SEED LONGEVITY 2534
SEED MIXTURES 2488
SEED PATHOLOGY 3060
SEED PELLETING 2480, 3109
SEED PRODUCTION 2533, 2535, 2536, 2538
SEED SIZE 2866, 2966
SEED STORAGE 2534
SEED TESTING 3106, 3134, 3405, 3418, 3470
SEED TREATMENT 2534, 2539, 2540, 2969, 2997, 3003, 3034
SEEDBORNE ORGANISMS 3058, 3106, 3117, 3127
SEEDING DEPTH 3161, 3177
SEEDLING BLIGHT 3099
SEEDLING DEVELOPMENT 3244
SEEDLINGS 2540, 2550, 2565, 2697, 2717, 2764, 2851, 2879, 2908, 2915, 2916, 2918, 2946, 2952, 2953, 2970, 2972, 2995, 3097, 3159, 3197, 3199
SEEDS 2510, 2514, 2618, 2640, 2690, 2701, 2745, 2869, 2884, 2898, 2902, 2922, 2963, 2975, 3039, 3049, 3060, 3063, 3067, 3110, 3116
SEGMENTS 2887
SEGREGANT ANALYSIS 2713
SEGREGATION 2640, 2697, 2745
SEGREGATION DISTORTION 2778
SELECTION 2460, 2671, 2715, 2719, 2728, 2751, 2757, 2758, 2802, 2815, 2825, 2936, 3088, 3269
SELECTION CRITERIA 2681, 2757, 2758, 2767, 2776, 2811, 2831
SELECTIVITY 3233
SEMIARID CLIMATE 2941
SEMIARID REGION 2600
SEMIDWARF CULTIVAR 2600
SEMINAL ROOTS 2974
SEMIOCHEMICALS 3034
SEMOLINA 3339
SENESCENCE 2606, 2948
SENSITIVITY 2917, 3189
SENSITIVITY ANALYSIS 3196
SENSORS 3455
SEPARATING 2859, 3232, 3332, 3342, 3418
SEPARATION 2803, 3199
SEPTORIA 3106, 3114, 3118, 3151
SEPTORIA TRITICI 3129
SEQUENCE 2638, 2727, 2740, 2768, 2896, 3050
SEQUENCES 2656
SEQUENTIAL CROPPING 2454, 2456, 3314
SERINE 2928
SERRADELLA 2892
SERUM CHOLESTEROL 3411
SESBANIA 2558
SESBANIA BISPINOSA 2617
SESBANIA ROSTRATA 2617
SETARIA (GRASS) 3221
SEVERITY 3129
SEWAGE SLUDGE 2571, 3186
SEX RATIO 2991
SHAANXI 3292
SHANDONG 2516, 3001
SHEAR 3427
SHEEP 2435, 3261, 3269
SHOOTS 3233
SHORT PROCESS BREAD 3360
SHORT TERM CHANGES 3279
SICHUAN 3288
SIDE EFFECTS 2902, 2994, 3044
SIDEROPHORES 2765
SIEVE TUBES 2856
SIGNAL 2949, 2974
SIGNAL GENES 2903
SIGNAL TRANSDUCTION 2934
SIGNALS 2904
SILAGE 2494, 3265, 3447, 3448, 3453
SILENT GENES 2740
SILICA 3324
SILICON 3288
SIMULATION 2799, 2837, 3301
SIMULATION MODEL 2835, 3196
SIMULATION MODELS 2843, 3203, 3321
SIMULATION WHEAT MODELS 3191
SINAPIS ALBA 2604, 3228, 3302
SITCHENSIS BONG CARR 2958
SITE FACTORS 2468, 2759, 3086
SITOBION 3005
SITOBION AVENAE 2998, 3009, 3013, 3014, 3047, 3049

SIZE 3244
SLOVAKIA 2435, 2476, 2492, 2505, 2714, 2836, 3154, 3160, 3319, 3468
SLOVENIA 2435, 2510, 2548, 2886, 3041, 3047
SLUDGE AMENDED SOILS 2931
SLUGS 3000, 3003, 3004, 3012, 3027
SLURRY 2556, 2626, 3285
SMALL INTESTINE 3272
SMALL SUBUNIT 2860
SMELL 3055
SMUTS 2540, 3158
SNAIL MEDIC 2616
SNAILS 2987
SO2 3174
SOAKING 3326
SODIC SOILS 2598
SODIC SUBSOIL 3316
SODIUM 2484, 2927, 3432
SODIUM AZIDE 2734
SODIUM CHLORIDE 2534, 2717, 3182
SODIUM HYDROXIDE 3451
SODIUM TRANSPORT 2953
SODIUM/CALCIUM INTERACTIONS 2953
SOFT DRINKS 3296
SOFT WHEAT 2432, 2433, 2774
SOIL 2458, 2478, 2485, 2553, 2555, 2556, 2569, 2576, 2585, 2616, 2937, 2974, 3128, 3186, 3190, 3202, 3285, 3290, 3291, 3297, 3300, 3311
SOIL AMENDMENT 2571
SOIL AMENDMENTS 2505, 2550, 3039, 3465
SOIL BIOLOGY 3300
SOIL BREAKING 2485
SOIL CHEMICOPHYSICAL PROPERTIES 2561, 2595, 2601, 3319, 3455
SOIL CHEMISTRY 2902
SOIL COMPACTION 2509, 3319
SOIL DEFICIENCIES 3190
SOIL DENITRIFICATION 3301
SOIL DENSITY 2513, 3319
SOIL DETERIORATION 2577
SOIL EROSION 3387
SOIL EXHAUSTION 2577
SOIL EXTRACTANTS 2931
SOIL EXTRACTIONS 2855
SOIL FERTILITY 2434, 2486, 2509, 2579, 2606, 3313
SOIL FLORA 3306
SOIL MANAGEMENT 2454, 2456
SOIL MATRIC POTENTIAL 3099
SOIL MICROBIAL BIOMASS 3290
SOIL MINERAL N 2585
SOIL MOISTURE 2465, 2466, 2491, 3193, 3387
SOIL NITRATE 2547
SOIL ORGANIC MATTER 2509, 3466
SOIL PH 2487, 2565, 3297
SOIL PHOSPHATE 3311
SOIL POLLUTION 2505, 3466
SOIL RESPIRATION 2547
SOIL SCIENCES 2577
SOIL SOLARIZATION 3242
SOIL SOLUTION 2565, 2590
SOIL STRUCTURE 3076
SOIL TEMPERATURE 2606, 3177
SOIL TEST N 2465, 2466
SOIL TESTING 2556, 2584, 3294, 3296, 3297
SOIL TEXTURE 3306
SOIL TILLAGE 3287
SOIL TOXICITY 2565
SOIL TRANSPORT PROCESSES 2859
SOIL TYPE 2568
SOIL TYPE AND LIMING 2931
SOIL TYPES 2454, 2456, 2463, 2483, 2484, 2557, 2596, 2608, 2834, 3112, 3317
SOIL WATER 2487, 2595, 3099
SOIL WATER CONTENT 2497, 2514, 2595, 2606, 2607, 2622, 2630, 3214, 3292, 3293, 3455
SOIL WATER DEFICIT 2600, 3320
SOILS 2558, 2559, 2578, 3068
SOLANUM TUBEROSUM 2477, 2513, 2626, 2631, 2669, 2731, 2754, 3469
SOLAR RADIATION 2958
SOLID ASSOCIATED MICROORGANISMS 3278
SOLUBILITY 2479, 2716, 3322, 3324, 3333, 3336, 3337, 3354, 3389, 3394, 3401, 3413, 3461
SOLUBILIZING 2479
SOLUBLE FRACTION PROTEINS 2905
SOLUBLE SULFUR 3305
SOLUTES 2865, 2927
SOLVENT EXTRACTION 3247
SOLVENTS 3337, 3409
SOMACLONAL VARIATION 2677, 2775, 2785, 3328
SOMATIC EMBRYOGENESIS 2529
SOMATIC VARIATION 2524
SORGHUM 2615, 2712, 2977, 3254, 3255, 3425
SORGHUM BICOLOR 2514, 2613, 3050
SORGHUM GRAIN HYBRIDS 3272
SORPTION 3289
SOURCE SINK RELATIONS 2517, 2976
SOUTH AFRICA 2453, 2609, 3013, 3051, 3113, 3219
SOUTH AUSTRALIA 2987, 3226
SOUTH DAKOTA 2704, 3069
SOUTH WEST AUSTRALIA 3309
SOUTHWESTERN IDAHO 2989, 2990
SOUTHWESTERN SASKATCHEWAN 2465, 2466
SOWING 2482, 2493, 2514, 3204
SOWING DATE 2454, 2456, 2468, 2471, 2490, 2492, 2493, 2517, 2816, 2843, 2961, 2964, 2984, 3008, 3052, 3136, 3320
SOWING RATES 2436, 2454, 2456, 2468, 2470, 2471, 2482, 2492, 2502, 3470
SOWING STUFF 2966
SOYBEAN FLOURS 3391
SOYBEAN MEAL 3264, 3268, 3409
SOYBEANS 2424, 2667, 2923, 3371
SOYBEANS GLYCINE MAX 2498
SPACING 2470, 2482, 2536, 2538, 2618
SPAIN 2991, 2992
SPATIAL CROP MODELLING 2835
SPATIAL UNCERTAINTIES 2839
SPECIES 2458, 2848, 3001, 3045, 3152, 3172, 3228
SPECIFICITY 2898, 2928
SPECTROMETRY 2859, 2890, 3232, 3459
SPECTRUM 3427
SPELT (TRITICUM SPELTA L) 2903
SPELT VARIETIES 2872
SPELTOIDES 2800
SPIKELETS 2864
SPIKES 2521, 2685, 2807, 2859, 2864, 2964, 3061, 3183
SPINACH 2931
SPINACH LEAVES 2928
SPLIT AMMONIUM SULFATE 2558
SPONTANEUM 2683
SPORES 3082, 3109, 3115, 3125
SPOT BLOTCH 2705
SPOTS 3086
SPRAY 2572
SPRAYING 2467, 3073
SPRING BARLEY 2498, 2683, 2842, 3161, 3216
SPRING CEREALS 2496
SPRING CROPS 2440, 2477, 2480, 2488, 2501, 2503, 2507, 2525, 2549, 2556, 2560, 2599, 2651, 2654, 2684, 2739, 2767, 2772, 2811, 2819, 2830, 2888, 2965, 2976, 3042, 3079, 3173, 3230, 3379
SPRING WHEAT 2427, 2428, 2746, 2956, 2961, 3189, 3387
SPRING WHEAT (CV MINARET) 3185
SPRINKLER 2572
SPRINKLER IRRIGATION 2483, 2484, 2557, 2595, 2596, 2599, 3230
SPROUTING 2690
STABILITY 3258, 3370, 3412
STAGONOSPORA 3086
STANDARDIZING 3297, 3418
STANDARDS 2449
STAPHYLINIDAE 3035, 3048
STARCH 2626, 2670, 2806, 2976, 2977, 3247, 3257, 3269, 3272, 3325, 3327, 3334, 3336, 3342, 3343, 3349, 3353, 3354, 3359, 3379, 3388, 3402, 3419, 3421, 3424, 3432, 3438, 3441
STARCH AVAILABILITY INVITRO 3435
STARCH BRANCHING ENZYME 2768
STARCH DEGRADATION 3278
STARCH FORMATION 2871
STARCH HYDROLYSATE 3402
STARCHES 3375
STATISTICAL METHODS 2424, 2458, 2482, 2487, 2493, 2504, 2524, 2586, 2628, 2647, 2648, 2699, 2718, 2723, 2749, 2756, 2784, 2799, 2813, 2816, 2818, 2840, 2888, 2921, 2962, 2967, 2988, 3015, 3016, 3024, 3025, 3030, 3031, 3032, 3036, 3040, 3043, 3057, 3058, 3059, 3060, 3063, 3064, 3081, 3082, 3084, 3087, 3088, 3092, 3093, 3094, 3097, 3123, 3126, 3134, 3135, 3148, 3149, 3169, 3170, 3173, 3209, 3211, 3225, 3231, 3283, 3292, 3321, 3446, 3470, 3471
STAUROSPORINE 2904
STEAM FLAKED CORN 3272
STEARIC ACID 2869
STELLARIA 3207, 3227
STEM 2912
STEM RUST RESISTANCE 2778
STEM SOLIDNESS 3176
STEMS 2717, 2864, 2899, 2908, 2995, 3232, 3312
STERILITY 2800
STERILIZING 2446
STEROIDS 2503
STICKINESS 3372
STIMULATION 2946
STOCKING DENSITY 3266
STOMATA 2844, 2893
STOMATAL CONDUCTANCE 2910, 2974
STOMATAL GUARD CELLS 2934
STORAGE 2712, 3250, 3252, 3255, 3257, 3283, 3336, 3349, 3351, 3377, 3446
STORAGE LOSSES 3254
STORAGE PROTEINS 2779, 3392, 3406
STORED PRODUCTS PEST CONTROL 3054
STORED PRODUCTS PESTS 3248, 3251, 3255
STOREHOUSES 3245, 3251
STRAIN 3068
STRAW 2426, 2463, 2501, 2506, 2604, 3246, 3253, 3260, 3445
STRAW MULCHES 2518
STRENGTH 3338
STREPTOMYCES 3078
STRESS 2504, 2686, 2765, 2845, 2850, 2868, 2894, 2977, 3434
STRESS GROWTH DATA 3427
STRESS RESPONSE 2850
STRESS TOLERANCE 3176
STRIPE RUST 2778
STRONG CONTINUOUS ILLUMINATION 2929
STUBBLE CLEANING 2603
STUNT NEMATODE 2469

STUNT WINTER WHEAT 2821
SUB TROPICS 2570
SUBCELLULAR COMPARTMENTATION 2898
SUBSEQUENT WHEAT CROPS 3309
SUBSIDIES 2430, 2444, 2613
SUBSOIL 2563
SUBSTANCES 2855
SUBSTITUTIONS 2778
SUBTERRANEAN CLOVER 2616, 2892
SUBUNIT I 2769
SUBUNITS 2872, 3415, 3423, 3439
SUCCINATE DEHYDROGENASE 2915
SUCCINIC ACID 2862
SUCKING INSECTS 2998
SUCROSE 2995, 3409
SUCROSE STARCH BIOSYNTHESIS 2943
SUGAR BEET 2435, 2452, 2934, 3302
SUGAR BEET PULP 3462
SUGAR CANE 2682
SUGARBEET PULP 3462
SUGARS 3409
SULFUR DIOXIDE 2838, 3174
SULPHATES 2565, 3432
SULPHIDES 3249
SULPHUR 2556, 3313
SULPHUR DIOXIDE 3174
SUNFLOWER 2835, 2974
SUNFLOWER MOTH 3017
SUNFLOWER SEED 3451
SUPEROXIDE DISMUTASE 2819
SUPERPHOSPHATE 2902
SUPPLEMENTATION 3261
SUPPLEMENTS 3263, 3264
SUPPLY BALANCE 2430
SUPPORT MEASURES 2423
SUPPRESSION 2778
SURFACE ACTIVE AGENTS 2979, 3353, 3354
SURFACE DRAINAGE 2436
SURFACE WATER 2584
SURVEYING 3203
SURVEYS 2430, 3058, 3064, 3113, 3210, 3350, 3367, 3471
SUSCEPTIBILITY 2727, 2957
SUSPENSION 2529
SUSTAINABILITY 2506, 2509, 2584, 2613, 2616, 2621, 2623
SWEDEN 3048
SWEDISH WHEATS 2779
SWELLING 3353, 3354, 3359, 3438
SWINE 2435, 3281, 3282, 3452, 3457
SWITZERLAND 2610, 3004, 3285
SYMPLASTIC AND APOPLASTIC TRANSPORT 2856
SYMPTOMS 3061, 3086, 3090, 3163, 3172
SYNECHOCYSTIS SP PCC 6803 2929
SYNTHASE 2868
SYNTHETIC PYRETHRINS 3119
SYRIA 2728, 2742, 2802, 2861, 2993, 3125
SYSTEM 2572, 2974, 3098, 3356, 3402
SYSTEMS 2426, 2429, 2855, 3301
T AESTIVUM 2662
T DURUM 2695
TAKE ALL 3068
TAN SPOT 2691
TANDEM MASS SPECTROMETRY 3436
TANZANIA / YIELD FORECASTING 2445
TAXONOMY 2520, 3006, 3037, 3045, 3331
TECHNICAL PROPERTIES 2652, 2653
TECHNOLOGY 2446
TECHNOLOGY TRANSFER 2421, 2431, 2432
TELOMERIC HETEROCHROMATIN 2674
TEMPERATE ZONES 2567
TEMPERATURE 2670, 2835, 2838, 2839, 2843, 2874, 2907, 2957, 2961, 2972, 2989, 2990, 3071, 3099, 3104, 3129, 3197, 3252, 3256, 3321, 3322, 3336, 3350, 3355, 3358, 3365, 3372, 3388, 3409, 3419, 3437, 3438
TEMPERATURE RESISTANCE 2906, 3181, 3327
TEMPERATURES 2702
TEMPERING 3358
TENNESSEE 2639
TENSILE STRENGTH 3373
TESTA 3451
TESTING 2422, 2697, 2993, 3061, 3067, 3088, 3121, 3143, 3215, 3238, 3455
TESTS 3289, 3316
TETRAPLOID WHEATS 2662
TEXAS 2514, 3266
TEXTURE 3338, 3349, 3358, 3441, 3443
TEXTURE PROPERTIES 3372
THAW CYCLES 3258
THERAPEUTIC DIETS 3464
THERMAL ANALYSIS 3253
THERMAL ENERGY 3388
THERMAL HYSTERESIS PROTEIN 2850
THIOBACILLUS FERROOXIDANS 3305
THIOBACILLUS THIOXIDANS 3305
THIOLS 3338
THIONINS 3050
THLASPI ARVENSE L 3216
THYLAKOID MEMBRANES 2929
THYLAKOIDS 2890, 2908
THYMIDINE 2954
TILLAGE 2428, 2465, 2475, 2477, 2491, 2495, 2513, 2601, 2602, 2605, 2613, 2973, 3076, 3153, 3286, 3318
TILLAGE SYSTEMS 3244
TILLER 2959, 3185
TILLERING 2481, 2521, 2583
TILLERS 2955
TILLETIA 2446, 3126, 3135
TILLETIA CARIES 2446
TILLETIA FOETIDA 3057
TILLETIA INDICA 2695, 3055, 3067, 3158
TIME 2931, 2939, 3324, 3390
TIME SERIES 2448
TIMING 2493, 2717, 2851, 2873, 2893
TISSUE 2529
TISSUE CULTURE 2525, 2963, 3328
TISSUE SPECIFIC EXPRESSION 2638
TISSUE SPECIFICITY 3100
TISSUES 2856, 2948
TITRIMETRIC ASSAY 2588
TLAXCALA 3072
TOBACCO LEAVES 2928
TOBACCO PLASTIDS 2781
TOCOTRIENOLS 3279
TOLERANCE 2702, 2845, 2933, 2946
TOMATO 2909
TOMATO PLANTS 3100
TOMATOES 2667
TONOPLAST 2933
TOOL 3286
TOP SOIL 2949
TOPDRESSING 3285
TOPSOIL LOSS 3387
TOXIC SUBSTANCES 3169
TOXICITY 2994, 3022, 3034, 3105, 3111, 3156, 3199, 3212, 3282
TOXOPTERA 3042
TRACE ELEMENT ANALYSIS 3398
TRACE ELEMENT DEFICIENCIES 3195
TRACE ELEMENTS 2834, 2932
TRACE METAL CHEMISTRY 2571
TRACER TECHNIQUES 2515, 2562, 2566, 2580, 2615, 2919, 2935, 2936, 2947, 2976, 3033, 3147, 3302, 3314
TRADE 2444
TRADE BARRIERS 3055
TRADE LIBERALIZATION 2430
TRADE UNIONS 2441
TRADESCANTIA VIRGINIANA L 2865
TRADITIONAL FARMING 2626
TRANSCRIPTION 2786, 2868
TRANSDUCTION 2904, 2905
TRANSFER RNA 2810
TRANSFERASE 2768
TRANSFERASES 2810
TRANSFORMATION 2668, 2701
TRANSGENIC PLANTS 2494, 2640, 2667, 2733, 2765, 2777, 2786, 2875
TRANSGENIC TOBACCO 2638, 2650, 2948
TRANSIENT RESPONSES 2835
TRANSLOCATION 3372
TRANSLOCATIONS 2778
TRANSPIRATION 2497, 2630, 2861, 2893
TRANSPIRATION EFFICIENCY 2910
TRANSPORT 2446, 2860, 2927, 2930
TRAPPING 3027
TRAPS 3002, 3012, 3027, 3046
TREATMENT DATE 2553, 2557, 2595, 2596, 3227
TRIADIMEFON 2972
TRIAL METHODS 3379, 3380
TRIAMIDE 3310
TRICHODERMA 3168
TRICHODERMA HARZIANUM 3112, 3128
TRICHODERMA VIRIDE 3056
TRICHOTHECENES 3363, 3449
TRIFLURALIN 3177
TRIFOLIUM 2494, 2631, 2836
TRIFOLIUM INCARNATUM L TIBBEE 2855
TRIFOLIUM PRATENSE L 2496
TRIFOLIUM RESUPINATUM 2585
TRIFOLIUM SUBTERRANEAUM L MT BARKER 2855
TRIFOLIUM SUBTERRANEUM L 3309
TRIGLYCERIDES 3354
TRIOSE PHOSPHATE UTILISATION 2943
TRITICALE 3436
TRITICEAE 2663
TRITICOSECALE 2453, 2471, 2500, 2533, 2536, 2557, 2595, 2596, 2712, 2744, 2763, 2791, 2793, 2815, 2852, 2998, 3035, 3229, 3239, 3452, 3453
TRITICUM (LOW TEMPERATURE STRESS) 2943
TRITICUM AESTIVUM CV TONIC (SPRING WHEAT) 3193
TRITICUM AESTIVUM L 2528, 2600, 2778, 2868, 2930, 2956, 2971
TRITICUM ARARATICUM 2720
TRITICUM BOEOTICUM 2720
TRITICUM DICOCCOIDES 2720, 2736, 3217, 3330
TRITICUM DICOCCUM 2722
TRITICUM DURUM 2529, 2597, 2619, 2632, 2645, 2652, 2658, 2681, 2714, 2722, 2728, 2739, 2752, 2809, 2861, 2863, 2919, 2936, 3086, 3135, 3143, 3212, 3330, 3339
TRITICUM MONOCOCCUM 2687, 2858, 3378
TRITICUM SPELTA 2669, 2872, 3428
TRITICUM TAUSCHII 2688, 2821
TRITICUM TURGIDUM 2645, 2735, 3086, 3143, 3347
TRITICUM TURGIDUM SSP 3176
TRITICUM URARTU 2662, 2720
TRITIUM AESTIVUM L COKER 983 2855
TRITROPHIC INTERACTIONS 3005

TRIUNCIALIS 2800
TROGODERMA 3032
TROGODERMA GRANARIUM 3254, 3255
TROPICAL LEGUMES 2558
TRYPTOPHAN RACEMASE 2970
TUNISIA 2936
TURF 3112
TURGIDUM CONV DURUM 3176
TURKEY 2993, 3176, 3250
TURNOVER 3290
TYLENCHORHYNCHUS SPP 2469
TYROSINE 2885
UKRAINE 3019, 3202
ULTRASONICS 3383
ULTRASTRUCTURE 2804, 2854, 2890, 2901, 3351
ULTRAVIOLET RADIATION 2841
UNDERSOWING 2547
UNIT ROOTS 2448
UNITED KINGDOM 2442, 2452, 2463, 2604, 2798, 3000, 3009, 3012, 3023, 3026, 3027, 3052, 3206, 3207, 3241, 3246, 3362, 3457
UNITED STATES 2821
UNIVERSITIES 2639
UPTAKE 2969
UREA 2473, 2566, 2569, 2577, 2617, 2902, 3261, 3264, 3312
URIC ACID 3295
URINE 3461
USA 2423, 2424, 2439, 2440, 2441, 2444, 2449, 2450, 2584, 2613, 2849, 3061, 3162, 3359, 3367, 3441, 3460
USE EFFICIENCY 2455, 2555
USES 2617, 3246, 3247, 3257, 3331, 3348, 3445, 3450
USTILAGO 3058, 3146, 3148, 3149
USTILAGO SEGETUM 2540, 3146, 3165
UTAH 2773, 2849, 3101
UTTAR PRADESH 2499, 2502, 2621, 2726, 2788
UV B RADIATION 2958
VA MYCORRHIZA 3304
VACUOLAR PH 2933
VACUOLES 2854, 2913, 2914, 2963
VALUE ADDED 2814
VALUES 3280
VARIABILITY 2846, 3191, 3196, 3301
VARIABLES 2427
VARIANTS 2683
VARIETIES 2421, 2434, 2436, 2443, 2453, 2459, 2460, 2461, 2472, 2494, 2497, 2500, 2501, 2507, 2541, 2543, 2575, 2599, 2612, 2631, 2639, 2644, 2645, 2646, 2651, 2652, 2653, 2654, 2657, 2658, 2659, 2665, 2666, 2680, 2684, 2704, 2707, 2708, 2709, 2710, 2715, 2716, 2724, 2725, 2726, 2737, 2739, 2744, 2745, 2751, 2757, 2758, 2761, 2772, 2773, 2779, 2780, 2794, 2796, 2797, 2801, 2802, 2807, 2816, 2819, 2843, 2852, 2857, 2869, 2886, 2903, 2922, 2941, 2964, 2983, 2998, 3008, 3018, 3019, 3020, 3021, 3047, 3051, 3052, 3061, 3067, 3069, 3071, 3079, 3086, 3089, 3090, 3093, 3102, 3114, 3119, 3121, 3135, 3136, 3143, 3148, 3180, 3204, 3205, 3227, 3256, 3266, 3297, 3320, 3326, 3328, 3330, 3331, 3332, 3333, 3335, 3342, 3343, 3347, 3358, 3359, 3365, 3369, 3374, 3383, 3385, 3389, 3394, 3396, 3403, 3404, 3415, 3426, 3428, 3438, 3441, 3442, 3443, 3455, 3470
VARIETY 2528
VARIETY TRIALS 2500, 2648, 2671, 2672, 2673, 2680, 2682, 2693, 2700, 2788, 2799, 3134
VARYING CHARACTERS 2655
VARYING RESISTANCE 2946
VECTORS 2996, 3023, 3119
VEGETABLE CROPS 2620
VEGETABLE GROWING 2509
VEGETATION 2458, 3185
VEGETATION CANOPIES 2958
VENTILATION 3245
VERNALIZATION 2961, 2967
VERTEBRATES 3026
VERTISOL 3316
VESICLES 3199
VIABILITY 2537, 3258
VICIA 2625, 3201, 3291
VICIA FABA 2452
VICIA SATIVA 2488
VICIA VILLOSA 2509
VIGNA MUNGO 2621
VIOLA 3223
VIROSES 2996, 3102, 3119, 3167
VIRULENCE 3098
VIRUS SPREAD 3120
VISCOELASTIC PROPERTIES 3427
VISCOSITY 2670, 3259, 3386, 3437, 3438
VITAMIN CONTENT 3369
VITAMIN DEFICIENCIES 3463
VOLATILE COMPOUNDS 3399
VOLATILE FATTY ACIDS 3263, 3274
VOLATILIZATION 2918
VOLUME 2937, 3349, 3388, 3389, 3442
VOMITOXIN 3282, 3365, 3366, 3367, 3449
VULGARE 3100
WASHINGTON 2623, 3007
WASTE UTILIZATION 3465
WASTES 3285
WATER 2465, 2478, 2495, 2835, 2922, 2939, 3191, 3196, 3298, 3337, 3354, 3372, 3388, 3390, 3396, 3419
WATER AVAILABILITY 2479
WATER BALANCE 3287
WATER CONSERVATION 2756
WATER CONTENT 3197
WATER EROSION 3317
WATER HARVESTING 2506
WATER HOLDING CAPACITY 3359
WATER POLLUTION 2548
WATER POTENTIAL 2622, 2865
WATER QUALITY 2584
WATER REQUIREMENTS 2593, 2889, 3292
WATER SOLUBLE 1 >3 3420
WATER STRESS 2911, 2949, 2977
WATER TRANSPORT 2912
WATER UPTAKE 2574, 2919, 2936
WATER USE 2465, 2864, 2881
WATER USE EFFICIENCY 2910
WATER VAPOR PERMEABILITY 3373
WAXES 2690, 2979, 3162, 3466
WAXY 3375
WEANING 3268
WEATHER 3321
WEATHER WEED BIOMASS 2568
WEED COMPETITION 3243
WEED CONTROL 2422, 2426, 2434, 2436, 2452, 2494, 2902, 3200, 3201, 3203, 3204, 3206, 3207, 3209, 3210, 3211, 3213, 3214, 3219, 3222, 3223, 3224, 3225, 3227, 3228, 3229, 3231, 3236, 3237, 3240, 3241, 3242
WEED DENSITY 2568, 3243
WEEDICIDE APPLICATION 2592
WEEDING 3241, 3242
WEEDS 2422, 2463, 2470, 2500, 2501, 2601, 2603, 2631, 2902, 3000, 3022, 3164, 3200, 3201, 3203, 3204, 3206, 3208, 3209, 3211, 3212, 3213, 3214, 3217, 3220, 3223, 3224, 3225, 3226, 3228, 3229, 3230, 3231, 3234, 3235, 3236, 3237, 3240, 3241, 3242, 3244
WEIGHT 2490, 2618, 2626, 2908, 3049, 3083, 3119, 3263, 3282, 3335, 3378, 3396, 3413, 3425, 3461, 3464
WEIGHT GAIN 3263, 3266, 3268, 3282
WEIGHT GLUTENIN SUBUNITS 3406
WESTERN ASIA 3117
WESTERN AUSTRALIA 2611, 2699, 3119
WESTERN STATES (USA) 3220
WETLAND RICE 2581, 3305
WHEAT (TRITICUM AESTIVUM L) 2768, 2912
WHEAT BRAN 3411, 3462
WHEAT BRAN PREPARATIONS 3462
WHEAT BREAD CRUST 3399
WHEAT BY PRODUCT 3281
WHEAT CANOPIES 2958
WHEAT CROPPING SYSTEM 2581
WHEAT CULTIVARS 3161
WHEAT DOUGH 3372
WHEAT DWARF VIRUS 3137
WHEAT FLOUR 2460, 2479, 2670, 2716, 2823, 3249, 3256, 3257, 3258, 3327, 3329, 3332, 3334, 3336, 3337, 3338, 3342, 3343, 3351, 3355, 3358, 3359, 3366, 3367, 3371, 3374, 3378, 3379, 3380, 3383, 3390, 3394, 3397, 3400, 3402, 3403, 3404, 3413, 3431, 3437, 3441
WHEAT GENOTYPES 2910
WHEAT GERM DIET 3017
WHEAT GLUTEN 3430
WHEAT GLUTEN FILMS 3373
WHEAT GROWING SOILS 3289
WHEAT LANDRACES 2742
WHEAT MITOCHONDRIAL GENE 2769
WHEAT NO TILL 2855
WHEAT PHYLOGENY 2720, 2858
WHEAT QUALITY 3387
WHEAT SILAGE 3444
WHEAT STRAW 2571, 2606, 2617, 3290, 3456, 3458, 3459
WHEAT TREATED WITH SODIUM HYDROXIDE 3265
WHEY 3325
WHOLE 2871
WIDE HYBRIDS 2641
WILD 2683
WILD BARLEY 2649
WILD PLANTS 2993, 3004
WILD WHEATS 2720, 2978
WIND RESISTANCE 2503
WINDBREAKS 2477
WINGS 3033
WINTER 2509, 2770
WINTER CEREALS 2702
WINTER CROPS 2461, 2468, 2470, 2483, 2484, 2500, 2503, 2508, 2509, 2514, 2516, 2517, 2545, 2546, 2556, 2557, 2562, 2564, 2573, 2595, 2596, 2603, 2605, 2613, 2622, 2623, 2634, 2651, 2653, 2666, 2669, 2715, 2735, 2737, 2749, 2761, 2791, 2816, 2822, 2830, 2831, 2834, 2889, 2902, 2920, 2921, 2998, 3008, 3019, 3035, 3046, 3048, 3054, 3065, 3066, 3070, 3091, 3103, 3106, 3133, 3142, 3152, 3159, 3181, 3195, 3202, 3205, 3249, 3251, 3285, 3292, 3296, 3299, 3319, 3385, 3400, 3417, 3442, 3452, 3455, 3469
WINTER INJURY 2702
WINTER OILSEED RAPE 2576
WINTER RYE 2966
WINTER RYE LEAVES 2850
WINTER WHEAT 2455, 2466, 2473, 2495, 2547, 2563, 2572, 2578, 2585, 2600, 2688, 2835, 2838, 2845, 2910, 2926, 2956, 2961, 3129, 3137, 3191, 3193, 3196, 3303, 3395
WINTER WHEAT (TRITICUM AESTIVUM) 2960
WINTER WHEAT CULTIVARS 3014
WINTER WHEATS 2871
WORLD COLLECTION 3176
X TYPE 2779

XANTHOMONAS CAMPESTRIS 3116, 3121
XANTHOPHYLLS 2873
XYLANASE 3462
XYLEM 2930
XYLEM LOADING 2927
XYLEM SAP 2948, 2974
YEASTS 3325
YIELD 2426, 2428, 2495, 2498, 2551, 2576, 2578, 2600, 2838, 2939, 2940, 2949, 2973, 3014, 3083, 3129, 3174, 3185, 3189
YIELD CHARACTERISTICS 3014
YIELD COMPONENT 2959
YIELD COMPONENTS 2466, 2483, 2489, 2503, 2513, 2514, 2516, 2517, 2521, 2557, 2583, 2599, 2606, 2617, 2618, 2632, 2655, 2673, 2685, 2715, 2767, 2816, 2822, 2864, 3018, 3175
YIELD FACTORS 2483, 2557, 2599, 2840, 3467
YIELD FORMING PROPERTIES 2552
YIELD RESPONSIVENESS 3289
YIELD SUSTAINABILITY 2592
YIELDS 2435, 2469, 2487, 2514, 2544, 2577, 3026, 3119, 3227, 3285, 3286, 3288, 3292, 3312, 3321, 3325, 3358, 3374, 3378
YM4 2770
YUGOSLAVIA 2536, 2763, 3157
ZDAR 3014
ZEA MAIS L 2868
ZEA MAYS 2476, 2477, 2494, 2513, 2542, 2584, 2586, 2589, 2609, 2613, 2628, 2631, 2634, 2639, 2667, 2752, 2768, 2777, 2786, 2815, 2836, 2841, 2843, 2868, 2902, 2933, 2937, 3080, 3233, 3236, 3244, 3284, 3313, 3447
ZEA MAYS L 2904
ZEARALENONE 3130, 3169, 3364, 3366, 3368, 3449
ZEATIN 2863
ZEATIN 9 N GLUCOSIDE 2863
ZEATIN NUCLEOTIDE 2863
ZEATIN RIBOSIDE 2863, 2948
ZEIN 2638
ZERO 2465, 2466
ZERO TILLAGE 2438, 2475, 2514, 2584, 2607, 2608, 2615, 2627
ZHEJIANG 3190
ZINC 2920, 2930, 2931, 3186, 3296, 3303, 3398, 3465
ZINC DEFICIENCY 2592
ZINC SULPHATE 2834
ZOOLOGY 2982

How to obtain the full texts of documents

1. Recommendations to scientists:

First determine whether your local library or another library in your country can provide you with a copy of the document you want.

Most authors keep small stocks of reprints of their own publications, and they are usually prepared to respond to a polite request from a fellow scientist. This can be sent on a postcard with a return (institutional) address. In addition, many of the AGRIS input centers have a document delivery service. Your librarian may write and request a photocopy, for which you will often be charged the direct photocopy and mailing cost.

If your librarian is unable to find the document you want, you could send us the document delivery coupon which is included in each copy of *Literature Update on Wheat, Barley and Triticale.* This coupon enables you to ask the CIMMYT or ICARDA library to supply one or two items for your personal research or study. CIMMYT and ICARDA make no charge for this limited service, but the coupons should be used only as a last resort.

Because of copyright regulations, photocopies of entire publications (eg., complete books) cannot be provided.

see Document Delivery Coupon, last page

2. Recommendations to librarians:

Make any effort to get access to, as well as collaborate in, *Union Catalogs of Serials*, covering the journal holdings of the libraries in your country or region.

Order a copy of the *Union Catalog of Serials in International Agricultural Research Centers* (available in electronic format from ICRISAT-India[1]).

Establish good working relationships with other librarians and be as helpful as possible in providing document delivery services from the collection you hold.

Make your managers aware of the importance of having your own collection effectively organized, with back copies available for document delivery, with access to a photocopy machine and some funds to provide requested copies of your documents.

Contact the AGRIS input center of your country to make sure that relevant publications of your institution are registered in AGRIS, as well as in your national or regional agricultural database.

Obtain the addresses of all AGRIS input centers and AGLINET libraries (CIMMYT or ICARDA may provide these on request).

There are other useful reference tools that help you to locate the addresses of institutions, such as *Agricultural Information Resource Centers: A World Directory*, published by IAALD[2] and CTA[3]; the *Tropical Agriculture Information Sources* published by CTA.

[1] International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh 502324, India
[2] International Association of Agricultural Information Specialists (IAALD)
[3] Technical Centre for Agricultural and Rural Cooperation, P.O. B. 380, 6700 AJ Wageningen, Netherlands

CIMMYT ADDRESSES

(February 1997)

Headquarters

CIMMYT
Lisboa 27
Apdo. Postal 6-641
06600 México, D.F.
MEXICO
Email:
cimmyt@cimmyt.mx
Web: http://www.cimmyt.mx
Telex: 1772023 CIMTME
Telefax: INTL (52595)54425
Telefax: NATL(91595)54425
+52(5)726-75-58/726-75-59

Other CIMMYT Offices

CIMMYT
P.O. Box 6057, Gulshan
Dhaka-1212
BANGLADESH
Email:
cm@cimmyt.bdmail.net
Telefax: 880-2-883516

CIMMYT
c/o ANAPO
Casilla 2305
Santa Cruz
BOLIVIA
Email:
cimmyt@mitai.mrs.bolnet.bo
Telefax: (591-3) 427194

CIMMYT
c/o CIAT
Apdo. Aéreo 67-13 Cali
COLOMBIA
Email:
c.deleon@cgnet.com
Telex: 5769 CIATCO
Telefax: (57-2) 4450273

CIMMYT
Apartado 55
2200 Coronado
San José,
COSTA RICA
Email:
gsain@iica.ac.cr
Telex: 2144 IICA
Telefax: (506) 229-2457

CIMMYT
c/o IITA 01 B. P. 2551
Bouake 01
COTE D'IVOIRE
Email:
a.o.diallo@cgnet.com
Telex: 69138 ADRAOCI
Telefax: (225) 634714

CIMMYT
P. O. Box 5689
Addis Ababa
ETHIOPIA
Email:
cimmyt-ethiopia@cgnet.com
d.tanner@cgnet.com
o.abdalla@cgnet.com
w.mwangi@cgnet.com
Telex: 21207 ILCA ET
Telefax: (251-1) 611 892

CIMMYT
12 Calle 1-25 Zona 10
Torre Norte 16 Nivel, Of. 1606
Apdo. Postal 231-A
GUATEMALA
Email:
cimmyt@ns.guate.net
jbolanos@ns.guate.net
jfournier@ns.guate.net
Telex: 6215 (ANAVI GU)
Telefax: (502) (2) 3353407

CIMMYT
c/o CIAT-Laderas
c/o IICA-Honduras
Apdo. Postal 1410
Tegucigalpa, DC 11101
HONDURAS
Email:
ciathill@hondutel.hn
Telefax: (504) 31-54-72

CIMMYT
P.O. Box 25171
Nairobi
KENYA
Email:
cimmyt-kenya@cgnet.com
j.ransom@cgnet.com
Telefax: (254-2) 631499/630164

CIMMYT
P. O. Box 5186
Kathmandu
NEPAL
Email:
esaari@cimmyt.mos.com.np
phobbs@cimmyt.mos.com.np
Telefax: CIMMYT-Office
977 (1) 419352-
Att'n. CIMMYT

CIMMYT
Cereal Improvement Program
c/o ICARDA
P. O. Box 5466
Aleppo
SYRIA
Email:
oferrara@cgnet.com
m.nachit@cgnet.com
Telex: 331206 ICARDA SY
Telefax: (963-21) 213490

CIMMYT
P.O. Box 9-188
Bangkok 10900
THAILAND
Email:
bangkok@cimmyt.mx
jlothrop@cimmyt.mx
Telex: 84478 INTERAG TH
Telefax: (66-2) 561-4057

CIMMYT
P. K. 39 Emek
Ankara
TURKEY
Email:
cimmyt-turkey@cgnet.com
h.j.braun@cgnet.com
IN%TURKEY
Telex: 42994 CIMMY TR
Telefax: (90-312) 287-8955

CIMMYT
c/o IICA
CC 1217
Montevideo
URUGUAY
Email:
cimmyt@chasque.apc.org
Telex: IICA UY 22571
Telefax: (598-2) 928522

CIMMYT
P. O. Box MP163
Mount Pleasant
Harare
ZIMBABWE
Email:
cimmyt-zimbabwe@cgnet.com
d.jewell@cgnet.com
s.waddington@cgnet.com
k.pixley@cgnet.com
m.banziger@cgnet.com
g.varughese@cgnet.com
Telefax: 263-479-0393/435-559

ICARDA ADDRESSES

(October 1996)

Headquarters

ICARDA
P.O. Box 5466
Aleppo
SYRIA
Telex: 331206/331208 ICARDA SY
Phone: (963-21) 213433/213477

ICARDA
c/o CIMMYT
P.O. Box 6-641
06600 Mexico, D.F.
MEXICO
Internet: cimmyt@cimmyt.mx
Phone: (52-5) 7269091,
(52-595) 54400/54410
Fax: (52-5) 7267559
(52-595) 54425

Regional Offices

ICARDA
15 G. Radwan Ibn El-Tabib Giza
11th Floor
P.O. Box 2416
Cairo
EGYPT
Email: ICARDA-Cairo@CGNET.COM
M.SLH@CGNET.COM
Phone: (20-2) 5724358/5725785/5735829
Telex: (091) 21741 ICARD UN
Fax: (20-2) 5728099

ICARDA
Immeuble STB
1st Floor
Appartment No. 1
Tunis
TUNISIA
Phone: (216-1) 232488
Telex: (409) 14066 ICARDA TN
Fax: (216-1) 751666

ICARDA
P.O. Box 950764
Amman 11195
JORDAN
Phone: (962-6) 825750
Telex: (493) 232781 ICARDA JO
Fax: (962-6) 825930

ICARDA
P.O. Box 39 Emek
06511 Ankara
TURKEY
Email: CG1450
Phone: (90-312) 2873595
Telex: (607) 44561 CIMY TR
Fax: (90-312) 2878955

Document Delivery Coupon

Please use this coupon only as a last resort after having tried to obtain the document you need from your own library or a national or regional information center/library (see "How to obtain the full text of documents" in this publication).

Send your request to either:
CIMMYT-Document Delivery Service, Lisboa 27, Apdo. 6-641, 06600 Mexico, D.F., MEXICO, or
ICARDA-Rachis Document Delivery Service, P.O. Box 5466, Aleppo, SYRIA

Please send me a reprint/photocopy of the following document listed in *Literature Update on Wheat, Barley, and Triticale* for purposes of personal study or research:

Volume No./Year _____ Entry Number _____ Author _____

Title _____

Source _____

Year _____ Pages _____ AGRIS Number (if available) _____

Write your name/address on the reverse of this coupon.

Document Delivery Coupon

Please use this coupon only as a last resort after having tried to obtain the document you need from your own library or a national or regional information center/library (see "How to obtain the full text of documents" in this publication).

Send your request to either:
CIMMYT-Document Delivery Service, Lisboa 27, Apdo. 6-641, 06600 Mexico, D.F., MEXICO, or
ICARDA-Rachis Document Delivery Service, P.O. Box 5466, Aleppo, SYRIA

Please send me a reprint/photocopy of the following document listed in *Literature Update on Wheat, Barley, and Triticale* for purposes of personal study or research:

Volume No./Year _____ Entry Number _____ Author _____

Title _____

Source _____

Year _____ Pages _____ AGRIS Number (if available) _____

Write your name/address on the reverse of this coupon.

Document Delivery Coupon

Please use this coupon only as a last resort after having tried to obtain the document you need from your own library or a national or regional information center/library (see "How to obtain the full text of documents" in this publication).

Send your request to either:
CIMMYT-Document Delivery Service, Lisboa 27, Apdo. 6-641, 06600 Mexico, D.F., MEXICO, or
ICARDA-Rachis Document Delivery Service, P.O. Box 5466, Aleppo, SYRIA

Please send me a reprint/photocopy of the following document listed in *Literature Update on Wheat, Barley, and Triticale* for purposes of personal study or research:

Volume No./Year _____ Entry Number _____ Author _____

Title _____

Source _____

Year _____ Pages _____ AGRIS Number (if available) _____

Write your name/address on the reverse of this coupon.

My name and institutional address are:

_____

_____

_____

_____

_____

_____ _____

Date **Signature**

My name and institutional address are:

_____

_____

_____

_____

_____

_____ _____

Date **Signature**

My name and institutional address are:

_____

_____

_____

_____

_____

_____ _____

Date **Signature**

ISSN 1405-1672