Vol. 16, No. 2, 1989

Lens NEWSLETTER

THE INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS (ICARDA)

UNIVERSITY OF SASKATCHEWAN

ICARDA and CGIAR

The overall objective of the International Center for Agricultural Research in the Dry Areas (ICARDA) is to increase agricultural productivity and food availability in both rural and urban areas, thus improving the economic and social well-being of people in developing countries, particularly in North Africa and West Asia. The center focuses mainly on winter rainfall areas with 200-600 mm annual precipitation. When appropriate, research also covers environments with monsoon rainfall or irrigation.

ICARDA is a world center for the improvement of barley, lentil, and faba bean, and a regional center for improving wheat, chickpea, farming systems, livestock, and pasture and forage crops. The training of agricultural researchers from developing countries and the communication of research results are an important part of ICARDA's activities.

ICARDA is a non-profit research center established in 1977 by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR, an informal association of donors including governments, organizations, and private foundations, supports agricultural research worldwide to improve food production in developing countries, through a network of 13 international research institutions, including ICARDA. The network covers crop and livestock systems that supply three-quarters of the food of the developing world.

LENS

LENS Newsletter is produced twice a year at ICARDA in cooperation with the University of Saskatchewan, Canada with the financial support of the International Development Research Center (IDRC), Ottawa, Canada. LENS, the newsletter of the Lentil Experimental News Service, is a forum for communicating lentil research results. Short research articles provide rapid information exchange, and comprehensive reviews are invited regularly on specific areas of lentil research. The newsletter also includes book reviews, key abstracts on lentils, and recent lentil references. The Lentil Experimental News Service provides information on lentil research free of charge through a question and answer service, photocopies, and searches of a lentil document collection.

DEADLINE: Contributions must reach LENS for Vol 17 (2) 1990 by 30 Apr 1990 and 18 (1) 1991 by 31 Oct 1990.

SUBSCRIPTIONS: LENS Newsletter is available free to lentil researchers under an IDRC grant. To subscribe, write:
LENS/STIP/ICARDA/P.O. Box 5466/Aleppo, Syria.

COVER PHOTO: Crossing lentil in the field under the supervision of Dr. A. Hamdi (lentil breeder) at Field Crops Research Centre, Giza, Egypt.
Photo Credit: Dr. M.C. Saxena

ISSN 0257-7143

Vol. 16, No. 2, 1989

Lens NEWSLETTER

CONTENTS

PESTS and DISEASES

SEED QUALITY

LENTIL INFORMATION

RESEARCH ARTICLES البحوث

Breeding and Genetics التربية والمورثات

Effect of gamma rays, ethylmethane sulphonate and hydroxyamine on type and frequency of chlorophyll mutations in lentil

D. Singh, R.M. Singh, and J. Singh
Department of Genetics and Plant Breeding
Institute of Agricultural Sciences
Banaras Hindu University
Varanasi 221005, Uttar Pradesh, INDIA

Abstract

Three types of chlorophyll mutations (albina, xantha, and viridis) occured in one small seeded and one large seeded variety of lentil (*Lens culinaris* Medik.) following treatment with gamma rays, ethylmethane-sulphonate (EMS), and hydroxylamine (HA). Chlorophyll mutations occured following gamma radiation at 5 and 10 kR, but not at higher doses. The 0.02 M EMS treatment produced a higher frequency of chlorophyll mutations than higher concentrations. The three concentrations of HA produced similar low frequencies of chlorophyll mutations. EMS was found to be the most efficient mutagen as compared to gamma rays and HA. The small seeded variety appeared more sensitive to mutagenic agents than the large seeded variety, indicating a possible role of seed size in mutagenesis.

Introduction

Lentil (*Lens culinaris* Medik.) is broadly classified into *microsperma* and *macrosperma* groups on the basis of seed size. Studies on experimental mutagenesis in this crop are limited and confined to *microsperma* varieties. Varietal differences in the spectrum and the frequency of chlorophyll mutations were reported by other workers (Goud 1967; Goud *et al.* 1970; Nerkar and Mote 1978; Sharma and Sharma 1981; Rao and Reddy 1984).

The objective of this study was to investigate the effects of physical (gamma rays) and chemical (EMS and HA) mutagens on the type and frequency of induced chlorophyll mutations in *microsperma* and *macrosperma* lentils.

Materials and Methods

Dry seeds of lentil varieties RAU 101 (*macrosperma*) and Pant L 639 (*microsperma*) with original seed moisture contents of 10.02 and 9.82%, respectively were selected. The seed moisture content of half the seeds of RAU 101 and Pant L 639 was decreased to 3.30 and 3.60%, respectively by drying in an oven. Seeds of the two varieties at both moisture levels were irradiated with 5, 10, 15, and 25 kR doses of ^{60}Co gamma rays. Fresh seeds of both varieties were presoaked for 6 hrs in distilled water at room temperature (22 + 1°C) and then the seeds were transferred either into a phosphate buffered solution of ethylmethanesulphonate (0.02, 0.04, and 0.06 M at pH 7.0) or a hydroxylamine solution (0.08, 0.12, and 0.16 M at pH 5.5) for 6 hrs, then washed for 4 hrs in water. After these treatments, both treated and control seeds were grown in the field to produce the M_1 generation. All M_1 plants were harvested individually and the M_2 was grown the following season. The M_2 populations were screened for chlorophyll mutations and frequencies are reported per thousand M_2 plants.

Results and Discussion

EMS was the most effective treatment in inducing chlorophyll mutations followed by low doses of gamma rays and HA in that order (**Table**). Chlorophyll mutation frequency was highest at the lowest concentration of EMS (0.02 M) and decreased with increasing concentrations. The lower doses of gamma rays (5 and 10 kR) were more effective than higher doses in inducing

Table Spectrum and frequency of chlorophyll mutations/1000 M_2 seedlings in lentil varieties RAU-101 (*macrosperma*) and Pant L 639 (*microsperma*) induced by physical and chemical mutagens

Treatment	Total plant population		Type of chlorophyll mutation						Total chlorophyll mutation frequency	
			Albina		Xantha		Viridis			
	A	B	A	B	A	B	A	B	A	B
Control	2260	2275	-	-	-	-	-	-		
Gamma ray										
HM 05 kR	1780	1655	-	-	3.37	1.21	1.69	4.83	5.06	6.04
HM 10 kR	1270	1628	-	-	3.94	1.84	4.72	1.23	8.66	3.07
HM 15 kR	1325	1635	-	-	-	-	-	-	-	-
HM 20 kR	1288	1265	-	-	-	-	-	-	-	-
HM 25 kR	1680	1098	-	-	-	-	-	-	-	-
LM 05 kR	1255	1877	-	-	-	1.07	-	2.13	-	3.19
LM 10 kR	1195	1188	-	-	-	-	-	-	-	-
LM 15 kR	1290	1286	-	-	-	-	-	-	-	-
LM 20 kR	1545	1370	-	-	-	-	-	-	-	-
LM 25 kR	1197	1496	-	-	-	-	-	-	-	-
EMS										
0.02 M	1598	1498	1.25	1.33	3.13	2.00	6.26	23.36	10.64	26.70
0.04 M	1477	1555	-	-	2.03	5.79	3.39	4.14	5.42	10.93
0.06 M	1388	1170	-	-	1.44	-	1.44	1.71	2.88	1.71
HA										
0.08 M	1615	1277	-	-	-	1.57	0.62	0.78	0.62	2.35
0.12 M	1450	1399	-	-	-	-	0.69	-	0.69	-
0.16 M	1425	1495	-	-	-	0.67	0.70	0.67	0.70	1.34

HM = High seed moisture; LM = Low seed moisture; A = RAU-101 (*macrosperma*); B = Pant L 639 (*microsperma*)

chlorophyll mutations. HA induced a low frequency of chlorophyll mutations and concentration had little effect. In general, the small seeded variety Pant L 639 was more sensitive to the mutagenic agents used compared to the large seeded variety RAU-101. This difference may be due to differences in seed size or genotype.

The spectrum of chlorophyll mutations was quite narrow as only three kinds namely albina, xantha, and viridis occurred in the different treatments in both lentil varieties. Albina occurred only in the EMS treatment which induced the highest frequency of chlorophyll mutations, possibly related to the greater effectiveness of this mutagen.

The high incidence of chlorophyll mutations in EMS treatments may be due to its specificity to affect certain regions of the chromosomes (Natrajan and Upadhya 1964). Reduction in frequency at higher doses has been attributed to the vigour of both diplontic and haplontic selections in the biological material (Swaminathan 1961) and elimination of mutations.

References

Goud, J.V. 1967. Induced polygenic mutation in hexaploid wheat. Radiation Botany 7: 321-331.

Goud, J.V., Nayar, K.M.D. and Rao, M.G. 1970. Mutagenesis in sorghum. Indian Journal of Genetics and Plant Breeding **30**(1): 81-90.

Natrajan, A.T. and Upadhya, M.D. 1964. Localised chromosome breaker induced by EMS and HA in *Vicia faba*. Chromosoma (Berl) **15**: 156-169.

Nerkar, Y.S. and Mote, S.B. 1978. Induced mutagenesis in Bengal gram (*Cicer arietinum* L.) I. Viable mutations. Journal of Maharashtra Agricultural Universities 3: 174-177.

Rao, D.M. and Reddy, T.P. 1984. Induction of mutations in pigeonpea (*Cajanus cajan* L.). Mutation Breeding Newsletter No. 24: 8.

Sharma, S.K. and Sharma, B. 1981. Induced chlorophyll mutations in lentil. Indian Journal of Genetics and Plant Breeding **41**(3) 328-333.

Swaminathan, M.S. 1961. Effect of diplontic selection on frequency and spectrum of mutations induced in polyploids following seed irradiation. Pages 243-277 *in* Effects of ionizing radiation on seeds Proc. Commitato Niozionale Energia Niclear Maggio. IPEA, Vienna, Austria.

تأثير أشعة غاما، وسلفونات ايثيل الميثان(س ا م)، وهيدروكسيل امين(ه ا) في طرز وتكرار طفرات يخضورية(كلوروفيلية)في العدس

ملخص

حدثت ثلاثة أنماط من الطفرات اليخضورية (albina,xantha و viridis) في صنف عدس (*Lens culinaris* Medik)صغير الحبة وآخر كبير الحبة، إثر المعاملة بأشعة غاما و(س ا م) و(ه ا). وقد حصلت تلك الطفرات بعد التعريض لأشعة غاما بجرعات شدتها 5 و kR10 وليس بجرعات أعلى، وأعطت المعاملة(س ا م) بتركيز0.02Mتكرارا من تلك الطفرات أعلى من التركيزات الأعلى، أما التركيزات الثلاثة من(ه ا)فأعطت تكرارات منخفضة متماثلة من تلك الطفرات. كما وجد أن(س ا م)هو أكثر المطفّرات فعالية مقارنة بأشعة غاما و(ه ا)، وبدا أن الصنف الصغير الحبة هو أكثر حساسية للعوامل المطفِّرة من الآخر الكبير الحبة، مما يشير إلى احتمالية أن يكون لحجم البذرة دور في الطفرات الاصطناعية.

Genetic variability, correlation studies and their implication in selection of high yielding genotypes in lentil

M. A. Rajput and G. Sarwar
Atomic Energy Agricultural Research Centre, Tandojam, Sind, PAKISTAN

Abstract

In a study designed to measure genotypic and phenotypic variances and the association of yield with other traits, 22 lentil genotypes of diverse origin were sown at one site. Maximum plant height (52.4 cm) was attained by a local check producing high grain yield/plant (7.14 g) and highest number of seeds/plant (216.0). Genotypic and phenotypic variances were very high for number of pods/plant followed by plant height. Maximum heritability was for 100 grain weight (91.0%) followed by number of pods/plant (98.5%). Genetic advance was very high for number of pods/plant followed by grain yield/plant and 100 grain weight (88.7). Heritability for 100 grain weight, number of pods/plant, and grain yield/plant were accompanied with a high magnitude of genetic advance. Correlation coefficients revealed that seed yield was positively and significantly correlated with number of pods/plant and number of seeds/pod. All other components except for 100 grain weight exerted positive, but non-significant effects on grain yield.

Introduction

Lentil (*Lens culinaris* Medik.) is the second major *Rabi* pulse crop after chickpea in Pakistan. It is rich in protein (24%). The average yield (531 kg/ha) is very low (Anon. 1985) due to continuous cultivation of cultivars with a low yield potential cultivars and excessive vegetative growth with poor response to inputs and improved management practices, narrow adaptability, low stability of yield, and susceptibility to stress conditions. To overcome these constraints it is important to develop varieties with improved characteristics. Estimates of genetic variability using suitable genetic parameters such as genotypic and phenotypic variance, heritability, and genetic advance are essential to initiate an efficient breeding program. The knowledge of the relationship of various growth and yield components with yield is of great value to breeders and forms a basis for effective selection. In this study we measure genotypic variance, phenotypic variance, heritability, genetic advance, the association of yield and its components and discuss the implication of this information to selection of better genotypes of lentil.

Materials and Methods

Twenty two lentil genotypes of diverse origin received from ICARDA (Syria) and NARC (Pakistan) provided the material for this study. The cultivars differed in their phenotypic behaviour (Rajput and Sarwar 1988). The experiment was planted in a randomized complete block design with three replications in a single line of 4 meters long. Rows were four meters long and 30 cm apart with 5 cm between plants in rows. At maturity, five plants from each plot were randomly selected to observe plant height, number of branches/plant, number of pods/plant, pod length, number of seeds/pod, 100 seed weight, and grain yield/plant. The data were subjected to analysis of variance and different genetic parameters like phenotypic and genotypic variance, heritability (broadsense (BS)) and genetic advance were estimated according to the method outlined by Johnson *et al.* (1955) and recently adopted by (Malik *et al.* 1983). Correlation coefficients were also computed for all characteristics (Steel and Torrie 1960).

Serial Number	Genotype	Plant height (cm)	Number of branches/ plant	Pod length (cm)	Number of seeds/ pod	Number of seeds/ plant	100 seed weight (g)	Grain yield/plant (g)
1.	ILL 8	41.6	1.66	1.03	1.53	67.4	2.26	1.37
2.	ILL 816	39.2	3.45	1.16	1.91	73.3	2.60	2.87
3.	ILL 1706	32.9	2.53	1.06	1.93	61.7	2.19	2.26
4.	ILL 3010	44.8	2.73	1.12	1.93	154.7	1.60	3.68
5.	ILL 3382	47.1	1.60	1.14	2.00	186.1	1.95	5.96
6.	ILL 3480	47.2	1.60	0.98	2.00	130.7	1.75	4.00
7.	ILL 1744 x Pant-L-406	24.3	2.73	1.06	2.00	58.1	3.90	3.28
8.	Jordan Local x Pant-L-406	28.4	2.73	1.03	1.93	67.1	4.16	4.19
9.	LIF-3-13	30.0	2.66	1.00	2.00	62.3	4.33	4.31
10.	LIF-3-20	29.4	2.60	1.06	2.00	28.7	4.19	2.15
11.	NARC-1	29.7	2.66	1.03	2.00	66.6	4.02	4.05
12.	NARC-3	44.2	3.11	1.19	1.80	154.4	1.25	3.84
13.	NARC-4	37.9	2.00	1.00	2.00	82.6	3.24	4.28
14.	NARC-5	39.1	3.03	1.13	1.30	21.1	2.00	0.39
15.	FLIP-86-19 L	30.6	2.13	1.17	2.00	78.6	5.03	2.92
16.	Lenka	32.8	2.60	1.46	1.60	47.9	3.17	1.37
17.	FLIP-86-3 L	36.1	2.70	1.20	1.50	77.8	2.61	1.85
18.	FLIP-86-12L	32.4	2.20	1.54	1.02	35.5	5.42	1.82
19.	Precoz	37.1	1.50	1.17	1.93	95.4	4.12	4.94
20.	Precoz x Pant-L-406	39.4	3.81	1.57	1.83	102.2	3.95	7.15
21.	9-6 (Masoor-85)	44.6	3.25	1.16	1.86	100.0	2.01	2.72
22.	Local*	52.4	3.00	1.13	2.00	216.0	0.70	7.14

Table 1 Morphological characteristics of lentil

* Purchased from local market

Results and Discussion

The morphological observations recorded are presented in **Table 1**. Plant height ranged from 24.3 to 52.4 cm. The maximum height was attained by a local check which had a very small grain size (0.70 g/100 seed). But with a high number of seeds/plant (216) it produced high grain yield/plant (7.14 g). The highest seed yield was realized by the genotype Precoz x Pant-L-406 and the main yield contributing factors were pod length and number of branches/plant. Accession FLIP-86-12 L had very bold grains (52.4/g/100 seed).

The estimates of genetic parameters, genotypic variance, phenotypic variance, heritability (BS), and genetic advance are presented in **Table 2**. These estimates provide the existing stability, variability, and future selection possibilities in the breeding material. The genotypic and phenotypic variances were very high for number of pods/plant (2501.6 and 2539.4) followed by plant height (50.1 and 54.2), which indicated a wide variation in the material. The high heritability for these characters further demonstrated that selection for these attributes will be very useful. For other attributes, the variance values both at genotypic and phenotypic levels were lower. In general, there was no great difference between phenotypic and genotypic variability, suggesting a small effect of environment on these characters. Thus, a selection for these attributes will provide a great chance of genetic improvement. The estimates of heritability ranged from 78.0 to 99.0%. Maximum heritability was for 100 grain weight (91.0%) followed by number of pods/plant (98.5%). The expected genetic advance observed was very high for number of pods/plant (116.1) followed by grain yield/plant (95.8) and 100 grain weight (88.7). High heritability is of low value unless it is supported by high genetic advance (Johnson *et al.* 1955 and Panse 1957). In the present work, very high heritability values computed for 100 grain weight, number of pods/plant, and grain yield/plant were accompanied with a high magnitude of genetic advance. This suggests that these characters are probably controlled by additive gene effects. Thus,

Table 2 Genetic parameters for various agronomic traits in lentil

Character	X mean	Genotypic variance	Phenotypic variance	Heritability (%)	Genetic gain	Genetic advance (% of means)
Plant height (cm)	37.3	50.10	54.22	92.4	14.01	37.54
Number of branches/plant	2.56	0.30	0.38	78.0	0.99	38.67
Pod length (cm)	1.16	0.03	0.03	90.4	0.31	26.72
Number of seeds/pod	1.82	0.06	0.08	82.2	0.45	29.67
Number of pods/plant	89.4	2501.6	2539.4	98.5	102.3	116.07
100 grain weight (g)	3.02	1.67	1.69	99.0	2.65	88.74
Grain yield/plant (g)	3.84	3.06	3.15	97.2	3.55	95.81

if these attributes in lentil are subjected to a suitable selection scheme aimed at exploiting fixable genetic advance, a lentil variety of general adaptability can be developed as the environment had a low influence on the expression of those traits. For the remaining characters (plant height, pod length, number of seeds/pod, and number of branches/plant) high heritability accompanied with comparatively low genetic advance revealed, that high heritability is mainly due to non-additive genetic effects (dominance, overdominance and their interactions). These characters exhibited high heritability due to favorable influence of environment, hence selection for such attributes would not necessarily result in genetic improvement. Similar behaviour of different genetic parameters in lentil had been found by Singh *et al.* (1977).

The correlation coefficients among different plant attributes are presented in **Table 3**. Examination of these data revealed that the seed yield was positively and significantly correlated ($P < 0.01$) with number of pods/plant (0.715) and number of seeds/pod (0.586). Significant positive association of yield with these attributes indicated positive contribution of these components towards seed yield in lentil. The number of pods/plant appeared to be the most important component of yield. All the other components except for 100 grain weight exerted positive, but non-significant effects on grain yield. Seed size (100 grain weight) had shown negative association with plant height and number of pods/plant. This negative correlation may be attributed to the large seeded varieties which are mostly late flowering. Hence, pod and seed setting is very poor due to rise in temperature during flowering and maturity stages (Sharma and Sharma 1982). For successful cultivation of *macrosperma* lentil in Sind, earliness in flowering and maturity should be incorporated (Rajput and Sarwar 1988). Plant height had very strong positive correlation with number of pods/plant. Hence, selection on the basis of plant height is useful in improving seed yield.

On the basis of variability parameters and association analysis of different characters with grain yield, it is suggested that selection criteria based on number of pods/plant and number of seeds/pod should be given due emphasis for exploiting maximum yield potential in lentil.

Table 3 Correlation coefficient between different morphological characteristics of lentil

Character	Number of branches/ plant	Pod length	Number of seeds/ pod	Number of pods/ plant	100 grain weight	Grain yield/ plant
Plant height	-0.004	0.012	0.013	0.675**	-0.759**	0.240
Number of branches/plant	-	0.320	-0.025	-0.047	-0.126	0.023
Pod length	-	-	-0.550**	-0.081	0.259	0.021
Number of seeds/pod	-	-	-	0.414	-0.104	0.586**
Number of pods/plant	-	-	-	-	-0.635**	0.715**
100 grain weight	-	-	-	-	-	-0.100

** Significant at $P < 0.01$ level

References

Anonymous 1985. Agricultural Statistics of Pakistan. Government of Pakistan, Ministry of Food, Agriculture and Cooperatives (Planning Unit) Islamabad, Pakistan.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. Agronomy Journal **47**: 314-318.

Malik, B.A., Hussain, S.A., Haqqani, M.A. and Chaudhry A.H. 1983. Genetic variability in mungbean (*Vigna radiata*.) Pakistan Journal of Agricultural Research **4**(3): 171-173.

Panse, V.G. 1957. Genetics of quantitative characters in relation to plant breeding. Indian Journal of Genetics and Plant Breeding **17**: 318-328.

Rajput, M.A. and Sarwar, G. 1988. Evaluation report of lentil yield screening nursery. Rabi Research Programme Meeting of Pulses Programme, 20-21 September, 1987. Islamabad, Pakistan.

Sharma, S.K. and Sharma, B. 1982. Induced early mutants in large seeded lentil. Indian Journal of Agricultural Research **16**(2): 79-82.

Singh, P. Bhatia, R.S. Singh, I.P., Shukla N.S. and Awasthi, R.L. 1977. Genetic variability and path analysis for yield attributes in lentil. Indian Journal of Agricultural Research **11**(1): 25-28.

Steel, R.G.S. and Torrie, J.H. 1960. Principles and Procedures of Statistics. McGraw Hill Book Co. Inc., New York.

التنوع الوراثي ودراسات الارتباط وانعكاساتهما على انتخاب طرز وراثية مغلالة من العدس

ملخص

في دراسة مصممة لقياس تنوع الطرز الوراثية وتركيبها المظهري، وارتباط الغلة بصفات أخرى، زُرع 22 طرازا وراثيا من العدس أصولها مختلفة في موقع واحد. وقد تم الحصول على أعلى طول للنبات (52.4 سم) من شاهد محلي أعطى غلة حبية مرتفعة(7.14غ/النبات)، وأعلى عدد من البذور (216.0/النبات) . وكانت التباينات بين الطرز الوراثية والتراكيب المظهرية شديدة جدا بالنسبة لعدد القرون/ النبات، يليه طول النبات. وبلغت أعلى قابلية للتوريث في صفة وزن المئة حبة (91.0٪)، تلاها عدد القرون/ النبات(98.5٪). وكان التحسُّن الوراثي على أشُدِّه في صفة عدد القرون/النبات، تليها الغلة الحبية/النبات، ووزن المئة حبة(88.7). كما واكب قابلية توريث وزن المئة حبة وعدد القرون/النبات والغلة الحبية/النبات تحسُّن وراثي كبير. وأظهرت معاملات الارتباط أن الغلة البذرية كانت مرتبطة بشكل موجب ومعنوي بعدد القرون/النبات، وبعدد البذور/القرن. وقد خلَّفت جميع المكونات الأخرى، باستثناء وزن المئة حبة، تأثيرات في الغلة الحبية إيجابية لكنها غير معنوية.

Effect of mutagenesis on M_1 parameters in lentil

A. Sarker[1] and B. Sharma[2]

1. Bangladesh Agricultural Research Institute Joydebpur, Gazipur, BANGLADESH

2. Indian Agricultural Research Institute, Division of Genetics, New Delhi-110012, INDIA

Abstract

The immediate effect of mutagenesis was studied in a land variety of lentil, L-3991. The mutagenic treatments caused significant biological damage which was measured by M_1 parameters. However, the pattern of mutagenic damage varied with different mutagens. Gamma rays had more drastic effect on fertility and seedling height, Ethyl methane sulphonate (EMS) on fertility, Nitroso ethyl urea (NEU) on germination, and survival and minimum toxicity was recorded with sodium azide (SA).

Introduction

Lentil occupies first position amongst pulses with respect to human consumption in Bangladesh. Its yield per unit area is very low. Use of traditional varieties with low yield potential is one of the major causes of low production of lentil. Moreover, the farmer's varieties all over the country have restricted variability in respect of the economic characters. In this situation induced mutagenesis seems to be useful in creating variability, subsequent improvement can be done through selection. The immediate effects of mutagenesis were studied in terms of germination, seedling height, plant survival and pod fertility. This information may be useful in selecting mutagens or doses/concentrations if there is any relationship existing between M_1 injury and the occurence of beneficial macro or micromutations.

Materials and Methods

The experiments were conducted on the seed of a local variety L-3991 at the Division of Genetics, Indian Agricultural Research Institute, New Delhi during the 1981/82 season. Four mutagens, *viz.* gamma rays, EMS, NEU, and SA with three doses/concentrations each were used. Five hundred seeds were used in each treatment.

Table Germination, seedling height at 40 days, plant survival, and pod fertility in M_1 generation

Treatment	Germination		Seedling height		Survival harvest		Pod fertility	
	% of treated seeds	% of control	cm	% reduction	% of germinated plants	% of control	% fertility	% of control
Control	96.2	100.0	4.9	0	94.8	100.0	97.5	100.0
Gamma rays								
4 kr	70.4	73.1	3.7	25.6	61.2	64.5	76.1	78.0
8 kr	62.6	65.1	3.3	33.5	47.4	50.0	58.7	60.2
12 kr	47.6	49.5	3.3	33.7	39.4	41.5	53.5	54.8
EMS								
0.1%	76.8	79.8	4.4	10.3	69.2	72.9	75.8	77.8
0.2%	65.0	67.6	3.7	25.6	54.4	57.3	57.9	59.3
0.3%	43.8	45.5	3.3	33.3	35.6	37.5	54.0	55.3
NEU								
0.005%	69.4	72.1	4.1	17.6	62.4	65.8	78.9	80.9
0.01%	54.4	56.6	3.6	26.0	42.4	44.7	76.4	78.3
0.02%	39.8	41.4	3.6	26.6	30.8	32.4	75.7	77.6
SA								
0.005%	81.2	84.4	4.4	11.5	75.4	79.5	85.6	87.7
0.01%	70.4	73.2	3.9	20.7	63.2	66.6	77.5	79.4
0.02%	64.8	67.4	3.7	24.7	57.0	60.1	77.3	79.2

The seeds were sown in rows 2.5 m long with 30 x 5 cm spacing without replication. The crop was irrigated twice and standard cultural and agronomic practices were followed to maintain good growth. The emergence of coleoptile was taken as an indication of germination which was recorded upto 30 days after seeding. Seedling height at 40 days was recorded for 20 randomly selected seedlings in each treatment. The survival percentage was computed as the percentage of plants surviving till maturity out of the total number of seedlings germinated. The pods of 20 randomly selected plants were taken and the number of fertile pods were counted. Pod fertility was measured as the ratio of the pods with seeds to the total number of pods in a plant averaged over the 20 plants in each treatment.

Results and Discussion

Germination

All mutagenic treatments caused considerable reduction in germination of the treated seeds. Among the mutagens tested, NEU proved to be more lethal than gamma rays, EMS, and SA mutagens. There was almost linear reduction in germination with increasing radiation doses or concentrations of the chemical mutagens. The effect of mutagens in reducing the germination is well established (Konzak *et al.* 1961). Several workers have also demonstrated that the dose has a direct bearing on germination (Bala Ravi 1982; Nalampang 1982; Sharma and Sharma 1983).

Seedling height

The reduction in seedling height (seedling injury) was also positively correlated with dose/concentrations in all the mutagens. Among the mutagens, gamma rays caused maximum reduction in height. Santos (1965) reported in *Phaseolus aureus* a decrease in plant height following treatment with gamma rays. Similar observations were also reported by Sharma and Sharma (1983) in lentil; Rajput *et al.* (1983) in soybean and Nalampang *et al.* (1982) in blackgram.

Plant survival

Plant survival at harvest drastically decreased in all treatments. In the control, 94.8% plants survived, whereas 30.8 (0.02%) NEU - 75.4% (0.005% SA) survived in the treatments. Thus, NEU caused maximum post germination lethality. The dose effect on plant survival was very clear with all mutagens. All the concentrations of SA showed less drastic effect on survival. The more drastic effect of NEU on survival was also reported by Sharma (1977) in lentil.

Pod fertility

Observations on pod fertility revealed that all the treatments caused considerable increase in sterility. In general, gamma rays and EMS produced more sterile pods as compared to NEU and SA. But, Nerkar (1974) reported great effect of EMS and NEU and recorded less pollen sterility with gamma rays in lathyrus. The possible reason for this discrepancy is the different dose range used in different studies.

In general, mutagenic treatments significantly influenced all these parameters selected for assessing the biological damage caused in the generation of treatment. However, there was some difference in the pattern of mutagenic damage also. For example, gamma rays had more drastic effect on fertility and seedling height, EMS on fertility, and NEU on germination and survival. Sodium azide displayed minimum toxicity in terms of M_1 damage.

The relationship between the M_1 injury detected due to different doses/concentrations of the mutagens used and the occurrence of beneficial macro and micromutations will be studied critically in M_2 and M_3 generations. The information from M_1 parameters may help in the initial rejection of less important mutagenized populations which may save time and effort in any mutation breeding program.

References

Bala Ravi, S. 1982. Mutational improvement of pigeonpea (*Cajanus cajun* L.) for plant architecture and grain yield. Induced Mutations for Improvement of Grain Legume Production II. IAEA-TECDOC No. 260:29-38.

Konzak, C.F., Nilan, R.A., Harle, J.R. and Heiner, R.E. 1961. Control of factor affecting the response of plants to mutagens. 14th Brookhaven Symp. Biol.: 128-157.

Nalampang, A. and Jan-on, J. 1982. Varietal improvement of mungbean and blackgram through mutation breeding. Induced Mutations for Improvement of Grain Legume Production II. IAEA-TECDOC No. 260: 133-143.

Nerkar, Y.S. 1970. Studies on the induction of mutations in *Lathyrus sativus* with special reference to the elimination of the neurotoxic principle. Ph.D. Thesis, IARI, New Delhi.

Rajput, M.A., Siddiqui, K.A. 1983. Induced mutation breeding studies for soybean improvement. Induced Mutations for Improvement of Grain Legume Production III. IAEA-TECDOC No. 299: 165-170.

Santos, I.S. 1965. Reduction of sensitivity to gamma rays in *Phaseolus aureus* through pre or post irradiation heat treatment of the seeds. Radiation Bot. (Suppl.) 5: 263-271.

Sharma, S.K. 1977. Induction of mutations for qualitative and quantitative in lentil (*Lens culinaris* Medik), Ph.D. Thesis, IARI, New Delhi.

Sharma, S.K. and Sharma, B. 1983. Mutation sensitivity mutability in lentil. XV. ICG. Abs. No. 578:329.

تأثير الطفرات الاصطناعية في معايير الجيل الطافر الأول M1 في العدس

ملخص

تمت دراسة التأثير المباشر للطفرات الاصطناعية في أصل محلي من العدس L-3991. وقد أحدثت معاملات التطفير ضرراً بيولوجيا كبيرا – تمّ قياسه وفق معايير الجيل M1 – تباين شكله بحسب المطفِّرات. إذ ظهر لأشعة غاما تأثير ضار جدا في الخصوبة وطول البادرة، ولسلفونات ايثيل الميثان في الخصوبة، ولنيتروزو ايثيل اليوريا في الإنبات، وسجِّل بقاء النباتات، وبحد أدنى من السمِّيّة، باستعمال آزيد الصوديوم.

Performance of exotic lentil genotypes in Sudan

Abdalla Ibrahim Sheikh Mohamed[1], Salih Hussin Salih[1], and Farouk Ahmed Salih[2]

1. Hudeiba Research Station, P.O. Box 31, Ed-Damer, SUDAN

2. Shambat Research Station P.O. Box 30, Shambat, SUDAN

Abstract

Ten exotic lentil genotypes were evaluated for growth duration, seed yield, and yield components for two seasons at Hudeiba and Rubatab in the Northern Region of Sudan. The genotypes varied in growth duration, but not in seed yield and yield components. The genotypes NEL 795 and NEL 812 were promising under Sudan conditions.

Introduction

Lentil (*Lens culinaris* Medik.) is a cool-season annual legume originated in the Near East. Lentils are subdivided into *microsperma* and *macrosperma* on the basis of seed size (Erskine and Witcombe 1984; Hawtin *et al.* 1980; Webb and Hawtin 1981). Within Sudan, the long cool winter season in the north is most favorable for lentil production, with the germplasm evaluation and cultivation improvement program on lentil concentrated at Hudeiba Research Station since the early seventies (El Sarag and Nourai 1983).

Positive lentil seed yield correlation with number of branches/plant, number of pods/plant, plant height, and biological yield were reported (Chauhan and Sinha 1982; Erskine and Witcombe 1984; Hawtin *et al.* 1980; Webb and Hawtin 1981). Rao and Yadav (1988) found that selection based on harvest index, biological yield, and seed yield could improve lentil yield. Ahamed and Pandey (1983), however, found seed yield stability in lentil was a complex independent character with limited use of yield components in characterizing this parameter.

The objective of this paper is to present the performance of some exotic lentil genotypes in Sudan.

Materials and Methods

Ten lentil genotypes, received through ALAD/ICARDA/ARC Collaborative program, were evaluated with a local type (Selaim) at Hudeiba (17.34 N, 33.56 E) and Rubatab (Abu Hasheem 19.32 N, 33.19 E) in the northern region of Sudan in the 1983-85 seasons.

The experiment was laid out in a randomized complete block design with four replicates and a plot size of 6 m x 3 m with net harvested area of 10 m^2. Sowing was in mid November with a seed rate of 142 kg/ha in both seasons. Sowing was on rows on both sides of ridges 10 cm apart. Irrigation was applied at about 12 day intervals till maturity. Basal nitrogen fertilizer dose of 43 kg N/ha was added as urea. Weed control was by hand weeding twice. Insect control was by spraying pesticides when required. The characters studied were growth duration, seed yield, and yield components.

Individual statistical analysis for each character, and combined analysis and stability test for seed yield were followed as described in Gomez and Gomez (1984).

Results and Discussion

The performance of the genotypes differed significantly in number of days to flowering, number of days to maturity, and 1000-seed weight, but performed similarly in the other characters (**Table 1**). The genotypes gave better seed yield at Rubatab in both seasons with a yield advantage over Hudeiba of more than 1 ton/ha. The

Table 1 Mean performance of the genotypes

Character[1]	Location					
	Hudeiba			Rubatab		
	Hudeiba	Mean	S.E.	Range	Mean	S.E.
Number of days to flowering	43-45	44	0.3**	45-49	47	0.7*
	46-51	48	0.6**	42-45	43	0.4**
Number of days to maturity	96-98	97	0.3**	93-95	94	0.8
	84-91	87	2.7	90-93	91	0.6
Plant height (cm)	37-40	38	1.2	41-47	45	1.7
	33-38	37	2.5	44-49	47	2
Number of pods/plant	10-17	13	0.6	29-37	33	3.5
	09-14	12	2	21-27	24	3
1000-seed weight (gm)	23-24	25	0.7	23-26	24	0.6*
	21-24	23	1	26-29	27	0.6*
Seed yield t/ha	0.4-0.8	0.6	0.1	1.6-1.9	1.8	0.1
	0.5-0.7	0.6	0.1	1.5-1.7	1.6	0.1
Straw yield t/ha	2.4-3.7	2.9	0.1	3.2-3.7	3.5	0.2
	3.0-4.0	3.5	0.3	3.2-4.1	3.7	0.3

1. For each character upper: the 83/84 season; lower: the 84/85 season

*, ** Significant at P = 0.05 and 0.01, respectively

low yields at Hudeiba may be due to soil type and high temperatures at the end of the season, but agronomic verification is needed for clarification (El Sarag and Nourai).

There was a significant genotype by season interaction for seed yield indicating that genotypes performed differently over seasons. However the genotypes NEL 795 and NEL 812 performed similarly in the two seasons at both Hudeiba and Rabatab stations, respectively, indicating high and stable yielding capacity (**Table 2**).

In conclusion, inspite of the low yields at Hudeiba and the similarity of the genotypes to the local type in seed yield, some genotypes such as NEL 795 and NEL 812 were promising under Sudan conditions.

Table 2 Mean seed yield (kg/ha) of the genotypes

		Location				
		Hudeiba		Rubatab		
Genotype	Origin	83/84	84/85	83/84	84/85	Mean
NEL 788	Egypt	804	535	1780	1663	1196
NEL 790	Egypt	580	675	1520	1507	1071
NEL 794	Egypt	525	650	1722	1554	1113
NEL 795	Egypt	691	688	1875	1518	1193
NEL 798	Egypt	539	635	1609	1657	1110
NEL 804	Egypt	602	682	1710	1553	1137
NEL 812	Egypt	476	622	1654	1559	1078
NEL 813	Egypt	709	684	1777	1657	1207
NEL 818	Egypt	542	670	1795	1687	1174
Giza 9	Egypt	386	487	1832	1469	1044
Silaim	Sudan	670	678	1899	1540	1197
Mean		593	637	1754	1585	1142
S.E. ±		51	62	64	97	

Acknowledgements

The financial support from ICARDA/IFAD/ARC Nile Valley Project is gratefully acknowledged. Our thanks to the technicians of the Plant Breeding section at Hudeiba Research Station for the help in data collection.

References

Ahamed, F.A. and Pandey, M.P. 1983. Stability of yield and its components in lentil. Lens **10**(2): 12-14.

Chauhan, V.S. and Sinha, P.K. 1982. Correlation and path analysis in lentils. Lens **9**: 19-21.

Erskine, W. and Witcombe, J.R. 1984. Lentil Germplasm Catalog. ICARDA, Aleppo, Syria.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research.

Hawtin, G.C., Singh, K.B. and Saxena, M.C. 1980. Some recent developments in the understanding and improvement of *Cicer* and *Lens*. pages 617-623. *in* Advances in Legume Science (Summerfield, R.J. and Bunting, A.H., eds.). Royal Botanic Gardens, Kew, England.

Rao, S.K. and Yadav, S.P. 1988. Genetic analysis of biological yield harvest index and seed yield in lentil. Lens Newsletter **15**(1): 3-5.

el Sarag, J. and Nourai, A.H. 1983. A review of research on lentils in Sudan. Lens **10**(1): 1-12.

Webb, C. and Hawtin, G. 1981. Lentils. CAB/ICARDA. 216 p. CAB International, England.

كفاءة طرز وراثية دخيلة من العدس في السودان

ملخص

تم على مدى موسمين تقييم عشرة طرز وراثية دخيلة من العدس، لتحديد فترة النمو، والغلة البذرية ومكوناتها، وذلك في الحديبة والروباتاب بالمنطقة الشمالية من السودان. وقد تباينت الطرز الوراثية في فترة النمو، وليس في الغلة البذرية ومكوناتها. وكان الصنفان NEL795 و NEL 812 مبشِّرين تحت الظروف السائدة في السودان.

Effect of spodnam application on lentil seed yield and harvest losses over different times and methods of harvest

S. N. Silim, M. C. Saxena, and W. Erskine
Food Legume Improvement Program
ICARDA
Aleppo, SYRIA

Abstract

Experiments were conducted in the 1987-1989 seasons at Tel Hadya, North Syria to determine the potential of the chemical 'Spodnam' in extending harvest period and reducing seed yield loss of mechanically harvested lentil. Averaged over both seasons, seed yield loss was 18.5% in a mechanically harvested crop as compared to hand pulling. Averaged over method of harvest, delaying the harvest had no significant influence on seed yield in the 1987/88 season, but caused significant seed loss (38%) in the 1988/89 season. Seed yield loss, however, was 50% in lentil harvested late by plot combine in the 1988/89 season. In both years, Spodnam did not influence seed yield of lentil significantly. Seed yield increase due to Spodnam was 7% and 3% in the 1987/88 and 1988/89 seasons, respectively.

Introduction

In the Mediterranean basin (West Asia and North Africa), lentil (*Lens culinaris* Medik.) harvest is traditionally done by hand pulling. The rapid rise in temperature in May associated with cessation of rain results in the entire area under lentils in the region reaching harvestable maturity at about the same time, with only a short period of not more than seven days becoming available for harvesting to avoid losses by pod drop and shattering. Thus, the availability and cost of labour for the hand harvest become major constraints in lentil production. The International Center for Agricultural Research in the Dry Areas (ICARDA) is, therefore, conducting a major research project on the mechanization of lentil harvest to work out economic solutions to the problem of lentil harvest (ICARDA 1987, 1988, 1989). Among the different systems of mechanical harvest tested is a combine harvester which shows great promise (ICARDA 1989). The optimum time of harvest by combine is, however, later than for hand pulling (Khayrallah 1981). This delay in harvest often results in high seed losses because of pod drop and dehiscence (Khayrallah 1981; Erskine 1985). Extending harvest period without incurring yield penalty would be of great benefit to farmers. A spray of a chemical named 'Spodnam EDB' has been reported to control pod shattering and delay time of harvest in peas, soybeans, mungbeans, dry beans, and oil seed rape (Mandops n.d.). Experiments were, therefore, conducted at ICARDA to test the potential of this chemical in controlling pod dehiscence and pod drop in lentil and in extending the period for mechanized harvest.

Materials and Methods

The experiment was conducted during the 1987-89 cropping seasons at ICARDA's main research station at Tel Hadya in North Syria. The experimental design in both seasons was randomized block with four replications and with factorial treatments as follows:

1. Chemical spray
   a. Control of distilled water sprayed on the crop at pod filling stage at 400 l/ha.
   b. Spodnam EDB sprayed at pod filling stage at a rate of 1.25 l/ha in 400 l/ha of tank mixed with distilled water.

2. Method of harvest
   a. Hand pulling
   b. Plot combine.

3. Time of harvest
   a. Normal time: (Physiological maturity when 40-60% of pods were yellow for hand harvest; full maturity when 100% of pods were mature for combine harvest).
   b. Delayed, harvested three weeks after 100% maturity.

A dressing of 22 kg P/ha was applied prior to sowing. Seeds of cultivar Idleb 1 (ILL 5582) were sown by Oyjord drill on 2 Dec 1987 and 5 Dec 1988 in plots 3 x 20 m. All plots were hand weeded as necessary.

Table 1 The effect of applying Spodnam and time and method of harvest on seed yield of lentil cultivar ILL 5582 Tel Hadya, 1987/88 season

	Method of harvest (H)						
	Hand			Plot combine			
Chemical spray (C)	Normal harvest	Delayed harvest	Mean	Normal harvest	Delayed harvest	Mean	Mean
Water	1944		84	014	450	8	1544
Spodnam	2173		45	208	566	4	1600
Mean	2058		64		508	6	
Mena for H				111		2	
	Time of harvest (T)						
	Normal	Delayed					
Water	1697	1861					
Spodnam	1869	1939					
Mean	1783	1900					

LSD (5%): C = NS, H = 141, T = NS, C x H = NS, C x T = NS, H x T = NS, H x T x C = NS, CV. (%): 15

Seed yield loss from plot combine harvester compared to hand pulling was 26% in the 1987/88 season and 11% in the 1988/89 season (**Tables 1** and **2**). Averaged over two years, seed yield loss was 18.5% which is similar to the two years' average of 20% reported at ICARDA in 1988 with a modified combine (ICARDA 1989).

Results and Discussion

The long term-average annual rainfall at Tel Hadya is 330 mm. The annual rainfall was 504 mm in the 1987/88 season higher than long-term average by 52% when only 229 mm was received in the 1988/89 season, representing 69% of the mean annual precipitation.

Table 2 The effect of applying Spodnam and time and method of harvest on seed yield of lentil cultivar ILL 5582 Tel Hadya, 1988/89 season

	Method of harvest (H)						
	Hand			Plot combine			
Chemical spray (C)	Normal harvest	Delayed harvest	Mean	Normal harvest	Delayed harvest	Mean	Mean
Water	484	501	493	607	302	455	474
Spodnam	542	510	526	605	304	455	490
Mean	513	506		606	304		
Mean for H			509			455	
	Time of harvest (T)						
	Normal	Delayed					
Water	545	402					
Spodnam	574	407					
Mean	559	405					

LSD (5%): C = NS, H = 48, T = 48, C x H = NS, C x T = NS, H x T = 68, H x T x C = NS. CV. (%): 13.5

Delaying lentil harvest resulted in yield losses in lentil (Khayrallah 1981; Erskine 1985). In this study, delaying harvest in the 1987/88 season had no influence on seed yield, but increased seed yield loss significantly in the 1988/89 season by 38% (**Tables 1** and **2**). In the 1988/89 season, mechanical harvesting by plot combine accentuated the losses due to delay in harvesting, giving a total seed loss of 50% (**Table 2**). The difference in response to delay in harvest and methods of harvest in the 1987/88 and 1988/89 seasons was probably due to differences in moisture supply for seasons.

Compared to control (water spray), application of Spodnam on lentil did not increase seed yield significantly (**Tables 1** and **2**). The yield advantage from applying Spodnam was 7% and 3% in the 1987/88 and the 1988/89 seasons, respectively. This contrasts with the higher values of 11-14% reported by Dick Hilsenkopf (Unpublished) on lentil in USA. Probably in the Mediterranean basin, the rapid rise in temperature and drought which cut short the reproductive period in lentil (Saxena 1981) were responsible for the ineffectiveness of this chemical.

References

Erskine, W. 1985. Selection for pod retention and pod indehiscence in lentils. Euphytica **34**: 105-112.

ICARDA (International Center for Agricultural Research in the Dry Areas) 1987. Food Legume Improvement Program Annual Report 1986: 108-111.

ICARDA (International Center for Agricultural Research in the Dry Areas) 1988. Food Legume Improvement Program Annual Report 1987: 78-87.

ICARDA (International Center for Agricultural Research in the Dry Areas) 1989. Food Legume Improvement Program Annual Report 1988: 91-99.

Khayrallah, W.A. 1981. The mechanization of lentil harvesting. Pages 131-141 *In* Lentils (Webb, C. and Hawtin, G.C., eds.). CAB, Slough, Great Britain.

Mandops, n.d. Spodnam. Mandops Inc. Lake Park, Florida, USA [Pamphlet].

Saxena, M.C. 1981. Agronomy of lentils. Pages 111-129 *in* Lentils (Webb, C. and Hawtin, G.C. eds.) ICARDA/CAB. CAB, Slough, United Kingdom.

تأثير إضافة Spodnam في الغلة البذرية وفاقد المحصول عند مختلف مواعيد وطرق حصاد العدس

ملخص

خلال الموسمين 1987–89 ، أجريت تجارب في تل حديا، بشمالي سورية، لتحديد إمكانية المستحضر الكيميائي Spodnam على تأخير فترة الحصاد، وتقليل الفاقد من الغلة البذرية للعدس المحصود آليا. إذ بلغ متوسط ذلك الفاقد عند الحصاد الآلي على مدى الموسمين 18.5٪ مقارنة بالحصاد اليدوي. وبأخذ متوسط طريقة الحصاد، لم يكن لتأخير الحصاد تأثير معنوي في الغلة البذرية خلال موسم 1987/88 ، غير أن ذلك سبب فقدا معنويا في البذور بلغ (38 ٪) في موسم 1988/89 . و من ناحية أخرى، وصل الفاقد إلى 50 ٪ في موسم 1988/89 عند تأخير حصاد العدس بحصادة درّاسة. وفي كلا الموسمين لم يؤثر الSpodnamفي الغلة البذرية للعدس بشكل معنوي، بل زادت بسببه إلى 7٪ و 3٪ في الموسمين 1987/88 و 1988/89 على التوالي.

Effect of mixed cropping lentil and wheat at varying seeding ratios

Shaikh Mostafa Zaman
On-Farm Research Division
Bangladesh Agricultural Research Institute
Mymensingh, BANGLADESH

Abstract

Monoculture lentil (*Lens culinaris* Medik.), monoculture wheat (*Triticum aestivum* L.), two cropping mixtures of lentil and wheat (100% lentil + 33% wheat, and 33% lentil + 100% wheat) were compared in an experiment. The highest lentil grain yield was obtained from sole lentil followed by 100% lentil + 33% wheat combination. The monocropped wheat gave the highest wheat grain yield. The highest Land Equivalent Ratio (1.25), gross benefit, net benefit, and benefit cost ratio were obtained from 100% lentil + 33% wheat combination.

Introduction

Mixed cropping as a method of crop intensification is commonly practiced in densely populated countries to provide more food. Farmers make the best use of their land and produce more through crop intensification. Lentil is the second most important pulse crop in Bangladesh in area and production (BBS 1985). It is often grown as a mixed crop with sugarcane, mustard, and wheat. The mixture of wheat and lentil (100:50 ratio) gave 23% more yield than monocropped wheat (Anonymous 1980). The wheat yield was not reduced by the presence of lentil in this experiment. The use of early maturing varieties, alternating row arrangement, spacing and plant population are some important methods that may help increase the yield of inter-crop (Harrera and Harwood 1974). The combination of lentil and wheat (100:30) produced more economic return over monocropped lentil (Rahman 1984).

In Bangladesh, very little work has been done in the farmers' fields to investigate the effect of lentil and wheat mixed cropping at varying seed ratios. The present study, therefore, was undertaken to determine optimum seedling ratio of lentil and wheat in a mixture at farmers' fields.

Materials and Methods

The experiment was conducted during the period from November, 1986 to March, 1987 in a farmers' fields at the Farming Systems Research site, Panchlia, Serajgonj, Bangladesh. The soil was of the Sonatala series under Karatoya flood plain soil. The monoculture lentil, monoculture wheat and two combinations of lentil and wheat (100:33 and 33:100) were included in the study. The experiment was laid out in a randomized complete block design with six replications. The size of the unit plot was 5 x 8 m. The seed rates of the monoculture lentil and monoculture wheat were 25 kg/ha and 120 kg/ha, respectively. The lentil cultivar L-5 and wheat cultivar Kanchan were used. Sowing was on 17 Nov 1986. The lentil sole crop received 20-40-20 of N, P_2O_5, and K_2O kg/ha, respectively. A mixture of 80-60-40 of N, P_2O_5, and K_2O kg/ha, respectively was applied in the mixed treatments. The sole wheat received 80-60-40 N, P_2O_5, and K_2O kg/ha, respectively. The entire dose of P_2O_5 and K_2O through triple superphosphate and muriate of potash, respectively along with 50% of nitrogen were applied during the final land preparation. The second half of nitrogen was applied as a top dressing 22 days after seeding. The plots were weeded once 21 days after seeding. One irrigation was given 17 days after seeding. Harvesting of wheat was on Mar 1987 and that of lentil on 9 Mar 1987. The data on different yield parameters were collected from 10 randomly selected plants in each plot and those on grain and straw yields were recorded from the whole plot. The collected data were then analyzed statistically. Land Equivalent Ratio (LER) was computed to assess the land use efficiency on yield advantage. The total hours of labour used for different operations was recorded along with the cost of variable inputs to compute the variable cost of different combinations. The cost and benefit analysis was done for each treatment on hectare basis.

Results and Discussion

Yield and yield components of lentil

The results showed that the effect of mixed crop treatments were significant on plant populations/m^2, number of branches/plant, number of pods/plant, and grain yield of lentil (**Table 1**). The highest grain yield (0.80 t/ha) was obtained from lentil sole crop followed by 0.56 t/ha from 100% lentil + 33% wheat. The lowest lentil grain yield (0.24 t/ha) was produced by 33% lentil + 100% wheat combination. The yields of lentil in 100% lentil and 100% lentil + 33% wheat were significantly higher than the yield from the treatment 33% lentil + 100% wheat. The highest grain yield produced by sole lentil crop could be due to maximum number of plant population/m^2, maximum number of branches/plant, maximum number of pods/plant, and maximum number of seeds/pod. The plant height of lentil was not significantly affected by the various plant population levels.

Table 1 Effect of mixed cropping on grain yield and yield components of lentil

Seeding ratio	Plant population/ m^2	Plant height (cm)	Number of branches/ plant	Number of pods/ plant	Number of seeds/ pod	Grain yield (t/ha)
100% lentil	75.6 a	28.8 a	13.7 a	99.2 a	1.65 a	0.80 a
100% lentil + 33% wheat	65.9 a	30.7 a	10.0 ab	65.4 b	1.63 a	0.56 a
33% lentil + 100% wheat	24.0 b	32.1 a	8.5 b	45.1 b	1.60 a	0.24 b
100% wheat	-	-	-	-	-	-

Values within a column followed by same letter(s) are not significantly different at 5% level according to Duncan's Multiple Range Test

Yield and yield components of wheat

The results revealed that the effect of mixed crop treatments were significant on the number of spikelets/ spike, number of grains/spike, number of spikes/m^2, and grain yield and straw yield (**Table 2**). The highest wheat grain yield (2.10 t/ha) was obtained in sole wheat treatment followed by that in 33% lentil + 100% wheat combination (1.70 t/ha). The lowest grain yield was obtained from 100% lentil + 33% wheat combination. Up to 33% of full lentil seed population had no significant effect on grain yield of wheat. The plant height of wheat was not affected significantly by the various plant population levels. The highest grain yield produced by sole wheat crop could be due to maximum number of spikes/m^2, maximum number of spikelets/spike, and maximum number of grains/spike. Due to higher population/unit area in the mixed cultures, the inter- and intra-crop competition increased and resulted in lower yields/plant.

LER, cost, and benefit analysis

The highest LER (1.25) was obtained from 100% lentil + 33% wheat mixture (**Table 3**). Thus, by mixed cropping 100% lentil + 33% wheat, a farmer could produce

Table 2 Effect of mixed cropping on grain yield and yield components of wheat

Seeding ratio	Number of spikes/m^2	Plant height (cm)	Number of spikelets/ spike	Number of grains/ spike	Grain yield t/ha)	Straw yield t/ha)
100% lentil	-	-	-	-	-	-
100% lentil + 33% wheat	70.7 b	88.2 a	17.1 b	13.4 b	1.16 b	1.29 c
33% lentil + 100% wheat	146.1 a	87.5 a	16.7 b	35.8 ab	1.70 a	1.96 b
100% wheat	166.1 a	90.1 a	18.3 a	40.0 a	2.10 a	2.50 a

Values within a column followed by same letter(s) are not significantly different at 5% level according to Duncan's Multiple Range Test

Table 3 Relative yields, LER, cost and benefit analysis as affected by different seeding ratios

Seeding ratio	Relative yield Lentil	Relative yield Wheat	LER	Gross benefit ($/ha)	Total variable cost ($/ha)	Net benefit ($/ha)	Benefit cost ratio
100% lentil	1.00	-	1.00	266.4	133	133.4	2.00
100% lentil + 33% wheat	0.70	0.55	1.25	361.6	176	185.6	2.05
33% lentil + 100% wheat	0.30	0.81	1.11	336.6	179	157.6	1.88
100% wheat	-	1.00	1.00	317.1	173	144.1	1.83

Market price: Wheat $ 0.151/kg
Lentil $ 0.333/kg

0.56 t/ha of lentil and 1.16 t/ha of wheat instead of growing them separately in 1.25 ha of land to obtain the same combined yield. The highest gross benefit, net benefit, and benefit cost ratio were obtained from 100% lentil + 33% wheat combination (**Table 3**). The lowest net benefit was obtained from sole lentil. The highest benefit cost ratio was produced by 100% lentil + 33% wheat followed by sole lentil.

The results suggest that 33% wheat seed can be mixed in normal cultivation of lentil for economic advantage of the farmer in Serajgonj area.

References

Anonymous 1980. Annual Report of Pulses Improvement Project. 1970-80: 67-69. Bangladesh Agricultural Research Institute.

BBS (Bangladesh Bureau of Statistics) 1985. Year book of Agricultural Statistics of Bangladesh. 1984-85: 17-18. Bangladesh Bureau of Statistics, Bangladesh.

Harrera, W.A.T. and Harwood, R.R. 1974. The effect of plant density and row arrangement on productivity of corn rice intercrop. Paper presented at the 5th Annual convension of the crop society of the Philippines, Naga city, May 16-18, 1974.

Rahman, M.A. 1984. Investigation into the effect of lentil and wheat mixed cropping. Bangladesh Journal of Agricultural Research 9(1): 48-53.

تأثير الزراعة المختلطة للعدس والقمح بنسب بذار مختلفة

ملخص

نفذت تجربة بهدف المقارنة بين زراعة العدس *(Lens culinaris* Medik) لوحده، والقمح (*Triticum aestivum* L.) لوحده، والإثنين معا بنسبة زراعة مختلطة (100 ٪ عدس + 33٪ قمح، و 33٪ عدس + 100٪ قمح) . وتم الحصول على أعلى غلة حبية من العدس عند زراعته لوحده، يليها زراعته مختلطا مع القمح بنسبة 100٪ عدس + 33٪ قمح. وأعطى القمح المزروع لوحده أعلى غلة حبية من القمح. وتم الحصول على أعلى نسبة معادل أرضي (1.25) وفائدة إجمالية وصافية، ونسبة فائدة إلى التكلفة، وذلك من الزراعة المختلطة 100٪ عدس + 33٪ قمح.

Environmental variation in time to flower in lentil

Liliana N. Gray and Norma C. de Delgado
Facultad del Ciencias Naturales
Universidad Nacional de Salta
Buenos Aires 177, 4400 Salta, ARGENTINA

Abstract

Twenty-one sowings of non-vernalized seeds of "Precoz" cultivar were grown in the field during the 1984-86 seasons to test the relationship between time to flower, temperature, and photoperiod according to the equation proposed by Summerfield *et al.* (1985) to predict the time to flowering. There was a linear relationship between the reciprocal of time to flower and mean photoperiod and temperature during the vegetative growth in the 1985 - 1986 seasons. Predicted values of time to flower matched observed values well in these seasons, validating the model. However, the observed values of time to flower did not match the predicted values in 1984 because of temperatures at and below the base temperature (T_b), thus highlighting the need to use the model only between the published limits of the respective ranges of mean temperature and photoperiod.

Introduction

The response of some lentil genotypes in time to flower to vernalization, photoperiod, and temperature under controlled environmental conditions has been described (Summerfield *et al.* 1985). It was concluded that seed vernalization and its later treatment at different photothermal regimes significantly affect the number of days to flowering, even when some genotypes differ in their relative sensitivity to each of the factors studied. Irrespective of genotype, photoperiod, or vernalization time to flowering is regulated by the mean daily temperature rather than by night temperature, or any daytime variation (Summerfield *et al.* 1985).

Gray and Delgado (1986) described "Precoz" cv from Argentina and its interaction with the principal climatic elements namely temperature and photoperiod. They found that there is a significant inverse association with "days of birth to flowering", thus suggesting a high temperature sensitivity of the cultivar.

Since Precoz cv is used in numerous hybridization programmes in the world, an understanding of its response to the factors temperature and photoperiod in different field environmental conditions is particularly useful.

This paper, involving twenty-one sowings spread over three years, presents experimental data from different field environments to test the predictive equation proposed by Summerfield *et al.* (1985) for Precoz cv as a means to predict time to flowering.

Materials and Methods

Precoz cv, designated as ILL 4605 in ICARDA, was sown in 1984, 1985, and 1986 every ten days (twenty-one sowings) in Salta, Argentina, Valle de Lerma, 24° 54'S, 65° 29'W, and 1,250 m above sea level beginning in Autumn, on May 5 in a randomized complete block design with four replications. Full experimental details are found in Gray and Delgado (1986). Seeds were not vernalized and the crop was conducted in a similar way to commercial sowing, applying three irrigations for each sowing, pre-sowing, after 40 days, and pre-flowering.

Time to flowering was considered as days from sowing to 50% plants flowering. With an average period of 4 days from the beginning of flowering till 50% plants in flower, it is more reliable to use the 50% observation in the field.

Multiple regression was used to study the association between flowering period and the factors considered. The theoretical pattern and its constants, described by the equation: $1/f = a + b + t + cp$, ($1/f$ = days to flowering inversed, a, b and c = constants, t = mean temperature, p = photoperiod) proposed by Summerfield *et al.* (1985) was used to give the predicted values for time to flower.

Results and Discussion

The vegetative period of the lentil crop in North West Argentina coincides with short and fresh days (autumn-winter), progressively becoming longer and hotter in winter-spring. The average data of field photothermal conditions show that the photoperiod during the three years was constant and within the range tested by Summerfield *et al.* 1985, (10-16 hrs.), but the average temperature was only within the tested range (9.33°C - 21.75°C) in 1985 and 1986, but not in 1984 when the mean temperature (t) was 8.61°C ± 0.59°C (**Table**).

No difference was observed between blocks in the time to flower, thus demonstrating that the seeds belonged to a pure stock. Means over blocks were used in the following analysis.

Within each year, a shortening of the vegetative period coincided with progressive raises in average temperature and photoperiod, thus demonstrating a marked inverse linear association.

Using the published values of response to temperature (b = 0.00093643) and photoperiod (c = 0.00075104) and intrinsic earliness (a = -0.005226) for unvernalized Precoz (Summerfield *et al.* 1985) in predicted values of time to first flower were calculated and are shown with observed time to 50% flowering in the field for each year (**Figures 1 and 2**).

Table 1 Field data of mean time to flowering (f) in days, its mean temperature (t) in °C, and photoperiod (p) in hours among sowing dates

Date	1984			1985			1986		
	t	p	f	t	p	f	t	p	f
1	8.70	11.49	77	11.87	11.47	70	12.51	11.46	60
2	8.43	11.48	72	11.03	11.49	74	12.30	11.46	64
3	7.81	11.50	66	10.14	11.57	72	12.92	11.50	60
4	8.28	11.54	56	10.90	11.69	74	12.79	11.61	63
5	8.56	11.68	52	9.51	11.81	69	12.99	11.75	64
6	8.80	11.81	54	11.54	11.96	62	13.61	11.91	57
7	9.75	11.94	50	12.16	12.09	61	14.69	12.09	54
X_g	8.61	11.63	61	11.02	11.72	67	13.11	11.68	60

Source: Estacion Agrometeorologica, INTA, Cerrillos, Salta, Argentina

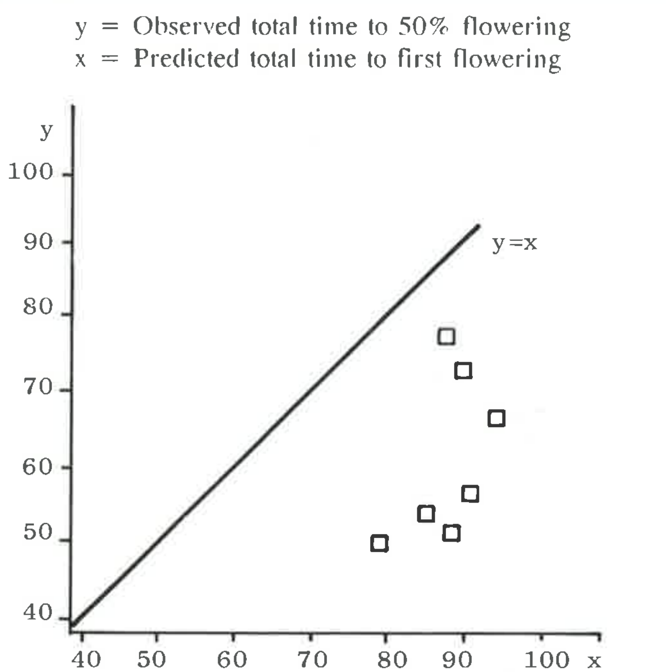

Fig. 1. Fitting between predicted and observed values of times to flower in 1984

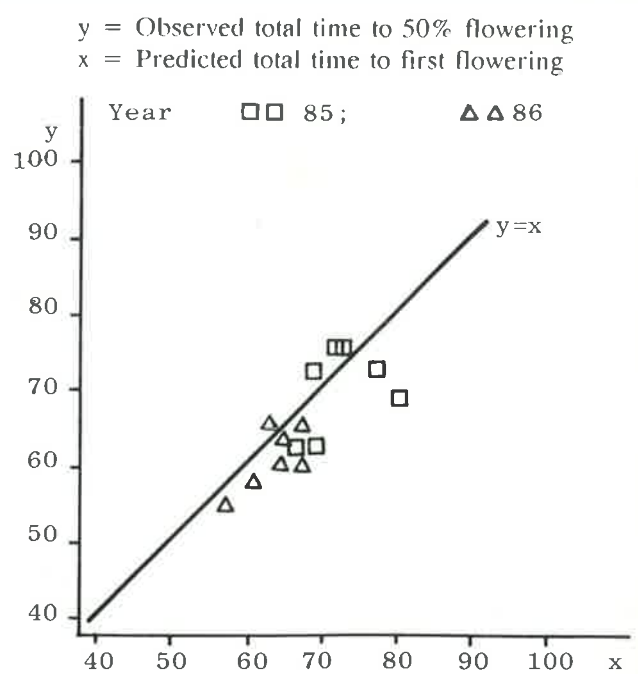

Fig. 2. Fitting between predicted and observed values of times to flower in 1985 and 1986.

The year 1984 (**Figure 1**) has a poor fit of observed to expected times to flower (y = x); in contrast to 1985 and 1986 when there was a very good fit of observed with expected values (**Figure 2**).

What caused the difference between the years in model fitting? The years 1985 and 1986 had temperature and photoperiodic regimes within the range of 9.33 - 21.75°C and 10-16 hours tested by Summerfield *et al.* (1985). However, the mean temperature in 1984 was 8.61°C and many nights were at or below the base temperature (T_b). The limits of the photothermal model proposed by Summerfield *et al.* (1985) are now known to be between the base (T_b) and optimum temperatures (T_o) and critical (P_c) and ceiling (P_{ce}) photoperiods (Ellis *et al.* 1989). Clearly the years 1985 and 1986 were within these limits and the model gives good prediction of time to flower. When temperature T_b was overstepped in 1984 the model no longer fitted well. This emphasizes the need to apply the model only within the ranges of mean temperature T_b to T_o and photoperiod P_c to P_{ce}.

Acknowledgements

The authors thank Mrs. Ana Olsen for undertaking the statistical analysis; Estacion Experimental INTA, Cerrillos, Salta; Lic. M. de Niederle for the translation of this paper into English; as well as Consejo de Investigaciones de la Universidad de Salta for financing this research. Thanks are also extended to Drs. W. Erskine and R.J. Summerfield for their helpful suggestions for the manuscript.

References

Ellis, R.H., Hadley, P., Roberts, E.H. and Summerfield, R.J. 1989. Quantitative relations between temperature and crop development and growth *in* Climatic Changes and Plant Genetic Resources, Jackson, M.T., Forld-Lloyd, B. and Parry, M. (editors). Belhaven Press, U.K. (In press).

Gray, Liliana N. and Delgado, Norma G.C. de 1986. Sowing dates for lentil in Salta, Argentina. LENS Newsletter **13**: 19-27.

Summerfield, R.S., Roberts, E.H., Erskine, W. and Ellis, R.H. 1985. Effects of temperature and photoperiod and flowering in lentils (*Lens culinaris* Medic.). Annals of Botany **56**: 659-671.

تباين بيئي في المدة حتى الإزهار عند العدس

ملخص

خلال الموسمين 1984-86 زرعت في الحقل واحد وعشرون بَذرة ببذور الصنف" Precoz " غير المرتبعة، وذلك لدراسة العلاقة بين المدة حتى الإزهار، ودرجة الحرارة، والفترة الضوئية طبقا للمعادلة التي اقترحها Summerfieldو آخرون (1985) للتنبؤ بالمدة حتى الإزهار. وقد ظهرت علاقة خطية تبادلية بين المدة حتى الإزهار، ومتوسط الفترة الضوئية ودرجة الحرارة خلال النمو الخضري في الموسمين المدروسين. كما طابقت قيمُ المدة حتى الإزهار المتنبؤ بها القيمَ المسجلة في ذلك الموسمين، الأمر الذي أكّد صحة النموذج. غير أن القيم المسجلة للمدة حتى الإزهار لم تطابق القيمَ المتنبأ بها في 1984 بسبب درجات الحرارة عند وما دون درجة الحرارة الأساس(Tb)، مما يؤكد الحاجة إلى عدم استخدام النموذج إلا في الحدود المنشورة للمدى الخاص بمتوسط درجات الحرارة والفترة الضوئية.

Insects associated with lentil in Northern India

Anuj Bhatnagar[1] and V. K. Sehgal[2]
1. Department of Entomology, Govind Ballabh Pant University of Agriculture and Technology Pantnagar, Nainital, 263145 Uttar Pradesh, INDIA
2. ICRISAT Patancheru P.O. Andhra Pradesh 502324 Hyderabad, INDIA

Lentil crop is grown as a *Rabi* crop in Northern India. The vegetative stages of the crop pass through a severe winter between November and January. Flowering and pod formation occur in February and March. The crop is mature and harvested in April. Thirty six species of insect pests, parasitoids, predators, and foraging insects have been associated with lentil during the weekly sampling observation in the 1985-87 crop seasons at Pantnagar.

Being a winter crop, relatively few insect species are associated with the crop. Twenty three species are associated with the crop in the vegetative stage and foliage growth of the crop, 20 species with the flowering stage, and 24 species with the pod formation and maturation stages. The insects associated with lentil crop during crop growth are listed in **Table 1a** and **1b** (Hariri 1981).

Table 1a List of insect pests associated with lentil at Pantnagar

	Plant parts damaged	Pest status
HOMOPTERA		
Aphididae		
Acyrthosiphon pisum (Harris)	Sucks the sap from foliage	Minor
Aphis craccivora Koch	Sucks the sap from foliage	Major
Myzus persicae (Sulz.)	Sucks the sap from foliage	Minor
Cicadellidae		
Balclutha sp.	Feed on foliage	Minor
Empoasca sp.	Feed on foliage	Minor
HEMIPTERA		
Coreidae		
Cletus signatus Walker Lygaeidee	Feeds on foliage	Minor
Graptostethus servus Fabricius	Feeds on foliage	Minor
Pentatomidae		
Eusarcocoris ventralis Westwood	Sucks the sap from foliage	Minor
Nezara viridula (L.)	Sucks the sap from foliage	Minor
Piezodorus rubsofasciatus Fabricius	Sucks the sap from vegetative	Minor
LEPIDOPTERA		
Noctuidae		
Helicoverpa armigera (Hubner)	Damages the pod and seed	Major
Thysanoplusia orichalcea Fabricius	Defoliation	Major

Cont'd...

DIPTERA		
Agromyzidae		
Chromatomyia horticola Goureau	Mines the leaf	Major
COLEOPTERA		
Bruchidae		
Bruchus lentis Froel.	Damages the pod and seed	Major
Callosobruchus maculatus (F.)	Damages the pod and seed	Major
Chrysomelidae		
Altica coerulea Olivier	Foliage feeder	Minor
Aulacophora foveicollis Lucas	Foliage feeder	Minor
Phyllotreta chotanica Duvivier	Foliage feeder	Minor
Coccinellidae		
Brumoides suturalis Fabricius	Damages foliage	Minor
Epilachna sp.	Damages foliage	Minor

Table 1b List of other insects of lentil reported at Pantnagar

Scientific name Order: family	Insect status
HEMIPTERA	
Nabidae	
Nabis indicus Stal.	Predator
LEPIDOPTERA	
Satyridae	
Ypthima sp.	Visitor
COLEOPTERA	
Coccinellidae	
Illeis cineta Fabricius	Visitor
Verania vincta Gorth.	Visitor
Scymnus sp.	Visitor
Coccinella septempunctata Linnaeus	Predator
Coccinella transversalis Fabricius	Predator
HYMENOPTERA	
Apidae	
Apis dorsata Fabricius	Forager
Apis indica Fabricius	Forager
Braconidae	
Aphedius smithi Sharma and Subba Rao	Parasito
Meteorus sp.	Parasito
Ichneumonidae	
Allophatnus fulvitergus Tosquinet	Parasito
Campoplex sp.	Parasito
Diplazon orientalis Cameron	Parasito
Trathala hapaliae Cushman.	Parasito

Acknowledgement

The authors wish to thank Dr V.K. Sharma for his help during the field study.

Reference

Hariri, G. 1981. Insects and other pests. Pages 173-189 *in* Lentils (Webb, C. and Hawtin, G.C., eds.) ICARDA/CAB. CAB, Slough, UK.

حشرات العدس في شمالي الهند

ملخص

تقدم هذه الورقة قائمة بالحشرات التي تلازم العدس خلال أطوار نموه في شمالي الهند.

The present article is part of M.Sc. (Entomology) thesis submitted to G.B. Pant University of Agriculture and Technology, Pantnagar, Nainital, Uttar Pradesh, India.

Centinela-INIA: A new lentil variety tolerant to rust (*Uromyces vicia fabae*)

Gabriel Bascur B. and Paulina Sepulveda R.
Programa Leguminosas de Grano
Estacion Experimental la Platina, INIA
Casilla 439/3
Santiago, CHILE

Abstract

This paper announces the release of the lentil variety "Centinela-INIA" on the basis of its resistance to rust (*Uromyces vicia fabae*) and high yield in areas with high incidence. The seed colour is light green with 60 to 80% of the seeds over 6 mm in diameter, making this variety prefered for export.

Introduction

Lentil (*Lens culinaris* M.) is grown in the drylands of Chile under many different agroclimatic conditions resulting in a great variability in production potential and incidence of diseases.

Lentil rust, caused by the fungus *Uromyces vicia fabae*, is one of the most important diseases of this crop (Sepulveda and Alvarez 1982). Although the disease incidence decreased recently due to the movement of lentil cultivation to the southern part of Chile, the disease in some areas is still a limiting factor to production resulting in great losses to the growers (Sepulveda 1984).

Fungicides can control the disease in lentil (Tapia *et al.* 1987), but they are not always recommended due to their high cost and the scarcity of water, of spray equipment, and of economic resources in the region. Thus, the use of lentil varieties resistant or tolerant to rust is the safest, most efficient, and most cost-effective means to control the disease. This paper presents the results of the breeding efforts of the Food Legume Program of INIA to develop the new lentil variety "Centinela-INIA" resistant to lentil rust.

Origin

The new variety, breeding line LP-6382 was selected from seed introduced from ICARDA through the Lentil International Screening Nursery (LISN-79). The nursery was established in 1979 at Matanzas, Navidad, Chile. The origin of this lentil line no. 74TA 470 is from Chile according to the information supplied by ICARDA.

Morphological Description of the Plant

The plant has an indeterminate habit of growth. It is erect, and of 40 - 45 cm height. The stems and leaves are green and the flowers are white with traces of blue in the petals. Inflorescences consist of 2 - 3 flowers. The pods are oval in shape, and usually contain a single seed. The seeds are light green, but may turn light brown depending on the moisture level of the seed at harvest.

Agronomic Characteristics

This variety, usually planted in the north-central drylands, flowers 130 - 145 days after planting in May, and matures 180 to 190 days after planting. A late planting date (June-July) reduces the number of days to harvest to 160 - 170 days. The new variety has some characteristics similar to the varieties Araucana-INIA and Tekoa.

Phytopathological Characteristics

The line LP-6382 was selected out of ICARDA line 74TA-470 for its high resistance to lentil rust (*Uromyces vicia fabae*).

A scale of 0 to 5 was used to evaluate disease severity. The ratings were 0 = no symptoms, 1 = few uredosores found only on the basal leaves of the plant, 2 = uredosores present on leaves throughout the plant, 3 = abundance of uredosores on stems and leaves with mild defoliation, 4 = uredosores on leaves, stems, petioles and pods with severe defoliation, and 5 = severe defoliation and death of the plants.

The results of the experiments conducted during the last four years at Matanzas, Chile are presented in Table 1. The new variety Centinela-INIA showed resistance to lentil rust similar to Tekoa and slightly superior to Corriente and Araucana-INIA varieties.

Seed Yield

The data on the seed yield of Centinela-INIA compared with the commercial varieties (Tekoa, Corriente, and Araucana-INIA) planted under different environmental conditions, and in the presence and absence of rust are presented in tables 2 and 3. The data clearly demonstrate that the variety Centinela-INIA is highly resistant to lentil rust.

Table 1 Varietal performance to lentil rust (*Uromyces vicia fabae*), during the 1983-86 seasons at Matanzas, VI Region of Chile

Variety	Rust rating* 1983	1984	1985	1986	Average
Centinela-INIA	3.8	3.3	2.2	3.3	3.3
Tekoa	2.5	2.2	3.5	3.3	2.9
Corriente	4.0	3.3	3.0	3.8	3.5
Araucana-INIA	4.0	3.9	4.0	4.0	4.0

* Rating: 0 to 5 in which 0 = no symptoms, and 5 = severe defoliation and death of the plants.

The observations on lentil rust at Matanzas during the five years showed that the new lentil variety gave 53% more yield as compared with the resistant variety Tekoa and 70% and 90% more yield as compared with the susceptible varieties Corriente and Araucana-INIA, respectively (**Table 2**). In locations where lentil rust is not a problem, Centinela-INIA gave a yield similar to Tekoa and Araucana-INIA (**Table 3**). These results indicate that Centinela-INIA is well adaptable to different agroclimatic conditions.

Region of Cultivation, Planting Date, and Seed Density

Centinela-INIA is well adapted for cultivation in the North-Central drylands of Chile where the disease is a limiting factor for the crop.

Planting date in May is considered normal for the species in the North-Central zone of Chile. Although it is possible to delay the planting date, but this will likely result in a yield reduction, the severity of which depends on the extent of the delay.

The seed density of 60 - 80 kg/ha is recommended for planting, depending on the planting method.

Seed Quality

Lentil quality is determined by the size of the seed. The percentage of seed over 6 mm in diameter produced by Centinela-INIA is compared to the control varieties (**Table 4**). The results show that the new variety produces a seed size similar to Araucana-INIA which is a large seeded variety.

The data on the seed size and commercial yield of different varieties show that the larger seed of Centinela-INIA is more easily marketed and exported than Tekoa or Corriente (**Table 4**). The commercial yield (CY), which is the relationship between the seed size and yield, can be calculated by the following formula:

CY = Field yield x (% 7 mm + % 6 mm x 0.864 + % 5 mm x 0.826)

The different coefficients in the formula correspond to the average export price for a specific time period, with 7 mm in diameter as the optimum seed size.

Summary

Centinela-INIA, selected from the Lentil International Screening Nursery 1979, is a new lentil variety developed by the Food Legume Program at La Platina Experimental Station (INIA). The new variety was submitted by ICARDA, and corresponds to the entry No. 4050 (74TA-470).

This variety is highly tolerant to lentil rust (*Uromyces vicia fabae*) and produces good yields in areas with high incidence of the disease. The seed color is light green with 60 to 80% of the seeds over 6 mm in diameter, making this variety prefered for export.

Table 2 Seed yield (kg/ha) of lentil varieties during five years, under a high incidence of rust at Matanzas, VI Region of Chile

Variety	Yield (kg/ha) 1980	1983	1984	1985	1986	Average
Centinela-INIA	1380a*	1180a	770a	1420a	1180a	1190
Tekoa	950b	720b	650ab	840bc	930b	820
Corriente	--	540bc	480bc	1090bc	700b	900
Araucana-INIA	--	440cd	190d	790c	830b	560

* In each column, values with the same letter are not statistically different from each other at P = 0.05 by Duncan's multiple range test.

Table 3 Seed yield (kg/ha) of lentil varieties at different locations, without incidence of rust

Variety	Yield (kg/ha) Pichilemu 1981	Paredones 1981	Mar Pacifico 1982	Lolol 1985	Hidango 1986	Average
Centinela-INIA	1770a*	780a	2340a	1590a	730a	1440
Tekoa	740c	380a	1920a	2200a	640a	1170
Corriente	--	--	2190a	1610a	--	--
Araucana-INIA	1130abc	360a	2310a	1580a	630a	1200

* In each column, values with the same letter are not statistically different from each other at P = 0.05 by Duncan's multiple range test

Table 4 Commercial yields and percent of seeds over 6 mm in diameter of lentil varieties at different locations in the North-central dryland areas in Chile

Variety	Seed size over 6 mm (%) Pichilemu 1981	Mar Pacifico 1982	Lolol 1985	Hidango 1986	Matanzas*	Commercial yield** Matanzas* (kg/ha)	100-seed weight*** (g)
Centinela-INIA	85.5	92.2	85.5	79.2	61.8	970	6.2
Tekoa	64.5	66.8	60.7	61.0	32.7	660	5.9
Corriente	--	50.0	62.9	--	28.7	590	4.5
Araucana-INIA	62.6	94.0	92.6	90.5	70.0	490	7.1

* Average of 4 years
** Commercial Yield = Field yield (% 7 mm + % 6 mm x 0.864 + 5 mm x 0.826)
*** 14% humidity content

References

Sepulveda R., Paulina. 1984. La roya de la lenteja disminuye el rendimiento del cultivo. Investigacion y Progreso Agropecuario. La Platina no. 26: 21-22.

Sepulveda, R., Paulina and Alvarez, A. Mario. 1982. Roya y antracnosis: enfermedades de la lenteja. Investigacion y Progreso Agropecuario. La Platina no. 13: 9-10.

Tapia F., Francisco, Sepulveda R., Paulina and Covarrubias Z., Carlos. 1987. Validacion de Tecnologia. Investigacion y Progreso Agropecuario. La Platina no. 41: 18-20.

Centinela-INIA : صنف جديد من العدس متحمل للصدأ *(Uromyces vicia fabae)*

ملخص

تشير هذه الورقة إلى اعتماد صنف العدس Centinela-INIA ؛ على أساس مقاومته للصدأ *(Uromyces vicia fabae)* ، وغلته العالية في المناطق الشديدة الإصابة . ومما يجعل هذا الصنف مفضلا للتصدير لون البذرة الأخضر الفاتح، وقطرها الذي يزيد في 60 إلى 80٪ من البذور على 6 مم.

Effect of sun drying of lentil seeds on the control of seed-borne *Ascochyta lentis*

S.P.S. Beniwal[1], Seid Ahmed[2], and Negussie Tadesse[2]

1. Institute of Agricultural Research/ICARDA, P.O. Box 2003, Addis Ababa, ETHIOPIA
2. Debre Zeit Agricultural Research Center, Alemaya University of Agriculture, P.O. Box 32, Debre Zeit, ETHIOPIA

Abstract

Sun drying of lentil seeds controlled significantly seed-borne *Ascochyta lentis*. However, sun drying with a polyethylene sheet cover was more effective in control than the treatment without a polyethylene sheet cover and provided 57 and 96% control in 10 and 30 days exposure, respectively. The figures for the same exposure periods without a polyethylene sheet cover were 12 and 49%, respectively. However, sun drying adversely affected seed germination in all the treatments except in 10 days exposure without a polyethylene sheet cover. In general, a decrease in seed germination was observed with the increase in the duration of sun drying which ranged from 18 to 44% and 9 to 36% in sun drying with and without a polyethylene sheet cover, respectively. The advantage of sun drying of lentil seeds in the Ethiopian context is discussed.

Introduction

Lentil (*Lens culinaris* Medik.) ranks fourth among the traditional highland pulse crops cultivated in Ethiopia. The grain yield and quality are affected by both biotic and abiotic stresses (Million and Beniwal 1988). Among biotic stresses, diseases like rust and wilt/root-rots are the major ones although ascochyta blight (*Ascochyta lentis* Vassil.) has recently become important in the improvement of the crop in the country. The seed-borne nature and chemical control of the fungus were studied at Debre Zeit Agricultural Research Center (Seid and Beniwal 1988a, b). The objective of the present study was to investigate the effect of sun drying in controlling the seed-borne infection of *A. lentis* in lentil seeds.

Materials and Methods

Lentil seeds naturally infected with *A. lentis* were sun dried at Debre Zeit Agricultural Research Center in January 1988. The seeds were uniformly spread on two tin trays; one tray was kept uncovered, whereas the other was covered with a polyethylene sheet. Both trays were exposed to direct sunlight from 0800 to 1700 hrs for one month. Seeds unexposed to sun and kept in a tin tray in the laboratory (20 - 25^{o}C) served as controls. Four hundred seeds were randomly counted from each treatment after 10, 15, 20, and 30 days of sun exposure and plated onto potato-dextrose-agar (PDA) following standard procedures used for seed health testing (ISTA 1966). The twenty petri dishes each with 20 seeds in both treatments and the control were incubated at room temperature (20 to 25^{o}C) with 12 h light. Each experiment was laid out in a randomized complete block design with five replications (80 seeds/replication). Observations on seed germination and *A. lentis* colonies developing from the seeds were made 7 days after incubation.

Results and Discussion

Sun drying was significantly effective in controlling *A. lentis* in lentil seeds (**Table**). However, sun drying with a polyethylene sheet cover was more effective in controlling *A. lentis* than the treatment without a polyethylene sheet cover and provided 57 and 96% control in 10 and 30 days exposure, respectively. However, sun drying adversely affected seed germination in all the treatments except in 10 days exposure without a polyethylene sheet cover. In general, there was a decrease in seed germination with every increase in the duration of sun drying. Several workers have found the advantage of thermotherapy in reducing and/or eradicating *A. lentis* infection in lentil seeds. Among these, grain drying (Gossen and Morall 1984) and aerated steam treatment (Kaiser and Hannan 1987) effectively reduced *A. lentis* infection in lentil seeds. Also in chickpea, exposure of *A. rabiei* infected seed seed to direct sun light was found effective in reducing the recovery of the fungus (Tripathi *et al.* 1987). The reduction was 50% after 15 days exposure without a polyethylene sheet cover whereas it was 68% for the same period with a polyethylene sheet cover. These results conform to our results which also showed the advantage of sun drying especially by using a polyethylene sheet cover which almost doubled the effectiveness of sun drying in controlling *A. lentis* in lentil seeds.

Sun drying of *A. lentis* infected lentil seeds for 30 days with a polyethylene sheet cover provided the most effective (96%) control of the seed-borne fungus.

However, this resulted in 44% reduction in seed germination. In a country like Ethiopia where seed dressing fungicides are not available for the farmers for several reasons, this practice offers a practical alternative for an effective control of *A. lentis* in lentil seeds. Most Ethiopian farmers routinely follow this practice of sun drying or lentil and chickpea seeds after harvest. This may be one of the reasons for less incidence of ascochyta blight of lentil in the fields of the farmers in the country.

Table Effect of sun drying with and without polyethylene sheet cover on percent seed germination and recovery of *A. lentis* from lentil seeds

Sun exposure (days)	Mean % seed germination[1,2]	Mean % *Ascochyta*[3] colonies	Percent *Ascochyta* control
With polyethylene sheet cover			
10	60.0 (50.89)	8.8 (2.98)	57.1
15	48.8 (44.37)	7.2 (2.74)	64.9
20	48.0 (43.85)	3.2 (1.82)	84.4
30	40.8 (39.63)	0.8 (0.89)	96.1
Unexposed check	73.0 (58.82)	10.5 (4.54)	-
LSD (0.05)	(6.42)	(0.93)	
Without polyethylene sheet cover			
10	73.0 (58.82)	18.0 (4.22)	12.2
15	65.0 (54.04)	13.5 (3.66)	34.1
20	65.0 (53.84)	11.0 (3.22)	46.3
30	51.5 (45.86)	10.5 (3.18)	48.8
Unexposed check	80.5 (64.51)	20.5 (4.46)	-
LSD (0.05)	(7.9)	(0.7)	

1 Four hundred seeds from each treatment were plated on PDA (20 seeds/petri dish).

2 Figures in parenthesis are angular transformed values (V %).

3 Figures in parenthesis are square root transformed values (X + 1/2).

References

Gossen, B.D. and Morrall, R.A.A. 1984. Seed quality loss at harvest due to ascochyta blight of lentil. Canadian Journal of Plant Pathology **6**: 233-237.

International Seed Testing Association (ISTA). 1966. International rules for seed testing. Proceedings of the International Seed Testing Association **31**: 152.

Kaiser, W.J. and Hannan, R.M. 1987. Seed-treatment fungicides for control of seed-borne *Ascochyta lentis* on lentil. Plant Disease **78**: 58-62.

Million, Eshete and Beniwal, S.P.S. 1988. Chickpea and lentil research in Ethiopia: achievements and future strategies. Pages 171-188 *in* Proceedings of the 19th National Crop Improvement Conference, 22-26 April 1987, Addis Abeba, Ethiopia. Institute of Agricultural Research, Addis Abeba, Ethiopia.

Seid, Ahmed and Beniwal, S.P.S. 1988a. Seed-borne nature and control of *Ascochyta lentis* in lentil (*Lens culinaris* Medik.). Ethiopian Plant Pathology Newsletter **13**: 22 (Abstract).

Seid, Ahmed and Beniwal, S.P.S. 1988b. Seed-borne nature of *Ascochyta lentis* in lentils in Ethiopia. LENS Newsletter **15**: 30-31.

Tripathi, H.S., Singh, R.S. and Chaube, H.S. 1987. Effect of sun drying on the recovery of *Ascochyta rabiei* from infected chickpea seeds. International Chickpea Newsletter No. **16**: 13-14.

تأثير التجفيف الشمسي لبذور العدس في مكافحة التبقع الأسكوكيتي *Ascochyta lentis* المحمول على البذور

ملخص

قضى التجفيف الشمسي لبذور العدس، وبشكل معنوي، على الفطر *Ascochyta lentis* المحمول على البذور، إلا أن استعمال غطاء من البولي ايثلين في التجفيف كان أكثر فعالية في المكافحة من التجفيف بدونه، مما أعطى نسبة مكافحة 57 و 96 ٪ بعد 10 و 30 يوما من تعريضها للشمس على التوالي. وبلغت هذه الأرقام لنفس فترات التعرض للشمس إنما بدون الغطاء البولي ايثليني 12 و 49 ٪ على التوالي. بيد أن التجفيف الشمسي قد أثّر بشكل عكسي في إنبات البذور في جميع المعاملات باستثناء معاملة التعريض للشمس لمدة عشرة أيام بدون ذلك الغطاء. وقد لوحظ على العموم انخفاض في إنبات البذور مع زيادة في مدةالتجفيف الشمسي تراوحت من 18 إلى 44 ٪ ، ومن 9 إلى 36٪ عند التجفيف الشمسي بوجود الغطاء البولي ايثليني وبدونه على التوالي. ونوقشت في الورقة مزايا التجفيف الشمسي لبذور العدس تحت الظروف الاثيوبية.

Variation and association amongst lentil cooking characteristics

A. K. Sharma, Bhupinder Singh, A. K. Saxena, A. K. Bakshi, and M. M. Verma
Department of Plant Breeding
Punjab Agricultural University
Ludhiana 141004, Punjab, INDIA

Abstract

Seven cooking characteristics namely 100-seed weight, 100-seed volume, specific gravity, % water uptake after 10 minutes of cooking, cooking time, % increased cooked weight, and % increased cooked volume were studied in 24 lentil strains to develop a simple, but sound cooking test. These parameters had significant genotypic variances and wide range of variability, but the coefficient of variation was low (1.42 - 5.73%). Highly significant positive associations were observed between 100-seed weight, 100-seed volume, and cooking time, but 100-seed weight had high negative associations with % water uptake after 10 minutes cooking and % increased cooked volume. Specific gravity was highly associated with increased cooked volume, but had no association with cooking time. Practical, repeatable, and reliable selection parameters for cooking characteristics are proposed in which lentil genotypes with low seed weight and seed volume with high specific gravity absorbing comparatively more water during the first 10 minutes of cooking are preferred as selection indices. A breeding strategy for evolving lentil varieties with better yield and cooking quality is discussed.

Introduction

Lentil (*Lens culinaris* Medik.) is one of the important *Rabi* pulses grown and consumed in India. It is also an important traditional dietary in the Middle East (Erskine *et al.* 1985). The All India Pulse Improvement Program develops and tests new high yielding strains/ varieties of lentil in different agroclimatic zones of India for cultivation, adaptability, and incidence of disease and insect pests. Attention to culinary characteristics is relegated to the last priority while evolving and evaluating new strains/varieties. On the contrary, the consumer first considers the culinary characteristics of the variety. The lentils which cook quickly, expand greatly in volume on cooking and finally disperse solidly in boiling water to make a thick gravy, are valued by Indians consuming *dahl* with *chapatis*. The other characteristics include texture, flavour, and appearance of food cooked from lentil like lentil soup.

Cooking time is the most important aspect of cooking quality. It has positive genetic correlation (r = 0.92) with seed weight (Erskine *et al.* 1985). In the present investigation in addition to test weight and cooking time, new parameters namely specific gravity, % water uptake after 10 minutes cooking, % increase in weight and volume of seed after cooking were included to study the inter-relationship to find quick, practical, repeatable, and reliable parameters to assess cooking characteristics of lentils.

Materials and Methods

Seed of 24 lentil strains used in the present study were grown at the Punjab Agricultural University, Ludhiana, India from the last week of October, 1982 to the 2nd week of April, 1983. These strains were either selections from land races or from hybrid derivatives which were bulked in advanced generations (F_6 onwards) and essentially homozygous. Many of the strains are released varieties and are under commercial production in India. Places of origin and pedigrees are given in **Table 1.** A randomised block design was used with four replications for growing the strains, but seeds of two random replications were used in the present study. Before sowing, fertilizer was applied at the rate of 40 kg P/ha and 15 kg N/ha. Inoculation with *Rhizobium* was not undertaken, but nodulation was good throughout. Plot size was 4 m long with eight rows of 22.5 cm apart, and with (approximately) 400 seeds/m^2. When 90-95% of pods in a plot were mature, six rows planted with control were harvested, air dried in the field, and then threshed and the clean seeds were stored in cloth bags. Prior to determining the cooking characteristics, the lentils were stored for approximately 4 months at room temperature (30-35°C).

For determining seed weight and volume, random sample of 100 air-dry seeds were recorded and their specific gravity (particle density) was determined as follows:

$$\frac{\text{Weight of 100 seeds (g)}}{\text{Volume of 100 seeds (ml)}}$$

The volume was determined in a graduated flask containing 10 ml of water and the difference between final and initial reading gave the volume. Method of Rao *et al.* (1964) was followed for measuring the cooking time with modifications.

In the present investigation, cooking time was determined by taking a random sample of 5 g of air-dry, unsoaked seed and placing it in 50 ml of distilled water in a 150 ml glass beaker boiling at a constant temperature of approximately 99.5°C. Five seeds were taken out from the beaker after 15 minutes and tested for softness by pressing the seeds between thumb and the index finger. Similar observations were repeated every 2 minutes to test the softness of five seeds. The final cooking time was recorded when all the five seeds became soft and an immediate duplicate sample confirmed the softness of all the seeds. The increase in the weight after cooking over initial weight was determined by draining the water completely over a sieve and weighing the cooked seeds. The volume of cooked seed was recorded as the volume of the water lost by them and the increase over the initial volume was expressed in percent. The water uptake after 10 minutes of cooking was determined by completely draining out the water over a sieve and then by weighing the cooked seeds. Analyses of variance, critical difference (CD), coefficient of variation (CV), and coefficient of correlations were worked out for the characteristics determined.

Results and Discussion

Mean performance and variation

The mean values of various characteristics studied for 24 strains of lentil are presented in **Table 1**. Analyses of variance for the seven characters studied in all the strains showed highly significant F values. Coefficients of variation for all the characteristics ranged from 1.42% for cooking time to 5.73% for % increase in cooked weight representing the repeatability of the tests. 100-seed weight varied from 1.56 for LL56 to 2.76 g for PL-77-12. Similarly, 100-seed volume ranged from 0.90 ml for LG 112 to 2.26 ml for PL 77-12, whereas LL 56 had 1.09 ml. The specific gravity (density) of seed varied from 1.10 to 1.76 with LG 112 having maximum density and LG 128 having the minimum. The range of variation for cooking time was 19.0 minutes for PL 79-8 to 24.3 minutes for PL 77-12. The percent uptake for water after 10 minutes cooking was maximum for the strains Pl 79-8 (86.8), LL 56 (86.6), and LG 112 (86.3) and minimum for the strains PL 77-12(70.0), HPL1(70.3), and L. 1268 (71.1). The percentage increase in cooked weight was maximum in VL2 (118.9) followed by L 1268 (110.7), LG 112 (105.5), and L 1304 (101.0), while it was minimum in LG 189 (70.3), LG186 (72.1), and L9-12 (72.2). A considerable amount of variability was observed for % increase in the volume of the seed after cooking. The strains LG 112 and L-1268 showed 200 and 193.3 % increase in the volume after cooking, respectively, while PL 77-2 showed minimum % increase in the volume (71.4). Kurien *et al.* (1964) and Sankaran and Sirinivasan (1963) also observed varietal differences in time taken and an increase in seed volume in rice and red gram (*Cajanus cajan* (L.). Mill.), respectively.

Correlations

The correlation coefficients among various cooking characteristics in lentils are presented in **Table 2**. Highly significant positive correlations were observed between 100-seed weight and 100-seed volume (r = 0.942), and cooking time (r = 0.841). But high negative correlations were found between 100-seed weight and % water uptake after 10 minutes of cooking (r = -0.733) and % increased cooked volume (r = -0.779). 100-seed volume had also high positive correlation with cooking time (r = 0.762), but there were negative correlations between it and specific gravity (r = -0.425), % water uptake in 10 minutes cooking (r = -0.719), increased cooked weight (r = -0.474), and increased cooked volume (r = -0.684). Similar trends were observed by Shivashankar *et al.* (1974) in a collection of green gram (*Phaseolus aureus* Roxb). A highly significant positive correlation was revealed between specific gravity and increased cooked volume (r = 0.929). Cooking time was negatively correlated with % water uptake after 10 minutes of cooking (r = 0.490), while it was not significantly correlated with specific gravity of the seed, cooked weight, and cooked volume. Cooked volume and cooked weight of seed had high positive association (r = 0.583).

In lentil, a close relationship existed between seed weight and seed volume, but both had high positive association with cooking time. That is, small-seeded lentils took less time to cook than bold-seeded lentil. Similarly, a very high positive correlation (r = 0.92) was reported between seed weight and cooking time in a set of 24 lentil genotypes, originating from seven lentil growing countries (Erskine *et al.* 1985). The

Table 1 Cooking characteristics of 24 strains of lentil along with their origins and pedigrees

Number	Strain	Origin	Pedigree	100-seed weight (g)	100-seed volume (ml)	Specific gravity	% water uptake in 10 min. cooking	Cooking time (min.)	% increased cooked weight	% increased cooked volume
1	L9-12	Ludhiana	Hyb. der.	1.81	1.44	1.25	80.0	20.8	72.2	112.1
2	LL 56	Ludhiana	Hyb. der.	1.56	1.09	1.42	86.6	19.8	93.3	127.2
3	LL 147	Ludhiana	Hyb. der.	1.70	1.40	1.21	79.0	22.8	88.2	114.2
4	LL 153	Ludhiana	Hyb. der.	1.86	1.55	1.18	80.3	21.3	95.5	110.0
5	LG 112	Gurdaspur	Hyb. der.	1.59	0.90	1.76	86.3	19.8	105.5	200.0
6	LG 120	Gurdaspur	Hyb. der.	1.60	1.40	1.14	83.3	21.0	81.2	78.6
7	LG 128	Gurdaspur	Hyb. der.	1.65	1.50	1.10	80.0	20.3	96.2	106.6
8	LG 175	Gurdaspur	Hyb. der.	1.59	1.60	1.50	84.3	20.8	87.5	163.6
9	LG 178	Gurdaspur	Hyb. der.	1.64	1.30	1.26	83.0	20.0	87.5	135.5
10	LG 186	Gurdaspur	Hyb. der.	2.18	1.69	1.29	74.3	23.0	72.1	110.8
11	LG 189	Gurdaspur	Hyb. der.	1.88	1.47	1.28	83.6	20.3	70.3	133.3
12	PL 77-2	Dholi	Mutant	2.70	2.24	1.20	73.3	23.3	85.5	71.4
13	PL 77-12	Dholi	Mutant	2.76	2.26	1.22	70.0	24.3	71.4	90.9
14	RAU 101	Dholi	Hyb. der.	2.55	2.05	1.24	74.3	23.0	80.0	100.0
15	PL 79-8	Pantnagar	Selection	1.60	1.25	1.28	86.8	19.0	98.7	153.6
16	PL 406	Pantnagar	Selection	1.76	1.39	1.27	80.0	21.8	88.8	124.2
17	PL 639	Pantnagar	Hyb. der.	1.66	1.30	1.27	84.3	20.8	81.2	90.9
18	K-81	Kanpur	Selection	2.20	1.84	1.24	76.6	20.8	79.5	107.7
19	K-82	Kanpur	Selection	2.10	1.75	1.20	73.3	21.8	90.4	117.6
20	HPL 1	Palampur	Selection	1.88	1.55	1.21	70.3	23.3	86.2	90.3
21	VL 1	Almora	Selection	1.70	1.42	1.20	83.3	21.0	88.2	114.2
22	VL 2	Almora	Selection	1.63	1.45	1.12	83.3	19.8	118.9	136.2
23	L-1268	Delhi	Selection	1.75	1.23	1.42	71.1	24.0	110.7	193.3
24	L-1304	Delhi	Selection	1.86	1.42	1.30	80.5	21.8	101.0	158.0
G. Mean				1.88	1.50	1.27	79.5	21.4	88.2	122.5
C.D. at 5%				0.14	0.11	0.04	7.12	0.63	10.52	13.10
CV				3.61	3.55	1.69	4.33	1.42	5.73	5.17

Note: Hyb. der. = Hybrid derivative

Table 2 Correlation coefficient of cooking characteristics of 24 strains of lentil

Character	100-seed volume (ml)	Specific gravity	% water uptake in 10 min. cooking	Cooking time (min)	% increased cooked weight	% increased cooked volume
100-seed weight (g)	0.942**	-0.161	-0.733**	0.841**	-0.492*	-0.779**
100-seed volume (ml)		-0.425*	-0.719**	0.762**	-0.474*	-0.684**
Specific gravity			0.373	0.002	0.094	0.929**
% water uptake 10 min. cooking				-0.490*	0.253	0.373
Cooking time (min.)					-0.087	-0.207
% increased cooked weight						0.583**
% increased cooked volume						

* Significant at 5% level

** Significant at 1% level

strains with low seed weight and volume absorbed more water after 10 minutes of cooking and consequently took less time for cooking.

Curiously enough, the strains with higher density attained more volume on cooking and were independent of cooking time. This is a culinary characteristic which gives thick gravy which is preferred by Indian consumers.

It may be concluded that while selecting lentils for culinary purpose, the genotypes with low seed weight and volume with high specific gravity (particle density) should be considered. Further, more water uptake after the first 10 minutes of cooking can be taken as an index for selecting early cooking types. It is possible to breed for early cooking with high specific gravity types since there is no correlation between these two traits. Thus, while selecting segregating generations in a hybridization programme for yield and agronomic characters, special emphasis should also be given to the low test weight and seed volume which would indirectly result in a variety with good cooking quality.

References

Erskine, W., Williams, P.C. and Nakkoul, H. 1985. Genetic and environmental variation in the seed size, protein, yield and cooking quality of lentils. Field Crops Research **12**: 153-161.

Kurien, P.P., Murty, R.R., Desikachar, H.S.R. and Subrahmanyan, V. 1964. Effect of parboiling on swelling quality of rice. Cereal Chemistry **41**: 16-22.

Sankaran, S. and Srinivasan, V. 1963. Evaluation of red gram types for cooking quality. Madras Agricultural Journal **50**: 470-472.

Shivshankar, G., Rajendra, B.R., Vijayakumar, S. and Sreekantaradhya, R. 1974. Variability for cooking characteristics in a collection of green gram (*Phaseolus aureus* Roxb). Journal of Food Science and Technology **11**: 232-233.

Rao, P.V.S., Ananthachar, T.K. and Desikachar, H.S.R. 1964. Effect of certain chemicals and pressure on cookability of pulses. Indian Journal of Technology **2**: 417-418.

التباين والترابط بين خصائص طهي العدس

ملخص

تمت على 24 سلالة من العدس دراسة سبع خصائص طهي، هي: وزن، وحجم المئة حبة، والثقل النوعي، والنسبة المئوية لامتصاص الماء بعد عشر دقائق من الطهي، وزمن الطهي، والنسبة المئوية لزيادة وزن، وحجم المطبوخ، وذلك لتطوير اختبار طهي بسيط ومعتمد. وقد اختلفت هذه المعايير معنويا بين الطرز الوراثية، وتباينت إلى حد واسع، إلا أن معامل الاختلاف كان متدنيا (1.42 - 5.73 ٪) . كما لوحظ وجود ترابط إيجابي معنوي عالٍ بين وزن وحجم المئة حبة، وزمن الطهي، وترابط سلبي عالٍ بين وزن المئة حبة وكل من النسبة المئوية لامتصاص الماء بعد عشر دقائق من الطهي، والنسبة المئوية لزيادة حجم المطبوخ. وارتبط الثقل النوعي بشدة بزيادة حجم المطبوخ، غير أنه لم يرتبط بزمن الطهي. واقتُرِح وضعُ معايير انتخاب عملية ومعادة وموثوقة لخصائص الطهي، بحيث تعتبرطرز العدس الوراثية ذات وزن وحجم البذور المنخفضين، مع نسبة عالية من الثقل النوعي بحيث يتشرّب ماء أكثر نسبيا خلال العشر دقائق الأولى من الطهي، كمعايير انتخاب مفضلة. كما بحثت استراتيجية التربية لاستنباط أصناف عدس ذات غلة أعلى، ونوعية طهي أفضل.

LENTIL INFORMATION معلومات متخصصة عن العدس

LENS Bookshelf مكتبة العدس

Bettencourt, E., Konopka, J. and Damania, A.B. 1989. Directory of Germplasm Collections. 1. I Food Legumes *Arachis, Cajanus, Cicer, Lens, Lupinus, Phaseolus, Pisum, Psophocarpus, Vicia* **and** *Vigna.* **190 p. IBPGR, Rome, Italy.**

The directory lists germplasm collections holding Lentil to facilitate exchange of genetic material. It replaces the first edition published in 1980. The entries in the directory are organized by crop name and, within the crop, by country order and, within the country by organizations where the curators or persons in charge are located. Each entry has name of the curator; telephone and telex numbers and his cable address, details of collection, maintenance of collection, duplication of collection, availability, quarantine, evaluation, and documentation. An index is also included.

Key Lentil Abstracts ملخصات هامة عن العدس

Ali-Khan, S.T. and Kiehn, F.A. 1989. Effect of date and rate of seeding, row spacing and fertilization on lentil. *Canadian Journal of Plant Science* 69(2): 377-381. Research Station, Agriculture Canada, Morden, Manitoba, Canada ROG IJO.

The effect of seeding date, seeding rate, row spacing and fertilizer level were investigated in two cultivars of lentil (*Lens culinaris* Medik.), Eston and Laird, in Manitoba. High yields were obtained by early seeding, narrow row spacing (15 cm) and high seeding rate (100 plants m^{-2}). Response to fertilizer levels was variable. Early seedings produced larger seeds. Effects of other treatments on seed size were not significant.

Bhatty, R.S. 1989. Influence of phytate-phosphorus on the cooking quality of lentil. *Canadian Journal of Plant Science* 69(2): 547. Crop Development Centre, Department of Crop Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N OWO.

Phytic acid (PA: MYO-inositol hexaphosphoric acid), the natural reservoir of seed phosphorus, has long been implicated in influencing the cooking quality of pulses. However, unlike in other legumes, few studies have been reported on the influence of PA in cooking quality of lentil (*Lens culinaris* Medik.). The objective of this study was to investigate the relationship between seed phosphorus (P), PA, PA-P (PA % P), inorganic-P and cooking quality in lentil grown under varying conditions of P availability. Fifty-six samples of Laird and Eston lentils were obtained from a Cooperative Test, farmers fields, a phosphate fertilization experiment, and a hydroponic experiment. The cooking quality of the lentil samples was determined using a Kramer shear press. Lentils having a shear force value of < 4.0 kg g^{-1} were considered cooked, and > 4.0 kg g^{-1} undercooked. All the samples were analyzed for P, PA, PA-P and inorganic-P. The most significant finding was that in each experiment, except the phosphate fertilization experiment, good-cooking lentil had significantly higher P, PA, PA-P, but a generally similar inorganic-P. Of the total 56 samples, the 20 good-cookers and 10.8% more P, 22.2% more PA, and 12.9% more PA-P, strongly suggesting beneficial effect of PA on the cooking quality of lentil. The shear force (cooking quality) was significantly negatively correlated with PA in the Cooperative Test (0.56) phosphate fertilizer experiment (0.64) and in the total samples (0.42). In another experiment, a good-cooking sample of Laird (shear force 3.4 kg g^{-1}) was soaked for 64 to 72 h in water and maintained at 25°C, 35°C and 50°C. On cooking, the soaked sample (50°C) showed an increase in shear force (from 3.4 to 6.0 kg g^{-1}), suggesting a hardening (difficult-to-cook) of the lentil sample. This hardening was accompanied by a general decrease in PA, presumably brought about by its degradation by the enzyme phytase which dephosphorylates PA and reduces its chelating capacity. The mechanism of PA in influencing the cooking quality of lentil is under investigation. Results of the present study strongly suggest that increased levels of PA in lentil, brought about by adequate levels of available soil phosphorus, will improve cooking quality.

Erskine, W., Adham, Y., and Holly, L. 1989. Geographic distribution of variation in quantitative traits in a world lentil collection. *Euphytica* 43(1-2): 97-103. ICARDA, Aleppo, Syria

In a world lentil collection the distribution of variation amongst accessions from 13 major lentil-producing countries was examined on the basis of nine quantitative morphological characters by discriminant analysis and canonical analysis. Stepwise discriminant analysis revealed major differences between accessions from different countries. Three major regional groups were apparent: 1) a levantine group (Egypt, Jordan, Lebanon and Syria, 2) a more northern group composed of Greece, Iran, Turkey, and USSR, and 3) accessions from India and Ethiopia with strikingly similar quantitative morphological characters. Misclassifications of individuals within groups were frequent. Characters useful in discriminating between accessions from different countries were in descending order of importance: time to maturity, lowest pod height and 100-seed weight. The regional grouping indicates the importance of local adaptation through clusters of associated characters with phenological adaptation to the ecological environment as the major evolutionary force in the species.

Havey, M.J. and Muehlbauer, F.J. 1989. **Variability for restriction fragment lengths and phylogenies in lentil.** *Theoretical and Applied Genetics* 77(3): 395-401. Agricultural Research Service, USDA, Grain Legume Genetics and Physiology Unit, Washington State University, Pullman, WA 99164-6421, USA

Thirty accessions of domesticated (*Lens culinaris* ssp. *culinaris*) and wild (*L. culinaris* ssp. *orientalis*, *L. culinaris* ssp. *odemensis*, *L. nigricans* ssp. *ervoides* and *L. nigricans* ssp. *nigricans*) lentil were evaluated for restriction fragment length polymorphisms (RFLPs) using 10 relative low-copy-number probes selected from partial genomic and cDNA libraries of lentil. Nei's average gene diversity was used as a measure of genetic variability for restriction fragment lengths within subspecies and a dendrogram was constructed from genetic distance estimates between subspecies. The wild lentils *L. culinaris* ssp. *orientalis* and *L. culinaris* spp. *odemensis* showed the greatest variability for restriction fragment lengths and were closely positioned to domesticated lentil in the dendrogram. Little variability for restriction fragment lengths was observed within accessions of *L. nigricans* spp. *ervoides* and *L. nigricans* spp. *nigricans.* This observation is consistent with a previously published proposal that *nigricans* may have been independently domesticated. Estimates of genetic variability based on RFLPs tended to be greater than estimates from isozymes.

Kaiser, W.J., Stanwood, P.C. and Hannan, R.M. 1989. **Survival and pathogenicity of *Ascochyta Fabae* f.sp. *lentis* in lentil seeds after storage for four years at 20 to -196C.** *Plant Disease* **73**: 762-764. Western Regional Plant Introduction Station, USDA-ARS, Washington State University, Pullman 99164-6402, USA.

Survival of *Ascochyta fabae* sp. *lentis* in naturally infected lentil (*Lens culinaris*) seed was studied over 4 years at temperatures of 20, 5, -18, and -160 to -196 C (liquid nitrogen). The pathogen was isolated from 52 to 78% of the infected seeds during the experiment. There was an 18-25% increase in the incidence of seedborne *A. f.* f. sp. *lentis* between the third and fourth years at all temperatures. Incubation of infected seeds for 4 years at 20 to -196 C did not adversely affect the pathogenicity of the fungus to lentil. Germination of infected seeds was appreciably lower than that of healthy seeds at all temperatures on each sampling date (1 day, 1, 2, 3, and 4 years). There was a significant reduction in germination of infected, but not of healthy, seeds at each temperature over the 4-years period.

McKenzie, B.A. and Hill, G.D. 1989. **Environmental control of lentil (*Lens culinaris*) crop development.** *Journal of Agricultural Science, Cambridge* **113**(1) : 67-72. Lincoln University, Department of Plant Science, Canterbury, New Zealand.

The lentil (*Lens culinaris* Medik.) cultivars Titore and Olympic were sown at Canterbury, New Zealand, on eight dates, from April to November in 1984 and in May and August in 1985. Of the four important physiological growth stages (sowing to emergence (S-E), emergence to flowering (E-F), flowering to physiological maturity (F-P_m) and physiological maturity to harvest (P_m-H), the duration of all except E-F depended upon accumulated thermal time above 2°C. The mean accumulated thermal times for E-F, F-P_m, P_m-H were 116, 565 and 293°C days, respectively. Stage E-F required from 1165°C days for an April sowing to 509°C days for a November sowing. There was a highly significant positive relationship (r^2 = 0.99) between the rate of development during E-F and mean temperature. Photoperiod also affected development rate. Neither of the two cultivars studied had a vernalization requirement for the induction of flowering. In both years, the development rate during E-F was highly dependent upon photoperiod-corrected temperature. The relationships presented show that development of lentil crops in Canterbury can be accurately predicted using accumulated temperature and photoperiod-corrected temperature.

Mueller, R. and Weder, J.K.P. 1989. **Isolation and characterization of two trypsin-chymotrypsin inhibitors from lentil seeds (*Lens culinaris* Medik.)**. *Journal of Food Biochemistry* **13**(1): 39-63. Institute of Food Chemistry, Technical University of Munich, Garching, Federal Republic of Germany.

The two major trypsin-chymotrypsin inhibitors of *Lens culinaris* Medik. LCI-1 and LCI-4, were purified to homogeneity from Italian red lentils by ammonium sulfate fractionation, gel and ion-exchange chromatography. At least two more trypsin-chymotrypsin inhibitors of minor importance were present. LCI-1 and LCI-4 inhibited human trypsin less (68-74%) but human chymotrypsin better (268-279%) than the respective bovine enzymes. The two inhibitors contained no carbohydrates, no methionine and no tryptophan and high contents of cystine, but no free sulfhydryl groups (seven and eight disulfide bridges for LCI-1 and LCI-4, respectively). In addition, LCI-4 contained no isoleucine. The isoelectric points were 5.35 and 7.70 and the average molecular weights 10,600 and 9,900 daltons for LCI-1 and LCI-4, respectively. Inhibitor extracts, as well as purified inhibitors in solution, were relatively stable against heating and treatment with human gastric juice, while soaking the whole seeds overnight and subsequent boiling for two hours totally destroyed inhibitor activity.

Silim, S.N., Saxena, M.C., and Erskine, W. 1989. **Effect of cutting height on the yield and straw quality of lentil and on a succeeding wheat crop.** *Field Crops Research* **21**(1): 49-58. ICARDA, Aleppo, Syria.

Lentil (*Lens culinaris* Medik.) seeds are an important source of protein in the human diet, while the straw is widely used as animal feed in the Mediterranean region and West Asia, but production is declining due to high cost of hand-harvesting. Investigations were conducted during 1984/1985 and 1985/1986 at Tel Hadya, North Syria, to assess the yield losses in seed and straw when lentil cultivars of differing plant type were harvested with a double-knife harvester at various heights above ground-level, compared with traditional hand-pulling. Averaged over both seasons, respective losses were 10.1%, 14.8% and 19.5% in seed yield and 16.1%, 39.9% and 45.1% in straw yield, for cutting lentil at ground-level and at 5 and 10 cm above ground, compared to hand-pulling. Digestibility of straw, and its protein percentage increased with height of cut. Percentage losses in seed and straw yields were least in the tall upright cultivar ILL 8 and greatest in the spreading-type ILL 4400.

The residual effect of the different heights of cut and cultivars of lentil on the succeeding wheat crop, given 0 and 60 kg N ha^{-1}, was investigated during the 1986/1987 season. Method of harvest of lentil in the 1985/1986 season did not significantly influence the total biological and seed yields of a succeeding wheat crop in the 1986/1987 season. Nitrogen applied at 60 kg/ha^{-1} on the wheat crop in 1986/1987 tended to increase total biological yield, but significantly decreased harvest index and seed yield.

Summerfield, R.J., Muehlbauer, F.J., and Short, W. 1989. **Controlled environments as an adjunct to field research on lentils (*Lens culinaris*). IV. Cultivar responses to above- and below- average temperatures during vegetative growth.** *Experimental Agriculture* **25**(1): 119-134. University of Reading, Department of Agriculture, Plant Environment Laboratory, Shinfield Grange, Cutbush Lane, Shinfield, Reading RG2 9AD, United Kingdom.

The climates to which lentil (*Lens culinaris*) crops are exposed can vary appreciably depending on location and date of sowing. The effects on growth, development and seed yield when three USA cultivars experienced relatively warmer or cooler day/night temperatures during the vegetative period were investigated in growth cabinets. Plants were nodulated and supplied with either 20 or 80 ppm inorganic N; they differed appreciably in morphology and vegetative vigour, and so in their potential for subsequent pod production, depending on pre-flowering temperature and on nitrogen nutrition. Variations in seed yield were largely a consequence of treatment and cultivar effects on pod number per plant, and a pre-flowering temperature regime of 21°/7°C (mean 14.9°C) was supra-optimal. The pre-flowering environment clearly affects potential pod production and has persistent effects on the capability to plants to fill the pods produced.

Summerfield, R.J., Muehlbauer, F.J. and Short, R.W. 1989. **Controlled environments as an adjunct to field research on lentils (*Lens culinaris*). V. Cultivar responses to above- and below- average temperatures during the reproductive period.** *Experimental Agriculture* **25**(3): 327-341. University of Reading, Department of Agriculture, Plant Environment Laboratory, Shinfield Grange, Cutbush Lane, Shinfield, Reading, United Kingdom.

Nodulated plants of three USA cultivars of lentil (*Lens culinaris*) were grown in controlled environment cabinets. They were given either 20 or 80 ppm inorganic nitrogen and experienced a mean temperature of 12.3°C during the vegetative period, i.e. until 73-77 days after sowing. Factorial combinations of above- (29°/11°C) and below-average (23°/8°C) day/night temperatures were then imposed, to give four mean temperatures within the range of 16.6° to 21.1°C until reproductive maturity. Post-flowering vegetative dry-matter production and seed yields were dominated by treatment effects on the initiation and growth of branches. Warmer temperatures accelerated progress towards maturity, limited branching and restricted dry-matter production; at a mean temperature of 20°C plants were almost barren. The implications of these and previous data to lentil crop production and to the use of controlled environments in lentil breeding programmes are discussed.

Weder, J.K.P. and Mueller, R. 1989. **Reaction of lentil proteinase inhibitors with human and bovine trypsin chymotrypsin.** *Journal of Food Biochemistry* **13**: 81-103. Institute of Food Chemistry, Technical University of Munich, Garching, Federal Republic of Germany.

The two main trypsin-chymotrypsin isoinhibitors previously purified from lentils (*Lens culinaris* Medik.), LCI-1 and LCI-4, inhibited one mol of human trypsin (1.05 and 1.00), more than one mol of bovine trypsin (1.53 and 1.38) and human chymotrypsin (1.70 and 1.43) as well as less than one mol of bovine chymotrypsin (0.62 and 0.54, respectively) per mol of inhibitor. Complex formation, together with chemical and enzymatic modification studies, showed that they were Bowman-Birk inhibitors with two independent reactive sites. One of these sites, mainly reacting with trypsin, contained arginine and bound tightly to bovine trypsin, less tightly to human trypsin and loosely to human chymotrypsin. The other reactive site, preferring chymotrypsin, contained tyrosine and bound tightly to human chymotrypsin, less tightly to bovine chymotrypsin and loosely to bovine trypsin. The amounts of bound enzyme exceeding one mol per mol of inhibitor reacted with the "wrong" sites: bovine trypsin with the chymotrypsin-reactive and human chymotrypsin with the trypsin-reactive one. The much higher inhibition of human chymotrypsin compared to that of bovine chymotrypsin resulted from a combination of two effects: the additional binding of human chymotrypsin at the "wrong" reactive site and the weak binding of the bovine chymotrypsin.

Editors' Note

LENS Newsletter has published many articles which use data from a variety trial grown at only one location and in one year. The data are usually analyzed for genetic and phenotypic variation, heritability, genetic advance and correlations between characters. We, the Editors, feel that there is little merit in adding to the literature more articles of this type. To this end we will only consider publishing articles which discuss the results of a variety trial sown in a single environment under exceptional circumstances (i.e. when the number of entries or genetic diversity is particularly high or when an unusual trait is discussed).

Latest Lentil References

احدث المراجع عن العدس

General

Khan, N.A., Khan, M.I. and Azam, Q.T. 1988. Inter-regional analysis of farmers supply response of gram and lentils acreages. Pakistan Journal of Agricultural Research **9**(2): 233-240.

Oppen, M. von, Patancheru, A.P. and Parthasarathy Rao, P. 1988. Trends in supply and demand of pulses with special reference to chickpea. Pages 487-500 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022336).

Scientific-Technical Soviet of Socialist Countries (SEV) on Wild and Domestic Plant Species Collections, V.I. Lenin All-Union Academy of Agricultural Sciences-VASKHNIL, and Scientific Research Institute of Plant Industry (Czechoslovak Socialist Republic). 1984. Uniform broad descriptors for socialist countries and international description. Lentil *genus*. 56 p. Leningrad, USSR.

Breeding and Genetics

Erskine, W., Adham, Y. and Holly, L. 1989. Geographic distribution of variation in quantitative traits in a world lentil collection. Euphytica **43**(1-2): 97-103.

Havey, M.J. and Muehlbauer, F.J. 1989. Linkages between restriction fragment length isozyme and morphological markers in lentil. Theoretical and Applied Genetics **77**(3): 395-401.

Havey, M.J. and Muehlbauer, F.J. 1989. Variability for restriction fragment lengths and phylogenies in lentil. Theoretical and Applied Genetics **77**(6): 839-843.

Jain, A.K. 1988. Cytogenetic effects of BHC II. Effect on the plants of *Lens* and *Pisum*. Biological Memories **14**(2): 165-168.

Jain, A.K. 1988. Cytogenetic effects of aldrin on some species of *Lens* and *Pisum*. Bionature **8**(2): 89-94.

Ladizinsky, G., Pickersgill, B. and Yamamoto, K. 1988. Exploitation of wild relatives of the food legumes. Pages 967-978 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Dordrecht, Netherlands. (AGRIS 89-024384).

Maesen, L.J.G. van der, Kaiser, W.J. Marx, G.A. and Worede, M. 1988. Genetic basis for pulse crop improvement: collection, preservation and genetic variation in relation to needed traits. Pages 55-66 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J. ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Dordrecht, Netherlands. (AGRIS 89-024398).

Rheenen, H.A. van, Bond, D.A., Erskine, W. and Sharma, B. 1988. Future breeding strategies for pea, lentil, faba bean and chickpea. Pages 1013-1029 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Dordrecht, Netherlands. (AGRIS 89-024404).

Sarkar, A. and Sharma, B. 1987. Induction and screening of polygenic variability for multiple characters in lentil *Lens culinaris* Medik. Indian Journal of Genetics and Plant Breeding **47**(2): 179-182.

Sinha, R.P. 1989. Induced shy mutant of lentil *Lens culinaris* Medik. Current Science (Bangalore) **58**(5): 252-253.

Vandenberg, A. and Slinkard, A.E. 1989. New qualitative genes and linkages in lentil. Canadian Journal of Plant Science **69**(2): 546. (Abstract)

Physiology

Angelini, R., Federico, R. and Mancinellia, A. 1988. Phytochrome-mediated control of diamine oxidase level in the epicotyl of etiolated lentil *Lens culinaris* Medicus seedlings. Plant Physiology **88**(4): 1207-1209.

Chanway, C.P., Hynes, R.K. and Nelson, L.M. 1989. Plant growth-promoting rhizobacteria effects on growth and nitrogen fixation of lentil *Lens esculenta* Moench and pea *Pisum sativum* L. Soil Biology and Biochemistry **21**(4): 511-518.

Cogoni, A., Farci, R., Medda, R., Rinaldi, A. and Floris, G. 1989. Amine oxidase from *Lathyrus cicera* and *Phaseolus vulgaris* purification and properties. Prep Biochemistry **19**(2): 95-112.

Dube, S.D. 1987. Regeneration of plantlets from excised shoot tips of some important legumes. Prog Horticulture **19**(1-2): 68-70.

Gregory, P.J. 1988. Root growth of chickpea, faba bean, lentil, and pea and effects of water and salt stresses. Pages 857-867 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Dordrecht, The Netherlands. (AGRIS 89-025168).

Kumar, R., Sharma, M.M., Jain, V.K. and Goyal, A.K. 1988. Growth response of lentil crop to UV-B irradiation under field conditions. Indian Journal of Plant Physiology **31**(3): 297-300.

McKenzie, B.A. and Hill, G.D. 1989. Environmental control of lentil (*Lens culinaris*) crop development. Journal of Agricultural Science, Cambridge **113**: 67-72. Lincoln University, Department of Plant Science, Canterbury, New Zealand.

Moran, M., Corchete, P., Guerra, H., Fernandez-Tarrago, J. and Herrera, M. T. 1989. Growth of lentil radicles under water and temperature stress. Environmental and Experimental Botany **29**(3): 343-350.

Moyer, J.R., Bergen, R. and Kozub, G.C. 1989. Chlorsulfuron persistence and response of legumes in an alkaline soil. Journal of Environmental Science and Health, Part B (Pesticides, Food Contaminants, and Agricultural Wastes) **24**(1): 37-56.

Mueller, R. and Weder, J.K.P. 1989. Isolation and characterization of two trypsin chymotrypsin inhibitors from lentil seeds *Lens culinaris* Medik. Journal of Food and Biochemistry **13**(1): 39-64.

Murray, G.A., Eser, D., Gusta, L.V. and Eteve, G. 1988. Winter hardiness in pea, lentil, faba bean and chickpea. Pages 831-843 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Dordrecht, Netherlands. (AGRIS 89-026640).

Pavelka, M. and Ellinger, A. 1989. Affinity cytochemical differentiation of glycoconjugates of small intestinal absorptive cells using *Pisum sativum* and *Lens culinaris* lectins. Journal of Histochemistry and Cytochemistry **37**(6): 877-884.

Penaloza, H.E. and Mera, K.M. 1988. Effect of artificial lodging on lentil yield and its components, at four plant population levels. Agricultura Tecnica **48**(2): 93-96. (AGRIS 89-026639).

Polanco, M.C., Palaez, M.I., and Ruiz, M.L. 1988. Factors affecting callus and shoot formation from *in vitro* cultures of *Lens culinaris* Medik. Plant Cell, Tissue and Organ Culture **15**(2): 175-182. (AGRIS 89-025237).

Roberts, E.H. and Osei-Bonsu, K. 1988. Seed and seedling vigour. Pages 897-910 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, The Netherlands. (AGRIS 89-023314).

Saxena, M.C., Saxena, N.P. and Mohamed, A.K. 1988. High temperature stress. Pages 845-856 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Dordrecht, Netherlands (AGRIS 89-026637).

Sharma, P.K. and Raina, J.N. 1988. Fabrication and evaluation of a simple root-core soil sampler. Journal of Indian Society of Soil Science **36**(3): 397-401.

Shekib, L.A., el Iraqui, S.M. and Abo Bakr, T.M. 1988. Studies on amylase inhibitors in some Egyptian legume seeds. Plant Foods for Human Nutrition **38**(4): 325-332.

Silim, S.N., Saxena, M.C. and Erskine, W. 1989. Effect of cutting height on the yield and straw quality of lentil and on a succeeding wheat crop. Field Crops Research **21**(1): 49-58.

Summerfield, R.J. and Roberts, E.H. 1988. Photo-thermal regulation of flowering in pea, lentil, faba bean and chickpea. Pages 911-922 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Dordrecht, Netherlands. (AGRIS 89-025170).

Summerfield, R.J., Muehlbauer, F.J., and Short, W. 1989. Controlled environments as an adjunct to field research on lentils (*Lens culinaris*). IV. Cultivar responses to above- and below- average temperatures during vegetative growth. Experimental Agriculture **25**(1): 119-134.

Summerfield, R.J., Muehlbauer, F.J., and Short, R.W. 1989. Controlled environments as an adjunct to field research on lentils (*Lens culinaris*). V. Cultivar responses to above- and below- average temperatures during the reproductive period. Experimental Agriculture **25**(1): 327-341.

Trivedi, B.S. and Gupta, M. 1988. Sem studies on seed coat of some varieties of *Lens culinaris* Medikus lentil. Phytomorphology **38**(2-3): 179-186.

V.I. Lenin All-Union Academy of Agricultural Sciences-VASKHNIL and Plant Industry Research Institute. 1987. List of lentil collections (drought and heat tolerance characteristics). 46 p.

Viktorova, N.V. and Fomicheva, V.M. 1988. Cell and population mechanisms of adaptation of higher plants to changes in the gravitation vector and magnetic field intensity. Fiziologia i Biokhimiya Kul'turnykh Rasteni **20**: 503-507.

Wood, S. 1989. Sodium chloride and the glycemic response to potatoes and lentils. FASEB Journal **3**(3): A757.

Biochemistry

Kolberg, J. and Rouge, P. 1989. Further characterization of monoclonal antibody 6 F-8 reacting with *Lathyrus*, *Lens* and *Pisum* lectins. Febs Letters **247**(1): 77-80.

Wenger, P., Heydt, A., Egen, N.B., Long, T.D. and Bier, M. 1988. Purification of lentil lectins using preparative electrophoresis. Journal of Chromatography **455**: 225-240.

Microbiology

Abdel-Daiem, M.M.F., Hamdi, Y.A. and Abdel-Ghaffar, A.S. 1988. Nitrogen fixation and yield of faba bean, lentil and chickpea in response to selected agricultural practices in Egypt. Pages 189-204 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-031071).

Bhattarai, A.N., Bharati, M.P. and Gyawali, B.K. 1988. Factors which limit the productivity of cool season food legumes in Nepal. Pages 217-228 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publisher, Dordrecht, Netherlands. (AGRIS 89-022900).

Bohlool, B.B., Bezdicek, D.F., Somasegaran, P. and Moawad, H. 1988. Inter-strain competition for rhizosphere colonization and nodule occupancy in the pea, lentil and chickpea *Rhizobium* symbiosis. Pages 675-689 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-031082).

Bremer, E. and van Kessel, C. 1988. Variation in Delta nitrogen-15-labelled of non-nitrogen-fixing reference crops. Page 807 *in* Nitrogen Fixation: Hundred Years After, 7th International Congress, Cologne, West Germany, 13-20 Mar 1988 (Bothe, H., de Bruijn, F.J. and Newton, W.E., eds.). VCH Publishers, Inc., New York, USA.

Cakmakci, M.L., Bezdicek, D.F. and Sakar, D. 1988. Improvement of nitrogen fixation and yield of lentil and chickpea crops in Turkey. Pages 167-174 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-031077).

Clark, K.W., Brockwell, J. and Thompson, J.A. 1988. Role of inoculants in improving nitrogen fixation in legumes. Pages 731-743 *in* World Crops: Cool season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-031078).

Cowell, L.E., Bremer, E. and Van Kessel, C. 1989. Yield and nitrogen fixation of pea and lentil as affected by intercropping and nitrogen application. Canadian Journal of Soil Science **69**(2): 243-252.

Mahler, R.L., Sharma, M.C. and Aeschlimann, J. 1988. Soil fertility requirements of pea, lentil, chickpea and faba bean. Pages 279-289 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-031169).

Moawad, H., El-din, S.M.S.B. and Khalfallah, M.A. 1987. Symbiotic nitrogen fixation by two lentil cultivars in relation to rhizobium strain competition and irrigation rates. Egyptian Journal of Microbiology 22(2): 203-212.

Nunez, C. and Fredy, J. 1987. Effect of six sowing dates on nitrogen fixation of two lentil cultivars (*Lens culinaris* Medik.). Thesis. Concepcion University, Chillan, Chile. (AGRIS 89-031076).

Sprent, J.I., Stephens, J.H. and Rupela, O.P. 1988. Environmental effects on nitrogen fixation. Pages 801-810 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-031083).

Ramirez, S.L.E. 1988. Pea (*Pisum sativum* L.) and lentil (*Lens culinaris* M.) response to inoculation with nine strains of

Rhizobium leguminosarum Baldwin et Fred. M.Sc. thesis. Universidad Austral de Chile. (AGRIS 89-031081).

Telaye, A. 1988. Cool season food legumes in East Africa. Pages 1113-1124 *in* World Crops: Cool Season Food Legumes. Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022903).

Weeden, N.F., Zamir, D. and Tadmor, Y. 1988. Applications of isozyme analysis in pulse crops. Pages 979-987 *in* World Crops: Cool Season Food Legumes. Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-024403).

Agronomy

Arjona-Berral, A., Mesa-Garcia, J. and Garcia-Torres, L. 1988. Herbicide control of broomrape in peas and lentils. FAO Plant Protection Bulletin **36**(4): 175-178.

Ali-Khan, S.T. and Kiehn, F.A. 1989. Effect of date and rate of seeding row spacing and fertilization on lentil. Canadian Journal of Plant Science **69**(2): 377-382.

Balyan, J.S. and Seth, J. 1987. Effect of phosphorus fertilizer on winter crops and after effects on succeeding maize crop. Indian Journal of Agronomy **32**(4): 476-477.

Chaudhary, M. and Singh, T.P. 1987. Studies on weed control in lentil. Indian Journal of Agronomy **32**(3): 295-297.

Cooper, P.J.M., Campbell, G.S., Heath, M.C. and Hebblethwaite, P.D. 1988. Factors which affect water use efficiency in rainfed production of food legumes, and their measurement. Pages 813-829 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-024903).

Coxworth, E. and Wright, A.T. 1988. Energy saving benefits of pulse crops in the cropping systems of Northeastern Saskatchewan Canada. Canadian Journal of Plant Science **69**(2): 552.

Ellis, R.H., Agrawal, P.K. and Roos, E.E. 1988. Harvesting and storage factors that affect seed quality in pea, lentil, faba bean and chickpea. Pages 303-329 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, The Netherlands. (AGRIS 89-023313).

Farah, S.M., Arar, A. and Miller, D.E. 1988. Water requirements and the irrigation management of pea, lentil, faba bean and chickpea crops. Pages 271-278 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-023842).

Hafeez, F.Y. and Malik, K.A. 1988. Production of legume biofertilizer (Rhizobium inoculant). Pages 138-140 *in* NIAB Annual Report. Nuclear Institute for Agriculture and Biology, Faisalabad, Pakistan. (AGRIS 89-031079).

Hawtin, G.C., Vancouver, B.C., Muehlbauer, F.J., Slinkard, A.E. and Singh, K.B. 1988. Current status of cool season food legume crop improvement: an assessment of critical needs. Pages 67-80 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Dordrecht, Netherlands. (AGRIS 89-024385).

Hernandez-Bravo, G. and Ramakrishna, B. 1989. Investigation on the production of broadbean, lentil, peas, and chickpea in the Andina subregion, 3rd short course. 400 p. Programa Cooperativo de Investigacion Agricola para la Subregion Andina, Prociandino, Quito, Ecuador.

Herridge, D.F., Sudin, M.N., Pate, J.S. and Peoples, M.B. 1988. Translocation and utilization of nitrogen by pulses. Pages 793-800 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-031072).

Hugo, F.M. 1987. Field crops production in Chile; cereals, legumes and industrial crops (In Spanish). 332 p. (AGRIS 89-022699).

Jermyn, W.A. 1988. Production practices and economic importance of pea, lentil, faba bean and chickpea in New Zealand and Australia. Pages 1125-1133 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022904).

Jotcham, J.R., Smith, D.W. and Stephenson, G.R. 1989. Comparative persistence and mobility of pyridine and phenoxy herbicides in soil. Weed Technology **3**(1): 155-161.

Khan, F.A., Samiullah, and Ansari, S.A. 1989. Increasing nodulation leaf NRA productivity and grain quality of lentil be seed enrichment with pyridoxine and nitrogen application. Plant Physiology **89**(4 suppl.): 41.

Knott, C.M. and Halila, H.M. 1988. Weeds in food legumes: problems, effects and control. Pages 535-548 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands, (AGRIS 89-026832).

Malik, B.A., Verma, M.M., Rahman, M.M. and Bhattarai, A.N. 1988. Production of chickpea, lentil, pea and faba bean in South-East Asia. Pages 1095-1011 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant and Science Technology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022890).

Matsunaga, R., Hamid, A. and Hashem, A. 1988. Dry matter production and yield performance of summer and winter pulses in Bangladesh. Journal of Faculty of Agriculture of Kyushu University **33**(3-4): 221-228.

Mohebbi, S. and Mahler, R.L. 1989. The effect of soil pH on wheat and lentils grown on an agriculturally acidified Northern Idaho USA soil under greenhouse conditions. Communications in Soil Science and Plant Analysis **20**(3-4): 359-382.

Musselmen, L.J., Aggour, M. and Abu Sbaieh, H. 1989. Survey of parasitic weed problems in the west bank and Gaza Strip. Tropical Pest Management **35**(1): 30-33.

Nassib, A.M., Sakar, S., Solh, M. and Salih, F.A. 1988. Production of cool season food legumes in West Asia and North Africa. Pages 1081-1094 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022892).

Nazir, M.S., Khan, H.U.R., Ali, G. and Ahmad, R. 1988. Inter-relay cropping in wheat planted in multi-row strips at uniform plant population. Pakistan Journal of Agricultural Research **9**(3): 305-309.

Picard, J.J.A., Bond, D.A., Monti, L. and Steuckardt, R. 1988. Production of pea, lentil, faba bean and chickpea in Europe. Pages 1065-1080 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022902).

Prasad, B., Prasad, J. and Prasad, R. 1989. Influence of iron-enriched organic wastes on crop yield and iron nutrition of crops in calcareous soil. Indian Journal of Agricultural Sciences **59**(6): 359-364.

Rahman, A., James, T.K. and Mortimer, J. 1988. Persistence and mobility of the sulfonylurea herbicide DPX-L5300 in a New Zealand volcanic soil. Landbouwwet Rijksuniv Gent 53(3 part B): 1463-1470.

Rahman, M.M. and Mallick, R.N. 1988. Factors which limit cool season food legume productivity in Bangladesh. Pages 229-234 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Technology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022891).

Sakar, D. Durutan, N. and Meyveci, K. 1988. Factors which limit the productivity of cool season food legumes in Turkey. Pages 137-145 *in* World Crops: cool season food legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022888).

Slinkard, A.E. and Blain, H.L. 1988. Production of pea, lentil, faba bean and chickpea in North America. Pages 1059-1063 *in* World Crops: cool season food legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-022901).

Pests

Bushara, A.G. 1988. Insect depredation during storage. 1988. Pages 367-378 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-026966).

Greco, N., di Vito, M., Saxena, M.C. and Reddy, M.V. 1988. Effect of *Heterodera ciceri* on yield of chickpea and lentil and development of this nematode on chickpea in Syria. Nematologica 34(1): 98-114.

Miline, W.M. 1988. Factors affecting the performance of *Aphidius ervi* in the laboratory and its potential for establishment in the field. Pages 237-242 *in* Ecology and effectiveness of *Aphidophaga*, International Symposium, Teresin, Poland, 31 Aug - 5 Sep. 1987. (Niemczyk, E. and Dixon, A.F.G., eds.). Academic Publishing BV: The Hague, Netherlands.

Reed, W., Cardona, C., Lateef, S.S. and Bishara, S.I. 1988. Screening and breeding for insect resistance in pea, lentil, faba bean and chickpea. Pages 1135-1152 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-024400).

Saly, A. and Vespremi, I. 1988. Nematode fauna of lentil cultures and its influencing by seed treatment with furadan. Polnohospodarstvo 3(5): 417-427. (AGRIS 89-025856).

Plant Pathology

Abdel-Hafez, A.I.I. 1988. Mycoflora of broad bean chickpea and lentil seeds in Egypt. Cryptogamie Mycologie 9(4): 335-344.

Bernier, C.C., Bijiga, G., Nene, Y.L. and Cousin, R. 1988. Breeding for disease resistance in pulse crops. Pages 97-106 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5, Dordrecht, Netherlands. (AGRIS 89-024399).

Bos, L., Hampton, R.O. and Makkouk, K.M. 1988. Viruses and virus diseases of pea, lentil, faba bean and chickpea. Pages 591-615 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5, Dordrecht, Netherlands. (AGRIS 89-026449).

Bretag, T.W. 1989. Evaluation of fungicides for the control of Ascochyta blight in lentils. Tests of Agrochemicals and Cultivars no. 10: 44-45.

Endin, H.F. van, Ball, S.L. and Rao, M.R. 1988. Pest, disease and weed problems in pea, lentil, faba bean and chickpea. Pages 519-534 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-025858).

France, I.A, Sepulveda, R.P. and Tay, U.J. 1988. Identification of *Botrytis cinerea* Pers. on lentils (*Lens culinaris* Med.) in Chile. Agricultura Tecnica 48(2): 158-160. (AGRIS 89-026444).

Kaiser, W.J., Stanwood, P.C. and Hannan, R.M. 1989. Survival and pathogenicity of *Ascochyta fabae* f.sp. *lentis* in lentil seeds after storage for four years at 20 to -196 C. Plant Disease 73: 762-764.

Kraft, J.M., Haware, M.P. and Hussein, M.M. 1988. Root rot and wilt diseases of food legumes. Pages 565-575 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Netherlands. (AGRIS 89-026442).

Kumar, K., Kolar, J.S. and Bhandari, S.C. 1987. Effect of terbutryn methabenzthiazuron and pendimethalin on soil microflora in Bengal gram *cicer arietinum* L. and lentil *Lens culinaris* Medic. Indian Journal of Ecology 14(1): 52-58.

Mathur, S.B., Haware, M.P. and Hampton, R.O. 1988. Identification significance and transmission of seed borne pathogens. Pages 351-365 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-026441).

Matthews, S., Powell, A.S. and Spaeth, S.C. 1988. Seedling vigour and susceptibility to diseases and pests. Pages 619-625 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-026450).

Medeiros, A.C.D.S. and Urben, A.F. 1988. Identification and evaluation of the damage caused by fungi associated with basic lentil seeds *Lens culinaris* Medic. as a function of their specific weight. Fitopatologia Brasileira 13(2): 125.

Nene, Y.L., Hanounik, S.B., Qureshi, S.H. and Sem, B. 1988. Fungal and bacterial foliar diseases of pea, lentil, faba bean and chickpea. Pages 577-589 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-026448).

Tay, J. and Slinkard, A.E. 1989. Transgressive segregation for Ascochyta resistance in lentil. Canadian Journal of Plant Science 69(2): 547. (Abstract).

Quality

Achi, T. 1987. Nutritional utilization of faba beans, lentils and chickpeas in growing rats. Effects of intestinal microflora on nitrogen digestion in the large intestine. Ph.D. Thesis, 94 p. Universite de Clermont-Ferrand, France. (AGRIS 89-031712).

Alvarez, J. 1989. Characteristics of two protease activities present in protein bodies of lentil seeds. Plant Physiology and Biochemistry (France) **27**(1): 53-60.

Babar, V.S., Chavan, J.K. and Kadam, S.S. 1988. Effects of heat treatments and germination on trypsin inhibitor activity and polyphenols in jack bean (*Canavalia ensiformis* L. DC). Foods for Human Nutrition. **38**(4) 319-324.

Bhatty, R.S. 1989. Influence of phytate-phosphorus on the cooking quality of lentil. Canadian Journal of Plant Science **69**(2): 547. (Abstract).

Bressani, R. and Elias, L.G. 1988. Seed quality and nutritional goals in pea, lentil, faba bean and chickpea breeding. Pages 381-404 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-024402).

Hallabo, S.A.S., el-Sharkawy, A.A., Ismael, A.I. and Raouf, M.S. 1987. Fatty acids composition and unsaponifiable matter constituents of some legume seed oils. Egyptian Journal of Food Science **15**(2): 203-210.

Hussain, A., Bushuk, W. and Clark, K.W. 1989. Discrimination of cultivars of lentil *Lens culinaris* Medic. by electrophoresis of seed proteins. Canadian Journal of Plant Science **69**(1): 243-246.

Khan, M.A., Rana, I.A., Ullah, I. and Jaffery, S. 1987. Physico-chemical characters and nutrient composition of some improved lines of lentils grown in Pakistan. Journal of Food Composition and Analysis. **1**(1): 65-70.

Leyshon, A.J. 1989. Sulfur nutrition of lentils. Canadian Journal of Plant Science **69**(2): 552. (Abstract).

Lucas, B. Guerrero, A. Sigales, L. and Sotelo, A. 1988. True protein content and non-protein amino acids present in legumes seeds. Nutrition Reports International **37**(3): 545-553. (AGRIS 89-041599).

Marquardt, R.R. and Bell, J.M. 1988. Future potential of pulses for use in animal feeds. Pages 421-444 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology Publishers, Dordrecht, Netherlands.

N.I. Vavilove All-Union Scientific Research Institute of Plant Industry and V.I. Lenin All-Union Academy of Agricultural Sciences-VASKHNIL 1989. Seed quality characteristics and some useful characters of lentils. World Catalog of VIR, Plant Industry Research Institute no. 516: 18 p.

Newman, C.W., Newman, R.K. and Lockerman, R.H. 1988. Utilization of food legumes in human nutrition. Pages 405-411 *in* World Crops: Cool Season Food Legumes (Summerfield, R.J., ed.). Current Plant Science and Biotechnology in Agriculture no. 5. Kluwer Academic Publishers, Dordrecht, Netherlands. (AGRIS 89-031714).

Sosulski, F., Waczkowski, W. and Hoover, R. 1989. Chemical and enzymatic modifications of the pasting properties of legumes starches. Starch staerke **41**(4): 135-140.

Weder, J.K.P. and Mueller, R. 1989. Reaction of lentil proteinase inhibitors with human and bovine trypsin and chymotrypsin. Journal of Food Biochemistry 13: 81-103.

ANNOUNCEMENTS

REPORTING OF MUTANTS IN LENS

Manuscripts that report new mutants in lentil will not be accepted for publication in LENS unless 1) the mode of inheritance has been determined, 2) seed of the homozygous mutant is provided to the Lentil Gene Bank (heterozygous for lethal or semi-lethal mutants), and 3) a gene symbol is proposed (the gene symbol should be patterned after the system used for genes in *Pisum*, as outlined in the *Pisum* Newsletter 9: 67-70, 1977, a copy of which can be obtained from either of the Technical Editors).

FORMATION OF LENTIL GENE BANK

As genetic information on lentil increases, the need for a central gene bank arises. Accordingly, the Crop Development Centre, University of Saskatchewan is initiating a Lentil Gene Bank to serve as a repository for lentil genes. Thus, as soon as a researcher describes a gene in the literature, determines its mode of inheritance and assigns a gene symbol, he is requested to send 20 seeds carrying the gene and 20 seeds carrying its contrasting allele to the Lentil Gene Bank. All genotypes in the bank will be available to interested researchers within the limits of available seed.

As soon as you have described a gene in lentils, determined its mode of inheritance and assigned a gene symbol, please submit seed samples to:

Lentil Gene Bank
c/o Dr. A. E. Slinkard
Crop Development Centre
University of Saskatchewan
Saskatoon
Saskatchewan, S7N OWO
CANADA

Second International Food Legume Research Conference 12 - 16 April 1992, Cairo, Egypt

The First International Food Legume Research Conference (IFLRC-I) on pea (*Pisum sativum*), lentil (*Lens culinaris*), faba bean (*Vicia faba*), and chickpea (*Cicer arietinum*) was held at Spokane, Washington, U.S.A. in 1986. It was a resounding success with over 500 registrants from 50 countries. The program consisted of 91 papers coauthored by 202 contributors from 40 countries. The Conference Proceedings was published as: Summerfield, R.J. (ed.). World Crops: Cool Season Food Legumes. 1988. Kluwer Academic Publishers, Dordecht, The Netherlands.

The success of IFLRC-I has prompted development of the Second International Food Legume Research Conference (IFLRC II) from April 12-16, 1992 in Cairo, Egypt. Recent success in development of low neurotoxin lines of grass pea (*Lathyrus sativus*) has resulted in the addition of this promising cool season food legume to the list of species covered.

The objectives of IFLRC-II are to 1) review and assess recent results from national and international research programs on cool season food legumes and 2) develop strategies for increasing production per unit area and increasing use of these cool season food legumes in various cropping systems. Both basic and applied research will be addressed and multidisiplinary research efforts will be emphasized.

The organizing committee is developing the program and details will be available in the Second Announcement. The primary function of this First Announcement is to alert everyone to the time and date so they can make plans to attend. In addition the organizing committee wishes to develop an updated mailing list of interested food legume researchers and those involved in technology transfer of these research results.

For further information regarding reservation for 1992 IFLRC-II, Cairo, Egypt, please contact:

Dr. A.E. Slinkard
Crop Development Centre
University of Saskatchewan
Saskatoon
Saskatchewan, S7N OWO
Canada

Forthcoming Conferences and Events - 1990

July

Third International Seed Technology Course and Workshop Cambridge, UK, 2-13 July.
Contact: P.T. Nelson, National Institute for Agricultural Botany, Huntingdon Road, Cambridge, UK.
Fax: 44 223 277707; Telex: 817455 NIABG.

This course will be given at the National Institute of Agricultural Botany, Cambridge, UK, 1990. The course is divided into two parts. The first is allocated to seed certification and the second to seed testing. A third optional part that deals with seed pathology or tetrazolium testing procedures is offered after the completion of the first two parts. Proficiency in English is required.

Summer

Legumes in Cropping Systems of the Tropics and Subtropics, Stuttgart, Germany in summer.
Contact: Course Coordinator, Centre for Agriculture in the Tropics and Subtropics, University of Hohenheim, P.O. Box 70 05 62, 7000 Stuttgart, Germany
Fax: 711/45 92 785; Telex: 72 29 50.

The course will be held in summer 1990, Stuttgart, Germany to discuss the principles of legumes and point out the issues, benefits, and possibilities of their integration into tropical or subtropical cropping systems. Requirements for application are: A university degree or equivalent in Agriculture and proficiency in English.

September

International Conference on Genetic Engineering and Biotechnology
Kathmandu, Nepal, 9-13 Sept.
Contact: Secretary General, ICGEB Conference Organizing Committee, NBA, P.O. Box 2128, Kathmandu, Nepal.
Telex: 2492 MURARKA NP

This conference, organized by the Nepal Biotechnology Association (NBA), aims to create awareness about genetic engineering and biotechnology and give the Nepalese scientists an opportunity to interact with scientists working in various areas of biotechnology. There will be invited speakers, contributed papers, as well as poster sessions.

Contributors' Style Guide

Policy
The aim of LENS Newsletter is to publish quickly the results of recent research on lentils. Articles should normally be brief, confined to a single subject, good quality, and of primary interest to research, extension, and production workers, and administrators and policy makers.

Style
Articles should have an abstract (maximum 250 words) and whenever possible the following sections: introduction, materials and methods, and results and discussion. Authors should refer to recent issues of LENS for guidance on format. Articles will be edited to maintain uniform style but substantial editing will be referred to the author for his/her approval; occasionally, papers may be returned for revision.

Disclaimers
The views expressed and the results presented in the newsletter are those of the author(s) and not the responsibility of ICARDA or the University of Saskatchewan. Similarly, the use of trade names does not constitute endorsement of or discrimination against any product by ICARDA.

Language
LENS Newsletter is published in English but ICARDA will publish articles submitted in Arabic and French.

Manuscript
Articles should be typed double-spaced on one side of the page only. The original and two other legible copies should be submitted. The contributor should include his name and initials, title, program or department, institute, postal address, and telex number if available. Figures should be drawn in India ink: send original artwork, not photocopies. Define in footnotes or legends any unusual abbreviations or symbols used in a figure or table. Good quality black and white photographs are acceptable for publication. Photographs and figures should preferably be 8.5 cm or 17.4 cm wide.

Units of measurement are to be in the metric system: e.g. t/ha, kg, g, m, km, ml (= milliliter), m^2.

The numbers one to nine should be written as words except in combination with units of measure; all other numbers should be written as numerals: e.g., nine plants, 10 leaves, 9 g, ninth, 10th, 0700 hr.

Examples of common expressions and abbreviations
3 g; 18 mm; 300 m^2; 4 Mar 1983; 27%; 50 five-day old plants; 1.6 million; 23 ug; 5°C; 1980/81 season; 1980-82 seasons; Fig.; No.; FAO; USA. Fertilizers: 1 kg N or P_2O_5 or K_2O/ha.
Mon, Tues, Wed, Thurs, Fri, Sat, Sun; Jan, Feb, Mar, Apr, May, June, July, Aug, Sept, Oct, Nov, Dec. Versus = vs, least significant difference = LSD, standard error = SE +, coefficient(s) of variation = CV(s). Probability: Use asterisks to denote probability * = P<0.05; ** = P<0.01; *** = P<0.001.

Botanical: Include the authority name at the first mention of scientific names. Cultivar(s) = cv(s), variety = var(s), species = sp./spp., subspecies = subsp., subgenus = subg., forma = f., forma specialis = f. sp.

References
Journal articles: Slinkard, A. E. 1981. Eston lentil. Canadian Journal of Plant Science 61: 733-734.

Books: Webb, C. and Hawtin, G. (eds.). 1981. Lentils. ICARDA/CAB, CAB, Slough, England, 216 pp.

Articles from books: Solh, M. and Erskine, W. 1981. Genetic resources. Pages 53-67 *in* Lentils (Webb, C. and Hawtin, G., eds.). ICARDA/CAB, CAB, Slough, England.

Papers in Proceedings: Hariri, G. 1979. Insect pests of chickpea and lentils in the countries of the Eastern Mediterranean: A review. Pages 120-123 *in* Food Legume Improvement and Development: Proceedings of a Workshop, /University of Aleppo (Hawtin, G. and Chancellor, G.J., eds.), ICARDA/Aleppo University, May 1979, Aleppo, Syria. ICARDA/IDRC, Ottawa, Ontario, Canada.

Submission of articles
Contributions should be sent to LENS, Library, ICARDA, P.O. Box 5466, Aleppo, Syria.

تعليمات النشر باللغة العربية

سياسة النشر :

تهدف هذه النشرة العلمية الى نشر نتائج البحوث الجديدة بالسرعة الممكنة . والغاية من هذه التعليمات مساعدة الباحثين على صياغة بحوثهم بالشكل الذى يسهل تبادل المعلومات فيما بينهم على اختلاف أمصارهم ومشاربهم العلمية . وهذه المطبوعة تعني بنشر الاوراق العلمية والبحوث المختصرة والمقالات المكتوبة بلغة واضحة واسلوب علمي ، والمطبوعة بمسافات مزدوجة بين السطور على ورق أطواله 21 x 28 سم على وجه واحد فقط . ترسل نسخة أصلية عن البحث وتعنون جميع المراسلات الى عنوان النشرة . ويشترط في المادة المرسلة للنشر ألا تقدم الى أى جهة أخرى . ولا تعبر نتائج البحوث المنشورة الا عن وجهة نظر أصحابها . كما أن استعمال الاسماء التجارية لا يعني بالضرورة أن ايكاردا تحبذ استعمال أى من هذه المنتجات مقارنة بمثيلاتها التجارية .

منهج الكتابة :

تكتب وترتب البحوث بالشكل التالي : 1) عنوان مناسب لا يزيد على 70 حرفا ، يليه اسم وعنوان الباحث/ الباحثين . 2) ملخص بالعربية يتألف من فقرة واحدة لا تزيد على 200 كلمة توجز العمل ، والنتائج المتوصل اليها ، بأقصر وأوضح طريقة ممكنة . 3) مقدمة وتبرز أهمية موضوع البحث وتستعرض بشكل نقدى الاعمال والبحوث السابقة المتعلقة بذلك . 4) المواد والطرق وتشمل المعلومات الخاصة بموقع تنفيذ التجربة ، والمواد والطرق المستعملة ، مع تحديد تصميم التجربة المتبع . 5) النتائج والمناقشة وتظهر المعلومات والبيانات التي حصل عليها الباحث ، ومدى أهميتها . 6) التوصيات ان وجدت فتكتب بفقرات محددة ومرقمة . 7) كلمة الشكر عند اللزوم . 8) ملخص بالانكليزية مترجم عن العربية بأسلوب علمي ينسجم مع روح اللغة الانكليزية . 9) المراجع ويتم العزو اليها في النص بكتابة كنية المؤلف وعام النشر بين قوسين ، واذا كان للمرجع أكثر من ثلاثة مؤلفين تكتب كنية الاول وتضاف اليها كلمة "وآخرون " اذا كان المرجع بالعربية أو et al. اذا كان المرجع بالاجنبية . أما عن ترتيب المراجع في نهاية المطبوعة فيتم هجائيا وبصورة مستقلة لكل من المراجع العربية والاجنبية . تستثنى المقالات من الترتيب السابق : مقدمة ومواد وطرق ... انما يكتفى بوضع ملخص لها بالعربية وآخر بالانكليزية ، يضاف الى ذلك ضرورة تقسيمها الى فقرات تحمل كل منها عنوانا مناسبا . وينصح هنا بالرجوع الى آخر أعداد هذه النشرة للتعرف الى طريقة اعداد المخطوطة وترتيب المراجع .

الجداول والاشكال والصور :

تفضل الجداول الصغيرة على الكبيرة ، والبسيطة على المعقدة . ويجب أن يحمل كل جدول رقما معينا حسب وروده في النص ، مع عنوان مناسب . وتستعمل الصور (الابيض والاسود فقط) والاشكال والرسوم الاصلية وليس صورا عنها ، على أن تكون في عمود واحد (8.8 سم) أو عمودين (17.7 سم) ويشار الى مكانها المناسب في النص ، ويراعى فيها أن تكون واضحة المعالم ، وتحمل عنوانا وأرقاما متسلسلة حسب ورودها في البحث .

الارقام ووحدات القياس :

تستعمل في جميع مطبوعات ايكاردا الارقام العربية Arabic figures (1 ، 2 ، 3 ، .... 9) ، ووحدات القياس الدولية SI Units مثل : طن/هـ ، كغ ، غ ، م ، كم ، مم ، $م^2$.

الاختصارات والرموز :

5 ع ، 325 مم ، 300 $م^2$ ، عام 1983 ، موسم 89/1988 ، موسما 1987-1989 ، مواسم 1986 - 1989 ، 20 $م^2$ ، الجدول 1 ، الشكل 5 ، الفاو (منظمة الاغذية والزراعة) ، ف م ع (الفرق المعوّل عليه LSD) .

Need More Information on ICARDA Publications and Services?
للمزيد من المعلومات عن مطبوعات ايكاردا

ICARDA Investing in the Future
ICARDA's historical background and research objectives are outlined in English and Arabic. For your copy, contact CODI.

FABIS (Faba Bean Information Service)
This service was established in June 1979 when FABIS Newsletter No. 1 appeared. Now produced triannually, it publishes up-to-the-minute short scientific papers in English and Arabic languages on the latest research results and news items. FABIS has also produced other publications, including *Genetic Variations within Vicia faba.* For further information, write: FABIS.

RACHIS (Barley, Wheat and Triticale Newsletter)
This ICARDA service is aimed at cereals researchers in the Near East and North Africa region and Mediterranean-type environments. It publishes up-to-the-minute short scientific papers on the latest research results and news items. RACHIS seeks to contribute to improved barley, durum wheat, and triticale production in the region; to report results, achievements, and new ideas; and to discuss research problems. For further information, write: RACHIS.

Opportunities for Training and Post-Graduate Research at ICARDA
ICARDA has active training courses on the development and improvement of food legumes, cereals, and forages with ICARDA's research scientists, trained instructors, and proven programs. For a complete brochure of the training opportunities at ICARDA, write: Training Coordination Unit.

Free Catalog of ICARDA Publications
Request your list of all currently available publications from the Communication, Documentation and Information Department (CODI).

ICARDA Information Brochure
ICARDA's historical background and research objectives are outlined in English and Arabic. For your copy, write: CODI.

Checklist of Books, Reports and Journals published outside ICARDA 1973-1988
This checklist, compiled to bring information to the attention of the scientific community and especially to those collaborating with ICARDA, consists of references of books, reports and journals prepared and/or edited by ICARDA scientists and published outside ICARDA as of 1973. Each reference includes within year of publication: author, primary title, pagination, place of publication and publisher, ISBN, AGRIS reference number and price. For your copy write: CODI.

Introduction to Food Legume Physiology
This comprehensive 105-page technical manual is designed for food legume scientists and their support staff. It covers several areas of food legume physiology in a practical way, with examples whenever possible. The book contains four chapters covering the following: plant structure and physiological functions; mineral nutrition; photoperiodism, vernalization, crop canopy and radiation, and growth analysis; and physiology and crop improvement. For your copy, write: Training Coordination Unit.

Screening Chickpeas for Resistance to Ascochyta Blight A Slide-tape Audio-tutorial Module
This slide-tape audio-tutorial module is the first in the food legume training series. It is designed for the use of legume trainees during the training courses at ICARDA as well as for scientists and their support staff in the various national programs. This module is also useful educational material for universities and training departments in national research systems. For your copy of this publication or package, write: Training Coordination Unit.

Checklist of Graduate Theses Prepared with Support from ICARDA 1980-1988
This checklist, compiled to bring information to the attention of the scientific community, consists of references of theses by graduate students supported by ICARDA during the period 1980-1988. Each reference is listed in a sequence determined by the calendar year in

which the thesis was accepted; by the country code and name of the University; by the level D (Doctorate) or M (Master); and by the graduate student's name (nationality given in parentheses after the name). For your copy, write: CODI.

Opportunities for Field Research at ICARDA

This brochure is intended primarily to assist Master of Science candidates, who are enrolled at national universities within ICARDA region and selected for the Graduate Research Training Program. It explains to them the opportunity they have to conduct their thesis research work at ICARDA research sites under the supervision of international scientists. For your copy, write: Training Coordination Unit.

Checklist of Journal Articles from ICARDA 1978 - 1988

This checklist, compiled to bring information to the attention of the scientific community, consists of references of articles by ICARDA research scientists submitted to refereed scientific journals as of 1978. Each reference includes within year of publication: author, primary title, volume number, issue number, pagination, language of the article and/or summary when necessary, and AGRIS reference number. For your copy write: CODI.

ICARDA Library Catalogue of Serials Holding 1989

This catalogue contains serial titles held in ICARDA Library. It includes holdings data of 574 serials covering monographic serials published in the countries of ICARDA region, annual reports, newsletters, abstract journals, and journals. For your copy write: Library.

TO OBTAIN PUBLICATIONS:

Address requests for publications to the specific department or service cited above, at: ICARDA, P.O. Box 5466, Aleppo, Syria.

When you contact any of the programs, departments or services cited in LENS Newsletter for your copy and/or further information, please indicate that you saw the announcement in the LENS Newsletter.

ICARDA publications deposited at AGRICULTURAL libraries

ICARDA publications are now deposited in the following AGRICULTURAL libraries to make them available to other users under normal inter-library loan and photocopy procedures.

Libraries Division
Agriculture Canada
Ottawa K1A 0C5
CANADA

Telex 533283 canagric ott

Library
Agricultural University
Postbus 9100
6700 HA Wageningen
NETHERLANDS

Telex 45015 blhwg nl

Helsinki University
Library of Agriculture
Viikki
SF-00710 Helsinki
FINLAND

Telex 122 352 hymk sf
Telefax (90)708 5011

John Hjeltnes
Head Librarian
The Library of the Agricultural University of Norway
P.O. Box 12
N-1432 Aas-NLH
NORWAY

Telex (56) 77125 nlhbi n

J-F. Giovannetti
Chef du Service Central IST
Avenue du Val de Montferrand
BP 5035
34032 Montpellier Cedex
FRANCE

Telex 480 762f

ARE YOU MOVING ?

If you are moving, please let us know your new address as soon as possible, send it to:

LENS
Documentation Unit
ICARDA
Box 5466, Aleppo, Syria

الفيزيولوجيا والأحياء الدقيقة

المعاملات الزراعية والمكننة

التربية والمورثات

لنس

نشرة علمية متخصصة بالعدس

مجلد 16، عدد 2، 1989

المركز الدولي للبحوث الزراعية في المناطق الجافة
(ايكاردا) ، حلب ، سورية

جامعة ساسكاتشيوان
كندا