RACHIS

Barley and Wheat Newsletter

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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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RACHIS—the Barley and Wheat Newsletter—is published by the International Center for Agricultural Research in the Dry Areas (ICARDA). It contains mainly short scientific articles but also includes book reviews and news about training, conferences, and scientists in barley and wheat.

Published half-yearly in January and July, RACHIS can be obtained free by writing to the Distribution Unit, Communications and Documentation Program, ICARDA, P.O. Box 5466, Aleppo, Syria. Contributions to RACHIS should be sent to Dr Habib Ketata.

COVER

Cereal trainees discussing the plant growth habit of one of the new promising bread wheat varieties at ICARDA's main research station, Tel Hadya, Aleppo, SYRIA.

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SHORT COMMUNICATIONS

Editorial

According to a recent FAO estimate, field losses due to diseases, insect pests, and weeds average 35% for major food crops, 12% of which could be due to diseases alone. Clearly, the FAO estimate is a warning that more concerted efforts than in the past are called for to solve the problems of diseases and pests. Success in minimizing these losses will greatly enhance the effectiveness of the drive for raising food production to meet the demand of the growing population, particularly in the developing countries. ICARDA feels greatly concerned about these losses, since in its mandated areas—West Asia and North Africa—barley and wheat, the major food crops, occupy about 70% of the annually cropped area.

Research in the past has provided new cultural practices for improved field crop production, but the new practices have brought in their wake new problems of plant diseases: certain diseases which were earlier considered to be of minor importance are now assuming epiphytotic proportions. For example, retention of crop residue on the soil surface to control soil erosion, and the increasing use of fertilizers, pesticides, and irrigation provide a more conducive environment for many pathogens.

By far, utilization of genetic resistance is the most appropriate means to control plant diseases and pests; it is economical, efficient, and environmentally safe. There is a need to speed up the research efforts to develop new cultivars with resistance or tolerance to diseases and pests that could be introduced into the prevailing farming systems. Modern technologies for the control of insect pests and weeds, however, rely heavily on the use of pesticides and herbicides, but greater attention needs to be paid to identify newer pesticides and herbicides which are safer for human health and are within the means of the small farmer. Even though the use of chemicals has proved quite efficient in controlling the pests and diseases, it has inherent dangers of causing hazards to human health, creating an ecological imbalance, promoting the prevalence of certain organisms up to the status of new pests, killing the predators and parasites, and leading to the development of resistance to pesticides and herbicides. Consequently, research efforts need to be intensified on developing integrated systems of pest control, using a combination of resistant varieties, appropriate cultural practices, introduction of natural predators and parasites, and the use of chemicals only when absolutely necessary.

Dr. J.C. Walker, a well known plant scientist, summarized his 50 years of research on disease resistance thus: «By and large the development of resistant varieties must be looked upon as a continuing program. The potential variability of most pathogens will not permit any currently successful variety to remain so for an indefinite period.» Experience has shown that the development of a new variety with desirable agronomic and disease and pest resistance traits may take about 10-12 years. As such, this challenging task cannot be accomplished by individual scientists or research centers: it is essential that national programs and international research centers pool their efforts and jointly fight the battle against plant diseases, insect pests, and weeds. The vulnerability of our crops to pests and diseases in the future will depend, to a great extent, on how we design our research and development efforts today, using our past achievements.

ICARDA has already established cooperative projects with several national programs with a view to (1) screening germplasm for disease and insect resistance at key locations in the region, (2) improving national program facilities for identifying different races of pathogens and for field and laboratory screening of germplasm, (3) developing lines with multiple disease resistance, (4) providing training to research workers from the region and elsewhere, and (5) developing manuals for disease and insect pest identification and control. In addition, the Center has developed cooperation with several research institutes in the developed countries for conducting basic research. The Center also encourages visits of scientists from national programs and elsewhere in the world to build upon the knowledge and expertise needed to handle the challenge of protecting the food crops from diseases and other pests.

This issue of RACHIS provides several articles on the subject of plant diseases and insect pests. We hope the readers will find the information useful. Suggestions from readers for further strengthening of research efforts in this area shall be greatly appreciated.

Review Article

Barley Breeding for Areas Receiving Less Than 250 mm Annual Rainfall

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Barley is a widely adapted crop and is next to wheat in its importance in the Near East and North Africa. In the drier areas it grows under soil fertility levels and moisture stress conditions where wheat performs poorly or fails to survive. It is grown for feed, food, malt, or grazing. The total area and the moisture levels under which barley is grown are given in Table 1 (modified from Srivastava, 1976).

Almost 40% of the 11 million hectares of barley grown in the Middle East and North Africa receives less than 300 mm rainfall as long-term average.

In recent years the increase in the consumption of animal products has resulted in a sharp rise in the demand of barley as animal feed. From a position of self-sufficiency in the late 1960s, the region became a net importer of about 4 million tonnes of barley by 1982, and this is expected to rise to about 15 million tonnes by the year 2000 (Khaldi 1984).

Low-rainfall areas are characterized by a high year-to-year variability. Therefore, almost half of the area where barley is grown is a «high risk» area where crop failures are frequent and they hit resource-poor farmers who have little or no other options (ICARDA Annual Report 1982, 1983).

Barley has for a long time been a neglected crop, and it is now being increasingly realized that strategies that could lead to an increase in barley production, especially in dry areas, may result in enhancing food security in the region without necessarily reducing wheat production.

ICARDA has accepted the responsibility of developing methodologies to improve barley productivity in dry areas.

How do we decide whether an area is sufficiently dry to deserve the attention of barley researchers? Long-term records of mean precipitation do not help, because the year-to-year variation is large, seasonal distribution is important, and soil type and structure interact with the amount and distribution of rainfall in determining crop responses. The 4.5 million hectares of barley grown in areas with less than 300 mm average rainfall may very often receive only 200-250

Table 1. Area and moisture levels (mm annual rainfall) under which barley is grown in the Middle East and North Africa.

Country	Total area	Irrig area*	Rainfall (mm)				
			500	400-500	300-400	200-300	200
Afghanistan	325	97.5			162.5	48.8	16.3
Cyprus	87	2.6	4.4	9	13.0	6.1	
Iran	1,500	30.0		75.	750.0	450.0	150.0
Iraq	1,375	715.0	110.0	206.3	178.8	165.0	
Jordan	50	1.0		5.0	2.5	22.5	9.0
Lebanon	10	1.0			4.0	5.0	
Saudi Arabia	20	1.0			12.0	6.0	
Syria	1,574	30.0		88.0	634.0	505.0	317.0
Turkey	3,000	150.0	300.0	450.0	1,050.0	1,050.0	150.0
Yemen (AR)	70			35.0	35.0		
Yemen (PDR)	1	1.0					
Algeria	770				693.0	38.5	38.5
Egypt	167	66.8					100.2
Libya	486	72.9				413.1	
Morocco	2,000	50.2		581.0	508.7	684.0	100.0
Tunisia	422				84.4	337.6	
Total	11,873.0	1,219.0	414.4	1,501.2	4,125.9	3,731.6	881.0
Percent		10.3	3.5	12.6	34.8	31.4	7.4

* Includes areas with one or two supplementary irrigations and areas where water is saline to grow wheat.

mm rainfall. We, therefore, define «dry areas» as the driest areas where barley is commonly grown, and where barley with sheep is the only farming activity. In Syria, for example, these areas could tentatively be identified with Zone 4 and the driest part of Zone 3. The areas where barley is grown only as an opportunity crop are not included in this definition.

The objective of barley breeding in dry areas is to improve yield as well as to improve yield stability. Yield in this context is defined as total biological yield (grain + straw) since in most dry areas the barley crop is either grazed by sheep in the field or harvested for animal feed. In either case, the commercial as well as the nutritive value of the straw is important. Therefore, genotypes with a large harvest index are not necessarily the desired ideotype to develop for these areas.

One issue which has been extensively discussed in the literature in relation to breeding strategies for stress environments is whether breeding for stress environments should rely on selection under good conditions and subsequent test in stress environments or on direct selection under stress conditions. There are numerous supporters of both strategies.

The first strategy assumes that varieties that give good yields in favorable conditions will also yield relatively well in unfavorable conditions. Selection is easier because there is a better expression of genetic variances and heritability in favorable conditions. This strategy also assumes that genotypes selected in dry environments will have a low yield potential in good environments. Although the argument for selection in favorable conditions has been supported by some workers (Frey 1964; Roy and Murty 1970; Mederski and Jeffers 1973), the efficiency of the second strategy (direct selection under stress conditions) has been emphasized by many others (Aufhammer *et al.* 1959; Burton 1964; Hageman *et al.* 1967; Johnson *et al.* 1968; Hurd 1968, 1971; Boyer and McPherson 1975; Johnson 1980; Bidinger 1980; Buddenhagen 1983).

The major problem with selection under stress environments is the variability of stress in the experimental field, but if innovative approaches are used to reduce this variability there is no reason for low heritability and poor repeatability of results. Additional problems in field testing for stress resistance, which are more difficult to remove without special field techniques, are the variability of stress from year to year, including stress intensity, time of occurrence during the growing season, and stress type (e.g. heat, drought, or a combination of heat and drought). The breeder dealing with testing for stress resistance should therefore always bear in mind that reliable results may not be obtained every year. Therefore, care must be taken in selecting multilocation test sites that would represent a wide range of stress conditions.

The second area of controversy in breeding for stress environments, with many implications on breeding strategies, concerns the extent to which one must understand the physiological and biochemical mechanisms underlying stress resistance in order to make progress in breeding (Boyer 1982; Quinsberry 1982). This is merely an extension to breeding for stress environments of the controversy between the synthetic approach and the component (or reductionist) approach which is debated in other areas of breeding. Although an understanding of the biochemical and physiological control of stress resistance and of its genetic control will be an important breakthrough for more efficient selection procedures, it is certainly not true that this understanding is essential before progress in breeding can be accomplished (Buddenhagen 1983). Actually, the material generated by the synthetic approach can help identify which characters, combinations of characters, or kind of mechanisms are associated with varying degrees of stress resistance/tolerance. Selection for physiological attributes which may be important in determining productivity under stress conditions has been discussed by Blum (1979), Morgan (1980), Jordan and Miller (1980), and Steponkus *et al.* (1980). It is a long-term approach because it involves (1) the evaluation of available genetic variability for a particular physiological attribute, (2) the demonstration that the particular physiological attribute is correlated with stress resistance, and (3) the demonstration that selection for that particular physiological attribute is possible and causes a correlated response in stress resistance.

A possible alternative to the physiological approach is the use of morphological and/or physiological responses to stress, as selection criteria at the final stage of a breeding program, when acceptable lines have already been developed for other attributes (Blum 1979; Bidinger 1980). This can be achieved by testing in dry sites the material promoted to advanced yield trials to capitalize on any residual variability for drought resistance mechanisms. If little variability is left for drought resistance mechanisms, the approach could be modified by incorporating resistance mechanisms into already established lines. This approach is conceptually similar to incorporating disease resistance into already established lines, and is probably the best way to begin to utilize the existing knowledge on plant adaptation to stress.

Selection Strategy

Given that the present knowledge of the morphological, physiological, and biochemical basis of stress resistance is still limited, the most practical approach is to evaluate and select early segregating populations directly under stress conditions. In addition to the sites used earlier, the earley segregating populations are grown at two additional sites southeast of Breda (Tel Dhaman and Bouider with long-term averages of 220 and 175 mm annual rainfall, respectively) to enhance the chance of having every year at least one site with no more than 200 mm rainfall. This permits to observe early segregating populations under a gradient of stress environments, to identify crosses giving similar responses to a set of environments, and, in unusually dry years, to evaluate the lower limits (in terms of total rainfall and rainfall distribution) for which sources of resistance/avoidance are available. This could also lead to a more precise identification of the lowest moisture limits where barley can be considered a reliable crop.

During the evaluation phase, observations are taken on those characteristics (such as early seedling vigor, rapid stand establishment, good grain filling, and early maturity) which are likely to be associated with stable yields under dry conditions (Roy and Murty 1970; Chang *et al.* 1972; Eslick and Hockett 1974). Promotion of material is, however, heavily based on biological yield and/or grain yield.

Control and better estimation of environmental variability and of its effects on selection efficiency is achieved by using appropriate field designs such as the modified augmented design (Lin and Poushinsky 1983) for the F_2 populations and the lattice design for the F_4 and F_6 segregating populations.

Crop growth, development, and yield are related to environmental data to allow a full assessment of experimental results with long-term environmental records.

Breeding Methods

The early segregating populations are handled using a modified bulk method; the objective is to identify superior crosses and then to practice selection within these successful crosses. With this procedure a heavy selection pressure is applied among populations during the early stages. The assumption behind this approach is that if a population performs well for several years and at many sites, it must possess a high frequency of desirable genotypes. It is expected that only few populations will go beyond the F_4 generation.

The modified bulk method, which is expected to be more efficient in terms of response to selection for dry areas, will not replace the modified pedigree method which is still the main breeding method for more favorable environments. Actually, since the same F_2 population is often being used for both single-plant selection and bulk, comparisons between the two methods are possible. Moreover, single-plant progenies derived with the pedigree method from crosses identified as superior by the bulk method can be used for testing in dry areas before the purification stage of the corresponding bulk population.

With the modified bulk, F_2 segregating populations are evaluated in at least five sites (four in Syria with different soil conditions and rainfall, and one in Tunisia), with two-row plots using a modified augmented design with dense planting (Fig. 1). After growing the F_3 populations in a summer nursery, the F_4 populations are grown at five sites as small plots, with dense planting, using a lattice design.

The F_5 populations are grown in the summer nursery and the F_6 are grown like the F_4 but also as spaced plants to apply single-plant selection.

This procedure is supposed to fully exploit the potential of the many crosses made with local cultivars. These crosses are expected to generate interesting materials for low-rainfall areas, which can be identified only if exposed to stress environments.

Identification of Suitable Parents

To improve the evaluation of parents to be used in designing crosses targeted for dry areas, a special nursery is grown, using a modified augmented design, at four dry sites near Aleppo, in Tunisia, and in dry areas of Latin America. This nursery is an expansion of the Barley Observation Nursery for dry areas.

Utilization of Local Cultivars

Local, unimproved cultivars are still widely grown in many dry areas. Although characterized by relatively low yields and disease susceptibility, they appear to

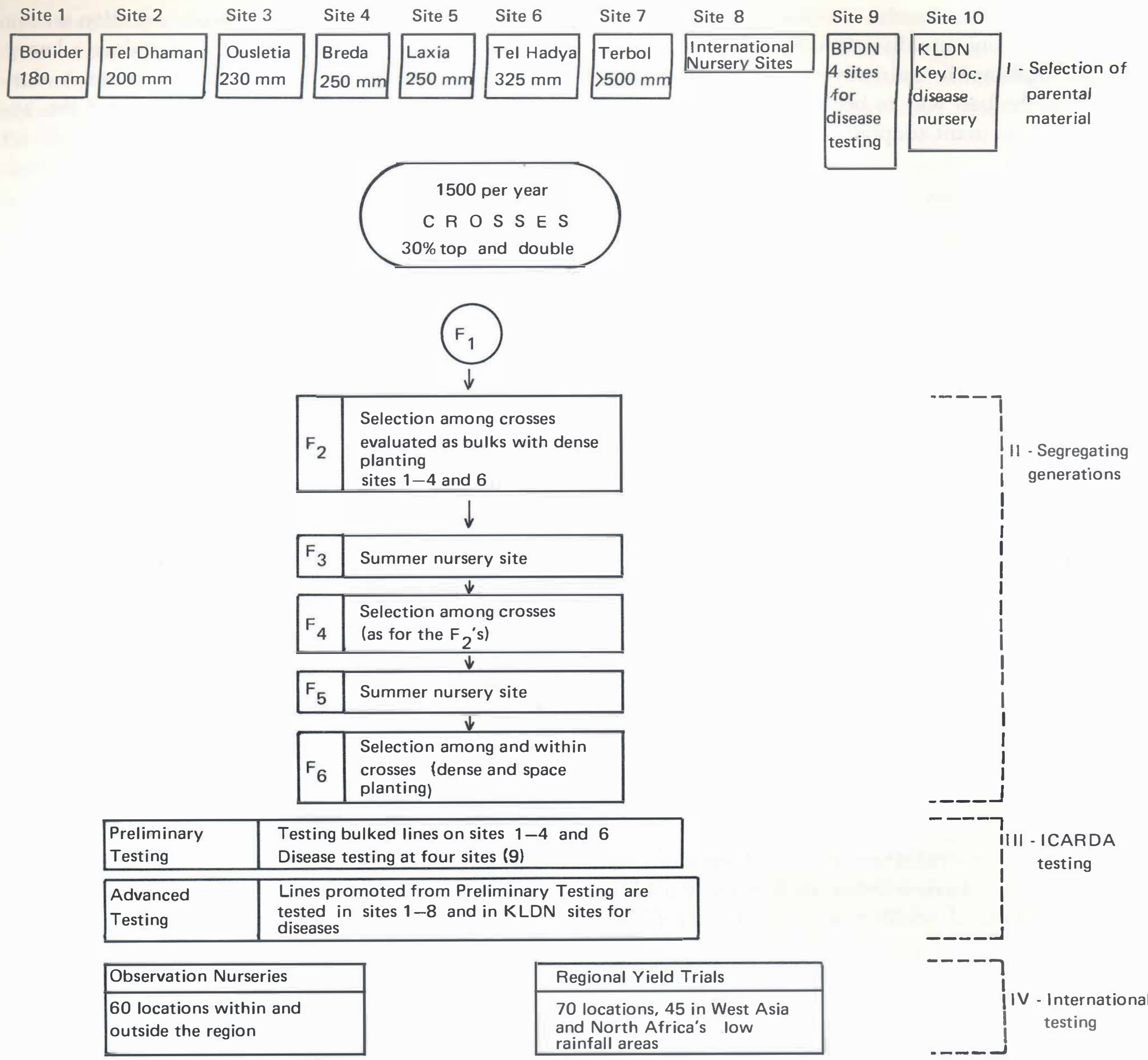

Fig.1. Barley breeding procedures for areas receiving less than 250 mm annual rainfall.

be very well adapted to local conditions, are relatively stable, and in areas where both grain and straw are used as animal feed, they are appreciated by the farmers for their feeding quality.

It has been shown that local cultivars are heterogeneous populations that can be improved by simple mass selection (Tamimi *et al.* 1975). Very little information is available on the amount of variability, its usefulness in breeding, and its importance in relation to adaptation to dry areas. However, preliminary data on a very small sample from a large population of ear—to—row progenies collected from farmers' fields in Syria and Jordan (Weltzien personal communication) indicated that local cultivars are variable, and that the variability is useful. Although promising, this information has been obtained from one trial only, in one location (Breda), and for one year (1984). Therefore, further testing is needed to assess the potential of this material. The following research activities have been initiated to clarify the role that the variability available within local barley cultivars can play in breeding for dry areas:

(a) Further multilocation testing of the best lines already identified. This also includes testing of mixtures of two to five lines to assess the performance and stability of mixtures as compared with pure lines under dry conditions.

(b) Preliminary testing of lines collected from sites where a high frequency of superior lines occurs.

(c) Observation and multiplication of lines not yet evaluated.

Utilization of superior genotypes available within local cultivars is an additional way of generating useful material in the short term. A better understanding of the so far largely neglected adaptation mechanisms of local cultivars, which can be obtained by studying their phenology and analyzing the within-populations variability, may also throw light on future developments of breeding for stress environments. As a medium-term approach, the best genotypes identified within local cultivars are used as parents to combine drought resistance/avoidance with a higher yield potential. In fact, there is no evidence to the belief that the presence of resistance/avoidance genes to water stress would necessarily mean lower productivity in nonstress conditions (Buddenhagen 1983). Although a number of morphological and physiological characteristics which seem to be associated with low yield potential, such as lodging, small heads, excessive earliness, shattering, short postanthesis period, are found in local cultivars, there is no evidence that the adaptation of these cultivars to stress environments is inevitably associated with those characteristics.

Utilization of *H. spontaneum*

H. spontaneum, the progenitor of cultivated barley, is widespread along the Fertile Crescent where it occupies an extraordinary large diversity of environments ranging from the Mediterranean to the desert. The species has already proved useful in contributing genes for resistance to powdery mildew (Moseman and Craddock 1976; Russel 1978), rust (Anikster *et al.* 1976), and scald (Baenzinger *et al.* 1981). There are also indications that *H. spontaneum* can contribute useful genes for grain yield, plant height, harvest index, earliness, total biological yield, drought resistance, and cold hardiness (Bakteyev 1974; Vega and Frey 1980).

H. spontaneum has never been systematically investigated as a source of genetic variation for drought resistance/avoidance mechanisms in the area where the species is likely to show its full potential; it is in the driest areas of the Fertile Crescent where the species is abundantly distributed and where cultivated barley is the most important cereal crop.

It seems, therefore, that ICARDA is in a unique position to assess the potential of *H. spontaneum* to improve barley yields and yield stability in dry areas.

Preliminary observations on seed dormancy, head morphology, awn roughness, and rachis brittleness of a collection of local cultivars from Syria and Jordan (Weltzien 1982) suggest that *H. spontaneum* germplasm could have played a major role in the formation of the local cultivars widely grown along the Fertile Crescent, and that those cultivars could be intermediate forms between *H. spontaneum* and *H. vulgare*. Should this hypothesis prove true, a more deliberate use of selected accessions of the wild progenitor of cultivated barley in a hybridization program could be planned.

The first activity concerning *H. spontaneum* in 1984/85 is the evaluation at Bouider of a collection of about 1500 accessions with the objective of screening for drought resistance/avoidance, and evaluating a number of F_3 segregating populations derived from crosses with cultivated barley carried out at the University of Perugia (Italy).

Thus, starting from the 1984/85 season, efforts to develop barley cultivars for the lower rainfall range ($<$250 mm) are being strengthened. It is, however, realized that development of appropriate agronomic practices for such areas is necessary. Farmers in these areas will benefit most if they adopt suitable varieties along with appropriate cultural practices for low-rainfall areas.

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Research and Production

Status of Rusts and Smuts in India

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Monitoring of wheat diseases in a systematic manner was initiated in India in 1967 and since then surveys have been continued through mobile teams and disease trap nurseries (Joshi *et al.* 1974a). Three mobile units, located at Delhi, Move out at least once every 3-4 weeks on fixed routes through the major wheat areas of the country to examine the crop health at every 20 km. The mobile teams cover about 30.000 km every year during the crop season. In South India, much of the information has been collected through individual efforts. The magnitude of the coverage of wheat belt by survey teams can be seen in Table 1.

The surveys conducted under the project have provided some valuable information on the time of rust appearance; directional movements; spread of rusts and losses due to these diseases; fluctuation in the prevalence of loose smut; spread of Karnal bunt; and above all performance of commercial varieties. On some occasions, the surveys have also been helpful in providing advance warnings of the impending disaster due to the appearance of new virulences.

1. Wheat Rusts

Investigations have shown that stem rust (*Puccinia graminis* f. sp. *tritici)* is present throughout the country, but in the northwestern region, it appears very late and in a very low intensity which would not normally cause an epidemic in the main wheat belt. The chances of its causing an epidemic are greatest in the peninsular, central, and at times, eastern parts of the country. However, under certain unusual conditions, such as high temperatures in February and March a very late sown crop coupled with an early introduction of inoculum, an epidemic in the northwestern region cannot be ruled out.

During the last 13 years, there have been six rust epidemics but stem rust was involved in only three localized ones. Two isolated epidemics in 1973 and 1975 occurred in the remote and isolated Sanchore region of Rajasthan (Joshi *et al.* 1974b). In this area stem and leaf rusts had severely affected an area of 20.000 hectares under local Kharchia variety and nearly two-thirds of the crop was totally lost. Similarly, a large area of Narmada valley of Madhya Pradesh was severely hit by these rusts in 1978/79, affecting the local susceptible varieties, such as Pissi and Malvi Local wheats. Some fields suffered losses of up to 60-80 %.

Leaf rust (*P. recondita* f. sp. *tritici*) is the most widely spread and frequently occurring disease. It is economically the most important because of its frequency of occurrence and its capacity to cause epidemics in almost all parts of the country if favorable climatic conditions, and because susceptible hosts are available. In the past, its importance was somehow overlooked, even though Butler (1918) considered it as the «most damaging rust in the eastern region.» In 1971/72 and 1972/73, leaf rust appeared in epidemic proportions in Punjab, Haryana, and western Uttar Pradesh. The leaf rust epidemic during the 1971/72 season in Punjab and Haryana suddenly flared up after 15 March due to rise in temperature. In the 1972/73 season, the epidemic started in February in Punjab, Haryana, and western Uttar Pradesh and developed gradually. During the same

Table 1. Survey routes and coverage of wheat fields.

Route No.	Region	Time required to complete the survey (day)	Average number of stops/ field examined per day	Average number of fields visited per trip
1	Northwestern	7	10-12/50-60	250-300
2	Northeastern	10-13	10-12/50-60	500-600
3	Central and Peninsular	15-17	10-12/50-60	750-850

year stripe rust also appeared in late season. On the basis of field sampling, the loss in yield was 0.8 million tonnes in 1971/72 and 1.5 million tonnes in 1972/73 (Joshi *et al.* 1980b).

«Sonalika epidemic» of leaf rust during 1980/81 in Bihar, Uttar Pradesh, and parts of Haryana and Punjab affected an area which normally produces over 16 million tonnes of wheat. The disease appeared in January and its intensity was 80-90% at dough stage. Using Chester's chart (1951), the estimated loss was about 6-8% or over a million tonne.

Stripe rust (*P. striiformis*) remains restricted to the Himalayan foot hills and northwestern plain region and some pockets in Madhya Pradesh and Rajasthan. It appeared in an epidemic form in 1971/72 along with leaf rust and severely attacked the Kalyansona variety. In South India its incidence was recorded mainly on *durum* wheats and barley varieties in Nilgiri hills. The situation has changed since 1972 and there are reports of stripe rust epidemics on *aestivum* wheats in these hills. In 1975/76, approximately 80% of the entries in the Plant Pathological Screening Nursery (PPSN) had stripe rust but it was almost totally absent from South India. So far, there is no evidence to suggest that stripe rust inoculum from Nilgiri hills is being introduced in the northern belt.

Spread of Wheat Rusts

Wheat disease surveys show that leaf rust has clearly two active foci of infection-the sub-Himalayan regions in the North and Nilgiri and Pulney hills in South India (Joshi *et al.* 1971, 1977a). It normally appears in the foot hills of Bihar and eastern Uttar Pradesh in the North as well as the plains of Tamil Nadu and Karnataka in the South in the second half of December or early January. In these secondary foci in South India, early builtup of inoculum takes place and the rust spreads to Maharashtra and Madhya Pradesh. At the same time, the infection from northern secondary foci slowly moves southwards till the two population merge together.

In the past, sub-Himalayan hills in North India were considered as the most important foci of infection for stem rust and central Nepal was considered as «the most dangerous foci» of infection (Mehta 1940). For this region, stem rust resistant varieties, such as Ridley, were released for northern hilly areas. However, it is now established that for stem rust, the South Indian hills are the chief foci of infection and that the hills of North India contribute little, if at all, to cause epidemics in the main wheat belt (Joshi *et al.* 1971; Joshi 1976, 1982). During the last 13 years, early outbreaks of stem rust have been recorded in many places in South India in December/January and, at times, even earlier, but in the North, the rust has seldom appeared before the middle of March or just 2-3 weeks before harvest. This rust differs from the other two rusts in its temperature requirements and during the winter months of December, January, and February, the prevailing conditions in sub-Himalayan ranges are adverse for any builtup or spread of stem rust in this region. This is supported by the fact that during this long period of 13 years not a single case of stem rust infection in foot hills of Kashmir, Himachal Pradesh, Kumaon hills, and western Nepal, before middle of March has even been observed. Even in foot hills of the eastern region (East Uttar Pradesh, Bihar, and Bengal) only on two or three occasions was stem rust observed about 4 weeks before harvest. Butler (1918) has also stated that *Puccinia graminis* does not appear on wheat until late in season. It is often not seen until March in North India, a time when wheat is in ears.

Impact of Sowing Date on Spread of Rusts

Experiments were conducted in Madhya Pradesh to shift sowing dates to September or even late August. This was attempted because of the availability of adequate moisture immediately after rains. However, it was found that early sowing could aggravate the leaf and stem rusts and therefore could cause a serious threat to the main wheat belt. Climatic conditions in Madhya Pradesh and in many other parts of Central and North India are favorable in October or early November for establishment and spread of stem and leaf rusts. It has been amply demonstrated that uredospores of stem and leaf rusts are deposited in Madhya Pradesh in late October/November by rain and rusts get established if suitable hosts are available. Such early sowing will provide the missing component, i.e., the suitable host. With this contemplated change in sowing date, suitable hosts will be available from August onward and a «man-made focus,» very dangerous for the crop, will be established in Madhya Pradesh as early as October/November (Joshi 1976). Thus, Madhya Pradesh could become the chief source of infection for the newly sown crop in the North. Epidemics at Sanchore in Rajasthan in 1974/75 and the 3 years experimental data on early sowings at Indore in Madhya Pradesh confirmed these observations. Not only is early sowing in Madhya Pradesh fraught with danger but even late-sown crop in the North is equally vulnerable to leaf and stem rust attack. In the northwestern region, rice-wheat rotation has become a usual practice, often causing delays in wheat sowing. Such late-sown crops mature 2 to 3 weeks later, giving ample time to leaf and also stem rusts to cause considerable damage to the late-sown crop. Such damage can be prevented by developing early-maturing rice varieties so that rice fields are available for timely wheat sowings.

Role of Cyclonic Disturbances in the Movement of Rusts

Rain sampling studies (Nagarajan *et al.* 1976, 1977; Joshi 1982) have shown that cyclonic disturbances in the Bay of Bengal in October and November can transport the inoculum of leaf and stem rusts from foci of infection in southern hills. The uredospores are transported by cyclonic currents and rain-deposited in Madhya Pradesh and Maharashtra in late October or November. Thus, Madhya Pradesh becomes the main secondary focus from where the inoculum is carried to the main wheat belt in subsequent months.

It is interesting to note that there were no cyclones passing over foci of infection in 1974/75, 1975/76, 1980/81, 1981/82, 1982/83, and 1983/84, but there were favorable cyclones in 1976/77, 1977/78, and 1978/79. Prediction of the probable dates of rust appearance for the years 1976/77, 1977/78, and 1978/79 was quite correct (Joshi *et al.* 1977b, 1978, 1979). In other years, between 1981 and 1984, cyclonic activity over foci of infection was limited and rain samples yielded very few spores. Therefore, the development of stem rust, as expected, was rather very poor.

In the 1980/81 season, the leaf rust epidemic was severe. The rust appeared in the foothills of Bihar as early as end of December (1980) and by January 1981 it had spread widely in Bihar and Uttar Pradesh. On the other hand, the intensity of leaf rust remained low in the entire South India during the crop season. Apparently, the leaf rust epidemic of 1980/81 in North India was a result of inoculum carried from northern hills.

2. Karnal Bunt of Wheat

Karnal bunt (*Neovossia indica*) of wheat, also known as «new bunt» or «partial bunt» was first reported by Mitra (1931) from Karnal, Haryana. From 1931 to 1968 it was considered a disease of minor importance and appeared sporadically. It occurred, in traces, in northwestern plains of India and in the Frontier Province of Pakistan but elsewhere it was unknown. However, in 1969/70, it appeared in some parts of Punjab, Haryana, western Uttar Pradesh, and Rajasthan (Swaminathan *et al.* 1971). During the 1974/75 crop season, the Karnal bunt was reported to occur in a somewhat severe form at many places in North India, Particularly northwestern foothills and «tarai» region of Uttar Pradesh (Singh *et al.* 1977).

In the last 9 years (1976-84) a total of 19,546 wheat seed samples of different varieties have been collected by mobile survey teams from all the wheat growing states of the country (Joshi *et al.* 1984). Karnal bunt surveys indicate that the incidence and spread of this disease has gradually increased. It is now present in the states of Punjab, Haryana, Delhi, Uttar Pradesh, parts of Bihar, and West Bengal, at low altitudes in Himachal Pradesh, Jammu region of Jammu & Kashmir, Northern parts of Madhya Pradesh, and Rajasthan. A solitary sample was collected from Junagarh district of Gujarat (Singh 1980). So far the disease has not been recorded in the states of Maharashtra, Orissa, Assam, Meghalaya, Karnataka, Andhra Pradesh. Tamil Nadu, and Kerala (Goel *et al.* 1977; Singh *et al.* 1980, 1983; Joshi *et al.* 1983).

On a countrywide basis, the maximum incidence was recorded during 1981/82, when about 50% samples were found infected, followed by the 1978/79 and 1980/81 crop seasons (Fig. 1)

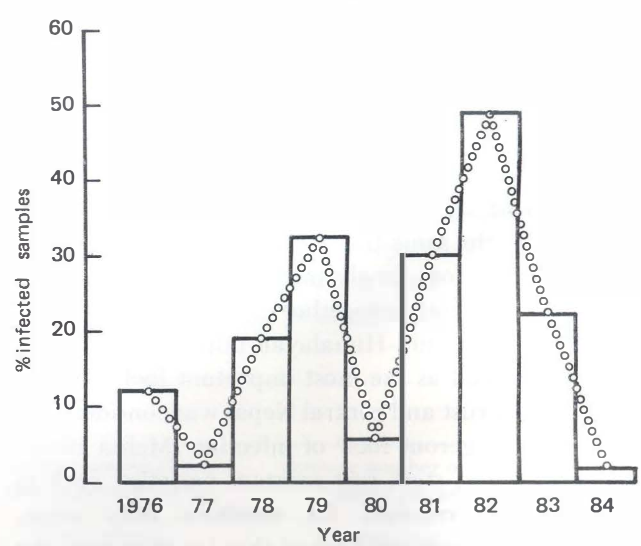

Fig.1. Frequency of Karnal bunt infected samples from 1976 to 1984.

It can be seen from Table 2 that in Punjab the incidence increased from 39.5% in 1975/76 to 93.0% in 1980/81, but decreased thereafter. A somewhat similar trend of gradual spread of the disease was observed in the states of Haryana, Uttar Pradesh, and Delhi. In the foothills of Himachal Pradesh and Jammu & Kashmir, the prevalence of infected samples increased from 25% to 86% between 1975/76 and 1983/84. Since very few samples from limited areas were collected, a definite conclusion could be drawn for these areas. In certain parts of Madhya Pradesh and Rajasthan states the disease has been occurring regularly since 1978/79 but with a minor incidence. The disease intensity is very low at Madhya Pradesh but in 1978/79 a sample collected from Chattarpur district had 22% infected grains.

Meteorological Factors Associated with Karnal Bunt Incidence

An analysis of meteorological data from 40 stations in the main wheat belt for epidemic and non-epidemic years revealed that the 1975/76, 1977/78, 1978/79, 1980/81, 1982/83 crop seasons favored the outbreak of Karnal bunt infection. On the other hand, the disease incidence was very low during the 1976/77, 1979/80, and 1983/84 crop seasons, possibly due to high temperature, low humidity, and no rainfall at the time of anthesis. It has been found that 18-20°C temperatures coupled with high humidity and mild rainfall at anthesis will create favorable conditions for disease development. Based on these conditions advance warning for possible outbreak of Karnal bunt, issued through Wheat Disease Newsletter (vol. 12, 1978/79 and Vol. 14, 1980/81), proved to be correct.

Impact of Karnal Bunt on Wheat Cultivars

In general, Sonalika, the chief commercial variety in the entire subcontinent at present, and, Kalyansona, the predominant variety till 1975/76, are much less susceptible in the field than some recently developed cultivars, such as Arjun, WG 357, WG 377, WL 711, and UP 262.

In Punjab, the average infection in WL 711 was 2.6 to 5.3% during 1975/76 to 1982/83, while the average infection in Sonalika in Punjab during the same period was 0.6 to 2.2%. After the 1972/73 rust epidemic, Kalyansona variety in Punjab was replaced by new strains, namely, WG 357, WG 377, WL 711, and Sonalika. The first three varieties were highly susceptible to Karnal bunt and their extensive cultivation seems to be responsible for higher incidence of the disease in the state. Even Sonalika had higher incidence in Punjab than in other states which may be due to the gradual increase of inoculum in Punjab and the prevalence of favorable climatic conditions. The teliospores of Karnal bunt are known to survive in the soil for 2-4 years or even more (Mathur and Ram 1963; Munjal 1970), and cultivation of susceptible cultivars should have increased the inoculum load in Punjab soils. On the other hand, in

Table 2. Percentage of Karnal bunt in samples collected from 1975/76 to 1983/84.

State	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84
Jammu & Kashmir			31.5	86.2	65.2	80.0	78.1	33.3	
Himachal Pradesh			25.0	74.0	22.7	60.0	52.9	15.6	6.2
Punjab	39.5	3.2	51.2	77.8	35.0	93.1	85.1	65.2	
Haryana	8.5	0	34.1	16.8	7.1	37.6	60.8	22.8	1.2
Delhi	0	0	17.3	16.0	0	25.3	29.6	4.3	0.6
Uttar Pradesh	0	1.0	22.2	42.6	2.9	19.7	32.1	10.4	3.5
Bihar			0	3.7	0	1.1	0	0	0.9
West Bengal					0	1.07	2.0	0	
Rajasthan			0.5	4.6	0	4.9	2.8	2.0	0
Madhya Pradesh			0	10.1	0.6	0.26	5.1	2.8	3.9
Gujarat					0	0	0	0	0
Maharashtra					0	0	0	0	0
Andhra Pradesh				0			0	0	
Karnataka			0	0	0	0		0	0
Orissa						0		0	0
Assam						0		0	
Meghalaya						0			
Manipur								0	

Uttar Pradesh, Sonalika is still the predominant improved wheat cultivar and it appears that this variety has not permitted any significant build up of inoculum which may explain the low incidence of the disease in the state.

It is threfore reasonable to assume that one of the major factors for the spread and increase in the incidence of disease is the cultivation of some high-yielding susceptible dwarf cultivars. The low incidence of Karnal bunt in Haryana may be due to the cultivation of Sonalika, WH 147, and C 306 which are less susceptible to the disease in the field. Even in Punjab the incidence of Karnal bunt appears to be decreasing for the last 2-3 years, possibly because some new wheat strains, such as WL 1562 and DWL 5023 have been introduced to replace the susceptible variety WL 711.

3. Loose Smut of Wheat

In India, loose smut (*Ustilago nuda tritici*) of wheat is found in all wheat growing states, however, its incidence is generally greater in the north than in the south. Yield tests have shown that generally the loss is proportional to percentage of infected heads (Weibel 1958).

Intensive cultivation after 1968 of Kalyansona and PV 18, which possessed a high degree of field resistance to loose smut had reduced the incidence of this disease to a great extent in the northwestern parts of the country (Joshi *et al.* 1973). In 1973, Kalyansona became susceptible to leaf and stripe rusts and was replaced by Sonalika and its derivatives in Uttar Pradesh, Haryana, and Bihar and by WG 357, WG 377, and WL 711 in Punjab. As these varieties are susceptible to loose smut, the incidence of this disease in the main wheat belt has increased considerably. For monitoring the disease, intensive surveys have been conducted since 1972. About 2.000 to 2.500 fields are annually visited at the flowering stage by mobile survey teams. Results of these surveys for the last 17 years are given in Table 3.

Table 3. Incidence of loose smut of wheat during 1967/68—1983/84 in India.

Area	Year	Maximum incidence (%)	Average (%)
Introduction of dwarf wheat			
Northwestern India	1967/68	35 *	5-7.2
Northern India (U.P.)	1968/69	15 *	2.0
Kalyansona period			
Northwestern India	1969/70	40	Less than 0.5
Northwestern India	1970/71	10 + (approx.)	Less than 0.5
Northwestern India	1971/72	5 +	Less than 0.5
North India	1972/73	3 +	Less than 0.5
North India	1973/74	3 +	Less than 0.5
North India	1974/75	3 +	1.0 (approx.)
Sonalika period			
North India	1975/76	6 x	3.0 (approx.)
Bihar	1975/76	10 x	5.6 (approx.)
North India	1976/77	1	0.5
North India	1977/78	1	0.5
North India	1978/79	5	0.9
North India	1979/80	12	3.4
All India	1979/80	15	3.0
Northwestern India	1980/81	10	3.4
All India	1980/81	10	3.2
All India	1981/82	15	3.5
All India	1982/83	10	4.0
All India	1983/84	7	3.8

* = Only few fields near Gurdaspur district of Punjab had as high as 35 % incidence. Otherwise incidence was around 5 %.
\+ = Mostly on local wheats C 306, Pb.C 591, Motia but Kalyansona was free.
x = Mainly Sonalika; very little infection on Kalyansona.

It is evident from Table 3 that loose smut is at present taking a fairly heavy toll. For instance, in 1983/84 the total yield was estimated to be 45 million tonnes and a conservative estimate of 3-4% infection will mean a loss of more than 1.4 million tonnes.

Analysis of meteorological data for the last 15 years and the builtup of loose smut indicate that unlike other diseases, the infection, survival, and expression of loose smut is governed by favorable climatic conditions in two consecutive years— particularly temperature (optimum temperature for loose smut infection is abouth 23°C Dean, 1969). If at the time of anthesis there is sudden rise of temperature the disease cannot get well established. In the next season, if temperatures are too high during the crop growth and particularly before flowering, the expression of disease is also hampered.

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Effect of Different Fungicides Against Leaf Rust of Wheat

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Leaf rust (*Puccinia recondita*) of wheat is a major problem in most of the wheat growing areas of the Punjab state in particular, and in Pakistan in general. Though leaf rust appears every year, the intensity of infection largely depends upon the duration of favorable weather conditions for perpetuation of the disease. In Pakistan severe epidemics of leaf and stem rusts were reported in 1948 and 1954 which reduced yields by 30-50%. The rust epidemic in 1978, caused a 10% loss in yield (Hassan 1979).

Cultivation of resistant high-yielding varieties may be the best and most economical method of controlling rusts; however, due to sudden change in the rust race-pattern, commercial varieties often become vulnerable to rust attack. According to Rowell (1973) the frequent failure of resistant varieties has revived the interest in fungicidal control of rusts. Grewal and Vir (1959) found Parzate, liquid Nabam plus zinc effective for the control of rusts when applied at fortnightly intervals. Von Mayer *et al.* (1979) and Singh and Nene (1973) reported RH-124 as a protectant and effective at small concentrations against leaf rust of wheat. Aujla *et al.* (1976) also found RH-124 effective in controlling severe epidemics of leaf rust by a single spray. Hak *et al.* (1980) found Indar to be most effective in controlling leaf rust as compared to Plantvax and Bayleton where grain yield was significantly increased (up to 48.94%). Though fungicidal control of rust has been reported from other parts of the world, very little work seems to have been done in Pakistan.

Materials and Methods

Two wheat varieties, WL-711 and Blue Silver both suceptible to leaf rust were planted on 13 December 1982 in a split-plot design using three replications and a plot size of 3 m x 1 m, with fungicide as main plot factor and variety as subplot factor. Fertilizer was applied at the rate of 84-84-0 kg/ha. Rust epidemic at early growth stages was created by planting spreader rows of a mixture of susceptible varieties around the experimental area. The spreader rows were also artificially inoculated with a mixture of races of leaf rust. Rust spores were also sprayed twice to induce the epidemic conditions. When the first visual signs of leaf rust infection appeared, seven fungicides were applied according to the recommended doses (Table 1).

All sprays were made at the rate of 467 l of water per hectare with the help of a Knapsack sprayer. Rust severity was scored five times starting from 13 March at 10-day intervals using the Modified Cobbo Scale (Loegering 1958). The coefficient of infection (CI) was calculated to quantify the pattern of rust development. At maturity, a net plot of 1 m^2 was harvested for yield estimation and samples of grains were drawn for 1000-kernel weight. Data for yield and kernel weight were analyzed according to the statistical procedures described by Le Clerge *et al.* (1962).

Table 1. Fungicides used for controlling leaf rust in wheat varieties WL-711 and Blue Silver.

Trade name of fungicide	Chemical name	Dose/ha	Date of application
Indar 70 LC	Triazole	420 ml	16-3-1983
Bayleton 25 WP	Triadirefon	0.988 kg	do
Plantvax 75 WP	Oxycarboxyle	1.975 kg	16-3-1983 & 26-3-1983
Daconil W 75	Chlorothalonil	0.988 kg	do
Sicarol 15 WP	Pyrocarbolid	1.975 kg	do
Benlate	Benomyl	0.395 kg	do
Saprol 19 EC	Triforine	0.4 l	do

Results and Discussion

The experiment was deliberately planted late, because the incidence of rust attack had been reported to be more severe on late-planted wheat during moderate or severe rust infection years. The combination of late planting and early inoculations favored a rapid and heavy infection of leaf rust at early stages of plant growth.

Severity of Infection

The artificial inoculations with favorable weather proved so successful that the leaf rust infection reached 100% intensity in the control plots of WL-711 within a period of 30 days. In Blue Silver, however, the rust development was somewhat slow and the intensity increased up to 80% by 24 April.

The yield of WL-711 was significantly higher (27.05%) as compared to Blue Silver, indicating a better response of WL-711 to fungicides. By and large all fungicides except Saprol were found to be very effective and exhibited significant differences in yield over the control (unsprayed) and Saprol (Table 2). The yield increase was 159.03, 139.14, 100.68, and 90.94% higher than the control by the use of fungicides Indar, Daconil, Bayleton, and Plantvax, respectively.

Differences in 1000-kernel weight were also significant for fungicide, variety, and their interaction. The kernel weight in WL-711 was significantly higher than for Blue Silver (Table 3). The differences in kernel weight were significantly higher in case of Indar, Daconil, Bayleton, and Plantvax than the other fungicides as well as the control. Differences amongst these fungicides were also significant: Indar showed the highest efficacy, followed by Daconil, Bayleton, and Plantvax. The increase in grain weight was 113.6, 99.2, 85.07, and 63.53% higher in plots treated with Indar, Daconil, Bayleton, and Plantvax, respectively, than the control.

Significant correlation ($r = 0.99^{**}$) was observed between the 1000-kernel weight and grain yield, indicating that fungicide treatments increased grain yield through a proportional increase in kernel weight.

Table 2. Yield (kg/ha) of leaf rust susceptible wheat varieties as influenced by fungicides at WRI, Faisalabad, 1982/83.

Fungicide treatment	CI value		Yield		
	WL-711	Blue Silver	WL-711	Blue Silver	Mean
Indar	0.5	0	5126	3950	4538
Daconil	5	5	4587	3031	3809
Bayleton	20	15	3835	3197	3516
Plantvax	25	20	3667	3021	3345
Sicarol	60	40	3353	2412	2883
Benlate	80	60	2608	1968	2288
Saprol	80	60	1825	1749	1787
Unsprayed (control)	100	80	1765	1739	1752
Mean			3346	2634	

	LSD (5%)	LSD (1%)
Fungicide (F)	192	267
Variety (V)	155	357
F × V	409	568

Table 3. Thousand kernel weight (g) of leaf rust susceptible wheat varieties as influenced by fungicides at WRI, Faisalabad, 1982/83.

Fungicidal treatment	1000-kernel weight		
	WL-711	Blue Silver	Mean
Indar	40.60	39.50	40.05
Daconil	38.20	36.50	37.35
Bayleton	37.30	32.10	34.70
Plantvax	32.50	28.87	30.67
Sicarol	29.20	23.67	24.53
Benlate	24.30	21.20	22.67
Saprol	18.50	20.27	19.37
Unsprayed (control)	17.40	20.10	18.75
Mean	29.74	27.78	

	LSD (5%)	LSD (1%)
Fungicide(F)	0.886	1.230
Variety(V)	0.774	1.717
F × V	1.276	1.771

It is well documented that leaf rust causes yield loss by reducing the number of kernels per head or kernel weight (Aujla *et al.* 1976; Peterson *et al.* 1945, 1948). Peterson (1945) suggested that the state of development reached by the plants before rust becomes severe determines whether the reduced kernel production or the reduced kernel weight is responsible for the reduction in grain yield. In our investigations the reduction in both kernel weight and yield was observed, substantiating the findings of earlier workers. However, the magnitude of reduction in yield is different in our experiment which can be attributed to the use of different experimental material as well as the time, severity, and duration of leaf rust infection.

Fungicidal rust control on a commercial basis has been considered uneconomical by some workers (Dickson 1959; Forsyth and Peterson 1958), but the present study revealed that application of fungicides such as Indar, Daconil, Bayleton, and Plantvax is economically viable.

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Influence of Weedicides on Wheat Yields

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Weeds compete with crop plants for nutrients, soil moisture, and sunlight. Hepworth (1979) reported 15-25% losses in wheat in Pakistan due to weed infestation. Friesen *et al.* (1960) reported 10 to 25% crop losses in Canada due to weed competition. Khan (1964) reported that weedicide treatments could increase wheat yeild by 10%. Hay (1970) reported a significant drop in wheat grain yield under the influence of weed infestation, while Randhawa *et al.* (1981) reported that postemergence application of Tribunil (Methabenzthiazuron), Tok-E-25 (Nitrofen), Dosanex (Metoxuron), and Tolkan (Isoproturon) decreased weed population and increased grain yield of wheat. Pandey (1981) reported that preemergence application of Stomp (Pendimethalin), as compared with Tribunil, Tolkan, or Dosanex, gave the highest grain yield in both normal- and late-sown wheat with better control of *Phalaris minor* and other weeds. He further reported that preemergence application of Tribunil gave good yield of normal-sown wheat, but adversely affected germination of the late-sown crop. Joshi and Singh (1982) reported that application of Dosanex (Metoxuron) and Terbutryne was most effective against *Phalaris minor*, *Avena ludouiciana*, and other monocot weeds, and gave 83-85% yield increase over the check.

Materials and Methods

The experiment was conducted at the Wheat Research Institute, Faisalabad, during 1983/84 using the wheat variety V-81188 (CC-Inia [Cal x BB-Cno/S108 x Cno-No.66]) pb.16488-27a-2a-6a-0a. Planting date was 5 November 1983, and fertilizer was applied at the rate of 84-84-0 kg/ha. The density of weed infestation was very high; *Chenopodium album* dominated the weed population, followed by *Fumaria parviflora*, *Phalaris minor*, *Medicago denticulata*, *Convolvulus arvensis*, *Anagallis arvensis*, *Cornopus didymus*, and *Vicia* spp.

Nine weedicides (Table 1) belonging to three groups; broad spectrum (No.1,2,3), broad leaf selective (No.4,5,6), and grass selective (No.7,8,9); were used, with two hand weeding treatments (before and after first irrigation) and an unweeded check.

The postemergence application of the weedicides was made on a dry soil (instead of a normal wet soil) when the crop was at the 3-6 leaf stage at the rates shown in Table 1.

Normally, the first irrigation is recommended 12-18 days after germination. However, in this experiment it was delayed up to 40 days and weedicides were sprayed 36 hr before irrigation. This was done with a view to create a short moisture stress. A randomized complete block design was used with a plot size of 10 m x 2.2 m. The plant population (wheat and weeds per m^2) from each replication was counted and infestation percentage per unit area was calculated. The effect of each weedicide on grain yield and percentage of weed control was estimated.

A back-power sprayer was used to spray the weedicides. The calibration was done on area basis. Accuracy and uniformity was maintained for all weedicides. The spray capacity of the machine came to 284 l/ha. The data were statistically analyzed according to procedures described by Le Clerge *et al.* (1965).

Table 1. Weedicides used and rates of application.

S.No.	Weedicide	Common name	Dose (a.i/ha)
1.	Dicuran MA 60 WP	Chlorotoluron + MCPA	2.5 kg
2.	Tribunil	Methabenzthiazuron	2.0 kg
3.	Graminon	Isoproturon	2.0 kg
4.	Buctril-M	Bromoxynil + MCPA	1.30 l
5.	Banvel-P	Dicamba + Mecoprop	5.00 l
6.	DMA-6	2,4-D	1.72 l
7.	Illoxan	Dichlofop methyl	2.5 l
8.	Suffix BW	Flamprop-Isopropyl	3.0 l
9.	Avenge	Difenzoquat	4.0 l

Results and Discussion

The plant population count along with other data recorded before the weedicide treatments are given in Table 2.

The effect of weedicide sprays was evaluated by the reduction in weed population and the grain yield increase due to control of weeds (Table 3).

The data revealed highly significant effects of all the weedicides in controlling weeds (Table 3). The broad spectrum group (Dicuran MA + Graminon + Tribunil), on an average, controlled 65% of broad leaf and grassy weeds. Dicuran MA has been highly effective for controlling both broad leaf and grassy weeds followed by Tribunil and Graminon (Table 3). However, weedicides Buctril-M, Banvel-P, and DMA-6 proved very effective against broad leaf weeds. The grass selective group of Illoxan, Suffix BW, and Avenge demonstrated an overall control of 51.22% of grassy weeds only. Individually, Suffix BW showed the highest control of grassy weeds, followed by Illoxan and Avenge.

Dicuran MA proved to be the best weedicide which could effectively control both broad leaf (79.65%) and grassy (84.05%) weeds, followed by Tribunil and Graminon. In broad leaf weedicide group all the three weedicides proved equally good and highly effective in controlling broad leaf weeds. However, grass selective weedicides had variable control of grassy weeds from 34.55% in the case of Avenge to 66.83% in the case of Suffix BW.

As for *Medicago denticulata*, it may be observed that only Banvel-P (broad leaf weedicide) and Graminon (broad spectrum weedicide) could induce 21.30 and 49.32% control, respectively, of this noxious weed.

The data revealed that grain yield was increased —

Table 2. Mean plant population/m² and number of leaves per plant prior to weedicide application, Wheat Research Institute, Faisalabad, 1983/84.

S.No.	Constituent of plant population	Total plants/m²	No. of leaves/plant (range)
1.	Wheat (V-81188)	98.18	3-6
2.	*Chenopodium album*	50.32	5-15
3.	*Fumaria parviflora*	19.51	7-16
4.	*Phalaris minor*	6.30	3-6
5.	*Medicago denticulata*	5.57	3-6
6.	*Convolvulus arvensis*	4.42	7-16
7-9.	*Anagallis, Vicia* and *Cornopus* spp.	6.00	6-12

Table 3. Effect of weedicides on weeds and grain yield of wheat variety V-81 188 at Wheat Research Institute, Faisalabad, 1983/84.

S.No.	Weedicide treatment	Percent reduction of weeds		Yield (kg/ha)	Percent increase in grain yield
		Broad leaf	Grasses		
1.	Dicuran MA (Chloroto-luron + MCPA)	79.65	84.05	3588	167.74
2.	Tribunil (Methabenzthiazuron)	70.50	45.95	3227	140.74
3.	Graminon (Isoproturon)	51.89	56.89	3166	136.28
4.	Buctril-M (Bromoxynil + MCPA)	85.68		3070	129.10
5.	Banvel-P (Dicamba + Mecoprop)	85.79		2529	88.70
6.	DMA-6 (2,4-D)	85.76		2450	82.86
7.	Illoxan (Dichlofop methyl)		52.29	1513	12.88
8.	Suffix BW (Flamprop-Isopropys)		66.83	1851	38.13
9.	Avenge (Difenzoquat)		34.55	1460	8.94
10.	Hand weeding (after first irrigation)	94.62	80.20	2252	68.07
11.	Hand weeding (before first irrigation)	85.71	24.95	1974	47.32
12.	No weeding (control)	0	0	1340	
LSD (0.05)				489	
LSD (0.01)				665	

by the use of weedicides. These findings are in agreement with those reported by Khan (1964), Hay (1970), Randhawa and Dhillon (1981), Alieve *et al.* (1981), and Joshi and Singh (1982). The grain yield increases over the control were highly significant for Dicuran MA, Tribunil, Graminon, Buctril-M, Banvel-P, DMA-6, and hand weeding after first irrigation. The yield increase was also significant for Suffix and hand weeding before irrigation, but not for Avenge. This increase has been as high as 167.74% over the control in the case of Dicuran MA, followed by Tribunil and Graminon (Table 3).

The results of this experiment show that grain yields increased with the decrease of weed population due to herbicide application. This suggests that weedicides can be used efficiently to improve grain yield of wheat in Pakistan.

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Identification and Exploitation of Diverse Variability for Disease Resistance and Yield Components to Improve and Stabilize Wheat Yields

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Diseases, particularly rusts, have been a major cause of instability in wheat production. Limitation in variability for disease resistance in wheat is largely due to the cultivation of a small number of widely adapted genetically homogenous cultivars. Maintenance of genetic diversity for resistance in crop population both at the entragenotypic and intergenotypic levels is therefore vital for the success of any breeding program.

Identification of Genes for Resistance to Rusts

In wheat, nearly 35 loci for reaction to *Puccinia graminis* and an equal number of loci for reaction to *P. recondita* are available mostly as isogenic lines of different backgrounds. The interactions between near-isogenic lines carrying specific genes for reaction to *P. graminis* and *P. recondita* and the isolates of these pathogens determine seedling reactions. Adult plant response of these genes has also been studied in field conditions at a number of locations and over a number of years in the country.

Tests with isolates of stem rust have revealed resistance genes *Sr* 24, *Sr* 26, *Sr* 27, *Sr* 31, *Sr* Tt1 + *Sr* 9e (combination III), and *Sr*Tt1 + *Sr*9b effective at the seedling stage and, in field tests, at the adult stage (except that combination III was ineffective against pathotype 40 at the seedling stage). TAF2d (*Sr*Agi) was effective against the prevalent and virulent pathotypes in the country. Low infection types and low coefficient of infection produced on Mq + *Sr*12 and «Spica» (*Sr*7b + *Sr*17), in contrast to the other stocks carrying the genes CS/Tc-3B (*Sr*12) and Baart + *Sr*12; and CS/Hope 7B (*Sr*17) and «Renown» (*Sr*7b + *Sr*17 + *Sr*1 + *Sr*2), suggest that resistance in these lines may be due to the interaction between known genes, or due to the presence of additional unknown genes. A comparison of the range of infection on lines with common known genes indicated the possibility that «McMurachy» and «Spica» carry additional factor(s) for resistance ot stem rust. Inadequate levels of resistance on adult plants were expressed by *Sr*25 and *Sr*Tt2 in contrast to the high degree of seedling resistance as recorded on 7D/Ag (*Sr*25) and line W (*Sr*Tt2) (Sawhney and Goel 1981; Sawhney *et al.* 1982a, 1983).

Leaf rust resistance genes *Lr*9 and *Lr*19 were completely effective against all the Indian leaf rust isolates at seedling stage and in field conditions, at adult plant stage (Sawhney *et al.* 1977). In addition, *Lr*24 («Agent,» Sear's 3Ag/3D and a white-seeded stock TR380-27 × 4/3Ag3-14), *Lr*25 «Transec,» *Lr*26 and *Lr*3 «Kavkaz,» *Lr*28 (CS A/2 M4/2), and *Lr*29 (CS7D/Ag) were effective at seedling stage against most prevalent and virulent pathotypes tested individually (Sawhney and Goel 1983). Lines with *Lr*14ab, *Lr*17, *Lr*21, *Lr*22, and *Lr*25 «Transec,» *Lr*26 «Benno,» *Lr*27 «Gatcher,» and «Klein Titan» were observed to be moderately resistant in field tests. The resistance of «Klein Titan» appeared to be due to so far undescribed factor(s) (Sawhney *et al.* 1982b).

The stem rust resistance expressed by single gene lines and cultivars with *Lr*19, *Lr*21, *Lr*24, and *Lr*26 appeared to be due to *Sr*25, *Sr*21, *Sr24, and Sr*31, respectively. Likewise, resistance to stem rust in lines with *Lr*2a and *Lr*23 may be due to *Sr*30 and *Sr*11, respectively, which are known to be present in the donors of these *Lr* genes. Effectiveness of lines carrying *Lr*22 and *Lr*25 against stem rust could be ascribed to the genes not yet known. Cultivar «Klein Titan» may have a stem rust resistance gene in common with «Barleta Benvenuto.»

Analysis of a cross section of wheat breeding material in the country for rust resistance genes has shown that varieties presently in cultivation derive their resistance from a very limited number of genes such as *Sr*5, *Sr*6, *Sr*8, *Sr*9b, *Sr*11, and *Sr*12 for stem rust resistance, and *Lr*1, *Lr*3, *Lr*10, Lr13, *Lr*15, and *Lr*17 for leaf rust resistance (Sawhney *et al.* 1984, unpublished). The resistance genes identified in the existing cultivars in India are few and are different from those identified as effective in field conditions at the adult stage and at the seedling stage in the prevalent races in the country. This would suggest an urgent need to mobilize and deploy diversity with respect to resistance genes since a large number of additional genes effective against Indian populations of both rusts are available.

Incorporation of Diverse Resistance Through Backcrossing into Agronomic Bases

Most of the genes identified as effective have their origin in alien species of wheat and are available in the background of tall, red seeded, late, and agronomically poor *aestivum* wheats. Also, there is a feeling that genes from alien species are associated with undesirable characters that make it difficult to combine other essential desirable attributes with resistance. A backcross program to transfer each of the leaf rust or/and stem rust resistance genes to «Kalyansona» and «Sonalika» background has been started in the Division of Genetics, IARI. Both «Kalyansona» and «Sonalika» are very popular varieties in India, occupying about 70% of the total wheat area.

Repeated backcrosses with extensive selection has made possible the development of a number of Kalyansona lines with leaf or/and stem rust resistance genes, which have been effective against all prevalent leaf or/and stem rust pathotypes. Lines have been developed with leaf rust resistance genes *Lr*9 (*Aegilops umbellulata*), *Lr*14b («Maria Escobar»), *Lr*14ab (W3551), *Lr*15 («Norka»), *Lr*17 («Klein Lucaro»), *Lr*22 (*Aegilops squarrosa* var. *strangulata*), *Lr*24 («Agent,» Sear's 3Ag/3D, TR380. 27 x 4/3 Ag3-14), *Lr*27 («Gatcher»), *Lr*28 (*Aegilops speltoides*), *Lr*29 (*Aegilops elongatum*), and *Lr*KT(«Klein Titan»). Adult-plant resistance to leaf rust obtained in the backcross lines involving *Lr*14b and *Lr*15 may, in contrast to the donor lines, be due either to additive effect or interaction between resistance gene(s) in the recurrent and the donor parents. Some of the other potential genes for resistance to leaf rust such as *Lr*19(«Agatha»), *Lr*21 (*Aegilops squarrosa* var. *meyeri*), *Lr*25 («Transec»), *Lr*26(«Kavkaz»—*Secale cereale*),have also been recovered in the backcross lines. Among the effective genes for stem rust resistance, Kalyansona backcross lines deriving resistance from *Sr*12 + Mq, *Sr*26 (*Agropyron elongatum*), and combination III (*Sr*Tt1 + *Sr*9e) have been developed. All the backcross lines deriving specific genes for resistance to either leaf or stem rust are not only resistant to both rusts at the adult stage but also free from any apparent undesirable characters.

Development of similar lines in «Sonalika» background is in progress. The cultivation of backcross lines individually or in a mixture will not only maintain the genetic diversity for rust resistance but will also be acceptable to farmers because of the phenotypic resemblance to the popular genotypes «Kalyansona» and «Sonalika.» In addition, these lines could serve as improved breeding stocks carrying diverse genes for resistance for future use.

Improvement of Genotypes for Increased Yield potential and Resilience

There has been a great concern among wheat scientists that grain yield in the presently available dwarf wheat varieties has reached a plateau. A basic approach to increase yield potential is to combine higher number of effective tillers per unit area (over 500 spikes m^2) with increased head weight which, in turn, comprises kernels per spike and 1000-kernel weight. These two major yield components seem to be negatively correlated. It is, therefore, imperative to improve these components in such a way as to reduce the component compensation effect. It has also been observed that the leaf size is invariably negatively correlated with the number of effective heads, i.e. smaller leaf size is associated with larger number of heads. It is also observed that length and thickness of peduncle are positively associated with higher head weight. Utilization of parents with high values for differnet desirable components in the hybridization program and selection of segregants with small leaf size and long, thick peduncle, could possibly help combine higher values for both yield components. A plant ideotype with thick, small leaves and long, thick peduncle is expected to achieve more ears per unit area and hence, increased head weight.

Effectiveness of selection for improvement of grain yield is perhaps the foremost problem in the breeding of self-pollinated crops. Many wheat breeding programs in India are based on visual selection of single plants through several generations of segregating population from F_2 onward, before yield tests under commercial planting are conducted. It was experienced that in F_2, selection of specific plants had no advantage over randomly selected plants in terms of high-yielding F_3 lines. However, the poor F_2 plants generally produced low-yielding F_3 lines. Therefore, rejection of poor F_2 plants is desirable. It was further observed that visually selected spaced plants often have poor performance in advanced generations when grown under conditions of commercial planting. We, therefore, evaluate the material for actual grain yield from the F_3 onward at normal spacing to select high-yielding families. For a quantitative trait, such as yield, chances of obtaining high-yielding genotypes are enhanced when selection is exercized among the elite high-yielding families. Single-plant selections are restricted to space-planted populations of high-yielding F_4 progenies evaluated in different environments.

The material at most of the experimental plots is evaluated at optimum management conditions. The promising genotypes thus identified often do not perform well in farmer's fields because of nonavailability of optimum conditions. One way of developing more resilient or stable genotypes would be to evaluate the same material under different agronomic practices. With this consideration, we have started the evaluation of a set of F_4 progenies at three dates of planting and under different agronomic practices. The families performing well in different sets of conditions were usually found to be more resilient. To illustrate the point, selections derived from a cross DL230 (K7537 × HD 2160M) have performed well in different series of All India Coordinated Trials in different agroclimatic zones, such as North Plains, Far Eastern, South Eastern, and Southern Hills zones of the country. Also, selections made under limited environments perform well even when grown with optimum inputs, provided the genotypes are resistant to lodging. A case in point is the variety DL153-2 (Tonari- 71 × NP 890) which was selected for limited-input environment and has been officially identified for rainfed, normal-sown conditions of North Plains Zone. This genotype when grown under moderate fertility with three irrigations produced a grain yield of 4800 kg/ha.

Rectification for Rust Resistance and Improved Grain of Popular Cultivars Through Induced Mutagenesis

Another approach that we have sucessfully explored for creating new variability for rust resistance and improved grain for quality of popular wheat cultivars is induced mutagenesis.

One of the tall and traditional wheat cultivars, Kharchia Local, which is still grown in the Sanchore area of Rajasthan because of its tolerance to salt, was treated with a mutagen. Two of the rust resistant mutant lines, KLM4-1 and KLM4-3, showed complete freedom from leaf rust when tested in field over several years for rust reactions under artificially created rust infection. KLM4-1 has also shown low infection of stripe yellow rust and KLM4-3 recorded only slight infection of stem rust (Sawhney *et al.* 1978). The yield performance of the mutant lines was tested at the Indian Agricultural Research Institute, New Delhi, as well as at the Udaipur University Farms in the State of Rajasthan. The mutant lines outyielded the parental variety significantly (Sawhney *et al.* 1984). In seedling tests the mutant lines have shown complete resistance against individual Indian pathotypes and to 879 Indian field isolates of leaf rust. The parental variety in comparison has shown highly susceptible reaction. The range of resistance of the Kharchia mutant is reminiscent of the action spectra of *Lr*9, *Lr*19. However, Kharchia mutant resistance is different from *Lr*9 because one Canadian virulence overcomes *Lr*9 but not the Kharchia mutant resistance. The operation of *Lr*19 could also be excluded because Australian stem rust virulences differentiated *Lr*19 and the mutant lines. Our analysis suggests that the induced mutation is a new potential source for leaf rust resistance (Sawhney *et al.* 1979).

Similar results have been obtained in a high-yielding but rust-susceptible triple dwarf wheat cultivar, «Lalbahadur» (Sawhney *et al.* 1978). The differential pattern of infection obtained on 20 mutant lines of «Lalbahadur» when tested with stem rust and leaf rust Indian pathotypes suggests that these lines could be used as components of multiline of «Lalbahadur» (unpublished data). The results establish the role of induced mutagenesis in the development of phenotypically identical lines with different resistance for compounding multiline.

«Arjun,» another dwarf wheat and still popular with the Indian farmers, has been improved for its grain characteristic because the variety suffers from grain mottling. Extensive testing for 2 to 3 years in a number of Delhi villages on farmers' fields have shown that a mutant of Arjun has given yield performance superior or comparable to Arjun in addition to being distinctly superior with respect to grain mottling (Sawhney *et al.* 1982c).The mutant and the parental line were compared in demonstration trials in 1983/84 in the State of Haryana where Arjun is still a very popular wheat. In all the 20 demonstrations at the National Dairy Research Institute, Karnal (Haryana), the mutant was superior for grain and straw yields with distinct improvement of grain quality. Additionally, the mutant has been observed to be early in maturity for about 7 days, a very desirable feature particularly under multiple or double cropping.

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Studies on Wheat Aphids in Egypt I. Surveys

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Aphids constitute a major insect problem of wheat in Egypt. Entomological surveys were conducted during 1980/81 and 1981/82 at Dakahlia and Kafr El-Sheikh governorates (Lower Egypt), Fayoum and Beni Suef (Middle Egypt), and Assiut and Sohag (Upper Egypt). Random plant samples were inspected at 10 to 15-day intervals from 1 December through 30 June.

The first aphid infestation was observed on wheat seedlings 15-25 days old. Infestation started on edges of the wheat fields near ditches and channels where wild weeds were observed. Counts indicated that infestations were relatively higher at Fayoum, Beni Suef, Assiut, and Sohag governorates.

Periodic examinations revealed the occurrence of four aphid species attacking the aerial parts of wheat plants: the oat cherry bird aphid, *Rhopalosiphum padi* L; the corn leaf aphid, *Rhopalosiphum maidis* (Fitch.); the green cereal bug, *Schizaphis graminum* (Rond); and the English grain aphid, *Macrosiphum avernae* (Fab.).

The data indicated that *R. padi* was the predominant species in Middle and Lower Egypt, accounting for 64.6% of the aphid population in these provinces. *S. graminum*, *R. maidis*, and *M. avenae* accounted for 28.1, 5.3, and 2.0%, respectively. However, in Schandaweel province (Upper Egypt), *S. graminum* accounted for 70% of the total aphid population.

In addition to these four aphid species, a number of other insect species were found to attack wheat although to a much lesser extent. In particular, the thrips, *Limothrips cerealium* Holiday, were found in considerable numbers during April and early May at Dakahlia and Kafr El-Sheikh governorates. Damage due to thrips at flowering and grain formation stage ranged from unfilled grains to completely empty heads. The thrips population in Middle and Upper Egypt was far lower than in Lower Egypt.

Fluctuation of Aphid Population

The variation of aphid population for the two major species, *Rhopalosiphum padi* L. and *Schizaphis graminum* (Rond), was studied in wheat fields of Fayoum and Beni Suef governorates in 1984. Random plant samples of 20 tillers were regularly inspected at 10-day intervals. The results indicate that *R. padi* was first recorded on 30 December when plants were 30 days old. while *S. graminum* was first observed one month later. The peak occurrence with means of 60.3 and 40.6 insects/tiller for *R. padi* and *S. graminum*, respectively, was during the last 10 days of April. The two species disappeared around the middle of May when plants were in the yellowing stage of growth.

Summer Host Plants

Surveys of the hosts of wheat aphids after the harvest of wheat were conducted at Dakahlia, Gharbia, Menufia, Kafr El-Sheikh, and Damietta governorates in the Delta. A random sample of 100 plants for each host was examined once each in July, August, and September, both in 1982 and 1983, to determine the different wheat aphid species and the percentage of infested tillers. Species of crops and graminaceous weeds included: *Zea mays* (corn), *Oryza sativa* (rice), *Saccharum officinarum* (sugarcane), *Echinochloa crusgalli*, *Echinochloa colonum*, *Panicum repens*, *Cynodon dactylon*, *Cyperus alopecuroides*, *Cyperus rotandus*, *Cyperus difformis*, *Agropyron repens*, and *Phragmitis communis*.

1. *Rhopalosiphum padi* and *R. maidis*

These two wheat aphid species seemed to attack a wide range of graminaceous weeds, Primarily *Echinochloa colonum* (100% infested tillers), *Phragmitis communis* (85%), *Cynodon dactylon* (60%), and *Agropyron repens* (21%). Rice plants were free from aphids. *Echinochloa colonum* was the most preferred host for these aphid species. This weed species may play a major role in the ecosystem of these aphids. It can be considered as a good source for carryover infestations. Eradication of these weeds in the summer may reduce aphid infestation for the following season.

2. *Schizaphis graminum*

Phragmitis communis was more favorable for *S. graminum* infestation, followed by Cynodon dactylon, whereas *Echinochloa crusgalli* was only slightly infested. Very few individuals of *S. graminum* were found on maize plants.

3. *Rhopalosiphum maidis*

All maize fields were heavily infested. Many of the graminaceous weeds such as *C. dactylon*, *P. communis*, *A. repens*, and *E. colonum*, were susceptible.

Studies on Wheat Aphids in Egypt II. Germplasm Evaluation and Crop Loss Assessment

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Due to the importance of wheat aphids in Egypt, this study was conducted to evaluate wheat germplasm for tolerance to aphids and to assess the crop loss due to this pest.

Germplasm Evaluation

Screening of wheat germplasm was carried out under conditions of artificial infestation both in the laboratory and the greenhouse (20-25°C). Greenbug cultures were maintained on the susceptible barley variety Giza 121. Test plants were sown in plastic pots and seedlings were thinned to 10 per pot and placed under cage. Infestation was made by uniformly sprinkling about 20 greenbugs over each pot. Damage was scored using a 0-5 scale: 0 = no visible sign of damage; 1 = red spotting on the leaves; 2 = red spotting and yellowing on the leaves; 3 = severe yellowing; 4 = dead leaves; 5 = some plants killed.

Results were expressed using an index for the rate of damage (IR) calculated as:

$$IR = \frac{0 \times N0 + 1 \times N1 + 2 \times N2 + 3 \times N3 + 4 \times N4 + 5 \times N5}{10}$$

where N0, N1, N2, N3, N4, and N5 are the numbers of seedlings for the respective values on the rating scale. The tested material was classified according to IR values in the following categories:

Resistant	: $IR < 1$
Tolerant	: $1 \leqslant IR < 2$
Moderately tolerant	: $2 \leqslant IR < 3$
Susceptible	: $3 \leqslant IR < 4$
Highly susceptible	: 4IR $\geqslant 4$

From the Amigo derivatives, the most tolerant entries were:
Bushland, TXF 795/8 - 2X77A/5/Amigo//T.101
Bushland, TXF 38924 - 8 Amigo/2T-105
Bushland, TX 38932 - 5 Amigo/4/A 562-6
Bushland, TX 38976 - 4X77A/5/Amigo//T.101
Bushland, TX 38967 - 6X77A/5/ Amigo//T-101

From the 1982/83 ICARDA Regional Crossing Blocks, the following bread wheat entries were found tolerant: RBS/Hork's'; Jup/BJY's'; Buck Buck; Lfn/Mz 4777//Reilly/3/Kt/4/Maya 74; Kal/Bb//Ald's'; and My54/3/N10/Y50/K.line/4/Cdz/5/CI 71's'/6/ PAT. 49.

From the 1981/82 material, only one entry, Maya 74-Moncho's', showed an acceptable tolerance to greenbugs.

Crop Loss Assessment

To evaluate grain yield losses due to aphids, around 2000 random samples were taken at maturity from wheat fields in Fayoum, Beni Suef, Minia, Assiut, and Sohag governorates. Six random samples were taken from each selected field, three from infested spots, and three from uninfested spots of the same field. Each sample consisted of 100 heads which were threshed for yield determination. Crop losses were estimated using: (a) the percent area of infested spots in each sampled field, and (b) the average number and weight of grains for the infested and uninfested spots in the same field. Loss was estimated as:

Percent yield loss = percent reduction of grain weight × percent area of infested spots.

Yield loss in kg/ha was obtained as the product of percent yield loss and estimated average yield (kg/ha) for the field. Results showed that estimated yield losses due to aphids ranged between 7.5 and 18.7% or 262 and 616 kg/ha. Wheat fields at Fayoum, Assiut, and Sohag were most damaged while those at Minia were much less so.

Chemical Control Studies

1. Experiment I

An experiment was conducted in 1982/83 at Sids Agricultural Experiment Station to investigate the effects on aphids and grain yield (using the variety Sakha 69) of seven insecticidal treatments with four application dates (Table 1). A split-plot design with three replications was used with insecticidal treatments in main plots. Each subplot consisted of 32 rows, 13 m long and 20 cm apart. Spraying was directed 20 cm below the top of the vegetation in order to reach the insects on the lower portions of the wheat plants. Measurements of aphid populations were made at 3, 7, and 15 days after the insecticidal applications. Thirty tillers from 30 random wheat hills were used to determine the mean number of insects for every treatment. In addition, the grain harvested from the six central rows in each plot was used to determine grain yield per hectare.

The results indicated that infestation by aphids was very high in the untreated plots. Almost 100% of the plants were infested with a relatively high density (3159 insects/30 tillers). Significant reductions of aphid population were observed following insecticide treatments; ranges of reduction were 29-98, 38-100, 34-100, and 32-97% for applications on 15 February, 1 March, 15 March, and 1 April, respectively. About the same order of effectiveness was obtained when observations were made 15 days versus 7 days after insecticide applications.

Table 1. Insecticidal treatments and dates of insecticide applications for the 1982/83 experiment.

Insecticide	Rate of application (400 l of water for 0.42 ha)	Date of application (for all insecticides)
Sevin, 43% S.L.	2 l	15 Feb
		1 Mar
Tamaron, 60% E.C.	1 l	15 Mar
		1 Apr
Azadrin, 40% E.C.	0.5 l	
Malathion, 57% E.C.	1.25 l	
Methavin, 90% S.P.	300 g	
Larvin, 80% D.F.	400 g	
Control (untreated)		

Sevin, Tamaron, and Azodrin were the most effective chemicals both with respect to aphid reduction and grain yield. The effect of Methavin was intermediate while Larvin was inferior to all other insecticides. It is recommended that early March is the optimum date for a single spray against aphids on wheat plants. As infestations generally start in small patches in the field, it was effective to apply chemicals in infested spots before the insects spread over the whole field. Moreover, spraying only the top of wheat plants was ineffective as the insecticide must reach the insects on the lower portions of the plants.

2. Experiment II

This experiment was conducted in 1983/84 at the same station to test the effect of 11 insecticidal treatments on aphids and grain yield using wheat variety Giza 157. The treatments were assigned to plots (7 m × 6 m) according to an RCB design with four replications. Insecticides were applied at one time during the first week of March. Observations on aphid population were made 3, 6, and 10 days after the chemical treatments (Table 2). In untreated plots, all tillers were infested with an average intensity of 1926 insects/20 tillers. Significant differences of aphid infestation were found between the treated and untreated plots and among the various treatments. Gardona, Sevin, Anthio, and Malathion gave complete control of aphids with no significant difference among these chemicals. Larvin and Lannette gave no satisfactory control. Singnificant grain yield increases from 34.8 to 102.2% were obtained as a result of insecticide applications.

Table 2. Reduction in aphid population and the increase in grain yield following treatments with different insecticides at Sids, 1984.

Insecticide	Rate of application (0.42 ha)	% reduction in population			Grain yield (kg/ha)	Increase in yield (%)
		3 days	6 days	10 days		
Gardona 70% Sus.	1 l	84.1	99.1	100	5575	87.5
Gardona 70% Sus.	2 l	100	100	100	5976	101.0
Sevin 43% S.L.	1 1/2 l	90.5	90.0	96.4	5502	85.1
Sevin 43% S.L.	2 l	97.0	98.6	100	5830	96.1
Larvin 80% D.F.	500 g	28.6	50.1	56.3	4081	37.3
Larvin 80% D.F.	800 g	88.6	92.6	100	5211	75.3
Anthio 33% E.C.	1 l	60.6	79.4	90.0	4737	59.3
Anthio 33% E.C.	2 l	100	100	100	6013	102.2
Lannette 90% S.P.	300 g	50.0	55.0	60.1	4008	34.8
Malathion 57% E.C.	1 1/4 l	92.6	100	100	5903	98.5
Untreated (check)					2974	

Use of Barley (*Hordeum vulgare* L.) for Forage and Grain in Tunisia

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Barley (*Hordeum vulgare* L.) is a traditional cereal crop in Tunisia where it is grown in subhumid as well as semiarid areas. It is used both for animal feed and human consumption. Straw was once an important crop product but has considerably lost its importance due to the development and widespread utilization of hay forage, particularly the vetch-oat combination.

In the dry environments of central and southern Tunisia, the barley crop may be completely grazed by sheep, particularly when prospects for grain production become slim. In the more favorable areas of northern Tunisia, barley is grown primarily for grain, although grazing combined with grain production is also practiced.

This study was designed to assess the relative performance of a number of barley cultivars for both forage and grain production in northern Tunisia.

Materials and Methods

Twelve cereal cultivars (10 barley, one oat, and one triticale) were subjected to six simulated-grazing treatments in five experiments. In the first season (1980) the barley cultivars were evaluated at Beja and Tunis where the annual rainfall was 635 and 471 mm, respectively. In the following season, two of the barley cultivars were replaced by one oat (TAM 312) and one triticale (Maya II/Armadillo) cultivars (Table 1). This experiment was conducted at Beja, Mateur, and Tunis where the annual rainfall was 596, 543, and 299 mm, respectively. The six grazing treatments were:

C0: no grazing (check)
C1: a unique clipping at full tillering
C2: a unique clipping at jointing
C3: a unique clipping at booting/early heading
C4: C1 followed by a clipping at the same date as C2
C5: C1 followed by a clipping at the same date as C3

The stages of development are those of the early and medium-early cultivars but clipping was done the same day for all cultivars in a given experiment. Grazed plots received 20 kg N/ha following each grazing. All plots were otherwise treated similarly. The 60 cultivar × treatment combinations were assigned to plots according to an RCB design with four replications in each experiment. Each plot consisted of six 2.5-m rows with 25 cm between adjacent rows.

Forage dry-matter yield (t/ha) was determined in all experiments while grain yield (t/ha) was determined in all experiments except at Tunis in 1980 where bird damage in some plots prevented an accurate measurement of this trait. Straw yield (at three sites) and forage N content (at two sites) were determined in 1981 only. Other traits (tillers/m^2, plant height, and lodging) were evaluated in three or more experiments.

Table 1. Characteristics of cultivars tested in 1980 and 1981.

Entry No.	Cultivar	Origin	Spike type	Maturity	Year tested
1	Antares	France	6 rowed	Medium	1980, 1981
2	Aurore/Esperance	Tunisia	2 rowed	Early	1980,1981
3	Ceres	France	2 rowed	Medium	1980, 1981
4	Delisa	France	2 rowed	Medium	1980, 1981
5	Gem	USA	6 rowed	Medium	1980, 1981
6	Martin	France	6 rowed	Medium	1980, 1981
7	Mari/CM67	CIMMYT	2 rowed	Early	1980, 1981
8	WI 2231	Australia	2 rowed	Early	1980, 1981
9	Ager	France	6 rowed	Late	1980
10	Capri	France	2 rowed	Late	1980
11	TAM 312 (oat)	USA		Late	1981
12	Maya II/Arm (triticale)	CIMMYT		Late	1981

Results and Discussion

Dry Matter

Significant differences were found among cultivars for forage dry-matter yield in each experiment. Aurore/Esperance outyielded the other cultivars in most of the experiments (Table 2) and ranked first based on overall performance. Other high-yielding cultivars were Ceres, Delisa, and Martin. The late barley cultivars Ager and Capri along with the triticale and oat cultivars formed the lowest yielding group. However, dry-matter production varied with grazing treatments and was highest for C3 followed by C2. The highest yields were recorded at Mateur where grazing occurred at a later developmental stage (end of heading) than at other sites. Such forage produced at a late stage has a lower nutritive value and can best be utilized as silage.

The capacity for regrowth following grazing varied with the genotype. Certain cultivars such as Antares produced comparable amounts of dry matter in C4 and C2, but most cultivars showed significant dry-matter yield decreases when grazed twice, particularly in late grazing (C5 versus C3). However, repeated grazing improved the quality of total forage as compared to single grazing. Average nitrogen yields (N percent × dry-matter yield) were 26, 68, 100, 70, and 101 kg N/ha for C1, C2, C3, C4, and C5, respectively.

Table 2. Forage dry-matter yield (t/ha) for the different cultivars and grazing treatments.

Cultivar[1]	Grazing treatment				
	C1	C2	C3	C4	C5
	Beja, 1980				
1	0.69	1.89	2.93	2.09	2.42
2	0.93	3.12	4.61	2.27	4.44
3	0.65	2.28	4.50	2.20	3.92
4	0.99	2.59	4.42	1.94	3.33
5	0.71	1.91	2.71	1.72	3.02
6	0.67	2.16	3.23	1.90	3.49
7	0.77	2.02	3.78	2.05	3.65
8	0.59	2.27	3.53	2.55	3.23
9	0.60	1.74	2.86	1.42	2.45
10	0.53	1.54	2.07	1.53	2.21
LSD (0.05) = 0.64					

Table 2. Contd.

Cultivar[1]	Grazing treatment				
	C1	C2	C3	C4	C5
	Beja, 1981				
1	0.59	1.44	4.37	1.23	3.10
2	0.67	2.50	5.06	1.46	4.13
3	0.55	1.75	3.98	1.46	3.60
4	0.45	2.05	4.13	1.34	2.66
5	0.53	1.76	3.35	1.26	3.25
6	0.44	1.68	4.04	1.21	3.68
7	0.49	1.85	4.35	1.22	3.31
8	0.45	1.66	4.39	1.25	2.59
11	0.26	1.04	2.64	0.93	1.86
12	0.42	1.33	2.68	1.04	2.17
LSD (0.05) = 0.51					
	Tunis, 1980				
1	0.57	3.25	2.30	1.94	2.20
2	0.92	4.74	4.77	2.62	3.86
3	0.85	3.68	5.71	2.32	3.84
4	1.12	2.90	5.11	2.86	2.80
5	0.64	3.53	3.72	2.42	2.36
6	0.77	3.55	3.88	2.42	2.74
7	0.86	3.20	4.17	2.16	2.86
8	0.74	2.91	3.15	2.14	3.00
9	0.50	2.80	1.91	2.31	2.01
10	0.54	2.06	2.61	1.57	2.07
LSD (0.05) = 0.65					
	Tunis, 1981				
1	0.61	2.17	4.29	1.97	3.22
2	0.77	3.86	5.30	2.57	5.47
3	0.62	2.52	5.41	3.22	3.80
4	0.63	2.72	5.10	2.63	4.11
5	0.60	2.46	4.77	2.10	4.09
6	0.77	2.81	4.71	2.03	3.92
7	0.65	2.37	4.32	2.56	4.21
8	0.64	2.73	4.43	1.97	3.38
11	0.19	1.33	3.04	1.07	2.11
12	0.34	1.91	3.24	1.66	2.83
LSD (0.05) = 0.64					
	Mateur, 1981				
1	0.83	2.39	5.66	2.25	7.03
2	1.10	3.86	6.89	2.42	5.56
3	1.03	2.46	6.18	2.67	5.00
4	0.85	2.61	6.00	2.17	5.55
5	1.15	2.77	7.33	2.56	5.44
6	1.31	2.52	7.14	2.55	6.05
7	0.79	2.27	4.85	1.95	3.93
8	1.01	2.46	6.52	2.15	5.17
11	0.51	1.31	3.82	1.23	3.03
12	0.70	1.74	4.46	1.56	4.25
LSD (0.05) = 0.83					

1. See Table 1 for cultivar names.

Grain Yield

Differences among cultivars for grain yield performance were detected both for the ungrazed and grazed treatments. In addition, cultivar × treatment interactions indicated that the various cultivars did not respond similarly to simulated grazing. Aurore/Esperance exhibited low grain yields when ungrazed and high yields when grazed (Fig. 1). This cultivar had a weak straw and lodged severely when grown for grain only. Furthermore, its earliness was associated with a pronounced shattering. It was clear from the results that grazing decreased plant height and delayed maturity for this cultivar, resulting in an overall grain yield increase. At the other extreme, Delisa showed higher grain yield when ungrazed than when grazed.

Other cultivars exhibited intermediate responses (Fig. 1). However, for all cultivars, early grazing did not seem to be detrimental to grain production, in contrast to grazing after the jointing stage which consistently reduced grain yield.

Total Yield

The economic value of a barley cultivar depends on the total forage, grain, and straw produced. However, these three components do not all have the same energetic value nor the same quality, and conversion factors had to be used to measure all com-

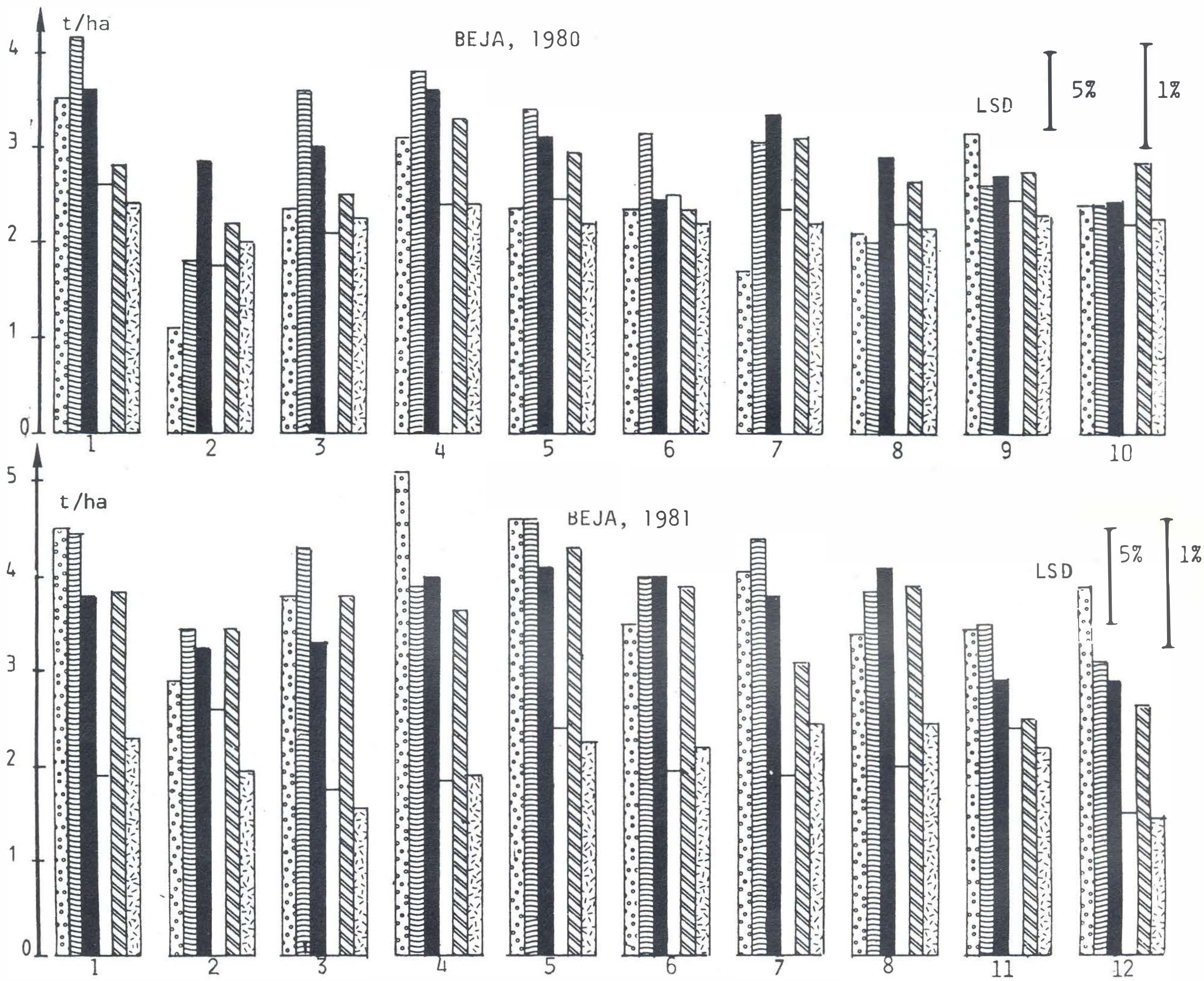

Fig. 1. Grain yield (t/ha) for all cultivars (on the x-axis, numbered 1, 2, 3, etc.) and all treatments (for each cultivar, the first bar represents C0, the second C1, the third C2, etc.), at Beja.

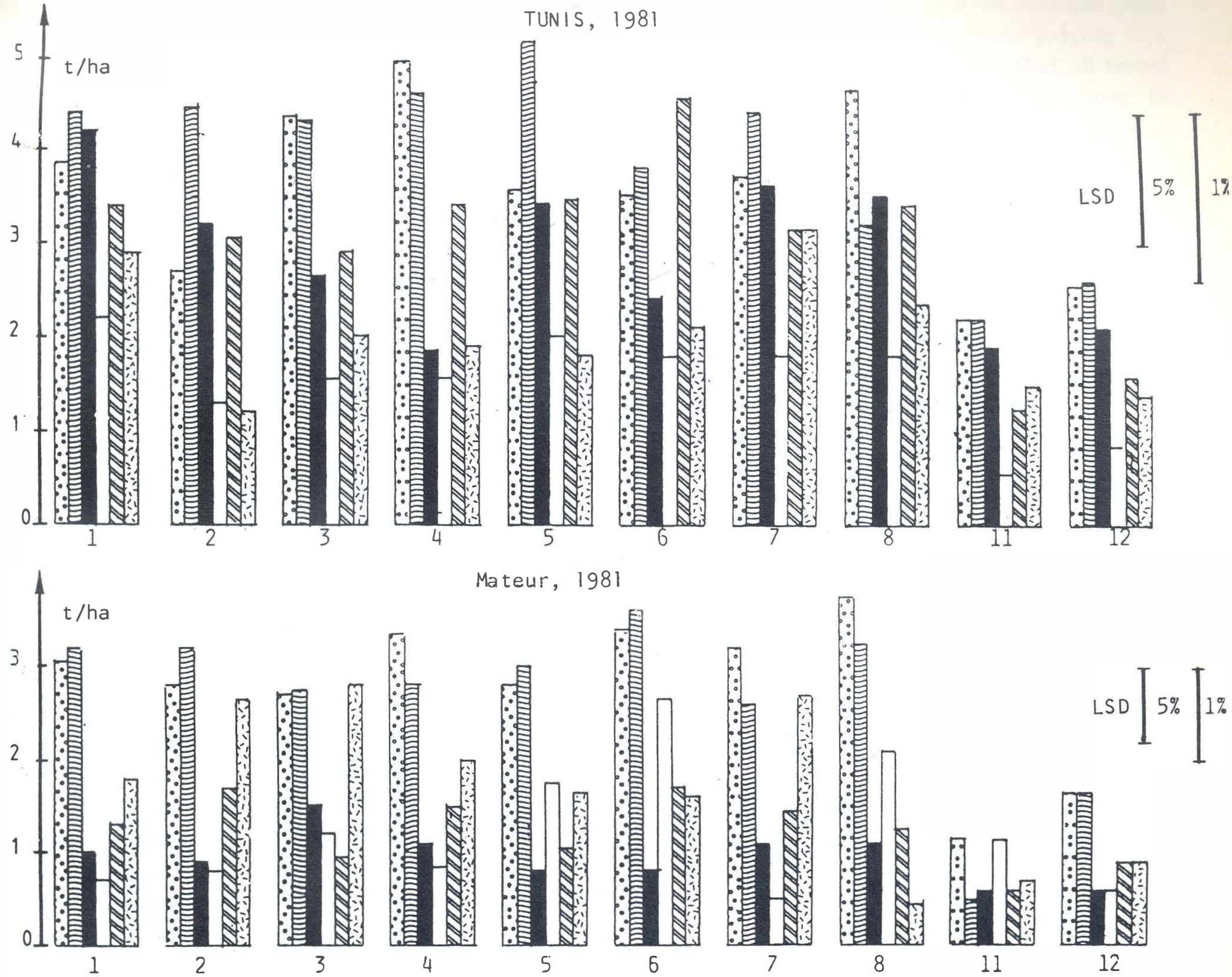

Fig. 1 (Contd). Grain yield (t/ha) for all cultivars (on the x-axis, numbered 1, 2, 3, etc.) and all treatments (for each cultivar, the first bar represents C0, the second C1, the third C2, etc.),at Tunis and Mateur.

Table 3. Conversion factors for metabolizable energy (UF/kg)* and digestible proteins (g/kg of product).

Product	Metabolizable energy			Digestible proteins		
	Barley	Oat	Triticale	Barley	Oat	Triticale
Dry-matter						
C1	0.91	1.10	0.83	131	122	125
C2	0.80	1.01	0.80	77	97	107
C3	0.76	0.92	0.71	48	72	89
Straw	0.34	0.49	0.41	22	0	6
Grain	1.00	1.00	1.21	88	96	111

*IUF = 13.7 MJ/kg dry weight.

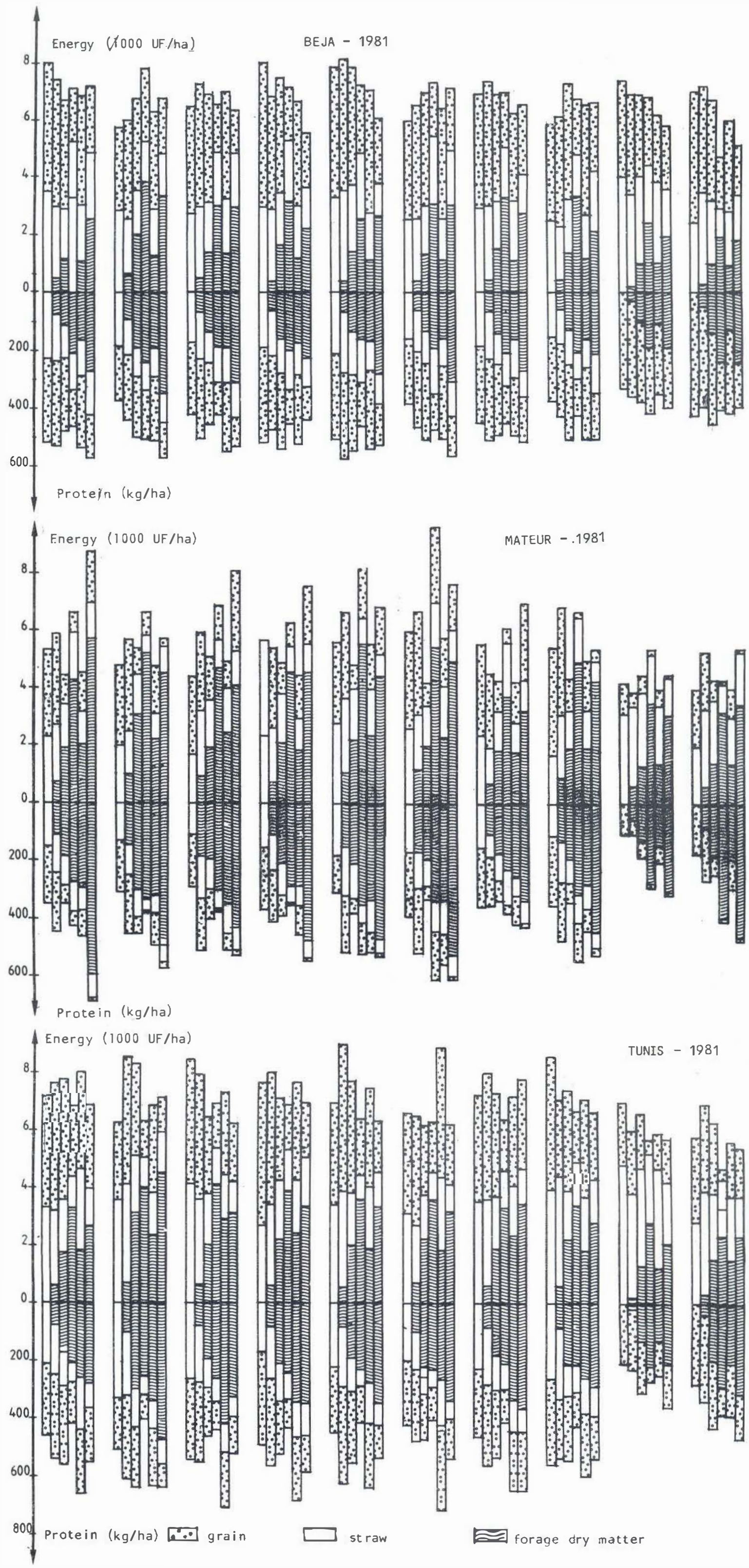

Fig.2. Total metabolizable energy (UF/ha) and digestible protein (kg/ha) yields for all cultivars (1,2,3,4,5,6,7,8,11,12) and treatments (C0,C1,C2,C3,C4,C5).

ponents on the same energy or quality scale. Using the conversion factors (Table 3) reported by Slim (1982), it was possible to estimate total energetic value (1 UF = approx. 13.7 units of metabolizable energy) and digestible protein yield. The combined utilization of barley for both forage and grain frequently resulted in increased total energetic and digestible protein yields (Fig. 2). Typical cases are the cultivars Aurore/-Esperance and Martin. If adequate barley cultivars are available, the Tunisian farmer can take advantage of the rapid and early plant growth in barley to feed his sheep or cattle early in the winter when green feed is scarce, and still ensure a good harvest (grain and straw) thereafter. Even when grain is the primary product, a single early grazing will not decrease grain yield and may even enhance it where lodging is a problem. It is also of interest to note that all tested barley cultivars showed superior performance in comparison to oat, indicating that barley offers a better alternative for hay or forage production in northern Tunisia.

Reference

Slim, 1982. Etude du comportement de l'orge (*Hordeum vulgare* L.) en double exploitation: fourrage/grain. Mémoire de fin d'étude de cycle de specialisation. INAT, Tunis, Tunisie.

Effect of Seed Rate, Row Spacing, and Sowing Method on Grain Yield of Wheat

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Cereal crops, particularly wheat, provide the major source of human food and animal feed in the world. The demand for these crops is ever increasing because of the rapid increase in human population, making it imperative to raise cereal productivity. Key measures for achieving this goal include the development of high-yielding cultivars and appropriate cultural practices.

Several researchers (Cholick 1979; Dhillon and Kler 1981; Gomaa *et al.* 1977; Habib and Makki 1979; Hagras 1981; Hussein *et al.* 1979; Khalil *et al.* 1977; Mehrotra *et al.* 1979; Urazaliev and Salimbaev 1980) have found that seed rates, row spacings, and methods of cultivation can be important factors in determining grain yield in wheat. However, results were often contradictory.

The objective of this investigation was to study the effect of four seed rates, two spacings, and two sowing methods on grain yield of two wheat cultivars in northern Syria.

Materials and Methods

The experiment was conducted in 1983/84 at Meslemieh, near Aleppo, Syria, according to a split-plot design with main plots in RCB. The treatments included two methods of sowing: normal or unidirectional sowing and bidirectional (in two perpendicular directions) sowing; two row spacings: 15 cm and 30 cm; four seed rates: 300, 400, 500, and 600 seeds/m²; and two cultivars: a durum wheat (Gezira 17) and a bread wheat (Siete Cerros). Sowing methods and row spacings were assigned to main plots and seed rates and cultivars to subplots. The size of a subplot was 5 m × 1.8 m, of which a central portion of 5 m × 1.2 m was harvested for yield determination. Cultural practices as recommended for the Meslemieh area, including sowing date and fertilizer, were adopted. Data were analyzed for each sowing method separately and then a combined analysis was performed for both methods following procedures described by Sokal and Rohlf (1981).

Results and Discussion

Results for each sowing method showed significant effects of row spacings and varieties with no significant effect of seed rates or any interactions among the various factors. It was observed that narrower spacing (15 cm) gave better grain yield than wider spacing (30 cm) for all seed rates and varieties (Table 1). Average yields for 15- and 30-cm spacings were, respectively, 5.23 and 3.64 t/ha for the bidirectional sowing and 3.86 and 2.46 t/ha for the normal sowing. This is in agreement with the findings of Hussein *et al.* (1979). The yield advantage of narrower spacing may be due to a more even plant distribution and a better coverage of the soil surface by the plants which limits soil evaporation and enhances the utilization of sunlight for photosynthesis. The bread wheat variety Siete Cerros showed a better yield potential than the durum wheat variety Gezira 17.

Table 1. Grain yield (t/ha) of Gezira 17 and Siete Cerros under different row spacings, seed rates, and sowing methods, at Meslemieh, 1984.

Row spacing (cm)	Seed rate (seeds/m²)	Bidirectional sowing			Normal (unidirectional) sowing		
		Gezira 17	Siete Cerros	Mean	Gezira 17	Siete Cerros	Mean
15	300	5.12	4.70	4.91	3.58	4.38	3.98
	400	5.12	5.12	5.12	3.85	4.03	3.94
	500	4.38	7.18	5.78	5.17	4.50	3.84
	600	4.86	5.37	5.12	3.75	3.64	3.70
	Mean	4.87	5.60	5.23	3.59	4.14	3.86
30	300	3.55	4.75	4.15	2.06	2.68	2.37
	400	3.33	3.15	3.25	2.26	2.55	2.41
	500	3.30	3.90	3.60	2.30	2.85	2.57
	600	3.07	4.05	3.56	2.36	2.66	2.51
	Mean	3.31	3.96	3.64	2.25	2.68	2.46
Mean		4.09	4.78	4.43	2.91	3.41	3.16

Combined analysis of the two sowing methods showed that cross cultivation was significantly superior to normal sowing for all varieties, seed rates, and row spacings (Table 1). This is in agreement with the results reported by Dhillon and Kler (1981). The better plant distribution per unit area in the bidirectional sowing allowed a better light interception, a weaker interplant competition, and a better soil coverage, leading to a decreased soil evaporation and a more efficient use of soil moisture. Such plant distribution could have also helped in better holding the CO_2 produced by nocturnal respiration and thus would have enhanced photosynthesis early in the morning.

It is concluded that bidirectional sowing at appropriate date combined with narrower spacing (15 cm) should be recommended whenever feasible. On the other hand, seed rates of over 300/m² may not be economical.

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Wheat Grain Yield as Affected by Date and Rate of Seeding

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Wheat (*Triticum aestivum* L.) is the basic food crop in Pakistan. In 1982/83, about 0.8 m ha was devoted to wheat in the Northwest Frontier Province (NWFP), producing approximately one million tonnes of grain. During the same period, the total wheat area in the country was 7.4 m ha, with a total production of 12.41 million tonnes (FBS 1985). The average yield per unit area in NWFP (1211 kg/ha) as well as on the national level (1678 kg/ha) is very low as compared with that of the developed countries. For instance, in the United Kingdom, the national average yield in 1980 was 5880 kg/ha against 2600 kg/ha in 1950. About 40% of this increase had been possible due to improved management systems and the rest 60% due to improved cultivars (Roth *et al. 1983*). Grain yield is a complex trait and is influenced by several management practices, most of which could be skillfully exploited to increase grain yield per unit area. Seeding date and seeding rate are reported to be important factors of management systems affecting grain yield in wheat.

Waraich *et al.* (1982) examined five wheat cultivars for six dates of planting with 10-day intervals from 16 October to 16 December, and found 16 November to be the best time for planting wheat at Islamabad. Yield reduction was observed if sowing was done earlier or later than that date. However, there was no significant difference in yield among the three dates in November At Faisalabad, Sattar *et al.* (1984) tested eight dates of sowing with 10-day intervals, from 30 October to 10 January and concluded that 10 November was the optimum sowing date. They reported that yield decreased progressively as planting was delayed thereafter. Khan and Saleem (1984a) recommended the last week of October as the best time for planting wheat variety Pak. 81 in NWFP. Ciha (1983) evaluated three dates of planting (early, normal, and late) and found that grain yields were reduced significantly with late planting. Similar results were obtained by Nass *et al.* (1975).

Ciha (1983) tested three seeding densities (40, 75, and 110 kg/ha) and found that several cultivars showed yield reductions with lowest and highest seeding rates. Decrease in yields with highest seed rates was attributed to lodging. Ciha elaborated that increasing seed rate at delayed seeding dates was not beneficial in increasing grain yield. Roth *et al.* (1983) tested three seed rates (100, 168, and 235 kg/ha) and concluded that yields were not increased by using more than 168 kg/ha. However, they reported a greater response to increased seeding rate at late planting. Increased lodging was reported with increased seed rate and especially when combined with high nitrogen rates. Results from CIMMYT (1978) showed no significant yield differences among four seed rates (50, 100, 200, and 300 kg/ha). Moreover, the wheat crop at higher densities is more likely to lodge, as such higher seed rates offer no seed advantage unless weeds are a problem. Khan and Saleem (1984b) found no significant increase in grain yield using seed rates ranging from 25 to 140 kg/ha.

This study was, therefore, undertaken to investigate the yield performance of two newly developed wheat varieties at different seeding dates and rates.

Materials and Methods

Experiments on seeding date and seeding rate of wheat were carried out during 1982/83, at Cereal Crops Research Institute (CCRI), Pirsabak, Nowshera, to identify optimum management practices necessary to maximize wheat under irrigated conditions. Improved wheat varieties (Sarhad 82 and Sarhad 83) recently developed at this institute were used.

In one experiment, six seeding dates: D_1 (20 Oct), D_2 (3 Nov), D_3 (22 Nov), D_4 (2 Dec), D_5 (16 Dec), and D_6 (1 Jan) were used for each of the two varieties. In the second experiment, six seeding rates ($SR_1 = 62$, $SR_2 = 74$, $SR_3 = 86$, $SR_4 = 98$, $SR_5 = 110$, and $SR_6 = 122$ kg/ha) were used in combination with the two varieties planted on 3 November 1982. Both experiments were laid out according to a split-plot design with a plot size of 5 m × 3 m for the main plot factor (dates in one experiment and varieties in the other) and 7.5 m^2 for the subplot factor. The season was rainy, humid, and favorable for crop lodging and disease development. Nitrogen and phosphorus were applied prior to planting at the rates of 100 kg/ha and 60 kg/ha, respectively. Lodging occurred on 9 April 1983 and plots were rated for lodging (0 = none and 90% = severe). Grain yield data based on a central area of 5 m^2 in each plot were expressed in kg/ha and analyzed separately for each experiment.

Results and Discussion

results from the first experiment showed no significant yield difference due to varieties or variety × date interactions. However, highly significant differences were detected among the seeding dates. For both varieties, grain yield decreased progressively as seeding was delayed (Table 1) and this agrees with the results reported by Ciha (1983), Nass *et al.* (1975), and Sattar *et al.* (1984). Field observations showed that Sarhad 82 was taller and more susceptible to lodging than Sarhad 83. Lodging may have contributed to yield decreases for Sarhad 82 at D2 and D3 but not at D1, probably because the plants at D1 were mature when lodging occurred. Sarhad 83, which did not show any sign of lodging for all dates could be recommended for productive and lodging-prone environments of Pakistan.

Results from the second experiment showed significant yield differences due to varietal effect only. Sarhad 83 had higher grain yield than Sarhad 82 (4973) vs 3886 kg/ha (Table 2), which was also noticed although to a lesser degree, in the first experiment. The low grain yield of Sarhad 82 may be due to its excessive lodging, particularly at the higher seeding rates. The impact of higher planting densities on lodging was also reported by Khan and Saleem (1984b) and Roth *et al.* (1983). In contrast, Sarhad 83 confirmed its good resistance to lodging despite the increased seed rates. This variety can, therefore, be sown at higher seed rates (100-120 kg/ha) particularly in areas where stand establishment is poor or weeds are a problem.

Table 1. Grain yield of two wheat varieties Sarhad 82 (S 82) and Sarhad 83 (S 83) at CCRI, Pirsabak, Nowshera, 1982/83.

Seeding date	Grain yield (kg/ha)			Lodging (%)		Plant height (cm)	
	S 82	S 83	Mean	S 82	S 83	S 82	S 83
D 1	5700	5280	5490	70	0	109	95
D 2	4690	5065	4878	30	0	109	92
D 3	3690	4270	3980	40	0	99	87
D 4	3235	3715	3475	30	0	97	85
D 5	3095	2975	3035	0	0	92	84
D 6	2620	2760	2690	0	0	88	83
Mean	3830	4011	3925	28	0	99	88

	Variety (V)	Date (D)	V × D
LSD (0.05) (yield)	ns	616	ns

CV (main plots) = 10%
CV (subplots) = 19%

Table 2. Grain yield of two wheat varieties Sarhad 82 (S 82) and Sarhad 83 (S 83) at CCRI, Pirsabak, Nowshera, 1982/83.

Seeding rate	Grain yield (kg/ha)			Lodging (%)		Plant height (cm)	
	S 82	S 83	Mean	S 82	S 83	S 82	S 83
SR 1	3880	4740	4310	85	0	108	95
SR 2	4160	4885	4523	70	0	111	95
SR 3	3675	5220	4448	90	0	108	96
SR 4	3850	4995	4423	80	0	107	95
SR 5	3850	5085	4468	85	0	110	95
SR 6	3900	4910	4405	90	0	109	96
Mean	3886	4973	4429	83	0	109	95

	Variety (V)	Seed rate (SR)	V × SR
LSD (0.05) (yield)	872	ns	ns

CV (main plots) = 21%
CV (subplots) = 11%

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Nitrogen Response and Conversion Efficiency of Dwarf Hull-Less Barley Varieties

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Response of dwarf high-yielding varieties to nitrogen has been extensively studied in rice (Jennings 1965; Jennings and Beachell 1965; Chandler 1969) and wheat (Ram 1974; Hanson *et al.* 1982). In general, these dwarf varieties have responded up to 200 kg/ha of nitrogen with corresponding increase in yield as compared to 60 kg/ha in the traditional tall varieties which are prone to lodging (Swaminathan 1984). In barley, traditional tall varieties did not show response to nitrogen beyond 60 kg/ha due to their lodging tendency (Choudhary *et al.* 1971; Singh and Prasad 1972). There are reports of breeding dwarf winter barley varieties from USA, Japan, and Europe (Konzak 1983) but little is known about the response of these varieties to nitrogen. However, there is no report of breeding dwarf hull-less spring barley varieties responsive to nitrogen. Further, little information is available on the «nitrogen conversion efficiency» of cereal crops.

The present investigation was therefore undertaken to study the response of newly bred dwarf hull-less barley varieties to nitrogen applications and to evaluate their nitrogen conversion efficiency.

Materials and Methods

In the 1982/83 season, three dwarf (Karan 3, Karan 16, Karan 18) and one semidwarf (Karan 4) hull-less barley varieties were grown at three locations representing three distinct climatic conditions: subtemperate humid (Karnal), subtropical dry (Kanpur), and semiarid desert (Durgapura). Three nitrogen levels (0, 40, and 80 kg N/ha) were used.

In the following season (1983/84) three dwarf hull-less barley varieties, viz. Karan 3, Karan 4, and Karan 16, and the two best dwarf wheat varieties in the area were used. Karan 18 was dropped due to its susceptibility to aphids. Since the trial at Kanpur was sown very late, yields were generally very low; hence the Kanpur data were not included in this study. With the addition of the two wheat varieties (HD 2329 and HD 1482), nitrogen level was raised up to 120 kg N/ha.

The trials were laid out according to a randomized complete block design with four replications and a plot size of 2.4 m × 4.5 m. Sowing was done by hand, and rows were spaced 20 cm. Seed was sown at the rate of 80 and 100 kg/ha in 1982/83 and 1983/84, respectively. Sowing in general was late, i.e., in mid-December, while normal sowing in irrigated conditions should end by mid-November. Two irrigations were given during 1982/83 and three during 1983/84. Yield data were statistically analyzed for significance between varieties and between treatments, as well as for V × N interaction. The nitrogen conversion efficiency was calculated thus:

$$\text{Nitrogen conversion efficiency} = \frac{\text{Yield for a given applied nitrogen level} - \text{yield for the control (N0)}}{\text{Total dose of applied nitrogen}} \times 100.$$

Results and Discussion

Nitrogen Response

The analysis of variance (Table 1) revealed that varietal as well as treatment differences were significant. The varieties showed significant response to nitrogen up to 80 kg/ha. However, all varieties showed similar response to nitrogen, since N × V differences were nonsignificant.

The results obtained for 1983/84 conformed to those of 1982/83. Karan 4 (barley) and HD 2329 (wheat) showed the highest response. Karan 3 and Karan 16 were equally good in nitrogen response.

It is to be noted that dwarf varieties of barley and wheat were equally responsive to nitrogen up to 120 kg/ha with a proportional increase in yield for increased nitrogen rates. In fact Karan 4 has outyielded the best wheat varieties in northern India (HD 2329) and in central India (RD 1482).

Nitrogen Conversion Efficiency

The dwarf hull-less varieties were found more efficient in nitrogen conversion efficiency (NCE) than the dwarf wheat varieties. Of all cultivars tested, Karan 4 showed the highest nitrogen conversion efficiency. Between the two dwarf wheat varieties, HD 2329 showed a higher NCE than RD 1482 (Table 2).

It is also to be noted that dwarf hull-less barley varieties showed the highest nitrogen conversion efficiency at 40 kg N/ha, against 80 kg N/ha for wheat varieties. Though the yield of both hull-less barley and wheat showed an increasing trend with increased nitrogen rates, there was a corresponding fall in the NCE of both crops. However, the fall in NCE of hull-less barley started after 40 kg N/ha, while for wheat, it began after 80 kg N/ha. This means that there was a corresponding reduction in the nitrogen absorption/uptake efficiency with the increase in the nitrogen rate.

Among the cereal crops, barley has been found to possess relatively high NCE both under rainfed and irrigated conditions (Swaminathan 1984). However, little is known about the varietal differences in NCE of wheat and barley. Asana *et al.* (1968) noted that the two most «efficient» wheat varieties as measured by the conversion of nitrogen into dry matter and grain were not the highest yielding. In our study, the highest yielding hull-less barley (Karan 4) and wheat (HD 2329) lines showed the highest nitrogen conversion efficiency.

Table 1. F values for different sources of variation of grain yield for two seasons.

Source	1982/83				1983/84		
	Karnal	Durgapura	Kanpur	Pooled over centers	Karnal	Durgapura	Pooled over centers
Locations (L)				26.67**			11.07**
Rep.	0.25	0.90	4.39*		0.69	0.74	
N levels (N)	163.32**	18.43**	83.63**	46.90**	308.09**	40.17**	75.61**
Varieties (V)	3.13*	4.42*	7.69**	3.45*	4.56**	1.25	1.33
N × V	0.24	0.10	1.21	0.22	1.37	0.36	0.27
L × V				1.12			0.28
L × N				0.11			0.66
L × V × N				0.77			0.79

* Significant at 5 % ; ** Significant at 1 %.

Table 2. Mean yield and NCE[1] (%) of selected hull-less barley and wheat varieties[2], 1982-84.

N level/ cultivar	1982/83 Karnal	1982/83 Durgapura	1982/83 Kanpur	1982/83 Pooled over centers
N0				
Karan 3	22.30	24.16	9.97	18.81
Karan 4	24.17	29.39	14.80	22.79
Karan 16	23.13	21.34	10.57	18.35
Karan 18	23.34	24.16	18.42	21.97
N40				
Karan 3	30.42	32.61	20.54	27.86
	(20.30)	(21.12)	(26.43)	(22.63)
Karan 4	32.92	40.26	25.67	32.95
	(21.88)	(27.18)	(27.18)	(25.40)
Karan 16	32.71	29.39	22.65	28.25
	(23.95)	(20.13)	(30.20)	(24.75)
Karan 18	30.83	30.20	25.07	28.70
	(18.73)	(15.10)	(16.63)	(16.83)
N80				
Karan 3	35.42	38.65	27.18	33.75
	(16.40)	(18.11)	(21.51)	(18.68)
Karan 4	38.75	46.70	33.22	39.56
	(18.23)	(21.64)	(23.03)	(20.96)
Karan 16	37.71	36.64	26.88	33.74
	(48.23)	(19.13)	(20.39)	(19.24)
Karan 18	36.46	37.44	28.99	34.30
	(16.40)	(16.60)	(13.21)	(15.41)
LSD (5%) for N	1.85	5.97	1.38	3.08
LSD (5%) for V	1.60	5.17	1.20	3.56
LSD (5%) for location				3.08

N level/ cultivar	1983/84 Karnal	1983/84 Durgapura	1983/84 Pooled over centers
N0			
Karan 3	23.33	19.67	21.50
Karan 4	23.54	22.33	22.94
Karan 16	22.50	23.00	22.75
Wheat	23.54	22.00	22.77
N40			
Karan 3	32.71	29.00	30.86
	(23.45)	(23.33)	(23.40)
Karan 4	35.43	30.67	30.05
	(29.72)	(20.85)	(25.29)
Karan 16	30.63	30.33	30.48
	(20.33)	(18.33)	(19.33)
Wheat	30.00	27.67	28.85
	(16.15)	(14.18)	(15.20)
N80			
Karan 3	37.71	33.00	35.36
	(18.10)	(16.67)	(17.30)
Karan 4	39.17	36.70	37.94
	(19.54)	(17.97)	(18.75)
Karan 16	37.50	37.00	37.25
	(18.75)	(17.50)	(18.13)
Wheat	38.33	34.33	36.33
	(18.49)	(15.41)	(16.95)
N120			
Karan 3	42.08	37.33	39.71
	(15.71)	(14.72)	(15.18)
Karan 4	45.00	41.33	43.17
	(17.88)	(15.83)	(16.86)
Karan 16	43.33	36.33	39.83
	(17.35)	(11.11)	(14.23)
Wheat	43.54	38.67	41.11
	(16.67)	(13.09)	(15.28)
LSD (5%) for N	1.43	3.34	6.76
LSD (5%) for V	1.43	3.34	6.76
LSD (5%) for location			4.78

1. % nitrogon conversion efficiency (NCE) is shown in parentheses.
2. HD 2329 variety was planted at Karnal and RD 1482 at Durgapura.

The present study thus showed that varietal differences for the nitrogen conversion efficiency exist both in hull-less barley and wheat, indicating that genetic variability exists for nitrogen uptake/utilization. Thus, hull-less barley varieties with higher nitrogen uptake and conversion efficiency could be developed. Four major variables—uptake of nitrate; level and activity of nitrate reductase; size of the storage nitrate pool; and ability to mobilize nitrogen from leaves and other parts to the developing grains—have been defined in the N utilization process. However, the mechanism of their genetical control remains to be studied. Now that nitrogen is becoming more and more expensive, a more thorough study of these factors is needed in order to breed varieties with increased yield and nitrogen conversion efficiency.

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Effect of Seed Type on Performance of Wheat

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There is a general belief that the quality of seeds can affect the crop performance to a great extent and that shrivelled seed is not desirable for sowing purposes. However, reports on the effect of seed type on grain yield are not consistent (Ekbote and Sahasrabudhe 1948; Mitra and Mathur 1949; Hampton 1981).

The present investigation was carried out to determine the effect of seed type on grain yield and other traits of bread wheat.

Materials and Methods

Normal (uncleaned), graded (screened to eliminate small and abnormal seeds), and shrivelled (not fully developed) seeds of the bread wheat variety Z.A. 77 were sown for two consecutive years following an RCB design with six replications. Plot sizes were 0.9 m × 3.66 m in 1981/82 and 1.22 m × 4.57 m in 1982/83. Fertilizers were broadcast at the rate of 67 kg/ha each of N and P_2O_5 at sowing and 67 kg/ha at the first irrigation, 3 weeks after sowing. Seed rates were 100 kg/ha in 1981/82 and 124 kg/ha in 1982/83. The crop was regularly irrigated at 3-week intervals during the growing season.

Results and Discussion

Shrivelled seed had lower germination percentage than normal or graded seed (Table 1). However, when the three types of seed were sown, the harvested grain from the three plots had similar germination.

Table 1. Germination percentage for three seed types of wheat sown at Tandojam in 1981/82 and 1982/83.

Seed type	Germination in the laboratory before sowing (%)			Germination of the produce (%)		
	1981/82	1982/83[a]	Average	1981/82	1982/83	Average
Normal	90.0	61.5	75.5	92.5	93.5	93.0
Graded	94.0	83.5	88.5	92.6	93.5	93.1
Shrivelled	82.0	63.5	72.5	91.5	92.5	92.0

a. Germination was low due to insect damage.

The number of seeds per 50 g was much higher for the shrivelled seed than for the other types, but this did not significantly affect the yields from the three groups (Table 2). In fact, the yield of plots sown to shrivelled seed was numerically superior to that of others, probably because more shrivelled seeds were sown per unit area as compared to normal or graded seeds.

Table 2. Grain yield (kg/ha) for three seed types of the bread wheat variety Z.A. 77 grown at Tandojam in 1981/82 and 1982/83.

Seed type	1981/82	1982/83	Average
Normal	4545	4861	4703
Graded	4545	4960	4752
Shrivelled	4844	5121	4982
SE	427	804	
CV (%)	9.2	20.2	

The effect of seed type on 1000-kernel weight and plant weight was significant in one season and nonsignificant in the other (Table 3). Maturity was not affected by seed type in either season.

In this study, thus, the seed size was not found to affect the performance of wheat. Small-sized or shrivelled seed can therefore be used for sowing.

Table 3. Effect of seed type on 1000-kernel weight (g) and plant height (cm) of the bread wheat variety Z.A. 77 grown at Tandojam in 1981/82 and 1982/83.

Seed type	1000-kernel weight			Plant height		
	1981/82	1982/83	Average	1981/82	1982/83	Average
Normal	49.0	47.1	48.4	103.8	97.7	100.7
Craded	47.8	43.9	45.9	96.1	92.7	94.4
Shrivelled	46.5	45.3	45.9	101.6	98.1	99.8
LSD (5%)	1.28	ns		4.82	ns	

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Wheat and Barley Research

Wheat and barley are of immense importance in the ICARDA region. These cereals account for about 70% of the area devoted to annual food crops. Their significance in rainfed agriculture is indicated by the fact that approximately 95% of durum wheat and 65% of bread wheat is grown under suboptimal water supply. They also provide the staple element of the diet, accounting for about half of the calorie and protein intake. The per caput consumption of bread in ICARDA region is amongst the highest in the world.

The region as a whole has an acute deficit in cereals and is heavily dependent on imported grain. Much of this, especially barley, is used for animal feed to satisfy the increasing demand for animal protein which is associated with rising standards of living. The barley crop is of major importance in the region, especially in the lower rainfall areas and where the land is marginal for arable agriculture. Barley/sheep systems predominate in these areas where the production of total biomass (grain + straw) assumes enormous significance.

Apart from rainfall, the other important environmental component determining production is altitude. About half of the cultivated bread wheat crop is found above 1000 m, but because of the low productivity of these areas they contribute a rather small proportion to the total volume of grain.

ICARDA's primary target areas for cereals are those of low to moderate rainfall (250-600 mm) where, characteristically, the winter rainfall is not only limited but erratic. There is often rapid soil moisture depletion in the spring followed by hot dry winds in summer.

1. Paper presented at the Workshop on Rainfed Agricultural Information Network in Amman, Jordan, 17-20 Mar 1985.

Main Areas of Research

Research on wheat and barley at ICARDA is generally of an applied nature and falls into three main categories:

(i) Breeding and release of improved germplasm. This involves improving the stability of yield over seasons by reducing the risks posed by pests, diseases, and physiological stresses. It also includes the activities of the recently established gene bank which is intended to maintain and evaluate an active collection of germplasm.

(ii) Agronomic investigations intended to provide the knowledge necessary to realize the potential of improved varieties on the farm.

(iii) Research on the utilization of cereal crops in different farming systems.

Limited available water is the major concern of all research programs, and improved tolerance to drought stress is the overriding breeding objective, although tolerance to cold, heat, or salinity can also be a local requirement. The problems posed by pests and diseases are formidable and there is much room for improving the quality of grain and straw for human and animal nutrition.

Clearly, the most rewarding fruits of research are improved varieties. Agronomic packages are generally 'location specific,' although they may provide solutions to problems of weed control and nutrient deficiency which are common throughout the region.

Existing Channels of Communication

The present network comprises:

(i) The international nursery system. The international nurseries provide the national programs with improved germplasm for local evaluation and exploitation. Equally important is the information provided by national programs on the performance of their own selections throughout the region.

(ii) Exchange of visits between ICARDA and national program scientists. These strengthen personal relationships and provide a better awareness of the local requirements, on the one hand, and of the objectives and technology of the Center on the other.

(iii) Workshops and conferences. These provide opportunities for personal interaction and for a more considered appraisal of research findings.

(iv) Publications. These keep the scientists aware of the latest research results.

(v) Training. Presently four types of opportunity are provided. These are residential training for technicians, individual specialized training, short-term training in groups on specific topics, and training of graduate students.

The Enhancement of Information Exchange in the Network

The above definition of the network is very flexible. First and foremost of the components which should be considered is the relationship between the Center and the national program research. As ICARDA builds up a cadre of trainees and therefore the level of research competence in the region, the need for faster exchange of information will become more pressing.

Secondly, there is the link with other IARC's—CIMMYT, in the case of wheat and barley. Since the recent quinquennial reviews of the two centers, there has been an increasing recognition of the need to develop the complementary nature of their work. ICARDA has a global responsibility for barley research and a regional responsibility for wheat research in cooperation with CIMMYT within the CGIAR system.

Thirdly, there are the relationships with transnational organizations within the region which have or should have a complementary role to that of ICARDA, such as ACSAD and perhaps AOAD. In addition, there are major projects in different countries funded through agencies, such as USAID, GTZ, IDRC, ODA, EEC, etc. on a bilateral basis. Some form of information exchange with the numerous universities within the region must also be considered since they account for the bulk of the trained scientists located there, although they tend to be teaching rather than research-oriented.

Finally, there are contacts with research programs in the advanced countries. Normally, these are restricted to specific research projects in which a particular expertise is brought to bear on a problem. All of these diverse activities are producing useful information but often they function in isolation from one another. In order to realize the full potential of the research already being conducted in the region, it is necessary to provide an effective forum from which the application of this research can transgress national boundaries.

In the region, research on bread wheat is relatively well developed, but on durum wheat it is less so and on barley it is rudimentary. Consequently, the need for networking of information is greatest in the case of barley. In terms of disciplines in all research on cereals, breeding is the most advanced, followed by pathology, agronomy, grain quality improvement, pest control, and physiology of stress tolerance. Raising the base level of cereal yields, particularly in the marginal areas, would require improved networking for information exchange in all these aspects.

International Nurseries and the Feedback of Information: Workshops

Similarly, the breeding work may be expected to change from the identification of widely adapted material to the identification of genotypes with more specific adaptation to particular ecological niches within the region. But, this implies some precision in the identification of such specific environments in order to set realistic breeding objectives. It would be highly desirable to make generally available information which already exists and to identify gaps in the database which should be filled. A workshop on the physical environment in relation to breeding objectives could be an appropriate trigger for such a venture.

The effectiveness of the existing nursery system would be greatly improved by the active participation of the national program scientists in deciding the type and composition of the nurseries, the experimental designs adopted, and the utilization of the information generated. The best mechanizm for this would be an annual or biennial review (workshop) preferably with the venue rotating, to identify general and specific recommendations on cereal germplasm and/or cultural practices.

However, some of the problems confronting cereal production are of more concern to certain areas in a country or group of countries. For example, aphid resistance in Egypt and the Sudan; Hessian fly in Morocco; *Septoria* resistance in North Africa; and cold tolerance in high-elevation areas. To meet these situations, workshops addressing specific problems and organized on a more restricted basis would need to be considered. For these particular workshops, it would be appropriate to invite scientists from outside the region who have expertise in the topic under discussion.

Training

The availability of skilled manpower at all levels is the foundation of agricultural development. While the existing concentration on training for research technicians is essential, there is also a need for more to be done at the graduate level. Scientists occupying positions of leadership in the national programs would benefit from the opportunity of working closely with their colleagues at ICARDA on visits of varying duration of up to one year. This would enhance their understanding of the objectives and research operations of the Center and would accelerate the uptake of new technology on their return to their countries.

Publications

In relation to wheat and barley, ICARDA currently produces the following publications: Annual Report; Research Highlights; reports on international nurseries; Rachis; and occasional reports on particular topics. Furthermore, individual scientists contribute to international or regional conferences or workshops and to established journals.

Rachis, the wheat and barley newsletter, has the dual purpose of providing a medium for publishing some articles of general and specific interest within the region and of serving the need for a general newsletter on cereal research. An Arabic version, recently launched, will further enhance the dissemination of information within the region. Financial support specially earmarked for this publication is required.

A catalog of work in progress on all aspects of cereal research in the region, with addresses and names of key workers to contact, and synopses of their research interests and achievements, would provide a useful basis for a scientific information service.

There is also a need for annotated bibliographies of relevant work on barley and durum wheat. At present, much of the work done in the region has not been published in a form available to the international abstracting services. Some of the information is summarized only in Arabic, Turkish, Persian, or Urdu. Making this information more accessible in the way described would improve the dissemination of research findings within the region and facilitate communication among the national programs.

An Ideal Gene Constellation in Barley

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The use of fertilizers and improved methods of cultivation have created the problem of lodging in cereals. Fertilizers, especially nitrogenous ones, have adverse effects on plant characters leading to lodging of the crop. Loss in yield due to lodging has been reported to be 12 to 66%, depending upon the degree of lodging, stage of occurrence, and subsequent weather conditions (Day 1957). Many workers have associated lodging resistance with plant characters (Howard and Howard 1912). Vaidya and Mahabalram (1982) have reported lodging in barley to be due to a weaker stem indicated by breaking strength: height × mothershoot (Br:HM), and that it is further aggravated if the root anchorage, indicated by shoot × height: root (SH:R), is weak. Therefore, there is an urgent need for developing dwarf, strong-stemmed, strongly rooted, and high-yielding varieties.

Jenning (1964) advocated the plant-type breeding in rice in which different morphological plant characters conducive to high yield are combined in one variety or type. Borlough (1968) has been successful in developing dwarf wheat varieties with strong stem, well developed root anchorage and high yield, that have revolutionized agriculture in the third world. In a recent project aimed at studying lodging resistance in barley, a study was conducted at IARI using recently recommended hull-less barley varieties. This study revealed that variety Karan 16 possessed many desirable characters along with high-yield and hull-less grain characters (Table 1).

Mexican dwarf high-yielding wheat varieties, S. 308 and S.227, have been further improved and renamed as Sonalika and Kalyansona, respectively. Therefore, an experiment was conducted at the Regional Station, Karnal, and the IARI, New Delhi, in 1984, with Karan 16, Sonalika, Kalyansona, and other barley varieties to make a comparative study of plant characters. Initially, these two experiments were so arranged that observations could be taken at the same stage of growth (immediately after anthesis), but in spite of different sowing dates, these two trials flowered at about the same time. Hence, observations at Karnal were taken immediately after anthesis as per method of Vaidya and Mahabalram (1982), while those at Delhi were taken 10-12 days after anthesis (Table 2).

Table 1. Characteristics of barley variety Karan 16 studied at IARI during 1981 and 1982.

Plant height (cm)	Breaking strength (g)	SH:R	Br:HM	Lodging behavior	Year of study
81	1168	18.87	2.13	erect	1981
71	1505	22.90	2.05	erect	1982

Table 2. observations on different indices related to lodging.

Variety	S:R #	SH:R	Br:H#	Br:HM
Delhi				
DL85	19.06	18.70	7.20	1.01
Ratna	23.70	21.53	7.16	1.04
Kalyansona	16.30	14.70	9.70	0.98
Sonalika	16.73	15.40	7.05	1.08
Karan 15	20.86	15.60	8.01	1.22
Karan 18	12.30	9.43	10.32	1.59
Karan 92	21.23	15.10	13.75	1.97
Karan 3	10.66	6.30	16.72	2.84
Karan 19	14.23	11.13	11.77	1.75
Karan 16	14.66	9.16	14.38	2.34
LSD (5%)	7.68	5.83	4.62	0.82
Karnal				
DL85	42.80	33.13	10.86	1.09
Ratna	34.73	27.43	9.45	1.14
Kalyansona	21.36	17.80	13.65	1.21
Sonalika	24.13	20.03	11.15	1.22
Karan 15	36.16	26.40	12.29	1.20
Karan 18	22.00	16.16	12.33	1.45
Karan 92	33.66	23.20	9.49	1.30
Karan 3	22.46	15.66	12.23	1.61
Karan 19	36.66	27.06	11.48	1.13
Karan 16	24.13	17.93	14.31	1.71
LSD (5%)	11.59	9.30	2.75	0.27

S:R = Shoot: root ratio; SH:R = Root anchorage; Br:H = Breaking strength: height ratio; Br:HM = Relative stem strength.

Since a varying number of plants were uprooted from these trials, yield could not be assessed for different cultures. However, the following data from different stations provide some information on yield. HD 2009 is a popular wheat variety grown in barley belt and used as a check in all barley trials.

	Yield (q/ha)		
	Karan 3	Karan 16	HD 2009
NWP Zone	20.51	22.32	18.89
NEP Zone	16.85	17.11	13.65
Average	18.63	19.71	16.27

These data indicate that the recommended barley varieties, Ratna and DL 85, are not as strong stemmed and well root anchored as Karan 3 and Karan 16. Subsequently, CIMMYT's further improved wheat varieties, Kalyansona and Sonalika, are not as strong stemmed as Karan 3 and Karan 16 (hull-less barley) as seen from Br:HM values. The relative stem strength (Br:HM) in Karan 3 and Karan 16, is nearly double that of Kalyansona and Sonalika. As regards root anchorage (SH:R), these hull-less Karan varieties were at par with Kalyansona and Sonalika at Karnal, but superior to them at Delhi. the yield data show that Karan 3 and Karan 16 possess genes for as high a yield as of HD 2009. Thus, these two barley varieties are dwarf, strong stemmed, well root anchored, hull-less, and high-yielding. The genes governing all these five characters have been combined in these varieties, and this is an ideal example of gene constellation in a single barley variety.

In order to build up an ideal gene constellation in rice, Jenning (1964) suggested the use of Japonika types as one of the parents. Borlough (1968) used Norin-10 and Brevor-14 Sel. as sources for his semi-dwarf wheat varieties. Barley dwarf varieties carrying 'Uzu' or semi-brachytic gene, are known to be growing in Japan and Korea (Takahashi and Yamamoto 1951). In India, RDB-1, a dwarf mutant was developed at Durgapura (Rajasthan), but has shown poor combining ability. At the IARI Regional Station, Karnal, an indigenous source, Azam dwarf (a natural mutant), has been used for developing new dwarf varieties which possess stronger stem like the best dwarf wheat varieties developed at CIMMYT, Mexico, and in India. It is hoped that this would encourage plant breeders to use local sources.

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Accelerating the Synthesis of Hexaploid Triticale

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Triticale breeding aims at combining the best traits of wheat (*Triticum* spp.) and rye (*Secale cereale*). Incomplete fertility and improper kernel development were the major drawbacks in triticale which have now been overcome through breeding efforts. Widening the genetic base for triticale improvement can be accomplished through synthesis of diversified primary triticales (octoploids and hexaploids). The success in synthesis of primary hexaploid triticales is often uncertain since the hybrid seeds involving *Triticum durum* and *Secale cereale* are often devoid of endosperm and therefore fail to germinate without embryoculture. In this study, an attempt was made to devise a breeding method by which durum wheat-rye hybrid seeds with adequate endosperm could be obtained so that the seedlings of such hybrids could be raised without recourse to embryoculture.

Materials and Methods

Four *Triticum durum* cultivars viz. Raj 911, Jairaj, HD 4502, and HD 4545 as well as four of their F_1

hybrids were crossed with diploid *Secale cereale* cv Assam. Percentage of seed set was calculated for each cross.

The proportion of kernels with varying extent of endosperm in each hybrid combination was recorded. The wheat-rye hybrid embryos were excised after 15 days from the date of pollination and placed on nutrient agar medium. The extent of recovery and quality of hybrid embryos from each cross and the proportion of normal seedlings recovered from nutrient culture, were recorded.

Results and Discussion

Characteristics of the different types of wheat-rye hybrids are given in Table 1. The percentage of seed set ranged from 6.7 to 29.6 in *T. durum* × rye crosses and from 6.1 to 12.0 in (*T. durum* × *T. durum*) F_1 × rye crosses. This difference in crossability indicates that in heterozygous condition the crossability promoting recessive genes Kr_1/Kr_2 would become less effective due to the presence of dominant allele Kr_1/Kr_2 either at homologous or at homeologous loci. This is in accordance with the findings of Riley and Chapman (1967) who stated that Kr_1 on chromosome 5B and Kr_2 on chromosome 5A actively suppress crossability of wheat with rye.

The crosses involving durum × rye produced kernels which lacked endosperm, whereas those involving (durum × durum) F_1 × rye produced kernels, 30.7 to 60.0% of which contained endosperm material to a varying extent. Germinability in the soil of the hybrid seed ranged from 4.4 to 8.5% in (durum × durum)F_1 × rye crosses, whereas seed from durum × rye crosses failed to germinate under similar growth conditions.

The percentage of normal embryos over total embryos recovered after excision and also that of normal seedlings over total number of seedlings obtained from embryoculture, were higher for the (durum × durum) F_1 × rye crosses than for the durum × rye crosses (Table 2). Moss (1970) noticed endosperm failure in tetraploid wheat × rye and attributed it to chromosome breakage in the early division of endosperm nuclei. Wojciechowska and Lange (1977) observed that, in contrast to tetraploid wheat × rye crosses, the hexaploid wheat × rye crosses show only a low degree of abnormality and many hybrid seeds in these crosses were viable. These contained a starchy endosperm and showed only partial shrivelling at maturity. The lack of endosperm in the hybrid seeds of tetraploid wheat × rye appears to be an extreme version of kernel shrivelling which exists in wheat × rye hybrid seeds in general.

Table 1. Characteristics of durum wheat × rye crosses.

Cross	% kernel set	% kernels with endosperm	% kernels germinated*	Number of amphidiploids obtained
Raj 911 × Assam rye	29.6	0	0	
Jairaj × Assam rye	13.0	0	0	
HD 4502 × Assam rye	13.4	0	0	
HD 4545 × Assam rye	6.7	0	0	
(Raj 911 × Jairaj) F_1 × Assam rye	6.1	38.4	8.5	3
(HD 4545 × Jairaj) F_1 × Assam rye	12.0	54.0	7.2	6
(Raj 911 × HD 4502) F_1 × Assam rye	7.6	60.0	4.4	0
(HD 4545 × Raj 911) F_1 × Assam rye	11.1	30.7	5.4	1

*Seed was put to germinate on the soil.

Table 2. Response of excised hybrid embryos of durum × rye and (durum × durum) F_1 × rye crosses.

Cross	% normal embryos recovered after excision	% normal seedlings germinated in nutrient agar
Durum × rye	48.2	42.9
(durum × durum) F_1 × rye	68.6	51.9

The heterozygosity in durum wheat parents has an advantage over homozygosity for producing better developed wheat × rye hybrid kernels. Rupert *et al.* (1973) reported that the use of F_1 durum hybrids in crosses with F_1 of self-fertile rye resulted in greater success compared to wheat × rye hybrids involving pure durum varieties. However, their report indicated that in raising the seedlings through embryoculture these wheat-rye hybrids did not offer any special advantage over those having homozygous durum wheat parents. In contrast to this, the seedlings of wheat-rye hybrids, i.e. (durum × durum) F_1 × rye involved in the present study could be raised on the soil without resorting to embryoculture. The heterozygosity and the accompanying heterosis of F_1 durum × durum combination could promote endosperm development in such wheat-rye hybrids. This procedure is of great practical significance as it can be conveniently adopted at the triticale breeding centers where the embryoculture facilities do not exist. Furthermore, the use of durum wheat hybrids helps in realizing the increased genetic variability.

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Influence of Experimental Method on Wet Gluten Determination in Wheat Flour

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The wet gluten test is widely used in the Middle East as an estimate of protein content and baking potential of wheat flour. The wet gluten content forms part of the import specifications set by some countries for wheat and flour. The purpose of this study is to draw the attention of researchers to the differences and possible misunderstanding which may arise as a result of different practices in the determination of wet gluten.

Materials and Methods

Three methods of wet gluten determination were studied. The first was the standard method used in France. This is essentially the same as the American Association of Cereal Chemists (AACC) hand-washing method[1] but uses a 2.5% solution of sodium chloride. The second method was the AACC machine-washing method which uses a Theby gluten washer, and a phosphate buffer solution at pH 6.8. This is the method in use at the Grain Research Laboratory, Winnipeg, Canada. The third method was a modification of the AACC machine-washing method, using a Theby gluten washer, and a 2% solution of sodium chloride[2]. This modification is employed at ICARDA to conform to the method used by flour mill laboratories in northern Syria, which use Theby gluten washes and salt solution. A second samll modification is that the gluten ball after washing in the machine for 12 min. is kneaded gently in tap water until the water no longer turns milky. Details of the three tests are as follows:

a. French Method

- Prepare 2.5% solution of sodium chloride.
- Weigh 33.33 g of flour and mix into a doughball using 17 ml of the salt solution. Mix the dough for 2-3 min. in a beaker, followed by a further 2-3 min. in the hands.
- Wash for 5 min. under dripping solution, followed by a further 2 min. with faster dripping salt solution.

1. Method No. 38-10, Cereal Laboratory Methods, 1969. The American Association of Cereal Chemists, St. Paul, Minnesota.

2. Ibid, Method No. 38-11.

— Dry for about 2 min. by pressing in the hands 6-8 times, drying the hands between presses.
— Weigh the wet gluten; result × 3 = wet gluten % .

b. Grain Research Laboratory Method

— Prepare buffer by dissolving 300 g of sodium chloride, 6.9 g of monobasic potassium phosphate (KH_2PO_4), and 8.1 g of anhydrus disodium phosphate (Na_2 HPO_4), in distilled or demineralized water and diluting to 15 l.
— Make a doughball with exactly 10 g of flour and 6 ml of buffer solution.
— Place doughball on nylon screen of Theby gluten washer (previously wetted with buffer solution) and wash by machine for 12 min. with buffer flow rate of 2-3 drops/sec.
— Remove doughball and wash by hand with buffer solution for 2 min.
— Dry by manipulating between fingers and the palm of the hand until very slightly sticky (about 2 min.).
— Weigh and report × 10 as wet gluten.

c. ICARDA Method

— Prepare a doughball by mixing exactly 10 g of flour with about 5.5 ml (2.0 %) sodium chloride solution for about 2 min.
— Place the doughball into the previously wetted nylon screen of the gluten washer, and wash for 10 min. periodically rinsing the sides of the screen with 2 % salt solution.
— Remove the gluten ball and wash by kneading in warm tap water until the water remains clear (this takes 5-7 min.).
— Dry the gluten ball using the fingers and the palm of the hand in a stream of warm air using a hair dryer, until the gluten ball becomes sticky.
— Weigh and report × 10 as wet gluten.

Twenty-six flour samples, six laboratory Buhler-milled and 20 from commercial flour mills in northern Syria were used in this study. The standard error of a single test was evaluated by 12 separate determinations of wet gluten by each method on a single flour.

The results are summarized in Tables 1 and 2. Table 1 gives the mean, standard deviation, standard error of a single test, and coefficient of variation for the three methods. The French method consistently gave higher results than the other two methods. The standard error of a single test was also higher and the method appeared to be about four to five times more variable than either of the other two methods. The ICARDA procedure which employs a slightly more rigorous system for the removal of the final traces of starch gave the lowest values.

Data in Table 2 indicate that all three methods were highly correlated to each other, but the regression coefficient between the GRL and ICARDA methods was significantly higher than either of the other two comparisons. The magnitude of difference between ICARDA and French method data was related to the absolute wet gluten content (r = 0.72), and regression analysis showed that the difference between the two methods increased at higher wet gluten content. At 25 % wet gluten by the ICARDA method, the French method gave a result of 30.9 %, and at 35 % it gave 43.3 % .

Table 1. Comparison of French, GRL, and ICARDA data for wet gluten determination.

	Method		
	French	GRL	ICARDA
Mean (%)	35.1	30.5	28.4
Standard deviation	6.3	5.5	5.2
Standard error per test	2.08	0.33	0.36
Coefficient of variation	5.1	0.9	1.2

Table 2. Statistical analysis of the French, GRL, and ICARDA data for wet gluten determination.

	French:GRL	French:ICARDA	GRL:ICARDA
r	0.92	0.98	0.94
b	0.814	0.808	0.999
a	1.95	0.02	2.26
d	+ 4.6	+ 6.7	+ 2.12
SDD	2.37	1.66	1.93

r = coefficient of correlation; b = coefficient of regression; a = intercept of regression; d = mean difference; and SDD = standard deviation of differences.

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Short Communications

Bacterial Stripe of Wheat in Pakistan

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In the spring of 1985, leaf stripe symptoms were observed in wheat (*Triticum eastivum* L.) fields at the National Agricultural Research Centre, Islamabad. The stripes on the leaves were first translucent and watery, then they turned yellow, and finally brown. An exudate which dried out to a thin silvery encrustation appeared on the affected area. The bacterium isolated from these lesions on yeast extract dextrose-calcium carbonate (YDC) formed yellow glistening colonies. It was gram-negative, rod-shaped, measuring 0.6-1um, H_2S-producing, catalase-positive, oxidase-negative, and gelatin-liquefied, and showed hypersensitive reaction in tobacco leaves.

Based on these characteristics, which matched the descriptions provided by Buchanan and Gibbons (1974), Young *et al.* (1978), and Dye *et al.* (1980), the pathogen was identified as *Xanthomonas campestris* pv. *translucens* (J.J. & D) Dye.

Pathogenicity tests were carried out by inoculating 30-day old wheat seedlings with bacterial suspension having an absorbance of 1.1 on spectronic 20 (Baush and Lamb). Typical stripe symptoms developed within 10 days of inoculation and the same becterium was reisolated from these lesions. This is the first report of *Xanthomonas campestris* pv. *translucens* as a pathogen of wheat in Pakistan. The disease was earlier observed in the exotic breeding material with 40-50% intensity.

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Recent Developments in Durum Wheat Improvement in Turkey

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Turkey grows approximately 9.2 million hectares of wheat with an annual production of 16.5 million tonnes. Recent estimates indicate that 25% of this hectarage is devoted to durums. Durum wheat is distributed in Turkey as follows: 20% in the coastal or spring durum areas, 55% in the central plateau and Thrace or winter durum areas, and 25% in the southeastern region which is a facultative or spring durum region.

Over the last decade there has been a shift from durum wheat to bread wheat production. High-yielding bread wheat varieties introduced in the late 1960s have been largely responsible for this shift. To counteract this change and to increase the durum wheat production, new high-yielding durum varieties were urgently needed for Turkey at that time.

An extensive breeding program initiated in 1969 under the National Wheat Research Project is currently attempting to combine broad-base resistance to the major diseases with wide adaptation and high yield potential. In the coastal regions, the main breeding problems are associated with resistance to diseases such as stripe rust, stem rust, and Septoria. Resistance to powdery mildew and leaf rust is also desirable in certain regions. An extensive breeding program has been operating in Izmir since 1969, and in 1975/76 a new durum variety, Gediz-75 = LD 35 7E-$Tc^2 \times$ Al «S», was recommended for release. This variety is moderately resistant to stripe rust, moderately susceptible to stem rust and Septoria, and is equal to high-yielding commercial bread wheat varieties in yield potential but 80-100% higher in yield potential than the local durums. Three lines have recently been submitted to the National Testing Organization for final evaluation before eventual release. These lines come from the cross Win «S»-USA 02237 × Cad «S»., CD 156559-C-7M-2Y-3M-1Y-0M., Oysa «S» -Magh «S» × Ruff «S» -Fg «S»., CD 15913-B-2M-2Y-3M-3Y-0M., and Bittern «S»., CM 9799-126M-1M-4Y-0M. The first two lines are resistant to stem rust and the third is moderately resistant or moderately susceptible to stem and leaf rusts.

In the southeastern region, the main breeding objectives are earliness of maturity and adaptation to the hot, dry conditions. Rust diseases are seldom a problem in this region. In 1973/74, the breeding program, located in Diyarbakir, recommended the release of the variety Dicle-74. This variety has consistently outyielded the local durum wheats grown in the region by 30-50% and has even outyielded the best recommended bread wheat variety by 10-15%. Although the yield potential of Dicle-74 is excellent, the grain quality is only fair due to a tendency to yellow berry. Because of this disadvantage, extensive efforts are being made to develop better types, and one line, Diyarbakir-81 = LD 393 × $Bell_E$ T_C2/Cit. 71. SE 0364-1S-4S-0S, appears to be very promising for yield and grain quality. It is anticipated that these and other new varieties will soon replace the local durum varieties.

In the winter durum growing area (central plateau, Thrace, and transitional zone), the durum varieties grown were tall weak-straw types with low yield potential and susceptibility to all the major diseases. Most of these are facultative types with low levels of cold resistance. Extensive breeding programs in Ankara, Eskisehir, and Edirne are attempting to isolate types with better yield potential, better disease resistance, and effective levels of cold resistance. In an environment as variable as the central plateau, drought tolerance and broad adaptation are crucial for yield stability.

Two lines, Üveyik 162-61-130 and Fata sel. 185-1 × 61-130-Leeds, named Çakmak 79 and Tunca 79, respectively, were released in 1979 by the institutes in Ankara and Edirne for the winter durum growing areas. The variety Gokgoll 79 from the cross B.Bal × $By^2{}_E$-T_C was also released by Yesilkoy Institute in 1979 as a spring durum.

An extensive crossing program carried out in Ankara and Eskisehir is currently focusing on transferring the high yield potential and disease resistance of different origin durums to the types adapted for the central plateau. However, difficulties in finding durums with adequate levels of winterhardiness is hampering this effort.

Three New Barley Cultivars for Tunisia

M. EL FALEH, A. MAAMOURI, M. DEGHAIES
INRAT, Ariana, TUNISIA
and A. EL AHMAD
ICARDA, B.P. 84, Ariana, TUNISIA

Barley (*Hordeum vulgare* L.) is the second most important cereal crop in Tunisia where it covers about 30% of the cereal growing area. Barley grain is used for feed, food, and brewing. In addition to the grain, Barley is also used for green grazing, hay, and straw.

Barley cultivation is traditionally confined to poor soils and dry areas in Tunisia. Little research efforts have been devoted in the past to the improvement of this crop. The two locally grown cultivars, Ceres and Martin, have low yield and unsatisfactory level of disease resistance. In 1978, a barley improvement program was initiated at the National Agricultural Research Institute of Tunisia (INRAT). This program has been strengthened with the establishment of a collaborative project on barley and cereal pathology with ICARDA in 1980. After 5 years of testing of fixed barley material both on research stations and farmers' fields, the program has registered in 1985 three barley cultivars for release: Faiz, Roho, and Taj. All three cultivars have higher grain yield and better disease resistance than Ceres and Martin.

Faiz

This cultivar is an advanced line from the ICARDA cross Early Russian/Apam introduced in the 1979/80 season and subjected to testing at several sites in northern and central Tunisia. It is a two-rowed, white-to-yellow barley with medium size kernels. Test weight is 61.5 kg/hl and grain protein content is around 9.3%. Faiz has good resistance to lodging in subhumid areas and heads two weeks earlier than Ceres. It is resistant to net blotch and moderately resistant to powdery mildew and BYDV. It outyielded the local check Ceres by 35% in the 300-450 mm annual rainfall areas.

Roho

Originating in the USA, this cultivar has been introduced in Tunisia in 1975 under the name of Roho. It is a two-rowed, grey-to-yellow barley cultivar with large size kernels. It has a test weight of 65 kg/hl and a protein content of 11.7%. It is resistant to lodging in semiarid environments and is 2 weeks earlier in heading than Martin. It is resistant to net blotch, BYDV, and loose smut, and moderately resistant to powdery mildew. It is recommended for cultivation in low-rainfall areas (200-300 mm) where it outyielded Martin by 26-57%.

Taj

This cultivar was introduced from ICARDA in 1980 under the designation of WI 2198 (Australian origin). It has similar plant and maturity characteristics to those of Roho, but possesses a higher protein content (13.7%) and samller kernels. It is resistant to net blotch and BYDV and moderately resistant to powdery mildew, scald, and loose smut. It outyielded Martin by 11-38% and, like Roho, is recommended for low-rainfall areas.

Seed from the three cultivars is being multiplied on 220 ha in the 1984/85 season by two seed organizations: COSEM and CCSPS. This is expected to yield enough seed for the cultivation of 5000 ha during the following season. Agronomic trials are being conducted in cooperation with the Office des Céréales in order to determine the agricultural practices suitable for these cultivars particularly in the central zones of the country.

Acknowledgement

Thanks are due to Dr H. Ketata for his contribution to the final version of this manuscript.

Recent Publications

ICARDA (International Center for Agricultural Research in the Dry Areas). 1985. ICARDA- a partner in cereal improvement. Aleppo, Syria. 74 pp.

This publication describes the research and associated activity of the cereal improvement program at ICARDA with a special focus on collaboration with national and international research institutions working on cereal crops.

ICARDA (International Center for Agricultural Research in the Dry Areas). 1985. Regional yield trials and observation nurseries, 1983/1984. Final report. Cereal Improvement Program, ICARDA, Aleppo, Syria. 344 pp.

This report includes summary results for the 1983/1984 regional and international cereal yield trials and observation nurseries. Results from various cereal research cooperators are tabulated separately for each test site, and pooled data are also provided for various sets of sites. The reported data include phenotypic, agronomic, and disease results, as well as climatic and edaphic characteristics for the various sites.

University of Jordan; Ministry of Agriculture, Jordan; and ICARDA (International Center for Agricultural Research in the Dry Areas). 1984. Cereal Improvement in the Dry Areas: a report on the Jordan cooperative cereal improvement project. ICARDA, Aleppo, Syria. 94 pp.

Kamel, A.H. 1985. Field guide to major pests of wheat and barley. (In Arabic.) ICARDA, Aleppo, Syria. 92 pp.

This manual provides a field guide for the identification, by Arabic speaking researchers, of important diseases and insect pests prevalent in wheat and barley growing areas. It also gives account of the economic importance of various pests and measures for their control.

Cereal News

Performance of ICARDA Straw Collector

The straw collector for research plots, newly developed at ICARDA (cf Rachis 4(1), p. 47), has been tested and then extensively used in barley and wheat yield trials at the main research station, Tel Hadya, in May and June 1985. The results show that the performance of this straw collector as adapted to a research plot combine is excellent. The adaptation of the straw collector to the combine did not affect either the threshing operation or the quality of the harvested seed. In addition, no grain or straw was lost during the operation. As compared to conventional harvesting where only grain is recuperated, the new system required one technician additional to the four-person threshing crew and 20% more time for yield trials with plots having a 5 m length.

In spite of the overall 20% additional cost, the new system is rated excellent not only for its high efficiency but also for the information provided on straw and total biological yield, which is of great importance in certain areas. The straw collector is thus recommended for better assessing the economic values of cereal breeding lines, especially for barley and wheat in areas where straw may at times be as valuable as grain.

ICARDA straw collector mounted on a small plot combine is being used to assess cereal biological yield.

North Africa Travelling Workshop, Morocco, 15-22 April 1985

The Travelling Workshop organized by ICARDA, CIMMYT, and National Programs in the Maghreb and the Iberian Peninsula was hosted by INRA in Morocco from 15 to 22 April 1985. Participants from the two centers as well as from Morocco, Portugal, Spain, and Tunisia visited seven research stations in Morocco (Codea, Cidera, Quiche, Merchouche, Beni Mellal, Jamat Shaim, and Tessaout) and participated in the selection of barley and wheat under various stress conditions including drought, diseases, and insects. Fruitful discussions took place during the visits. Dr Ignacio Cubero, member of ICARDA Board of Trustees from Spain, was a special invitee to the Workshop. The other participants were from Morocco: Messrs M. Mergoum, N. Haque, D. Dyoussi, M. Youssefi, and Drs. M. Ameziane and A. Zahour; from Portugal: Messrs F. Baguhlo, J. Cortes, M. Guerra, and J. Coco; from Spain: Ms M. G. Nogues, and Messrs J. Aracil, M. Espinosa, and M. Conradi; from Tunisia: Messrs M. El-Felah and S. Rhouma; from ICARDA and CIMMYT: Drs A. H. Kamel, P. Burnett, S. Fuentes, M. M. Nachit, G. O. Ferrara, Joop Van Leur, D. Mulitze, and J. P. Srivastava.

Middle East Travelling Workshops, Jordan/Syria, 9-17 May 1985

The Middle East Travelling Workshop took place in Jordan and Syria from 9 to 17 May 1985. Twenty-five scientists from 10 countries and 10 from ICARDA and CIMMYT spent 4 days (9-12 May) in Jordan where they visited research plots of wheat and barley at Maadaba, Deir Alla, Ramtha, and Marrow. The participants reviewed the breeding, agronomy, and pathology nurseries of the national program (joint nurseries of the Ministry of Agriculture and the University of Jordan, Amman), ACSAD, ICARDA, and CIMMYT.

In Syria, the participants visited the research stations of Izraa, Karahta, Homs, and El Ghab, and also the on-farm trials at Lattamneh. The last 2 days of the workshop were devoted to the presentation of the cereal research work at ICARDA related to:

breeding (barley, durum wheat, bread wheat, and triticale) both for low- and high-altitude areas, pathology, entomology, agronomy/physiology, and grain quality. The closing session on 16 May at Aleppo was headed by Dr P. R. Goldsworthy, ICARDA Deputy Director General for Research. It was noted that scientists from the national programs are requesting more material from ICARDA particularly for areas where cereal production is confined to dry rainfed environments. A major emphasis was placed on certain aspects of breeding strategies, agronomy, and pathology. The participants expressed their thanks to ICARDA/CIMMYT organizers of the workshop and indicated that the concept of travelling workshop was very practical and beneficial. They recommended that, in future, such workshops should be held every 2 years and that more time be allotted to observe the material and for on-the-spot discussions.

The following scientists participated in the workshop, Chile: Edmundo Beratto; Cyprus: Constantinos Josephides; Ecuador: Jaime Tola; Egypt: Abdel Maboud Abdel Shafi Ali, Yousef Daoudi; Jordan: E. Drannon Buskirk, Dr Khairallah, Abdullah A. Jaradat, Maen Shiqwarah, Abdel Majid Tell, Akram Turk; Lebanon: Adnan Alameddine; Mexico: Hugo Vivar (CIMMYT); Spain: J. Hernando Velasco; Sudan: Abdalla B. El-Ahmadi; Syria: Edmondo Acevedo (ICARDA), Hasen El-Hag Ahmed, Kadem Ahmed, Samir Ahmad (ICARDA), Mohamed I. Almahmoud, Azes Al-Saher, Salvatore Ceccarelli (ICARDA), Kasem El Arab, Abdul Razak El-Kurdi, Hesham El Salum, G. Ortiz Ferrara (ICARDA), Hassan Hamod, Tufek Makhlouta, Omar Mamluk (ICARDA), Michael Michael (ICARDA), Miloudi Nachit (ICARDA), Ali Shehadeh, J. P. Srivastava (ICARDA), S. K. Yau (ICARDA); PDR of Yemen: Sami Gawad Hamshari; Canada: S. Jana.

Cereal Training at ICARDA

The 3-month Cereal Residential Training Course ended on 5 June 1985. Fifteen trainees from 12 countries participated in the course which emphasized cereal breeding, agronomy, pathology, entomology, grain quality, and on-farm trials. Practical field sessions and laboratory techniques covered a major part of the course schedule. The trainees were: Ahmed M. ...aby El Bawab (Egypt); Kiflemariam Menghistu (Ethiopia); Mohamed R. Islampoor, Goodarz Gorjian, Hussein Sabere Khabaz, and Syrous Mahfoozi (Iran); Yasir Gasim Mohamed (Jordan); Fatima

Participants in the 1985 ICARDA cereal residential training course; first row (left to right): G. Gorjian, Dr H. Ketata (training officer/ breeder), A. Al Hakimi, K. Menghistu, F. Jarari, and A. El Bawab; second row: I. Bhutta, A. Ben Jewad, N. Ben Abdallah, and S. Mahfoozi; third row: M. Mohamed, A. Ismail, Y. Mohamed, and H. Khabaz.

Jarari (Morocco); Amin A. Al Hakimi (North Yemen); Irshad B. Bhutta (Pakistan); Ahmed S. Ben Jewed (South Yemen); Mustafa Khalil Mohamed (Sudan); Abdel Majid Ismail (Syria); Noureddine Ben Abdallah (Tunisia); and Nusret Zencirci (Turkey).

Individual short training was provided to three trainees from Iran (pathology), one from Syria (entomology), one from Morocco (barley improvement), and one from Tunisia (germplasm characterization and improvement). A 2-week course on pathology of cereal crops and food legumes was also organized for the training of 15 Syrian researchers.

An in-country training course was organized in Pakistan in cooperation with NARC (see below).

Pakistan In-Country Training Course

An in-country training course on «Analysis and Interpretation of Cereal Research Data» was jointly organized by the Cereal Improvement Program of ICARDA and the National Agricultural Research Centre (NARC) at Islamabad, Pakistan, from 5 to 16 May 1985. The major objective of the course was to improve the technical competence of cereal researchers in conducting sound agricultural experiments, analyzing the data from those experiments and drawing valid conclusions from the results.

Twenty-one researchers from NARC and other research centers in Pakistan participated in the course.

The major topics covered in the course included some of the experimental designs most widely used in cereal research along with useful modifications of those designs for single- and multiple-factor experiments, techniques of linear correlation and simple and multiple regression, sampling in agricultural experiments, multiple comparison and trend analysis in factorial experiments, and analysis of genotype × environment interactions.

The curriculum of the course included practical sessions and initiation of the use of microcomputers for statistical analysis of research data.

The scientists involved in organizing and/or conducting the course were: Drs M. S. Khan Rana, N. I. Hashemi, and Nassir A. Khan (NARC); H. Ketata and B. Chakraborty (ICARDA); and Messrs Farouq Maqsood and Liaqat Majeed (PARC).

The opening session was headed by Dr M. Y. Chaudhery, Member, PARC, and attended by Dr C. M. Anwar Khan, Director, NARC, and other NARC scientists. The closing ceremony was hosted at NARC by Dr Amir Muhamed, Chairman, PARC, who congratulated the contributors for the success of the course.

Seed Technology Course

A short course on seed technology will be held at ICARDA, Aleppo, Syria from 9-26 Sept 1985. The course is cosponsored by the Arab Organization for Agricultural Development (AOAD). About 20 researchers from the Arab countries will be invited to participate in the course.

The main objectives of the course are: (1) to show the participants all components of a well-organized seed program, (2) to increase the awareness of the participants regarding the importance of high quality seed, and(3) to train them in seed testing techniques.

The curriculum of the course includes:

(1) Lectures on the main elements of a seed program: breeding, seed production, processing, marketing, distribution, and seed-quality control.
(2) Lectures and practical exercises on seed purity, seed moisture, germination, viability, and health.
(3) Review of the progress made in seed industry in a few selected countries.
(4) Visits to National Seed Testing Station, Seed Processing, and Plant and Seed Certification Service.

The course coordinator will be Dr A. J. G. Van Gastel who has recently joined ICARDA as seed production specialist.

A follow up course is being considered for Spring 1986 to train participants in seed production and certification techniques.

Cereal On-Farm Trials in Morocco

ICARDA and FAO are pooling efforts with the National Program in Morocco to conduct a number of cereal on-farm trials in Morocco. These trials will be used as part of a training course on cereal on-farm trials and serve as a vehicle for transferring research results to farmers. The training course will take place in Oct 1985 and will include 20 research and extension workers from INRA and the Ministry of Agriculture and Agrarian Reform. Dr H. Ketata from the Cereal Improvement Program, ICARDA, will be the coordinator of the course.

A team of ICARDA scientists including **Drs J. P. Srivastava; O. F. Mamluk;** M. Nachit; and **G. O. Ferrara,** and **Mr I. Naji** (Cereal Improvement Program) and **Drs M. C. Saxena** and **W. Erskine** (Food Legume Improvement Program) spent 6 days (29 May-3 June 1985) in Turkey visiting the following research institutions: Adana Agricultural Research Institute; Bugdus Mustefa Eflatun Vakfi Farm near Gaziantep; South Eastern Anatolian Regional Agricultural Research Institute, Diyarbakir; Aegean Regional Research Institute, Izmir; and Central Anatolian Regional Agricultural Research Institute, Ankara. ICARDA scientists were impressed by the research efforts of Turkish scientists. They urged the need for strengthening cooperation with the Turkish National Program for the improvement of barley, wheat, and food legumes. A number of cereal lines being tested in Turkey on a large scale appears to be promising. A coordination meeting to review the work for the 1984/85 season and to develop the 1985/86 workplan will be held in Ankara, 19-20 Aug 1985.

Triticale is gaining increased interest among researchers and production specialists in the world. **Dr Tom Daziang** from the People's Republic of China, stated that triticale lines outyielded bread wheat and barley in mountainous and poor soil areas and also under drought and disease stress conditions. Triticale is looked upon as a promising crop in marginal areas of Jing Yuan county in Northwestern China

Dr T. E. Matheson from Australia mentioned that the triticale lines received from ICARDA have shown an outstanding performance as compared to other triticale material. Two ICARDA lines have eclipsed oat and barley in dry-matter production and outyielded ungrazed wheat by 23-61% in grain production. These lines are being evaluated for possible release as grazing grain types in NSW, Australia.

Dr A. Jaradat from Yarmuk University, Jordan, reported plumpy seed and good performance of ICARDA triticale lines in Irbid area. In Syria, the joint research project between ICARDA and the University of Aleppo is focusing on the utilization of triticale as poultry feed.

In a letter to Dr J. P. Srivastava, **Dr J. Hernando**, Head, Department of Cereal and Legume Crops, CRIDA, INIA, Madrid, Spain, indicated that scientists in his department are conducting research on durum wheat with emphasis on agronomy (tolerance to herbicides) and breeding (interspecific and intergeneric hybridization). He stated that four winter durum wheat varieties are available for cultivation in Spain. These varieties, named Camacho, Jiloca, Penafiel, and Castronuevo, have high, stable yield, stiff straw, and wide adaptation.

Researchers in Libya are making increased efforts to improve cereal production in the country. Cereal nurseries and trials are being avaluated by national scientists at a number of research stations throughout the country. **Dr M. M. Nachit** from the Cereal Improvement Program of ICARDA and Libyan scientists from Tripoli research stations: Messrs **Ramadan Omar, Soleiman M. Sebai,** and **Ali Salem Shreidi,** visited Tajoura Research Station in western Libya where durum and bread wheats are tested under supplemental irrigation and rainfed conditions. They also visited in the same area the stations of Tarhouna, Digga, and Jilealeu where cereal material is screened for drought tolerance. At El Marj in Benghazi area, cereals, mainly durum wheat and barley, are being tested under rainfed conditions, while at Sebha, in Central Libya, durum and bread wheats are being evaluated under irrigation.

The following wheat varieties were recently released in Libya: durum wheat; Marjawi, Baraka, Zorda, Fazan, and Dara; bread wheat: Zeldaf, Sebha, and Germa.

The FAO/ICARDA/PARC Project on «Cereal On-Farm Demonstrations in Baluchistan, Pakistan,» was recently reviewed by **Dr W. M. Tahir** from FAO, **Dr M. Y. Chaudhery** from PARC, Pakistan, and **Dr M. Tahir** from ICARDA.

The progress made so far and the results achieved were rated highly satisfactory. The three parties involved have therefore agreed to provide the necessary inputs for continuation of the project.

Dr A. Hadjichristodoulou, Head of the Agronomy Division and Barley Breeder, ARI, Nicosia, Cyprus, was invited by INRAT, Tunis, Tunisia, and ICARDA, Aleppo, Syria, to visit the Tunisia/ICARDA collaborative barley improvement project. Following his visit to research plots at Beja, El Kef, Tejerouine, Hendi Zitoun, Kairouan, Ouslatia, Siliana, and El Fahs. Dr Hadjichristodoulou submitted a report in which he commended the research work being done and provided suggestions for future work.

Dr Edmundo Acevedo arrived in Aleppo on 28 April 1985 from Santiago, Chile, to join the Cereal Improvement Program of ICARDA as a crop physiologist/agronomist.

Dr Acevedo completed his Ph.D program in 1975 at the University of Davis, California (Dr T. C. Hsiao, major advisor). Prior to joining ICARDA, Dr Acevedo was a professor of soil-plant-water relations and crop physiology at the University of Chile. He has produced 40 publications dealing with arid zone research particularly water stress physiology.

Dr Stefania Grando arrived in Aleppo on 26 April 1985 from Italy to join the Cereal Improvement Program of ICARDA as a visiting scientist for a period of 6 months.

Scientists from ICARDA and CIMMYT exchanged visits during the 1984/85 season. In particular, the visits by **Dr J. P. Srivastava** to CIMMYT, Mexico, in Apr 1985, and **Dr B. Curtis** to ICARDA, Syria, in May 1985, contributed to further strengthening the cooperation between the two centers for better serving the research and training needs of national research programs.

Seed Request for 1985/86 Nurseries

The following information has been sent to our cooperators separately, but is reproduced for the benefit of those scientists who may fail to receive it and, therefore, may wish to write to us to obtain the nurseries.

The wheat and barley international nurseries for 1985/86 will be assembled and shipped from the Cereal Improvement Program, ICARDA, Aleppo, in August/September 1985. Please indicate on the attached seed request form which nurseries and the number of sets for each you require. To help ensure fulfillment of your seed requests, please mail the attached form as soon as possible.

In order to help you select the appropriate nurseries, the following information, first in general for each type of nursery and then in specific for each crop, has been provided. Entries for all nurseries have been selected under rainfed conditions and are of spring growth habit unless otherwise specified.

1. Regional Crossing Blocks (RCB)

The Regional Crossing Blocks (RCB) are designed to complement and broaden the genetic bases of the national cereal improvement programs. Through the RCB, cooperators can evaluate additional parental genotypes for use in their crossing programs. The RCB provide a diversity of germplasm selected in response to the various needs of the national programs.

Entries in the RCB originate from a number of sources: (1) ICARDA nurseries, primarily the Observation Nurseries and Regional Yield Trials, (2) national programs, and (3) other sources.

For each entry, 10-12 g of healthy treated seed to plant two rows 2.5 m long will be provided. The entries are arranged into groups according to specific traits. Typical groupings are: (1) entries with wide adaptation or adaptation to more specific environments, (2) early or long-maturity genotypes, (3) winter types, (4) entries with tolerance to various environmental stresses (drought, heat, frost, cold, and salinity), (5) entries with resistance to important diseases (yellow rust, leaf rust, scald, stem rust, powdery mildew, septoria, etc.) in the region, (6) entries with multiple disease resistance, (7) entries with resistance to insect pests (sawfly, Hessian fly, aphids, etc.) in the region, and (8) parental genotypes with good grain quality.

The field books for the RCB provide the following information, where available, on each entry: name or cross, pedigree, country of origin, seed source, plant height, days to heading and maturity, grain color and size, 1000-kernel weight, protein percentage, and disease resistance, and additional information on traits specific to each cereal. Finally, a general-comments line, providing further characterization of a genotype, assists scientists in the national programs in identifying lines potentially suitable to their environment.

2. Regional Segregating Populations (RSP)

The Regional Segregating Populations provide a source of genetic diversity for selection by the cooperators in their environments. Cooperators can thereby develop genotypes with more specific adaptation to their environments. All RSP are F_2 families. For each entry, 8-12 g of F_2 seed for planting in four to six 5 m long rows will be provided.

3. Observation Nurseries (ON)

The Observation Nurseries are designed to distribute the most recently developed and most promising lines from the advanced yield trials of the ICARDA base cereal breeding programs. These new genotypes are intended for direct use or as parents in national plant breeding programs. These lines have been evaluated for disease resistance from several key disease locations in the region.

The ON consist of entries promoted from ICARDA's advanced yield trials, entries repeated from the previous year, a number of triticale lines, a few entries from national programs, and checks (long-term, improved, and national or local check). For each entry, 12-15 g of seed for planting in two 2.5 m rows will be provided.

4. Regional Yield Trials (RYT)

The Regional Yield Trials (RYT) have three main objectives: (1) to provide an opportunity for the cooperating scientists to assess the performance of advanced promising lines, with respect to grain yield, diseases, agronomic traits, and other important characters; (2) to allow the analysis and comparison of performance of entries under a wide range of agroclimatic conditions; and (3) to disseminate sources of new genetic variability which scientists of the national programs may utilize for further testing and possible release or use as parents in their crossing programs.

Each RYT consists of 24 entries, with the last entry reserved for the national check to be supplied by the cooperator. The 23 entries shipped to cooperators are either entirely promoted from the ON or repeated from the previous RYT, allowing for analysis of performance over two consecutive years.

The entries are planted in a randomized complete block design with three to four blocks. Each block can be planted in two groups of 12 entries, in an effort to reduce the effect of soil heterogeneity on the comparison of treatment means. Approximately 60 g of seed will be provided for planting each plot, recommended to consist of six 2.5 m long rows placed 30 cm apart. Field books supplied with each seed shipment provide information on each entry and on the layout of the trial, and also instructions on nursery management and data collection. For each crop, please note the following information:

Barley. The regional yield trials, observation nurseries, and segregating populations have been grouped into three separate sets designed for the most widely encountered barley growing environments in the region. These are:

(1) Cold tolerance (CT) set, germplasm with cold tolerance required for high-altitude areas and other areas with low temperatures encountered during the crop growth cycle. This set has entries with a facultative growth habit.

(2) Moderate-Rainfall Areas (MRA) set, with germplasm targeted for dry areas, with less than 300 mm long-term average annual rainfall.

(3) Moderate-Rainfall Areas (MRA) set, with germplasm targeted for areas with more than 300 mm long-term average annual rainfall, or areas with limited supplementary irrigation.

Durum. The regional yield trials and observation nurseries will be prepared in two separate sets:

(1) Low-Rainfall Areas (LRA) set, with genotypes meant for rainfed, low-rainfall areas with 250-350 mm long-term average annual rainfall.

(2) Moderate-Rainfall Areas (MRA) set, with genotypes selected for areas with more rainfall (350-500 mm long-term average annual rainfall), or areas with limited supplementary irrigation.

Bread Wheat. The observation nursery has been partitioned into two sets:

(1) Low-Rainfall Areas (LRA) set, with entries developed and selected under unfavorable environments with limited fertilizer and targeted for dry areas with 300-400 mm long-term average annual rainfall.

(2) Moderate-Rainfall Areas (MRA) set, with entries developed and selected under more favorable environments (higher rainfall, more fertilizer), and targeted for areas with more rainfall than for the LRA set (400-600 mm long-term average annual rainfall), or areas with limited supplementary irrigation. Entries in this set have been especially grouped for resistance to diseases and insects common to moderate-rainfall bread wheat growing areas.

Seed Request Form, 1985/86
International Nurseries
Cereal Improvement Program
ICARDA
P.O. Box 5466, Aleppo, SYRIA

Barley

Barley Yield Trial (BYT)

BYT-CT (24)*	: Cold Tolerance/High Altitude Areas
BYT-LRA (24)	: Dry or Low Rainfall Areas
BYT-MRA (24)	: Moderate Rainfall Areas
BON	: Barley Observation Nursery
BON-CT (100)	: Cold Tolerance/High Altitude Areas
BON-LRA (100)	: Dry or Low Rainfall Areas
BON-MRA (100)	: Moderate Rainfall Areas
BSP	: Barley Segregating Populations
BSP-CT (150)	: Cold Tolerance/High Altitude Areas
BSP-LRA (150)	: Dry or Low Rainfall Areas
BSP-MRA (150)	: Moderate Rainfall Areas
BCB (175)	: Barley Crossing Block

Durum

Regional Durum Yield Trial (RDYT)

RDYT-LRA (24)	: Low Rainfall Areas
RDYT-MRA (24)	: Moderate Rainfall Areas
DON	: Durum Observation Nursery
DON-LRA (100)	: Low Rainfall Areas
DON-MRA (100)	: Moderate Rainfall Areas
DSP (150)	: Durum Segregating Populations
DCB (150)	: Durum Crossing Block

Bread Wheat

RWYT (24)	: Regional Wheat Yield Trial
WON	: Wheat Observation Nursery
WON-LRA (100)	: Low Rainfall Areas
WON-MRA (100)	: Moderate Rainfall Areas
WSP (150)	: Wheat Segregating Populations
WCB (200)	: Wheat Crossing Block

*Approximate number of entries for each nursery.

Name of Cooperator (s):

Designation of Cooperator:

MAILING ADDRESS:

SHIPPING ADDRESS:

Special instructions concerning shipping (customs, phytosanitary certificate, etc.):

The following list of high-yielding hull-less cultivars recommended for cultivation in the Indo-Gangetic Plain and Central India has been provided by Dr Mahabal Ram, Project Coordinator (Barley), IARI, Karnal, India.

Cultivar	Year of identification/ release	Plant type*	Grain quality	Optimum yield (q/ha)	Crop duration (days)	Cropping conditions
Karan-3	1982	Dwarf	Amber, rich in protein (16%)	40-50	120	Irrigated, timely sown as well as saline-alkaline soil conditions
Karan-4	1982	Semidwarf	Amber	45-50	115	Rainfed conditions
Karan-16	1982	Dwarf	Amber	45-50	120	Timely sown, irrigated
Karan-18	1984	Dwarf	Amber	45-50	120	Timely sown, irrigated, timely sown diaraland and saline-alkaline soil conditions
Karan-19	1984	Semidwarf	Amber	50-55	120	Rainfed, irrigated and late sown, saline-alkaline soil and diaraland
Karan-231	1983	Dwarf	Amber, rich in protein (14%)	50-55	115	Timely sown, irrigated/late sown conditions
Karan-265	1983	Dwarf	Amber	40-45	110	Late sown conditions
Karan-163	1984	Dwarf	Amber, rich in protein (16%)	50-55		Normal sown, irrigated conditions
Karan-201	1984	Semidwarf	Amber, rich in protein (16%)	40-45		Rainfed

*Semidwarf = 95-110 cm; Dwarf = 80-90 cm; Triple dwarf = 60-75 cm; double dwarf = 40-55 cm in height.

The following are wheat and barley cultivars released in Portugal as listed by Dr Manual Barradas, Director of the National Plant Breeding Station at Elvas, Portugal.

	Name	Cross/pedigree	Entry number in ICARDA nurseries
Bread wheat	Almansor 1	E 4870-C306 × M5392666.5/Bb × CC-Inia CM 22099	
	Caia	Azteca × Mucaba	
	Degebe	UP 301 × Son 64-Pitic 62 JT 35-2L	In RWYT 1975/76
	Mira	Y 50 E-Kalyan³ 35188-5M(F1)-39Y-0M-24M-0Y	No. 99 in 1978/79 WON
	Tejo	(21931/Ch53-An × Gb56) An64 11 20985-5h-2h-11h	No. 19 in 1978/79 WON-RF
	Vouga	Npo-Cd1 × Zbz CM 8935-D-5M-3Y-3M-2Y-0M	No. 59 in 1979/80 WON
Durum Wheat	Castico	USA-111 C-Gs'S' × [(G11'S'/ByE2-Tc × ZB-W)] Fg'S' CM 1-403-G-3Y-6M-1Y	
	Celia	Plc'S'-Ruff'S' × Gta'S'-Rtte CM 179.4-B-3M-1Y-0M	No. 125 in 1976/77 PON-D
	Faia	(Preto Amarelo × Oviachic) Trigo Mex. Anao	
	Faisca	Oviachic × Capelli	No. 79 in 1976/77 PON-D
	Helvio	Jo'S'-AA'S' × Fg'S' CM 9799-126M-1M-5Y-0Y	No. 46 in 1978/79 PON-D
	Timpanas	Gerardo 469-Gr'S' CM 362-21M-2Y-7M-0Y	
Barley (6 rows)	Enxara	CM 67-U. Sask 1744 CMB 72-45-19Y-2B-2Y-1B-1Y-0B	
(2 rows)	Ribeka	Rika × Beka	No. 26 in 1981/82 BON
(2 rows)	Tagide	Sagres × UMRC	

Forthcoming Events

International Symposium on Genetic Manipulation in Plant Breeding, 8-13 Sept 1985, Berlin, West Germany.

Contact: Prof. W. Odenbach, Institut fur Augewandte Genetik, Albreacht-Thear-Weg 6, D-1000 Berlin 33, Germany. Tel: 10301 838 5800.

ICARDA Cereal Program Planning Meeting, 23-25 Sept 1985, Aleppo, Syria

The Cereal Improvement Program of ICARDA holds its Annual Program Planning Meeting on 23-25 Sept 1985 at Aleppo. The 1984/85 research results will be reviewed and discussed, and plans for the forthcoming season will be proposed and finalized. The meeting will be attended by scientists from ICARDA and invited researchers from national programs in the region.

Contact: Dr J. P. Srivastava, Leader, Cereal Improvement Program, ICARDA, P. O. Box 5466, Aleppo, Syria.

First Annual Conference of the International Plant Biotechnology Network (IPBNET), 21-25 Oct 1985, Fort Collins, Colorado, USA

The Tissue Culture for Crops Project (TCCP) will hold the first Annual Conference of the International Plant Biotechnology Network at the University Park Holiday Inn, Fort Collins, Colorado, on 21 Oct 1985. This 5-day conference will focus on tissue culture propagation of cereal crops. Among the agenda topics are the following: somatic embryogenesis and plant regeneration, manipulation of plant protoplasts, and selection for stress resistance in plant tissue cultures.

Contact: Ms Julie L. Fischer, Operations Director, TCCP/Botany Department, Colorado State University, Fort Collins, CO 80523, USA. Tel. (303) 491-1813.

Seminar on Developing Improved Winter Cereals for Moisture-Limiting Environments, 27-31 Oct 1985, Capri, Italy

Jointly organized by the Centro Nazionale delle Ricerche (CNR) and the International Center for Agricultural Research in the Dry Areas (ICARDA), this seminar will be held at Capri, Italy, 27-31 Oct 1985. The primary objective of the seminar is to encourage a dialogue between breeders and physiologists in an effort to increase stability and production of wheat and barley in rainfed areas of West Asia and North Africa. Focus will be on characterization of rainfed environments in the region, breeding strategies for dry areas, and screening techniques for tolerance to moisture stress.

Contact: Dr E. Acevedo, ICARDA, P.O. Box 5466, Aleppo, Syria.

Annual Meetings of American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, 1-6 Dec 1985, Chicago, USA

Contact: ASA, CSSA, SSSA Headquarters Office, 677 South Segoe Road, Madison, WI 53711, USA. Tel. (608) 273-8080.

1986 UCLA Symposia on Molecular and Cellular Biology, 20 Jan-25 Apr 1986, Los Angeles, California, USA

These Symposia will cover topics in: cancer biology, cell biology, development, entomology, immunology, molecular biology, parasitology, plant science, and virology.

Contact: UCLA Symposia, Molecular Biology Institute, University of California, Los Angeles, CA 90024, USA.

International Triticale Symposium, 2-8 Feb 1986, University of Sidney, Australia

The Symposium was announced in Rachis 4(1) For more information, contact: Dr N. Darvey, organizing secretary, International Triticale Symposium, Plant Breeding Institute, The University of Sidney, NSW 2006, Australia.

International Wheat Conference, Apr 1986, Cairo, Egypt

This conference is the fifth in a series initiated by the University of Nebraska in 1972. It is sponsored by the

University of Nebraska and the International Maize and Wheat Improvement Center and will be hosted by the Egyptian Ministry of Agriculture at Cairo in Apr 1986 (exact date will be communicated later). The conference will focus on international cooperation in wheat research including such areas as breeding, pathology, entomology, agronomy, physiology, biotechnology, and others.

Contact: Dr V. A. Johnson, Department of Agronomy, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, NE 68583, USA.

First European Congress of Food Science and Technology, 1-3 July 1986, Bournemouth, UK

The European Federation of Food Science and Technology will hold its First European Congress at Bournemouth, UK, 1-3 July 1986. The Congress will focus on cereal quality and technology. Emphasis will be on wheat but other cereals may be discussed. Among the topics on the agenda are the following: cereal genetics and breeding, cereal and nutrition, milling technology, cereal chemistry, baking technology, and fermentation.

Contact: Prof. John Hawthorn, C/o Conference Clearway Limited, Conference House, 9 Pavilion Parade, Brighton BN2 1RA, UK.

International Congress of Plant Tissue and Cell Culture, 3-8 Aug 1986, University of Minnesota. St. Paul, Minnesota, USA

The themes of the congress will deal with genetics, biochemistry, physiology, molecular biology, and application of culture technology.

Contact: VIth IAPIC Congress Secretariat, Office of Special Programs, 405 Coffey Hall, University of Minnesota, St. Paul, Minnesota 55108, USA.

The Fifth International Barley Genetics Symposium, 6-11 Oct 1986, Okayama City, Japan

The symposium was announced in Rachis 4(1). For more information, contact: Prof. S. Yasuda, Chairman, Local Organizing Committee, Institute for Agricultural and Biological Sciences, Okayama University, Kurashiki, 710 Japan.

Corrections

RACHIS Vol. 3, No. 2, p. 29, second paragraph, left column, the sentence should read: "The dried grains are mixed with about 3% water..."

RACHIS Vol. 4, No. 1, p. 2, first paragraph, right column, the sentence should read: "Over 95% of the durum wheat (*Triticum turgidum* L. var. *durum*) crop..."

Reminder

We wish to remind those of our readers who have not yet returned the yellow **Reader** Inquiry Card, which was mailed with RACHIS Vol. 4, No. 1, January 1985 issue, to return the Card **by** 31 December 1985, failing which the supply of RACHIS to them will be discontinued.

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 n 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; $5^{o}C$; 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.

References
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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