RACHIS

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The Center and its Mission

The International Center for Agricultural Research in the Dry Areas (ICARDA) was established in 1977 to undertake research relevant to the needs of developing countries and specifically for the agricultural systems in West Asia and North Africa. The overall objective of the Center is to contribute towards increased agricultural productivity, thereby increasing the availability of food in both rural and urban areas, and thus improving the economic and social well-being of people.

The Center focuses mainly on winter-rainfall areas with 200 to 600 mm annual rainfall. Where 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 the improvement of wheat, chickpea, farming systems, pasture and forage crops, and livestock. Training agricultural researchers from developing countries is an important component of ICARDA's activities.

ICARDA is one of 13 international research centers receiving support from donors through the Consultative Group on International Agricultural Research (CGIAR). CGIAR, an association of governments, organizations, and private foundations, supports agricultural research worldwide to improve food production in developing countries.

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COVER

Various insect pests attack cereal crops in West Asia and North Africa. Shown are examples of (clockwise from top left): Hessian fly, sunn pest, aphids, and sawfly.

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Editorial

A conservative estimate places the number of insect species at slightly over 1,000,000. Of these about 360,000 feed on living plants while the remainder are predators, parasites, and scavengers. Those insects competing with man for the same resource, frequently food, have earned the title "pest" and somewhat surprisingly comprise only about 1% of the total number of insect species. Of the 10000 pest species, about 59 species distributed in 8 orders are pests of cereals in West Asia and North Africa. ICARDA's Cereal Improvement Program has chosen to concentrate its efforts on 4 of these, namely the Hessian fly, sunn pest, wheat stem sawfly, and aphids (see cover). The reason for this concentration of effort is twofold. First, each of these insects occurs across a wide range of countries in West Asia and North Africa, and second, each insect causes significant economic damage warranting the expenditure of limited research and management funds to control it.

Consider, for example, the case of the Hessian fly, *Mayetiola* destructor Say. The Hessian fly is small cecidomyid midge which as an adult is smaller than a mosquito. Originating most probably in West Asia, the Hessian fly now infests wheat crops in Europe, North Africa, Asia, and North America. In the ICARDA region it is most serious in Morocco, where it has been recognized as a pest since 1930, but also causes crop damage in Algeria and Tunisia. Morocco experienced yield losses of up to 50% due to the fly in 1984, and in 1986 USAID/INRA estimated fly induced losses in wheat and barley at US$ 30,000,000 and US$13,000,000, respectively, in the 6 Moroccan provinces that account for 30% of Morocco's total wheat area and 44% of its total barley area. All the commercial cereal varieties now grown in the ICARDA region are susceptible to Hessian fly, although 13 genes for resistance have been identified. Other control methods such as late seeding, plowing stubble, or chemical control either do not work or are incompatible with farming practices and available resources in the region. In short, the Hessian fly problem is an economically devastating and biologically complex pest problem that falls well within ICARDA's operational mandate of enhancing cereal production and stability in the region.

The sunn pest, *Eurygaster integriceps* Put. and the wheat stem sawfly, *Cephus* spp. are serious pests of wheat, and to a lesser extent barley in West Asia and North Africa. *E. integriceps* has two adverse effects on the plant. Piercing of the stem by the adult bug's proboscis and an injection of saliva containing proteolytic enzymes can kill the plant outright. Dough made from flour with over 20% "stung" kernels cannot be made into traditional Arabic flatbreads due to low gluten strength. Current control techniques are limited to aerial spraying of infested fields when an economic threshold of 2 bugs/m^2 is attained.

Damage caused by wheat stem sawflies is most evident after a windy day following heading. The sawfly larvae burrow inside the stem down to the ground level where they pupate. As they do so they weaken the base of the stem so it easily breaks. The result is a 5 to 15% lodging rate in otherwise healthy crop.

A number of aphid species infest wheat and barley in the ICARDA region, although the most serious losses occur in the irrigated areas of the Nile Valley. Researchers in Egypt and Sudan have placed yield losses due to aphids as high as 30% under particularly severe infestations. While current chemical control practices are effective, concerns about environmental contamination, expense, and the development of insecticide resistance in key species have stimulated interest in developing aphid-resistant varieties, and biological control methods that can be integrated with chemical applications.

There remain major gaps in our understanding of these and other insect pests, and the true extent of their impact on yield. Adequate data are lacking in many countries and in some cases insect damage has been attributed to frost or drought by mistake. In other countries no unified pest management programs have been devised although substantial biological information may be available. It is time now for national programs and international research centers to jointly develop ecologically sound and economically sensible management strategies to combat these efficient and prolific insect competitors.

Review Article

Screening for Resistance to Cereal Insect Pests of West Asia and North Africa

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Small grain cereal production in the rainfed areas of West Asia and North Africa is beset by a number of insect pest problems that annually inflict yield losses of approximately 14% (Srivastava 1987). For example the Hessian fly is a small cecidomyid gnat that causes annual crop losses of up to 50% in the Maghreb region of North Africa. Similarly, the European wheat stem sawfly, a small phytophagous wasp, is responsible for yield losses of up to 80% in localized areas of Syria, Turkey, and Jordan. Although greatly overshadowed by the Hessian fly in North Africa, the European wheat stem sawfly is also a serious problem in that region. The sunn pest, a large, seed-sucking brownish bug that overwinters in hilly terrain is currently only partially controlled by aerial applications of expensive chemical pesticides in northern Syria and southeastern Turkey. The insect continues to be a serious pest throughout the region with populations erupting in large scale outbreaks every few years. The aphids *Rhopalosiphum padi* and *Schizaphis graminum* have become serious pests of wheat and barley in the Nile Valley as cereal-growing areas have been expanded and traditional irrigation techniques are replaced. National program entomologists in these countries estimate yield losses due to aphids to range up to 30% during heavy infestations. The major economically important insect pests of North Africa and West Asia are shown in Table 1. Many of the pests mentioned are serious pests in localized regions of individual countries.

Due to these and other reasons, demand for wheat and barley is far exceeding current production capabilities, and cereal imports in the region are increasing at an alarming rate. Developing effective and ecologically sound management strategies for these and other insect pests will almost certainly result in huge monetary rewards as small grain cereal productivity is increased and sustained.

Inherent in the mandate given to ICARDA is the development of cost effective, practical methods of controlling noxious insect pests, conducting and coordinating basic research into insect pest systems, and training entomologists in national programs to identify serious insect pest problems, effect their remedy, and anticipate and prepare for future insect pest depredations.

As insecticide use is limited by high cost and low effectiveness in cold, windy weather, and since cultural and biological controls have not been suitably developed to reduce crop damage by insects, the identification and development of insect-resistant varieties is a most promising approach to resolving several of the region's chronic pest problems. In addition, the development of plant resistance to insects lends itself well to the development of integrated pest management programs (IPM), which can be defined as the application of multiple forms of pest control in an ecologically sound and economically relevant manner.

Theoretical Considerations

There is sound theoretical and experimental basis for identifying and developing resistant varieties as part of an integrated pest management program. The host plant may possess two distinct mechanisms of defense against pests (Berryman 1977). The first of these consists of morphological or chemical adaptations that repel or intoxify the attacking insect. These "primary defenses" are in place on the plant in advance of insect attack. They exert a negative effect, also called negative feedback, on the pest. Performed defensive responses such as pubescence, epidermal texture and composition, and tannin concentration have been correlated to insect resistance observed among grasses (Bernays *et al.* 1980; Joern 1979).

The second line of defense, or "secondary defense," consists of physiological responses in the plant which are initiated in response to stimuli, called elicitors, from the attacking insect. The elicitors may generate a

Table 1. Important cereal insect pests of North Africa and West Asia.

Order	Family	Scientific name	Common name
Qrthoptera	Acrididae (Grasshoppers)	*Calliptamus italicus* L.	Italian locust
	Do	*Diciostaurus maroccanus* Thrb.	Moroccan locust
	Do	*Schistocerca gregaria* Forsk	Desert locust
	Gryllotalpidae (mole crickets)	*gryllotapla gryllotalpa* L.	Common mole cricket
Thysanoptera	Phlaeothripidae (Thrips)	*Haplothrips tritici* Kurd.	Ear thrips
	Thripidae	*Limothrips cerealium* Halid.	Grain thrips
Hemiptera	Pentatomidae (Stink bugs)	*Aelia accuminata* L.	Pointed wheat Shield bug
	Do	*Aelia rostrata* Boh.	
	Scutelleridae	*Eurygaster integriceps* Put.	Suni bug, Sunn pest
	Do	*Eurygaster maurus* L.	
Homoptera	Aphidae	*Rhopalosiphum maidis* Fitch.	Corn leaf aphid
	Do	*Rhopalosiphum padi* L.	Oat bird cherry aphid
	Margarodidae (Margarodid scales)	*Porphyrophora polonica* L.	
	Do	*Porphyrophora* (= *Margarodes*) *tritici* Bod.	
Lepidoptera	Noctuidae (Owlet cutworms)	*Agrotis flammatra* Danis & Schiff	
	Noctuidae	*Euxoa* (= *Agrotis*) *segetum* Danis & Schiff.	Turnip moth, Winter cutworm
		Agrotis (*Noctua*) *Pronuba* L.	Large yellow
	Scythrididae	*Syringopais* (= *Scythris*) *temperatella* Led.	Cereal leaf miner
Coleoptera	Carabidae	*Zabrus tenebriodes* Geoz	Wheat ground beetle
	Chrysomelidae (Leaf beetle)	*Marsenlia dilativentris* Reiche	Cereal leaf beetle
	Do	*Oulema* (= *Lema*) *melanopous* L.	Cereal leaf beetle Wheat leaf beetle
	Elateridae (Wireworms)	*Agriotes lineatus* L.	Striped elaterid beetle
	Scarabaeidae	*Anisoplia austeriaca* Hbst.	Wheat scarab
	Do	*Anisoplia leucaspis* Lab.	
	Do	*Phyllopertha nazarina* Mars.	Winter wheat scarab
	Do	*Rhizotrogus causcasicus* Gyll.	
Hymenoptera	Cephidae (Stem sawflies)	*Cephus libanensis* Andra	Lebanese wheat stem sawfly
	Do	*Cephus pygamaeus* L.	European wheat stem sawfly
	Do	*Cephus tabidus* F.	Black grain stem sawfly
Diptera	Cecidomyiidae	*Phytophaga* (= *Mayetiola*) *destructor* Say.	Hessian fly
	Chloropidae (Chloropid flies)	*Oscinella frit.* L.	Frit fly, Swedish fly
	Ephydridae	*Hydrella griseolla* Fall.	Rice leaf miner

variety of plant responses including thickened leaf epidermis in response to prolonged feeding, or elevated levels of toxic or inhibitory compounds. Elicitors are generally small molecules present in the wound region of the plant during insect feeding or fungus growth. Some feel that elicitors may be small carbohydrates or pectins released from plant cell walls when they are damaged by the insect (Walker-Simmons 1983).

The effects of insect attack and breeding for host plant resistance can be visualized in a conceptual model (Fig. 1) that depicts the interrelated physiological processes of a single host plant. The model is similar to those proposed to describe plant insect interactions in cotton (Gilbert *et al.* 1976; Gutierre *et al.* 1977; Wang *et al.* 1977) and conifer energetics and bark beetle attack (Miller 1984).

The plant is represented as a reservoir of photosynthetically derived energy that is available for use (E), the level of which represents the overall vigor of the plant. The reservoir level may increase as additional energy is added through photosynthesis. Energy expenditure, in turn, lowers the reservoir level and results from basic cell metabolic processes (BMP), creating and maintaining preformed or induced defensive responses (DM), and growth and reproduction (GR).

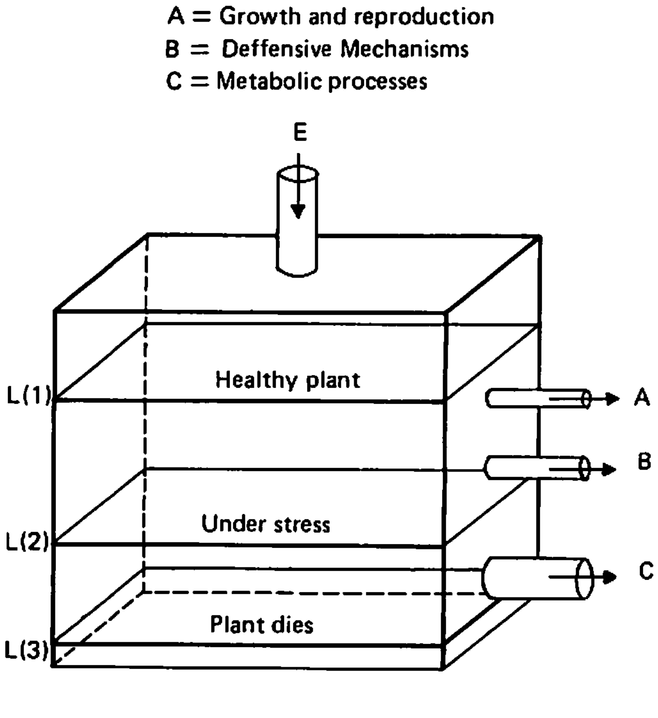

Fig. 1 Conceptual model of photosynthate partitioning in a plant (Miller 1984)

When the environment is favorable, the rate of photosynthesis is such that the energy added to the reservoir equals or exceeds that expended (L_1). Under stress, the energy level decreases as BMP increases and E decreases. If the stress is sufficient the rate of energy outflow exceeds that of input, and the reservoir level drops below the amount required to sustain growth and reproduction. This may result in stunted plants with poor, or delayed, or no reproduction. If the stress is sufficiently severe the energy level may drop below that required to produce and maintain effective defensive responses (L_2). Under extreme stress the energy level may drop below the level necessary to sustain basic cell processes (L_3) and the plant dies.

Insect attack affects the level of energy available to the plant and may therefore result in suppression of growth, reproduction, defense, photosynthesis and metabolism in proportion to its severity. Insects that feed on plant juices, such as many Hemiptera and Homoptera, reduce the overall vigor of the plant and may predispose it to diseases and other insect pests. Severe infestations may kill the plant outright. Insects that depend on the plant to provide food during development may rapidly kill the plant by disrupting energy transport processes, insuring that adequate energy levels remain in the dead host for developing larvae.

Breeding for insect resistance may take several directions. Generally vigorous plants are more resistant to insects or may better tolerate insect damage. Increasing or stabilizing the amount of energy (E) available to the plant will therefore reduce the ability of the insects to alter the level of the plant's energy reservoir. Breeding programs may also alter the relationship between energy outputs between growth and reproduction, defensive mechanisms, and metabolic processes as well as changing the amount of energy that is expended in each case. In terms of Fig. 1 the position of the outputs A and B may be lowered so as to function at lower overall energy levels. Similarly as plant efficiency is increased the diameters of outputs A, B, and C may be decreased without affecting yield. The result is a plant with consistently higher yields under stressful conditions.

As suggested by Fig. 1, certain physiological events in a plant's development occur, or cease, only when a certain energy level, or energy threshold, is attained. The concept of thresholds also pertains to insect population behaviour (Berryman 1986). Fig. 2 shows a hypothetical numerical response of an insect population characteristic of pests that undergo periodic catastrophic outbreaks. Lines A and C represent stable equilibrium population densities around which the population normally cycles. Lines B and D represent unstable

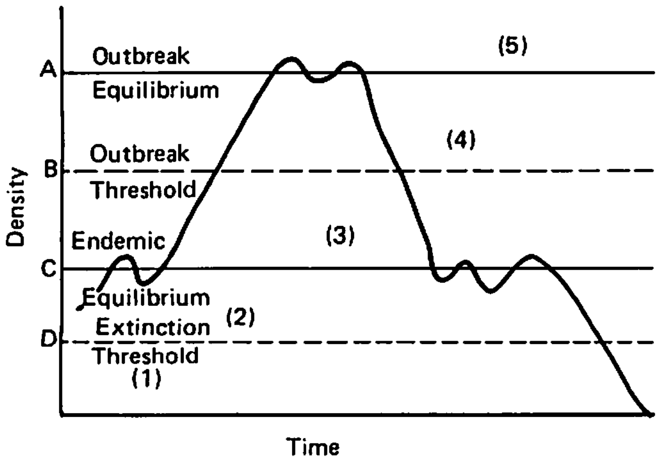

Fig. 2. Numerical response of an insect pest exhibiting eruptive behavior. Shown are stable population equilibria (A,C) and unstable equilibria (B,D).

equilibrium points, called action thresholds, where the population will either rise or decrease to the closest stable equilibrium position. If a population is at point (1) then there is an insufficient population density to sustain reproduction and the population will eventually become extinct. Therefore, the population density represented by line D may be called the threshold of extinction. If a population is at point (2) or (3) it will eventually oscillate around a density corresponding to line C. The density represented by line C may be called the endemic population equilibrium. If a population is at point (4) its density will rise until it attains the outbreak population equilibrium density represented by line A. The population density that must be exceeded to the outbreak may be called the outbreak threshold. A population at point (5) will decrease until the outbreak equilibrium density is attained.

The effects of breeding insect resistant varieties can be visualized using the model in Fig. 2. For example, a breeder may increase the distance between the outbreak threshold and the endemic population equilibrium by incorporating plant characters that lower insect reproduction.

Other control tactics may alter population density of the pest relative to the outbreak threshold and endemic population equilibrium. Pesticide application may be necessary during stressful periods when even vigorous, and relatively resistant plants are unable to defend themselves, or when migration of pests from outside the immediate area bolsters the population so that the outbreak threshold is exceeded. At such times, pesticides can be used to lower pest populations below the critical outbreak threshold until economical non-chemical tactics can again be employed. Similarly biological control will not alter the position of the equilibria, but will aid in keeping pest populations below the outbreak threshold.

Screening for Insect Resistance - Procedures

Resistance screening programs should comprise an integral component of integrated pest management programs since their use is based on theoretical concepts of population biology and plant physiology as discussed previously.

Basic screening techniques for insect resistance have many similarities in different insect-crop systems. New germplasm developed from crosses or untested landraces are exposed to high densities of the insect pest in question. After an appropriate period, the degree of damage to the plant and/or the performance of the pest population is evaluated for each line.

Heavily infested lines and/or those with no tolerance are discarded. Lines showing moderate to high potential are retested, and again selections are made. Promising lines are tested a third time and if they perform well are selected as parent material for crosses designed to combine insect resistance with other favorable characteristics, such as high yield. They will also be tested in the field under naturally occurring pest infestations and under varying environmental stresses. Varieties performing well in advanced trials will then be recommended for release, a process that often takes many years and involves the combined efforts of breeders, physiologists, agronomists, entomologists, pathologists, and others. Following the release of a variety, research continues in developing other resistant lines to replace introduced lines as conditions change and inherited characters dissipate.

Sawflies

Personnel at ICARDA's headquarters at Tel Hadya, Syria have developed effective screening procedures for wheat stem sawfly involving collecting of larvae from infested fields, storing them in refrigerators during the winter, and rearing the adults to coincide with plant development in the field.

Infested fields are located in the summer by sampling for larvae and cocoons in stubble. When an infested field is located, a portion of it is cultivated with a "duck-foot" cultivator so that stubble and roots can be easily collected, examined, and sorted in the field. Infested stubble is trimmed of excess plant material, washed and placed in perforated plastic bags. These are then stacked in a refrigerator and maintained at

7-13°C until about a month before the adults are needed. At this time the infested stubble is placed on shelves illuminated with fluorescent tubes and maintained near 25°C. Pupation takes about 20-25 days. When adults emerge they are captured by aspirator and introduced at known densities (usually 10 females/m^2 to produce 1 egg/stem under large cages covering susceptible test lines in the field). The square cages measure 9 m on a side and are about 1.7 m high. Each cage can contain up to 180 lines planted in rows 1 m long and spaced about 20 cm apart. A randomized complete block design with 2 replications is used, with each cage constituting a block. The percentage of infestation is determined for each line after harvest, usually 3 to 4 weeks after introduction of the adult sawflies. At harvest, 60 stems per replicate are collected at random and examined in the laboratory to determine the percentage of infestation. All lines are also screened under high natural infestations on farmers' fields surrounding the caged trials at Tel Hadya. The same experimental design is employed at both locations.

Constructing cages over growing cereals causes temperature and relative humidity to rise inside the cages, even though the cages are erected only a few days before sawflies are introduced. As a result, by the time the sawfly screenings are completed, aphid populations have usually become established and increase rapidly if the cages are left in place. This allows screening for aphid resistance on the same lines tested for sawfly resistance using the same techniques described in the previous section. One must remember, however, that sawfly infestation may predispose plants to aphid infestation, and ratings for aphids must not be considered absolute. Such secondary screenings may suggest lines of special interest for further evaluation. Yields estimated for plants infested by sawflies and aphids must also take the confounding effects into consideration.

There are not many problems associated with the caged sawfly technique. Once the basic plot design is established and the cages constructed, they may both be reused indefinitely. Collecting infested stubble requires much time and manual labor. Development of specialized equipment to collect and clean stubble would greatly speed up the procedure. Storage facilities for the collected stubble need not be elaborate. Normal kitchen refrigerators are adequate, and fluorescent tubes are easily installed on common wall shelves. Gauze cages are also easily constructed, as are mouth operated aspirators, from materials locally available in most countries.

As with aphid screenings, care must be taken that sawflies are not inadvertently exposed to insecticides during their development or during the actual field test. Any pesticides used on the test lines during early development must have no residual action that could affect sawflies.

Aphids

ICARDA, in collaboration with the national program in Egypt screens about 5000 lines per year of barley, durum wheat, and bread wheat at facilities in Giza, Egypt. The following techniques have been adapted from practical experience at the Giza facility.

There are a number of methods for screening cereals for aphid resistance. Central to all of them is to have healthy, adequate aphid populations for infesting test lines. Aphids do best on young wheat plants when kept at about 16.7°C under a 16:8 hour light-dark regime. To establish the culture aphids are introduced onto tray grown plants when the plants are about 3 cm tall. Three banks of 3 fluorescent tubes provide light for seedling growth. It is important to also provide light near the red end of the visible spectrum, so normal fluorescent tubes be supplemented with special tubes with an emittance adjusted for optimum plant growth. Incandescent light may also be employed, although they radiate more heat than fluorescent tubes and may cause overheating of the rearing room if precautions are not taken. Temperature controls may be very elaborate and expensive, with automatic timers and thermostats, or they may be very simple and consist simply of window-installed air conditioners and space heaters. The size of the research budget, and the climatic extremes encountered decide the degree of sophistication necessary. Photoperiod control and temperature control within 5°C are very desirable as migratory alate morphotypes develop in response to changes in these variables. An apterous, parthenogenetically reproducing aphid population gives the best results.

Contamination of aphid populations by unwanted species and decimation of cultures by parasitoids and predators are major obstacles to culturing aphids. Usually these pests are introduced when doors and windows are opened or they may be carried in with soil or plants. It is usually necessary to seal off the culture area and fumigate to get rid of these unwanted insects. Measures to prevent parasitoid contamination are well justified, as it may take 2 to 3 weeks to reestablish an aphid colony following fumigation. Some workers fumigate their facilities every 6 months as a prophylactic measure designed to minimize interruptions to the screening schedule. Cages of gauze or plastic may also be placed over plants and aphids to reduce the chance of external contamination.

Plants to be screened are grown in shallow metal trays about 5 cm deep. Twenty seeds of each line are planted in a row and later thinned to 10 seedlings per row. Trays are kept in a separate screening room under adequate light and temperature regimes. Aphids are introduced onto seedlings immediately upon germination. Clippings containing aphids are placed along each row, so that the resulting aphid density on test plants is at least 2 insects per plant. Care must be taken to insure that distribution is uniform and that final densities are not so high as to conceal resistance differences among plants. Plants are observed every 24 hours and rated after 14 days. Numerical ratings based on aphid density estimates, actual density counters, or diagnostic plant variables may be used to rank resistant plants. Plants with moderate or high rankings are observed after an additional 24 hours has passed, after which the trial is terminated, plants are destroyed, and the soil and trays prepared for subsequent tests. Soil preparation may include autoclaving, fertilization, and altering sand-clay ratios. After data has been analyzed, potentially resistant plants are rescreened two times and then field tested as previously mentioned.

Field tests should be made where aphid populations are consistently high. A number of trials in different locales may be necessary to insure that at least one trial is adequately infected. Care must be taken that pesticide use in other fields does not contaminate the trial, or eliminate aphids from the area. A number of experimental designs can be employed. Among the easiest to use and analyze is the randomized block design with 3 or more replications. In this design all test lines, including checks, are randomized in each block. Lattice designs are also easily employed and may be more efficient than randomized block designs. Field layout restrictions may prevent their use however.

If glass greenhouses are not available, then any room or plastic house may be converted for screening purposes. Plastic houses are notoriously open to outside insect pests, and problems with contamination by parasitoids and predators are inevitable unless preventive measures are taken. Photoperiod and temperature control are also less reliable in plastic houses. Screenings may have to be suspended during months of temperature extremes. Photoperiod can be extended during fall, winter and spring with supplemental lighting.

Hessian Fly

Screening procedures for resistance to Hessian fly can be conducted in the field and greenhouse. Field screenings, such as those conducted by national program scientists in Morocco and by ICARDA staff in western Syria, involve planting numerous test varieties in areas known to be infested. In North Africa, cereals are planted in late November or early December. Plants are evaluated at the 3 to 5 tiller stage, sometime between mid-January and March. Susceptibility is determined by counting the number of stunted seedlings with abnormally dark blue green leaves out of a sample of 50 plants of each line. Larval density is also determined by counting the larvae on 5 to 10 plants.

Greenhouse screenings follow the same general protocol as described for laboratory testing of aphids. Twenty seeds of each test line are planted in trays containing soil. Adult flies are confined over the seedlings for about one week using cloth cages. Infestation percentages are calculated 20 days after the adult flies are removed. Dead larvae are counted on resistant plants, which is a sure sign of resistance. Flies used in the screenings are field collected and then reared for 1 generation in the greenhouse on susceptible varieties.

Optimum fly development, growth, and reproduction occur at 21°C. At this temperature, development to the flaxseed stage is about 12 days and female flies will produce an average of 71 offspring. Overcrowding of larvae on single plants reduces the development and survival of flies, probably through larvae competition. The density of adult flies on plants used for rearing larvae must therefore be monitored and adjusted accordingly.

Summary

The environment, in part, determines the general level of vigor of a plant which in turn affects the critical action thresholds for insect pests. An understanding of the thresholds of population behavior for a particular pest, and of their relationship to chemical, biological, and cultural control measures allows the implementation of sound, integrated pest management strategies. Among the most important of cultural control measures in an integrated pest management strategy is the development of host resistance. Resistance in wheat and barley can be developed through controlled screenings in the laboratory and field.

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Research and Production

Collection and Evaluation of Cereal Genetic Resources of Turkey and Jordan

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Major Objectives

Collection of wild relatives of barley and durum wheat was the central theme of our expeditions. These were designed to alleviate one of the major deficiencies of existing collections in many national and international gene banks, which lack adequate samples of wild and weedy relatives of cultivated species (see Walsh 1981 and Hawkes 1983 for review).

Environmental characteristics of species distribution were emphasized. Collections were made from a wide range of habitats in the target region to sample maximum amount of genetic diversity. Emphasis was placed on collecting germplasm materials for possible use in breeding for environmental stress tolerance.

Method of Sampling

Contrary to the usual practice, individual plant samples were collected. These materials were appropriate for both within and among sites estimates of diversity. A special attempt was made to collect landrace populations of cultivated barley and its progenitor species (*Hordeum spontaneum* Koch.) from 68 sites where both species appeared sympatrically. These "paired-samples" were suitable materials for a statistically efficient, comparative evaluation of diversity in the wild and primitive forms of diploid barley (see Evaluation).

Some areas in the target region, particularly in Turkey, were believed to have been well sampled during several earlier expeditions. Available information on collection sites was used to avoid additional collections from the areas previously explored. High priority areas were identified and special efforts were made to collect as many diverse materials as possible from these areas during our explorations. The proposed site of the Ataturk Dam on the river Euphrates in southwestern Turkey received special attention. As the construction of the huge dams progresses rapidly, the water reservoir and irrigated agriculture in the area not only threaten the natural populations of many valuable wild species with extinction, but also threaten to permanently alter the nature and level of genetic diversity in many cultivated species, including barley and durum wheat. High priority was also assigned to the everincreasing settlement areas in northern Jordan where massive grazing and land development also threaten many wild species and primitive forms of cultivated species with extinction.

Evaluation

The diploid barley and tetraploid wheat germplasm lines, collected during our expeditions in 1984 and 1985, are being evaluated for 45 characters including environmental and biotic stress tolerance (Table 1). Preliminary results are now available from our evaluation and characterization of the 1984 collections of barley and durum wheat and their two progenitor species. These results indicate that durum wheat landraces are more salt tolerant than wild emmer wheats of the target region. Similarly, cultivated landrace populations of barley are more salt tolerant than wild barleys of the region. The wild-cultivated "paired-samples" of *Hordeum* (see Methods of Sampling) provided an excellent opportunity of comparing diversity in the two species. Twenty-two of the 68 "paired samples" were used in a survey of electrophoretically discernable diversity in wild and cultivated landrace populations. These consisted of 12 pairs from Jordan, 5 pairs from Turkey, 4 pairs from Greece, and only 1 pair from Syria from a previous collection. Of the 16 isozyme systems investigated, two (6-phosphoglucoisomerase-3 and shikimate dehydrogenase-1) were found monomorphic. Shannon's information sta-

Table 1. Descriptors for the evaluation and characterization of barley and durum wheat germplasm. The evaluation for seed protein content has been planned, but not yet undertaken.

A. Descriptors for barley and wild barley

I. Agronomic characters: days to heading, days to maturity, plant height at maturity, lodging resistance, tillering capacity, kernel size, and overall agronomic performance.

II. Morphological characters: juvenile growth habit, leaf size and shape, leaf attitude, flag leaf size and shape, flag leaf attitude, color of auricles, waxiness of plant, growth type (winter, spring, or facultative), male sterility, straw strength, spike length, spike shape, spike density, attitude of spike, row number, lemma awn length, awn barbing, glume color, rachilla hairiness, color of caryopsis, and kernel covering.

III. Isozyme characters: (alphanumeric symbols in parentheses denote international nomenclature): esterases (E.C.3.1.1.2), peroxidases (E.C.1.11.1.7), 6-phosphogluconate dehydrogenase (E.C.1.1.1.44), phosphoglucoisomerases (E.C.5.3.1.9), acid phosphatases (E.C.3.1.3.2), phosphoglucomutases (E.C.2.7.5.1), shikimate dehydrogenase (E.C.1.1.1.25), and lipoamide, oxidoreductase (E.C.1.11.4.3).

IV. Other traits: seed dormancy (wild barley only), disease resistance, salinity tolerance (germinability and seedling response in the growth room), field drought tolerance (overall agronomic performance under moisture stress conditions), and wide adaptation.

B. Descriptors for durum wheat and wild emmer wheat

I. Agronomic characters: days to heading, days to maturity, plant height at maturity, lodging resistance, tillering capacity, kernel size, and overall agronomic performance.

II. Morphological characters: seedling vigor, juvenile growth habit, leaf size and shape, leaf attitude, flag leaf size and shape, flag leaf attitude, waxiness of plant, growth type (winter, spring, or facultative), stem solidness, straw strength, spike length, spike density, glume color, glume hairiness, awn length, awn color, seed color, and seed vitreousness.

III. Isozyme characters: (alphanumeric symbols in parentheses denote international nomenclature): esterases (E.C.3.1.1.2), peroxidases (E.C.1.11.1.7), 6-phosphogluconate dehydrogenase (E.C.1.1.1.44), phosphoglucoisomerases (E.C.5.3.1.9), acid phosphatases (E.C.3.1.3.2), phosphoglucomutases (E.C.2.7.5.1), shikimate dehydrogenase (E.C.1.1.1.25), and lipoamide oxidoreductase (E.C.1.11.4.3).

IV. Other traits: seed protein content, disease resistance, salinity tolerance (germinability, seedling and adult plant response in the growth room), field level drought tolerance, excised-leaf water retention capacity, and wide adaptation.

tistic (h_s) was calculated for the 14 remaining isozyme systems as follows (Pielou 1977):

$$h_s = -p_i \ln p_i, \text{ for } i = 1,2,\ldots,n,$$

where p_i is the relative frequency of the i^{th} phenotype for a given isozyme character. The mean diversity (H) was calculated as the arithmetic average of h_s values over the 14 isozyme systems.

The results of the survey, summarized in Table 2, indicate that only in 4 cases out of 22 was wild barley significantly more diverse than cultivated. The average diversity over the entire region demonstrated no real difference between the two species occurring sympatrically. We have also investigated the difference in variability between the wild and cultivated forms of barley for DNA fragments of the organelle genomes, both chloroplastic and mitochondrial, cleaved by 16 different restriction endonucleases (Holwerda *et al.* 1986). In these studies, cultivated landraces of barley appeared to possess slightly higher levels of diversity than the diploid wild barley (*H. spontaneum*) of the region.

We conclude, therefore, that there is little or no difference in diversity between the wild and cultivated forms of diploid barley in one of the most important centers of diversity of diploid *Hordeum*. We suspect, but have no unequivocal evidence so far (experiments in progress), that a similar picture will emerge for tetraploid wheats (*T. durum* and *T. dicoccoides*) with the possible exception of seed protein content.

Documentation and Long-Term Preservation

At the end of our evaluations, all accessions of barley and durum wheat and their wild relatives will be de-

Table 2. Estimates of diversity indices ($\bar{H}$) for wild and cultivated barley from 22 sites in four eastern Mediterranean countries.

Country	Site number of paired-sample	$\bar{H}$ Wild	$\bar{H}$ Cultivated
Jordan	1	0.44	0.51
	2	0.16	0.61*
	3	0.48	0.58
	5	0.21	0.12
	6	0.53*	0.26
	7	0.46	0.43
	8	0.18	0.25
	10	0.46	0.32
	13	0.11	0.51*
	25	0.34	0.45
	28	0.40	0.45
	33	0.12	0.47*
Turkey	35	0.40	0.37
	36	0.42*	0.21
	38	0.39	0.43
	40	0.24	0.25
	41	0.47*	0.07
Syria	59	0.39	0.41
Greece	61	0.25*	0.02
	62	0.25	0.32*
	63	0.01	0.30
	65	0.23	0.39
Average of $\bar{H}$'s:		0.35	0.32

* Significantly ($P \leq 0.05$) larger $\bar{H}$ than the respective neighboring species of barley by the normal deviate (Z) test.

posited at the Central Office for the Plant Gene Resources of Canada (PGRC), Ottawa, for long-term preservation and distribution. Documentation of the accessions, expected to be completed by December 31, 1986, will also be available from the PGRC Office.

In addition to the four target species (wild and cultivated barley, durum, and wild emmer wheat), 128 bulk samples of *Aegilops*, and a small number of legumes and rye accessions were also collected from diverse sites in Turkey and Jordan. These accessions will be deposited at the PGRC Office in November, 1986, for long-term preservation and distribution to potential users.

Acknowledgements

The above explorations and collections were supported by a grant from the International Board for Plant Genetic Resources (IBPGR), Rome, Italy, to each of us. Facilities provided by the Director Generalof the International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria; the President of Yarmouk University, Irbid, Jordan; and the Director of Aegean Agricultural Research Institute, Izmir, Turkey, are gratefully acknowledged.

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Conservation of Barley Genetic Resources: Report of a Workshop

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A workshop on germplasm conservation was held during the Fifth International Barley Genetics Symposium in Okayama, Japan, in October 1986. An abstract of the workshop will be published in the proceedings of the symposium. Because of general interest in barley in the drier areas of ICARDA region and of ICARDA's major involvement in barley genetic resources conservation and development, it is believed that this report on the major issues and concerns raised and discussed during the workshop could be of benefit to the readers of RACHIS.

Summary

There exists a deplorable gap between the worldwide collections of barley genetic resources and their utiliza-

tion in breeding and basic research. It is possible that existing collections of barley germplasm adequately represent the global genetic diversity. It is also possible that, except for a few endangered wild species and primitive cultivars in some regions of the world, there is no compelling reason for additional collection of barley and wild barley germplasm. These are very basic issues in barley germplasm conservation. However, no survey or experimental data are currently available to resolve these issues. Consequently, barley germplasm collection and conservation strategies in the past have been based largely on conjectures, speculations, and personal preferences of individual scientists or administrators. What is urgently needed is a world survey of genetic diversity in barley and its immediate wild progenitors so that future collections and conservation efforts could be developed on the basis of sound scientific data.

From a wide range of problems and concerns expressed during the workshop, it was evident that the basic issues in barley germplasm conservation remain the same in 1986 as they were in 1982 during the Edinburgh Symposium. The foremost among the multitude of issues are evaluation and utilization. For germplasm collections to be of any practical value they should be precisely and adequately evaluated for characters that are relevant to present-day agriculture (e.g., physical and biotic stress tolerance) and probable future needs. All available barley accessions should be reliably evaluated and the data analyzed and interpreted to resolve the basic issues, as well as to identify desirable accessions for germplasm enhancement. Despite frequent discussions in numerous national and international conferences, these basic issues have so far remained unsolved.

Issues and Discussions

As mentioned earlier, a wide range of issues related to *Hordeum* germplasm conservation were discussed in the workshop. These included both general issues (such as the purpose and priorities of future collection) and specific issues (such as the expected role of the International Centre for Agricultural Research in the Dry Areas - ICARDA - in barley germplasm evaluation and enhancement). A brief account of the major issues is given below.

(a) Collection and utilization of wild relatives

Professor R. von Bothmer of the Swedish University of Agricultural Sciences, Svalov, reported his recent exploration and collection of wild *Hordeum* in Western China. Because both cultivated and wild barleys of this major center of diversity are exposed to several types of stresses such as drought, cold, salinity, and diseases, these might provide very useful source materials for barley improvement. The distribution of wild species of *Hordeum* is relatively wide, ranging from South America to Central Asia, and barring a few species, these are not yet in real danger of extinction. Representative samples of the wild species should be collected in a systematic manner so that a reliable assessment of genetic diversity in the tertiary gene pool can be made. There is a deficiency of diploid *Hordeum bulbosum* in germplasm collections. This deficiency should be corrected by planned future explorations. Although the utilization of the tertiary gene pool in the near future appears to be in the area of basic research, its potential value in barley improvement in the long run cannot be overstated.

(b) Landraces and their immediate progenitor

Some recent surveys of wild barley (*H. spontaneum*) and landraces of cultivated barley from their primary center of diversity in the eastern Mediterranean countries have revealed that the landraces of the region are a richer source of genetic diversity for a wide range of agriculturally useful characters than their wild evolutionary progenitor. Because of recent successes in national plant breeding programs in centers of diversity for barley and vigorous collaborative efforts of international agricultural research institutions, such as ICARDA, for improved barley cultivar development, landraces in the region have become increasingly vulnerable to genetic erosion at the present time. Therefore, current emphasis should be placed on collecting landraces, and wild barley collections should be made only from the areas of special interest and significance.

(c) How much more to collect and where?

A world survey of genetic diversity in barley germplasm is urgently needed. Because the status of genetic diversity in world collections of barley vis-a-vis naturally occurring variation is unknown, the limit of collection can be determined only by the physical limits of the genetic resources centers. Frequent collection missions took place in the regions reputed for their genetic diversity, whereas other regions, such as Northwest Africa and South America received little or no attention. Explorations in these neglected regions should be encouraged. However, it was emphasized that while planning future explorations, the richness of genetic diversity of the target regions and danger of genetic erosion should be given primary consideration, rather than regional disparities in existing collections. As far as the landraces are concerned, the possible danger of losing potentially valuable materials outweighs the cost of possible repeated sampling and duplication of materials. Prevailing opinions on optimal number of accessions and collection sites are largely based on conjectures and speculations, rather than sound factual evidence.

(d) The widening gap

The inadequacy of barley germplasm evaluation was blamed for the ever-increasing gap between the large number of accessions preserved in various genetic resources centers and their utilization in breeding and research. Some participants held the extreme view that further collections of barley genetic resources, both wild and cultivated, should be halted until all available accessions are precisely and reliably evaluated and the data adequately analyzed and interpreted. Research data obtained from these evaluations would then form the basis for future collection and conservation strategies. The more moderate view was that, barring justifiable special cases, new explorations should be undertaken only if resources and manpower for evaluation of newly collected materials are committed beforehand.

The utilization of presently available barley germplasm (approximately 50,000 accessions) had been seriously limited by the lack of reliable evaluation of data. The critical need for a comprehensive evaluation program was repeatedly emphasized. It was recognized that the task was enormous and its success depended on careful planning, coordination, and international cooperation.

The relevance and usefulness of current IBPGR recommended barley-descriptor list were questioned. The use of a large number of characters for germplasm evaluation not only makes the task formidable, but also reduces the reliability of evaluation data. At present, there appear to be two feasible approaches toward obtaining reliable evaluation data: (1) careful evaluation of as many accessions as possible for a limited number of characters that appear most appropriate for the foreseeable future, and (2) evaluation of a limited number of accessions for a large number of characters irrespective of their apparent usefulness. The general consensus was in favor of the first approach.

The lack of leadership and long-term planning of international agencies for germplasm evaluation was regretted. Since ICARDA has the world mandate for barley germplasm development, it was considered to be the most appropriate institution for assuming the leading role in barley germplasm evaluation and characterization. Dr. B.H. Somaroo, Head of ICARDA's Genetic Resources Unit, presented a brief report of the Unit's ongoing barley germplasm evaluation program. Also, he emphasized that ICARDA will increase its future efforts towards comprehensive evaluation of both wild and cultivated species of barley. Starting with the diploid species, ICARDA's stepwise germplasm evaluation program is expected to significantly reduce the presentgap between numerous accessions in the global network of genebanks and their scanty utilization in breeding and research.

(e) Germplasm enhancement

For germplasm collections to be of any practical value, they should be reliably evaluated for economically useful traits and the potential donors of desirable genes or gene complexes identified. However, since the desirable genes are often found in agronomically unacceptable genetic backgrounds, an essential step between the evaluation and utilization of useful genetic resources should be the identification and transfer of desirable genes to acceptable genetic background. Maximum benefits from both national and international investments in the conservation of barley genetic resources would be accrued from transferring the genes of interest to genetically favorable but diverse backgrounds of a few modern cultivars with wide adaptation and high general combining ability.

Professor J.D. Franckowiak of North Dakota State University presented an outline of a proposed barley germplasm enhancement program for the USA. This project envisages a two-step backcrossing program employing closely linked morphological markers to facilitate transfer of specific genes or DNA segments into elite breeding materials. Dr. S. Ceccarelli, the principal barley breeder of ICARDA in Aleppo, Syria, gave an elegant illustration of their germplasm enhancement program, which was designed to exploit genetic diversity in wild barley and local landraces for germplasm development for the dry areas.

Notwithstanding these excellent reports, it was reckoned that the known barley germplasm enhancement programs are in their infancy. More concerted efforts are needed to facilitate greater utilization of available genetic resources. Dr. B.H. Somaroo of ICARDA acknowledged that germplasm enhancement was the most effective way of closing the present intolerable gap between collection and evaluation, and emphasized ICARDA's commitment to promote research and development in this area. This commitment was received with great enthusiasm and satisfaction.

(f) Other issues

The following issues were considered important, but were not discussed adequately because of time limitations:

1. Appropriate rejuvenation sites; should these be in centers of diversity or elsewhere?
2. Appropriate multiplication and preservation procedures, e.g., bulks versus pure lines - their relative usefulness to barley breeders.
3. Documentation and preservation of special genetic stocks, e.g., maintenance of barley mutants at the Nordic Genebank.
4. Future roles of genetic resources centers in enhancing genetic diversity - dynamic conservation, rather than museum preservation.
5. Plant variety protection laws in developed countries and their implications for international, free exchange of genetic resources and long-term germplasm conservation.
6. Identification of areas of basic research in germplasm conservation and assignment of priorities.
7. The duplicate accessions, their identification and elimination.

(g) The barley register

The first Barley Register was prepared by B.R. Baum and B.K. Thompson in 1985. This Register needs updating and revision. International cooperation and suggestions for viable mechanisms were sought. Dr. B.H. Somaroo of ICARDA expressed his keen interest and willingness to assume the responsibility of collecting new information and updating the first Barley Register published by Agriculture Canada.

Author's Comments

Barley offers one of the most useful organisms for research in genetic conservation. Several attributes of barley make it a nearly ideal organism for such research:

(a) Diploid segregation
(b) Wide adaptation
(c) Wide distribution
(d) Well-established linkage maps
(e) Existence of large numbers of morphological and isozyme markers with multiple alleles
(f) Well-defined mating system
(g) Crossability with diploid wild progenitor species
(h) Known genetic basis of many morphological and biochemical markers
(i) Availability of genetically broad-based mass reservoirs with long histories of natural selection in varying environments
(j) Relatively well-known origins and mechanisms of maintenance of genetic diversity in both wild and cultivated forms
(k) Well-defined centers of origin and diversity
(l) Availability of large numbers of accessions from many diverse locations

These favorable attributes of barley, together with its importance in world agriculture particularly in arid areas, and the opportunity of *in situ* research on genetic diversity at ICARDA, should promote both academic and targeted research in genetic conservation, using barley as a model organism. Barley geneticists and breeders may look forward to seeing some exciting research and development in barley germplasm conservation in the years to come.

A New Barley Variety for China

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"Gobernadora" is a new barley variety cultivated in several townships (new name for Commune) in a region near Shanghai. This variety gave superior yields to the local varieties of the region on farmers' fields during 1985 and 1986 (Table 1). It was developed through close cooperation between CIMMYT, ICARDA, and the Chinese Academy of Agricultural Sciences in Shanghai.

Table 1. Yield of Gobernadora and two check varieties grown at several locations.

Location	Gobernadora Yield (kg/ha)	Percent of BYMV Susceptible check Humai 4	Percent of BYMV Tolerant check Jingda 1	Year
1*	4314	148	107	1985
2*	4021	160	111	Do
3- Qin-lu Country	5587	106	110	1986
4- Song-Jiang	5064	109	111	Do
5- Yin Country	3906	108		Do
6- Yin Hai	4338	123	108	Do
7- Xong-Xing farm	4108	147	110	Do

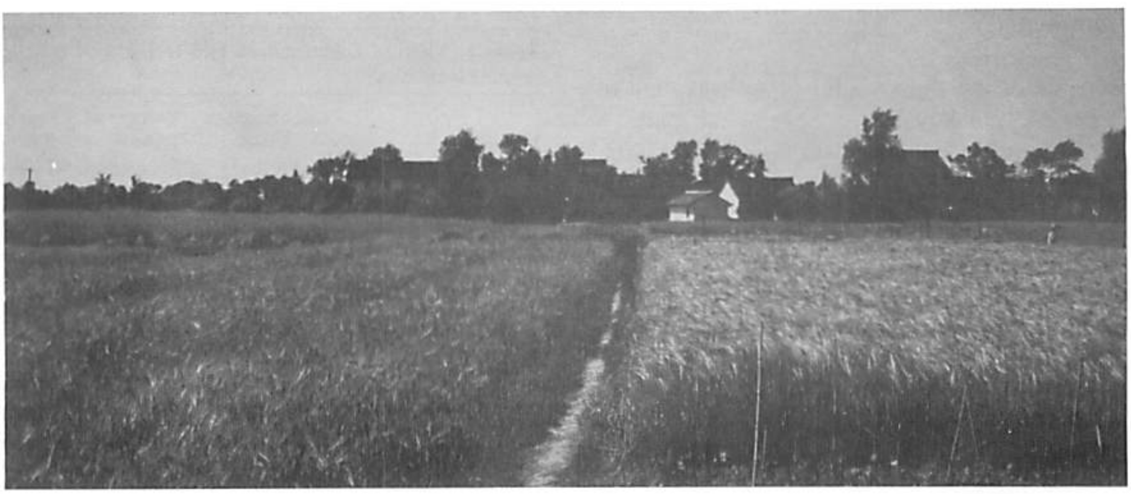
* Summary of 10 locations.
Data source: Professor Liu Zongzhen.

The variety carries resistance to scab *Fusarium graminearum* and tolerance to Barley Yellow Mosaic Virus (BYMV). Both diseases are considered to cause a considerable yield reduction in the region, corresponding to the lower part of the Yangtze river. BYMV is a virus transmitted by a soil borne fungus called *Polymyxa graminis* and may cause up to 50% losses.

The intensive land use by Chinese farmers is one of the most noteworthy aspects of agricultural management in this part of China. As water is available year-round for irrigation, farmers practice multiple cropping. One of the several rotations consists of two rice crops followed by barley. As a result, the period of time during which barley remains on the land is essentially fixed. Therefore, barley varieties to be released should have the ability to mature within this time frame. In this regard, Gobernadora is still considered a little late (6 days later than the local variety Zhow Shu 3).

Barley is usually planted in the first two weeks of

Field section left unharvested for the May 23 visit at Jingei township. Gobernadora's yield in the area already harvested was 5 tons/ha.



Humai 4 (left) and Gobernadora (right) varieties planted for demonstration at Xianxu township.

November and harvested before 20 May. Some of the fields planted to Gobernadora were already harvested or ready to harvest during 10-25 May.

Yield data for 1985 and 1986, provided by Professor Liu Zongzhen (Table 1), show the superiority of Gobernadora over the two local varieties Humai 4 which is BYMV susceptible, and Jingda I which is tolerant.

Yield of the new variety was superior to the check by a range of 6.4 to 60.1% in all locations.

Seed Multiplication

Seed of Gobernadora can be obtained from two locations (Jinshan and Songjiang) where it was grown in multiplication fields. This variety has been widely accepted by farmers who have had the opportunity to see or cultivate it. According to Professor Liu, release of Gobernadora will result in expansion of the area under production as soon as seed is made available to farmers.

There were two problems with seed multiplication: (1) the appearance of six-row types (Gobernadora is a two-row barley) which is probably due to an early contamination by cross pollination. In this respect, it was suggested to practice head selection for two-row, homozygous types in order to obtain new breeders' seed. (2) there is regular occurrence of one infertile floret in a head, - a trait also observed in Mexico and described in the barley literature for spikes of *Hordeum irregulare*.

Pedigree

Gobernadora, was obtained by crossing three spring and one winter cultivars:

0C640/MARI//PIONEER/3/MARIS CANON

CMB78-1176-B-3Y-1B-1Y-1B-0Y

In 1981 seed of the advanced line was sent to Professor Liu Zongzhen in China, who tested it and found it to be resistant to scab. Gobernadora continues to maintain its resistance and it is kept as resistant check in the scab nursery.

There is no definitive information about the origin of scab resistance or tolerance to BYMV in this cross. A close look at its pedigree suggests the Pioneer, Mari, and Maris Canon (all from Europe) might be involved. According to Dr. Friedt, from W. Germany, BYMV is presently one of the major diseases of winter barley in Europe. Gobernadora seed has been sent over to several European scientists for two purposes: first, to study if the Gobernadora tolerance to BYMV holds under European conditions and second to find out if the gene(s) conferring tolerance to the virus in Gobernadora is the same or different from those already described in the literature.

Crosses to incorporate BYMV resistance into our germplasm have been made in the program using the resistant German winter variety Birgit. F2 Masa generation seed from these crosses was sent to Professor Liu for testing for BYMV in China during November 1986. The same F1 crosses were utilized for top crossing with early material resistant to scab and with Gobernadora. Seed of these F1 tops has been planted in Obregon 1986/87 and next year, early-maturing plants will be selected and sent to China for field testing.

Comparison of Triticale with Barley as a Dual-Purpose Crop

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Though triticale (*X. Triticosecale* Wittmack.) was originally developed to be a food grain, it has been grown mainly as a feed grain. In West Asia and North Africa, barley is the traditional and predominant animal feed. Therefore if triticale is to be accepted, it must show an advantage over barley. Grain yield of triticale relative to barley in the region was generally low, but the gap is narrowing (Hadjichristodoulou 1984; International Nurseries Reports of ICARDA from 77/78 to 84/85).

Some investigators believe that triticale has a potential as a forage grain crop. Studies in areas of the USA having mild winters showed that it is comparable to other winter cereals for forage (Brown and Almodares 1976), for hay (Ciha 1983) and for both forage and grain (Bishnoi 1980). In many parts of the region, barley crops are commonly grazed in the winter months and then are allowed to recover for grain production (Yau and Mekni 1987). A study in northern Syria indicated that some triticale lines produced more forage and grain yield after simulated grazing than the local barley (Nachit 1983). However, this experiment was carried out under supplementary irrigation and high doses of fertilizers, a condition favorable to triticale and seldom found in the actual barley-growing areas of the country.

The aim of this study was to compare triticale with barley as a dual-purpose crop in representative barley growing conditions and areas in Syria. The broad-sense definition of dual-purpose (Yau and Mekni 1985) was adopted, i.e., for green-stage grazing and then grain harvesting, as well as only for grain harvesting. Differences in important agronomic characters besides yields will also be reported and discussed.

Materials and Methods

The experiment was conducted during 1985/86 in northern Syria at Tel Hadya (35.55 N, 36.55 E, 282 m asl) and at Breda (35.55 N, 37.10 E, 350 m asl) with seed drilled on 18 and 2 Nov 1985, respectively. The first rain came unusually late, on 15-17 Dec instead of November. The rainfall of the season was below average but no irrigation was given. The rainfall distribution for the two sites is shown in Fig. 1.

Breda: season total = 218mm; long term ave.= 283
Tel Hadya: season total = 316mm, long-term ave. = 330

S: sowing, E: emergence, H: heading,
M: maturity, T: triticale, B: barley.

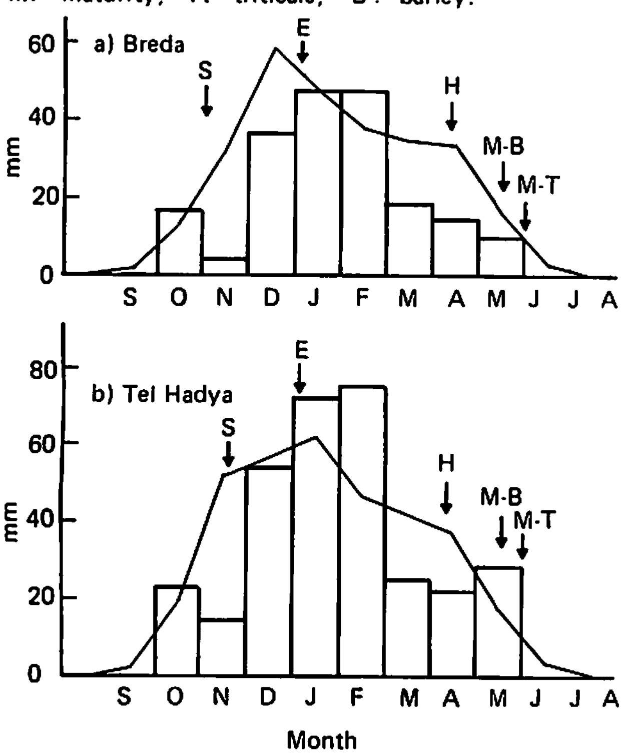

Fig. 1. Rainfall distribution at Breda and Tel Hadya for the season (bar) in comparison to the long-term average (line).

Four high-yielding triticale lines: Drira Outcross 7, Juanillo 95, Ram'S' (X12257-1N-0M) and Tejon/Bgl'S'// NV'S' (X22680-1Y-1M-6Y-2M-1Y-1M-0Y), were compared with four barley genotypes: Arabi Abiad, Arabi Aswad, C-63, and Matnan'S'. A. Abiad and A. Aswad are the widely grown local landraces (both 2-row type). C-63 and Matnan'S' are 6-row lines found to have good dual-purpose potential at Tel Hadya for many seasons.

The experiment was a split-plot design with two replications. Grazing management (with or without simulated grazing) was the main plot and lines constituted the subplots. The plot size was 9 m^2 (six 5-m rows, 30 cm apart). The seeding rate was 120 kg/ha.

At Tel Hadya, 60 kg P_2O_5/ha was banded into the soil before planting. No N fertilizer was applied as the land was fallowed in the previous season. At Breda, 20 kg N/ha and 60 kg P_2O_5/ha were applied before seeding. Weeds were controlled by herbicides. Diseases development was slight.

Mowing at 2-3 cm above ground level was used to simulate grazing at mid-tillering stage on 24 Feb 1986 at Breda and on 26 Feb at Tel Hadya, when many farmers in the areas started to allow sheep grazing in their fields. To measure forage production, an area of 1 m^2 was hand-clipped before mowing and the collected plant materials were oven-dried and weighed.

The central four rows of each plot were harvested when the triticale had matured, by a small-plot harvester equipped with a straw collector. For the grazed treatment, total biological yield included the forage dry matter removed.

Seedling vigor and recovery ability after simulated grazing were scored visually on a 1 - 5 scale (1=best, 5=worst). Days to heading and days to maturity were recorded from the date of emergence. Within each plot, two representative 1-m rows of plants were marked off for taking the total number of shoots and heads at booting and maturity, respectively. At Breda, the number of fallen stems caused by wheat stem sawfly infection was recorded for triticale. For sawfly infection, a 1-5 scale (1=best, 5=worst) was used for visual assessment.

Results

Combined analyses of variances of the split-plot experiments over the two sites were carried out as described by Gomez and Gomez (1984). There were highly significant differences among entries for all the characters measured. Effects of grazing were not significant except for days to heading. Grazing caused the plants to head later. There were significant differences between the two sites for all characters except seedling vigor.

regrowth ability, shoot number, days to heading, and tiller mortality. The location x entries interactions were nonsignificant or the mean squares were small relative to the entry mean squares, except for the yield characters. The entry x grazing, entry x location and entry x grazing x location interactions were all nonsignificant.

a) Yield

The average yield performances of triticale and barley are compared in Fig. 2. Triticale produced 20% less forage dry matter (statistically significant at Tel Hadya) than barley at the time of simulated grazing. Furthermore, its grain yield was significantly lower than barley's at both the locations, with and without simulated grazing. The relative difference between the two species was larger with grazing and at the drier site. Triticale produced significantly more straw and had a higher biological yield than barley at Tel Hadya. The relative difference in straw yield between the two species was higher after grazing. In general, the performance of triticale relative to barley was worse at Breda than at Tel Hadya.

Table 1 gives the yield performance of the individual entries. At Tel Hadya, the barley line C-63 performed generally well, especially under the grazed treatment. A. Abiad gave high grain yield, while the triticale lines Drira Outcross 7 and Tejon/Bgl'S'// NV'S' had high straw yields. At Breda, A. Abiad produced large amount of forage and grain but little straw. C-63 also performed well when not grazed. Among the triticale lines, Ram'S' had the best overall performance and Drira Outcross 7 gave the highest grain

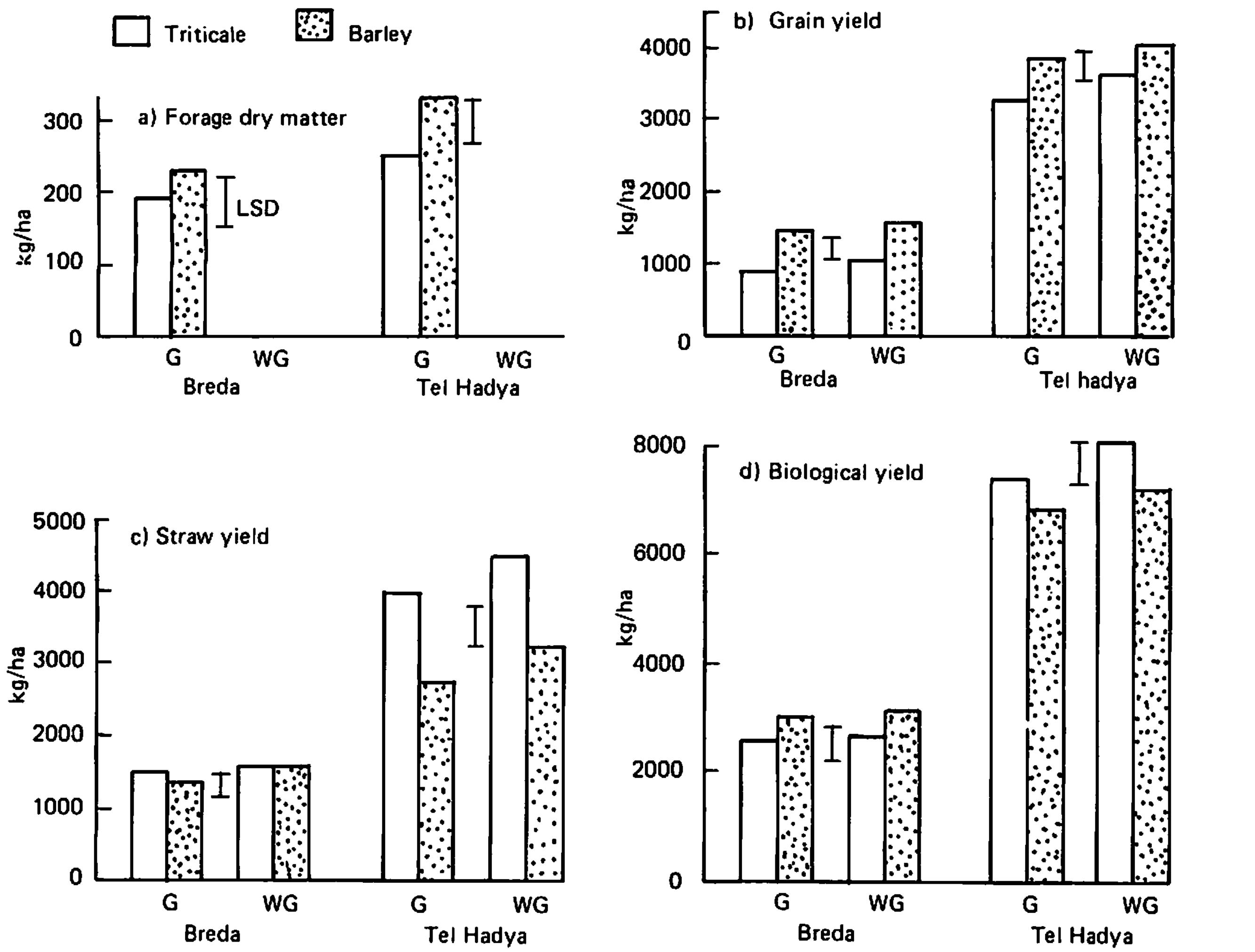

Fig. 2. Mean yield of 4 triticale lines vs 4 barley entries with and without simulated grazing (G vs WG) at Breda and Tel Hadya. (LSD given at 5%).

Table 1. Yields (kg/ha) of the triticale and barley entries under the two different grazing treatments at Tel Hadya and Breda (G-grazed, WG-without grazing).

Line	Forage yield	Grain yield		Straw yield		Biological yield	
		G	WG	G	WG	G	WG
(a) Tel Hadya:							
Barley							
C-63	410 a@	4620 c	4240 b	4080 c	3920 bcd	9110 c	8160 bc
Matnan's'	345 ab	3540 ab	3670 ab	2250 a	2580 a	6140 a	6250 a
A. Aswad	295 ab	3080 a	3870 ab	2420 ab	3420 abc	5790 a	7280 abc
A. Abiad	255 b	4130 bc	4330 b	2080 b	2920 ab	6470 ab	7240 abc
Triticale							
Tejon/Bgl's'//NV's'	235 b	3140 a	3880 ab	4170 c	5080 d	7540 abc	8960 c
Juanillo 95	260 b	3330 ab	3290 a	3670 c	3500 abc	7250 ab	6790 ab
Drira Outcross 7	245 b	3530 ab	3750 ab	4420 c	4920 d	8200 bc	8670 c
Ram's'	275 b	2930 a	3480 ab	3500 bc	4330 cd	6700 ab	7810 abc
Site mean	290 ns	3540 **	3810 **	3320 *	3830 *	7150 *	7640 **
(b) Breda:							
Barley							
C-63	260	1240 abc	1790 c	1500	2250 b	3000 b	4040 b
Matnan's'	245	920 a	860 a	1080	1420 a	2250 ab	2280 a
A. Aswad	145	1690 bc	1820 c	1580	1500 a	3420 b	3320 ab
A. Abiad	280	1890 c	1710 bc	1150	1170 a	3320 ab	2880 ab
Triticale							
Tejon/Bgl's'//NV's'	205	680 a	860 a	1230	1420 a	2130 ab	2280 a
Juanillo 95	165	1020 ab	1100 ab	1700	1580 a	2890 ab	2680 a
Drira Outcross 7	155	870 a	1170 abc	1420	1670 a	2440 ab	2840 ab
Ram's'	220	1010 ab	1080 ab	1580	1600 a	2810 ab	2680 a
Site mean	210	1160	1300	1410	1580	2780	2870

@ Within sites, values followed by the same letter are not significantly different at 5% level.

*,** Significantly different between site means at the 5 and 1% levels, respectively.

and straw yields without grazing.

At Breda, the crop was attacked by stem sawflies. The barley entries received little infestation (Table 2) while the triticale lines suffered relatively heavy damages, especially Juanillo 95 and Drira Outcross 7. Table 2 also shows that the average grain yield of triticale after adjustment of sawfly damage was still significantly less than that of barley both with or without grazing, and the rankings of the eight entries remained essentially unchanged.

b) Agronomic characters

The agronomic characters of the entries are presented in Table 3. There were highly significant differences between triticale and barley in all the characters measured. The former had poorer seedling vigor and regrowth ability after grazing; later heading and maturity dates; a longer grain filling period; taller plants; fewer shoots, heads, and aborted tillers; and a lower harvest index. The two local barleys were outstanding in a few characters: high numbers of shoots and heads, early heading and maturity, and a high harvest index.

Discussion

The experiment showed that triticale is inferior to barley as a dual-purpose crop under representative barley-growing areas and conditions in Syria. Results on the performance of the two species without simulated grazing agreed with a previous study conducted at Breda (ICARDA 1986a). Poor seedling establishment and slow seedling growth probably caused triticale to yield

Table 2. Sawfly damage (1-5 scale: 1 slight, 5 severe) at Breda and grain yields (kg/ha) of the 4 triticale lines after adjustment of sawfly damage in comparison to the 4 barley lines.

Line	Simulated grazing With	Simulated grazing Without	Sawfly damage
Barley			
C-63	1240 abc@	1790 b	1.0 a
Matnan's'	920 a	860 a	1.0 a
A. Aswad	1690 bc	1820 b	1.0 a
A. Abiad	1890 c	1710 b	1.0 a
Mean	1430 *	1540 *	1.0 ***
Triticale			
Tejon/Bgl's'//NV's'	700 a	890 a	2.0 b
Juanillo 95	1360 abc	1330 ab	4.3 d
Drira Outcross 7	1030 ab	1380 ab	4.3 d
Ram's'	1100 ab	1200 ab	3.3 c
Mean	1050	1200	3.4
Grand mean	1240	1370	2.2

@ Values followed by the same letter are not significantly different at the 5% level.

*,*** Significantly different between species means at the 5 and 0.1% levels, respectively.

less forage than barley. During winter, there is usually a lack of green feed for the sheep and many farmers allow the flocks to graze in their barley fields. The early availability of a sizable amount of forages definately gives barley a decisive advantage over triticale for such green-stage grazing. The lower grain yield of triticale could be due to a poorer tillering, poorer regrowth ability after grazing, and more importantly, due to a much later maturity. As shown in Table 3, though triticale had practically the same heading date as barley, it matured more than 2 weeks later. Thus it was more exposed to the moisture and heat stress at the end of the growing season, as reflected by the much lower harvest index. In order to make triticale adapted to the dry Mediterranean environments, a reduction in the length of the grain-filling period accompanied by an increase in the rate of dry-matter accumulation in the grain, as suggested by Anderson (1984), is clearly needed.

The yield inferiority of triticale relative to barley was smaller at the more favorable site (Tel Hadya) than at the drier and less fertile site (Breda). A study by Hadjichristodoulou (1984) over years and locations showed that high-yielding triticale lines exploited good environments better than the local barley cultivar, because they were more resistant to diseases and lodging and the barley matured too early to fully utilize all the available resourses. Triticale was also found to perform relatively better under early

Table 3. Agronomic characteristics of the triticale and barley entries. (Averaged over Breda and Tel Hadya as well as grazed and non grazed treatments, except regrowth ability).

Line	Seedling vigor	Regrowth ability	Days to heading	Days to maturity	Days of grain filling	Harvest index	Plant height (cm)	Shoot no/m	Head no/m	Tiller mortality no/m
Barley										
C-63	2.0 a@	1.6 a	96 e	128 c	31 b	0.49 b	76 c	138 b	70 ab	68 c
Matnan's	2.1 a	1.9 ab	94 cd	123 b	30 a	0.51 b	63 a	153 b	87 bc	65 bc
A. Aswad	2.8 abc	1.9 ab	92 a	121 a	29 a	0.54 c	69 b	245 d	155 d	91 d
A. Abiad	2.6 ab	2.1 ab	93 bc	123 b	30 ab	0.62 d	60 a	208 c	146 d	62 bc
Mean	2.4 ***	1.9 ***	93.7**	124 ***	30 ***	0.54 **	67 ***	186 ***	115 **	71 ***
Triticale										
Tejon/Bgl's'//NV's'	4.1 d	4.1 c	97 e	144 f	47 d	0.40 a	93 d	103 a	59 a	44 ab
Juanillo 95	3.5 cd	3.1 bc	94 cd	141 e	47 d	0.44 a	99 e	94 a	50 a	45 ab
Drira Outcross 7	3.0 bc	3.0 bc	93 b	140 de	48 d	0.42 a	102 e	94 a	55 a	39 a
Ram's'	2.3 ab	2.4 ab	94 d	139 d	45 c	0.42 a	91 d	107 a	67 ab	39 a
Mean	3.2	3.2	94.3	141	47	0.42	96	99	58	42
Grand Mean	2.8	2.5	94.0	132	38	0.48	81	143	86	56

@ Values followed by the same letter are not significantly different at the 5% level.

,* Significantly different between species means at the 1 and 0.1% levels, respectively.

planting with supplementary irrigation than under normal planting at Tel Hadya (ICARDA 1986b). Such results have an important implication, i.e., one must examine critically the environments under which triticale is being compared with barley before drawing conclusions. For example, the discrepancy between the results of the present experiment with those of Nachit (1983) could probably be largely explained by the fact that the two experiments were conducted under different conditions.

The use of the same seed rate for triticale and barley in this study might have biased against triticale's performance to some extent. Under good growing conditions, the optimal seed rate is higher for triticale than for wheat because of triticale's poorer tillering and larger, more shrivelled seed (Larter, *et. al.* 1971; Bishnoi 1980). The optimal seed rate for triticale under typical barley-growing conditions in Syria is not known. The author is of the opinion that seed rate effect on the relative performance of the two crops, if there was any, would have been small in the presence of the large difference in maturity between triticale and barley.

In the country, straw is a valuable source of feed for livestock in dry areas and seasons (Mazid and Hallajian 1983). Triticale produced more straw than barley at Tel Hadya but not at the drier site, Breda. Besides, its straw is tough and thick and contains a lower N percentage than barley straw (Hadjichristodoulou 1984). Thus the advantage of triticale over barley in straw yield was negated by its poorer straw quality.

Finally, it should be pointed out that the larger damage of triticale lines caused by wheat stem sawfly (*Cephus pygmaeus*) at Breda did not necessarily indicate that it is more susceptible than barley to the insect. It might be that barley matured faster and escaped the attack.

Acknowledgements

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Phenotypic Stability of Seed Yield in Barley

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Screening of advanced strains for environmental adaptability is of paramount importance in India where barley is cultivated over varying soil and moisture conditions. Therefore, some elite lines of barley were evaluated for their yield stability in different environmental conditions.

Materials and Methods

Twelve lines of barley were grown during *rabi* season of 1985 in an RCB design with 3 replications and in 2 locations namely, (i) C.R.S., Masodha (normal soil) under irrigated (E_1) and rainfed (E_2) conditions, and (ii) M.E.S., Kumarganj (saline-alkali soil) under irrigated (E_3) and rainfed (E_4) conditions. Plots consisted of 12 rows, 5 m long and 23 cm apart. The fertility level in E_1 and E_3 was 60:30:20 NPK kg/ha, and in E_2 and E_4 30:20:20 NPK kg/ha. Yield data were recorded on a plot basis. Stability parameters were computed following Eberhart and Russell (1966).

Table 1. Analysis of variance for stability of seed yield in barley.

Source of variation	d.f.	Mean square
Varieties (V)	11	0.732**
Varieties x Environment + Environment	36	1.375**
Environment (linear)	1	32.988**
V x E (linear)	11	0.617**
Pooled deviations	36	0.196**
Pooled error	144	0.025

** Significant at P = 0.01.

Results and Discussion

Pooled analysis of variance for yield stability (Table 1) showed significant differences among the strains. The significant genotype by environment (V x E) component indicated real differences in varietal performance over environments. Variance due to pooled deviations was highly significant, indicating that an important component for differences in stability was due to the deviation from linear regression and not to the differences in slope only.

In general, the highest mean yields, were recorded in E_1 followed by E_3, E_4, and E_2. In comparison to check P 267, all the strains were registered for higher seed yield in E_1 and E_2 except P 486, BR 3148, and Karan 92. Under saline soil conditions, K 392, K 393, P 487, P 488, and P 490 in E_3, and RD 1961 and P 486 in E_4 yielded better than the check.

The performance of a given cultivar is assessed by considering its phenotypic index (P_i), regression coefficient (b_i), and deviation from regression (s_d^2) (Table 2). P_i reflects the mean performance over environments of a given entry relative to the check. P_i was highest in P 488 followed by P 490. These strains showed high average yields but possessed below average stability as b_i was greater than 1.

Table 2. Mean performance of 12 barley strains over four environments and their stability parameters.

Serial no.	Strain	Yield in kg/plot E_1	E_2	E_3	E_4	Mean	% over check	P_i	b_i	S_d^2
1.	RD 1824	3.17	2.17	2.97	2.25	2.640	104	0.113	0.519	-0.014
2.	RD 1961	2.57	1.70	2.57	2.72	2.390	95	-0.137	0.249**	0.214
3.	K 391	4.07	2.37	2.95	1.42	2.702	107	0.175	1.249	0.311
4.	K 392	3.75	2.92	3.17	1.50	2.835	112	0.308	1.000	0.042
5.	K 393	3.52	1.35	3.25	2.22	2.585	102	0.058	0.625	0.925**
6.	P 486	3.77	0.80	2.72	2.47	2.440	97	-0.087	1.015	0.827**
7.	P 487	3.40	1.75	3.42	0.80	2.342	93	-0.185	1.253	0.321
8.	P 488	4.10	1.85	4.82	1.10	3.217*	127	0.690	2.143**	0.526**
9.	P 490	4.17	2.20	4.97	1.20	3.135*	124	0.608	1.698**	0.540**
10.	BR 3148	2.82	0.67	2.97	1.47	1.982	78	-0.545	1.124	0.069
11.	Karan 92	2.75	0.50	1.80	2.20	1.812	72	-0.715	0.606	0.846**
12.	P 267 (check)	2.22	1.32	3.07	2.37	2.245	100	-0.282	0.519	0.381*
Mean		3.359	1.633	3.223	1.810	2.527			1.000	

*, ** Significant at the 0.05 and 0.01 levels, respectively.

Eberhart and Russell (1966) emphasized the need for considering both b_i and s_d^2 components of V x E in judging the phenotypic stability of a genotype. Later on, Paroda and Hayes (1971) and Paroda *et al.* (1973) emphasized that b_i should simply be regarded as a measure of response for a particular genotype, whereas the s_d^2 should be considered as a measure of stability: genotypes with lowest deviations being the most stable and vice versa.

P 488 and P 490 which had above average mean values showed considerable response to favorable environments, but had poor stability as the values of s_d^2 were significantly high. These strains yielded low under E_2 and E_4, but as the environment became more favorable, their yield increased at a rate well above the average. The cultivar K 391, having high mean values and non significant b_i and s_d^2, was relatively stable despite a better adaptation to more favorable environments.

K 392 had relatively high mean yields, unit slope, and low s_d^2. Therefore, it can be described as being generally adapted to most environments with relatively predictable yields. Other cultivars (such as P 486, Karan 92, and P 267) showed specific adaptation to one or more environments.

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Identification by Electrophoresis of Bread and Durum Wheat Varieties Grown in Algeria

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The problem of varietal identification in wheat is not new, but the usual tests (Phenic acid coloration, grain size) are not very satisfactory. Autran (1975) used gliadin electrophoresis on starch gel as the basis for a key to identify wheat varieties. He showed that environment and year did not modify electrophoretic diversity of gliadins. Bushuk and Zillman (1978) and Autran (1979) developed a new determination key using polyacrylamide gel.

Wheat varieties grown in Algeria are relatively well known in North Africa and the Middle East. This paper describes a system of identification of these varieties through analysis of the diversity of grain reserve proteins (gliadins and high molecular weight glutenins) and presents an identification key.

Materials and Methods

Materials

The following 10 bread wheat and 13 durum wheat varieties were used in the study: Anza, Arz, Blue-bird, Dougga, Florence-Aurore, Hamra, Mahon-Demias, Siete-Cerros, Strampelli, Pavon, Bidi 17, Cocorit, Hedba 3, Inrat 69, Khroub, Mohamed-Ben-Bachir, Montpellier, Oued-Zenati, Polonicum, Sahel, Tassili, Tell, Timgad.

For each of these varieties, 40 grains were analyzed individually to characterize each variety and to determine varietal purity.

Methods

Gliadin electrophoresis on polyacrylamide gel at pH 3.2

The separation of gliadins on polyacrylamide gel was carried out using the method of Bushuk and Zillman (1978) modified by Courvoisier (1984) on vertical gel. The aluminum lactate buffer was replaced by 0.008 M sodium lactate. The gel composition was also modified as follows:

Acrylamid 6.5 g; Bisacrylamid 0.325 g; Urea 5 g; Aluminum lactate 0.15 g; Potassium lactate 0.02 g; Ascorbic acid 0.22 g; Iron sulfate 1 mg; Distilled water to 100 ml.

Electrophoresis of high molecular weight glutenins subunits

The methods of protein extraction and reduction to subunits and electrophoretic separation were those used by Payne *et al.* 1979. Subunit nomenclature is that proposed by Payne and Lawrence (1983).

Results and Discussion

Wheat Variety Identification by Gliadin Polymorphism

Methodology of interpretation

According to Autran and Bourdet (1975), the reading of a diagram consists in determining the mobility and intensity of each of the bands present in the diagram. The relative mobilities of different components, revealed by electrophoresis at pH 3.2 in sodium lactate buffer, are calculated from a control band found in all the Algerian wheat varieties that have been analyzed. This band is a major component of the γ gliadin group and is given a mobility of 68. Thus all the diagram components have a mobility between 12 and 100. The five classes of concentration proposed by Autran and Boudet (1975) are applicable to the diagrams. These classes are defined as: absence, trace, presence, +, ++, and +++. Typical diagrams are presented in Fig. 1.

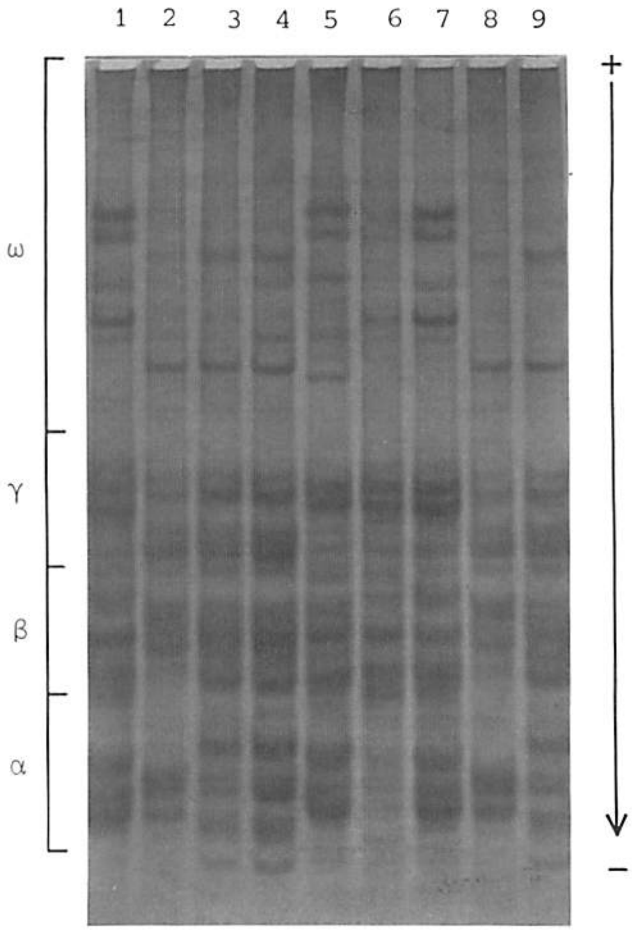
These diagrams consist of 15 - 27 visible electrophoretic bands depending on the variety. The gliadin diagrams present marked differences both qualitative and quantitative. The gliadin diagrams of bread wheat varieties are composed of 22 - 27 bands, compared with 15 - 22 for durum wheats.

Varietal purity of samples

Electrophoretic polymorphism of gliadins was used to characterize varietal purity. Among the many possible origins of impurities, the most important ones are: Mixture at threshing; and outcrossing, generally highest in warm countries. For most of the genotypes, there were no differences between the 40 diagrams for each cultivar, but a few varieties (e.g. Hebda 3 and Timgad) showed two types of diagrams.

Development of an identification table for wheat varieties:

The identification key is based on two characters: qualitative (presence or absence) and quantitative (trace, +, ++, +++). In the present model, the region of ω gliadins, with molecular weights between 45000 and 78 000 Daltons was used. These proteins correspond to genes situated on the chromosomes arms 1 D and 1 A



1,5: Florence-Aurore 2,8: Cocorit
3,9: Oued-Zenati 4: Bidi 17
6: Siete-Cerros 7: Anza.

Fig. 1. Electrophoretic diagrams of some durum and bread wheat on polyacrylamide gel.

and are generaliy wellseparated on gel. According to the electrophoretic analysis, the identification table indicates that durum wheats can immediately be distinguished from bread wheats by the fact that they have no bands in the slow ω gliadin zone (12 to 20).

The identification key (Table 1) also shows that the varieties indicated can be distinguished without ambiguity, from one or several visible differences in the diagrams, with the exception of Hedba 3 and Timgad, which appear to be mixtures.

Identification of Wheat Varieties by Glutenin Polymorphism

The electrophoregrams of high molecular weight glutenin subunits from some durum and bread wheat varieties are shown in Fig. 2.

Table 1. Identification key for bread and durum wheat varieties grown in Algeria, based on gliadin electrophoretic diagrams.

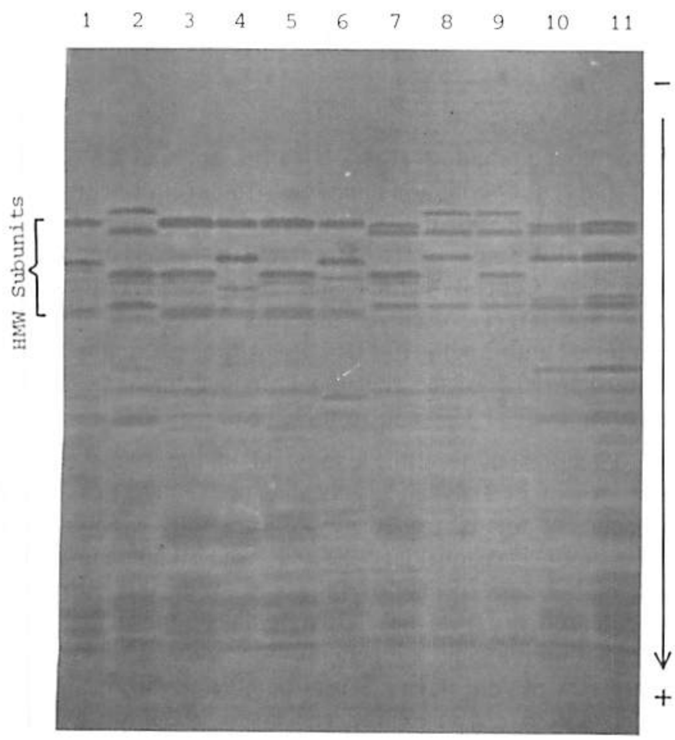
Presence of 3 components in the 12-20 mobility zone: Bread wheat type:	
- Presence of 13-17-20	
+ Presence (+ + or + + +) of 49-51.5	
* Presence (+ +) of 37	Mahon-Demias
* Absence 37	Siété Cerros
+ Presence (+ + or + + +) of 51-53	
* Presence (+ + +) of 45	Strampelli
* Absence of 45	Florence-Aurore
+ Presence (+ + +) of 50-53 and 32	Anza
+ Presence (+ + +) of 50.5-53	Dougga
+ Presence (+ + +) of 52-54	Pavon
+ Presence (+ + +) of 51-53	Blue-Bird
- Presence of 12-16-18	
+ Presence (+ + +) of 50-53 and (+ +) of 33	Arz
+ Presence (+ + +) of (54-55) and (+ +) of 39.5	Hamra
Absence of components in the 12-20 mobility zone: Durum wheat type	
- Presence of 22-26	
+ Presence of 37.5	
* Presence (+ + or + + +) of 50.5	
: Presence (+ or + +) of 28-29.5-32	INRA 69
: Presence (tr) of 27.5-35	Tassili
: Presence (+) of 32.5-33.5-35	Tell
* Presence of 52-53	
: Presence (tr or +) of 33-35	Oued Zenati
: Presence (tr) of 31.5-36.5	Montpellier
: Presence (tr) of 28-32.5	Mohamed-Ben-Bachir
: Presence (tr or +) of 27-29-36	Khroub
* Presence (+ +) of 53 and absence of 52	
: Presence (+) of 33	Hedba 3
* Presence (+ + or + + +) of 50-52	
: Presence (+) of 32-55	Bidi 17
: Presence (+ +) of 32 and absence of 55	Cocorit
: Presence (+) of 55 and absence of 32	Sahel
- Absence of 22-26	
+ Presence of 37.5	
* Presence (tr) of 28-36	Polonicum
* Presence (tr) of 33	Timgad

The different subunits observed in these varieties of quite diverse origins are few in number: 17 compared with 98 gliadins among the same varieties.

These 17 electrophoretic bands are the following: 1, 2, 2*, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, and 20. The group of 10 bread wheat varieties provides 9 distinct glutenin diagrams, as against 5 diagrams for the 13 durum wheat varieties (Table 2).

The band coded by 1 DL (2, 3, 4, 5, 10, and 12) is, of course, absent from the durum varieties. In addition, all the durum wheats carry the null allele of the gene Glu A1. Subunits 1 or 2* coded by the gene Glu A1 were not observed.

The identification of bread and durum wheat varieties grown in Algeria in 1983 was possible by observation of the electrophoretic diversity of omega gliadins. In contrast, analysis of the polymorphism of high molecular weight glutenin subunits does not permit identification of all varieties. In bread wheat, the omega gliadins, controlled by two genes, provide an electrophoretic diversity greater than that of the high molecular weight glutenin subunits, coded for by three genes. The presence of SDS masks the charge of proteins and so reduces the potential revelation of genetic diversity. Observation of high molecular weight glutenins completes electrophoretic analysis of gliadins and provides information on quality (Branlard and Dardevet 1985; Khelifi and Branlard 1987).



1: Mahon-Demias 2: Ciano (check) 3: Siete-Cerros
4: Arz 5: Dougga 6: Magnif (check)
7: Pavon 8: Strampelli 9: Blue-Bird
10--11: Florence-Aurore.

Fig. 2. Electrophoregrams of high molecular weight glutenin subunits from bread wheat varieties.

Table 2. List of high molecular weight glutenin subunits in bread and durum wheats.

Varieties	Glutenin diagrams
Bread wheat:	
Anza	2 - 7 - 8 - 12
Mahon - Demias	2 - 14 - 15 - 12
Siété - Cerros	2 - 2* - 17 - 18 - 9 - 12
Arz	2 - 2* - 7 - 8 - 12
Dougga	2 - 2* - 17 - 18 - 12
Pavon	2* - 5 - 17 - 18 - 10
Blue-bird, Hamra	1 - 5 - 17 - 18 - 10
Strampelli	1 - 5 - 7 - 8 - 10
Florence-Aurore	2* - 5 - 7 - 9 - 10
Durum wheat:	
Bidi 17, Oued-Zenati, INRAT 49 Polonicum, Khroub, Montpellier	20
Timgad, Cocorit, Tell, Sahel	6 - 8
Tassili	7 - 8
Hedba 3	14 - 15
Mohamed-Ben-Bachir	13 - 16

Conclusion

The results described should help to orientate geneticists and breeders. The uses of this identification are multiple; a particularly useful application is commercial transaction where disagreement occurs about the varietal purity of a sample. In addition, this identification should help to evaluate genetic diversity: genetic markers, distances between genotypes and variation within and among wheat populations. The dichotomic identification table should also help to distinguish a known variety from an unknown sample.

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Storage, Protein Composition, Morphophysiological, and Quality Characters of 24 Old Durum Wheat Varieties from Sicily*

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Till a few decades ago cultivation of both common and durum wheat in Italy was largely based on the use of local populations which were very different from one another and suited to specific environments. Afterwards, these old local varieties (minutely described by Ciferri and Bonvicini 1960) were replaced by cultivars obtained through controlled crossing and selection. This greatly increased grain yield but it reduced the genetic variability of the grown germplasm. In fact most present cultivars of bread wheat come from only three old populations (Rieti, Gentilrosso, and Cologna) and share other common ancestors. In durum wheat, the old population "Jean Retifah" from North Africa was successfully used by N. Strampelli to select the cultivar Sen. Cappelli which has been widely grown in Italy and largely used in breeding programs abroad (Vallega and Zitelli 1973). It is worth noting that more than 80% of the registered Italian durum wheats have the cultivar Cappelli in their pedigree.

The present levelling in yield of the wheat cultivars grown in Italy is largely due to the fact that they are closely related genetically. Therefore it could be opportune to reconsider the old wheat populations as potential donors of new useful genes. With this purpose a research program has been initiated to define the morphophysiological, biochemical, and technological characters of old durum wheat populations from Sicily. In order to estimate the genetic variability within each population we have analyzed the endosperm storage proteins (gliadins and glutenins). because protein composition. as shown by electrophoresis. is not affected by environmental factors such as area of growth. year. or climate (Zillman and Bushuk 1979; Lookhart and Finney 1984) and is important in determining both nutritional and pasta-making quality of semolina.

In a previous paper (Boggini *et al.* 1985) we have analyzed the gliadin composition of 24 Sicilian durum wheat populations by means of Acid-Polyacrylamide Gel Electrophoresis (A-PAGE). However, in the present work

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we report on the glutenin composition examined by electrophoresis in presence of Sodium Dodecyl Sulphate (SDS-PAGE) as well as on some morphological and quality aspects of those populations.

Materials and Methods

The 24 wheat (*Triticum durum* Desf.) varieties used in this study were taken from the collection kept at the Experimental Institute for Cereals, Catania, Italy. They are listed in Table 1 according to the botanical classification by De Cillis (1942). Five seeds from 20 spikes chosen at random within each population were used for the electrophoretic analysis. The remaining seed were grown at Catania in 1.5 m-long head rows. The morphological and physiological characters measured on each row were: plant height, heading date, glume and awn color, and glume hairiness. The quality measurements were: 1000-kernel weight, protein content and SDS-sedimentation volume (Axford *et al.* 1979). The storage protein composition was analyzed by electrophoresis on 10% polyacrilamide gel slab in the presence of sodium dodecyl sulphate (SDS-PAGE) according to the procedure of Laemmli, as modified by Payne *et al.* (1980). The gliadin composition has been determined by electrophoresis at pH 3.1 (A-PAGE) as described previously (Boggini *et al.* 1985).

Table 1. Botanical classification of local varieties.

Triticum durum Desf.	Local varieties
Var. Leucurum Koern	Cannizzara
	Regina
	Tripolino S. Agata
Var. Leucomelan Koern	Biancuccia
	Inglesa
Var. Reichenbachii Koern	Tunisina
	Urria
Var. Melanopus Koern	Farro Lungo
	Giustalisa
	Martinella
	Realforte
	Semenzella
Var. Erythromelan Koern	Castiglione Glabro
	Cotrone
	Gioia
	Pavone
	Ruscia
	Vallelunga Glabra
	Lina
Var. Apulicum Koern	Vallelunga Pubescente
Var. Coerulescens Koern	Scorsanera
Var. Hordeiforme Koern	Russello
Var. ?	Sicilia Lutri
Var. ?	Sicilia Reste Nere

Results and Discussion

The results of the morphophysiological observations can be summarized as follows. Most varieties consisted of two or more lines which differ from one another in several aspects. The plant phenotype of eight varieties (Cannizzara, Regina, Inglesa, Tunisina, Urria, Giustalisa, Castiglione glabro and Lina) was clearly different from that described by De Cillis (1942) and in five varieties (Farro lungo, Martinella, Ruscia, Vallelunga pubescente and Scorsanera) the original phenotype was present only in few lines. Moreover, two varieties (Regina and Inglesa) and some lines belonging to Biancuccia and Urria were indistinguishable from Tripolino S. Agata. All these observations indicate that a high degree of heterogeneity exists within those varieties and that correspondence with the description by De Cillis (1942) is rather limited.

The High-Molecular Weight (HMW) glutenin subunits present in the 20 seed samples from each variety were separated by SDS-PAGE and numbered according to Payne and Lawrence's nomenclature (1983). A typical electrophoretic pattern obtained by SDS-PAGE is shown in Fig. 1. The seed samples were also analyzed by A-PAGE to check the presence of γ-gliadin bands designated 45 and 42, closely correlated with gluten strength and weakness, respectively (Damidaux *et al.* 1978).

The storage protein composition (gliadin and glutenin) of the 24 Sicilian cultivars (Table 2) is very heterogeneous: 19 varieties showed two to five different electrophoregrams. As expected, the varieties Regina, Inglesa and Tripolino S. Agata had the same electrophoretic pattern, clearly indicating their genetic equality. The HMW glutenin subunits 13+16, 6+8 and 20 were present in 20, 17 and 14 varieties, respectively. These bands are allelic forms coded by the complex locus *Glu-B1* in the long arm of chromosome 1B and the subunits united by the sign plus are controlled by genes very close together within that locus (see Payne *et al.* 1984 for a review).

The HMW subunits 6+8 and 20 are very frequent in the durum wheats grown in Italy whereas bands 13+16 are rare (Pogna *et al.* 1985), being present only in two

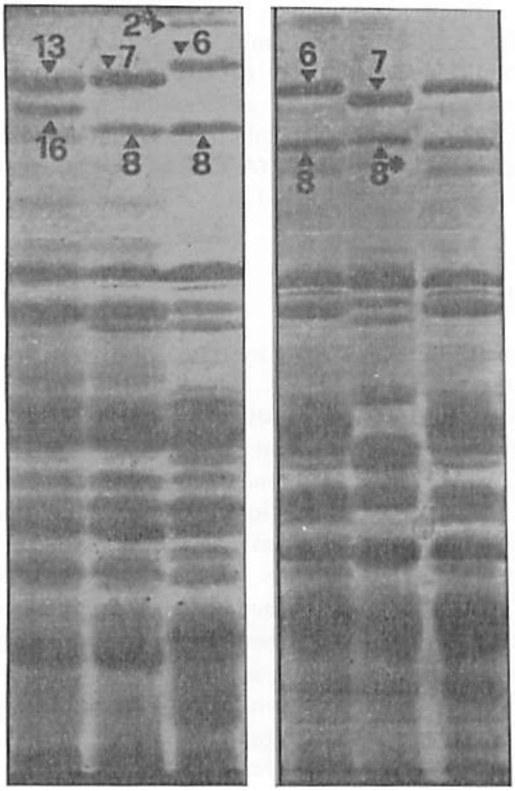

Fig. 1. SDS PAGE fractionation of endosperm proteins from three lines of vallelunga Glabra (at the left) and three lines of Sicilia Reste Nere (at the right). The HMW glutenin subunits are numbered. The new subunit 8* has an electrophoretic mobility little lower than band 8.

cultivars, Isa and Murgia, both related to the Sicilian variety Russello. In this context it is worth noting that HMW subunits 13+16 were shown to be correlated with gluten strength as measured by SDS-sedimentation test (Payne *et al.* 1981). The HMW 7+8 (locus *Glu-B1*) were present in minor lines of Realforte and Vallelunga glabra (Fig. 1); as for bands 13+16 a consistent relationship has been found between the presence of subunits 7+8 and strong gluten properties (Payne *et al.* 1984; Pogna and Mellini 1986). Two new HMW subunits compositions never described before have been found in Sicilia Reste Nere: one of these is constituted by subunit 7 and a subunit designated 8* whose electrophoretic mobility is a little lower than that of subunit 8 (Fig. 1). The second composition is made by a pair of subunits similar to bands 13+16 but a little faster (Fig. 2). Some electrophoretic patterns showed the simultaneous presence of two allelic HMW subunit compositions (6+8 and 20 or 6+8 and 13+16), clearly indicating that spontaneous crossing occurred between lines, a fact that partly explains their remarkable genetic variability.

The durum wheats grown in Europe, North America, and North Africa lack HMW subunits coded by the locus *Glu-A1* in the long arm of chromosome 1A (Pogna *et al.* 1985; Pogna *et al.* 1986a). The only exceptions we know are the Italian cvs Avanzi E. and Lambro, the French cv Nita, and the Canadian cv Nugget. In the old Sicilian germplasm three varieties (Ruscia, Vallelunga glabra, and Vallelunga pubescente) showed HMW subunit 2* coded by chromosome 1A (Fig. 1). Moreover three lines of Sicilia Reste Nere showed a new HMW subunit possibly coded by the locus *Glu-A1* as suggested by its electrophoretic mobility (Fig. 2). Several authors showed that cultivars or lines with HMW subunits controlled by chromosome 1A possess superior gluten quality to those lacking these subunits (Payne *et al.* 1981; Moonen *et al.* 1983; Pogna and Mellini 1986).

Except for the triad Regina, Inglesa, and Tripolino S. Agata, all varieties had lines with the quality associated gliadin 45 whereas its allelic gliadin 42 was present in 12 varieties.

SDS-Sedimentation tests have been applied to estimate gluten quality of some lines in 10 varieties (Table 3). The SDS-sedimentation values are closely correlated with viscoelastic properties of gluten, loaf volume, and firmness of cooked pasta (Preston *et al.* 1982; Dick and Quick 1983). As the sedimentation volume reflects both protein quantity and quality, we have reported in Table 3, as measure of protein quality, the specific sedimentation volume, that is the volume divided by the percentage of protein. In general the specific volumes were very low because the seeds were shrunk owing to a grave attack of root rot; therefore the results must be considered rather rough. The highest values have been obtained in lines with HMW subunits 2* and/or subunits 6+8, whereas the lowest value has been measured in a type 42 line of Biancuccia. The lines with subunits 20 or 13+16 had similar sedimentation values.

The Sicilian wheat germplasm possesses several morphophysiological characters typical of plant adapted to environments prone to drought and high temperatures. Typical characters are (i) reduced leaf apparatus with thick, glaucous leaves able to crumple up when air temperature is high; (ii) long, black awns and pubescent glumes, and (iii) long and rather loose spikes with many seeds. All these characters are not present in a single genotype whereas all plants are high, late in flowering, and subject to root rot. By use of chemical hybridising agents recently developed (Carver and Nash

Table 2. **HMW Glutenin subunits and γ-glutenin bands present in 24 varieties from Sicily.**

Local varieties	**Locus**	**HMW Glutenin subunit and gliadin band**										
	Glu-A1	-	-	-	2*	-	2*	-	-	-	-	N.C.
	Glu-B1	13+16	13+16	6+8	6+8	20	20	20	7+8	7+8	7+8*	N.C.
	Glu-B1	γ 45	γ 42	γ 45	γ 45	γ 45	γ 45	γ 42	γ 45	γ 42	γ 42	γ 42
Cannizzara			+			++						
Regina			++									
Tripolino S. Agata			++									
Biancuccia				+		+		++				
Inglesa			++									
Tunisina			+	++		+		+				
Urria			+	+		++		+				
Farro Lungo		+		+		++						
Giustalisa		++				++						
Martinella		++				+						
Realforte		++		++		+				+		
Semenzella		+		++				+				
Castiglione Glabro		+		++		+						
Cotrone				++								
Gioia		++		+								
Pavone				++		+						
Ruscia				+	++		+					
Vallelunga Glabra		++		+	+	+			+			
Lina		++		++								
Vallelunga Pubescente		++		+			+					
Scorsanera			++	+								
Russello		++										
Sicilia Lutri			+	++								
Sicilia Reste Nere			+	++							+	+

N.C. = New HMW Subunit Composition (see text), ++ = Major composition, + = Minor composition.

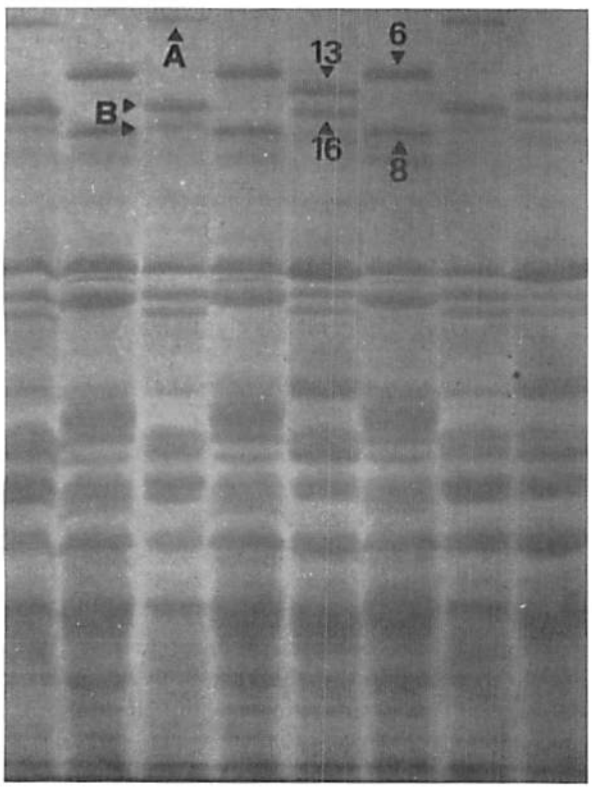

Fig. 2. SDS–PAGE of proteins from Sicilia Reste Nere. The HMW glutanin subunits are numbered and the new subunits coded by chromosome 1A and chromosome 1B have been given letters A and B, respectively.

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1984) we are trying to introduce all the above mentioned positive characters as well as the quality associated protein bands into productive genotypes with a view to selecting lines fit to the dry, marginal areas in southern Italy where durum wheat is the main or sole crop.

Table 3. SDS-sedimentation specific volume (ml/% prot.) of lines with different HMW glutenin subunit composition from old durum wheat cultivars.

	Gene locus	HMW Glutenin Subunits				
	Glu-A1	None	None	None	2*	2*
Variety	*Glu-B1*	6+8	13+16	20	6+8	20
Vallelunga Glabra		2.06	1.88	1.25		
Urria		2.19		1.23		
Tunisina		1.31		1.17		
Biancuccia		2.06		1.41 0.99[(a)]		
Ruscia		1.92			2.18	2.02
Realforte		1.53	1.24			
Castiglione Glabro		1.47	1.28			
Sicilia Reste Nere		1.33	1.29			
Semenzella		1.72	1.48			
Giustalisa			1.23	1.78		

(a) = Line with γ gliadin 42. All other lines have γ gliadin 45.

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Impact of Mechanization on Wheat Production in Rainfed Areas of Jordan*

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Jordan has an area of about 9.0 million hectares out of which 1.2 million hectares are arable and only 0.54 million hectares are under cultivation. Of these 0.04 million hectares are irrigated, and 0.5 million hectares are rainfed. The most important field crops produced in the rainfed areas are wheat, barley, and lentils.

Total wheat production in Jordan varies widely from year to year. In 1974 production covered about 50% of the total consumption and in 1979 it covered only 3% of the total demand.

It has been observed that the wheat yield in Jordan is low compared to yields obtained from similar rainfed areas (> 350 mm annual rainfall) in other countries. Average wheat yield in Jordan has been 481 kg/ha for 11 years (1975-1985), with a maximum of 979 kg/ha in 1980, a high-rainfall season, and a minimum of 158 kg/ha in 1979, a low-rainfall season. Comparisons between yields of three main districts of Jordan for the years 1975-1985 are shown in Table 1. Variations in yields were due to amount and distribution of annual rainfall.

Table 1 shows that a positive relationship exists between yield and annual rainfall. Any deviation from this is due to unevenness in rainfall distribution throughout the season. Yields (410 and 438 kg/ha) obtained from Irbid area at high rainfalls (347.8 and 414.7 mm, respectively) were lower than the yield (503 kg/ha) obtained at low rainfall (280.1 mm). This is due to the fact that more than half the amount of seasonal rain fell in one or two months in the first case, while rainfall in the second case was evenly distributed over 5 months. Similar observations were recorded for Karak area where the yield (82 kg/ha) obtained at rainfall of 257.8 mm was lower than those (290 and 275 kg/ha) obtained at 240.9 and 222.4 mm rainfall, respectively. In Amman district unevenly distributed rainfall of 524 mm produced a yield of 189 kg/ha as compared to higher yields at lower but evenly distributed rainfall.

The main factors that could influence wheat yield in rainfed areas are the availability of seed and root environmental characteristics including soil temperature, aeration, nutrients, and moisture content.

Also proper tillage practices, depth of sowing, time of sowing, seeding rate, moisture conservation, and fertilization are important factors that can improve seed germination and emergence rates which in turn, will increase plant growth and yield.

In order to increase wheat yield in Jordan up to the standard averages (3000-5000 kg/ha) which are prevailing in similar rainfed areas in the developed countries, it is essential to change from the conventional wheat production methods to advanced practices.

The (traditional) practices being used in Jordan are as follows:

1. Land preparation is performed by using moldboard plow, disc plow, or disc harrow during Oct-Dec. This operation is practiced late in the season in

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Table 1. **Wheat yields (kg/ha), area (ha), and rainfall (mm) for three main districts of Jordan for the period 1975-1985.**

	Amman			Irbid			Karak		
Year	Yield	Area	Rainfall	Yield	Area	Rainfall	Yield	Area	Rainfall
1975	404	33083	471.0	410	50083	347.8	290	20143	240.9
1976	268	40599	318.5	608	59200	522.1	82	22795	257.8
1977	531	38216	446.1	438	53524	414.7	435	22386	386.5
1978	189	45941	524.0	510	56233	426.3	350	20146	258.7
1979	135	30269	287.6	135	42966	216.8	230	17003	285.7
1980	1037	41351	752.5	1076	60670	724.5	728	21126	606.4
1981	509	34883	506.7	503	39329	427.3	402	16932	364.5
1982	509	35581	459.1	503	40509	280.1	402	17440	300.3
1983	1080	30885	645.2	1150	37107	532.9	850	20459	493.5
1984	915	22183	482.7	459	24135	339.9	275	10930	222.4
1985*	600	20305	448.2	905	26942	351.9	804	12220	362.7

Source: Various Agricultural Statistical Yearbooks, Department of Statistics, Jordan, and records from Meteorological Department of Jordan.

* Data obtained from the 1985 annual report, Ministry of Agriculture, Economic and Planning Directorate, Statistical Division.

order to allow the growth of weeds after heavy rains; seasonal rains usually start late in Oct and last until the end of April.

2. Sowing is performed after land preparation and cultivation for weed control during late Nov-Jan by hand broadcasting. Then seed are covered by disc harrow. This method of sowing results in uneven seed depth.
3. No fertilizers or herbicides are added or used.

Late land preparation and sowing operation during the season, particularly in wet soil, result in planting at low soil temperature and less utilization of the limited moisture available from the rain. Since moisture content availability in the soil is the most critical factor in rainfed areas, practices in which most of the rain will be utilized should be recommended. These include early land preparation and sowing as well as proper sowing depth (6-8 cm). Such depth will not permit seed to germinate at the low amount of rainfall at the beginning of the season, but only when the amount of water is enough to penetrate the soil to that depth, (i.e. 6-8 cm). When water reaches a depth of 6-8 cm. It is an indication that heavy rainfalls have started and will continue, in most seasons, all through the rest of the season. Therefore, no high risk is taken if sowing was performed early in the season, provided that seed are placed at the proper depth (i.e. 6-8 cm). If early sowing was practiced, weed control by herbicides is a must in order to conserve moisture and nutrients.

In order to improve the wheat yield in Jordan, several studies were made in which different land preparation implements and tools, sowing and weed control methods, and fertilization rates were compared.

An economic evaluation was made, based on research conducted by a team from the Ministry of Agriculture (MOA), Jordan, and Oregon State University (OSU), USA, (Schmissaur 1976). The MOA/OSU study, which was carried out for seven years (1968-1974), compared the wheat yield obtained from using a technology package, which included the use of chisel plow; grain drill; fertilizers; and chemical weed control, with the yield obtained from using the traditional practices specified earlier. The results of this study indicated that the average wheat yield obtained from using the technology package for five seasons in Amman Governorate was 2010 kg/ha compared with 1250 kg/ha for the traditional method. The same study showed that additional cost and net income, based on the 1975 prices, due to the use of the technology package were 33.34 JD/ha and 42.70 JD/ha, respectively (1JD = 3 USD).

Greenfield (1977) concluded that the use of grain drill to sow wheat seed increased the yield to 1400 kg/ha from 800 kg/ha produced when hand broadcasting was used. He also concluded that an additional net income of 30 JD/ha was obtained when the grain drill was used.

In 1984, another study was conducted by a team from the University of Jordan, MOA, and the International Center for Agricultural Research in the Dry Areas (ICARDA) on wheat production, using different cultivation techniques, seed rates, and fertilizers and also different methods of planting and herbicidal treatments. The results indicated that the use of grain drill for sowing doubled the grain yield obtained from hand broadcasting. The use of herbicides by boom sprayer increased the yield by about 50% as compared to no herbicidal treatment.

Based on the above results, the following recommendations were made in order to obtain higher yields under rainfed conditions of Jordan:

1. Early tillage operation (Sept - Nov), using chisel plow should be practiced for better soil moisture conservation.
2. Seedbed preparation should be followed using sweep.
3. Early sowing (late Oct - early Dec) should be practiced using grain drill with hoe-type furrow openers. Covering device behind the furrow openers on the drill is not needed in most rainfed areas of Jordan. Leaving furrows and ridges after sowing would help retain more moisture and reduce runoff.
4. Fertilizing with N and P_2O_5 at the rates of 60 and 30 kg/ha, respectively, should be applied during sowing, using grain drill.
5. Herbicides should be used to control broad-leaved weeds, using 2-4-D sprayed by boom sprayer.

Demonstrations for several years have proved that the yield and net return obtained from using the recommended practices were at least 50% higher than those obtained from using the traditional methods. Observations made indicated that differences in yield between using the new technology and the traditional one are more pronounced at dryer seasons.

Most of the wheat production practices recommended require different types of farm implements from the ones used in the traditional practices.

The majority of the farm machinery services provided in Jordan are offered through private custom operators, due to land fragmentation. Therefore, it was necessary for owners of hired farm machinery to acquire the implements suitable for performing the operations as recommended. Until they do so, the government assigned to the Jordan Cooperative Organization (JCO) the establishment of farm machinery hiring stations in Amman, Irbid, and Karak districts. These stations were established in Amman district in the 1981/1982 season and in Irbid and Karak districts in the 1983/1984 season to provide services. The number of machines and implements operated by these stations could serve 5000 hectares in each of Amman and Irbid districts and 1000 hectares in Karak district.

The three stations are providing farm machinery services to wheat and barley producers through two methods:

1. As requested by individual farmers with as small holdings as 3 ha. Smaller holdings are served if prior arrangements were made with neighboring farmers to join-in and form a larger parcel of land to be served as one unit. Charges for the different operations provided by the farm machinery hiring stations and traditional custom operators and cost of inputs are shown in Table 2.
2. Serving contracted farmers for seed multiplication purpose in which farmers are given the machinery services at the same charges as for individual farmers. In addition, seed and fertilizers are sold to farmers through the seed multiplication project at cost. Then the project through its seed cleaning and distribution units is obliged to buy the product at a 20% higher price than the market price.

Table 2. Charges and cost (JD/ha) of "New Technology" implements and inputs provided by the farm-machinery hiring stations and traditional practices.

Operation	New Technology		Traditional	
	Implement or materials	Charges or cost	Implement or materials	Charges or cost
Tillage	Chisel	5.00	moldboard	10.00
Seedbed preparation	sweep	4.00	none	
Sowing and fertilizer	grain drill	6.00	hand broadcasting	
	seeds	12.00	seeds	12.00
			disc harrow	3.50
	fertilizers	8.00	none	
Weed control	boom sprayer and materials	6.50	none	
Harvesting	grain combine	12.50	grain combine	12.50
Others	sacks and transport	9.00	sacks and transport	7.00
	Total	63.00		48.50

Strict rules, controls, and field inspections are applied in this arrangement.

Contracted farmers are requested to use the technology package, and to keep their fields free from unwanted plants of other wheat varieties or weeds which were not controlled by the herbicide. To do so, contracted farmers agree that 50 cm-wide strips of land are kept unplanted every 5 meters of planted strips, in order to allow for field inspectors and manual laborers to walk through the field. The cost of this additional hand weeding or roguing is minimal (3-6 JD/ha) and rarely needed. At harvesting time, seed are sampled and tested, and if the product was accepted, the harvesting operation is performed by the grain combine available in the hiring stations or from any private custom operator, however, under the guidance and control of personnel from the seed multiplication project. The product is then delivered to the nearest seed cleaning station, owned and operated by MOA and JCO.

The objective of this paper is to study the impact of using the "new technology" on wheat yield in Jordan.

Procedure

In order to study the impact of using the new technology to produce wheat in Jordan, a questionnaire was made for individual farmers acquiring machinery services through the first method. The questions covered topics such as the time when farmers started using the new technology, the amount of yield obtained, and the willingness of farmers to perform land preparation and sowing earlier in the season than the traditional dates. Some socioeconomic questions regarding part-time farming, renting-in, renting-out, and sharing in and out were also included in the questionnaire.

For the seed multiplication contracting method, records of the yield which were accepted from the contracted farmers were obtained from the seed cleaning stations for the three districts. These yields were compared to yields obtained from previous statistical national data for the same districts.

Results and Discussion

Results of the two methods of providing the new technology package will be discussed as follows:

1. In case of providing services to individual farmers, a sample of 100 farmers hiring farm machinery services in the three districts (50 in Amman, 30 in Irbid, and 20 in Karak) were interviewed.

   Comparisons between eight combinations of the tillage practices, sowing methods, and type of inputs were made; however three combinations are recorded in Table 3. The purpose of the questionnaire was mainly to compare yield of fields cultivated traditionally, prior to availability of new technology, with yield of the same fields cultivated by the new technology for the last 5 years (1981-1985).

   Table 3 shows that in the three districts, the wheat yield was higher when the new technology for wheat production was practiced. Average yields for 4 seasons (1981-1984) in the case of traditional practices were 1098, 1635, and 788 kg/ha for Amman, Irbid, and Karak, respectively. However, average yields for 3 seasons (1983-1985) in the case of the new technology were 2022, 2312, and 1679 kg/ha for Amman, Irbid, and Karak districts, respectively. An increase in yield ranging from 41 to 115% was achieved when the new technology was applied. It should be stated here that in answering the questionnaire, some farmers relied on their memories and not on recorded data of yields for the five seasons. However, unusual incidents such as higher yields than usual are well remembered by farmers and for a long time.

   Also, it is worth mentioning that comparisons between yields were based on averages of different seasons. If the comparisons are to be made for the same seasons, then it is best to compare yields of same seasons in Tables 1 and 3 for each district. In this case the differences in yields are much larger. In fact, the data obtained from 2 or 3 seasons for small areas may not be sufficient to draw such conclusions, but it could be stated with confidence that there is a trend of higher wheat yields when the new technology was used.

2. In the case of using the yields of contracted farmers, records of the seed cleaning stations were used. Yield comparisons are made based on the 1984 and 1985 records of the stations (new technology). Data were obtained from statistical yearbook (traditional and new technology) and from the 1985 yield estimation made by a qualified team from the seed cleaning stations for the three districts (traditional) (Table 4). It is worth mentioning here that national statistical data for the 1984 and 1985 seasons included wheat areas served by the new technology through the machinery-hiring stations in the three districts (Table 4). For this reason the statistical data involved both the traditional and the new technology practices.

   It is realized that the average yields obtained through the national statistical data from large areas in the three districts should not be compared

Table 3. Comparisons between combination of tillage and sowing practices for wheat production in three districts of Jordan for 5 years (from the questionnaire).

Method	Year	Amman Area (ha)	Amman Yield (kg/ha)	Irbid Area (ha)	Irbid Yield (kg/ha)	Karak Area (ha)	Karak Yield (kg/ha)
Traditional (moldboard, hand broadcasting, no weed control and no fertilizer)	1981	1022	1100	59	1750	814	750
	1982	992	1000	64	1500	504	800
	1983	352	1350	16	1750	420	850
	1984	50	1250			15	750
	1985						
	Average		1090		1635		788
Traditional (+ weed control by herbicide)	1981	300	1000	26	1700	40	900
	1982			34	1500	350	800
	1983	50	2250	32	1900	295	850
	1984			24	2000	150	800
	1985			13	1500		
	Average		1179		1833		932
New technology (chisel + grain drill + fertilizer + weed control)	1981						
	1982						
	1983	150	1800				
	1984	298	2000	17	2150	461	1650
	1985	513	2100	20	2450	621	1700
	Average		2022		2312		1679

Table 4. Yields (kg/ha), area (ha) from records of seed cleaning stations (contracting), statistical data, estimated yield and areas (ha) served by farm-machinery hiring stations for 1984 and 1985 in three districts.

District	Year	Area served by hiring station (ha)	Contracting (new technology) Yield	Contracting (new technology) Area	Statistical* (traditional and new technology) Yield	Statistical* (traditional and new technology) Area	Estimated (traditional) Yield	Estimated (traditional) Area
Amman	1984	2050	not available		915	22183		-
	1985	1950	1790	1029	600	20305	1050	-
Irbid	1984	1500	1100	246	459	24135		-
	1985	1250	1750	378	905	26942	921	-
Karak	1984	150	1230	56	275	10930		-
	1985	300	1337	402	804	12220	723	-

* From Table 1.

to those obtained from much smaller areas, particularly because the large areas received the highest rainfall in the district. For this reason the difference in yield for the 1984 season in the Karak district between the statistical data, obtained from a total area of 10930 ha, and the new technology which was applied on a total area of 56 ha was very sharp.

It could be concluded from the data in Table 4 that areas served by the new technology yielded higher than areas served by the traditional methods whether completely (1984) or partially (1985), in all three districts. In 1985 percentage yield increase in the case of the new technology as compared to the traditional practices were 70,90, and 85% in Amman, Irbid, and Karak, respectively. However, these percentages were 192, 100, and 66% for Amman, Irbid, and Karak, respectively, when yields of contracted farmers were compared with the national statistical data for 1985.

These increases in yield as a result of using the new technology would bring to farmers average additional net income of 92 JD/ha based on 740 kg/ha average yield increase at a price of 144 JD/t and after subtracting the 14.5 JD/ha additional cost of production taken from Table 2. Also an additional net income of 10-20 JD/ha could be obtained if straw baling operation is performed at a rate of 0.12 JD/bale.

The additional yields and net income are reflected positively in the level of food security in the country. It has been observed that farmers in the rainfed areas were encouraged to put more areas under wheat cultivation because of the considerable increase in net income.

Conclusions

It could be concluded from the above that:

1. The use of chisel plow and sweep for tillage and seedbed preparation, grain drill for sowing, herbicides for weed control in addition to fertilizer application increases the yield significantly as compared with the traditional practices used for wheat production.
2. Although the cost of production is higher in the case of the new technology than in the traditional one, the net return is significantly higher.
3. The high net return obtained from producing wheat using the new technology convinced farmers to cultivate more areas, thus increasing the total production of the country.

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Cultural and Fertilizer Management Practices for Wheat Production in Pakistan

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The yield gap which exists between potential wheat yield and yield at the farm level can be narrowed by the development of high-yielding varieties, judicious use of fertilizers, and proper management of cultural practices. The intensive cropping of the newly introduced high-yielding varieties has led to the deficiency of nitrogen in Pakistan's soil. Therefore the use of nitrogenous fertilizers became widespread. The use of nitrogen has been reported to affect yield components, straw, and grain yield (Khan 1973; Hussain 1973; Ahsan 1976; and Yousef *et al.* 1977).

Cultural practices such as sowing methods and row orientation are also known to affect wheat yield. Day *et al.*(1978) found that wheat grown on beds with east-west orientation gave lower grain yield as compared to flat sowing. Khan and Agrawal (1985) studied the effect of sowing methods on mustard and found that ridge and furrow sowing was significantly superior to conventional flat sowing for increasing seed yield. Mustard sown in a furrow in the ridge and furrow system by ridge seeder made more efficient use of water. This may increase the efficiency of N use and response to applied nitrogen (Batra *et al.* 1976). Day *et al.* (1978), and Gupta and Singh (1983) reported higher wheat grain yield with east-west sowing direction than with north-south sowing direction. However, Reddy and Prasad (1981) found that nitrogen content and uptake in grain and straw were similar in crops grown in northwest-southeast and northeast-southwest directions.

Less information is available regarding the effect of sowing method and row orientation on wheat productivity under irrigated conditions of Pakistan. This study was therefore conducted to determine the effective combination of nitrogen fertilizers, sowing method, and row orientation for enhancing wheat yield under irrigated conditions of Faisalabad.

Materials and Methods

This study was conducted at the Agronomy Research Area of University of Agriculture, Faisalabad, Pakistan, using wheat cultivar WL-711. Two methods of sowing viz. bed and flat (conventional) were used in combination with two row directions: east-west and north-south. Fertilizer rates used in the study were 0, 56, and 112 kg N/ha. A split split plot design with three replications was used, with sowing methods in the main plots, row positions in the subplots and fertilizer levels in the sub-subplots. Plot size was 10 m x 3 m. A basal dose of 56 kg P_2O_5/ha in the form of superphosphate was applied during seed bed preparation. Urea was used as a source of nitrogen.

The crop was sown in the second week of November 1980, using a single-row hand drill with rows 25 cm apart and a seed rate of 90 kg/ha. At maturity, various yield-related traits were recorded and grain yield was determined by harvesting a central 10-m^2 area from each plot.

Results and Discussion

Plant height was not significantly affected by sowing methods, row orientation, or nitrogen rates (Table 1). The effect of row direction on productive tillers, harvest index, grain yield, and fertilizer efficiency was also nonsignificant. This is due to the fact that in plain areas of Pakistan, abundant sunlight is available, therefore, shading effect, if any, in case of north-south rows could not affect the photosynthesis. These results are in agreement with those of Reddy and Prasad (1981), who did not notice any effect of row direction on wheat yield and nitrogen utilization in grains, but are contradictory to results by Day *et al.* (1978) and Gupta and Singh (1983), who obtained higher wheat yields with east-west rows than with north-south rows.

Methods of sowing significantly affected the productive tillers, grain yield, and fertilizer efficiency. Bed sowing resulted in significantly more productive tillers, and higher grain yield and fertilizer efficiency as compared to flat sowing (Table 1). Similar results were reported by Batra *et al.* (1976) who attributed the superiority of bed sowing to more efficient use of water. This argument is supported by higher efficiency of nitrogen of bed sowing as compared to flat sowing.

Fertilizer rates significantly affected the productive tillers, harvest index, grain yield, and fertilizer efficiency, but had no effect on plant height. More productive tillers at different fertilizer levels contributed towards greater grain yield. However, fertilizer efficiency was lower at the higher fertilizer level (Table 1). This is probably due to a better utilization and lower losses of nitrogen at the lower fertilizer level. These results are in agreement with those of Pearman *et al.* (1978) who obtained lower agronomic and physiological efficiency at higher rates of nitrogen fertilizer.

Despite the significant interactions of sowing method with nitrogen fertilizer detected for productive tillers, grain yield, and nitrogen efficiency (Figs. 1 and 2), the superiority of bed sowing versus flat sowing was maintained at all levels of nitrogen application for all three traits.

Table 1. Effect of sowing method, row direction and nitrogen rate on wheat plant height, productive tillers, harvest index, grain yield, and fertilizer efficiency.

Treatment	Plant height (cm)	Productive tillers (No./m^2)	Harvest index (ratio)	Grain yield (tonnes/ha)	Fertilizer efficiency (kg grain/kg N)
A. Sowing method					
Bed sowing	78.4a	427.5a	32.7a	5.3a	29.1a
Flat sowing	79.4a	318.8b	33.11a	4.0b	20.0b
B. Row direction					
East-West rows	78.7a	380.4a	32.9a	4.7a	24.6a
North-South rows	79.3a	349.2a	32.8a	4.6	24.5a
C. Nitrogen rate					
Control	79.9a	334.5b	31.9b	3.3c	-
56 kg/ha	80.0a	388.8a	34.2a	4.7b	26.6a
112 kg/ha	81.1a	403.0a	32.5b	5.8a	22.5b

Mean values sharing same letters are not significantly different at the 5% level of significance, using LSD.

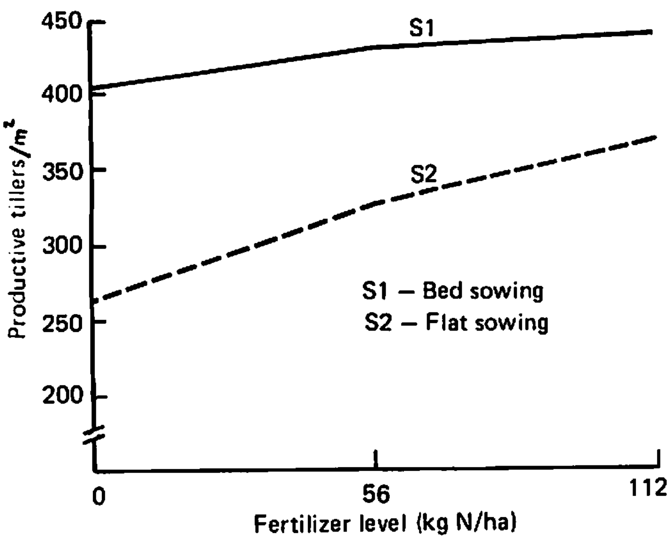

Fig. 1. Effect of sowing methods and N levels on productive tillers.

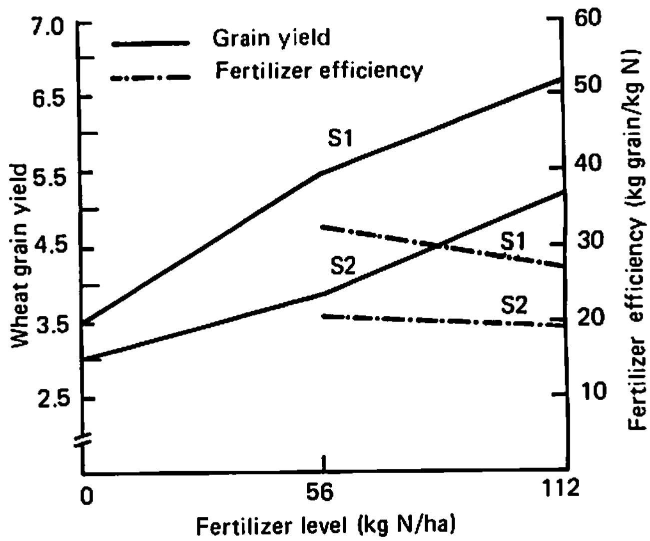

Fig. 2. Effect of sowing methods and N levels on grain yield and fertilizer efficiency.

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Short Communications

Testing for Barley Yellow Dwarf Virus (BYDV) at ICARDA

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Preliminary surveys carried out by the virology laboratory at ICARDA, Aleppo, Syria, during 1985 and 1986 indicated that BYDV is endemic in the countries surveyed. BYDV incidence varied greatly among countries (5-22%) and more so among fields within the country (1-100%). BYDV is considered the most serious viral problem of cereals world-wide.

To assess the economic importance of BYDV in West Asia and North Africa - ICARDA region - more testing is needed in each country. It is not possible to accurately determine the presence of BYDV in an infected plant on the basis of symptoms alone. A more precise image on BYDV spread could be obtained by testing serologically (ELISA) for the presence of the virus. Since not all research centers in the region have the facilities for testing for BYDV, the virology lab of ICARDA is prepared to cooperate with all those interested in evaluating the importance of BYDV in their region.

For each field to be surveyed, 200-300 single leaves should be collected at random and grouped and placed in one plastic or paper bag. Each bag should be labelled with the location (town and country), date of sampling, kind of crop (barley, bread wheat, durum wheat, or oat) and name of the collector. The best time for collecting samples is late in the growing season when the plants are still green. If it is not possible to send the samples to reach Aleppo, Syria, within 3-4 days from the day of collection, it is preferable to let the leaves dry in the shade or-if available - use a desiccator at room temperature. Samples when received will be processed and results obtained will be mailed to the sender within a reasonable period of time.

Interested individuals - or research centers - can send their samples to the above address.

Natural Infection of the Cereal Aphid Metopolophium dirhodum with a Fungus in Syria

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During a study on population dynamics of cereal aphids in relation to incidence of barley yellow dwarf virus on cereals in the northwestern region of Syria, an aphid (*Metopolophium dirhodum* (Walker)) was found to be naturally infected with the fungus *Entomophthora planchoniana* Cornu (Fig. 1a).

This is the first report of *E. planchoniana* as a fungus which infects aphids in Syria. In addition, the aphid, sampled in May, contained only resting spores of the fungus (Fig. 1b), whereas in Europe resting spore formation usually occurs in the fall. By producing resting spores early, the fungus will have a better chance to survive the dry, hot summer in Syria.

The early production of resting spores is of particular interest, and there are analogous problems concerning insect parasites and the development of pesticide resistance. In the drier parts of the Middle East, the growing season is October/November to April, and by June the ground is bare, and only little food is available for aphids, and traps catch almost nothing during July, August, and September. Every October or November, however, the crops are reinfested. The question is, what proportion survive the summer locally in moist gullies, caves, etc. and what proportion are reintroduced from afar-probably from distant mountains?

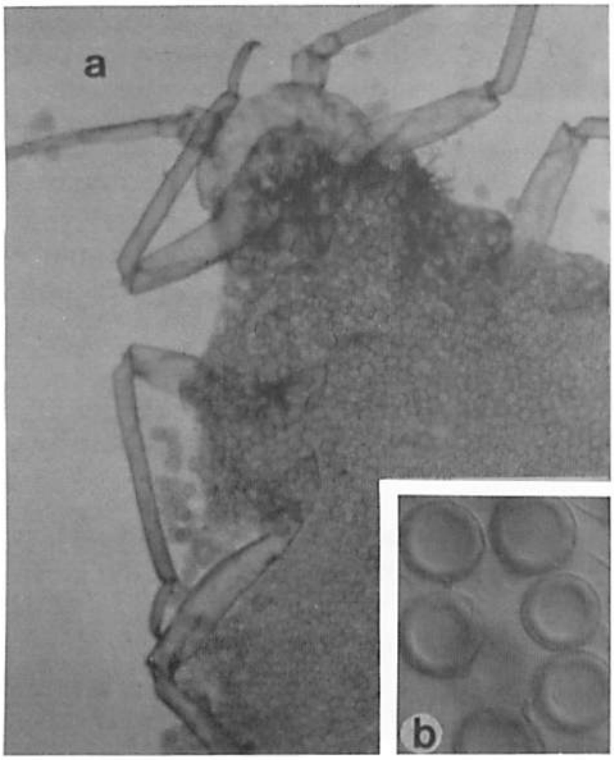

Fig. 1. Immature *Metopolophium dirhodum* invaded with the fungus *Entomophtora planchoniana* (x40) — a, and resting spores of the fungus (x25) — b.

The situation is obviously likely to be different at different places and in different years. It is relevant to the development of pesticide resistance, because if a high proportion of each year's population originates locally, then the previous year's pesticide applications are likely to affect the current year's pesticide tolerance. However, if the area is mostly recolonized from afar, then the previous year's local spraying program is irrelevant. Hymenopterous aphid parasites belonging to several genera also appear every year, and it is not known whether they diapause early, thereby avoiding the dry season, or are reintroduced from afar.

Hyperparasites are relatively much rarer in the Middle East than in northwestern Europe, perhaps because the aphid and primary parasite season is shorter in the Middle East and there are not enough host generations for large hyperparasite populations to develop. Perhaps hyperparasites have no aestivating ability, but like primary parasites, they could presumably be carried by the wind. Anyway, there are some very interesting problems in aphid biology waiting to be solved.

The development of pesticide resistance in aphids encourages workers to investigate the usefulness and practicality of using parasites in their control. The possible use of the fungus *E. planchoniana* for the control of cereal and other aphids in Syria should be further investigated.

Investigation of Seed-Borne Infection with <u>Leptosphaeria</u> <u>nodorum</u>

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Seed can be one of the means by which *Leptosphaeria nodorum* infection can occur. Therefore planting of disease-free seed is one of the major prerequisites for obtaining good yields of wheat. Seed-borne infection is primary and can appear at any stage of the wheat growth cycle, from emergence to maturity. Tests were conducted on 25 varieties to determine whether there is a difference in infection percentage between individual varieties. Deep freezing blotter method was used (Mathur and Silvia 1977; Mathur 1977) since it showed to be the most suitable for this kind of testing.

Readings of *Leptosphaeria nodorum* seed infection were taken 14 days following inoculation by counting the kernels covered with pycnidia or orange-red-pinkish conidia. Samples were checked through a microscope and the results were subjected to statistical analysis.

Analysis of 3-year results shows that the varieties and grain infection, as well as their interaction had statistically significant effect on grain infection percentage. Percentage of *Leptosphaeria nodorum* grain infection was significantly higher in artificially infected plants than on check plot. The results indicate that none of the varieties is resistant or tolerant to *Leptosphaeria nodorum.*

Table 1. Percentage of grain infected with *Leptosphaeria nodorum*

Variety	Year 1982	1983	1984
Zlatna dolina	64	46	29
Kavkaz	50	44	19
M-33-1	43	44	34
Dika	48	69	43
Lonja	43	52	42
Granka	29	46	29
Sanja	62	59	35
Korana	27	57	51
Nova zlatna	64	57	40
Dobra	54	44	44
Vučedolka	44	50	63
Baranjka	50	49	66
Nova marijana	50	51	42
Super zlatna	66	70	44
Morava	36	28	50
K-17/75	46	54	55
Libellula	25	50	47
N.S. Rana 2	22	38	65
Zlatoklasa	43	62	45
Istra	45	72	57
Lepenica	34	43	40
Sivka	45	40	27
Bistra	48	71	45
Osječanka	27	34	61
Partizanka	35	47	44
For interaction			
LSD (5%)	11.0	11.8	11.4
LSD (1%)	14.5	15.6	15.0
For variety			
LSD (5%)	7.8	8.4	8.0
LSD (1%)	10.2	11.0	10.6

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A Brief Introduction to the Production of Barley in China

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Barley is as ancient a crop as agriculture itself. It dates back to 5000 - 7000 B.C. or earlier. In China, barley was first planted 50 centuries ago. The growing area during 1931-1937 was about 7 million hectares and per unit area yield was 1.3 t/ha, and total yield 8.500.000 tons, making China the leading barley producing country in the world during that period. However in the 1950's, the area devoted to barley production dropped back to about 4 million hectares and total yield to 3.45 million tons. In the early 1980s, the area was only about 3.3 million hectares with a mean yield of 2.1 t/ha.

Barley is grown in China more widely than bread wheat. It is mainly cultivated in Jiangsu, Zheijiang, Hubei, Sichuan, Anhui, Hebei, Shanxi, Shandong, Xizang, Qinghai, and Gansu provinces, where not only the climatic conditions, including temperature, rainfall (250-2000 mm), and atmospheric pressure vary considerably, but also the elevations (1 - 4700 meters asl), although winter barleys are the predominant types grown in those elevated areas. In fact there are large differences in the per-unit-area yield among these provinces. For example, yield is about 4 t/ha in Jiangsu and Shanghai; 2.5 t/ha in Zhejiang, Beijin, and Anhuei; 1.5 t/ha in Fujian, Jiangxi, Hebei, Hubei, Sichuan, Xizang, Qinghai, Tianjin, and Xingiang; and 1 t/ha in Guezhou and Yunnan. This indicates that there is a great potential for increasing barley yield in China, and if more efforts are paid to barley production, China can rank first among the barley-producing countries in the world. So more work has to be done by the Chinese barley breeders, agronomists, and other agricultural research workers to improve the production of barley by providing both suitable agronomic practices and varieties with higher yield, good grain quality, higher tolerance or resistance to diseases, lodging, and climatic stresses.

Several barley varieties have been selected and distributed since the establishment of new China in 1949. These include the new varieties Yanfuaizao No. 3, Supi No. 1, Humei No. 4 and No. 6, Zhoumei No. 1, Danmei No. 1, Zhepi No. 1, etc., which have been bred by means of crossing and other methods such as radiation and haploid techniques. Among these, Supi No. 1, selected by the Institute of Agricultural Sciences in the Coast Area, Yancheng City, Jiangsu Province is one of the best malting barleys, which covers about 30,000 hectares. It yields up to 7 t/ha under good agronomic conditions.

Barley in China is used as human food and animal feed, and also for brewing purposes and in other feed processing industries. The proportions of barley used as feed and food are 70 and 20%, respectively, the remainder (10%) being used as malting barley and seed. However the situation is different in some provinces (e.g. Zheijiang and Jiangsu) where feed barley makes up 60% and malting barley 30%, and food barley plus seed only 10% of the total production. This trend in barley production shows that agriculture in China is gradually meeting the diversified market demands in the country.

Barley breeding in China was cooperatively initiated by Jiangsu and Zheijiang Academies of Agricultural Science in 1985. Scientists are making every effort to strengthen fruitful cooperation with foreign and international research organizations working on barley, particularly the International Center for Agricultural Research in the Dry Areas (ICARDA).

Barley-Growing Environment in Jiangsu Province and Shanghai

Both Jiangsu and Shanghai are located on the West shore of the Pacific Ocean and belong to the drainage area of Changjiang River (Yangtz River). Both are famous for their many lakes and irrigating rivers. The plain accounts for about 70% of the total area. The lowest temperature in January is usually about - 10°C and the mean annual rainfall varies between 1000 mm in the north and 1500 mm in the south. Silt-loamy soil is predominant, and shows a calcareous reaction (pH=8.5) in the north, but a slightly acid reaction (pH=5.5) in the south. The environment is therefore good for barley growing, especially for malting barley. The crop is sown in late October and harvested in late May. The major problems of barley production in these regions are frost damage, salinity, lodging, and certain diseases

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Good Performance of ICARDA's Advanced Barley Lines in China

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During the 1985/86 season ICARDA's three international Barley Yield Trials (one for moderate-rainfall areas, one for low-rainfall areas, and one for cold areas, were planted for the first time in Yan-Cheng (33.1°N, 120.05°E, 219 m asl), Jiangsu province, in the eastern coastal area of China. The encouraging results reported by the Chinese cooperators, Gong Gi Sheng and Lin Guo Yu, showed that most of the entries in the three trials gave high yields under their local conditions. Among the 66 advanced lines tested, 31 (9 in BYT-LRA, 10 in BYT-MRA and 12 in BYT-CT) yielded significantly ($P < 0.05$) better than the local check, Yan 7521. The yields, names, and pedigrees of the highest yielding lines are presented in Table 1. Among the entries, the Rihane sib lines were the most outstanding.

Table 1. Names, crosses, pedigrees, and yield of the highest yielding entries in the three ICARDA's International Barley Yield Trials planted at Yan-Cheng, Jiangsu, in China.

Name/cross/pedigree	Name of trial	Yield (kg/ha)	Yield % of local check*
Rihane-03 (= As46//Avt/Aths) Sel, 02L-1AP-3AP-0AP	BYT-LRA	11034	191%
Comp. Cr. 229//As 46/Pro ICB 78-0752-1AP-1AP-0AP	BYT-MRA	9725	156%
Rihane-05 Sel, 02L-1AP-4AP-0AP	BYT-MRA	9608	154%
Rihane-01 Sel, 02L-1AP-1AP-0AP	BYT-MRA	9582	154%
Api/CM67//Emir/Nacta/3/ MGH 6355/4/Lignee 686 ICB80-0669-0SH-5AP-0AP	BYT-CT	8770	154%
Th. Unk. 23	BYT-LRA	8748	151%

* All six entries are significantly ($P < 0.001$) higher yielding than the local check, Yan 7521.

Effect of Soil Water Deficit on Leaf Water Content of Four Barley (Hordeum vulgare L.) Varieties in Algeria

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Water deficit is one of the main problems facing agricultural production in Algeria. Barley is a major crop in Algeria where extensive areas are planted. These areas are subject to water deficit during the growing period of the crop. The physiological responses of barley to environmental conditions are relatively constant. Barley has been reported as highly resistant to drought, which makes it a good experimental material.

Four varieties: Saida, Techedritt, Robur, and Giza, were planted in pots and subjected to water stress after the emergence of the eighth leaf. Leaf water potential was measured with a Scholander bomb. Leaf area, transpiration rate, leaf water saturation deficit, and soil water content were measured.

Compared with results obtained by other researchers, our results indicated that all four barley varieties retained higher leaf water content than either soybeans (*Glycine max* L.) or wheat (*Triticum durum* L.), which confirms the drought resistance of barley.

Our results showed no difference between the leaf water content of all four varieties when soil water was not limiting. However, when soil water content decreased to 20% of soil dry weight, a difference in the leaf water content of all four varieties was observed. When soil water content was severely reduced (10-16%), leaf water potential in Robur and Tichedritt was higher than in Giza and Saida, indicating that these two varieties have a greater aptitude for resisting moisture stress.

Cereal Institute of Thessaloniki, Greece

Eleyi Theoulaki
Cereal Institute Thessaloniki
GREECE

The Cereal Institute of Thessaloniki is the only Institute in Greece responsible for the improvement of cereals (bread wheat, durum wheat barley, oats, triticale, rice, and maize) and for the study of cultural practices.

The institute was established in 1925 when agricultural research was initiated in Greece, starting with a survey of the local populations and selection of the best biotypes which significantly increased the yield.

Almost at the same time foreign varieties had been introduced for the selection of those which have good adaptation in Greece. Also, a wide program of crosses had been started through which remarkable varieties had been released.

Because of these effects, Greece became self-sufficient in wheat in 1957.

Agriculture is the main industry in Greece and cereals, the most important crops in the country, occupy about 1.400.000 hectares.

Greece is a country which has a wide variety of soil and climatic conditions. Generally, the soil is loamy and the precipitation low, decreasing from west to east. Because of the rather mild winter, wheat and barley are sown in mid-November in spite of the fact that most of them are spring varieties.

The Cereal Institute is a research institute subordinated to the Northern Greek Agricultural Research Center and belongs to the Ministry of Agriculture. It is responsible for the breeding of the following crops: bread wheat, durum wheat, triticale, barley, oats, rice, and maize.

The major objectives of the program are the following:

1. Release of new varieties with higher yield and better quality than the cultivated ones.
2. Study of the interaction between varieties and fertilization.
3. Development of varieties resistant to insects and diseases.
4. Evaluation of the herbicides for economic and effective control of weeds.
5. Study of improved cultural practices.
6. Improvement of the quality of the final products (flour, bread, etc).

Recently more emphasis has been placed on hybridization. Each new variety is evaluated through a series of trials in the fields of the Cereal Institute and in Experimental Stations all over the country for a period of at least 5 years. Close cooperation is also maintained with seed production services and extension offices. The best varieties are then transferred to the Research Institute of Cultivated Plants for final control and finally to a Greek seed organization for multiplication.

Because of the variability in soil and climatic conditions, the release of a new variety requires a long period of time, and a lot of effort. However, in spite of these difficulties, the Cereal Institute disposes a large number of local cereal varieties which covers the country's need for seed almost completely. The support of International Agricultural Research Centers (such as ICARDA and CIMMYT with whom the Institute has close cooperation), in providing valuable material every year, plays a big role in this regard.

Recent Publications

Agribookstore 1987 Catalog

This book offers description of publications from CGIAR and other international agricultural research centers and intitutions. Order from Agribookstore, Winrock International, 1611 North Kent St., Arlington, Virginia 22209, USA.

Peter B. R. Hazell (ed.). 1986. Summary Proceedings of a Workshop on Cereal Yield Variability. 1986. IFPRI, 277 pp.

This volume summarizes the workshop discussions and includes an assessment of findings prepared by a review panel. It also contains summaries and abstracts of 35 papers specially prepared for the workshop. A book recommended to all plant breeders.

Barigozzi, C. (ed.). 1986. he Origin and Domestication of Cultivated Plants. Elsevier, 218 pp.

This publication contains proceedings of a Symposium on the same topic organized by Centro Linceo Interdisciplinare di Scienze Mathematiche e loro Applicazioni, Accademia Nazionale dei Lincei, Rome, 25-27 November, 1985. Twelve papers were presented at the symposium by scientists from all over the world. One of the most interesting papers deals with the origin and early spread of agriculture in the old world. Another paper deals with the origin and evolution of wheats. The book is recommended to all those interested in crop evolution and early origins of agriculture, as some of the contributors are recognized authorities on the subject.

Plucknett, D.L., Smith, N.J.H., Williams, J.T., and Anishetty, N.M. 1987. Gene Banks and the World's Food. Princeton University Press, 247 pp., $35. (available from Agribookstore).

This book is dedicated to the memory of N.I. Vavilov, the Russian plant explorer, geneticist, and biogeographer whose 100th birth anniversary is being celebrated at several institutions all over the world. By the turn of the century, according to reliable estimates, the world will need 60% increase in food production to meet its needs. The authors discuss cases of past crop failures due to genetic uniformity and suggest ways to avoid catastrophies in the future when the consequencies will be greater. The reader will find included 10 chapters discussing the concept of gene banks, germplasm storage and their use for crop improvement. The authors also mention the present controversy on the ownership, control, and benefits of germplasm deposited in gene banks which is one of the topics being discussed by an FAO International Commission on Plant Genetic Resources.

Wricke, G. and Weber, W. E. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter & Co., 406 pp. $79.50.

This book, containing a presentation of the principles of selection in plant breeding, is intended for students as well as plant breeders and geneticists. It comprises chapters dealing with statistical problems involved in precise estimation of variance and covariance components.

Proceedings of the International Symposium on Wheats for More Tropical Environments, Sept 24-28, 1984, Mexico, DF., UNDP/CIMMYT.

The proceedings represent a premier attempt at bringing together wheat scientists from all over the world in order to search for solutions to the problems which face farmers who grow wheat under wetter environments than it can tolerate. The book is of primary interest to scientists working on wheat in the tropics, but other workers in the region can also benefit from some of the methodologies presented by more than 50 participants.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research. (2nd Edition). John Wiley & Sons, New York, 680 pp. $39.95, also paperback version $15.50. ISBN 0-471-87092-7.

This book is designed to introduce agricultural research

The contribution of Dr. A.B. Damania, ICARDA, in compiling information for the "Recent Publications, Cereal News, and Forthcoming Events" sections is gratefully acknowledged.

workers in developing countries to statistical procedures involving results of experimental trials, including advise on field experimental methods. The illustration of Duncan's test is given with an example in which there is considerable structure among treatments. The book also includes a chapter on problem data, and ends with chapters on soil heterogeneity, competition effects, mechanical errors, sampling in experimental plots, experiments in farmers' fields, and presentation of research results.

Bushnell, W.R. and Roelfs, A.P. (eds). 1985. The Cereal Rusts. Two volumes, ISBN: 0-12-148401-7 and 148402-5, 560 and 512 pp., respectively. Academic Press, $130.00 for both volumes.

These volumes were written to help in the worldwide effort to control cereal rusts by bringing together, in a single reference source, the accumulated knowledge of these important diseases for the region. The first volume contains chapters on the origin as well as structure and physiology of the rusts. The second volume contains chapters on various different rusts, their distribution in the world, epidemiology, control (strategies using resistance, strategies using chemicals). Each chapter includes a reference index. The book is recommended to cereal pathologists.

Hoseney, C. R. 1986. Principles of Cereal Science and Technology. American Association of Cereal Chemists, Inc. 327 pp.

An excellent book on cereal quality. It consists of 14 chapters in which the author describes structure, starch content, proteins, storage, milling, processing, malting, brewing, pasta-making, breakfast, and snack cereals. The end use of cereal production has been emphasized. Some sharply photographed electron micrographs give a vivid picture of grain layers, embryo, and contents of endosperm cells. The book is recommended to all scientists working on cereal quality. It can also be used as a textbook at university level as the book has a list of review questions at the end of each chapter.

David Rindos. 1984. The Origins of Agriculture, Academic Press, 325 pp. $29.50, ISBN: 0-12589280-2.

This volume contains the author's interpretation of earliest agricultural practices and domestication of crops. The most interesting chapters are those dealing with "The Naturalness of the Man-Plant Relationship and Domestication from an Evolutionary Perspective." The book may be of interest to those working on crop evolution and origins of agriculture.

Cereal News

Staff Changes at ICARDA's Cereal Improvement Program

Dr. Ahmed Zahour joined the program as a senior visiting scientist. He received a B.Sc. degree in Agronomy in 1975 from the Institute of Agronomy in Rabat, Morocco, and an M.Sc. degree in plant breeding in 1977 from the same institute. Following these achievements he was appointed assistant professor and barley breeder at the Institute of Agronomy, Rabat. Later, Dr. Zahour proceeded to the University of Minnesota for a period of 2 years to work for a Ph.D. degree. His research dealt with semi-dwarf character and yield component of barley for which he was awarded a doctoral degree in 1984. Dr. Zahour has been appointed to the barley project at ICARDA where his work will mainly focus on improving barley for the moderate-rainfall areas.

Dr. Stefania Grando joined ICARDA in March 1987 as Barley Research Scientist. She received her first degree in Agricultural Science from University of Perugia, Italy, in 1980. Subsequently she conducted research on barley breeding at the Plant Breeding Institute of the same University. Dr. Grando was awarded a Ph.D. degree by the University of Perugia in 1987 for her thesis on "Variation for Morphological and Agronomical Characters in Syrian and Jordanian Barley Landraces and in Accessions of *Hordeum vulgare* subsp. *spontaneum.*" She will be mainly responsible for the project financed by Italy on "Improving Yield and Yield Stability of Barley in Stress Environments," which is being conducted by ICARDA in collaboration with Italian institutions.

Mr. Adil Diefalla Mohamed joined the Cereal Improvement Program as Research Student. He is from the University of Gezira, Faculty of Agricultural Sciences, Gezira, Sudan. He is working on an M.Sc. thesis in the Agronomy/Physiology project, this topic of research pertains to effect of heat stress on growth and productivity of wheat.

Mr. Pedro Perez Marco joined the program as a Ph.D. student. He hails from Zaragosa in Spain and is supported at ICARDA by a fellowship from the Ministry of Agriculture of the Government of Spain. His topic of study is "Yield and Yield Stability of Barley Genotypes and Their Relation to Morphological Traits."

Ms. Helena Gomez MacPherson is also a Ph.D. student who joined the Program recently to work on photosynthesis and water use efficiency of wheat and barley. She comes from Còrdoba in Spain, supported by a scholarship from the Spanish Ministry of Foreign Affairs.

Mr. Paolo Annicchiarico who was attached to the Evaluation and Documentation of Durum Wheat Germplasm Project as research associate, left the Cereal Program in August 1987 returning to his home country, Italy, to take up a position with the Ministry of Agriculture.

Other News

A delegation from the People's Republic of China visited ICARDA during 19-31 August 1987. The team comprised of Dr. Liu Zhicheng, (leader), Dr. Xin Naiquan, Dr. Yang Zhong-yuan, Dr. Zheng Zhoujie, and Dr. Chen Aiguo (interpreter). The delegation had discussions with ICARDA scientists including those of the Cereal Improvement Program and areas for future collaboration on research and training were identified. Later, an agreement, including clauses on mutually beneficial research and training for scientists and on exchange of germplasm and visits, was signed between the Chinese Academy of Agricultural Sciences (CAAS) and ICARDA.

Kudos to SHAM 1. In his letter to Dr Srivastava, Dr. Zaid Al-Jowairah, Director General of Agricultural Research Department, Riyadh, Saudi Arabia, thanked him and all those concerned in the Cereal Improvement Program for the seed material of Sham 1 which gave a yield of 6.4 tons/hectare at one location under pivot irrigation system.

Dr. Viktor Shevtsov, barley breeder at Krasnodar Research Institute of Agriculture in the Soviet Union, thanked the Cereal Improvment Program and ICARDA for his successful and memorable stay in Aleppo, from October 86 to April 87. Dr. Shevtsov informed that some lines from the ICARDA barley collection which he had planted at Krasnodar have performed well. Many of these will be retested in nurseries next year. Also he indicated that there was a possibility of testing 50-100 barley lines for cold tolerance in controlled environment chambers at his research institute.

Dr. A. H. Kamel (Regional Representative Tunisia/North Africa) reported that the following lines are resistant to barley yellow dwarf virus (BYDV) in barley and wheat: In barley, Rojo, CM 67, CM 72, UC 566, CCXXV, CCXXXIII (Yd1). CI 2376, CI 3208-4, CI 14088, Benton, Mari, Atlas 68, Sutter, Abate, Corracle, Shannom, Norbert, Prato (Yd2) and Manchuria (minor genes). In wheat, Anza, Riebesel, Yamhill, Novi Sad 874-4, Aurifen, V-19, Elmo (Yd1). Yd1 is a recessive gene and Yd2 has varied expression from completely dominant to fully recessive major gene.

Dr. Ross Miller, Cereal Entomologist, visited Egypt and USA where he was interviewed by a leading local newspapers on his work at ICARDA. Dr Miller met scientists from Washington and Kansas State Universities from whom he obtained a critical review of the entomology training text.

Dr. Carla Ceoloni, an Associate Professor of Plant Cytogenetics in Institute of Agricultural Biology at the University of Tuscia, Viterbo, Italy, visited the Cereal Improvement Program of ICARDA. Dr. Ceoloni will supervise the cytology work at Viterbo pertaining to a collaborative project on "Enhancing Wheat Productivity in Stress Environments Utilizing Wild Progenitors and Primitive Forms" funded by the Government of Italy.

Dr. Emmanuel Picard, Biotechnologist at GIS Moulon Laboratory of the University of Paris (South), visited the Cereal Improvement Program of ICARDA from 4 to 7 September 1987. During his stay a memorandum of agreement for scientific cooperation between University of Paris (South), Orsay, France, and ICARDA was developed. Dr. Picard and Dr. M. Tahir (Cereal Prog) also produced a workplan for the project on "Biotechnologies for Cereal Improvement at ICARDA with Special Emphasis on Double Haploid Production." This collaborative project will be financed by the Government of France.

Dr. Virgil Johnson of the Department of Agronomy, University of Nebraska at Lincoln (UNL), has retired. He had a long and fruitful career spanning 34 years. He spent his last years of employment as Emeritus Professor at the Department of Agronomy, University of Nebraska at Lincoln (UNL). Dr. Johnson's retirement marks the end of his duties as coordinator of the international winter wheat evaluation network based at the UNL and which includes up to 40 other countries. He was instrumental in the creation of this network which resulted in organizing a series of international wheat conferences, the last of which was held in Rabat, Morocco, in 1986, where 200 wheat scientists from 52 countries participated. He has been the recipient of several national and international awards.

Dr. Habib Ketata, Cereal Training Scientist, visited Algeria during October 1986 to finalize the topics of the In-Country Training Course on Cereal and Food Legume Improvement. The course was held in Sidi Bel Abbas, Algeria, between 25 and 29 October 1986 for 37 participants.

The following Tunisian scientists have been awarded a **medal of merit in agriculture** by the President of Tunisia: Mr. Mustapha Lasram, Director, INRAT, Mr. A. Maamouri, cereal coordinator and durum wheat breeder, INRAT, Mr. M. Deghais, bread wheat breeder, INRAT, Mr. M. El Felah, barley breeder, INRAT, Dr. A. Daaloul, wheat breeder, INAT, and Dr. M. Harrabi, pathologist, INAT. Two other Tunisian scientists were awarded a medal of merit for their work in food legume research. These are: Mr. H. Halila, food legume coordinator, INRAT, and Dr. M. Bou Slama, food legume breeder, ESAK.

Dr. Omar F. Mamluk (Cereal Pathologist) and **Dr. Marlene Diekmann** (Seed Pathologist, GRP) of ICARDA went to Algiers from 10 to 11 November, 1986, to discuss areas of collaboration in cereals pathology with Algerian national program scientists. Several important points on the ojectives and implementation of the project arose from the meeting, and these were discussed, clarified, and finalized.

An In-Country Training Course on Cereal On-farm Verification and Demonstration Trials was organized during the 1985/86 cropping season following ICARDA Training Scientists' visit to Morocco in August 1985. The first part consisted of trial preparation and sowing (October 1985) and the second part included harvest and interpretation of trial results (June 1986). The course was sponsored by INRA, (Morocco), Food and Agriculture Organization (FAO), and ICARDA.

A short intensive training course was held at ICARDA between 10 and 21 May, 1987, on **Germplasm Evaluation: Cereal Landraces and Wild Relatives.** The training course, which attracted participants from nearly all countries of the region, was conducted jointly by the Cereal Improvement and Genetic Resources Programs. The course will be repeated in the future.

A Principal Collaborators Meeting on Barley Diseases and Associated Breeding Methodologies was held at INAT, Tunisia, from 3 to 4 November, 1986. The meeting was cosponsored by Montana State University, USA and ICARDA. The collaborators discussed development of national centers within the national programs and the progress made so far. The meeting will be held annually to discuss results, sort out constriants, and devise the next season's workplan.

A Cereal Germplasm Collection Expedition was mounted in north and east of Morocco during June 1987. The expedition, which was led by Dr. Ardeshir B. Damania, Durum Germplasm Scientist at ICARDA, was sponsored by the National Agricultural Research Center (NARC) of Japan and the Genetic Resources Program of ICARDA. Consisting of two teams, the expedition included members from NARC and INRA, Rabat, Morocco. The teams collected 188 samples as follows: 59 barley (all *Hordeum vulgare* except one which was *H. distichum*, now a rarity in Morocco), 57 *Triticum durum*, 50 *T. aestivum*, 7 *H. bulbosum*, 5 *Aegilops* spp., 3 *H. murinum*, 2 *Avena sativa*, 2 *Brassica* spp. (used mainly as forage), 1 *Vicia faba*, and 1 *Phaseolus* spp. One of the *Triticum* spp. was a primitive form, probably *dicoccum*. A short account on the expedition will be reported in future issues of RACHIS.

A Workshop on the Genetics and Physiology of Photosynthesis and Crop Yield was held in Cambridge, UK, between 20 and 24 July, 1987. Nearly 100 scientists from leading research centers in the world gathered to critically review the evidence on genetic variation in photosynthetic capacity, and assess whether it can be exploited to increase crop yields. ICARDA's Cereal Improvement Program was represented at workshop by Dr. E. Acevedo who presented a paper entitled "Field Observations on Gas Exchange of Barley Genotypes Affected by Drought." The workshop was sponsored by the OECD of UK. The proceedings will be published in due course.

The Second National Wheat Coordination Meeting was **held at ARC-Wad Medani, Sudan, from 20 to 23 July, 1987.** The meeting was organized to review the progress of the ARC/ICARDA/OPEC pilot project for "Verification and Adoption of Improved Wheat Production Technology in the Sudan." The Deputy Director General of ARC-Wad Medani welcomed the participants and expressed his satisfaction over the achievements made by the project. He thanked OPEC, ICARDA, and CIMMYT for providing funds and technical inputs, respectively, for this high priority project in the Sudan. On behalf of Dr. Mohamed A. Nour, ICARDA Director General, Dr. J. P. Srivastava thanked the Sudanese scientists and administrators for their excellent work on the project and announced that OPEC had agreed to provide funds for a further period of one year.

An International Symposium on Improving Winter Cereals Affected by Temperature and Salinity Stresses was held at Cordoba in Spain from 26 to 29 October 1987. The symposium was sponsored by Spanish Agricultural and Research Institutions and ICARDA. Several cereal scientists from all over the world attended the symposium and presented papers. ICARDA's Cereal Program was represented by Drs. J.P. Srivastava, M. Tahir, M. Nachit, G. Ortiz-Ferrara, S. Ceccarelli, and E. Acevedo the latter having acted as secretary for the symposium.

An Annual Wheat Newsletter (AWN) sponsored by the US National Wheat Improvement Committee has been in existance for some time. The editor of the newsletter, Dr. J.S. Quick, would like to identify one key person in each country of the region to work as a coordinator and to encourage manuscript and financial contributions to the AWN. Contributors shall be recognized on the first page of each volume of the newsletter. Interested wheat scientists should contact Dr. J. S. Quick, Editor, Annual Wheat Newsletter, Department of Agronomy, Colorado State University, Fort Collins, Colorado 80523, USA.

A red winter durum wheat variety resistant to hessian fly has been developed by the Agriculture Research Service (ARS) and Kansas State University scientists. A single dominant gene found in a wild wheat collected in Iran in the 1950s is effective against all known strains of the fly, which is one of the most destructive wheat pests in the world. This is only the second time that a gene for fly resistance has been transferred from the wild to the cultivated form. For further information contact Dr. J.H. Hatchett or Dr. T.S. Cox, Plant Science and Entomology Research, Manhattan, Kansas, USA.

A bread wheat variety with genetic resistance to hessian fly and powdery mildew has been developed and registered by the ARS and researchers based at Aberdeen, Idaho, USA. Seed of the new breeding line (PI 468960) is now available to United States wheat breeders for further crop development. For more information contact Dr. Donald W. Sunderman, Cereal and Vegetable Crop Production, Aberdeen, Idaho, USA.

Primitive forms of wheat (*Triticum* spp.) have been evaluated for 28 agronomic characters by the Cereal Improvement Program, and the information has been documented in computerized data base at ICARDA. They are as follows: *T. aestivum* var. *macha* (IC Nos. 9805 & 9843), *T. carthlicum* (IC 9814 & 9811), *T. dicoccum* (IC 9838, 9840 & 9841), *T. dicoccoides* (IC 12543 & 12466), T. *durum* var. *turgidum* (IC 9842), *T. monococcum* (IC 9802), *T. polonicum* (IC 12194 & 12196), *T. polonicum* subsp. *hispanicum* (IC 9807), *T. spelta* (IC 9810), and *T. urartu* (IC 9808). This germplasm has also been analyzed electrophoretically for storage proteins at the Institute of Agricultural Biology, University of Tuscia, Viterbo, Italy, under the framework of collaborative research.

Small Grain Collection has just received its 500,000th germplasm sample, reports Dr. George A. White, Plant Introduction Officer, USDA/ARS. Beltsville, Maryland. This honor has been bestowed on a sample of wheat with purple straw collected from southeast Asia which has already been used as parental material for breeding other successful wheat varieties. The computer data base of the National Plant Germplasm System at Beltsville enables scientists to locate germplasm accessions which are tolerant to diseases, pests, harsh environments, and poor soil conditions.

Release of 'Shield' (PI 491570) - a red spring durum wheat. The South Dakota Agricultural Experiment Station, Brookings, and the USDA/ARS have just announced the release of 'Shield', a new hard red spring wheat, which is an F4-derived plant selection from a cross between 'Coteau' spring wheat and 'Dawn' (CI 17801) winter wheat. The cross was made in 1977. 'Shield' has spring growth habit, early heading, and a standard height with a white, hollow stem. Spikes are awned, fusiform, mid-dense and erect. Awns and glumes are white. Kernels are red, hard, medium-to-short in size and ovate in shape. According to the information released, 'Shield' carries resistance to leaf rust (*Lr2a*, *Lr3*, and *Lr10* seedling genes), prevalent races of stem rust (probable seedling genes Sr6 and 'Waldron'), and hessian fly ('Marquillo' gene). This cultivar has good milling and baking properties. Grain protein content is classified as medium. For further information on 'Shield' write to Dr. R. Moore, Director, South Dakota Agricultural Experiment Station, South Dakota State University, Brookings, South Dakota 57007, USA.

Korifla, Sham 4, and Sham 1 outyield ACSAD 65 at Ras Al Ain. Dr. Mohammed Zuhair Taghlabi, Director General of Lybian-Syrian Company for Industrial Investment, has reported that the above three durum cultivars developed at ICARDA have outyielded ACSAD 65 at Ras Al Ain site in Al-Hassaka in spite of stresses such as drought, frost, and hot winds. The yields were 4.225, 4.219, and 4.170 tons/ha, respectively, versus only 3.120 tons/ha for ACSAD 65. The three ICARDA lines also outperformed Haurani, the local well adapted durum wheat check by 0.5 ton/ha.

Evaluation Network for Selected Durum Germplasm

A Durum Germplasm Evaluation Consultation Meeting sponsored by ICARDA and the University of Tuscia was held at Viterbo, Italy, on 27-29 July, 1987, to discuss constraints to evaluation, documentation, and utilization of germplasm and to study the feasibility of developing a work plan for the evaluation studies of selected germplasm in different countries at diverse locations. It was strongly recommended that germplasm selected at ICARDA as a result of the evaluation should be further developed to meet the breeders' needs, in order to encourage them to utilize this trait-specific material in their germplasm enhancement programs.

It was, therefore, decided to develop a network of cooperators who will evaluate the selected germplasm in their respective countries and make sure that the pooled information be provided to interested scientists. The network is already in operation, with the following countries participating in the first year (1987/88): Ethiopia, Kenya, India, Pakistan, Turkey, Tunisia, and Italy. Two hundred accessions selected for specific traits, as well as one regional check (Sham 1), and a local check have been included in these experiments. The research team, located at the University of Tuscia, Viterbo, will look at the electrophoretic banding patterns of storage proteins (gliadins) to see if there is any correlation between specific traits such as drought tolerance or resistance to specific diseases. The team will meet again next year during the same period to review the work carried out

Participants in the Durum Evaluation Consultation Meeting, Viterbo, Italy, 27 - 29 July 1987. From left to right: Ardeshir B. Damania (ICARDA, Syria); A. Abou-Zeid (GTZ Genebank in Kenya, Kenya); Carla Ceoloni (Univ. of Tuscia, Italy); Bhal H. Somaroo (ICARDA, Syria); Loretta Dominici (Univ. of Tuscia, Italy); Angelo Grottannelli (Univ. of Tuscia, Italy), Luciano Pecetti (ICARDA, Syria); E. Seme (GTZ Genebank in Kenya, Kenya); Jitendra P. Srivastava (ICARDA, Syria); Domenico Lafiandra (Univ. of Tuscia, Italy); Enrico Porceddu (Univ. of Tuscia, Italy); Hailu Mekbib (PGRC/E, Ethiopia), and Pietro Perrino Germplasm Institute, Italy).

by all concerned, develop plans for the 1988/89 season, and expand the network to other countries that may wish to join.

As a result of the meeting, the following recommendations were made:

1. The progress made by the on-going project on "Evaluation and Documentation of Durum Wheat Germplasm at ICARDA" was commended at the meeting. The team praised the project and rated highly its objectives in thoroughly evaluating approximately 10,500 durum accessions at different locations in Syria and Tunisia, in providing relevant training to personnel of national programs, and in summarizing the results in a progress report.
2. The team discussed the problem of presenting data which are recorded at different locations and in different seasons, and recommended the use of a consultant biometrician services for the analysis and presentation.
3. For the coming season (1987/88) the following workplan was developed for the evaluation project at ICARDA:

   a) Complete the evaluation of remaining durum accessions in ICARDA collection.

   b) Produce a report on the results of analyses on germplasm originating from Ethiopia.

   c) Produce a document on drought-tolerant lines.

   d) Initiate, in cooperation with national programs of the region, and put into practice a network of evaluation nurseries involving a limited number of selected germplasm.

   e) Develop a trait-specific short list of germplasm accessions with detailed evaluation information, to be supplied to querists, breeders, and interested scientists as computer printout on request.
4. It was strongly recommended that germplasm selected at ICARDA as a result of evaluation be further developed so that it can be recommended to breeders

for better utilization. This could be achieved through conducting evaluation studies in different countries, taking into consideration performance under diverse ecological regimes. Therefore, it was decided to develop a network of cooperators who will evaluate the selected germplasm in their respective countries, and the pooled information will be provided to interested scientists. Thus breeders would be encouraged to use trait-specific germplasm in their germplasm enhancement programs. The final list of countries participating for the first year was thus presented:

Ethiopia	-	2 sets of germplasm
Kenya	-	2 sets
India	-	2 sets
Pakistan	-	1 set
Turkey	-	1 set
Tunisia	-	1 set
Italy	-	1 set (electrophoresis)

5. Next meeting be held during the same period of the following year to review the work carried out by all concerned and develop plans for the 1988/89 season.
6. Realizing that the current set of landrace durum germplasm in the base collections was sufficiently representative of the available genepool (however, there may be gaps where no collections were made), the team felt that special efforts should be made to collect germplasm from remote and somewhat inaccessible areas in the region which may not have been covered by previous missions.
7. Recognizing the valuable use of wild relatives of crop plants and primitive forms in broadening of genetic base, the team felt that the genetic variability of this type of germplasm could be exploited to stabilize and improve wheat production in stress environments. In this respect, it was agreed that: (a) ICARDA take the lead in developing a plan for the collection of wild species and primitive forms of *Triticeae* in collaboration with national programs and other interested institutions, and (b) support be provided to personnel to undertake systematic collecting activity by identifying donor agencies aiding work on germplasm conservation.
8. ICARDA should provide technical assistance and training for personnel in germplasm evaluation and related matters.

An International Symposium on Problems and Prospects of Winter Cereals and Food Legumes Production in High-Elevation Areas of West Asia, Southeast Asia and North Africa was held at Ankara, Turkey, from 6 to 10 July, 1987. This symposium, at which about 50 scientific papers were presented, was sponsored by the Ministry of Agriculture, Forestry and Rural Affairs and ICARDA. Dr. M. Tahir acted as secretary for the Symposium. The proceedings will be published in English.

Forthcoming Events

XIth International Congress on Plant Protection 5 to 9 October, 1987 at Los Banos, Philippines. This international congress which is the eleventh in a series will be held at the College of Agriculture, University of Philippines. Those interested in attending and presenting papers are requested to contact Prof. E. D. Magallona, Department of Entomology, College of Agriculture, University of Philippines at Los Banos, College, Laguna
3720, Philippines.

Meeting of the Barley Workers in the Sub-Saharan Africa. ICARDA is planning to hold a workshop for barley workers in the region in Addis Ababa, Ethiopia between 7 and 10 October, 1987. The main topic of discussion will be the present status of research and potential of production of barley in sub-saharan Africa. The meeting will also concentrate on assessing the real importance of barley in the economy of the Sub-Saharan countries and on establishing a network of barley improvement work in the Sub-Saharan region. For more information contact Dr. Ahmed Zahour, Cereal Improvement Program, ICARDA, P.O. Box 5466, Aleppo, Syria.

International Congress on Plant Physiology, 8 to 13 February, 1988. The Congress will be held in New Delhi, India, by the Society of Plant Physiology and Biochemistry and ICARDA in collaboration with the Indian Society for Plant Nutrition and the International Association of Plant Physiology. Papers are invited on the following topics: 1. Physiological basis of crop yield, crop modelling, and crop improvement (cereals, oilseeds, grain legumes, plantation crops, and tubers); 2. Environmental stresses (drought, salinity, temperature, waterlogging, pollution, etc., and remote sensing); 3. Nutritional stress, and 4. Preharvest and postharvest physiology and biochemistry in relation to storage (grains, fruits, vegetables, and flowers). The language of the symposium will be English throughout including publication of proceedings. For further details contact Dr. S. K. Sinha, Secretary General, International Congress of Plant Physiology, Water Technology Centre, IARI, Pusa Complex, New Delhi 110 012, India.

Ist International Conference in Africa on Computer Methods and Water Resources, 14 to 18 March, 1988. The first conference concentrating solely on water resources management in the African context will be held in Rabat, Morocco. For further details contact Prof. D. Ouazar, Head of Hydraulic Department, Civil Engineering, EM I BP 765, Agdal, Rabat, Morocco.

III International Symposium on Genetic Aspects of Plant Mineral Nutrition, 19 to 23 June, 1988. The symposium will be held on the campus of the Federal Research Center of Agriculture in Braunschweig, F. R. Germany. English will be the official language used for all posters and oral presentations as well as for publications. The symposium has been organized by the Institute of Crop Science and Plant Breeding of the Federal Research Center of Agriculture (the F.A.L.) and will consider papers on the following topics: physiology and biochemistry of mechanisms associated with intraspecific differences in plant breeding, plant improvement and genetic control of mineral stress problems, low input genotypes, genotype tolerance to salinity and drought, screening techniques, and utilization and conservation of germplasm resources. For further particulars and procedure for submitting contributions please contact the Secretary, Dr. N. El-Bassam, Third International Symposium on Genetic Aspects of Plant Mineral Nutrition, Institute of Crop Science and Plant Breeding, F.A.L., Bundesallee 50, D-3300 Braunschweig-Volkenrode, F. R. Germany.

VII International Scientific Conference on Agricultural Projects in the Development of an Efficient Agriculture in Developing Countries - Experiences, Methods and Appraisals, 27 June to 1 July, 1988. This conference is being organized by the Institute of Tropical Agriculture and the Agrarwissenschaftliche Gesellschaft der DDR, Bezirksverband, Leipzig, and will be held at the Institute of Tropical Agriculture, Fichtestrasse 28, 7030 Leipzig, DDR. Participation is invited from experts in agricultural sciences, economics, and social systems who are engaged in teaching or research. The working language of the conference will be English. Those willing to present papers should inform the organizers of their participation, providing a preliminary title of their paper, by 30 September 1987.

Copies of the papers to be presented should be submitted by 31 December 1987. Further particulars can be obtained from Prof. Dr. sc. G. Franke, Director, Institute of Tropical Agriculture, Fichtesrasse 28, 7030 Leipzig, German Democratic Republic.

Australian Plant Breeding Conference, Wagga Wagga, 27 June to 1 July, 1988. The conference is the ninth in a series which began with the Australian Conference of Cereal Breeders and Geneticists, which was held at Roseworthy, South Australia, in 1946. Contributions are sought for poster presentation and inclusion in the proceedings. Selected papers will be presented orally. Further details and first circular may be obtained from Dr. Barbara Read, Secretary, APBC, Agricultural Research Institute, Private Mail Bag, Wagga Wagga, NSW 2650, Australia.

XVIIIth International Congress of Entomology, 3 to 9 July, 1988. A definite must for all entomologists. For further particulars write to Dr. G. G. E. Scudder, Secretary General, XVIII International Congress of Entomology, Department of Zoology, University of British Columbia, Vancouver B.C. V6T 2A9, Canada.

VII International Wheat Genetics Symposium, 13 to 19 July, 1988. This Symposium is organized once every five years. It was last held in Kyoto in December 1983, and will now be held at Cambridge, UK. This will once again provide an opportunity to bring together scientists working on all aspects of wheat genetics and its application to wheat breeding. Papers are invited in all areas from molecular genetics and cytogenetics through to whole plant genetics, genetic resources, pathology, and breeding methodology. First circular has already been sent. Participants intending to send contributions should do so before November 1987. Please address all correspondence to Dr. C. N. Law, Chairman, Administrative Committee, Seventh International Wheat Genetics Symposium, Plant Breeding Institute, Trumpington, Cambridge CB2 2LQ, UK.

International Conference on Dryland Farming, 15 to 19 August, 1988. An international meeting of scientists working on dry areas will be held at Amarillo, Bushland, Texas, USA. Scientists interested in participating should contact immediately The International Conference on Dryalnd Farming, USDA Conservation and Production Research Laboratory, P. O. Box Drawer 10, Bushland, Texas 79012, USA.

Vth International Congress of Plant Pathology, 20 to 27 August, 1988, Kyoto, Japan. For further details contact Secretariat, Fifth International Congress of Plant Pathology, 1-43-11, Komagome, Toshima-Ku, Tokyo 170, Japan.

XVI International Congress of Genetics, August 20 to 27, 1988, Toronto, Canada. The Congress, which is held once every five years (last one was in New Delhi, 1983), will be held at the Metropolitan Toronto Convention Centre, Toronto, Ontario, Canada. It is sponsored by several Canadian Societies and professional bodies. The scientific program will consist of symposia, workshops, and poster sessions grouped into four main divisions as follows: 1. Genes and chromosomes, 2. Genomes and Organisms, 3. Populations and Evolution, and 4. Genetics and Society. The deadline for receipt of abstracts for presentation of papers and posters is 31 January 1988. For further information please contact immediately XVIth International Congress of Genetics, National Research Council Canada, Ottawa, Ontario, Canada K1A 0R6.

International Symposium on Factors Affecting Herbicidal Activity and Selectivity, 6 to 8 September, 1988. This international symposium will be held at Wageningen in the Netherlands. Those interested in participating may write to Mrs. E. J. L. Holtke-Staal, International Agriculture Centre, P.O. Box 88, NL-6700 Wageningen AB, The Netherlands.

CONTRIBUTORS' STYLE GUIDE

Policy

The aim of the newsletter is to publish quickly the results of recent research. Articles should normally be confined to a single subject, be of good quality and of primary interest to research, extension and production workers, administrators and policy makers. Articles for publishing in the newsletter should not be submitted to or published in any other journal.

Editing

Articles will be edited to preserve uniform style but substantial editing will be referred to the author for his 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. Similarly, the use of trade names does not constitute endorsement of or discrimination against any product by ICARDA.

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 and postal address and telex number if available. Photographs, figures, tables etc. should be either 8.5 cm wide (single column) or 17.5 cm wide (double column including space). Figures and diagrams 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.

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

3g, 18 mm, 300 m^2, 4 Mar 1983; 27% ; 50 five-day old plants; 1.6 million; 23 µ g; 5°C; 1980/81 season; 1981-83; 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.

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Journal articles: Baker, R.J. and Briggs, K.G. 1983. Relationship between plant density and yield in barley. Crop Science 23(3): 590-592.

Books: Evans, L.T. and Peacock, W.J. (eds.). 1981. Wheat science - today and tomorrow. Cambridge University Press, Cambridge 290 pp.

Articles from books: Zadocks, J.C. and van Leur, J.A.C. 1983. Durable resistance and host pathogen environment reactions. Pages 125-140 *in* Durable Resistance in Crops. Plenum Publications Corporation, New York.

Papers in proceedings: Srivastava, J.P. 1983. Status of seed production in the ICARDA region. Pages 1-16 *in* Seed Production Technology. Proceedings of the Seed Production Technology Training Course-1, ICARDA/the Government of Netherlands, 20 Apr - 6 May 1982, Aleppo, Syria. Available from ICARDA.

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