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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, Wheat, and Triticale 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, wheat, and triticale.

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

Winnowing the frekeh grain from soot, ash, charred awns, and leaves (see page 25)

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Editorial

Increasingly larger volumes of information are being constantly generated by agricultural research institutions all over the world, but a considerable proportion of this information often fails to reach the scientific communities, particularly in the developing countries. The major reason is that the communication channels are not well developed and sometimes not easily accessible to many of the scientists in developing countries. The international agricultural research centers are among the major producers of new knowledge, but face the challenge of communicating it to national programs for use in improving food production.

The major objective of ICARDA's Cereal Improvement Program is to increase the productivity and yield stability of barley, durum wheat, and bread wheat in rainfed areas. The Program has produced a substantial amount of research results applicable to many of these areas, and is striving to disseminate the results to colleagues in national programs through several methods. The most important method is the international nursery system which provides broad-based germplasm to national programs for testing and use. The international nurseries data returned to ICARDA are analyzed and the results promptly sent back to national programs. This method has been extremely useful, as evident from several new cereal varieties recently released by national programs.

Trainees from national programs come to ICARDA every year for varying periods of time to gain knowledge in various aspects of cereal improvement research and to share their experiences with ICARDA scientists. Scientists from national programs and ICARDA exchange visits during the crop season to share their knowledge and expertise in handling specific research problems. The Cereal Program organizes, from time to time, scientific meetings, workshops, and conferences on various topics to bring scientists together from different countries to enable personal interaction and informal discussions.

We are pleased with the increasing interest of readers in RACHIS; the last issue had to be reprinted to meet the increased demand. Readers are invited to send us their suggestions to make this publication more useful.

REVIEW ARTICLE

Improving Wheat and Barley Production in Moisture-Limiting Areas

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In the past, efforts of governments and international agencies to increase cereal production focused on high-rainfall and irrigated areas. Low-rainfall areas remained neglected, because the potential productivity gain from these areas was less. Data from ICARDA multilocation trials illustrate this situation. (Table 1). Responses to optimum rates of fertilizer and herbicide ranged from 50% increase at the driest sites to 130% increase at the wettest sites. Although the practices were profitable in all tests, they gave the greatest return in the higher-rainfall areas (ICARDA 1983).

Yet, in West Asia and North Africa, it is in low-rainfall areas that the major hectareage and production occur. Ninety percent of the bread wheat (*Triticum aestivum* L.) crop in the Middle East-North Africa region is rainfed (250-650 mm annual precipitation) with about 50% of it receiving less than 400 mm (ICARDA 1983). Over 95% of the durum wheat (*Triticum durum* L.) crop is rainfed, and it is grown at lower rainfall levels (250-500 mm) than bread wheat (Srivastava 1984). Only 6% of the barley (*Hordeum vulgare* L.) crop in the region is irrigated, the remainder being grown under marginal rainfed conditions (200-450 mm), usually on poor soils and with limited management (Srivastava 1977).

However, the demand for increased cereal production in the region continues to rise with the rapidly growing population. As a result, limited foreign exchange must be used for purchasing imported cereal grain. Many countries subsidize the price of bread and pay low prices to the farmer for his grain; practices which placate the urban consumers but reduce the incentive for greater farm inputs and production. However, governments are beginning to realize that the need for increased cereal production within the region is acute and central to their long-term objective of achieving self-sufficiency.

Table 1. Yield response and profitability of fertilizer and herbicide use on cereals at six dryland sites in northern Syria during 1982/83.[1]

Location	Rainfall (mm)	Crop	Total DMY with (t/ha): Local Pract.	Total DMY with (t/ha): Recom.[2] Pract.	Rate[3]
Jindiress	417	Bread wheat	3.79	8.80	3.03
Kafr Antoon	341	Bread wheat	3.57	6.36	2.23
Tel Hadya	323	Durum wheat	3.58	5.71	4.21
Breda	285	Barley	1.14	2.23	1.54
Ghrerife	232	Barley	1.55	2.93	1.78
Khanasser	295	Barley	1.70	2.40	1.32

1. Source: Farming Systems Program data (ICARDA 1983).
2. Recommended practices are nitrogen and phosphorus application and herbicide use (levels of application vary with the site).
3. Rate of return = increased revenue/additional costs.

*. Left ICARDA in 1984.

National research programs are now looking carefully at the vast potential of the previously neglected rainfed areas to increase cereal production. International Agricultural Research Centers are now turning their attention to subsistence farmers in marginal, low-rainfall areas who have not benefited much from the improved technology designed for irrigated areas. The rainfed sector should become the centerpiece of future progress in increasing cereal production.

Characteristics of Rainfed Cereal Production

The dominant feature of rainfed areas is their insufficient and variable moisture supply. This has a direct effect of reducing the availability of water to the growing crop and many indirect effects which lower crop yield. The soils of rainfed areas are often shallow and stony and have coarse texture with lower water-holding capacity. They are less productive and, hence, have low organic matter contents. This results in high pH, low microbial activity, and low nutrient availability.

The effects of reduced biological productivity of the rainfed areas on the agricultural system of those areas can be described as a "vicious circle" which keeps yields low. The farmers have less money to invest in improved management practices, hence yields remain depressed. The high variability in amount and timing of rainfall adds a component of risk to the farmer. These factors discourage the farmer from investing in improved management techniques. To stabilize his income, he often seeks non-farm employment which results in a further decrease in farm-management activity.

Clearly, socioeconomic factors are intertwined with biological ones in explaining the low-input nature of rainfed cereal agriculture. If governments are determined to increase production from these areas, they must offer economic incentives and help reduce the financial risk of dryland farming. This paper describes approaches towards overcoming the biological limitations to higher yield in rainfed cereals.

Improved Practices

Obviously, substantial yield increases can be achieved despite low rainfall through the use of improved practices in rainfed areas. Six practices are discussed which have shown promise based on research in the ICARDA region.

Nitrogen and Phosphorus Fertilizers

Fertilizers help correct the inherently low nutrient content in many of the soils in rainfed areas. Fertilizer requirements are always site-specific, depending on the geological as well as cropping history of the soil, both factors interacting with rainfall. Therefore, few generalizations about specific levels of application can be made without soil tests or crop-response trials.

However, from research in northern Syria it seems that nitrogen is more often limiting in wetter rainfed areas, and phosphorus in drier areas (Table 2). High rainfall leads to increased crop extraction of N and leaching of N below the root zone with resultant N deficiency to the crop. Low rainfall results in the accumulation of nitrate in the upper soil levels (30-80 cm) which may be the limit of the wetting front. This increases the amount of N in the root zone, reducing N stress in such areas. Conversely, increased microbiological activity and organic matter content and more favorable pH of wetter soils often increase phosphorus availability. Low-rainfall soils with higher pH tend to have less available phosphorus and hence show larger responses to P fertilizers.

Table 2. Significance of effects of nitrogen and phosphorus fertilizers on grain yields in different rainfall zones, from combined analysis of on-farm trials in Syria, 1982/83 season.[1]

Number of sites	Average annual rainfall (mm)	Nitrogen	Phosphorus
		F ratios [2]	
5	> 350	67.4	ns
6	250-350	13.1	ns
6	> 250	6.3	21.1

1. Source: ICARDA Cereal Improvement Program/Syrian Ministry of Agriculture and Agrarian Reform On-Farm Verification Trials Report, 1982/83 season.
2. F ratios shown are significant at 5% level, ns = not significant.

Phosphorus stimulates root growth and enhances cold tolerance in the cereal plant, and these consequently increase the amount of water available to the plant and stimulate vigorous winter growth. Transpiration efficiency (grams of dry matter produced per unit of water transpired) is higher in winter when atmospheric evaporative demand is low; hence a larger amount of dry matter is produced with limited water supply.

Nitrogen enhances canopy growth as well as root growth. The larger canopy covers more of the previously bare soil surface. As a result, less moisture is lost through evaporation from the soil, and more is used through transpiration by the plant (Cooper *et al.* 1983). The result is greater dry-matter production and hence higher yield.

There is a fear that fertilizer use (especially nitrogen) in dry years may lead to rapid consumption of limited soil moisture, increasing crop stress during later stages of the growth. This could reduce kernel weight and yield, as well as seed quality. However, our trials in the Mediterranean climate of northern Syria have not substantiated this fear. Even in dry years with appropriate fertilizer rates, losses in kernel weight have not exceeded 10% while yields were increased substantially (M.D. Winslow, unpublished data).

Further evidence on the potential of enriched soil fertility towards increasing yields in dry areas comes from studies of crops growing on anthills (Weltzien and Srivastava 1981). The activity of ants (*Messor* spp.) in accumulating organic matter into anthills greatly increases available phosphorus and mineral nitrogen levels, so crop growth in these spots is vigorous, even in barley-growing areas with less than 300 mm annual rainfall. Yields on these spots were found to be 181 to 448% that of the surrounding farmers' fields. Despite lush, vigorous early growth, there was no reduction in kernel weight in barley (Weltzien and Zaklouta 1980). Data collected by M.D. Winslow indicated that kernel weight of durum wheat grown in an anthill with 159 mm rainfall was 37% greater than of the non-fertilized farmers' crop in the surrounding field (Table 3). Apparently, crop stress during grain fill was less inside than outside the anthill. Better crop nutrition may have allowed greater root growth, and hence made more water available to the crop. However, it must be cautioned that fertilizer addition alone does not increase productivity to the levels found in anthills, and has not been found to increase kernel weight either. Nevertheless, the evidence from our trials in the Mediterranean climates does not substantiate undue concern over kernel weight losses caused by appropriate fertilizer application in rainfed areas, as long as cultivars of appropriate maturity duration are used.

Table 3. Yield and yield components of durum wheat grown outside and inside an anthill in a farmers' field near Hegla, Syria, 1983/84 season. (Total season rainfall was 159 mm).

Location	Grain yield (kg/ha)	Heads/ m^2	Seeds/ head	Mean KWT
Outside anthill	175	81.0	8.1	28.4
Within anthill	317	24.3	34.1	38.9
LSD (0.05)			9.7	5.9

Fallowing, Moisture Conservation, and Rotation

A properly-managed fallow system can increase total productivity and also stabilize production over years. Proper fallow management involves the use of tillage techniques which increase the infiltration rate of water during the winter and by creating a "mulch," reduce soil evaporation during the summer. By such methods, 20-30% of the rainfall of the fallow season can be conserved. Such techniques contributed to large yield increases when introduced in Turkey (USAID/Oregon State University 1975).

In extremely low-rainfall areas (less than 300 mm), fallowing fails to store much moisture, especially if soils are shallow, coarse-textured, and stony, as they often are. Nevertheless, fallowing dramatically increases yield (Table 4).

The reasons for the low yield of continuous barley and large yield increase due to fallow are not completely known; they cannot be accounted for by moisture conservation alone. Accumulation of mineral nitrogen and phosphorus must play a role, but addition of these elements to continuous barley still fell far short of the performance of fallow (Table 4). One hypothesis is that there may be phytotoxic compounds formed during the incomplete breakdown of barley residues, and fallow allows completion of the breakdown process.

Table 4. Barley productivity when grown continuously or in rotation with fallow or vetch, with and without NP fertilizer, Breda, Syria.[1]

Crop	Total DMY of barley (kg/ha)	
80/81-81/82	Without NP	With NP
Barley/barley	1300	2790
Fallow/barley	3700	5250
Vetch/barley	2380	2890 [a]
LSD (0.05)	740	

1. Rainfall was 292 and 324 mm for 1980/81 and 1981/82 seasons, respectively. Data collected by Farming Systems Program (ICARDA 1982).
a. The vetch crop received no fertilizer.

Breaking the continuous cereal rotation with a legume crop increases barley yield (although not as much as fallowing) without causing the land to sit idle every other year (Table 4). Legumes provide valuable forage in the typical cereal-livestock farming systems of the Middle East and North Africa. Further research is needed to identify appropriate legume species and cultivars for the region and the most efficient inoculum systems to enhance nitrogen fixation (ICARDA 1983).

Early Planting

Traditionally, farmers with weed problems use the first rains to germinate the weed seed and then destroy the seedlings by plowing. This may push the date of planting three to eight weeks later than normal, forcing rapid crop development and grain fill under moisture stress after the spring rains have stopped. Early planting, combined with herbicide use, if weeds are a problem, gives effective weed control while allowing a longer and more favorable period for crop growth and development. Consistent, large yield increases have been attained with this practice (Jordan Ministry of Agriculture/University of Jordan/ICARDA 1984).

Proper fallow management for moisture conservation can conserve sufficient soil water to germinate and establish the cereal crop before the first rains (USAID/Oregon State University 1975). This increases the stability of the cereal production system by allowing planting based on calendar date rather than on rainfall. It also increases yield by extending the length of the growing season which ensures vigorous winter rooting and top growth before the onset of the dry spring season.

Weed Control

Weed control during the early part of the growing season is essential for high cereal yields. It allows early planting, an advantage discussed above. New short-strawed cereal cultivars with erect leaves are less competitive with weeds because they fail to shade them out so well as do traditional cultivars. Hence, weed control becomes more important if less competitive cultivars are introduced.

Drill Seeding

Drill seeding reduces gaps in the stand, allowing complete exploitation of soil nutrients by the crop. Phosphorus fertilizer can be placed in a band near the seed by drilling, decreasing the rate of P fixation. Drill seeding is of greatest advantage in high-rainfall areas (300-650 mm), where heavy early rains germinate the crop uniformly.

In the drier rainfed areas (less than 300 mm), the value of drilling has not been consistent (Jordan Ministry of Agriculture/University of Jordan/ ICARDA 1984). In these areas, a risk is created by drill placement of all the seed at one depth. Early rains which germinate the seed may be followed by periods of drought which can kill much of the crop. Deeper drilling is necessary in such areas to ensure that only heavy rainfall will cause the wetting front to reach and germinate the seed. Improved fallow techniques for moisture conservation would reduce the risk of drill seeding and help take advantage of its benefits.

In such a risky situation, broadcasting provides a measure of insurance because it distributes seed through a range of depths in the soil. Light but repeated rains will germinate the upper seeds, allowing them the advantage of early establishment and growth. If unusual droughts should kill these seeds, those at the lower depths can still germinate and grow when rains resume. The relative insensitivity of cereal yields to plant population density (ICARDA 1982) helps compensate for thin stands as long as large patches of barren soil are not present.

Improved Varieties

Breeding programs have developed high-yielding varieties for irrigated areas, but little impact has been made on the low rainfall(< 300 mm) agro-ecosystems. Improved varieties selected under optimum conditions often lack resistance to the stresses encountered in rainfed environments. An example is the two-row barley variety ER/Apam which outyields the local check under favorable growing conditions but falls behind in marginal environments (Tables 5 and 6). The biological reason for this genotype/environment interaction is not known. However, data in Table 6 indicate that more than just drought resistance is involved, because the location effect was far greater than that of supplementary irrigation in increasing the yield of ER/Apam (Table 6). As mentioned earlier, low-rainfall areas suffer from a complex of deficiencies and stresses, of which low moisture supply is only one. Damage caused by severe cold, poor germination and establishment, poor root growth, and inefficient nutrient uptake could be other reasons for poor performance in such environments.

Table 5. Grain yields of ER/Apam barley compared to local check varieties in high- and low-rainfall barley areas in Syria, 1982/83 season.[1]

Site	Rainfall (mm)	Grain yield (kg/ha): ER/ Apam	Grain yield (kg/ha): Local check[2]	LSD (0.05)
Sheikh Miskine	380	4951	3625	672
Saraqeb	340	3839	3401	ns
Muslimiyeh	317	3188	3078	ns
Hememeh	224	1016	1448	180
Tel Khuddar	186	859	995	230
Chinchar	189	250	714	185

1. Source: ICARDA Cereal Improvement Program/Syrian Ministry of Agriculture and Agrarian Reform, On-farm Verification Trials Report, 1982/83 season.
2. The local check was "Arabi Abied" in the first three sites and a closely related variety, "Arabi Aswad" in the second three sites.

Table 6. Yields of local (Arabi Abied) and improved (ER/Apam) barley varieties at two moisture levels in two locations in Syria, 1983/84.

Location	Total water[1] (mm)	Arabi Abied (kg/ha)	ER/Apam (kg/ha)
Tel Hadya	250	2795	3802
	350	3475	3970
Breda	250	1387	974
	350	2344	1915

1. Rainfall plus irrigation. Values are predicted from linear regression from a line-source sprinkler experiment.

The development of short-statured modern cereal cultivars made possible the application of high rates of irrigation and fertilizer without lodging problems, and was a breakthrough for high-input agriculture. However, low-rainfall conditions prevent these cultivars from expressing their high-yield potential. In addition, short stature has several negative side-effects in low-input cereal management systems. It is associated with short coleoptile length, and the consequence can be a reduction in plant emergence and stand density when the seed is sown deep—a necessary practice in areas plagued with drought at planting time (Bhardwaj 1978). Short stature and erect leaf growth reduce competition against weeds and thereby increase the need for herbicide, which may be unavailable to poor farmers. Short cultivars may have plant height reduced so greatly under low-rainfall conditions that mechanical harvesting is difficult and seed is lost. As a result, traditional tall varieties are still grown in most of the rainfed hectareage of the Middle East and North Africa.

Local cultivars are often genetically diverse, and contain individual plants with resistance to different stresses likely to plague the crop in different years. This gives these varieties a measure of buffering to environmental fluctuations. Diversity within the local barley varieties grown in Syria and Jordan for seed dormancy, vernalization requirement, and maturity date has been observed (Weltzien 1982). Investigations of diversity within the "Haurani" durum wheat variety are being pursued at ICARDA. These local varieties can serve as donors for different kinds of stress-resistance genes. When combined with the high-yield potential and disease and insect resistance of modern cultivars, these stress-resistance traits can contribute to increased adaptation and yield stability of new cultivars, while maintaining high-yield potential which can be expressed in favorable years.

The superior performance of local varieties under stress conditions can be attributed to their long history of selection (by nature and by man) in those stress environments. Breeders can use the same system, i.e., to select and test advanced lines in the environments for which they are intended if the newer varieties are to surpass the local ones and achieve a high level of yield stability.

Evidence of specific adaptation in breeding nurseries is indicated in Tables 7 and 8. Table 7 compares the performance of ICARDA advanced durum breeding lines with that of the local variety "Haurani," under low-rainfall and supplementary irrigation conditions. Entry 117 performed well in all tests, whereas entry number 607 only did well in high-rainfall or supplementary irrigation trials.

Table 7. Grain yield performance, as percent of the local check "Haurani," and rank in the trial (parentheses) of two contrasting durum wheat lines in three environments differing in rainfall and location, in two seasons.[1]

Entry number	Season	Environment[2] RF	SIR	TB
		Percent of Haurani (rank out of 259 entries)		
117	82/83	136(2)	128(18)	129(34)
	81/82	124(1)	144(12)	
607	82/83	103(202)	129(13)	143(11)
	81/82	98(217)	150(1)	

1. Source: ICARDA (1983).
2. RF = Rainfed (339 and 324 mm in 1981/82 and 1982/83, respectively); SIR = supplementary irrigation (total water including rainfall = 450 mm); TB = Terbol (approximately 650 mm rainfall, both yeras). RF and SIR trials were conducted at Tel Hadya, Syria; TB trial at Terbol, Lebanon.

Table 8. Number of bread wheat lines yielding significantly higher than the widely-grown check "Mexipak" in preliminary and advanced yield trials under rainfed and supplementary irrigation conditions at Tel Hadya, Syria, 1982/83 season. (Total number of lines tested is given in parentheses).[1]

Type of yield trial	Condition of yield test: Rainfed[2]	Supplementary irrigation[2]
Preliminary	9(858)	9(396)
Advanced	0(176)	17(176)

1. Source: ICARDA (1983).
2. Rainfall during the season was 324 mm. Supplementary irrigation increased total water supplied to 450 mm.

If selection and testing had been conducted only in high-moisture environments, both entries (117 and 607) would have been selected. However, entry 607 would have been disappointing when released to farmers who grow durum wheat mainly in low-rainfall environments. Thus, selection and testing should be done under the range of conditions expected to be encountered by the released variety. If this is done, adapted lines such as entry 117 will be identified.

The same situation arises in bread wheat trials (Table 8). Seventeen lines in the advanced yield trials were found to yield higher than the widely-adapted check "Mexipak" under supplementary irrigation, but none did so under rainfed conditions. Newer germplasm emerging from the program has been selected under a wide range of environments, and nine lines (from the preliminary yield trial) performed better than Mexipak under both rainfed and supplementary irrigation conditions.

The types of stresses encountered under rainfed conditions are many and complex. Ideally, research should be carried out to develop rapid, inexpensive selection techniques to identify resistant genotypes. Indeed, the development of such techniques should be an important phase of plant breeding research (Boyer 1982).

In the meantime, the breeder should continue to use multilocation selection and yield testing in the specific environments for which the crop is intended. Locally-adapted cultivars should be useful as parent material in such breeding programs, as mentioned earlier.

The value of using locally-adapted material in the breeding program in Jordan for low-rainfall areas is illustrated in Table 9. The Dier Alla lines were developed in chronological sequence by crossing and selecting within locally-adapted Jordanian lines of the Haurani type. The first release from this program was Deir Alla 2. Later, the introduced high-yielding variety, Stork, gave a yield advantage over Deir Alla 2. However, subsequent releases of the Deir Alla series have performed better than Stork while maintaining the desirable characteristics of the local varieties (taller stature, better weed competition, easier harvesting, more cold tolerance, superior germination at deep planting, and excellent grain quality.

Improved varieties for rainfed conditions are expected to contribute significantly to productivity gains in the Middle East-North Africa region. Improved cultural practices coupled with superior varieties will give interactive or synergistic effects in addition to the independent effects of these factors (Bolton 1981). An integrative approach is necessary to achieve maximum results in increasing rainfed cereal production.

Table 9. Yields of locally-improved (Deir Alla lines) and an introduced-improved (Stork) durum varieties, expressed as percentage of Deir Alla 2. Average over three seasons (79/80, 80/81, and 81/82) in Jordan.[1]

Cultivar	Zone A[2]	Zone B[3]
	Percent	
Deir Alla 7		109
Deir Alla 6	126	
Deir Alla 5	113	
Deir Alla 2	100	100
Stork	111	105
Haurani		101

1. Source: Jordan Ministry of Agriculture/University of Jordan/ICARDA, 1984.
2. Sites with long-term mean seasonal rainfall > 350 mm.
3. Sites with long-term mean seasonal rainfall between 250 and 350 mm.

References

Bhardwaj, R.B.L. 1978. New agronomic practices. Pages 79-98 *in* Wheat Research in India. (Jaiswal, P.L., Tata, S.N., and Gupta, R.S., eds.), Delhi Press, New Delhi, India.

Bolton, F.E. 1981. Optimizing the use of water and nitrogen through soil and crop management. Pages 231-247 *in* Soil Water and Nitrogen in Mediterranean-Type Environments (Monteith, J. and Webb, C. eds.), Martinus Nijhoff/W.Junk, The Hague, The Netherlands.

Boyer, J.S. 1982. Plant productivity and environment. Science 218: 443-448.

Cooper, P.J.M., Keatinge, J.D.H., and Hughes, G. 1983. Crop evapotranspiration—a technique for calculation of its components by field measurements. Field Crops Research 7: 299-312.

ICARDA (International Center for Agricultural Research in the Dry Areas). 1983. Cereal improvement. Pages 59-106 *in* ICARDA Annual Report 1982. Aleppo, Syria.

ICARDA (International Center for Agricultural Research in the Dry Areas). 1984. Cereal improvement. Pages 71-133 *in* ICARDA Annual Report 1983, Aleppo, Syria.

Jordan Ministry of Agriculture/University of Jordan/ICARDA. 1984. Final Report of the Jordan Cooperative Cereals Improvement Project, ICARDA, Aleppo, Syria.

Srivastava, J.P. 1977. Barley production, utilization and research in the Afro-Asian region. Pages 242-259 *in* Proceedings of the Fourth Regional Winter Cereal Workshop-Barley. Amman, Jordan.

Srivastava, J.P. 1984. Durum wheat—its world status and potential in the Middle East and North Africa. Rachis 3(2): 1-8.

USAID/Oregon State University. 1975. More wheat from fallow farming. Second Edition. Ankara, Turkey.

Weltzien, Eva. 1982. Observation on the growth habit of Syrian and Jordanian landraces of barley. Rachis 1: 6-7.

Weltzien, H. C. and Srivastava, J.P. 1981. Stress factors and barley productivity and their implications in breeding strategies. Pages 351-361 *in* Proceedings of the Fourth International Barley Genetics Symposium, Edinburgh, Scotland.

Weltzien, H.C. and Zaklouta, M. 1980. Yield potential of dry land barley in Syria. ICARDA unpublished manuscript.

Barley Lines Resistant to Corn-Leaf Aphid (*Rhopalosiphum maidis* Fitch)

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Corn-leaf aphid (*Rhopalosiphum maidis* Fitch) is an economically important pest of barley in India. With the development of new high-yielding varieties of hull-less barley in which growers in dryland areas have started showing greater interest, control of this pest has become much more important.

More than 6000 germplasm accessions are available in the Germplasm Collection Evaluation Unit of the All India Coordinated Barley Improvement Project, Karnal. The present study was undertaken to identify resistance sources from this collection, so they could be utilized in the development of commercial high-yielding barley varieties.

A screening trial was sown with 657 germplasm accessions (606 hulled and 51 hull-less) in the third week of November 1983 at the experimental farms of All India Coordinated Barley Improvement Project, IARI, Regional Station, Karnal. Plots were 4 m long, and each had two rows of barley placed 20 cm apart. Four infector border rows of Karan-8 (hull-less, highly susceptible to aphid) were sown around the trial to encourage corn-leaf aphid infestation. The trial was uniformly fertilized with 100 kg N and 60 kg P_2O_5/hectare. Three irrigations were applied to maintain humidity suitable for heavy aphid infestation. The season was very favorable for aphid multiplication; almost every plot had a high aphid infestation.

The aphids appeared in the first week of January and the infestation reached a peak in the first week of February, but started declining in the first week of March as the crop started maturing. The intensity of infection was recorded on individual plants three times at 7-day intervals beginning from 14 February 1984. The average of the last two observations was used to assess the reaction of the germplasm material. The accessions were grouped into three classes: resistant (R) which included completely aphid-free plants and plants with 5-10 aphids; moderately resistant (MR) which included plants with 20-30 aphids with a tendency to build up but causing only negligible damage; and susceptible (S) which included the plants showing heavy infestation with severe damage without much grain formation. The results are presented in Table 1.

Table 1. Classification of barley germplasm according to aphid (*Rhopalosiphum maidis* Fitch) reaction.

Type	Number of lines screened	Reaction to aphid		
		S	MR	R
Hulled	606	156	307	143
6-rowed	513	117	267	129
2-rowed	93	39	40	14
Hull-less	51			
6-rowed	49	6	31	12
2-rowed	2	0	2	0

In hulled barley, 22 six-rowed resistant lines were found to have desirable plant type with good agronomic traits. According to Ram (1983), resistance is a digenic character governed by two recessive genes (s_1 and s_2) in the homozygous condition, while the hulled character in barley is monogenic in nature and is controlled by a dominant gene (H). Thus, the incorporation of resistance to aphids in the hulled barley is not a difficult task. Murty *et al.* (1968) reported EB 921 (hulled) to be highly resistant and this line has been extensively used as a sole source of aphid resistance. But this unique source could easily become ineffective if new virulent biotypes develop. If genes from the resistance sources identified in this study are different from those of EB 921, the chances for the development of new virulent biotypes become smaller.

The moderately resistant lines from six-rowed material had good plant type. Moderate resistance (MR) is due to the presence of a single dominant gene in the homozygous ($S_1 S_1 s_2 s_2$ or $s_1 s_1 S_2 S_2$) or heterozygous ($S_1 s_1 s_2 s_2$, $s_1 s_1 S_2 s_2$) condition (Ram 1983).

Out of the 12 resistant lines in hull-less barley, nine were highly resistant and with good agronomic characters. These were: EB 113, EB 137, EB 146, EB 179, EB 391, EB 455, EB 628, EB 707, and EB 709. These genotypes are useful donor parents for transferring the resistance genes to high-yielding hull-less varieties.

With the identification of these resistant hull-less lines, the incorporation of resistance into hull-less varieties is easier than with the hulled variety EB 921 which was the only available source of resistance.

In crosses of EB 921 with hull-less barley, the chances of recovering promising hull-less recombinants with built-in resistance to aphids were low because hulled is dominant over hull-less. Furthermore, EB 921 is a poor combiner. Now with the identification of diverse sources of resistance with different geographic origin, genes for high yield as well as resistance could be simultaneously incorporated into new barley lines.

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References

Murty, B.N., Jain, K.B.L., Mathur, V.S., Gulati, S.C., and Satyawati, D. 1968. Aphid resistance in barley. Indian Journal of Genetics, 28: 91-93.

Ram, Mahabal. 1983. Inheritance of corn leaf aphid resistance in hull-less barley. Sabrao Journal 15(1): 1-5.

Grain Yield and Quality Characteristics of Triticale Strain NIAB-T-183

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Triticale is a man-made crop derived by crossing wheat (*Triticum*) and cultivated rye (*Secale*). Although good triticale varieties have been developed which yield equal to or higher than bread wheat varieties, improvement in their test weight has been very slow (Zillinsky and Borlaug 1971). This study was conducted to evaluate the yielding ability and quality characteristics of an elite triticale strain in comparison with bread wheat cultivars.

Materials and Methods

The experimental material comprised 13 advanced lines/varieties of bread wheat developed at the Wheat Research Institute, Faisalabad, and one triticale strain, NIAB-T-183 evolved at NIAB, Faisalabad. All entries were evaluated for their yield potential in the Micro Early Yield Trials carried out during 1982/83 under irrigated conditions at 14 locations in the Punjab province. The trials were laid out in a randomized complete block design with four replications and a plot size of 30 m^2. Nitrogen and Phosphorus fertilizers were applied at seeding at the rates 100 kg N/ha and 75 kg P_2O_5/ha, respectively.

The yield performance of NIAB-T-183 was also evaluated in comparison with the drought-resistant bread wheat variety Lyallpur-73 in Macro Yield Trials at six sites in the rainfed areas of Attock, Jhelum, Rawalpindi, and Gujrat districts during the same year. Fertilizer rates of 75, 50, and 25 kg/ha of N, P_2O_5, and K, respectively, were used at the seeding time.

The quality characteristics of NIAB-T-183 and Lyallpur-73 were studied. Protein estimates were made by Micro Kjeldahl method and amino acid spectrum was determined by E.E.L. Model 193 High Speed Amino Acid Analyzer. A factor of 5.7 at 12% moisture content was used to convert nitrogen to protein (Tkachuk 1969). Chapatis were prepared out of a 100% whole ground grain following locally-adapted method. Scoring of quality characteristics was made by a panel of 15 judges.

Results and Discussion

1. Yield and adaptation

Under irrigation, NIAB-T-183 yielded (4213 kg/ha) significantly higher than all other entries except Pak 81 (4139 kg/ha). The percentage increase in yield of NIAB-T-183 over other advanced lines/varieties of bread wheat ranged between 1.8 and 32.9 (Table 1).

Table 2 indicates that NIAB-T-183 significantly outyielded Lyallpur-73 under rainfed conditions. The percentage increase in grain yield of NIAB-T-183 ranged from 7.5 to 15.4. NIAB-T-183 yielded consistently higher at all the locations indicating its higher yield potential and wider adaptation over the variety Lyallpur-73.

Among the yield components 1000-kernel weight played an important role in increasing the yield of triticale. Similar results have been reported by Zillinsky (1974), Gustafson and Qualset (1975), and Qualset *et al.* (1976).

2. Quality characteristics

As compared to Lyallpur-73, NIAB-T-183 had heavier grains, whereas Lyallpur-73 showed significantly higher test weight and flour extraction rate (Table 3). NIAB-T-183 showed higher protein content as well as amino acids suggesting its improved nutritional value. These findings are in agreement with those of Villegas *et al.* (1968) and Kaltsikes (1973).

Chapatis prepared from a 100% triticale flour of NIAB-T-183 were of acceptable standard (Table 4); Lovrenz *et al.* (1972) and Tsen *et al.* (1973) reported similar results.

Table 1. Yield performance of NIAB-T-183 in comparison with advanced lines/varieties of bread wheat in Panjab province, 1982/83.

Advanced lines/ varieties	1000-kernel weight (g)	Yield [1] (kg/ha)	% increase in yield of NIAB-T-183
NIAB-T-183	48.1	4213	
Pak-81	45.1	4139	1.8
Chenab 79	39.7	4017	4.9
V.81599	41.2	4014	5.0
V.81589	42.9	3962	6.4
V.1361	42.0	3650	15.5
V.5685	44.5	3611	16.3
WL.711	39.9	3602	17.0
V.5890	38.1	3595	18.0
V.79138	41.5	3558	18.4
V.80200	40.8	3512	20.0
V.81597	44.6	3407	23.7
V.80237	37.6	3303	27.6
V.61632	43.9	3170	32.9
LSD (5%)	3.4	137	
(1%)	4.6	181	

1. Mean over 14 locations.

Table 2. Yield performance of NIAB-T-183 and Lyallpur-73 under rainfed areas, 1982/83.

Location	Yield (kg/ha)		% increase in yield of NIAB-T-183
	NIAB-T-183	Lyallpur-73	
Attock-Changi	4500	4100	9.8
Kot Saring	4300	4000	7.5
Jhelum-Dhudial	4800	4300	11.6
Gujranpindi	5000	4400	13.6
Rawalpindi-Rawat	4850	4275	13.5
Gujarat-Chak Murtaza	4500	3900	15.4
Mean	4658.3	4162.5	
LSD (5%)	129.0		
(1%)	202.3		

Table 3. Quality characteristics of NIAB-T-183 and Lyallpur-73, 1982/83.

Characteristic	NIAB-T-183	Lyallpur-73
Kernel hardness	Medium hard	Hard
1000-kernel weight (g)	45.3	41.1
Test weight (kg/bl)	81.8	84.9
Flour yield (%)	65.0	68.0
Protein content (%)	13.4	9.3
Amino acids (mg/100 mg of sample)		
Aspartic acid	0.70	0.49
Threonine	0.40	0.33
Serine	0.54	0.41
Glutamic acid	3.37	2.91
Proline	0.50	0.78
Glycine	0.48	0.42
Alanine	0.41	0.36
Valine	0.52	0.46
Methionine	0.22	0.20
Isoleucine	0.55	0.34
Leucine	1.02	0.78
Tyrosine	0.25	0.15
Phenyl alanine	0.81	0.51
Lysine	0.40	0.36
Histidine	0.29	0.28
Arginine	0.66	0.50

Table 4. Chapati-making quality of some bread wheat and triticale cultivars, 1982/83.

Cultivar	Chapati-making quality
Bread wheat	
Lyallpur-73	Fairly good
Pb-81	Fair
Pak-81	Very good
Triticale	
NIAB-T-183	Fair (except for its color which is red)

References

Gustafson, J.P. and Qualset, C.O. 1975. Genetics and breeding of 42 chromosome triticale (ii). Relations between chromosomal variability and reproductive characters. Crop Science 15: 810-813.

Kaltsikes, P.J. 1973. Early seed development in hexaploid triticale. Canadian Journal of Botany 51: 2291-2300.

Lovrenz, K.J. Welsh, R. Normanu, and Megu, J. 1972. Comparative mixing and baking properties of wheat and triticale flour. Cereal Chemistry 40: 187.

Qualset, C.O., Rupert, E., and Prato, I.D. 1976. Triticale in California; review of current research and appraisal as a new cereal crop. Pages 47-72 *in* Proceedings of the International Triticale Symposium, 1973. Lubbock, texas, USA. ICASALS.

Tkachuk, R. 1969. Nitrogen-to protein-conversion factors for cereals and oil seed meals. Cereal Chemistry 46: 419-423.

Tsen, O.S., Hoover, W.J., and Farel, E.P. 1973. Baking quality of triticale flour. Cereal Chemistry 50: 16.

Villegas, E., McDonald, E.C., and Gillas, K.A. 1968. Variability in the lysine content of wheat, rye, and triticale proteins. CIMMYT Research Bulletin 10: 1-32.

Zillinsky, F.J. 1974. The development of triticale. Advanced Agronomy 26: 315-348.

Zillinsky, F.J. and Borlaug, N.E. 1971. Progress in developing triticale as an economic crop. CIMMYT Research Bulletin 17: 1-27.

An Approach to Breed Dwarf High-Yielding Hull-less Barley Varieties

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Very few reports are available on the systematic approach to breeding high-yielding hull-less barley varieties. According to Chodkov (1959), GB-18, a hull-less barley variety developed in the USSR, was productive, early-maturing, and tolerant to drought and soil salinity.

With the increased production of wheat in India, barley is finding place as an animal feed and in the brewing industries, but it still remains a staple food grain in the areas predominated by poor agricultural productivity due to low fertility and stress conditions.

Efforts, therefore, were concentrated to breeding high-yielding varieties of hull-less barley with wide adaptability and good tolerance to the major diseases and pests.

This study was designed to compare the performance of hull-less barley lines with that of traditional hulled barleys.

Materials and Methods

Four tall hull-less barley germplasm materials viz. EB-7508, EB-7742, EB-7576, and Puskin and three dwarf genetic stocks viz. Azam (dwarf-1), Azam (dwarf-13), and RDB-1 were used in this study. The cultivars EB-7508 and EB-7742 are two-row, and EB-7576 and Puskin are six-row exotic hull-less collections; Azam (d_1) and Azam (d_{13}) are indigenous natural dwarfs obtained from eastern Uttar Pradesh. RDB-1 is an induced mutant of RS-17 developed at Durgapura (Rajasthan).

Crosses were made in 1976/77 at HAU, Hissar. The F_1 and derived segregating generations were advanced through the generation breeding method. For advancing the breeding materials, two crops were grown per year: a winter crop at Karnal and an off-season (summer) crop at Wellington, Nilgiri hills. In the F_5, the uniform lines selected were maintained separately without bulking, and seed was multiplied in summer 1979 at Wellington for national-level trials.

Initially, five high-yielding dwarf hull-less lines viz. Karan-3, Karan-4, Karan-16, Karan-18, and Karan-19 were selected, on the basis of their genetic homogeneity, for the Initial Evaluation Trial along with 29 tall low-yielding, lodging-susceptible hull-less lines. A hulled, tall variety 'Jyoti' and a newly released high-yielding dwarf wheat variety 'HD-2009' were included as checks. This trial was conducted at six locations under irrigation. On the basis of overall performance, only 10 entries were promoted to the Uniform Regional Trials conducted during winter 1981 at seven locations under irrigation, and five locations under rainfed conditions.

Variety trials were conducted using a randomized block design with four replications. In the Initial Evaluation Trials, plot size was 5 x 1.38 m^2 with six rows, but in the Uniform Regional Trials, plot size was extended to 5 x 2.76 m^2 and number of rows was doubled (12 rows). The rows were 23 cm apart in all the trials. Fertilizers were applied at the rates of 40 kg N, 20 kg P_2O_5, and 20 kg K_2O/ha in the Initial Evaluation Trial and at the rates of 60, 30, and 20 kg/ha in the Uniform Regional Trial.

Results

1. Breeding Strategy

Out of a dozen crosses of hull-less germplasm materials with hulled Azam (d_1), Azam (d_{13}), and RDB-1, which were used as donors for dwarfing genes, only five crosses were promising: RDB-1 x EB-7576, Azam (d_1) x EB-7576, Azam (d_{13}) x Puskin, Azam (d_1) x Puskin, and Azam (d_{13}) x Puskin.

Realizing that lodging, low yield, and hulled grains are the major limiting factors to barley cultivation in India, selection was directed towards isolation of hull-less genotypes which are semi-dwarf/dwarf, with stiff straw, synchronous tillering, short thick dark-green steeply inclined leaves, long spikes, bold amber grains, and high grain: straw ratio.

However, in crosses of hulled with hull-less genotypes, selection of desirable plant types was hindered by the monogenic dominance of hulled grain character over hull-less and earthy-greenish grain color over amber. Furthermore, hull-less genotypes again segregated for hard threshability vs free-threshing in the ration 3:1, reducing the proportion of desirable hull-less genotypes in the F_2 and other segregating generations. Again, the selection of genotypes with high harvest index was culled down with the earthy-greenish grain color. However, this was overcome by the biparental/interpopulation mating and by inducing IB-65 and other genotypes in crosses having free threshability and amber bold grains.

Hull-less lines Karan-3 and Karan-4 [Azam (d_1) x EB-7576] , Karan-18 [Azam (d_1) x Puskin] , Karan-19 [Azam (d_1) x Puskin] , and Karan-16 [Azam (d_1) x EB-7576 x Rhizo Mutant 1508]were found promising. Among these, Karan-4 and Karan-19 are semi-dwarf with lodging resistance; Karan-3, Karan-16, and Karan-18 are dwarf cultivars with stiff straw, and they all possess small, thick, dark green, erect leaves with wheatish (amber), hard grains. The spikes are long with well-developed awns and remain erect at maturity. All the five lines are tolerant to yellow rust (*Puccinia striiformis*) and leaf spot (*Helminthosporium gramineum*) but susceptible to smut (*Ustilago* sp.) and corn-leaf aphids (*Rhopalosiphum maidis*).

2. Performance under Irrigated Conditions (1979/80)

Out of 36 entries, Karan-3, Karan-4, Karan-16, Karan-18, and Karan-19 (at Karnal), BH-503 and BH-504 (at Hissar), P-414, P-427, and P-428 (at Pusa) outyielded all the other varieties. Moreover, some of these outyielded the wheat check 'HD-2009.'

Based on their yield performance in 1979/80 (Table 1), these entries were promoted to the Uniform Regional Trials conducted in 1980/81 in which the tall varieties BH-503 and BH-504 (Hissar), P-414 and P-427 (Pusa) lodged badly following the nitrogen application. However, Karan-19, Karan-18, Karan-3, Karan-4, and Karan-16 outyielded 'Jyoti' at Karnal, Kanpur, Chandeshwar, and Deoria as well as 'HD-2009' at Hissar, Bawal, and Deoria (Table 2).

3. Performance under Rainfed Conditions (1980/81)

The semi-dwarf hull-less variety, Karan-19, outyielded the others at Karnal, Kanpur, Chandeshwar, and Deoria, followed by Karan-18, Karan-3, and Karan-4 (Table 3). Accordingly, Karan-19 and Karan-4 were recommended for commercial cultivation under rainfed conditions in the Gangetic Plain and the remaining three cultivars are underway for release. 'Jyoti' and HD-2009 gave significantly higher grain yields at Hissar only (Table 3), which indicates that hull-less barley varieties may perform equally well under rainfed conditions as compared to hulled barley varieties.

Discussion

Availability of the natural mutants Azam (d_{13}) and Azam (d_1) from the local collections of eastern Uttar Pradesh have opened new prospects for barley improvement. RDB-1 is a good source of dwarfness, but dwarfing in this variety might be linked with small spike, and as a result, recovery of desirable plant types may be limited from crosses with this variety.

Evaluation of the yielding ability of the dwarf and semi-dwarf hull-less varieties developed using dwarfing genes indicated that under low-to-moderate fertility conditions, new hull-less barley

Table 1. Grain yield (q/ha) of new high-yielding dwarf hull-less barley varieties under low fertility irrigated conditions (1979/80).

Variety	Location					
	Karnal	Hissar	Pusa	Azamgarh	Deoria	Sabour
Karan-3	19.02	32.50	18.12	18.93	24.82	16.03
Karan-4	24.46	33.47	28.68	17.86	25.36	15.76
Karan-16	23.55	34.03	23.55	21.17	26.74	13.86
Karan-18	29.35	36.00	37.74	18.99	27.72	18.21
Karan-19	28.99	33.97	30.50	24.44	30.30	19.02
BH-503	19.02	35.33	16.00	12.31	18.48	
BH-504	14.86	26.56	27.78	18.76	9.93	7.61
P-414	18.48	28.10	36.23	12.98	15.51	
P-428	10.02	17.29	37.74	14.51	15.22	18.75
HD-2009	24.09	32.02	32.91	16.94	23.19	18.48
LSD (5%)	2.67	3.38	5.80	7.69	5.76	4.59

Table 2. Grain yield (q/ha) of new high-yielding hull-less barley varieties under moderate-fertility irrigated conditions (1980/81).

Variety	Location							
	Karnal	Hissar	Bawal	Kanpur	Chandeshwar	Deoria	Pusa	Mean
Karan-3	52.17	23.15	32.13	33.94	34.42	28.86	25.27	34.28
Karan-4	45.17	29.19	33.45	34.54	34.18	28.14	37.56	34.60
Karan-16	51.53	23.75	34.54	32.61	34.54	29.23	37.92	34.87
Karan-18	46.50	22.95	34.30	33.82	35.14	29.95	42.87	36.08
Karan-19	52.90	29.89	33.33	35.02	36.23	31.40	38.41	36.74
BH-503	31.64	23.95	26.21	24.15	20.29	15.22	27.17	24.09
BH-504	25.36	25.46	33.04	22.46	19.81	14.49	30.19	24.41
P-414	28.50	22.14	30.19	24.44	20.05	16.55	39.98	25.98
P-427	30.43	23.25	33.70	24.30	22.95	19.64	43.12	28.21
P-428	33.57	20.93	27.78	23.07	21.74	18.00	41.67	26.68
Jyoti (tall hulled barley)	35.27	33.01	39.25	29.01	26.33	19.44	41.79	32.01
HD-2009 (wheat)	52.17	19.32	28.86	33.33	34.30	19.32	38.53	32.26
LSD (5%)	3.93	1.90	5.13	3.79	2.10	3.03	5.59	

Table 3. Grain yield (q/ha) of new high-yielding hull-less barley varieties under low fertility rainfed conditions (1980/81).

Variety	Location					
	Karnal	Hissar	Kanpur	Chandeshwar	Deoria	Mean
Karan-3	48.67	23.45	17.63	20.05	19.69	25.90
Karan-4	43.48	23.75	15.46	18.72	23.55	24.99
Karan-19	40.82	25.65	14.25	17.39	23.31	24.29
Karan-18	45.17	23.25	14.73	20.05	27.42	26.12
Karan-19	50.00	22.75	17.87	20.53	29.47	28.12
BH-504	19.69	22.64	11.47	10.87	9.54	14.84
Jyoti (hulled barley)	31.40	34.22	14.49	18.12	19.08	23.22
HD-2009 (wheat)	44.69	36.84	17.63	16.91	18.36	27.13
LSD (5%)	5.11	2.76	3.21	2.48	2.91	

varieties had outyielded Jyoti and HD-2009. While Karan-19 and Karan-18 were top yielders, Karan-19 showed good performance both under irrigated and rainfed conditions.

Greater tillering capacity, higher 1000-kernel weight and grain: straw ratio can explain much of the yield advantage of hull-less barley cultivars in this study. In addition, the erect leaves of the short hull-less cultivars allowed more photosynthesis than the tall hulled or hull-less cultivars where shading by upper leaves hindered the photosynthetic activity of lower leaves. Gardner *et al.* (1966) found that high-yielding barley varieties had narrow upright leaves while low-yielding varieties had wide drooping leaves. Using these leaf criteria (Tanner *et al.* 1966), selection of high-yielding strains of wheat, barley, and oats was possible.

Similar studies were carried out on wheat under rainfed conditions (Donald 1968; Asana 1970). The wheat 'ideotype' for rainfed conditions, as described by Donald, consists of a single short, strong culm with relatively few small erect leaves and large erect awned ears. On the other hand, Asana (1970) reported that wheat 'ideotype' for water-stress conditions should possess deep root system, seven horizontally disposed leaves, and a large number of spikelets with well-filled grains. But, in the case of barley, plant ideotypes appear to be intermediate between these two types . This study indicated that Karan-19, a semi-dwarf hull-less barley variety, was superior to tall as well as dwarf genotypes.

One of the most important features of the high-yielding hull-less barley varieties is that they possess, in general, higher grain: straw ratio than the tall traditional barley variety 'Jyoti.' However, the dwarf hull-less barley varieties and dwarf wheat possess similar grain: straw ratio.

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References

Asana, R.D. 1970. Tailoring new crop varieties for dry areas. A new technology for dry-land farming. Indian Agricultural Research Institute, New Delhi.55-63.

Chodkov, I.N. 1959. Breeding naked awnless barley. Sbornic Ceskoslovenske Akademie Zemedelskych rostlinna Vyrobam 32: 1176-80.

Donald, C.M. 1968. The breeding of crop ideotype, Euphytica 17: 385-403.

Gardner, C.J., Tanner, J.W., Stoskopf, N.C. and Reinbergs, E.R. 1964. A physiological basis for yield performance of high and low yielding barley varieties. Agronomy Abstract Annual Meetings, American Society of Agronomy.

Pendleton, J.W., Smith C.E., Winter, S.R. and Johnston, T.J. 1968. Field investigations of the relationships of leaf angle in corn to grain yield and apparent photosynthesis. Agronomy Journal 60: 422-24.

Ram, M. 1980. Cultivation of dwarf wheat: (Hindi). Indian Council of Agricultural Research, New Delhi. 124 pp.

Rao, M.V. 1972. Twenty five years of wheat research in India. Indian Farming 22(5): 69-74.

Tanner, J.W., Gardner, C.J., Stoskopf, N.C. and Reinbergs, E.R. 1966. Some observations on upright leaf-type in small grains. Canadian Journal of Plant Science 46: 690.

Survey of Wheat Flours Used in the Near East

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Cereals provide up to 80% of the total calorie requirement and a significant proportion of protein in the diets of the people in the Near and Middle East (including South West Asia). The chief cereals grown include wheat (56%), barley (19%), maize (10%), rice (6%), and sorghum and millet (2%). Wheat includes durum wheat, of which a high proportion is traditionally grown in the region. During 1970-1980, cereal consumption in the Near and Middle East averaged 393 kg per caput per annum. This included cereals fed to animals and poultry. Based on the formula: (net production + imports) — exports of cereals, to estimate consumption, the use of cereals in the region increased by 4.8% per annum, which outpaced the population growth rate. At the same time, cereal production in the region increased by 3.9% per annum, and cereal imports averaged 8.4% per annum. Although these trends in production and consumption may be expected to fluctuate due to seasonal changes in production and demand, the 10-year trend over the last decade, if sustained, protracts an increase in cereal imports from 13 million tonnes in 1980 to over 66 million tonnes by 2000. The countries of the Near East, for the purpose of this report, are listed in Table 1, together with their population trends for the period 1970-80. The most important cereal foods in the Near East are summarized in Table 2.

Table 1. Population trends in the Near East for the period 1970-80[a].

Country	Population (1970)	Population (1975)	Population (1980)	Change (1970-80)
	(x 1000)	(x 1000)	(x 1000)	(%)
Algeria	13,307	15,686	18,594	+40
Cyprus	615	639	651	+ 6
Egypt	33,329	36,916	41,995	+26
Jordan	2,299	2,702	3,190	+39
Lebanon	2,469	2,799	3,161	+28
Libya	1,982	2,436	2,977	+50
Morocco	15,126	17,305	20,296	+34
Syria	6,258	7,354	8,644	+38
Tunisia	5,127	5,608	6,363	+24
Turkey	35,321	40,063	45,346	+28
Total	115,833	131,508	151,217	+30.5

[a] Sources of data were the FAO monthly and annual bulletins of statistics.

Table 2. Principal cereal foods used in the Near East[1].

Bread wheat	%	Durum wheat	%	Barley	%	Triticale	%
Two-layer breads[2]	55	Two-layer breads[2]	30	Feed	90	Feed	95
Single-layer breads[3]	15	Single-layer breads[3]	18	Soups	4	Others	5
Raised breads[4]	10	Burghul	15	Cous-cous	4		
Patisserie	5	Cous-cous	10	Breads	1		
Cous-cous	5	Pasta	15	Other	1		
Burghul[5]	5	Feed	5				
Feed	5	Frekeh[6]	2				

1. Estimates based on various reports in eight countries in the Near East.
2. Two-layered breads include khobz (Syria, Lebanon, and Jordan); baladi (Egypt); Shami (Egypt), and others.
3. Single-layered breads include tannour and saaj (Syria and Lebanon); mountain bread, and markouk (Lebanon), mehrahrah (Egypt), and others.
4. Raised breads include pain francais baguettes (Tunisia, Algeria, and Morocco); khobz in Morocco which are raised single-layered breads, sour dough raised single-layered breads in Cyprus, and others.
5. Burghul is granulated, boiled, sun-dried wheat used in several ways, ranging from steamed burghul (similar to rice) to burghul/minced meat dishes, and sweets.
6. Frekeh is green, dried, parched wheat.

Burghul, cous-cous, two-layer and single-layer flat breads and pain francais baguettes are described in separate reports (Williams 1983; Williams and El-Haramein 1984). Burghul is a widely used raw material which is steamed and used as a rice-type dish, or used mixed with finely-minced meat in the preparation of the widely used Kibbe, and other forms such as Khishke and Tabuli (a fresh salad).

Wheat and barley imports to the Near East for 1970-80 are summarized in Table 3.

Most of the cereal imports have been of wheat of various types. The dramatic increase in wheat and wheat flour imports is the result of several factors, including the steady increase in population during the period, but more significantly, it reflects the effect of an increase in subsidization of bread prices. Bread (baladi or shami) in Egypt costs 1 piastre per piece (the equivalent of about 2 Canadian cents for a complete bread "loaf" weighing about 145 g). Milling extraction is usually between 82-87% for baladi bread, up to 82% for shami bread, and 70-75% for raised bread rolls in Egypt. Variation in extraction rates is common in the Near East, but where extraction is traditionally high, as in Egypt for baladi flours, there is a general preference for white wheats. Imported wheat and wheat flour varied very widely within and between countries. Table 4 illustrates the main characteristics of flours from bakeries and flour mills in the Near East countries.

In general bakery flours from Turkey and Jordan showed least variability. Turkey has been more or less self-sufficient in wheat production during recent years, and this is reflected in a fairly consistent supply of wheat to the mills. Variability does exist, however, and it is likely that at different times of the year wheat from different regions will cause greater fluctuation in flour quality. The Jordanian flours reflect a more consistent pattern of wheat purchasing by the government. Bakeries in Jordan consume about 400,000 tonnes of wheat and flour annually and only about 150,000 tonnes are grown locally, a high proportion of which is durum. The high variability of flour quality in Syria, Lebanon, Egypt, and Morocco reflects variation in sources of purchases of wheat, since in most cases the flours were accumulated over a 12- to 24-month period. Lebanon tends to purchase wheat from the USA

Table 3. Wheat and barley imports to the Near East during 1970-80 (x 1000 tonnes).

Country	1970			1980		
	Wheat	Barley	Total	Wheat	Barley	Total
Algeria	403	0	403	3002	269	3271
Cyprus	44	88	132	49	62	111
Egypt	851	0	851	5424	0	5424
Jordan	24	164	188	327	21	348
Lebanon	367	121	488	389	25	364
Libya	26	161	187	746	82	828
Morocco	358	0	358	1693	13	1706
Syria	424	58	482	342	205	547
Tunisia	426	183	609	651	18	669
Turkey	1127	0	1127	0	0	0
Total	4245	775	5020	12797	695	13268

Table 4. Ranges of quality characteristics in the Near East.

Country	Protein (%)	Farinograph			Starch damage	Ash (%)
		Abs. (%)	DT	ST		
Turkey	9.6 - 9.9	54 - 59	1.2 - 2.5	3.7 - 5.0	14 - 22	0.43 - 0.70
Morocco	9.6 - 10.9	56 - 63	1.3 - 6.1	1.9 - 10.5	9 - 16	0.51 - 0.92
Lebanon	9.6 - 12.9	59 - 66	1.5 - 9.3	4.2 - 19.4	15 - 27	0.54 - 1.00
Jordan	10.0 - 11.1	57 - 60	2.0 - 7.0	10.0 - 15.0	13 - 19	0.45 - 0.75
Egypt	9.1 - 13.4	55 - 61	1.0 - 5.8	4.0 - 8.0	6 - 33	0.49 - 0.98
Syria	9.1 - 12.8	55 - 68	1.7 - 7.4	3.0 - 11.0	10 - 51	0.49 - 1.02
Overall	9.1 - 13.4	54 - 68	1.0 - 9.3	1.9 - 19.4	6 - 51	0.43 - 1.02

and Canada, whenever possible, so the strength of Lebanese bakery flours is usually higher than that of neighboring countries.

Variability in flour characteristics is not unique to the Near East. A survey of bakers' "straight run" flours carried out over North America during 1973 revealed ranges of 11-14.7% protein, 14-47 units of starch damage, and 47-69 micrometers in particle size. This variability reflects differences in the wheat available to local mills. Among other factors, price and freight are important in determining the availability of wheat to a flour mill in North America. Essentially, the same system prevails in the Near East, except that the respective governments have to go further afield in their quest for wheat.

The "Ideal" flour for flat bread baking, including Khobz, Baladi, and Shami types is a medium strength flour, preferably (but not necessarily) milled from white wheat (due to the high extraction rate required). This would have a farinograph absorption of 56-60% , a farinograph stability of 4.5-7 minutes and mixing tolerance (15 minutes) of 60-100% . This type of flour could be obtained from a wide range of wheats, including Australian Standard White at 11.5% protein and upwards, US Soft Red Winter at similar protein content, Argentine wheat, Canadian Soft White Spring at 11% protein and upwards, and Canadian Hard Red Winter at 11% protein and upwards. The proposed Canadian medium strength wheats, typified by HY 320, a soft red spring wheat type, appear to be ideally suited to flat bread baking.

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References

Williams, P.C. 1983. Cous-cous. Technical Report, Grain Research Laboratory, Canada.

Williams, P.C. and El-Haramein, F.J. 1984. Burghul and its preparation. RACHIS 3(2): 28-30.

Wheat Agronomy Research in Azad Kashmir, Pakistan

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Azad Kashmir is a mountainous area with limited land suitable for crop production. Wheat is the second major crop in the area and the first in Mirpur and Kotli districts. It covers 31% of the total cropped area. The grain yield is very low in the state due to the use of poor yielding varieties, traditional sowing methods, soil erosion, insufficient water, and reluctance of farmers to adopt improved technology.

The rapid population increase coupled with harshness of nature has made it imperative to develop improved technologies to increase wheat yields. Maize is considered to be the major crop of the area which explains why wheat remained neglected for so long. No research on wheat agronomy was carried out until 1978. Systematic research began in 1979 under the Hill Farming Technical Development Project with the technical assistance of the Pakistan Agricultural Research Council. Research was carried out at the Bagh (1330 m above sea level), Danna (1700 m), Kotli (609 m), Abbaspur (1250 m), and Garhi Bopatta (835 m) experimental demonstration farms on agronomy, high-yielding varieties, sowing methods and dates, weed control, fertilizer, and insect control.

Results

An improved technology was developed appropriate to the soil and climatic conditions of Azad Kashmir and a seed multiplication and demonstration/extension program was started in the 1981/82 rabi (winter) season.

Zoning

Three agroecological zones were identified according to the time required by the crop to reach maturity. Wheat matured 46 days later at Danna than at Bagh where it matured 20 days later than at Kotli. The difference in flowering time decreased with altitude. Flowering was 20 days earlier at Kotli than at Bagh and 10 days earlier at Bagh than at Danna.

Varieties

Screening of varieties for major agronomic characters such as yield, disease resistance, and response to fertilizer was carried out by the National Cooperative Program of the Pakistan Agricultural Research Council. Of the varieties tested, Pak 81 (Veery 'S') showed resistance to leaf and yellow rust, whereas Pavon, Lu 26, Lyallpur 73, and Punjab 81 showed limited resistance. Sonalika and all local varieties were highly susceptible to rusts. Pak 81 gave the best overall performance.

Sowing Date

Sowing date is very critical at altitudes higher than 1300 m because of the need to sow wheat early enough to allow sowing of a following crop of maize. The optimum sowing dates were determined for all three zones; subject to adequate rainfall, the best times for sowing were mid-to late Nov at 600-800 m, early to mid-Nov at 800-1300 m, and late Sept to early Oct at 1300-2000 m.

Cropping Sequence

At altitudes above 1300 m, the sowing and harvesting of rabi (winter) and kharif (summer) crops overlap. Exceptionally, where there is an excess of farmyard manure and modern technology is used, two early-maturing crops can be grown. However, this is discouraged because of management complications in favor of growing one good grain crop per year followed by either a legume or forage crop. The improved three-crop sequences suggested are grain wheat/forage maize/grain wheat; grain wheat/mung or mash beans/grain wheat; and forage oats or wheat/grain maize/forage oats or wheat.

Seed Rate

The farmers' practice of broadcasting the seed produces a poor stand easily invaded by weeds which reduce the yield.

Trials showed that crops sown in rows at a rate of 80-100 kg seed/ha discouraged weeds and minimized yield losses.

Fertilizer

Most of the soils in Azad Kashmir are deficient in major elements, especially phosphorus. Trials were carried out on wheat cultivar SA 42 to determine economical rates of fertilizers. The farmers' local practice produced 800 kg wheat grain/ha, whereas the use of fertilizers increased the yield to 2200 kg/ha. Based on data from Muzaffarabad, Poonch, and Kotli, local practice produced total dry-matter yield of 5-7 tonnes/ha whereas modern technology produced three to four times as much.

Weeding

Weed competition trials were carried out at Kotli on the improved wheat cultivar Layallpur 73 using modern methods of cultivation. The mean yield in weed-free plots was 2800 kg/ha compared with 2000 kg/ha in weed-infested crops.

Seed Quality Maintenance and Seed Multiplication

Seed quality was maintained on experimental farms by the project staff; seeds of Pak 81 were sown on 2 ha and seeds of Punjab 81 on 0.1 ha. Seed multiplication was carried out by forming farm improvement groups of farmers to meet the seed needs of the individual farmer group and to demonstrate modern cultivation methods. Each farm improvement group consisted of 10 farmers. Fertilizer and seed were supplied free of charge to one farmer in every group for producing the seed and storing it under the close supervision of the project staff for sale to other members of the group.

Yield Improvement in Hull-less Barley

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Hulled barley, which usually contains 12-15% hull, poses the problem of dehusking the grain before consumption. But, hull-less barley, like wheat, can be directly used for consumption. Moreover, the hull-less barley threshes freely, contains greater utilizable dry matter, and has more effective use of vitamins and minerals of pericarp than hulled barley. As early as 1948, Aberg stressed the need for breeding naked barleys in Sweden for green fodder due to their abundant vegetative growth. Hull-less barley has advantage in the brewing industry as it absorbs water more rapidly, has higher extract content, and positive effects on the color and flavor of the beer (Lau 1973). Johnson and Sundermann (1979) reported that hull-less cultivars had 2.2 to 3.7 times less fiber, and higher protein percentage than hulled cultivars but significantly lower yield. Though some high-yielding hull-less barley varieties have been developed for the hills, yield potential of hull-less barley in plains is lower (20-30%), when compared with the best hulled barley. This study was carried out to determine the factors responsible for low yield in hull-less barley.

Materials and Methods

Twenty-three hull-less barley strains were grown in a randomized block design with four replications at the experimental site of Haryana Agricultural University, Hisar, during the 1982/83 postrainy season. Each plot (4.40 x 0.92 m) consisted of six 5-m long rows placed 23 cm apart. Data on biological and grain yields were collected on plot basis, while number of effective tillers was taken on onemetre length basis. Number of grains/ear and basal, middle, and tip sterility (cm) of the spikelets in the ear were also recorded for 20 ears taken randomly from each replication for each entry. Plant height and 1000-grain weight were recorded for five random samples in each replication for each entry. Variance and correlation analyses were made according to the procedures described by Panse and Sukhatme (1967). Genotypic (GCV) and phenotypic (PCV) coefficients of variability and heritability in the broad sense (h^2) were estimated as suggested by Burton (1952).

Results and Discussion

The barley strains exhibited significant differences for all characters, indicating considerable genetic variability (Table 1).

Values of phenotypic and genotypic coefficients of variability ranged from 8.87 to 78.94% and 6.32 to 74.43% , respectively, and were highest for tip sterility and lowest for 1000-grain weight. The estimates of heritability varied from 0.51 for 1000-grain weight to 0.89 for tip sterility. In the present investigation, high heritability was observed for tip, middle, and basal sterilities, number of effective tillers, and harvest index. Therefore, it is recommended that proper consideration be given for these traits by breeders while selecting for high-yielding hull-less genotypes. Thousand-grain weight should not be considered during the selection due to low heritability and coefficients of variability.

Significant positive phenotypic correlation coefficients were observed for grain yield with number of effective tillers, biological yield, and harvest index, but negative and significant with tip and middle sterilities of the ear (Table 2). Environmental correlation coefficients were positive and significant for grain yield with number of effective tillers and harvest index.

Positive and significant correlations of grain yield with number of tillers have also been reported by Salim *et al.* (1963), Sarwicki (1959), Jain (1968), and Sethi and Singh (1971). Also, Varma and Gulati (1981) and Singh (1982) observed positive correlation of grain yield with biological yield and harvest index in barley. Plant height, number of grains/ear, and 1000-grain weight were found to be positively but not significantly correlated with grain yield. However, Jain (1968) reported negative correlation of yield with plant height.

Although all three types of sterility exhibited negative association with grain yield, it was significantly so in the latter two types only. Emphasis should therefore be placed on those genotypes which possess high fertility for middle and tip spikelets in the ear. Thus, correlation study indicates that in hull-less barley, effective tillers and harvest index are two main yield components as both showed significant and strong association with grain yield.

Table 1. Analysis of variance and genetic parameters for some hull-less barley strains, Hisar, 1982/83.

Source	d.f.	Plant height (cm)	No. of effective tillers/ m	Grain yield/ plot (kg)	Biol. yield/ plot (kg)	Harvest index (%)	No. of grains/ ear	1000-grain weight (g)	Sterility of basal spikelets	Sterility of middle spikelets	Tip sterility (cm)
Block	3	854.68 **	154.18 **	0.003 **	0.063	26.12	20.04	21.14	4.90	0.48	0.04 *
Varieties	23	367.55 **	1467.41 **	0.138 **	0.455 **	262.88 **	115.61 **	25.43 *	45.26 **	14.94 **	0.36 **
Error	69	50.70	50.72	0.013	0.068	30.87	11.74	4.95	2.95	0.75	0.01
Mean		91.56	66.77	0.833	2.422	34.95	67.07	35.75	8.66	2.79	0.38
Range		70.90 to 106.68	41.75 to 105.50	0.400 to 1.150	1.375 to 2.862	15.98 to 49.99	56.85 to 79.60	31.50 to 40.25	3.23 to 14.79	0.87 to 6.98	0.02 to 1.47
PCV		12.44	30.13	25.44	16.79	26.97	9.15	8.87	42.45	74.23	78.94
GCV		9.72	28.18	21.34	12.85	21.79	7.59	6.32	37.54	67.43	74.43
h^2		0.61	0.87	0.70	0.59	0.65	0.69	0.51	0.78	0.83	0.89

* Significant at P = 0.05; ** Significant at P = 0.01.

Table 2. **Phenotypic, genotypic, and environmental correlations of grain yield with other characters in some barley strains, Hisar, 1982/83.**

Character	Coefficient of correlation with grain yield		
	Phenotypic	Genotypic	Environmental
Plant height (cm)	0.038	0.056	0.005
Number of effective tillers/m	0.523 **	0.547 **	0.496 **
Biological yield kg/plot	0.250 *	0.290 *	0.183
Harvest index (%)	0.714 **	0.720 **	0.703 **
Number of grains/ear	0.139	0.157	0.098
1000-grain weight (g)	0.116	0.188	0.010
Sterility of basal spikelets	− 0.119	− 0.197	− 0.185
Sterility of middle spikelets	− 0.342 **	− 0.436 **	− 0.093
Tip sterility (cm)	− 0.354 **	− 0.409 **	− 0.168

* Significant at P = 0.05; ** Significant at P = 0.01.

Strains P 480, DL 422, RD 1650, Karan 521, DL 393, BH 517, and RD 1646 were superior to others for at least three traits (Table 3). These strains also ranked first for different characters. It is suggested that multiple crosses among these parents be attempted to combine desirable genes available in these strains. Biparental approach in the segregating generations would help break up the undesirable linkages and release hidden variability for a more effective selection.

Table 3. List of the best five barley varieties for different characters, Hisar, 1982/83. (Mean values are given in parenthesis).[1]

Plant height (cm)	Number of effective tillers/ m	Grain yield/ plot (kg)	Biol. yield/ plot (kg)	Harvest index (%)	No. of grains/ ear	1000-grain weight (g)	Sterility of basal spikelets	Sterility of middle spikelets	Tip sterility (cm)
P 478 (106.68)	DL 422 (105.50)	RD 1650 (1.075)	Karan 521 (2.862)	DL 393 (49.99)	BH 517 (79.60)	DL 393 (40.25)	BH 517 (3.23)	RD 1646 (0.88)	BH 517 (0.02)
P 480 (106.20)	Karan 439 (105.25)	RD 1646 (1.037)	Karan 452 (2.825)	DL 424 (46.71)	K 1132 (75.15)	DL 421 (39.00)	Karan 521 (4.00)	P 480 (0.94)	BH 518 (0.06)
DL 422 (106.00)	P 480 (102.75)	RD 1659 (1.000)	RD 1721 (2.762)	RD 1650 (42.94)	P 479 (71.40)	DL 424 (39.00)	BH 518 (5.55)	RD 1650 (0.98)	K 1130 (0.20)
P 479 (104.35)	HBL 226 (95.75)	Karan 439 (0.987)	P 479 (2.712)	DL 423 (41.08)	RD 1650 (70.95)	RD 1646 (39.00)	RD 1721 (6.05)	DL 423 (1.36)	K 1131 (0.22)
RD 1646 (102.40)	DL 393 (84.25)	P 480 (0.987)	RD 1654 (2.700)	RD 1659 (40.04)	Karan 521 (70.50)	DL 422 (37.75)	DL 393 (6.19)	DL 424 (1.39)	DL 422 (0.25)
SE 5.03	5.03	0.081	0.184	3.92	2.42	1.57	1.21	0.61	0.07

1. The last line in the table shows the standard error of the difference between two means for a given character.

References

Aberg, E. 1948. Naked barleys in Sweden. Kungliga Skogs Och Lantbruksakademiens Tidscrift Supplement 87: 333-345.

Burton, G.W. 1952. Quantitative inheritance in grasses. Pages 277-283 *in* Proceedings of the Sixth International Grassland Congress, part 1.

Jain, R.P. 1968. Studies on correlation in barley (*Hordeum vulgare* L). Allahabad Farmer 42: 227-231.

Johnson, J.W. and Sundermann, S.E. 1979. Agronomic characteristics and protein and amino acid content of hulless barley (Abst.) Agronomy Abstract, 1979 Annual Meetings, American Society of Agronomy, Madison, USA.

Lau, D. 1973. Breeding naked barleys with a view to its use as a raw product of brewing. Archiv fur Zuchtungsforschung 3: 141-151.

Panse, V.G. and Sukhatme, P.V. 1967. Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi.

Salim, A.K., Omes, A.A.M., and Khalifa, M.I. 1963. Correlation studies in certain varieties of barley. Annals of Agricultural Science 8: 199-209.

Sarwicki, J. 1959. Studies in local varieties of barley from the carpethion region I. Spring barley (*H. vulgare* L). Acta Agrobotanica 8: 67-150.

Sethi, G.S. and Singh, H.B. 1971. Variability, correlation and regression analysis in hulless barley. Plant Science 3: 43-47.

Singh, D. 1982. Genetics of certain quantitative characters in barley (*H. vulgare* L.) with special reference to water/salt stress conditions. Unpublished Ph.D Thesis, Haryana Agricultural University, Hisar.

Varma, N.S. and Gulati, S.C. 1981. Inter-relationship between yield and some plant characters in barley. Crop Improvement 8: 124-127.

Frekeh Making in Syria — A Small but Significant Local Industry

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Frekeh is green, parched wheat. It is highly nutritious and delicious, and a valuable source of revenue to many villages in Syria and other countries in the Middle East and North Africa. Frekeh is made by drying the green wheat in the sun, burning off the awns and leafy material, drying the heads until the moisture is low enough to allow threshing the heads without damaging the grains, and threshing and cleaning the grains. A typical system for frekeh preparation is given in Table 1.

Frekeh is made from immature wheat cut at about the mid to late dough stage. Ideally, the wheat should have developed to the extent that the grains have reached as late a stage as possible, but are still completely green. The most suitable wheat is durum wheat, and varieties with large grains, such as the old variety Senator Cappelli are preferred. The best frekeh is that with the biggest and greenest grains. Hardness of the kernel is essential to the preparation of frekeh, which is why the frekeh industry is practically confined to durum varieties. Varieties such as Haurani and Stork are used, but their rounder kernels are not as practicable as the longer types for processing into food.

The most suitable growing conditions are those which tend to give a slightly slower maturity rate for the wheat, so that the kernels have the best opportunity to fill out. These conditions are met in areas of medium to high fertility and with an adequate supply of moisture. These areas are usually fairly localized and frekeh making is essentially a village industry in contrast to burghul making, where the large-scale production is town- and city-oriented. In many villages of the Aleppo province, and in the Orontes valley (particularly the El-Ghab area) frekeh is one of the most important sources of income. It is still a small industry in comparison with burghul, yet probably 200-300 thousand tonnes of frekeh is produced annually in the Middle East. Frekeh making is not confined to Syria only; under different names it is prepared in Turkey, Lebanon (to a small extent), Jordan. Egypt, Iraq, and Iran, and probably other countries.

Table 1. Sequence of operations in frekeh preparation.

Operation	Approximate time of day
First day	
- Cut green wheat stems	6 a.m.- noon
- Spread and allow to dry in the sun	6 a.m.- noon
- Gather into loose swathes and burn	2 - 7 p.m.
- Separate burned leafy material	2 - 7 p.m.
- Gather cleaned heads into heaps to dry	2 - 7 p.m.
Day 8th-12th	
- Thresh heads in combine, by donkey power, or by hand	9 a.m.- 7 p.m.
- Clean grains free of chaff and other foreign material	9 a.m.- 7 p.m.
- Store grains (frekeh) in sacks or in granaries for sale	

In contrast to burghul making, which usually lasts from late June through mid-October (in Syria), the frekeh-making period is short, about 1-2 weeks. It cannot begin until the grain reaches a minimum degree of filling, and can continue only as long as the grain is green. The wheat is cut early in the morning to allow the sun plenty of time to dry the leaves and stems. On a small scale it is cut by hand with sickles and knives, but in villages where frekeh is a major source of income, the crop is cut with various types of mechanized mower. Hand cutting continues for about 5-6 hr from early morning, but machine cutting is much faster, and sufficient wheat for a day's frekeh making can be cut in one hour or so. The green-cut material is spread to dry in the sun and left until the afternoon. It is then hand-gathered and laid in swathes so that all the heads are in one direction, usually slightly elevated by laying across a piece of metal stove-piping, or a row of stones, and always laid so that the heads face into the wind. A light to medium breeze is essential to frekeh making. Fig. 1. illustrates the burning of the green wheat.

Fig. 1. Green wheat being burned in swathes for frekeh making.

When the dry green crop is set afire, the awns and all leafy material are burned away, and the heads fall off the stem. Due to their orientation they all fall in about the same place. The effect of the wind is to burn off the heads to a light charring. If the heads are faced away from the wind, the flames and heat would be directed toward the heads, charring and burning them severely, which is not desirable. The charring gives a characteristic flavor to the final frekeh, but too high a degree of charring would cause "burnt" flavor, which would lower the quality of the product. After charring, the heads are separated from the soot, ash, charred awns, and leaves, etc. by hand winnowing, using the wind. These operations usually start in the early afternoon and continue until about 7 p.m. The amount of crop cut is usually limited to the amount processable in the afternoon, but some crop may be left until the next day. The blackened heads are left in heaps to dry under the influence of the sun and wind. The heads on the outside of the heaps protect those on the inside from bleaching by the sun. Ideally, the heads should be spread in thin layers in the shade but this is usually not practicable due to space limitations. A thin layer of heads is less subject to the damage caused by fermentation and heating. The moisture content, at cutting, is about 35-50%, depending on the stage of maturity, and must be reduced to about 15% or less before threshing. The stage of cutting is critical because if the wheat is too immature the moisture content is very high, and during drying there is not only a danger of fermentation and spontaneous heating, but also the final grains will become more shrunken. The extra greenness of this type of frekeh is not sufficient to compensate for the reduction in grain plumpness. Ideally, the crop should be cut at a moisture content of 40-45% . However, this is difficult to achieve with the hand-cutting method due to the time involved, but with mechanized cutting this tends to lead to good-quality frekeh due to the more precise control over the cutting stage.

Threshing is carried out, on the small scale, by hand rubbing through a metal sieve, but on the large scale, the heads are passed through a combine harvester, or more frequently threshed by a donkey or ox-drawn "nawraj", or simply by driving a tractor over the heads. The tractor tends to cause damage to the grains. It is important to assess the moisture content of the grains accurately before threshing by combine, nawraj, or tractor to avoid squashing the grains. The combine harvester has the advantage of removing most of the chaff, although the grains are more subject to breakage. After threshing, the grains must be separated from chaff, rachis, and other foreign material. This is achieved by wind elutriation in a manner similar to the removal of branny material from peeled burghul, except that natural wind is used for frekeh cleaning. Finally, the clean frekeh is stored in sacks, or in bulk in small granaries to await sale. Dealers in frekeh visit the villages toward the end of the frekeh-making season and evaluate the quality of the frekeh visually before offering a price. Frekeh can be sold from the village at prices of 5-9 SL/kg depending on its quality and the demand in market (this is about two times the price of mature wheat). Prices are lower in seasons when frekeh is abundant. Frekeh quality depends on the shape, plumpness, and greenness of the final grain, and is also affected by the degree of charring, which should be absent, or very light. The economics of wheat production are heavily in favor of frekeh, rather than mature grain. In areas where frekeh is made, the durum wheat yields are about 2500-2700 kg/ha and the farmer earns a revenue of about 5000-5500 SL/ha (@ SL 2 per kg). In the same areas, returns from frekeh reach 10.000-14.000 SL/ha in spite of lower grain yields from the green crop (about 2000 kg/ha).

Finally, frekeh is used as a staple meal in the same way as rice, burghul, cous-cous, and pasta. The grains are ground into coarse chunks on a stone mill, or a small burr mill, and steamed or boiled. Often the chopped frekeh is steamed with sheep or chicken meat, and the fat of the meat combines with the frekeh to give a very rich flavor. A small nut called "sanobar" is sometimes mixed with the frekeh to add to the flavor.

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Augmented Designs for Preliminary Yield Trials (Revised)

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Plant breeding activities at ICARDA include the development and screening of a large number of new selections. As a part of the screening process, the new selections are evaluated for yield in a preliminary yield trial. In the past, these trials consisted of single rows of the new selections along with rows of one or more standard, or check, varieties placed systematically throughout the trial. The new varieties were evaluated, subjectively, by comparing their yield with that of a nearby check. Since the new selections were not replicated it was not possible to perform a valid statistical analysis of their yields.

In an effort to put yield analysis on a more sound statistical basis, the Food Legume Improvement Program and the Cereal Crops Improvement Program have adopted the use of "Augmented Designs" for some of their preliminary yield screening trials. These designs were developed by Federer (1956, 1961) and described by Federer and Ragavarao (1975). Their purpose is the evaluation, including statistical analysis, of a large number of new selections.

Design Plan

The basic design plan is to divide the experimental area into a number of blocks of test plots. With augmented designs three or more check varieties are assigned at random to plots within each block, while the remaining plots in each block are assigned to the new selections under test. Although the check varieties are replicated the new selections are not. They are assigned at random to plots throughout the blocks. Yields of the new selections are adjusted for block differences, which are measured by the check varieties which occur in every block.

Blocks need not all contain the same number of plots. The trial is most efficient, however, if block size is the same for all blocks. Block size is determined by the number of blocks, b, the number of check varieties, c, and the number of new selections, v. If the block size is constant (same number of plots in each block) the following definitions and relationships hold:

c = number of check varieties per block
v = number of new selections
b = number of blocks
$n = v/b$ = number of new selections per block
$p = c + n$ = number of plots per block
$N = bc + v = b(c + n)$ = total number of plots

The total number of blocks is determined by the need to have at least 10 degrees of freedom for error in the analysis of the yield data. This, in turn, is determined by the number of check varieties (c) used in the trial. In the analysis of variance of the check varieties, the experimental error has (b-1) (c-1) degrees of freedom. As a result, the number of blocks (b) must be such that the following inequality holds: $b > [10/(c-1) + 1]$. For example, with four check varieties:

$b > [10/(4-1) + 1] \qquad b > 4.33$

The minimum number of blocks would be five. Each block would contain five or more plots depending on the number of new selections to be tested.

In constructing the design, the checks should be randomly assigned to plots within each block. Little is lost, however, if one check is systematically assigned to, say, the first plot in each block. The other c-1 checks are assigned at random to c-1 of the remaining plots in each block. The v new selections are then assigned to the remaining bn plots in the trial.

For example, suppose we want to evaluate 24 new selections and use three checks with one systematically assigned to the first plot in each block, we would require a minimum of:

$b > [10/(3-1) + 1] = b > 6$

Assume we choose to use six blocks, then:

$c = 3 : A,B,C$
$v = 24 : 1,2, ..., 24$
$b = 6$
$n = v/b = 24/6 = 4$
$p = c + n = 3 + 4 = 7$
$N = bc + v = (6)(3) + 24 = 42$

The field plan might appear as follows:

Block I	II	III	IV	V	VI
A	A	A	A	A	A
13	17	21	2	B	19
8	9	C	B	12	C
B	C	15	10	5	20
C	24	B	C	16	B
18	B	1	3	6	4
7	11	23	22	C	14

Analysis

The first step in the analysis is to construct a two-way table of check yields, totals, and means:

Check variety	Block 1	2	3	...	b	Total	Mean
1	x_{11}	x_{12}	x_{13}	...	x_{1b}	C_1	$\bar{x}_1$
2	x_{21}	x_{22}	x_{23}	...	x_{2b}	C_2	$\bar{x}_2$
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
c	x_{c1}	x_{c2}	x_{c3}	...	x_{cb}	C_c	$\bar{x}_c$
Total	B_1	B_2	B_3	...	B_b	G	M

In this table:

x_{ij} = yield of the i^{th} check in the j^{th} block

$B_j = \sum_i x_{ij}$ = sum of all checks in the j^{th} block

$C_i = \sum_j x_{ij}$ = sum of all yields of the i^{th} check

$G = \sum_j B_j = \sum_i C_i$ = grand total of all check yields

$\bar{x}_i = C_i/b$ = mean yield of the i^{th} check

$M = \sum_i \bar{x}_i = G/b$ = sum of the check means

The next step is to compute an adjustment factor, r_j, for each block. This is computed as: $r_j = (1/c)(B_j - M)$

Note: as a check on the computation, $\sum_j r_j = 0$

A table of the actual yields of the new selections, and the yields adjusted for the effect of the block in which the new selection was grown can now be constructed:

Selection	Block	Yield: Observed	Adjusted
1		y_{1j}	$\hat{y}_1$
2		y_{2j}	$\hat{y}_2$
.		.	.
.		.	.
.		.	.
v		y_{vj}	$\hat{y}_v$

where:

y_{ij} = yield of the i^{th} new selection (in the j^{th} block)

$\hat{y}_i = y_{ij} - r_j$ = adjusted yield of the i^{th} new selection (adjusted for block effect)

An estimate of experimental error which can be used to compute standard errors and LSD's is most easily obtained using an analysis of variance of the check yields. The format for this is:

		Anova	
Source	**d.f.**	**SS**	**MS**
Total	bc - 1	SSTot	
Blocks	b - 1	SSB	
Checks	c - 1	SSC	
Error	(b-1)(c-1)	SSE	MSE

The entries in the Anova Table are computed as follows:

$$SSTot = \sum_i \sum_j x_{ij}^2 - G^2/bc$$

$$SSB = (1/c) \sum_j B_j^2 - G^2/bc$$

$$SSC = (1/b) \sum_i C_i^2 - G^2/bc$$

$$SSE = SSTot - SSB - SSC$$

$$MSE = SSE/(b-1)(c-1)$$

Note: the Anova in this table is simply a randomized block Anova on the check yields.

An estimate of the experimental error is given by s^2 = MSE.

There is a number of kinds of differences to be computed in an augmented design. These differences and their variances are:

1. Difference between the means of two check varieties:
   Variance = 2MSE/b = s_c^2

2. Difference between adjusted yields of two new selections in the same block:
   Variance = 2MSE = s_b^2

3. Difference between adjusted yields of two new selections in different blocks:
   Variance = 2MSE (c + 1)/c = s_v^2

4. Difference between the adjusted yield of a new selection and a check mean:
   Variance = MSE (b + 1)(c + 1)/bc = s_{vc}^2

5. Average variance of the difference between adjusted yields of two new selections:
   Variance = MSE (2c + 1)/c = s_a^2

Note: an LSD based on the average variance, s_a^2, is satisfactory for comparing adjusted yields of two new selections in most cases.

Least significant differences (LSD's) may be computed using the variances, given above, in the following way: $LSD = t_a\sqrt{s^2}$ where:

t_a = the 100a% (5% or 1%) two-tailed t with (b-1)(c-1) degrees of freedom

s^2 = the variance of the difference for which the LSD is being computed.

Numerical Example

A cereal breeder wanted to conduct a preliminary yield trial on 30 new selections of durum developed for use in the A rainfall zone of northern Jordan. He wanted to compare the new selections against three standard varieties: (1) ST = Stork, (2) CI = Cimmaron, and (3) WA = Waha. He had only enough seed of the new selections to plant a single 2.5 m-row of each, so he decided to use an augmented design. Since he wanted to include c = 3 standard varieties, he required a minimum of:

$$b > [10/(c-1) + 1]$$
$$b > [10/(3-1) + 1]$$
$$b > 6$$

blocks to have sufficient degrees of freedom for estimating experimental error. Using six blocks, he had a design with the following characteristics:

1. Number of checks, c = 3: ST, CI, WA
2. Number of new selections, v = 30: (1), (2), ..., (30)
3. Number of blocks, b = 6
4. Number of new selections per block, n = v/b = 30/6 = 5
5. Number of plots per block, p = c + n = 3 + 5 = 8
6. Total number of plots, N = bc + v = (3)(6) + 30 = 48

Suppose that the field plan, after randomization, and the grain yields (kg/ha) were as given in the following plan:

I Sel.	Yield	II Sel.	Yield	III Sel.	Yield
(14)	2405	CI	3023	(18)	2603
(26)	2855	(4)	3018	ST	2260
CI	2592	(15)	2477	(27)	2857
(17)	2572	(30)	2955	CI	2918
WA	2608	WA	2477	(25)	2825
ST	2972	(3)	3055	(28)	1903
(22)	2705	ST	3122	(5)	2065
(13)	2391	(24)	2783	WA	3107

IV Sel.	Yield	V Sel.	Yield	VI Sel.	Yield
(9)	2268	(2)	1055	(29)	2915
(6)	2148	(21)	1688	(7)	3265
CI	2940	ST	1315	CI	3483
WA	2850	WA	1625	(1)	3013
(20)	2670	CI	1398	WA	3400
(11)	3380	(10)	1293	(12)	2385
(23)	2770	(8)	1253	ST	3538
ST	3348	(16)	1495	(19)	3643

To begin the analysis, a table of yields, totals, and means of the standard varieties (checks) is constructed. For this set of data we have the following:

	Block							
Variety	I	II	III	IV	V	VI	Total	Mean
Stork	2972	3122	2260	3348	1315	3538	16555	2759.17
Cimmaron	2592	3023	2918	2940	1398	3483	16354	2725.67
Waha	2608	2477	3107	2850	1625	3400	16067	2677.83
Total	8172	8622	8285	9138	4338	10421	48976	2720.89
							M	8162.67

The block adjustment factor, r_j, is $r_j = (1/c)(B_j - M)$ in which, for this analysis, $c = 3$ and $M = 8162.67$. These factors for the six blocks in this trial are:

Block	I	II	III	IV	V	VI	$\sum$
r_j	3.11	153.11	40.78	325.11	−1274.89	752.78	0.00

The observed yields, y_{ij}, of the new selections and the adjusted yields, $\hat{y}_i$*, are:

Sel.	Block	OBS.y_{ij}	ADJ.$\hat{y}_i$	Sel.	Block	OBS.y_{ij}	ADJ.$\hat{y}_i$
1	6	3013	2260.2	16	5	1495	2769.9
2	5	1055	2329.9	17	1	2572	2568.9
3	2	3055	2901.9	18	3	2603	2562.2
4	2	3018	2864.9	19	6	3643	2890.2
5	3	2065	2024.2	20	4	2670	2344.9
6	4	2148	1822.9	21	5	1688	2962.9
7	6	3265	2512.2	22	1	2705	2701.9
8	5	1253	2527.9	23	4	2770	2444.9
9	4	2268	1942.9	24	2	2783	2629.9
10	5	1293	2567.9	25	3	2825	2784.2
11	4	3380	3054.9	26	1	2855	2851.9
12	6	2385	1632.2	27	3	2857	2816.2
13	1	2391	2387.9	28	3	1903	1862.2
14	1	2405	2401.9	29	6	2915	2162.2
15	2	2477	2323.9	30	2	2955	2801.9

* $\hat{y}_i = y_{ij} - r_j$

An analysis of variance is now done on the yields of the standard (check) varieties. This gives an estimate of the experimental error for the trial. The Anova for this set of data is:

Anova

Source	d.f.	SS	MS
Total	17	7,899,564	
Blocks	5	6,968,486	
Checks	2	20,051	
Error	10	911,027	91,103

$$cv = (\sqrt{MSE}/\bar{\bar{x}})\ 100 = (\sqrt{91,103}/2720.89)\ 100 = 11.1\%$$

MSE = 91,103 is the sample estimate of the experimental error for this trial.

The variances of the different types of comparison are:

1. Difference between the means of two check varieties
   s_c^2 = 2MSE/b = (2)(91103)/6 = 30,368
2. Difference between adjusted yields of two selections in the same block
   s_b^2 = 2MSE = (2)(91103) = 182,206
3. Difference between adjusted yields of two selections in different blocks
   s_v^2 = 2MSE (c + 1)/c = (2)(91103)(4)/3 = 242,941
4. Difference between an adjusted selection yield and a check mean
   s_{vc}^2 = (b + 1)(c + 1) MSE/bc = (7)(4)(91103)/(6)(3) = 141,716
5. Average variance of the difference between two adjusted selection yields
   s_a^2 = (2c + 1) MSE/c = [(2)(3) + 1](91103)/3 = 212,574

It is possible to compute an LSD for each of the preceding comparisons. However, the most useful comparisons are the comparison of a new selection with the mean of a check variety and those among the adjusted yields of the new selections. The 5% LSD's for these comparisons are computed as follows:

1. For both LSD's the required t_a is the 5% two-sided t with (b - 1)(c - 1) = (6 - 1)(3 - 1) = 10 d.f. This value is $t_{0.05(10)}$ = 2.228
2. The 5% LSD for comparing an adjusted selection yield with the mean yield of a check is:

Table 1. Mean yields of standard varieties and adjusted yields of new selections (kg/ha) arranged in order of decreasing yields.

Rank	Sel.	Yield	Rank	Sel.	Yield	Rank	Sel.	Yield
1	11	3054.9	12	Cimm.	2725.7	23	13	2387.9
2	21	2962.9	13	22	2701.9	24	20	2344.9
3	3	2901.9	14	Waha	2677.8	25	2	2329.9
4	19	2890.2	15	24	2629.9	26	15	2323.9
5	4	2864.9	16	17	2568.9	27	1	2260.2
6	26	2851.9	17	10	2567.9	28	29	2162.2
7	27	2816.2	18	18	2562.2	29	5	2024.2
8	30	2801.9	19	8	2527.9	30	9	1942.9
9	25	2784.2	20	7	2512.2	31	28	1862.2
10	16	2769.9	21	23	2444.9	32	6	1822.9
11	Stork	2759.2	22	14	2401.9	33	12	1632.2

cv = 11.1% s^2 = 91,103

$$LSD_{0.05} = t_{0.05(10)}\sqrt{s_{vc}^2} = 2.228\sqrt{141,716} = 838.7$$

3. The 5% LSD for comparing two adjusted selection yields may be computed using the average variance
$$LSD_{0.05} = t_{0.05(10)}\sqrt{s_a^2} = 2.228\sqrt{212,574} = 1,027.2$$

The results of this trial can be summarized for the cereal breeder in the form of a "Report of Results." An example of this type of report is given below.

Report of Results

A preliminary yield trial was conducted to evaluate 30 new selections of durum for possible use in the A rainfall zone of northern Jordan. The new selections were compared against three standard varieties, Stork, Cimmaron, and Waha, using an augmented design with six blocks of eight plots each. The mean yields of the standard varieties and the yields, adjusted for block differences, of the new selections are presented in Table 1.

Although the adjusted yields of 10 of the new selections are greater than the yield of the highest check, Stork, none of these yields is significantly (5%) higher. On the other hand, two of the new selections, 6 and 12, have a yield which is significantly (5%) less than the yield of the lowest check, Waha. Among the new selections, the top 25 form a group in which none of the adjusted yields are significantly different.

References

Federer, W.T. 1956. Augmented (or Hoonuiaku) designs. Hawaiian Planters' Record 55: 191-208.

Federer, W.T. 1961. Augmented designs with one-way elimination of heterogeneity. Biometrics 17: 447-473.

Federer, W.T. and Ragavarao, D. 1975. On augmented designs. Biometrics 31: 29-35.

SHORT COMMUNICATIONS

Effect of the Semidwarf Character and Yield Components on Yield of Barley (*Hordeum vulgare* L.)[1]

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Arig 8, a high-yielding barley variety adapted to Morocco, was crossed and then backcrossed to six different genotypes from Minnesota, USA, to develop two populations with diversity for each of plant height (populations I and II), kernel number (populations III and IV), and tiller number (populations V and VI). Populations were developed at St. Paul, Minnesota, and the yield trials were conducted at four environments in Morocco. The purpose of the study was to determine whether genetic improvements in yield could be made using a semidwarf character, high kernel number, and high tiller number.

The data obtained showed that semidwarf genotypes did not differ significantly from their tall counterparts in dry-matter or grain yield production, although the semidwarf lines showed a slight advantage over the tall ones in grain yield. Semidwarf lines were similar to tall lines in heading time in population II but were five days later in population I. Semidwarf lines were more lodging resistant and had a higher harvest index than tall lines in both populations. Based on the mean of all tests, only two semidwarf lines exceeded Arig 8 in grain yield.

Evidence from the four yield component populations (III, IV, V, and VI) indicated that the four Minnesota parents and their component characteristics (Manker, M76-230, M75-61, and M73-129) in combination with Arig 8 produced some progenies with higher grain yield than the adapted parent, Arig 8. Four lines from the two kernel number populations and three lines from the two tiller number populations exceeded Arig 8 in grain yield by 15% or more and 10% or more, respectively. Also, some high-yielding, early, and lodging-resistant lines were derived from the Manker/2* Arig 8 (population III) cross. The strategy of using the Minnesota yield component parents and a cross and one backcross to adapted cultivar, Arig 8, appeared to be effective in that it produced high-yielding progenies.

Phenotypic correlation, ridge regression, and path coefficient analyses were applied to data from the yield component populations (III, IV, V, and VI). These analyses showed that, under the conditions of this study, kernel weight and head weight were more closely associated with grain yield than head number or kernel number. However, examination of the highest yielding lines in each population showed that high yield tended to be associated with moderately high head number and high kernel weight. Some of the highest yielding lines had modest positive increases in each of the three yield components.

In light of all the evidences from this study, it appears appropriate to conclude that high yield results from a special balance or the right combination of the three yield components rather than any particular component.

1. PhD thesis submitted to the Faculty of Agriculture, Institute of Agronomy and Veterinary Science, Hassan II. Morocco, 1984. 90 pp.

Characterization of Dual-Purpose Barley—An Approach

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In the agricultural systems of the Middle East and North Africa barley has been known as a versatile crop, resilient to a variety of treatments at any stage of its development. One such treatment in the Middle East and North Africa is the green-stage grazing of barley during the winter months and then leaving it to produce a grain crop. In Syria, an average of 48.7% [a] of barley-growing farmers

a. The figure varies between climate, zones, provinces, and seasons.

practice such green-stage grazing every year (Mazid and Hallajian 1983). Green-stage grazing of barley is also practiced with varying intensities in Cyprus, Iran, Tunisia, Iraq, Saudi Arabia, Morocco, and Turkey (Ceccarelli, ICARDA, personal communication).

Research at ICARDA over the past 5 years has showed that improved high-yielding barley genotypes which were conventionally bred for grain generally do not perform well when subjected to grazing, indicating the need for special dual-purpose genotypes (ICARDA Annual Report 1981; 1982; 1983). Moreover, in these experiments, large genotypic differences in dry-matter production at tillering, ability to recover after grazing and in final grain yield after grazing were detected, suggesting the possibility of developing genotypes suitable for green-stage grazing without detrimental effect on final grain yield.

To meet the widely recognized need for dual-purpose barley varieties, a small project was initiated at ICARDA in 1980/81 to identify and develop appropriate genotypes. Since then, several hundred genotypes have been screened by clipping once at the tillering stage to simulate grazing. Among the characters observed, two were considered most important: dry-matter yield at tillering and grain yield after clipping. Based on these two traits, genotypes were grouped into grain, forage, and dual-purpose types (Fig. 1). Dual-purpose genotypes thus were classified as producers of high forage yield at the time of grazing as well as high grain yield afterwards.

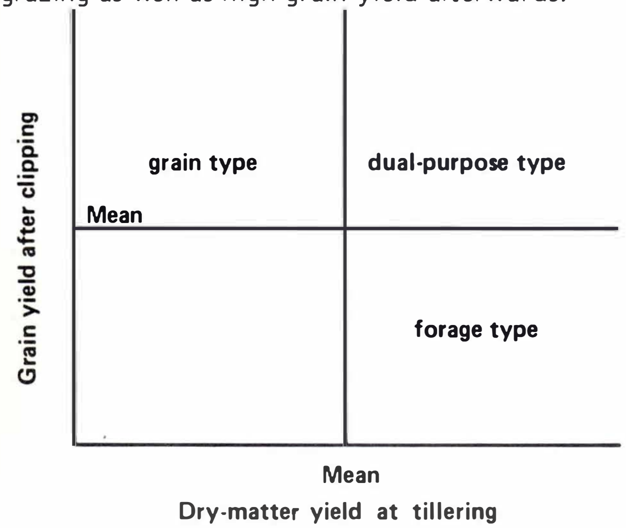

Fig. 1. Classification of barley genotypes according to their dry-matter yield at tillering stage and grain yield after clipping.

Starting in the 1983/84 season, the classification of dual-purpose barley was improved. It was realized that the above classification of dual-purpose barley based on high forage yield and high grain yield after grazing was a 'narrow-sense' definition. In a broad sense, dual-purpose barleys should be able to perform well whether grazed or not, i.e., they should combine the narrow-sense performance with the capability to produce high grain yield if not grazed. Moreover, when selecting dual-purpose barleys, the amount of straw produced also deserves attention since barley straw is a valuable source of feed for livestock in the region (Ceccarelli, ICARDA, personal communication; Mazid and Hallajian 1983).

A theoretical comparison of barley genotypes is attempted with all characters discussed above. Dual-purpose genotypes of barley at ICARDA are those giving above-average value for all characters (Fig. 2).

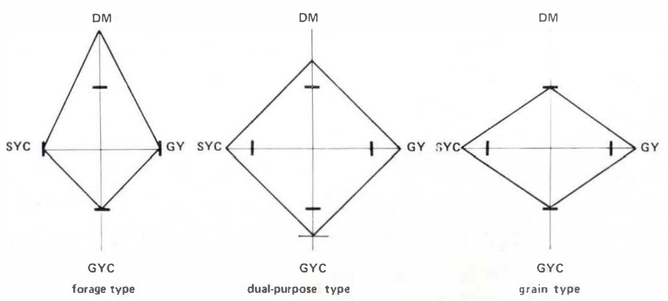

Fig. 2. Classification of barley genotypes according to their dry-matter yield at tillering stage (DM), grain yield after clipping (GYC), grain yield without clipping (GY), and straw yield after clipping (SYC).

References

Mazid, A. and Hallajian, M. 1983. Crop - livestock interactions. Information from a barley survey in Syria. Farming Systems Research Report, No. 10, ICARDA, Aleppo, Syria.

ICARDA (International Center for Agricultural Research in the Dry Areas). 1982. Annual Report 1981. Aleppo, Syria. 164 pp.

ICARDA (International Center for Agricultural Research in the Dry Areas). 1983. Annual Report 1982. Aleppo, Syria. 215 pp.

ICARDA (International Center for Agricultural Research in the Dry Areas). 1984. Annual Report 1983. Aleppo, Syria, 264 pp.

Days to Heading and Days to Maturity as Important Factors of Barley Resistance to Wheat Stem Sawfly

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During 1983/84, 306 barley genotypes were tested at Suran (Hama, Syria) in an unreplicated trial to determine their resistance for wheat stem sawfly under natural infestation.

Days to heading and maturity were recorded for each barley genotype. At harvest, 60 stems were taken at random from each line and examined for infestation by wheat stem sawfly larvae.

Significant correlations were found between the percentage of infestation and both days to heading ($r = -0.306^{**}$) and days to maturity ($r = -0.25^{**}$). Also, early barley lines were much more susceptible than late ones, possibly because there is a coincidence between the time of wheat stem sawfly oviposition (which takes place below the head of the plant) and the heading of the early barley genotypes.

On the other hand, in late genotypes, the preferred site of oviposition has not appeared when the peak of oviposition occurred. This suggests that late-heading barley genotypes probably escape wheat stem sawfly infestation.

Barley Agronomy in Jiangsu, China

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Barley is an important winter cereal crop in China. About 4 million hectares are planted to barley, and Jiangsu province alone accounts for 25% of the total planted area.

Due to its salt tolerance and earlier maturity as compared with wheat, barley is widely grown along the coastal area, and in areas where double and triple cropping systems are adopted. Multicropping with barley has many forms among which are: barley-rice - rice, barley - rice, barley - maize - rice, barley - soybean - rice, barley - maize and sweet potato, barley - maize and ground peanuts, and barley - cotton etc. High and stable yield; late sowing; early maturity; medium plant height; resistance to scab, virosis, and water logging; and tolerance to cold are desirable traits in barley.

The temperature at Nanjing, Jiangsu, ranges between 1.9 and 28.2°C from January through December. The rainfall ranges between 30.2 and 181.7 mm. Sowing at Jiangsu starts early in October in the north, and lasts from mid October to early November in the south. Harvesting lasts from mid- to end of May. Two regional institutes at Jiangsu conduct research on barley:

Prefectural Agricultural Research Institute, Yancheng, Jiangsu, People's Republic of China.
and
Prefectural Agricultural Research Institute, Nantong, Jiangsu, People's Republic of China.

Ahgaf—A New Wheat Variety Released in the People's Democratic Republic of Yemen

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Mr. Hussein S. Bamakharamah, Director, Agricultural Research Institute Seryan, PDRY, has informed us about the release of a new wheat variety, Ahgaf, and the status of wheat production in the country.

Local *aestivum* types and cultivars of different maturity periods are being cultivated in the PDRY. These types are, to some extent, adapted to the local water and soil salinity environment. However, their high susceptibility to leaf and stem rusts, low response to chemical fertilizers, and tendency to lodge, result in low productivity and unsuitability to mechanical harvesting. Therefore, emphasis was placed on introducing high-yielding varieties and appropriate agronomic practices to help improve wheat productivity and increase wheat production in the country. As a result of varietal testing, two wheat varieties, Kalyansona and Sonalika released in India (CIMMYT origin), were introduced and released in 1973 in Yemen.

As the resistance to leaf and stem rusts of Kalyansona and Sonalika was breaking down, extensive efforts were made by the national program to identify new high-yielding varieties, resistant to diseases and tolerant to the relatively high temperature occurring early in the season. Selection for relatively taller lines within the semi-dwarf group was practiced to obtain increased straw yield.

Following three seasons of selection and testing, the three most promising new lines were compared with Kalyansona and Sonalika, the check varieties (Table 1).

These new lines, along with commercial varieties, were tested in farmers' fields and state farms. Simultaneously, agronomic trials were conducted .o determine appropriate sowing time, fertilizer requirements, and seed rate. Based on better yielding ability and rust resistance, as compared to the commercial varieties, the PDRY's National Committee for Varietal Release (NCVR) approved the release of wheat line S 311 x Norteno—Jit 43.2L under the local name Ahgaf. Due to its heat tolerance at seedling stage, the variety Ahgaf is suitable for early planting (late October) in Wadi Hadramout, whereas other varieties suffer badly if planted early. This will provide flexibility to farmers for their sowing time. Furthermore, Ahgaf appears to possess more tolerance to soil and water salinity which is very important for the PDRY. The same line was identified and named by the Syrian National Program as "Golan"

Originally, the cross was made in Pantnagar, India, by Dr. J.P. Srivastava, wheat breeder and presently leader of the cereal improvement program, ICARDA. Sample 311, received from CIMMYT, Mexico, was found to be highly resistant to rusts, and Norteno, also received from Mexico, was selected as the second parent for its earliness and large, lustrous kernels. Seed of this promising line, in the early generation, was sent for evaluation in Lebanon and other countries in the Middle East and North Africa through Arid Lands Development Program (ALAD), a predecessor organization of ICARDA. This line was included in ICARDA's Regional Wheat Yield Trials for 3 years and was among the highest yielders in several countries of the region.

During 1983/84, Ahgaf was grown on 500 hectares in the PDRY and is expected to soon replace Kalyansona and Sonalika. The release of Ahgaf is a reflection to the cooperation between National Programs and the IARC's supported by the CGIAR.

Table 1. Performance of selected strains as compared to Kalyansona and Sonalika at ARI, Seryan.

Pedigree/variety	Grain yield (t/ha)	Plant height (cm)	Days to maturity	Leaf rust reaction
S 311 x Norteno—Jit 43.2L	3.6	90	105	Free
7C—On x Inia x B. Man.	3.1	73	93	Present
LR—Son 64 x CC/Ska	2.5	71	91	Present
Kalyansona (improved check)	2.6	76	92	Present
Sonalika (improved check)	2.4	74	89	Present

Occurrence of Hessian Fly (*Maytiola destructor* Say) in High-Elevation Areas

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Hessian fly (*Maytiola destructor* Say) is an insect pest which attacks cereal crops in most of the world. The damage is caused by larvae feeding on stems and making them weak to various degrees depending on the crop and the environmental conditions. The development of the insect is generally favored by high relative humidity and moderate temperature (Anonymous 1976). Occurrence of the insect in Syria has been reported at Tel Hadya by Rashwani (1978) with average infestation of 13, 19, and 21% on barley, bread wheat, and triticale, respectively. Losses are typified by the appearance of dead tillers or shortened stems with small spikes and shriveled kernels. In favorable conditions, up to 80% of the plants in an infested field can be damaged (Anonymous 1976).

While Hessian fly had been observed in several countries of North Africa and West Asia, no report has yet confirmed its occurrence in high-elevation areas, particularly in the mountains of the Syria-Lebanon border. In this study, it was at a site 1400 m above sea level located at Jabadine (55 km northwest of Damascus) that Hessian fly pupae were observed on maturing plants of durum wheat, bread wheat, and triticale. The fields were experimental plots of the ICARDA 1983/84 summer nursery planted in June and regularly flood-irrigated throughout the growing season. Observations were made prior to harvest in October. The average percent infestation, calculated for durum and bread wheats, was around 30% . In a sample of 60 random plants from the durum wheat observation nursery, the percentage of infested stems ranged from 6 to 24 in fertile tillers and from 10 to 46 in infertile dead tillers. This indicates that Hessian fly can reduce tiller fertility in irrigated wheat grown during the summer in high-altitude areas. These findings warrant further investigations to evaluate the varietal resistance and to assess the economic importance of crop losses caused by Hessian fly in these areas.

References

Anonymous. 1976. Maladies et ravageurs des plantes cultivees au Maroc. Ministère de l'Agriculture et de la Réforme Agraire, Direction de la Recherche Agronomique, Rabat, Maroc. Tome 1: 33-34.

Rashwani, A. 1978. Introduction to the major insect pests of wheat and barley in the Middle East and North Africa. Technical Manual 9. International Center for Agricultural Research in the Dry Areas. Aleppo, Syria. p. 66.

Reconfirmation of Levels of Resistance to Wheat Stem Sawfly in Some Bread Wheat Lines

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In 1983, a trial was conducted at Tel Hadya, northern Syria, to reevaluate the sources of resistance to wheat stem sawfly and determine the degree of damage under artificial infestation. Three bread wheat lines classified in previous years for varying degrees of resistance to wheat stem sawfly were used in this study: MP-112 (susceptible), Golan (improved local check), and MT-777 CI 9294/ Fortuna (resistant).

The trials were planted under insect-proof cages with a plot size of 2.5 x 1.8 m^2. The trial was laid out in a randomized complete block design with four replications. Plots were infested at the ear-formation stage with four different levels of adult wheat stem sawfly females per m^2. The adults had been reared in the laboratory from larvae collected from infested fields.

After harvest, percentages of infestation by wheat stem sawfly were calculated on the basis of 120 stems per sample per plot.

Regression of percent infested stems on level of infestation was significant ($P < 0.01$) for all three cultivars (Fig. 1). At all levels of infestation the resistant line MT-777 CI 9294/Fortuna showed consistently significant lower damage than the local and the susceptible checks. This confirms the resistance previously detected in Fortuna and

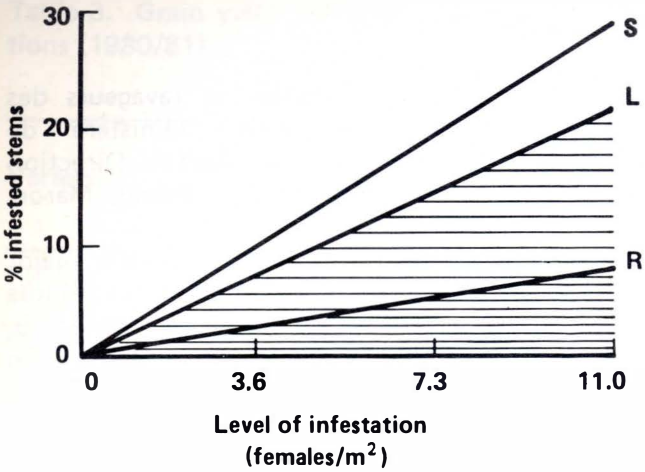

Fig. 1. Regression of percent infested stems on level of infestation for three bread wheat cultivars (S = susceptible, L = local, R = resistant).

Fortuna-derived lines which are being used at ICARDA as sources of resistance to wheat stem sawfly.

Bacterial Leaf Blight of Wheat in Pakistan

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Wheat (*Triticum aestivum* L.), planted at the National Agricultural Research Centre, Islamabad, was found heavily infected with a phytobacterial pathogen during spring 1984. The disease appeared on leaves in the form of watersoaked oily spots measuring 1 mm in diameter. The lesions expanded with time and were gray-green to tan-white in color. They gradually coalesced with each other causing severe blightening of the leaves. On a heavily infected plant, entire leaves became necrotic. A white crust of bacterial dried-out ooze was also observed on the underside of the older water-soaked lesions. The bacterium isolated from these lesions on yeast extract-dextrose-calcium carbonate (YDC) formed slimy colonies on the culture medium. It was identified to be gram negative with rounded end rods and measured 0.7—1.2 x 1.5—3.0 μm. It produced a green flourescent pigment in culture. It liquified gelatin and on beef extract agar it gave gray-white to bluish color.

The bacterium was thus identified as *Pseudomonas syringae* Van Hall. Its characteristics agreed with those described by Otta (1974).

Twenty-day old seedlings of wheat variety Pak 81 grown in the plastic house were inoculated with bacterial suspension having an absorbance of 1.2 on spectronic 20 (Bausch and lamb). Typical water-soaked lesions developed within seven days of inoculation and the same bacterium was reisolated from these lesions. This is the first report of *Pseudomonas syringae* as a wheat pathogen in Pakistan.

The disease was observed in the exotic breeding material which was heavily damaged by this pathogen. The bacterium has been reported to be a common inhabitant of soil and water all over the world (Wiese 1977). It seems that the exotic material is highly susceptible to this pathogen, but there are good indications of the availability of sources of genetic resistance to meet any future threat by this disease to wheat in Pakistan.

References

Otta, J.A. 1974. *Pseudomonas syringae* incites a leaf necrosis on spring and winter wheats in South Dakota. Plant Disease Reporter 58: 1061-1064.

Wiese, M.V. 1977. Compendium of wheat diseases. The American Phytopathological Society of America, USA. 106 pp.

Effect of Growth Regulator and Photoperiod on Spring Wheat (*Triticum aestivum* L. em. Thell.)

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Chlormequat or Cycocel (CCC) retards growth by inhibiting GA biosynthesis in many dicots and monocots including wheat. This experiment was designed to examine the effects of CCC on the growth and development of two spring-wheat cultivars under two photoperiods.

Two spring-wheat cultivars, Timmo (tall) and Highbury (short), were subjected to two photoperiods (10 and 16 hr) and two growth regulator treatments (with and without CCC). The experimental design was a split-plot in five replications with photoperiod as main factor, and variety and growth regulator treatments as subfactor.

Both wheat cultivars were subjected to photoperiod treatments immediately after emergence, and to CCC at the double ridge stage.

Data were collected on tiller number, pseudo-stem and true stem lengths, number of unfolded leaves per plant, length and width of leaves, developmental score (Zadock scale), and length of main-stem-spike initial.

The results indicated that the photoperiod treatments influenced the plant development for both the tall and short varieties in the same manner. As compared to short photoperiod, long photoperiod increased tiller number, leaf width, spike length, and developmental score. It was clear that long photoperiods favored faster development of reproductive structures, the developmental

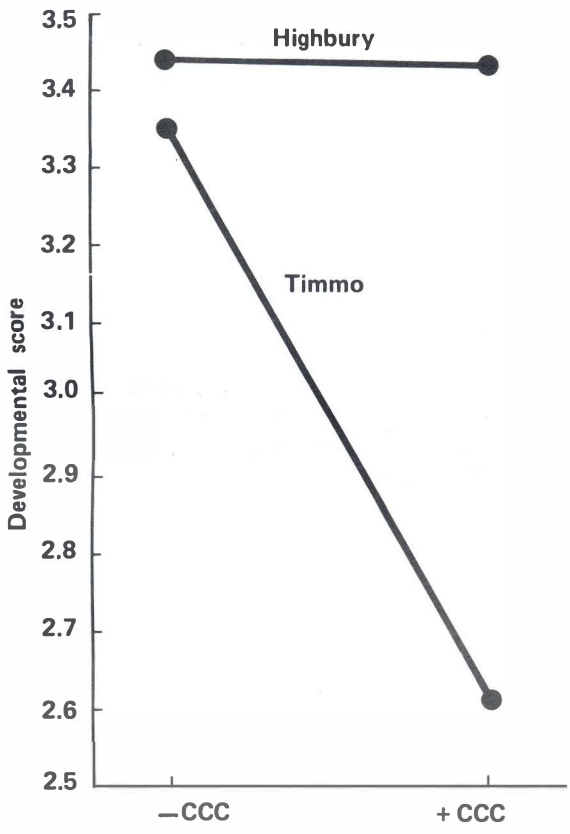

Fig. 1. Effect of CCC on the plant development of Timmo and Highbury cultivars of spring wheat.

scores being 4.44 and 1.98 for the long and the short photoperiods, respectively.

The growth regulator CCC, known to have a dwarfing effect through the suppression of cell division in the rib meristem, caused a reduction in shoot elongation.

In this experiment, CCC had more pronounced effects on Timmo as compared to Highbury (Fig. 1). Interactions between CCC and photoperiod were observed for pseudo-stem and true stem lengths for both varieties (Fig. 2).

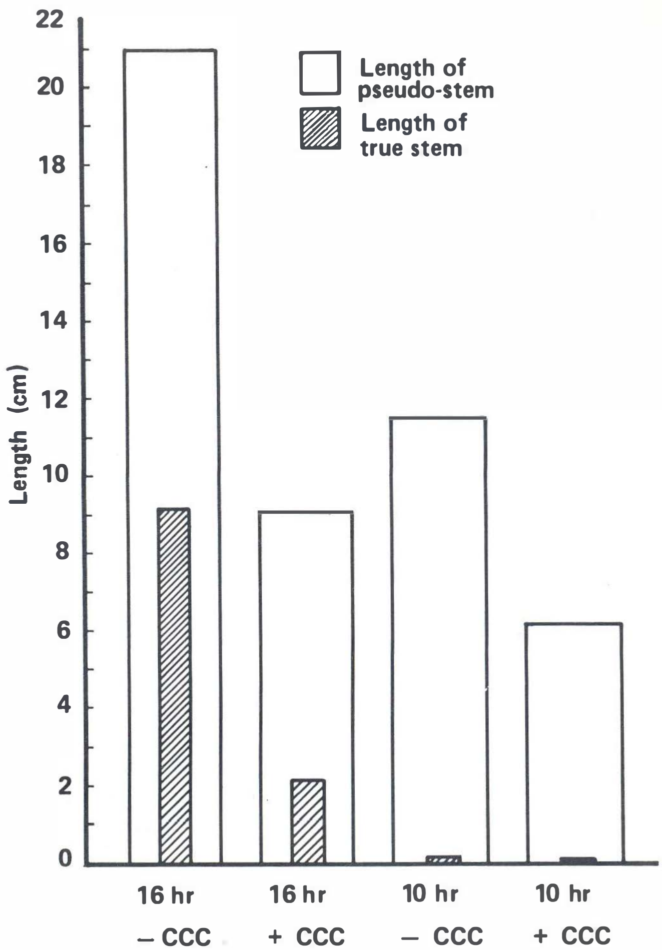

Fig. 2. Effect of CCC and photoperiod on the length of pseudo- and true stems of Timo and Highbury cultivars, 1983.

In general, application of CCC resulted in increased tiller number and reduced leaf and pseudo-stem length. A reduction in developmental score was observed for Timmo only.

These results showed that CCC is an effective growth retardent which can be useful in inducing higher tillering and shortening the plants where lodging is a problem. Therefore, it can increase yields in highly favorable growing conditions including high fertility and soil moisture.

Acknowledgements

This search was conducted under the supervision of Dr. P.M. Carwright, University of Reading, UK, to whom the author is grateful for guidance and advice. Thanks are also due to Dr. H. Ketata, ICARDA, for his help in the preparation of the manuscript.

Effect of Stem Rust (*Puccinia graminis* f. sp. *tritici*) on 1000-Kernel Weight of Wheat in Zagreb, Yugoslavia

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Severe attack by stem rust (*Puccinia graminis* f. sp. *tritici*) can completely damage a wheat crop. Since severe attack by this disease rarely occurs in Yugoslavia, artificial infestation method was used to determine economic losses in yield.

This report provides the results of a five-year research (1980-84) on the effect of stem rust on 1000-kernel weight of wheat at the experimental site of the institute, Botinec, under artificial infestation following procedures described by Koric' (1978, 1980) and Little and Hills (1966). Fifteen wheat varieties and two promising lines were used. Artificial infestation was performed hypodermally by injecting the suspension of uredospores at the development stage 7 (Calpouzos *et al.* 1976). The check plots were treated with systemic fungicide. Severity and type of infection were estimated using the modified Cobb scale (Chester 1946). The results were used to determine the resistance of some varieties and lines to most common physiological races and biotypes of stem rust.

Previous studies on 1000-kernel weight of wheat revealed reduction of 3% at the 25% severity on Cobb scale. Any further increase in the severity can result in higher reductions of 1000-kernel weight. Reductions in the present study ranged between 6.6 and 36.6% at the 65 and 99% severity on Cobb scale, respectively (Table 1).

The material used in this study can be classified into two main groups. The first group comprises varieties which are mainly susceptible to stem rust, the variety Kavkaz which is resistant to the disease, and Bistra, a variety which is highly susceptible to stem rust. The latter two varieties have been used as check varieties in breeding trials for resistance to stem rust. The second group comprises some high-yielding varieties which have been adopted after several years of testing, in addition to two promising lines.

Due to their good performance, the recently-developed varieties of the second group can successfully replace the old varieties used in the trials. However, susceptibility of the variety M-33-1 and the line Zg 3479/76 is of minor importance since they have been selected for other desirable agronomic traits.

References

Calpouzos, L., Roelfs, A.P., Madson, M.E., Martin, F.B., Welsh, J.R., and Wilcoxon, R.D. 1976. A new model to measure yield losses caused by stem rust in spring wheat. Technical Bulletin 307, University of Minnesota, USA.

Chester, K.S. 1946. The cereal rust. Waltham, Massachussetts, USA.

Koric', B. 1978. Effect of the wheat stem rust (*Puccinia graminis* f. sp. *tritici*) on the weight of 1000-kernels of wheat. Arhiv za Poljoprivredna Nauke XXXI, 114: 75-81.

Koric', B. 1980. Effect of the stem rust (*Puccinia graminis* f. sp. *tritici*) on the weight of 1000-kernels of wheat. Poljoprivredna Znanstvena Smotra 52: 313-317.

Little, M.T. and Hills, F.J. 1966. Experimental methods for extension workers. Agricultural Extension Service, University of California, USA.

Table 1. Effect of stem rust on 1000-kernel weight of wheat.

Variety	Losses of 1000-kernel weight (%) 1980	1981	1982	1983	1984	Severity and type of infection on Cobb scale 1980	1981	1982	1983	1984
First group										
Zlatna										
Dolina	13.4	22.0	22.3	22.0	8.3	99 VS	99 VS	99 VS	99 VS	99 VS
Bistra	20.5	36.6	26.6	35.2	32.3	99 VS	99 VS	99 VS	99 VS	99 VS
Libellula	8.1	19.0	14.9	12.3	17.3	65 S	99 VS	99 VS	99 VS	99 VS
NS Rana 2	8.9	19.5	16.5	16.8	22.4	65 S	99 VS	99 VS	99 VS	99 VS
Kavkaz	0	0	0	0		0	0	0	0	
Partizanka	6.6	23.3				65 S	99 VS			
Orasanka			18.7	20.8				99 VS	99 VS	
Second group										
Granka	0	0				0	0			
Nova Zlatna	0	0				5 S	0			
Baranjka	0	0			tr S		0			
Zlatoklasa	0	0				5 S	0			
Dika			0	0				0	0	
Lonja			0	0				0	0 S	
Lorana			0	0				0	tr S	
M-33-1			16.0	18.5				99 VS	99 VS	
Zg 6569/76			0	0				0	0	
Zg 3497/76			17.5	17.0				99 VS	99 VS	

VS = very susceptible; S = susceptible; tr S = trace susceptible.

Phoma Leaf Spots on Wheat in Pakistan

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During the 1982/83 season, wheat plants with disease symptoms on leaves and leaf sheaths were observed in fields at the National Agricultural Research Center, Islamabad. The symptoms appeared in the form of brown-to-dark-brown lesions of an irregular shape. The pycnidia in the host lesion were dark, round, and ostiolate, about 100-200 μ in diameter. The pycniospores were hyaline, single celled, and ovoid to ellipsoid, and measured 3-7 μ in length. The fungus was identified as *Phoma glomerata* (Corda) Wr. & Hochapf. similar to that reported by Zillinsky (1983).

The fungus was cultured on potato-dextrose-agar at 20°C. The fungus colonies were dark brown-to-black and produced abundant pycnidia and pycniospores. The fungus was also isolated from wheat seed samples subjected to seed-health tests on blotter papers. This is the first report of *Phoma glomerata* as a seedborne pathogen of wheat in Pakistan. Previously, it has been reported to exist in high-rainfall areas (Wiese 1977).

References

Zillinsky, F.J. 1983. Common diseases of small grain cereals. A guide to identification. Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico. 141 pp.

Wiese, M.V. 1977. Compendium of wheat diseases. The American Phytopathological Society, USA. 106 pp.

Farmers' Field Verification Wheat Trials in The Sudan

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Experimental research data with improved wheat varieties and recommended cultural practices indicated average yields of about 3.5 tonnes/ha. Grain yields in farmers' fields ranged from 0.8 to 1.5 t/ha in recent years. Poor seed stock, late sowing, poor land preparation, poor fertilizer spreading, moisture stress, weeds, and delayed harvest are the main reasons for low yields in the Sudan.

The absence of on-farm trials is another key factor for reduced yield in farmers' fields. Therefore, farmers' field verification wheat trials are urgently needed in the Sudan to inform the farmers of the improved varieties and cultural practices.

The primary objective will be to encourage the researchers to verify their findings in farmers' fields. This will be done by testing the performance of released and local varieties as well as advanced promising lines under environmental conditions that differ from those of the main breeding stations. Other objectives of this project are (1) to verify the validity of the recommended cultural practices in farmers' fields with respect to the new varieties and improved cultural practices, and (2) to provide demonstration plots for farmers with respect to the new varieties and the improved cultural practices.

Project Description

Considering this is the first year for this project and also other constraints such as limited resources and limited water availability, the size of the project is rather small. The following is a general description of these trials:

Locations: six; Maatug, Turabi, New Halfa, Wad Medani, Sinner, and Hudeiba.

Cultivars: 10 entries in each trial. One old variety, one newly released variety, four promising lines from New Halfa breeding program, and four promising lines from Wad Medani breeding program.

Design: randomized complete block with four replications.

Plot Size: 36 m^2.

Seed Rate: 125 kg/ha.

Fertilization: only nitrogen. To be applied at sowing at the rate of 92 kg N/ha.

Weeding: hand weeding if needed.

Spraying: common insecticide. Usually once when needed against aphids.

Irrigation: every 10-15 days.

Planting Date: third week of October to second week of November.

Data Collection: yield, agronomic, and disease data.

Participating Institutions: the Agricultural Research Corporation (ARC), Sudan, the International Center for Agricultural Research in the Dry Areas (ICARDA), Syria, and the International Maize and Wheat Improvement Center (CIMMYT), Mexico.

Ascochyta Leaf Spots on Wheat in Pakistan

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During a survey of wheat diseases in the 1982/83 season, plants showing leaf spotting were observed in wheat fields at the National Agricultural Research Center, Islamabad. The symptoms appeared as chlorotic, elongated or rounded spots on the lower leaves. The spots enlarged by merging with each other and were grey brown in color. Dark brown, round, ostiolate pycnidia were observed at the center of the lesion. They measured 105-300 x 105-200 µm, and were found to be immersed in the host tissue. The pycnidiospores were bicelled, hyaline, and straight and measured 15-25 x 3-6 µm. The fungus was identified as *Ascochyta tritici* Hori & Enj, similar to that described by Buhl *et al.* (1975).

Bits of diseased plant parts when transferred to potato-dextrose-agar, yielded *A. tritici.* Seed samples subjected to seed health tests on blotter paper also yielded *A. tritici.*

Pathogenicity tests were carried out by inoculating 30-day old wheat seedlings with spores and mycelial suspension of the fungus. The symptoms appeared within seven days of inoculation. This study revealed that the fungus is seedborne in nature. This is the first report of *A. tritici* as a pathogen of wheat in Pakistan. The disease has already been reported in other areas with high rainfall and in fields with dense wheat crops (Wiese 1977).

References

Buhl, C., Weidner and Zogg, H. 1975. Krankheiten und Schdlinge an Getreide und Mai, Stuttgart. 431 pp.

Wiese, M.V. 1977. Compendium of wheat diseases. The American Phytopathological Society, USA. 106 pp.

Distribution of International Cereals Nurseries

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For the 1984/85 season, 810 seed sets were distributed by Cereal Improvement Program of ICARDA to 93 cooperators in 45 countries. Except for the Key Location Disease Nurseries (KLDN), all nurseries were sent upon requests from cooperators in the ICARDA region and elsewhere. The numbers and types of germplasm distributed to seven areas (West Asia, North Africa, Other Africa, Mediterranean Europe, East Asia, North America, and Other) appear in Table 1. West Asia includes the countries east of Egypt to Pakistan, North Africa includes Morocco to Egypt plus The Sudan, East Asia includes the countries in Asia east of Pakistan, and North America includes Canada, USA, and Mexico. The countries of the ICARDA region are thereby included in the West Asia and North Africa areas, which received approximately two-thirds of all the seed sets.

Essentially, three different types of germplasm constitute the international nurseries: (1) parental genotypes as provided in the crossing blocks, (2) segregating populations (F_2) with more specifically targeted nurseries in the case of barley, and (3) advanced lines in the regional observation nurseries and yield trials.

Computerization of the data of the international nurseries continued in 1984. Newly-developed CERINT and CRISP modules for ranking, sorting, transforming, selecting, and analyzing data from test genotypes have facilitated the interpretation of the international nurseries data. A preliminary report was sent to cooperators in Dec 1984, and a final report for the international cereal nurseries is scheduled to be published in early 1985.

Table 1. Distribution of ICARDA international nurseries and trials for the 1984/85 season.

		Number of sets distributed							
Nursery/Trial	**No. of entries**	**West Asia**	**North Africa**	**Mediterranean Europe**	**Other Africa**	**Asia east of Pakistan**	**North America**	**Others**	**Total**
Barley									
Regional Yield Trial (RBYT)	24	20	24	8	3	9	1		65

Cont'd

Cont'd

Nursery/Trial	No. of entries	West Asia	North Africa	Mediterranean Europe	Other Africa	Asia east of Pakistan	North America	Others	Total
Observation Nurseries									
- High-Altitude Areas (BON-HAA)	100	15	10	5	3	1	4	2	40
- Low-Rainfall Areas (BON-LRA)	100	17	18	6	3	6	3	1	54
- Higher-Rainfall Areas (BON-HRA)	100	6	15	5	1	6	3	1	37
Crossing Block (BCB)		13	12	4	3	7	2	1	42
Segregating Populations									
- High-Altitude Areas (SPB-HAA)	150	4	2	2	1	2		1	12
- Low-Rainfall Areas (SPB-LRA)	150	5	4	1		1			11
- Higher-Rainfall Areas (SPB-HRA)	150	2	5	4		1			12
Key Loc. Disease Nursery (BKLDN)	250	6	9	4	1		4	1	25
Durum wheat									
Regional Durum Yield Trial									
- Moderate Rainfall (RDYT-MR)	24	20	20	7	4	2	1	1	55
- Low Rainfall (RDYT-LR)	24	20	12	8	2	3	1		46
Observation Nurseries									
- Moderate Rainfall (DON-MR)	93	16	16	7	2	2	3	1	47
- Low Rainfall (DON-LR)	143	15	15	8	2	4	3		47
Crossing Block (DCB)	150	11	11	3	1	1	1		28
Segregating Populations (DSP)	150	9	10	7	1	1	1		29
Key Loc. Disease Nursery (DKLDN)	250	5	10	3	1		4	1	24
Bread wheat									
Regional Yield Trial (RWYT)	24	34	22	8	3	3	2	1	73
Observation Nursery (WON)	125	26	19	5	3	7	4	3	67
Crossing Block (WCB)	150	20	17	2	1	2	1		43
Segregating Populations (WSP)	150	13	12	4					29
Key Loc. Disease Nursery (WKLDN)	320	7	10	1	1		4	1	24

RECENT PUBLICATIONS

Borror, D.J. and De Long, D.M. 1981. An introduction to the study of insects. 5th edition, Saunders Collection Publication, USA. 827 pp. ISBN 0-03-043531-5.

Cook, R.J. and Baker, K. 1983. The nature and practice of biological control of plant pathogens. American Phytopathological Society, St. Paul. 539 pp. ISBN 0-89054-053-5.

Davies, H.R.J. (ed.). 1984. Natural resources and rural development in arid lands: case studies from the Sudan. UNU Publications, Japan. ISBN 92-5-808-0504-5. $ 15.

FAO, 1982. Regional study of rainfed agriculture and agronomic inventory of all countries in the Near East region. 174 pp. ISBN 92-5-101222-9. $ 10.

FAO. 1984. List of national plant quarantine services. AGPP: MISC/38. via della Terme di Caracalla, 00100, Rome, Italy. 15 pp.

FAO/IAEA/GFS/SIDA. 1984. Cereal grain protein improvement. IAEA, Vienna. A.Sh. 760.

Fowden, L. and Miflin, B.J. (eds.). 1984. Seed storage proteins. Philosophical transactions of the royal society of London 304 (1120). London, Royal Society. 273-407 pp. £ 24.75.

The volume comprises the proceedings of a conference on seed proteins held in June 1983 and contains excellent reviews of the progress of knowledge on all aspects of seed proteins: their synthesis, transport, deposition, genetics, and structure. In addition, the last chapters discuss the problems of seed technology.

France, J. and Thornley, J.H.M. 1984. Mathematical models in agriculture. Butterworths, UK. 352 pp. ISBN 0-408-10868-1.

Gallagher, E.J. (ed.). 1984. Cereal production. Butterworths, Borough Green, Sevenoaks, Kent, TN15 8PH, England.

This is a comprehensive book that covers the morphology, growth, and quality of a range of cereals. It contains contributions from experts worldwide, including a review of the high input, high-yield cereal production systems used in western Europe. It presents a series of major papers and abstracts on cereal production written by international scientists from different parts of the world. The book deals with the following subjects: cereal markets, cereal breeding, cereal quality, cereal structure and development, cereal soils, cereal pests and diseases, cereal agronomy, and cereal production systems.

Gates, H. 1984. Library software for microcomputers. British Library Research and Development Report No. 5798, 78 pp. Cairns Library, John Redcliffe Hospital, Headington, Oxford, UK. OX3 9DU.

Goldsworthy, P.R. and Fisher, N.M. (eds.). 1984. The physiology of tropical field crops. John Willey and Sons, USA. 664 pp. ISBN 0471-10267-9. $ 63.50.

ICARDA, ISNAR, and FAO. 1983. 60 pp. (Arabic).

A report on the technical consultancy upon the cooperation in agricultural research in the Far East and North Africa, held on 17-19 Oct 1983, at Nicosia, Cyprus.

Janick, J. (ed.). 1983. Plant breeding reviews, Volume 1. AVI Publishing Company, Inc., Westport, Connecticut. 397 pp. $ 36.50.

This volume contains nine chapters written by authoritative reviewers on genetics and breeding of maize protein, sweet corn endosperm genes, pearl millet, soybean disease resistance, black walnut, apple rootstocks, phaseolus bean protein, lettuce, and petunia.

Kruger, J.E. and LaBerge, D.E. (eds.). 1984. Third International Symposium on Pre-harvest Sprouting in Cereals. Westview Press, Inc. /5500 Central Avenue, Boulder, Colorado 80301, USA. Bowker Publishing Company, Erasmus House, Epping, Essex, CM16 4BU, England. $ 24.00.

This proceedings volume contains valuable information on pre-harvest sprouting which could be useful for breeders, physiologists, and chemists working on relevant research. It deals with diffеrnt aspects of pre-harvest sprouting, discussed in three sections:

1. Physiology of pre-harvest sprouting
2. Chemistry of pre-harvest sprouting
3. Plant breeding and genetic aspects of pre-harvest sprouting.

The examined species are: wheat, barley, maize, and triticale.

The volume includes a list of participants and a detailed index.

The Fourth International Symposium on Pre-harvest Sprouting Damage in Cereals has been tentatively scheduled for January 1986 in Australia. Members of the committee for that meeting will be: Dr. J.E. Kruger, Canada, President; Dr. D.J. Mares, Australia, Secretary; Mr. N. Derera, Australia; Dr. V. Stoy, Sweden; Dr. F. Weilenmann, Switzerland; and Dr. M. Gale, England. Information concerning the meeting can be obtained from any of the above organizers.

Maindonald, J.H. 1984. Statistical computation. John Wiley and Sons, USA. ISBN 0471-864528-8. $ 53.15.

Mead, R. 1983. Statistical methods in agriculture and experimental biology. Chapman and Hall, UK. 332 pp. ISBN 0-412-24230-3.

Pomeranz, Y. (ed.). 1983. Advances in cereal science and technology. Vol. 4. American Society Cereal Chemists, USA. 357 pp.

Sandford, S. 1983. Management of pastoral development in the third world. John Wiley and Sons, USA. 316 pp. ISBN 0-471-90085-0.

Staples, R.C. and Toenniessen, G.H. (eds.). 1984. Salinity tolerance in plants. John Wiley and Sons, NY. 443 pp. ISBN 0-471-89674-8.

This book comprises papers presented at an international conference, held in Bellagio, Italy, to review the current state of scientists' knowledge of the mechanisms of plant tolerance to salinity and the development of salt tolerant varieties in different crops.

Stillwell, T.C. 1983. Periodicals for microcomputers: an annotated bibliography. MSU International Developing Working Paper No. 6. 65 pp.

UNDP and FAO. 1984. National agricultural research. FAO, via della Terme di Caracalla, 00100, Rome, Italy. 91 pp. (Arabic).

A report on the evaluation of the status of many countries: Algeria, Egypt, Pakistan, etc.

Wilson, M.C. and Broersma, D.B. 1984. Practical insect pest management. Vol. 1. Fundamentals of applied entomology. 2nd edition. Wayeland Press, USA. 216 pp. ISBN 0-88133-031-0.

CEREAL NEWS

Plot Straw Collector Being Developed at ICARDA

The Cereal Crops Improvement Program of ICARDA has initiated a project for the development of a straw collector to be adapted to the conventional research plot combines. Such device will help the cereal scientists to more accurately estimate the grain as well as the straw yields from research plots. The importance of determining the straw yield of the newly developed cereal lines is due to the high economic value of straw in dryland areas. In some countries, the price of straw is close to that of grain and therefore, farmers are keen to grow cereal varieties which produce large total biological yield (straw + grain).

The methods and devices for straw collection presently available in the world are unsatisfactory because of their low efficiency. A newer collector is being designed and tested with the objective of collecting the maximum above-ground dry matter and at the same time maintaining an efficient separation of threshed seed from the nongrain matter. The principle of collection is based on separation of the nongrain matter from the air stream using aerodynamical and mechanical principles. The gravitational forces and inertia of the solid material (straw, chaff, etc.) are used to filter out this material from the air stream for its collection.

The design and subsequent fabrication are being implemented at ICARDA's engineering division. This joint venture between Dr. J.P. Srivastava of the Cereal Crops Improvement Program and Dr. P. Jegatheeswaran will bring out a production of prototype of straw collector with at least 95% efficiency at the initial stage.

Cereal Collaborative Project Tunisia/ICARDA

The collaboration between ICARDA and the national program of Tunisia started in 1980 and has since continued to grow. A cereal scientist from ICARDA was posted at INRAT to work with the national team on barley improvement and cereal pathology. Since 1984 the barley breeding program has been primarily headed by a Tunisian scientist who places more emphasis on the pathology aspects of the three main cereal crops. This is carried out in collaboration with INRAT and INAT.

The total cultivated area is about 4.5 million hectares out of which 1.5 million is planted to cereals (55% durum wheat, 15% bread wheat, and 30% barley). Average annual production from 1976 to 1982 was 1 million tonne (60% DW, 17% BW, and 23% barley) with yield averages of 760, 880, and 530 kg/ha for DW, BW, and barley, respectively.

The commercial varieties grown at present are: Karim, Ben Bechir, Maghrebi, Bedri, INRAT 69, Chili, for durum wheat; Tanit, Salambo, Dougga, Carthage, Ariana 66, and Florence Aurore, for bread wheat; and Martin, Ceres, and unknown landraces, for barley.

Three new high-yielding barley varieties are being registered and released under the names "Taj," "Roho," and "Faiz."

The major diseases of cereal crops in Tunisia are: septoria, tan spot, yellow rust, root rot complex, stem rust, barley stripe, root rot complex, and BYDV, for barley.

ICARDA Contribution

In addition to the national plant material, a considerable amount of durum wheat, bread wheat, and triticale germplasm (segregating material, crossing blocks, observation nurseries, and yield trials) is received every year from ICARDA and CIMMYT. This germplasm is tested for disease resistance, yield, and adaptation in different locations of the country.

Scientists from ICARDA and the national program exchange visits every year to discuss work plans and future course of action. Also, ICARDA is providing certain research equipment and operating support to the national program.

Tunisian scientists and technicians have the opportunity for training in the different training categories of base ICARDA cereal program. From 1979 to 1984 nine technicians have been trained at ICARDA for residential courses and seven others for specialized short courses.

Laboratoire des Céréales,
INRAT, Tunis, Tunisia.

ICARDA's Impact Widens

The International Nurseries Network of the Cereal Crops Improvement Program is helping ICARDA to test and distribute better cereal varieties to more countries each year.

The number of countries which have released cultivars identified through the nurseries system is steadily increasing (Table 1), and many more lines are being considered for release (Table 2).

In the People's Democratic Republic of Yemen, the bread wheat line S 311 x Norteno-Jit 43.2L has just been released, under the name Ahgaf, by the National Committee for Varietal Release.

In Cyprus, one barley and two durum wheat lines identified through ICARDA's international nurseries have been released by the national program. The barley variety, named Kantara, was included in the nurseries under the name Roho, and is also being considered for release in Tunisia. One of the durum varieties, named Mesauria, originates from the cross Anhinga 'S' x Volunteer originally made in CIMMYT, Mexico. The second variety is called Karpasia and is the same variety released in Syria as Sham 1. Karpasia is performing well in farmers' fields, and is replacing older varieties. Large quantities of seed of these three varieties are being provided to farmers.

Table 1. Barley and wheat varieties released in the ICARDA region.

Bread wheat	
Iran	Azadi
Morocco	Jouda = Kal x Bb
	Merchouche
Pakistan	Zargoon = CC-Inia/Tob-Cfn x Bb/7C
PDR of Yemen	Ahgaf = S311 x Norteno
Sudan	Debeira = HD 2172
Syria	Sham 2 = 7C x Tob/Cno/Kal
Durum wheat	
Cyprus	Mesauria = Anhinga'S' x Volunteer
	Karpasia = Sham 1
Egypt	Sohag = Stork'S'
Morocco	Marzak = E12 - BD11
	ACSAD 65
Portugal	Celta = Sham 1
Syria	Sham 1 = Plc'S'/Ruff'S'//Gta'S'/Rtte
Barley	
Cyprus	Kantara = Roho
Iran	Val Fajr
Morocco	Asni
	Taamellalt
	Tissa
Qatar	Gulf = Arivat x Athenais

Table 2. Potential candidates for release.

Thailand	Bread wheat	SW 9 = Tob66-Cno'S' x Pi62/Sk9
Tunisia	Barley	ER/Apam
		Roho
		WI 2198
Morocco	Bread wheat	Nasma = Potam 70
		Potam = Nasma
		Pun (Pato(R)Cal/3/7C//Bb/Cno
		Pavon'S'
		Maya 74-Pvn'S'
	Durum wheat	Belikh = Cr'S'/Stk'S'
		Porzana = 21563-Cr 'S' x Fg'S'
		Toubkal = (Yamen-Cr x Plc/Tebo)Mex
		Grebe'S' = Gs-Cr/21563-AA x Cit
		Erpel/Russo'S'
	Barley	ER/Apam
		UC 77095
	Triticale	Beagle
		Juanillo 95
		Drira-outcross

Sakha 69 and Sakha 61: Two New High-Yielding Bread Wheat Varieties*

Sakha 69 and Sakha 61 are two medium tall, white, spring bread wheat (*Triticum aestivum* L. em Thell) cultivars with white kernels. They are resistant to leaf and stem rusts and also to lodging and shattering, and tolerant to stripe rust.

Both varieties were selected from the F_5 generation of the cross CM 15430 grown at Sakha as F_2 in the 1972/73 season. Their pedigrees are Inia-RL 4220 x 7c Yr "S" CM 15430-2S-5S-0S for Sakha 61 and Inia-RL 4220 x 7c Yr "S" CM 15430-2S-1S-0S for Sakha 69.

Sakha 69 and Sakha 61 were evaluated in the preliminary and screening national yield trials during 1978-82. Grain yield of Sakha 69 exceeded Giza 157 and Giza 155 by 7 and 31%, respectively, while comparable values for Sakha 61 were 7 and 15%, respectively.

Based on their agronomic performance and rust reaction, Sakha 61 was recommended for cultivation in northern Delta, and Sakha 69 for southern Delta and Middle Egypt. About 150.000 feddan was planted to Sakha 61 and 30.000 feddan to Sakha 69 in the 1983/84 season.

Giza 160 (Takamol): A New Bread Wheat Variety for Upper Egypt**

Giza 160 (Takamol) is a medium tall, white, spring bread wheat (*Triticum aestivum* L. em. Thell) cultivar with white kernels. It is resistant to shattering and lodging and tolerant to rusts.

Giza 160 is selected as F_5 (Line 2188/1131) from the cross Chenab 70 x Giza 155 made in 1974. National yield tests carried out during 1978-1982 showed that Giza 160 exceeded Giza 155 and Giza 157 by 19 and 10%, respectively.

Giza 160 is adapted to the wheat-growing area of Upper Egypt and can successfully replace Giza 155 and local types. It is being introduced for cultivation in the northern province of the Sudan, and basic seed is being reproduced.

Release of Glenman (PI 483235) Hard Red Spring Wheat in USA.

The Agricultural Research Service, United States Department of Agriculture, and the Montana Agricultural Experiment Station have jointly developed a semidwarf hard red spring wheat cultivar with resistance to wheat stem sawfly and stem and stripe rusts. This cultivar is named Glenman (PI 483235) and is expected to be released in April 1985.

Cereal Residential Training Course

ICARDA Cereal Residential Training Course will take place at Tel Hadya, Syria, 1 March to 5 June 1985. Emphasis will be given this year to practical training with focus on breeding, pathology, agronomy, and associated research techniques. Participants were accepted from 12 countries: Egypt, Ethiopia, Iran, Jordan, Morocco, Pakistan, Syria, Tunisia, Turkey, North and South Yemen (YAR and PDRY).

Dr. M.A.S. Kirmani, senior scientific officer, PARC/CDRI-Murree, visited ICARDA from 30 Sept to 4 Oct 1984. During his stay, Dr. Kirmani discussed with Dr. O. Mamluk, plant pathologist, and Mr. Joop Van Leur, associate expert (pathology), the salient agricultural system in Syria with reference to ICARDA region, the collaborative research, and the disease nurseries. The discussions covered the following:

1. Continuation of the bread wheat, durum wheat, and barley KLDN at Islamabad, karachi, and Quetta in Pakistan for screening for stripe, leaf, and stem rusts.

*. Abstract of a research paper written by A.S.I. Gomaa, O.S. Khalil, R.A. Abo-Elenin, Kadria F. Hegazi, Enayat H. Ghanem, A. Abdel Shafi, F.F. El-Sayed, A. Gouda, M. El-Shami, A. Agizi, M.S. Saleh, M. El-Hadidi, S. Attia, and M.G. Mosaad and presented at the 2nd General Conference of ARC, Giza, Egypt, 9-11 April 1984.

**. Abstract of a research paper written by A.S. Gomaa, R.A. Abo-Elenin, O.S. Khalil, Kadria F. Hegazi, Enayat H. Ghanem, A. Abdel Shafi, H.A. Ghanem, M.G. Mosaad, M.A. Gouda, G.S. Yousif, R.A. Mitkees, and S. Attia and presented at the 2nd General Conference of ARC, Giza, Egypt, 9-11 April 1984.

2. Planting of stripe and stem-rust nurseries at Islamabad and Karachi, respectively.

3. Planting of a common bunt nursery at Quetta.

4. Presence of common virulences of stripe, leaf, and stem rusts in the Middle East region including Iran, Afghanistan, and India, necissitates planting of a set of trap nurseries at different hot spot locations in Syria and neighboring countries using existing commercial varieties, breeders' advanced material (ready for release), and known resistance genes for stripe, leaf, and stem rusts, separately.

5. Planting of one set of national bread wheat disease screening nursery from Pakistan at a hot spot location in Syria, primarily for stripe-rust screening.

6. Possibility of using the facilities available in Pakistan (PARC/CDRI) for leaf and stem-rust analyses by ICARDA pathologists upon request.

7. The need to develop a stripe-rust virulence analysis in Pakistan; the facilities available at IPO, Wageningen, are being presently used but this might be difficult to continue in the future.

8. Utilization of PARC/CDRI expertise in collecting data on rusts and other diseases from a large number of nurseries in ICARDA region.

9. The need to establish a regional center in Pakistan where infrastructure and expertise could be made available.

Drs. J.P. Srivastava, B.H. Somaroo, and S. Ceccarelli of ICARDA visited Prof. E. Porceddu at the University of Viterbo, Italy, Jan 1985. Italian support for the completion of the Genetic Resources Unit, a collaborative project on evaluation and characterization of durum wheat germplasm, and a joint organization of a workshop on cereal breeding for dry areas were discussed. Prof. Porceddu expressed a keen interest in strengthening the cooperation between Italy and ICARDA and anticipated an official approval of this support by the Italian Government.

Drs. Ortiz Ferrara, Ahmed Kamel, and Miloudi Nachit of ICARDA have recently visited national programs and different research stations in both Tunisia and Morocco. In Morocco, 19-24 Oct, they visited Guiche, Koudia, Merchouche, and Cidera research stations and met with senior scientists from the national programs to discuss possible ways of collaboration of ICARDA and CIMMYT, with the national programs.

Dr. Ferrara travelled to the Sudan where he coordinated the aphid-tolerance screening project and initiated a farmers' field verification trial project.

Dr. Miloudi Nachit visited Jordan from 16 to 18 Oct 1984. During the visit, he met with Drs. M. Duwayri and A. Tell from the University of Jordan, and Mr. Mesaadeh of the Ministry of Agriculture and discussed the joint ICARDA/ University of Jordan/ Ministry of Agriculture on-farm durum wheat and barley trials. The on-farm trials have arisen from the recommendations of the Jordan Collaborative Project on cereals.

Dr. H. Ketata of ICARDA's Cereal Crops Improvement Program visited Pakistan, 18-25 Jan 1985, to finalize technical topics and arrangements for the in-country training course to be held in April 1985 at NARC, Islamabad. The course will be jointly organized by PARC and ICARDA and will focus on the analysis and interpretation of cereal research data. Dr. Ketata worked with Dr. N.I. Hashmi and other NARC and PARC scientists on the curriculum of the course. He discussed training with Dr. Zafr Uddin, Director of AZRI, Quetta, and visited cereal plots accompanied by Dr. M. Nazir at Pishin and by Mr. Sher Mohamed at ARI, Sariab.

Drs. Tahir and Ketata of ICARDA's Cereal Crops Improvement Program visited the Yemen Arab Republic, 18-24 Oct 1984. The aim of the visit was to review the research work on wheat, sorghum, and maize and discuss further cooperation between the national program and ICARDA. With the help of national scientists and FAO experts in Yemen, Drs. Tahir and Ketata visited research stations at Dhamar and Taiz and other research sites and discussed major cereal research issues and findings with national and expatriate scientists. Based on these discussions and their own observations, the two scientists formulated a set of recommendations and a proposal for on-farm verification/demonstration trials for the coming season. Training needs were also discussed with the Director General of the Agricultural Research Authority, Mr. Abdulrahman Sallam, who appreciated ICARDA collaboration and expressed a keen interest in cooperating with ICARDA. The mission was partly financed by FAO to whom a report was sent.

Dr. M. Tahir of ICARDA's Cereal Crops Improvement Program visited the People's Democratic Republic of Yemen as an FAO consultant, 24 Oct-1 Nov 1984, to review research results of sorghum, wheat, and maize and formulate on-farm trials for these crops. Wheat is becoming a staple food crop in this country. Sonalika and Kalyansona bread wheat varieties cover 50-60% of the wheat area, the remaining being planted to old local varieties which are low yielding and susceptible to diseases. A new bread wheat variety, Ahgaf, has been released for commercial production.

Mr. Mumtaz A. Malik from the Cereal Crops Improvement Program participated in a Symposium on 'Advances in Genetics and Crop Improvement' held on 27-29 Dec 1984 at the Department of Agricultural Botany, Meerut University, Meerut, India. Mr. Malik presented a research paper entitled: 'Triticale: potential and constraints as a rainfed crop.' (co-authors of the paper: J.P. Srivastava, M. Nachit, and H. Ketata).

FORTHCOMING EVENTS

Annual Meeting of the Weed Science Society of America, Seattle,Washington, USA. 5-8 Feb 1985.

A Workshop on Rainfed Agricultural Information Network, Amman, Jordan. 17-20 Mar 1985.

The main objective of the workshop is to develop research, training, and information networks among national programs in the ICARDA region. The goal of the workshop is to establish and strengthen linkages among the national programs for a better exchange of information and technical experience in the field of agricultural research in the dry areas.

Arab Conference for Agricultural Research on Basic Food Crops: jointly organized by the Arab Fund of Economical and Social Development (AFESD) and the International Center for Agricultural Research in the Dry Areas (ICARDA). Aleppo, Syria. March 31-April 4 1985.

International Symposium on Chemistry and Physics of Baking: Materials, Processes, and products. The School of Agriculture, Sutton Bonington, near Loughborough, Leicestershire, 10-12 Apr 1985.

The Symposium, organized by the Royal Society of Chemistry; Industrial Division; Food Chemistry Group with the University of Nottingham; School of Agriculture; Department of Applied Biochemistry; and Food Science, will include critical review lectures by international authoroties on constituents, interactions, process developments, and product developments in baking as related to bread, cakes, pastry, and biscuits. In addition, poster and oral presentations are planned on current research topics.

Contact: Mr. J.M.V. Blanshard, Department of Applied Biochemistry and Food Science, The University of Nottingham, School of Agriculture, Sutton Bonnington, Loughborough, LE12 5RD, UK.

ARCO Plant Cell Research Institute-UCLA Symposium, Keystone, Colorado, USA. 13-19 Apr 1985.

This is a part of the University of California, Los Angelos Symposia on Molecular and Cellular Biology, Molecular Biology Institute, Los Angelos, California 90024, USA.

ICARDA/CIMMYT North African Travelling Workshop, Morocco, 15-22 Apr 1985.

A joint ICARDA/CIMMYT North African Travelling Workshop will take place in Morocco, 15-22 Apr 1985. Participants will include scientists from Morocco, Algeria, Tunisia, Spain, and Portugal as well as ICARDA and CIMMYT. The scientists will visit research stations and participate in note taking and plant selection. Common problems encountered during the visits will be discussed and conclusions will be drawn for the improvement of future research work and cooperation in the area.

Fourth Meeting of Technological Exchange in Arid and Semiarid Zones, Villa Dolores, province of Cordoba, Argentina. 26-27 Apr 1985.

Travelling Workshop for the Middle East Region, Jordan/ Syria, 8-15 May 1985.

The International Center for Agricultural Research in the Dry Areas (ICARDA), and the International Maize and Wheat Improvement Center (CIMMYT), are jointly planning a Travelling Workshop for the Middle East region. The main objective of this workshop is to give the national program scientists in the Middle East an opportunity to interact with each other and with scientists in other international centers, and to discuss the on-going research activities.

The workshop will be held from 8 to 15 May 1985 and will include visits to the national cereal research programs in Jordan and Syria as well as to ICARDA research station at Tel Hadya, Aleppo. The last day will be devoted to discussions on breeding and selection methodologies and appropriate agronomic practices for the improvement of barley and wheat production in the rainfed areas.

Thirteen countries in the Middle East region have been invited to participate in this event.

20th International Congress European Brewery Convention, Helsinki, Finland. 2-7 June 1985.

The congress is organized by the: European Brewery Convention, Secretariat General, P.O. Box 510, 2380 BB Zoeterwoude, The Nethrlands, the Finnish Member Organization, Oy Panimolaboratorio/Bryggerilaboratorium AB, P.O Box 192, SF-00121 Helsinki, Finland, and the Congress Secretariat, Finland Travel Bureau Ltd., Congress Department, P.O. Box 319, SF-00101 Helsinki, Finland.

Contact: any of the above organizers.

Meeting of the Cereal Section Working Group on Rye, Svalov, Sweden, 11-13 June 1985.

The meeting of the Cereal Section Working Group on Rye will be held in Svalov, Sweden, during 11-13 June 1985. The following topics are proposed to be discussed:

1. Genetics and biotechnological methods.
2. Breeding of hybrid varieties.
3. Methods for selection and population breeding.
4. Genetic resources and resistance breeding.
5. Breeding for quality.

Contact: EUCARPIA Meeting 1985, Svalov, S-26800 Svalov, Sweden.

International Symposium on Southeast Asian Plant Genetic Resources: The Next Century of Development, Jakarta, Indonesia. 21-24 Aug 1985.

Topics of the symposium include utilization of plant genetic resources in crop improvement, biotechnology and genetic engineering, and training.

Contact: Secretary, Symposium on Southeast Asian Plant Genetic Resources, c/o Lembaga Biologi Nasional - LIPI, Jalan Raya Juanda 18, Bogor, Indonesia.

Middle East Agriculture '85' Dubai, 13-17 Oct 1985.

Contact: Overseas Exhibition Services Ltd., 11 Manchester Square, London W1M 5AB, UK.

Arid Lands: Today and Tomorrow: An International Arid Lands Research and Development Conference, Tucson, Arizona, USA. 20-25 Oct 1985.

Sponsored by the University of Arizona, UNESCO, the US Man and Biosphere Program, the 1985

Arid Lands Conference is to be held in Tucson, Arizona, as part of a three-week long series of events with a focus on desert research, management, conservation, and development. Papers on all topics relating to arid lands water use and conservation, agricultural systems, genetic resources, natural resource management, conservation and reclamation, human adaptations, migrations, and habitations are welcomed.

Send abstracts and other inquiries to: Dr. G.P. Nabhan, OALS, University of Arizona, Tucson, Arizona 85721, USA.

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

Organized by the Triticale Association of Australia, the University of Sydney, and the Australian Institute of Agricultural Science, the symposium will be held in two parts, the first part comprising keynote addresses related to the following topics:

1. Germplasm collection and classification of triticale.
2. Cytogenetics of triticale.
3. Breeding technology and agronomy.
4. Triticale production in specific regions and grower experience.
5. Grain quality and chemistry.
6. Utilization for stockfeed, petfoods, hay, and grower experience.
7. Utilization for human food products.
8. International development and trade.

The keynote addresses will be followed by the presentation of submitted papers and a general discussion will be held at the end of each session. Time will also be allocated for poster presentations. A mid-symposium tour to the Castle Hill Research Station will be organized to observe the National Rust Laboratory and other facilities. This visit will incorporate submitted papers on disease aspects in triticale.

The main objectives of the symposium are the promotion of international trade and development of triticale, the exchange of technical information (agronomy, breeding, and utilization) and the exchange of germplasm.

Contact: Dr. N. Darvey, Organizing Secretary, International Triticale Symposium, Plant Breeding Institute, The University of Sydney, NSW 2006, Australia.

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

This symposium is the first one to be held in East Asia; the last one was organized in Edinburgh in 1981. It will include oral and poster sessions, meetings of scientific and technical committees, workshops for developing subjects and pre- and post-symposium tours. The following tentative topics will be covered:

1. Natural variation, phylogeny and genetic resources
2. Genetic analysis and linkage
3. Mutation
4. Interspecific and intergeneric hybridization
5. Cytogenetics and chromosome engineering
6. Physiological and biochemical genetics
7. Quantitative genetics
8. Molecular genetics and biotechnology
9. Resistance to disease and insect pests
10. Tolerance to environmental stress
11. Malting quality and nutritional quality
12. Breeding methods and hybrid barley

Contact: Prof. S. Yasuda, chairman local organizing committee, Institute for Agricultural and Biological Sciences. Okayama University, Kurashiki, 710 Japan.

CONTRIBUTORS' STYLE GUIDE

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

Editing
Articles will be edited to preserve uniform style but substantial editing will be referred to the author for his approval; occasionally, papers may be returned for revision.

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

Manuscript
Articles should be typed double spaced on one side of the page only. The original and two other legible copies should be submitted. The contributor should include his name and initials, title, program or department, institute and postal address and telex number if available. Photographs, figures, tables etc. should be either 8.5 cm wide (single column) or 17.5 cm wide (double column including space). Figures and diagrams should be drawn in India ink; send original artwork, not photocopies. Define in footnotes or legends any unusual abbreviations or symbols used in a figure or table.

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

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

Examples of common expressions and abbreviations
3g, 18 mm, 300 m^2, 4 Mar 1983; 27%; 50 five-day old plants; 1.6 million; 23 μg; 5^oC; 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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(ICARDA)

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