RACHIS

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The Center and its Mission

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

The Center focuses on areas with 200 to 600 mm annual winter rainfall. Where appropriate, research also covers environments with summer rainfall.

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). The CGIAR, an association of governments, organizations, and private foundations, supports agricultural research worldwide to improve food production in developing countries.

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

Qualified cereal researchers and the libraries of institutions conducting research on barley and wheat may apply for a free subscription by writing to RACHIS, ICARDA, P.O. Box 5466, Aleppo, Syria. Contributions to RACHIS should be sent to Mr Tarek Abdel Malak.

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SHORT COMMUNICATIONS

Editorial

RACHIS, the Barley and Wheat Newsletter, was first published at ICARDA in 1982 with the main objective of disseminating scientific information and research results on barley and wheat, with particular emphasis on stress-affected areas. Over the years, RACHIS has witnessed a continuous increase in the number of its contributors and readers, and attracted the attention of scientists from more and more countries. Thanks to the coordinated efforts of all contributors, it has now become an important source of information for many cereal researchers in the world.

One of the founders and active supporters of this Newsletter, and also a Committee member from its first issue, Jitendra P. Srivastava, completed a 13-year tenure at ICARDA to join the World Bank as crop science specialist. A pioneer researcher associated with ICARDA's work from its early days, Dr Srivastava worked in India from 1965 until 1974 as a wheat breeder and university professor, then joined the Arid Land Agricultural Development Program in Lebanon and Egypt as a project specialist, before finally leading the Cereal Improvement Program of ICARDA in Syria from 1977 to 1989.

Dr Srivastava is well known to cereal workers and farmers for his contribution to wheat and barley research and production in the dry areas of West Asia and North Africa. The members of the Editorial Committee wish him further success in his new career.

Evaluation and Selection of Barley Lines for the Balochistan Highlands, Pakistan

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Abstract

Barley grain and straw are important sources of animal feed in upland Balochistan. The objective of this study was to evaluate the yields of some exotic barley genotypes selected in preliminary screening. Fourteen entries were planted in two locations in both 1987/88 and 1988/89. Two entries, Landrace selection 39-58 and Arabi Abiad, produced a higher grain yield, harvest index, and 1000-kernel weight than the local check. Desirable characteristics for barley selection in upland Balochistan are discussed.

Introduction

In Balochistan province, 0.79 million ha, or 53% of the total cultivated area, are used for rainfed agriculture (Nagy *et al.*, 1987). Rainfed agriculture includes both the "sailaba" and "khushkaba" farming systems. In the "sailaba" farming system farmers preserve moisture from monsoonal rains and then plant cereals (usually wheat) early in the winter. In the "khushkaba" farming system farmers plant crops after the first rain of the winter season. Wheat and barley are the main winter cereal crops.

Most cereal growing areas in upland Balochistan receive less than 250 mm rainfall seasonally. Therefore, the likelihood of growing wheat successfully with this limited precipitation is small in "khushkaba" farming. Barley probably is a more suitable crop since it is more drought tolerant and requires less water to reach maturity than wheat (Ceccarelli *et al.* 1987; Khaled 1987).

Barley grain and straw are mainly used for animal feed. Due to overgrazing of the very large range areas of the province by the rapidly increasing number of ruminants (Asif *et al.* 1988), a large deficit in animal feed exists in Balochistan, especially in the winter season when most of the range vegetation is dormant.

One way to raise barley production in the Balochistan Highlands is to identify more productive barley genotypes to replace the local varieties. A large number of exotic barley genotypes have been introduced and screened under different conditions in upland Balochistan for this purpose. The objective of this study was to evaluate in detail the performance of selected lines in different locations and years.

Materials and Methods

During 1986/87, 142 lines of barley for highland areas, which were received from the International Center for Agricultural Research in the Dry Areas (ICARDA), were planted at three different sites: Quetta (altitude 1750 m, 30^{o} 14'N, 67^{o} 2' E), Khuzdar (altitude 1250 m, 27^{o} 46'N, 66^{o} 39'E), and Kan Mehtarzai (altitude 2250 m, 30^{o} 00'N, 67^{o} 45'E). Fourteen lines with cold and drought tolerance, high yield, and disease resistance were selected for yield trials. Plots were established at Quetta and Kan Mehtarzai in 1987/88 and Quetta and Khuzdar in 1988/89. A randomized complete block design with three replications was used. Plots were 5 m long with 6 rows spaced 25 cm apart. Seed was planted following a 50 mm pre-sowing irrigation. Phosphate and nitrogen were both applied at sowing at the rate of 60 kg/ha. Seeds were hand-drilled at the rate of 100 kg/ha. At maturity the four central rows of each plot were harvested.

Results and Discussion

The 1987/88 cropping season, with poorly distributed, average rainfall less than 200 mm was comparatively less favorable for crop growth and development. The

1988/89 season had better rainfall distribution, particularly in Quetta. Rain occurred during both the crops' vegetative and reproductive growth stages.

Significant differences in grain yield among the entries were recorded in Quetta, but not at Khuzdar nor at Kan Mehtarzai (Table 1). In 1987/88, Landrace selection 39-58 (entry 10) and Arabi Abiad (entry 13) produced the highest grain yield at Quetta and Kan Mehtarzai, respectively. In 1988/89, selection 39-58 developed a significantly higher grain yield in Quetta than the local barley. On average, selection 39-58 and Arabi Abiad yields were higher than the local check and appeared to have the ability to perform moderately well with poor moisture conditions as well as respond when environmental conditions are more favorable.

The biological yield of Kenya Research/Belle (entry 3) was significantly higher than the local check at Kan Mehtarzai in 1987/88 (Table 2). This entry is tall, has a longer maturity period as compared to other tested entries, and requires vernalization to complete its life cycle. However, this entry's grain yield was lower than that of the local barley. Because farmers in upland Balochistan prefer to grow varieties with both good straw and grain production characteristics, both the grain and straw yields of the crop are important selection criteria for desirable genotypes. The importance of straw is exemplified by the fact that in 3 out of 10 years it is too dry to expect grain formation.

Differences in harvest index among the entries were significant ($P<0.05$) in Quetta in both years (Table 3). Harvest index was low in 1987/88 due to severe drought stress at the grain formation stage, which resulted in few and very shrivelled grains in some of the entries tested, particularly in Quetta. Selection 39-58 and Arabi Abiad had higher harvest indices than the local barley in less favorable seasons. Singh and Stoskopf (1971) also reported a strong relationship between the harvest index and grain yield in barley. Therefore, selection for this trait could be useful in upland Balochistan.

Differences in 1000-kernel weight were significant ($P<0.01$) among entries at each site and season (Table 4). Landrace selection 39-58 and Arabi Abiad produced a significantly greater 1000-kernel weight across different environments than the local barley. Knott and Talukdar (1971) also reported that yield could be increased by selecting entries with higher kernel weight.

Table 1. Grain yield (kg/ha) of 14 barley lines tested in four environments.

Entry number	1987/88 Quetta	1987/88 Kan Mehtarzai	1988/89 Quetta	1988/89 Khuzdar	Mean
1	360	1210	1990	890	1113
2	220	1560	1070	440	823
3	20	1090	800	970	720
4	30	1080	620	510	560
5	320	1620	1220	980	1035
6	410	1390	1090	1050	985
7	230	1590	1120	1420	1090
8	340	1010	2020	760	1033
9	610	1530	1660	860	1165
10	870	1310	2870	1050	1525
11	370	1230	1650	720	993
12	520	1040	620	580	690
13	540	2490	1660	1170	1465
14[&]	600	1460	1160	1520	1185
Mean	415	1400	1396	923	
LSD	484	NS	759	NS	

[&] Local check.

NS = nonsignificant at the 0.05 level.

Table 2. Biological yield (kg/ha) of 14 barley lines tested in four environments.

Entry number	1987/88 Quetta	1987/88 Kan Mehtarzai	1988/89 Quetta	1988/89 Khuzdar	Mean
1	3450	4970	9970	2970	5340
2	3900	6600	7200	3250	5238
3	3200	7800	8240	4670	5978
4	2500	4300	11290	3220	5328
5	2750	5190	8550	2970	4865
6	4050	6520	10470	4250	6323
7	3850	6050	10810	4860	6393
8	3150	3700	7950	2830	4408
9	4550	4320	8410	2970	5063
10	3900	4750	10970	3250	5718
11	3400	4920	10050	3140	5378
12	2350	3850	6280	1970	3613
13	3800	6400	8140	4190	5633
14[&]	6450	5330	11070	3890	6685
Mean	3664	5336	9243	3145	
LSD	NS	1766	NS	NS	

[&] Local check.

NS = nonsignificant at the 0.05 level.

Table 3. Harvest index (%) of 14 barley lines tested in four environments.

Entry number	1987/88 Quetta	1987/88 Kan Mehtarzai	1988/89 Quetta	1988/89 Khuzdar	Mean
1	10	24	20	30	21
2	6	24	15	14	15
3	1	14	10	21	12
4	1	25	7	16	12
5	12	31	14	33	23
6	10	21	10	25	17
7	6	26	11	29	18
8	11	27	25	27	23
9	13	35	20	29	24
10	22	28	26	32	27
11	11	25	16	23	19
12	22	27	10	29	22
13	14	39	20	28	25
14[&]	9	27	10	39	21
Mean	11	27	15	27	
LSD	0.8	NS	0.1	NS	

[&] Local check

NS = nonsignificant at the 0.05 level.

Table 4. Thousand-kernel weight (g) of 14 barley lines tested in four environments.

Entry number	1987/88 Quetta	1987/88 Kan Mehtarzai	1988/89 Quetta	1988/89 Khuzdar	Mean
1	28	37	27	38	33
2	30	38	22	34	31
3	31	39	23	42	34
4	20	23	17	27	22
5	23	35	21	34	28
6	26	33	22	34	23
7	30	34	21	39	31
8	20	34	22	36	28
9	29	36	26	44	34
10	29	43	27	38	34
11	26	43	24	43	34
12	29	26	20	34	27
13	31	42	25	40	35
14[&]	17	33	22	37	27
Mean	26	35	23	37	
LSD	0.8	0.5	4	4	

[&] Local check

All 14 selected entries in this trial were facultative types, with a high level of cold tolerance and a prostrate growth habit. Ceccarelli *et al.* (1987) reported that prostrate winter growth habit is a desirable characteristic when selecting cold tolerant genotypes. The prostrate growth habit genotypes usually display very slow vegetative growth in winter, thus not wasting stored soil moisture. However, such lines are usually late maturing and often cannot escape terminal drought. The reported research indicated that early growth vigor in spring is an equally important selection criterion if associated with prostrate growth. Derrera *et al.* (1969) reported that earliness allowed crops to avoid drought during the grain-filling period of crop growth. Clearly, early-maturing varieties would also be at an advantage in this environment, if sufficiently cold tolerant. Therefore, desirable characteristics for barley selection in upland Balochistan are cold tolerance, prostrate growth habit, early growth vigor in spring, and early maturity with a long vegetative and a short reproductive period.

Testing numerous exotic barley genotypes in upland Balochistan under different environmental conditions revealed that the probability of finding high-yielding genotypes is low. However, a few barley lines were selected which are tolerant to environmental stresses and possess the ability to increase yield and stability of production.

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Association of Some Morphological Characters with Barley Grain Yield under Dryland Conditions in Libya

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Abstract

The objective of the study was to determine the association of some morphological and phenological characters with barley grain yield under dryland conditions. Twenty-four barley genotypes were studied in a field experiment during 1988/89. Measurements were taken on grain yield, maturity (growing degree days), grain weight/spike, plant height, coleoptile length, and total root length. Grain yield was significantly correlated with all the morphological characters, but not with maturity.

Introduction

It is still uncertain what the desirable selection criteria are, besides yield itself, for high-yielding barley (*Hordeum vulgare* L.) under dryland conditions. Several researchers have found that early maturity and plant height are associated with high grain yield (Samarrai *et al.* 1987). Plant height and coleoptile length were also found to be correlated with grain yield (Nachit and Jarrah 1986). On the other hand, Zahour (1985) reported that semidwarf barley types did not differ significantly from their tall counterparts in dry-matter or grain yield production. Levitt (1972) found that deep-rooted plants were more drought resistant than shallow-rooted plants.

In the dry eastern part of Libya, successful barley cultivars are generally early-maturing, have good plant height, and long coleoptiles and roots. These characteristics probably are important for barley growing in dry areas. This study aimed to determine the association of four morphological and one phenological characters with barley grain yield under dryland conditions.

Materials and Methods

The Barley Yield Trial for Low Rainfall Areas provided by ICARDA was selected for this study. The experiment was conducted in 1988/89 at El-Fataeh Agricultural Research Station located approximately 300 km northeast of Benghazi, Libya, in a dry region with average annual precipitation of 240 mm. A randomized complete block design with three replications was used. There were 24 genotypes, and the plot size was 9 m^2.

Measurements were taken on grain yield, maturity date, grain weight/10 spikes, plant height, coleoptile length, and root length. Maturity was measured by using the growing degree days method (GDD) from germination to physiological maturity (Everson *et al.* 1976). Growing degrees were calculated as (max. temp. - min. temp)/2 - 4.4^oC. The total root length was estimated by using the line-intersect technique developed by Newman (1966) to the nearest 0.1 cm.

Results and Discussion

The means and ranges for characters are presented in Table 1. The mean grain yield was 2610 kg/ha. Rihane-03 had the highest grain yield, and Esp/1808-4L//WI 2291 the lowest. Rihane-03 also had the highest grain weight/spike. The line WI 2198/4/Avt/Ki//Avt/Tol1/3/Bg/Vt was the earliest. It matured in 114 degree days less than Kv/Mazurka, the latest matured line. There were significant differences among the entries in all studied characters, with the exception of coleoptile length.

Simple linear correlation coefficients among the different characters are shown in Table 2. There was no correlation between earliness and grain yield, a finding in disagreement with the results obtained by Samarrai *et al.* (1987). Grain yield was positively correlated with plant height and coleoptile length. Similar results were obtained by Nachit and Jarrah (1986) in a study on durum wheat under low rainfall conditions. Grain yield was also positively correlated with grain weight/spike and total root length. With the exception of maturity, all the characters considered were significantly inter-correlated. The highest cor-

Table 1. Mean and range of grain yield, grain weight/10 spikes, days to maturity, plant height, coleoptile length, and total root length for the 24 barley genotypes.

Characters	Mean	Range
Grain yield (kg/ha)	2610	1290-3950
Grain weight/10 spikes (g)	18	8-28
Days to maturity (°C day)	1206	1140-1260
Plant height (cm)	96	80-110
Coleoptile length (cm)	7	5-8
Total root length (cm)	161	100-200

Table 2. Linear correlation coefficients among six characters of barley under dryland conditions.

	Grain yield	Grain weight/ spike	Maturity	Plant height	Coleoptile length
grain weight/spike	0.64**				
Maturity	0.16	0.15			
Plant height	0.40*	0.67**	0.06		
Coleoptile length	0.40*	0.55**	0.14	0.50**	
Root length	0.43*	0.58**	0.02	0.81**	0.38*

*, ** = significant at the 5% and 1% levels, respectively.

relation was between plant height and root length. It appears that plant height and coleoptile length in combination are good selection criteria for realizing optimal yields of barley grown in dryland Mediterranean environments.

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Improvement of Grain Yield and Quality of Hexaploid Triticale

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Abstract

The result of using octoploids to improve hexaploid triticale at AEARC, Tandojam, are presented. In an irrigated yield trial in Faisalabad, the highest yielding entry was NIAB-T-598, which was derived from an octoploid X hexaploid triticale cross. It significantly outyielded the barley, durum wheat, and bread wheat checks, and had a 1000-kernel weight as high as that of the best wheat check. It also had a test weight and grain hardness comparable with those of wheat. Further selection was conducted within NIAB-T-598. The encouraging performance of these selections was confirmed in Tandojam the following year.

Research work on triticale at AEARC, Tandojam, focuses primarily on improving the productivity and quality of spring-type hexaploid triticale. The base material was received from CIMMYT, Mexico. Genetic variability was further broadened through the synthesis of primary triticales (Kaltsikes 1974) by utilizing local, well adapted bread wheat and Behrain rye collected from the northern parts of the country. These locally synthesized octoploids were crossed with triticale (6x). Bread wheat X triticale (6x) and its reciprocal cross were also carried out (Hsam and Larter 1974). The resulting segregating generations were selected visually.

Improvement of hexaploid triticale through the use of octoploids was reported by Zillinski (1974) and Skovmand *et al.* (1984). The results of using this approach in triticale improvement at the Atomic Energy Agricultural Research Center (AEARC) are summarized below.

Advanced lines of triticale were compared with durum wheat, bread wheat, and barley in a randomized complete block design under irrigated conditions at NIAB, Faisalabad, in 1985/86. Entries differed significantly in grain yield and percent tiller survival (Table 1). NIAB-T-598, which was derived from an octoploid X triticale (6x) cross, produced the highest yield, significantly higher than the bread wheat, durum wheat, and barley checks. Its 1000-kernel weight was as high as that of the best wheat check. Differences in tiller survival between barley and triticale were non-significant.

The performance of NIAB-T-598 triticale, in comparison with standard bread wheat varieties, was confirmed in another replicated experiment under normal growing conditions at AEARC, Tandojam, in 1986/87. Five of the twelve NIAB-T-598 tested selections significantly outyielded the three bread wheat checks (Table 2). Selection 598-8 had the highest yield and 1000-kernel weight. All 12 selections had a similar or slightly better spike fertility than bread wheat.

Soft kernels and low test weight have been persistent characteristics in triticale. These traits were improved through selection at AEARC, and, as a result, compared well with those of existing commercial bread wheat varieties in Pakistan (Table 3). High-yielding triticale line NIAB-T-598 showed desirable grain hardness as well as test weight. Similar results on quality improvement in triticale have been reported at CIMMYT, Mexico (Amaya *et al.* 1986).

Table 1. Grain yield (kg/ha), tiller survival (%), and 1000-kernel weight (g) of various varieties/advanced lines of durum wheat, bread wheat, barley, and triticale at NIAB, Faisalabad, in 1985/86.

Varieties/ advanced lines	Tiller survival	Grain yield	1000-kernel weight
Barley			
Barley-83	50	3350	37
Durum wheat			
Wadanak	40	3650	40
Bread wheat			
Pak-81	40	4100	38
Lu-26S	42	4250	45
Pb-85	41	4050	39
Triticale			
NIAB-T-183	49	4450	43
NIAB-T-273 (bread wheat X triticale)	50	4380	34
NIAB-T-306 (bread wheat X triticale)	48	3990	36
NIAB-T-598 (octoploid X triticale)	49	4500	45
LSD 5%	5.5	198	

Table 2. Mean grain yield and other characteristics of advanced lines of triticale and bread wheat varieties at AEARC, Tandojam, in 1986/87.

Varieties/ advanced lines	Grain yield (kg/ha)	Plant height (cm)	Spike fertility (%)	1000-kernel weight (g)
Triticale				
NIAB-T-598 -1	4730	140	93	40
" -2	4330	123	93	40
" -3	4670	135	95	42
" -4	5130	130	89	42
" -5	4560	128	94	38
" -6	4650	135	96	41
" -7	4910	135	93	42
" -8	5740	130	93	43
" -9	5550	135	92	41
" -10	5500	132	94	41
" -11	5060	138	94	38
" -12	5580	141	95	42
Bread wheat				
Pavon	3940	94	90	39
Sind-81	5260	112	90	40
Sonalika	3770	100	84	42
LSD 5%	202			

Table 3. Quality characteristics of triticale in comparison with barley, durum wheat, and bread wheat.

Varieties/ advanced lines	Grain color	Moisture content (%)	Hardness (%)	Test weight (kg/hl)
Barley				
Barley-83	Dull white	10.4	70	56
Durum wheat				
Wadanak-83	Amber	9.8	62	74
Bread wheat				
Lu 26S	Amber	9.5	68	74
Pak-81	Amber	10.2	62	73
Barani-83	Amber	10.8	73	77
Triticale				
NIAB-T-183	Amber	9.8	58	70
NIAB-T-256	Amberish-red	10.8	61	71
NIAB-T-273	Amber	10.2	58	69
NIAB-T-598	Amber	11.3	66	72

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Plant Breeders' Right: Its Relevance in India Under Changing Scenario

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Abstract

In India, more than 2,000 cultivars developed by public institutes have been released. The private plant breeding program, although relatively small, has developed gradually over the last years. Arguments in favor of and against the introduction of plant breeders' right (PBR) into India are discussed. Requirements and implications of such introduction are presented.

Plant Breeding in India

India became self-sufficient in food-grains primarily through increasing wheat and paddy production. This was achieved by introducing high-yielding cultivars either developed by CIMMYT and IRRI or bred within the country.

In India, public plant breeding has a major impact on the seed sector. Agricultural universities (26 in total) and institutes under the Indian Council of Agricultural Research (ICAR) play an important role in cultivar development. More than 2,000 cultivars developed by public institutes have been released and notified (Table 1). Since these cultivars were developed by government-funded programs, no attention was given to the plant breeders' right (PBR).

Seed companies started their activities by producing and selling seeds of varieties/hybrids developed by public institutions. For example, in Gujarat seeds of varieties of four crops developed by public institutions have been produced and marketed mainly by the private sector (Table 2).

The private plant breeding program, although very small as compared to the public program, became effective in the last 10 years. Twelve companies are now engaged in plant breeding activities as compared to none before 1947. In 1980, only six private companies had plant breeders. This number increased to 10 in 1986 (Table 3).

Table 1. Number of varieties/hybrids released in India by the Central Variety Release Committee up to 1985.

Cereals		521
Wheat	167	
Paddy	322	
Millets		307
Maize	66	
Sorghum	59	
Pearl millet	58	
Pulses		307
Oilseeds		299
Fibre crops		138
Cotton	114	
Jute	12	
Forage crops		87
Vegetables		344
Flower		1
Total		2004

Source: Handbook of cultivars, N.S Tunswar and S.V. Singh (1985).

Table 2. Percentages of seeds of four crops sold by public and private agencies in Gujarat State, India, during 1985-88.

Crop	1985/86		1986/87		1987/88		Mean	
	Public	Private	Public	Private	Public	Private	Public	Private
Hybrid bajra	8	92	46	54	32	68	29	71
Hybrid cotton	21	79	30	70	24	76	25	75
Hybrid castor	71	29	79	21	7	93	52	48
Wheat	32	68	25	75	32	68	30	70
Mean	33	67	45	55	24	76	34	66

Table 3. Number of seed companies having plant breeders in 1980 and 1986.

No. of breeders/ company	No. of companies	
	1980	1986
1-2	2	4
3-8	4	4
9-14	0	2
Total	6	10

Private companies have so far developed more than 122 crop varieties including vegetables (55), millet (39), cotton (13), fodder (4), oilseed (9), and pulses (2), of which 68% are hybrids (Agrawal 1988a). Most of these varieties/hybrids have not been entered into the system of release and notification by the Sub-Committee on Crop Standard, Release, and Notification of Varieties, and are sold as labelled seeds.

Private investment in plant breeding research has been promoted by the following three instances:

- The severe outbreak of downy mildew on the most popular pearl millet hybrid (BJ-104 released in 1977) in 1984 and 1985, coupled with the decision of the authorities to phase out the seed production of this hybrid, created a very serious situation in India and prompted private companies to develop and test new resistant hybrids.
- Government incentives for growing sunflower encouraged some of the companies to develop suitable sunflower hybrids.
- A number of companies succeeded in popularizing the cultivation of tomato and cabbage hybrid varieties in a few states, e.g. Karnataka. The profit margin from selling seeds of these varieties was stated to be very high.

Most of these developments related to Indian seed companies only. Transnational corporations remained reluctant to start plant breeding programs in India.

Why Plant Breeders' Right

Plant breeding has become expensive over the years. Although no authentic information is available, expenditures involved in developing a variety/hybrid in India have been estimated at Rs 400,000 to 1,000,000. In the USA these costs amount to US$ 600,000 for a soybean or wheat cultivar, and US$ 900,000 for a maize hybrid (Brim 1987). Mastenbrock (1988) estimated a very high expenditure (Dutch Guilders 4 million) for development of a new sugarbeet or wheat cultivar. These costs prompted private companies to seek protection before investing in plant breeding.

Jain (1988) argued that companies would prefer to develop highly uniform and widely adapted varieties. They would take full advantage of breeding materials developed by International Agricultural Research Centers (IARCs) and would weaken the link between IARCs and national programs. The search for new types of genetic resources may not receive the attention needed, and the free flow of genetic materials would be restricted.

The Seed Review Team Report (1968) states that PBR as a means to encourage private research can develop only in the course of time after the establishment of private research facilities. Thus, perhaps the time has come to introduce PBR in India. It may help to boost food grain production to 205 million tonnes or more by 1995, which is a major national objective.

In a survey Agrawal (1988b) found that most private companies were in favor of establishing PBR in India. The aspects of PBR introduction should be debated in view of private plant breeding programs and the new seed policy announced by the Government of

India in Sept 1988. Although the new policy encourages foreign companies to start activities in India, they may be reluctant to do so in the absence of PBR.

PBR: Requirements and Implications

The concept of PBR was developed to secure institutions, companies, or individuals a certain profit margin from developing cultivars. The International Convention for the Protection of New Varieties of Plants (UPOV) was signed in Paris on 2 Dec 1961 by 18 nations.

The introduction of PBR in a country requires that the variety be distinct (D), uniform (U), and stable (S). A system to check these three requisites should be established. No such system exists in India, but two different systems are followed elsewhere: (i) the European system, which requires state-controlled field trials, and (ii) the American system, which is based on computer search for verification of DUS characters.

If PBR is introduced in India, varieties should be either registered, or released and notified by the Central Sub-Committee on Crop Standard, Notification, and Release of Varieties. Under local conditions, the second option is preferable, but its adoption necessitates amending the Seed Act of 1966. A non-restrictive market, however, would allow selling unstable and unadapted varieties under high pressure of publicity (Seed Review Team Report 1968), which happened recently. The PBR is therefore likely to have an important impact on market conduct by seed companies and, hence, on the structure of plant breeding.

The main implications associated with PBR may be (i) economic, including investment consideration, private plant breeding activities, public plant breeding activities, market structure, administrative costs, and cost of seed, or (ii) general, including control of PBR, genetic maintenance, and uniformity.

Theoretically the PBR scheme should be self-financing, but at initial stages government support is needed. At present, seed certification and other related activities in India depend heavily on government subsidy. Therefore, if the scheme is introduced, the government should cover its operating cost. However, it has been reported that increased costs for administering the PBR scheme have been a problem in some of the countries adhering to the UPOV.

Research at the public institutions will be more important than ever before. Many breeders working in private companies will have to rely on scientific research by governmental institutes, whereas most seed companies that do not have breeding programs will rely on varieties bred by the public program. This may provide a check on the price of future varieties.

The PBR, if introduced, should cover both public and private institutions. Breeding a variety in a public institute involves many scientists; consequently, it is difficult to ensure that the right accrue to a particular scientist. In this case, the beneficiary could be the whole institution, or a coordinated project such as ICAR. In addition, part of the royalty received by the institution may be distributed among the research workers who participated in developing the released varieties. This would provide an incentive for better work. Institutions also should invest part of the royalty received in their research activities.

Advantages of PBR are that it would:

- encourage private research, and eventually increase the number of new varieties available to growers;
- make foreign plant varieties, particularly vegetables, available; and,
- create competition.

However, its disadvantages are that it might:

- increase seed cost and create difficulties for small farmers, who account for about 75% of the total agricultural holding in India;
- inhibit exchange of material and foster unhealthy practices;
- encourage the emergence of monopolies in genetic material for specific traits; and,
- allow the holder of the PBR to bring production below demand to increase prices and make more profit.

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Yield Reduction in Seven Egyptian Wheat Cultivars Caused by Stem Rust Infection

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Abstract

The study assessed wheat yield loss and reduction in 1000-kernel weight caused by stem rust infection, and evaluated the tolerance to the disease of seven Egyptian wheat cultivars. The first experiment was conducted in 1985/86 and 1986/87 at Gemmeiza Agricultural Research Station. Seven widely grown bread wheat cultivars were studied under four treatments: natural plus artificial inoculation, natural inoculation, natural inoculation with partial protection, and natural inoculation with full protection. Disease severity and plot yield were measured. In the second experiment, about 300 primary tillers of each cultivar were labelled, disease severity recorded, and later individually harvested and 1000-kernel weight calculated.

Grain yield differed significantly among treatments and cultivars. The reduction in yield was parallel to stem rust severity. The highest yield reduction, 24%, when averaged over seasons and cultivars, was recorded under the artificial and natural inoculation treatment. Giza 162, the only cultivar showing resistant reaction to the disease, produced the highest yield under all treatments in both seasons.

There was significant interaction between cultivars and treatments. In the second experiment, 1000-kernel weight decreased as the severity of stem rust increased. However, the decrease varied among cultivars. Sakha 69 showed the best performance, with less than 3% reduction in kernel weight at up to 50% stem rust infection. Giza 162 and Sakha 69 are recommended as parents for breeding stem rust resistance/ tolerance.

Introduction

Stem rust infection caused by *Puccinia graminis* Pers. f.sp. *tritici* Erikss & Henn. has been a major foliar disease of wheat in Egypt. However, little information on yield losses caused by the disease on local wheat cultivars is available. The problem of stem rust infection of Egyptian wheat varieties probably has been diminished by the introduction of resistant germplasm. In 1947, the cv. Giza 139 (cross between Hindi 90 and Kenya B.256), which carries resistance to stem rust, was bred. Later, different cvs. were bred, such as Giza 144, Giza 150, and Giza 155, that carry stem rust resistance of the same source[1] (Dessouki *et al.* 1974). Since 1962, dwarfing genes and genes for stem rust resistance have been transfered to local cultivars from material introduced from CIMMYT, Mexico (Gomma *et al.* 1988).

The objectives of this study were to assess yield loss and reduction in 1000-kernel weight caused by different levels of stem rust infection to seven Egyptian wheat cultivars, and to evaluate the cultivars' tolerance to the disease.

Materials and Methods

Seven widely grown wheat cultivars, Giza 155, Giza 157, Sakha 8, Sakha 61, Sakha 69, Takamol, and Giza 162, having different genetic backgrounds and different levels of stem rust resistance, were studied. The experiments were conducted in two successive growing seasons (1985/86 and 1986/87) at Gemmeiza Agricultural Research Station in a split-plot design with four replications. The main plots were assigned to the wheat cultivars, and the sub-plots to four different treatments to induce different stem rust levels of infection:

- A - Natural inoculation, plus artificial inoculation with fresh urediospores.
- B - Natural inoculation from the spreader area.
- C - Natural inoculation from the spreader area with partial protection. Plantvax 20* was sprayed at the rate of 2.38 l/ha only once at growth stage 5 (Large 1954).
- D - Natural inoculation from the spreader area with full protection. Plants were kept nearly rust-free by spraying Plantvax 20 four times, once a week, from the beginning of growth stage 5 until ripening stage (11.4).

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1. Giza 144 = Regent 975 - 11 X Giza 139^2
Giza 150 = Mida Cadet (C.I. 12441) X Giza 139^2
Giza 155 = (Regent 975 - 11 X Giza 139^2) X Mida Cadet X Hindi 62

* Plantvax 20 = 2.3 dihydro-5 carboxanilido-6 methyl-1.4 Oxathin- 4.4 dioxide.

Table 1: Grain yield (kg/plot), stem rust severity (%), and grain yield loss (%) for different treatments on seven Egyptian wheat cultivars.

Cultivars	Artificial and natural inoculation (A)			Natural inoculation (B)			Partial protection (C)			Full protection (D)	
	Yield	Rust severity	Yield loss	Yield	Rust severity	Yield loss	Yield	Rust severity	Yield loss	Yield	Rust severity
1985/86											
Giza 155	1.45	40 MS-S	22	1.50	20 MS-S	20	1.66	10 MS-S	11	1.87	0
Giza 157	1.14	80 S	35	1.16	30 S	34	1.40	30 S	20	1.77	10 S
Sakha 8	1.62	60 S	18	1.66	40 S	16	1.67	20 S	16	1.98	5 S
Sakha 61	1.45	20 MS	22	1.52	20 MS	18	1.79	10 MR-MS	4	1.86	0
Sakha 69	1.58	20 MS	23	1.70	20 MS	17	1.97	10 MR-MS	4	2.04	0
Takamol	0.96	90 S	47	0.98	90 S	46	1.39	40 S	24	1.82	10 S
Giza 162	1.90	30 R-MR	10	1.97	20 R-MR	7	2.09	10 R-MR	1	2.11	TR MR
Mean	1.44		25	1.50		22	1.71		11	1.92	
1986/87											
Giza 155	1.34	50 MS-S	27	1.47	50 MS-S	19	1.46	10 MS-S	20	1.82	0
Giza 157	1.11	90 S	34	1.29	80 S	29	1.46	40 S	14	1.70	10 S
Sakha 8	1.47	80 S	4	1.41	80 S	7	1.41	20 S	7	1.52	0
Sakha 61	1.63	30 MS-S	6	1.48	30 MS-S	17	1.52	10 R-MR	14	1.79	0
Sakha 69	1.69	40 MS-S	10	1.32	40 MS-S	30	1.75	10 MS-S	7	1.88	TR R-MR
Takamol	0.78	90 S	46	1.01	90 S	30	1.19	50 S	18	1.45	5 MS-S
Giza 162	1.83	40 MR-MS	14	1.94	30 MR-MS	9	2.13	20 MR-MS	0	2.13	TR-S
Mean	1.40		22	1.42		21	1.58		12	1.80	

LSD (5%) for yield among treatments = 0.09 in 1985/86 and 0.19 in 1986/87.

Main plots and replicates were surrounded by highly susceptible varieties (*Triticum spelta saharences*, Little Club, Baart, and Ramona), which acted as spreaders for the disease. The plants were artificially inoculated with freshly collected urediospores of the prevalent stem rust races to generate an epidemic. The fungicide Indar (R H 124**) was used at the rate of 600 cc/ha to prevent leaf rust infection. Disease severity was recorded at 7-day intervals after rust symptoms had developed by using the modified Cobb's scale (Peterson *et al.* 1948). Yield loss was calculated relative to treatment D.

In the second experiment, the method of Nazim *et al.* (1984) was followed. After heading stage (growth stage 10.1, Large 1954) about 300 primary spikes (main tillers) were individually labelled. Rust severity was recorded for each main tiller, including leaves, sheaths, and head. These spikes, after ripening, were collected by hand and threshed separately. The number of grains per spike and spike yield were determined, and 1000-kernel weight was calculated.

** Indar (RH 124) = 4-n-butyl-1,2,4 triazole.

Results

Table 1 shows that the wheat cultivars were susceptible and moderately susceptible to stem rust, with the exception of Giza 162, which showed a resistant to moderately resistant reaction. On average, Takamol and Giza 157 were the most susceptible, followed by Sakha 8, Giza 155, Sakha 61, and Sakha 69.

Grain yield differed significantly among the seven cultivars under the full protection treatment (Table 1). Giza 162 produced the highest grain yield in both seasons, followed by Sakha 69.

Stem rust infection was highest in treatment A (Table 1), followed by treatment B, C, and D in that order, as expected. Yield differences among treatments were highly significant. The highest yield was obtained under treatment D, and the reduction in yield was parallel to rust severity.

The interaction between cultivars and treatment effects on yield was significant in both seasons. Sakha 61 and Sakha 69 showed high response to one fungicide spraying, which resulted in significant increases in grain yield in 1985/86 (Table 1). Grain loss in Sakha 8 was the same in treatments A, B, and C. Takamol and Giza 157 had good response to both treatments C and D.

Thousand-kernel weight decreased as the severity of rust increased (Table 2). However, the loss varied among cultivars. In addition, there appeared in some cultivars, such as Sakha 61 and Giza 155, a threshold level of infection beyond which a large reduction in kernel weight occurred. Takamol, which showed the highest percentage of infection (100%), was the most susceptible cultivar, with a 43% decrease in kernel weight at that level of infection. Giza 162 was more tolerant to the disease, sustaining a small reduction in kernel weight, even at 60% stem rust infection. Sakha 69 showed the best performance, with less than 3% reduction in kernel weight at up to 50% stem rust infection.

Correlation analysis was carried out between disease severity and reduction in kernel weight. The coefficient of determination (r^2) was lowest for Sakha 69 (0.15) and Giza 162 (0.56). The r^2 value for all the other tested cultivars was higher than 0.90.

Discussion

Inducing different epidemic conditions to achieve a wide range of disease levels by using different treatments resulted in highly significant yield differences. Grain yield of the different cultivars was clearly affected by disease infection, particularly at high disease incidence. However, the responses of the cultivars were different, and it was difficult to determine the threshold of pathogen stress because of the large difference in the infection levels. Therefore, single heads (primary tillers) were used in the second experiment to study the relationship between disease severity and reduction in 1000-kernel weight, to estimate loss in grain yield, and to determine the economic threshold for each cultivar.

Stern *et al.* (1959) used the term 'economic threshold' to indicate the level of infection at which crop-protection measure is recommended. El-Daoudi

Table 2. Thousand-kernel weight (g) and percentage decrease (%D) with increasing stem rust infection for seven Egyptian wheat cultivars.

Rust severity classes	Giza 155		Giza 157		Sakha 8		Sakha 61		Sakha 69		Takamol		Giza 162	
	1000-KW*	%D	1000-KW	%D	1000-KW	%D	1000-KW	%D	1000-KW	%D	1000-KW	%D	1000-KW	%D
0	46	0	42	0	39	0	44	0	43	0	45	0	41	0
5	43	6	39	3	39	1	42	4	43	0	42	6	40	1
10	42	7	39	4	38	2	42	6	42	2	41	9	40	2
20	42	7	37	8	37	6	42	5	42	2	40	11	40	3
30	39	14	36	10	36	8	42	4	42	2	38	14	39	5
40	38	16	34	16	36	8	39	13	42	1	35	21	37	10
50	38	16	34	17	35	11	38	15	42	2	35	22	35	13
60	34	24	31	23	33	17	37	17			33	25	36	14
70	33	28	31	23	30	24	36	20			33	27		
80	32	29	29	29			36	22			32	28		
90			25	37			34	22			31	31		
100											26	43		
Regression coef. (b)[&]	0.35		0.37		0.30		0.23		0.02		0.35		0.14	
Coef. of determination (r^2)[&]	0.95		0.97		0.93		0.90		0.15		0.95		0.56	

*1000-KW = thousand-kernel weight.

[&] % decrease in 1000-KW on rust severity.

(1983) and Nazim *et al.* (1984) reported that the economic threshold for yield loss in Giza 155 caused by leaf rust was below 30% severity, a level beyond which the loss was sharply increased. Results of the second experiment showed that each cultivar has a specific threshold for stem rust infection. The best cultivar was Sakha 69, followed by Giza 162.

Romig and Calpouzos (1970), Mundy (1973), and Nazim *et al.* (1984) reported that the relationship of yield decrease to infection level was strong for varieties susceptible to wheat rust and weak for resistant varieties. In the reported results, the relationship of decrease in 1000-kernel weight to infection level was lowest for Sakha 69 and Giza 162, indicating the superiority of Sakha 69, followed by Giza 162, over the other tested cultivars. Both have been recommended as parents when breeding for stem rust tolerance.

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Rainfed Wheat as Affected by Cycocel, Ascorbic Acid, and Gibberellic Acid Seed Treatments

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Abstract

The use of pre-sowing seed treatment for increasing drought resistance has received attention in different countries. The objective of this study was to investigate the effects of cycocel (CCC), ascorbic acid (AA), and gibberellic acid (GA_3) seed treatments on some physiological traits and grain yield of wheat. Seed was soaked in three different concentrations of each growth-regulator. The field trial was conducted for two winter seasons under rainfed conditions. Physiological traits were measured during the booting/heading stage. Relative water content (RWC), leaf moisture, total chlorophyll content, stomatal aperture length, leaf area, and grain yield were increased, while transpiration was decreased by the treatments over the control. The effects were greater with higher concentrations of the chemicals. The highest RWC, leaf moisture, chlorophyll content, stomatal aperture length, and grain yield (30% more than control) and the lowest transpiration rate were recorded with the 1500 ppm CCC treatment.

Introduction

Unirrigated wheat grows under a gradually increasing moisture stress when conserved soil moisture from the preceding monsoon is the only water source for the crop. To overcome this condition, certain management practices are adopted to induce drought tolerance in plants. An increase in seedling resistance to desiccation can be achieved by a succession of alternate hydrations and desiccations of the seeds. The vitality of the embryo is not affected as long as dehydration and desiccation have only a physical effect on the colloids of the embryo (Arnon 1975). On the basis of these findings, a method for increasing drought resistance of plants by pre-sowing seed treatment was developed by Genkel and Henckel (1961). Plant growth regulators have been found to play an important role in pre-sowing seed treatments by bringing about certain physiological and biochemical changes in the plants (Yadav 1971). The objective of this study was to investigate the effects on some physiological traits and grain yield of wheat under rainfed condition by treating seed with cycocel. ascorbic acid. and gibberellic acid.

Materials and Methods

The experiment comprised 11 treatments: cycocel (CCC) at concentrations of 500. 1000. and 1500 ppm; ascorbic acid and gibberellic acid each at 50. 100. and 150 ppm; distilled water; and no treatment as control. Seeds of the wheat variety Kalyansona were soaked in the above solutions. stirred thoroughly. covered by a cloth wetted with the same experimental solution. and kept moist for 12 hrs at room temperature (25^{o}C). The seeds were stirred frequently to maintain a uniform moisture level. After soaking. the moist seeds were spread out in thin layers and air dried in shade until they reached their original weight (Chinoy 1968).

The seeds were sown at the Agricultural Research Farm of Banaras Hindu University in the winter seasons of 1981/82 and 1982/83. and grown under rainfed conditions. A randomized complete block design with four replications was used. The seeding rate was 100 kg/ha. A uniform basal fertilizer dose of 60. 40. and 30 kg/ha of N. P_2O_5. and K_2O was applied as urea (46% N). single superphosphate (16% P_2O_5). and muriate of potash (60% K_2O). respectively. The soil was sandy clay loam and slightly alkaline (pH = 7.6).

Total rainfall during the crop growth period in 1981/82 and 1982/83 was 102.2 and 59.5 mm. respectively; 48.2 mm were received just after sowing in 1982/83. while in 1981/82. most of the rainfall occurred after flowering.

All the physiological characters were studied 70 days after sowing (at booting/heading) when the inherent drought tolerance of the plant is believed to be lowest (Singh 1981). For transpiration measurement. the intact root system of the plant was placed in a conical flask that was covered with black paper and filled with water through a cotton plug. Vaseline was applied to the cotton plug to check any loss of moisture through evaporation. The whole set up was weighed. kept under field conditions for 24 hrs. and reweighed. The difference between the initial and final weights was considered as transpiration/day. Relative water content (RWC) and stomatal aperture length of the leaf were determined by the methods of Stutte and Todd (1969) and Zelitch (1961). respectively.

Leaf chlorophyll was extracted in 80% acetone solution. The optical density of the extract was measured at 652 nm wavelength with a Spectronic-20 photoelectric colorimeter and calculated by the formula of Maclachlan and Zalik (1963). Length and breadth of the leaves were measured. and leaf area was calculated as per the following formula:

$$\text{Leaf area} = L \times B \times K$$

where L = leaf length. B = leaf breadth. and K = constant.

Results and Discussion

RWC and leaf moisture were significantly increased by the different chemical treatments in both years (Table 1). They were highest in the 1500 ppm CCC treatment. followed by 1000 ppm CCC. and lowest in the control. This indicated that the water saturation deficit in these treatments was lower than in the control.

Some differences in stomatal aperture length were observed among the treatments although they were not statistically significant (Table 1). The longest aperture was observed in the 150 ppm AA and 1500 ppm CCC treatments. and the shortest in the control. Woodruff (1969) also observed that plants from hardened seeds maintained longer stomatal apertures. The aperture length being inversely proportional to pore size probably led to smaller aperture size with the two treatments. This partial closure of the stomata might be responsible for the lower transpiration rates in treated plants (Table 1). The lowest transpiration was recorded in the 1500 ppm CCC treatment. and the highest in the control. Waggoner *et al.* (1964) also attributed the reduction in transpiration to the partial closure of the stomata.

Cycocel at 1500 ppm also recorded the highest total chlorophyll content in both years (Table 1). That the leaf with this treatment retained more moisture was indirectly substantiated by the higher cholorophyll content. as higher chlorophyll indicates greater moisture content of leaves (Freeman and Duysen 1975).

All the chemical treatments significantly increased the leaf area as compared to the control (Table 1). The values were greater at higher concentrations of the chemicals and largest for the GA_3 treatment. which was expected. as GA_3 is a growth stimulant (Bhat *et al.* 1987).

Treating seed with CCC at 1500 ppm produced the highest yield (30% more than control) in both years (Table 1). CCC. being a growth retardant. might have arrested the excessive diversion of photosynthates for stem elongation and favored dry matter production and grain yield. Krishnamoorthy and Goswami (1983) also reported an increase in grain and straw yield by CCC application.

Table 1. Effect of different seed treatments on physiological characters, leaf area, and grain yield in two seasons.

Treatment	Total chlorophyll content (mg/g F.W.)	Stomatal aperture length (μm)	Leaf area (cm^2/plant)	Grain yield (kg/ha)	Relative water content (%)	Leaf moisture (%)	Transpiration rate (g/day/plant)
1981/82							
Control	6.12	41.2	160	1878	70.5	76.3	10.8
Distilled water	6.21	42.0	232	2174	71.6	77.1	10.7
CCC 500 ppm	6.95	42.7	237	2203	74.0	79.3	8.3
CCC 1000 ppm	7.28	42.1	318	2306	74.6	80.1	8.2
CCC 1500 ppm	7.32	42.4	327	2541	75.3	81.4	7.9
AA 50 ppm	6.87	41.2	230	2183	72.3	78.4	9.5
AA 100 ppm	6.92	41.3	336	2291	73.1	78.9	9.3
AA 150 ppm	6.96	42.4	341	2316	73.6	79.1	9.0
GA_3 50 ppm	6.34	41.3	242	2254	72.3	78.6	9.6
GA_3 100 ppm	6.35	41.3	359	2283	73.5	79.0	9.4
GA_3 150 ppm	6.37	41.4	380	2391	73.8	79.4	9.1
LSD at 5%	0.10	NS	68	112	0.3	0.4	0.4
1982/83							
Control	6.15	41.0	174	2102	69.6	75.9	11.4
Distilled water	6.28	41.4	260	2278	70.3	76.4	10.9
CCC 500 ppm	7.01	41.9	263	2417	72.6	78.9	9.1
CCC 1000 ppm	7.35	42.0	347	2532	74.1	79.3	8.7
CCC 1500 ppm	7.37	42.0	358	2862	75.1	80.1	8.3
AA 50 ppm	6.92	41.1	252	2351	72.0	77.9	9.8
AA 100 ppm	6.99	41.2	362	2498	72.8	78.0	9.7
AA 150 ppm	7.02	42.2	368	2601	73.4	78.8	9.3
GA_3 50 ppm	6.42	41.2	269	2418	72.0	77.4	9.8
GA_3 100 ppm	6.45	41.2	370	2501	73.2	78.7	9.7
GA_3 150 ppm	6.50	41.3	399	2653	73.5	79.0	9.4
LSD at 5%	0.13	NS	76	121	0.3	0.5	0.3

CCC = cycocel, AA = ascorbic acid, GA_3 = gibberellic acid.

The overall beneficial effect of CCC on wheat yield against moisture stress also might be due to its influence on root elongation (Pikush and Grinchenko 1973). Deeper penetration of roots in the soil helps to maintain the internal water balance of the plant more effectively by enabling it to absorb more moisture and nutrients. The higher grain yield in the second year was probably due to rainfall coinciding with the crown root initiation as moisture at this stage is believed to be most critical for yield (Varma 1973).

Ascorbic acid is known to bring about certain changes in the lypophillic colloids of the seed, which helps the latter imbibe water even at a high moisture tension (Chinoy *et al.* 1970). This resultant hydrolytic activity was most probably the reason for the better performance of plants raised from AA treated seeds over the control under rainfed conditions.

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Growth Response of Barley to Isoproturon and Bromofenoxim Herbicide Mixture under Saline and Non-saline Conditions

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Abstract

The objective of the study was to compare the effect of a mixture of isoproturon and bromofenoxim herbicides on barley growth under saline versus non-saline conditions. The experiment was conducted in a rain shelter in 1984/85 using potted barley plants. Soil with electrical conductivity of 3.2 ds/m was considered as non-saline. The saline treatment (13.1 ds/m) consisted of adding NaCl, $CaCl_2$, and $MgSO_4$ solutions to the soil. There were four herbicide treatments: 0, 2.0, 2.5, and 3.0 kg a.i./ha. Under non-saline conditions, a significant decrease in plant dry weight and height occured only when the herbicide was applied at the highest rate, whereas under saline conditions, significant decreases in plant dry weight and height started at the lowest rate of herbicide application.

Introduction

In Iraq, moderately salt-affected lands have been cultivated mainly with barley due to its high tolerance to salinity (Pahwa *et al.* 1979). Maas and Hoffman (1977) reported that barley plants could tolerate an electrical conductivity of up to 8.0 ds/m with no reduction in yield. However, they indicated that each additional ds/m above this level may cause a yield reduction of 5%.

There are many reports on the effects of herbicides on barley and other crops under non-saline conditions. Reports on the efficacy of herbicides under salt stress conditions, however, are limited (Pahwa *et al.* 1979) although salt-affected lands are increasing worldwide. Kumar *et al.* (1981) indicated that simazine (2-chloro-4,6-bisethylamino-1,3,5-triazine) had an inhibitory effect on two Bajra genotypes at early seedling stage under saline conditions, but had no adverse effects under normal conditions. Habib *et al.* (1987) found that height of onion plants was significantly reduced by methazole at salinity levels above 4 ds/m.

Isoproturon (N'-(4-isopropylphenyl)-N,N-dimethyl-urea) and bromofenoxim (3,5-dibromo-4-hydroxy-benzaldehyde 2,4-dinitrophenyloxime) mixture has been in common use worldwide to increase the efficacy of weed control in barley fields (Cole and Horsnail 1976; Holroyed and Thornton 1976). The herbicide mixture has also been used in Iraq recently. The current work aims to investigate the effect of isoproturon and bromofenoxim herbicide mixture on barley growth under saline and non-saline conditions.

Materials and Methods

The experiment was conducted at the Agricultural and Water Resources Research Center, Fudalia, Baghdad, in 1984/1985. Plants were grown in 20 cm diameter Mitchrlich's pots holding 6 kg of soil, and kept in a rain-sheltered area. Clay loam soil with electrical conductivity of 3.2 ds/m was regarded as non-saline. The saline treatment (13.1 ds/m) consisted of adding to the soil a solution of NaCl, $CaCl_2$, and $MgSO_4$ at the ratio of 30:50:20. The appropriate amount of the salts was dissolved in distilled water, and the solution was sprayed over air-dried soil while being thoroughly mixed. Twenty seeds of barley (*Hordeum vulgare* L.), cv. Numar, were sown in each pot and seedlings were thinned to twelve, 2 weeks after germination.

The herbicidal treatment included four rates of isoproturon and bromofenoxim mixture, i.e. 0, 2.0, 2.5, and 3 kg a.i./ha. Plants were sprayed with the mixture at tillering stage. Pots were watered to 50% field capacity by weight as needed and the experiment was terminated 9 weeks after planting. Measurements were taken on plant height and shoot dry weight. The experiment was conducted in a split-plot design replicated three times, with salinity as the main plot and herbicide treatments as the sub-plots.

Results and Discussion

The analysis of variance (Table 1) indicated that salinity and herbicide main effects were significant for both dry weight and plant height. Salinity x herbicide interaction was significant for plant height only. When the herbicide mixture was not applied, barley plants grown under saline conditions showed a slight reduction in vegetative vigor, as evidenced by the non-significant shortening of stems and decrease in straw weight (Table 2). Under non-saline conditions, a sig-nif-icant decrease in dry weight and plant height occurred only when the herbicide mixture was applied at the highest tested rate (3.0 kg a.i./ha). But under the saline treatment, significant decrease in dry weight and plant height occurred at the lowest tested rate (2.0 kg a.i./ha). Table 2 also shows that under the saline treatment, shoot dry weight was less affected by the lowest rate of the herbicide than plant height. Similar results were obtained in onion (Habib *et al.* 1987).

Reports indicate that herbicidal phytotoxicity increases under saline conditions (Turner and Loader 1972, 1975, and 1978; Wills and McWhorter 1985), which may be caused by enhanced absorption, penetration, and translocation of the herbicide in plant tissues. The increased penetration and translocation of isoproturon was found to increase phytotoxicity in barley through its effect on the photosynthetic processes (Boyall *et al.* 1980). When this occurs, selectivity of the herbicide might be lost and adverse effect on the plants is expected (Blair 1978).

Table 1. ANOVA for dry weight and plant height (mean squares).

Source of variation	D.F.	Dry weight	Plant height
Replicates	2	22.55	2.17
Salinity (S)	1	256.12*	360.37**
Error (a)	2	3.8	0.50
Herbicide (H)	3	137.73**	73.26**
S x H	3	24.98	27.71**
Error (b)	12	10.93	1.61

*, ** = $P<0.05$ and $P<0.01$, respectively.

Table 2. Effect of herbicide rates on plant dry weight under saline and non-saline conditions.

Herbicide (kg a.i./ha)	Dry weight (g)			Plant height (cm)		
	Non-saline	Saline	Average	Non-saline	Saline	Average
0	24.9	22.7	23.8	28.3	27.0	27.7
2.0	24.2	17.9	21.6	29.0	19.0	24.0
2.5	24.5	12.5	18.5	26.3	17.0	21.7
3.0	15.4	9.8	12.6	23.6	14.0	18.2
Average	22.5	15.7		25.18	19.5	
LSD (P=0.05)						
Salinity		3.43			1.24	
Herbicide		4.16			1.60	

This work suggests that the herbicide mixture of isoproturon and bromofenoxim may not be suitable for barley grown in salt-affected soil with salinity levels of about 13.0 ds/m. Under non-saline conditions, spraying the herbicide mixture at a high rate of 3.0 kg a.i./ha is also not advisable. However, applying the lowest rate, i.e 2.0 kg a.i./ha, may not be adequate to control weeds.

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The Response of Durum Wheat to Early Sowing and Supplementary Irrigation in the Eastern High Plateaux of Algeria

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Abstract

An experiment was conducted at Setif in 1987/88 to study the response of four cultivars to three sowing dates and to supplementary irrigation. Early sowing in Nov significantly decreased the number of plants/m^2, but significantly increased heads/m^2. Supplementary irrigation increased heads/m^2 by 42% over rainfed cultivation. Mean grain yields for the irrigated and non-irrigated treatments were 5160 and 680 kg/ha, respectively. Mean grain yield for Nov sowing was significantly higher than those obtained with later sowings. However, a significant sowing date x irrigation interaction was present. Nov sowing produced higher yield under irrigation, but lower yield under rainfed conditions as compared to later sowings. Significant variety x irrigation interaction was also detected. Under irrigation, cultivars Waha, ACSAD 65, and Vitron significantly outyielded Mondur, though without irrigation, Mondur developed the best yields at the two earlier sowings.

Introduction

Durum wheat (*Triticum turgidum* var *durum*) is the most important food crop in Algeria, and ranks second after barley in terms of area planted. It has been traditionally cultivated in the northern and central parts of the High Plateaux where growing conditions are more favorable.

The major constraints to durum wheat production in these areas are terminal drought and heat stress. With the increasing food demand, government policy tends to encourage farmers to practice supplementary irrigation on durum wheat wherever water is available. Usually, farmers delay wheat planting until the first rains for good seedbed preparation. The objective of the present study was to examine the response of four durum wheat cultivars to early seeding and supplementary irrigation.

Materials and Methods

The experiment was conducted at the Setif ITGC Research Station in the eastern High Plateaux of Algeria during the 1987/88 cropping season. Three sowing dates, 11 Nov (S1), 16 Dec (S2), and 17 Jan (S3), were tested with and without supplementary irrigation on four durum cultivars, ACSAD 65, Waha, Vitron, and Mondur. The supplementary irrigation treatment involved applying approximately 60 mm per irrigation in Feb, Mar, and May (*Fig. 1*). The first irrigation occurred at the beginning of stem elongation stage (Feekes stage 6) in S1, and at tillering stage in S2 and S3.

A split-split-plot design with six replications was used. Irrigation occupied the main plot, sowing date the sub-plot, and cultivar the sub-sub-plot. Seed was sown at a rate of 300 viable seeds/m^2 in 7.5 m^2 plots. N and P were broadcast at the rates recommended for the region, and weeds were controlled with 2,4-D. Data were collected on number of plants/m^2, heads/m^2, grain yield/plot, and emergence and heading dates.

Results and Discussion

Rainfall from Sept to June for the 1987/88 season was only 256 mm (Fig. 1), compared to an average of 450 mm for the region (Baldy 1974). The crop suffered from drought early in the season from Jan to Feb, and from May to June, which hastened crop maturity.

The average growing period in actual days or growing degree days was longer for the irrigated treatment, and decreased with later sowing (Table 1). Averaged over seeding dates, a 2-day difference was found between irrigated and non-irrigated treatments at heading (Table 2). Number of days to heading differed by 31 and 17 between S1 and S2, and S2 and S3, respectively.

The mean number of plants/m^2 was not significantly different between irrigation treatments and among cultivars, whereas significant differences were found among the three sowing dates (Table 2). Percent seed

Table 1. Growing period in days and growing degree days as affected by sowing date and irrigation (averaged over cultivars).

Sowing date	Days*				Growing degree days*		
	S-E	E-H	H-R	Total	S-E	E-H	Total
Irrigated							
S1	18	142	64	224	108	1055	1163
S2	27	109	53	189	161	888	1049
S3	24	85	47	156	163	745	908
Non-irrigated							
S1	18	141	58	217	108	1042	1150
S2	27	104	51	182	161	830	991
S3	24	82	49	155	163	715	878

*S = sowing; E = emergence; H = heading; R = harvest.

	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
Rainfall (mm)	5.7	21.8	34.1	26.2	15.6	7.2	46.1	36.7	37.7	24.9	256
ET (mm)				58	58	62.2	70.7	98.4	113	131	
S1			S11	E28				H18-19		R22	
S2				S16	E11			H25-30		R	
S3					S17	E10			H3-6	R	
Irrigation (mm)						121 (72)	125 (42)		115 (62)		176

Fig. 1. Monthly rainfall and evapotranspiration (ET) during the cropping season with the dates (averaged over cultivars) of sowing (S), emergence (E), heading (H), harvest (R), and irrigation (I).

Table 2. Days to heading, plants/m², heads/m², and grain yield (kg/ha) for the four durum wheat cultivars under two irrigation regimes and three seeding dates (S1, S2, and S3).

Cultivar	Irrigated				Non-irrigated				Grand mean
	S1	S2	S3	Mean	S1	S2	S3	Mean	
Days to heading									
Waha	159	125	110	131	157	122	107	129	130
ACSAD 65	157	123	108	129	157	123	108	130	130
Vitron	158	135	112	135	159	125	111	132	133
Mondur	160	135	114	136	159	129	111	133	135
Mean	159	130	111	133	158	125	110	131	132
Plants/m²									
Waha	140	248	185	191	177	235	178	197	194
ACSAD 65	195	217	205	206	185	216	212	204	205
Vitron	177	211	229	206	179	224	202	202	204
Mondur	165	222	214	200	159	207	207	191	196
Mean	169	225	208	201	175	221	200	199	200
Heads/m²									
Waha	383	320	357	353	281	245	228	251	302
ACSAD 65	444	346	370	387	304	256	251	270	329
Vitron	423	311	340	358	290	246	229	255	307
Mondur	398	309	331	346	252	253	226	244	295
Mean	412	322	350	361	282	250	234	255	308
Grain yield									
Waha	6470	4920	4550	5310	400	710	850	650	2980
ACSAD 65	6140	4840	4910	5300	360	680	750	600	2950
Vitron	5900	4780	5060	5250	400	820	790	670	2960
Mondur	5830	4490	4090	4800	640	080	780	830	2820
Mean	6090	4760	4650	5160	450	820	790	680	2930

emergence was 57.4, 74.1, and 68.1 for S1, S2, and S3, respectively. A 70% seed emergence is considered good under the conditions of the High Plateaux in Algeria, therefore emergence in S1 was unacceptably low. This phenomenon has not been well studied at the ITGC, but it is generally agreed that most losses are due to inadequate seedbed preparation and drought stress when seeds are sown early, and to high soil humidity when sown late.

Irrigation increased the number of heads/m² by 42% (significant at $P<0.01$) (Table 2). The number of heads per unit area is determined at the beginning of the stem elongation stage. It depends on the number of established plants and on the capacity to produce fertile tillers, which in turn depends on soil water availability during the stem elongation stage (Couvreur 1985). Malik *et al.* (1985) reported that early irrigation promotes the development of a secondary root system. Kramer and Sionit (1980) reported that, under competition for water and/or nitrogen, only tillers having a root system longer than 3 cm will survive and produce spikes. Such competition for soil moisture probably took place in the non-irrigated treatment in this study and resulted in 29% tiller mortality.

Early sowing (S1) produced significantly more heads/m² than the later sowings (Table 2). As shown above, Nov seeding (S1) produced fewer plants/m² than Dec (S2) and Jan (S3) sowings. This result suggests that a longer tillering phase allowed the plants in S1 to produce more head-bearing tillers than those in S2 and S3. S1 produced 19.5% fewer plants/m² than S2, but 26.8% more heads/m².

Significant differences were detected among cultivars in the number of heads/m^2 (Table 2), with ACSAD 65 producing the highest number and Mondur the lowest. There was no cultivar x irrigation nor cultivar x sowing interaction.

Mean grain yields averaged over seeding dates differed significantly ($P<0.01$): 5160 and 680 kg/ha for the irrigated and non-irrigated treatments, respectively (Table 2). Water use efficiency, defined as the difference in grain yield between the irrigated and non-irrigated treatments relative to the amount of irrigation water applied, was 25.5 kg grain/mm water. The high value found in this study was due to the low yield of the non-irrigated treatment which resulted from the year's prevailing harsh climatic conditions. Similar results were reported in Tunisia where the yield of cv. Karim was doubled (an increase of 2400 kg/ha) with a supplementary irrigation of 176 mm (Anonymous 1985).

Mean grain yield under S1 was significantly higher than yields under S2 and S3 (Table 2). However, a significant seeding date x irrigation interaction was present. In the absence of supplementary irrigation, the mean grain yield under S1 was significantly lower than those for S2 and S3, but the reverse was true under irrigation.

Mean grain yields were not significantly different among cultivars, but a significant cultivar x irrigation interaction was observed. Under irrigation, Waha, ACSAD 65, and Vitron significantly outyielded Mondur. However, without irrigation, Mondur outyielded the other cultivars at the two earlier sowings. Such genotype x environment interaction has been reported by Duwayri (1984) between Stork and Haurani, and by Keim (1974) between Yamhill and Nugaines. These results suggest that, under a favorable environment, it is preferable to grow Waha, ACSAD 65, and Vitron, whereas Mondur, which seems to be drought tolerant, is recommended for harsh environments.

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The Response of Sprinkler-irrigated Wheat to Nitrogen Application

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Abstract

This experiment studied the responses of bread wheat cultivars to nitrogen application under sprinkler irrigation in Oman. The trial was carried out in 1988/89 at Wadi Quriyat, based on seven cultivars with four N levels: 50, 100, 150, and 200 kg N/ha. The experimental design was a strip-plot with four replications. There were significant differences in grain yield among the cultivars and N rates, but no cultivar x N interaction. Cultivars W.Q.S. 160 and W.Q.S. 151, which were selected from ICARDA materials, were the highest yielding entries. The mean grain yield response to increased N rates was sigmoidal. The rate of 150 kg N/ha appeared to be optimum. The highest yielding cultivar, W.Q.S. 160, was responsive to N, particularly when N was increased from 50 to 100 kg/ha.

Introduction

Sprinkler irrigation of field crops is encouraged in the Sultanate of Oman to make efficient use of the scarce water resources. Accordingly, development of a package of practices for growing bread wheat under sprinkler irrigation has assumed importance in the Sultanate's wheat research strategies. The objective of this experiment was to study the responses of seven wheat cultivars to four levels of nitrogen application under sprinkler irrigation.

Materials and Methods

The trial was conducted in 1988/89 at Wadi Quriyat using seven cultivars (names and origins provided in Table 1) and four nitrogen levels: 50, 100, 150, and 200 kg N/ha. The recommended dose of phosphorus fertilizer (90 kg P_2O_5/ha) and one fourth of the nitrogen were applied to the respective plots at sowing. One week after seeding, the recommended dose of potassium (60 kg K_2O/ha) and one-fourth of the nitrogen were applied. The third split dose of nitrogen was top-dressed at the heading stage, and the last dose was applied at the milky grain stage. Urea (46% N) was used as the source of nitrogen.

The experiment had a strip-plot design with four replications. The replications were laid along the sprinkler lines. The fertilizer treatments were imposed randomly along the sprinklers in each replication and the varietal strips perpendicular to the sprinkler line. The plot size was 9 m^2 and the sowing rate 100 kg/ha. The crop was irrigated daily until good germination was observed, then once every 5 days for an average duration of 5 hrs. All other agronomic practices were followed as per recommendations. Grain was harvested from each plot and the ANOVA was carried out following Gomez and Gomez (1984).

Table 1. Grain yield (t/ha) of seven sprinkler-irrigated wheat varieties under four levels of nitrogen.

Variety	Source	N rate (kg/ha) 50	100	150	200	Mean	Rank
Gonnen	Saudi Arabia	1.00	1.35	1.20	1.55	1.28[a]	6
VR NS 2699	"	1.97	1.84	2.06	1.82	1.92	4
Yecoro Rojo	"	1.20	0.83	1.17	1.05	1.06	7
Sannin	Lebanon	1.35	1.57	1.50	1.72	1.54	5
Cooley	Local check	1.56	2.06	1.99	2.22	1.96	3
W.Q.S.151	ICARDA selection	1.70	1.94	2.40	2.35	2.10	2
W.Q.S.160	"	1.61	2.15	2.32	2.42	2.13	1
Mean		1.48[b]	1.68	1.81	1.88	1.72	

a. LSD (P=0.01) for variety = 0.68.
b. LSD (P=0.01) for nitrogen = 0.26.

Results and Discussion

As expected, highly significant differences in grain yield were observed among cultivars because of their diverse origins (Table 1). There were also significant differences among the different levels of nitrogen. However, the variety x nitrogen level interaction was nonsignificant (ANOVA not presented).

W.Q.S. 160 and W.Q.S. 151, which were selected from ICARDA materials (Mahmoud *et al.* 1987), produced the highest yields (Table 1), followed by Cooley, the local check. Among the cultivars from Saudi Arabia, only VR NS 2699 gave satisfactory yields. This result suggests that varieties should be checked for their adaptability before being included in cultural practice trials. W.Q.S. 160 and W.Q.S. 151 have been monitored over several seasons and found to be highly adapted to Omani conditions.

Table 2. Agronomic performance and other characteristics of wheat varieties included in the experiment.

Variety	Days to heading	Plant height (cm)	Number of productive tillers	Lodging score	Bird damage score	Grain color	1000-grain wt. (g)	Harvest index
Gonnen	65	80	7	0.0-0.5	0.5-2.0	Yellow	30.0	0.15
VR NS 2699	65	84	7	0.0	0.5-1.0	Yellow	36.5	0.30
Yecoro Rojo	55	65	7	0.0	0.5-2.5	Amber	46.5	0.20
Sannin	65	70	7	0.5	0.5-1.0	Yellow	35.9	0.25
Cooley*	80	105	15	1.5-4.0	1.5-2.5	Yellow	47.0	0.10
W.Q.S.151	65	83	7	0.5-1.0	0.5-1.0	Yellow	29.1	0.25
W.Q.S.160	75	70	8	0.0-0.5	0.0-0.5	Amber	35.0	0.30

* Awnless and susceptible to smut.

The high yields of W.Q.S. 160 may be due to its high harvest index and late maturity (Table 2). However, it has amber-colored seeds which may not be appreciated by farmers. The local check, Cooley, had the highest productive tiller number and seed weight, and was the latest maturing. However, it was susceptible to lodging because of its tall, weak stem, and also was susceptible to bird damage due to its awnless feature. It had the lowest harvest index, and the highest biomass. Yecoro Rojo, the earliest to mature, produced less biomass and was heavily damaged by birds. Consequently, it had the lowest yield among the tested cultivars. The average yield of the experiment was comparable with previous fertilizer application experiments on wheat. This confirms that sprinkler irrigation combined with high doses of nitrogen may increase yields in Oman.

The mean grain yield response to increases in nitrogen application doses was positive and sigmoidal (Table 1). The rate of 150 N/ha appeared to be optimum. This is in contrast to an earlier experiment conducted at Wadi Quriat, in which the responses were nonsignificant (Mackenzie 1986). The reported results also differ from those obtained in a previous experiment on cv. Sannin, where 88 kg N/ha was the optimum dose (Anonymous 1989).

With a 50% yield increase between the lowest and highest nitrogen levels used, W.Q.S. 160 was the second most responsive to nitrogen application after Gonnen (55%) (Table 1). It was particularly responsive when N was increased from 50 to 100 kg/ha. Interestingly, Cooley, the local cultivar, was also very responsive to fertilizer application. Application of 150 kg N/ha appears to be optimum under sprinkler irrigation, particularly for the highest yielding cultivars, W.Q.S. 160 and W.Q.S. 151.

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The Response of Two Bread Wheat Cultivars to N, P, and K Application in Northern Sudan

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Abstract

The objective of the study was to compare the grain yield response of two bread wheat cultivars to different levels of N, P, and K fertilizer application. The experiments were conducted over three seasons in the arid tropics of northern Sudan. There were 10 N-P-K combination treatments in a split-plot design. Giza 155, a long-strawed cultivar widely grown in the region, did not respond to nitrogen levels exceeding 48 kg/ha, whereas the newly-released Wadi El Neel, a medium-strawed cultivar, responded to the high nitrogen level of 144 kg/ha. Wadi El Neel also responded to 96 kg P_2O_5/ha while Giza 55 did not. Neither cultivar responded to potassium application.

Introduction

The agricultural soils of the Sudan are rich in phosphorus and potassium. Ayoub and Hassan (1978) reported a P range of 645-685 ppm in Gezira. In the heavy clayey soils of the Gezira region, where about 112,000 ha of wheat are grown, Akasha and Ahmed (1978) found that this crop responded to nitrogen, but not to phosphorus nor to potassium. In the arid regions of northern Sudan (16-22°N), where climatic conditions are more favorable to wheat production, similar findings were reported by Lazim (1973), Kaufmann and Otto (1965), and Dafalla and Gabar (1967, 1968) with various short and tall varieties. The present study was conducted to elucidate the effects of N, P, and K application on yield and yield components of a recently released cultivar, Wadi El Neel, and the traditionally grown Giza 155.

Materials and Methods

The experiments were conducted at Hudeiba Research Station (17° 34' N, 33° 56' E, 350 m above mean sea

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level) in 1982/83, 1983/84, and 1984/85. The soils at Hudeiba are aridisols and known locally as "Karu." These are heavy-textured, calcareous, alkaline old soils (3-8 km from the Nile river) that crack easily due to their appreciable montmorillonitic clay content. They are low in organic matter and relatively poor in nitrogen in the top 40 cm layer. Soil analysis of this layer (Saxena and Stewart 1983) showed a pH of 8.2, an electrical conductivity of 0.53 mmho/cm, a CEC of 51 meq/100g, an ESP of 10, 3.6% $CaCO_3$ and 0.39% organic carbon contents, and a texture of 16% sand, 40% silt, and 43% clay. The mean value for exchangeable K in the area is 1.28 meq/100g (AOAD 1983). The climate is tropical arid with relatively cool winters from Nov to Feb. Rainfall mainly occurs between July and Sept (0-200 mm).

A recently released bread wheat cultivar, Wadi El Neel, and the widely grown cultivar, Giza 155, were tested under 10 N-P-K combinations (Table 1): five levels of nitrogen (0N = no nitrogen; 1N = 48 kg N/ha; 2N = 96 kg N/ha; 3N = 144 kg N/ha; and 4N = 196 kg N/ha); three levels of phosphorus (0P = no phosphate; 1P = 48 kg P_2O_5/ha; and 2P = 96 kg P_2O_5/ha); and two levels of potassium (0K = no potash; and 1K = 96 kg K_2O/ha). Nitrogen was applied as urea, phosphate as superphosphate, and potassium as potassium sulphate. Nitrogen was split in three equal doses that were applied at planting, and 3 and 6 weeks later. Phosphate and potash were banded in the soil prior to sowing.

The factorial treatments were arranged in a split-plot design with three replications in 1982/83, and four each in 1983/84 and 1984/85. The fertilizer combinations were the main plots and the cultivars the sub-plots. The sub-plot size was 12.6 m^2 in the first two seasons and 16 m^2 in the third. Planting occurred during the first week of Nov. Seed was hand-planted in rows spaced 20 cm apart at a seeding rate of 167 kg/ha. The plots were irrigated at intervals of 7-10 days, and were kept weed-free. A single chemical spray against aphids was necessary each season. No disease incidence was reported. In 1983/84 and 1984/85 a random sample of 1 m^2 per plot was taken prior to harvest to determine the number of heads/m^2, seeds/head, and 1000-seed weight.

Results

Differences in mean grain yield among N-P-K combination treatments and between varieties were significant ($P<0.05$) in each of the three seasons (Table 1).

Table 1. Grain yield (kg/ha) of two wheat cultivars under ten different N-P-K treatments in 3 seasons.

N-P-K treatment	Seasons						Grand Mean	
	1982/83		1983/84		1984/85			
	Giza 155	Wadi El Neel	Giza 155	Wadi El Neel	Giza 155	Wadi El Neel	Giza 155	Wadi El Neel
0N-0P-0K	2048	2119	2240	2098	1540	2067	1943	2095
1N-0P-0K	5395	4000	3029	3148	2652	2793	3692	3314
1N-1P-0K	3381	3881	3740	3857	2419	2960	3180	3566
2N-0P-0K	3926	4286	3483	3986	2674	3231	3361	3834
2N-1P-0K	3833	4595	3436	3969	2645	3188	3305	3917
3N-0P-0K	3810	4786	3550	4748	2502	2990	3287	4175
3N-2P-0K	4024	5357	3669	4664	2319	3629	3337	4550
3N-2P-1K	4048	4738	3657	4314	2364	3293	3356	4115
4N-2P-0K	3929	5310	3650	4719	2443	2900	3341	4310
4N-2P-1K	3929	4833	3612	4993	1998	2657	3180	4161
Mean	3652	4391	3407	4050	2356	2971	3138	3804
Significance								
Cultivar	** (±61.4)[&]		** (±74.3)		** (±56.0)			
N-P-K	**		**		*			
N-P-K x cultivar	*		*		NS			

NS, *, ** = nonsignificant at P = 0.05, significant at P = 0.05, and significant at P = 0.01, respectively.

& SE

However, there was significant N-P-K treatment x variety interaction in 1982/83 and 1983/84. Hence, it is more appropriate to examine the individual cultivar response rather than the main effects.

For Giza 155, maximum grain yield was obtained with 1N-0P-0K, 1N-1P-0K, and 1N-0P-0K in 1982/83, 1983/84, and 1984/85, respectively (Table 1). Increase in grain yield as a result of nitrogen application was highest from 0N to 1N (48 kg N/ha). Phosphorus application did not increase grain yield significantly, except for the addition of 1P (48 kg P_2O_5/ha) to 1N and 0K in 1983/84. No response to potassium application was observed. Averaged over the three seasons, the highest yield was obtained with the 1N-0P-0K treatment.

For Wadi El Neel, maximum grain yield was achieved with 3N-2P-0K, 3N-0P-0K, and 3N-2P-0K for 1982/83, 1983/84, and 1984/85, respectively (Table 1). There was a great grain yield response from 0N to 1N, and grain yield continued to increase with nitrogen application up to 3N (144 kg N/ha). A significant grain yield response to the addition of 1P (48 kg P_2O_5/ha) was detected in 1983/84, and to 2P (96 kg P_2O_5/ha) in 1982/83 and 1984/85. Application of 96 kg K_2O/ha decreased yield in general. Averaged over the three seasons, maximum yield was obtained with the 3N-2P-0K treatment. Except in the 0N and 1N treatments, the mean yield of Wadi El Neel was significantly higher than Giza 155.

Differences among N-P-K combination treatments in heads/m^2, seeds/head, and 1000-seed weight were nonsignificant in both 1983/84 and 1984/85 seasons (Table 2). There were no significant differences in heads/m^2 between the two cultivars in the two seasons, and in seeds/head and 1000-seed weight in 1984/85. However, Wadi El Neel had significantly more seeds/head and higher seed weight than Giza 155 in 1983/84. There was no N-P-K x cultivar interaction for the three yield components in both seasons.

Discussion

Giza 155, which is widely grown in the northern region of Sudan, is a long-strawed cultivar (100 cm), while Wadi El Neel, a recent release for the region (Mohamedali 1987), is medium-strawed (87 cm). The height difference probably explains the variation in response to N-P-K application between the two cultivars. The addition of more than 48 kg N/ha resulted in lodging and, consequently, yield reduction in Giza 155. Wadi El Neel, being resistant to lodging, responded posi-

Table 2. Mean heads/m^2, seeds/head, and 1000-seed weight (g) of two wheat cultivars in ten N-P-K treatments over two seasons.

	Heads/m^2			Seeds/head			1000-seed weight		
	1983/84	1984/85	Mean	1983/84	1984/85	Mean	1983/84	1984/85	Mean
N-P-K treatment									
0N-0P-0K	448	450	449	20	35	28	39.7	39.7	39.7
1N-0P-0K	458	542	500	26	34	30	39.6	41.0	40.3
1N-1P-0K	490	563	527	29	33	31	41.0	40.3	40.7
2N-0P-0K	503	557	530	28	32	30	40.0	39.5	39.8
2N-1P-0K	480	554	517	28	35	32	40.0	41.2	40.6
3N-0P-0K	540	541	541	30	34	32	38.1	42.4	40.3
3N-2P-0K	521	617	569	28	30	29	38.5	38.7	38.6
3N-2P-2K	512	584	548	28	32	30	38.3	39.6	39.0
4N-2P-0K	486	576	531	29	34	32	38.6	39.3	39.0
4N-2P-2K	540	556	548	29	32	31	38.3	39.0	38.7
SE$\pm$	21.5	36.8		2.1	2.3		0.97	1.15	
Variety									
Giza 155	506	566	536	25	32	29	38.0	40.5	39.3
Wadi El Neel	489	541	515	29	33	31	40.4	39.6	40.0
SE$\pm$	9.2	11.1		0.7**	0.9		0.42**	0.56	

** = significant at P = 0.01.

tively to high nitrogen doses up to 144 kg N/ha. The response of Wadi El Neel to phosphorus application also was more pronounced, particularly when high levels of phosphorus were added with high levels of nitrogen.

The response to nitrogen application of both varieties is logical as the soils in this area have poor nitrogen and organic matter content. The lack of response to potassium application agrees with the findings of Lazim (1973), Kaufmann and Otto (1965), and Dafalla and Gabar (1967-1968), and confirms that arable soils in northern Sudan are rich in potassium. However, more research is needed to understand the effect of phosphorus and nitrogen x phosphorus interactions, particularly on new varieties.

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Economics of Fertilizer Use on Barley in Rainfed 'Diara' Areas of Eastern Uttar Pradesh, India

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Abstract

The objective of this study was to determine the most profitable N, P, and K fertilizer combination for rainfed barley in the 'Diara' areas. The experiment consisted of eight treatments, and was conducted on large plots in farmers' fields for three seasons. The application of 40, 30, and 20 kg/ha of N, P_2O_5, and K_2O, respectively, resulted in the highest yield and benefit. The application of 40 kg N/ha plus 20 kg K_2O/ha is recommended because it gave the maximum marginal rate of return.

Introduction

'Diara' lands in India suffer from flooding during the monsoon for various periods of time, and from drought before and after the floods. Barley, the dominant winter crop on these lands, gives very low average yields (1010 kg/ha), mainly due to the difficult economic conditions of farmers, who still follow traditional cultural practices, and seldom use fertilizers, particularly phosphorus and potassium. The objective of this study was to determine the most profitable fertilizer combination to be applied to barley in this region.

Materials and Methods

The experiments were conducted on farmers' fields under rainfed conditions at Ganga 'Diara', Karanda, Ghazipur, Uttar Pradesh, India, for three consecutive winter seasons (1985/86, 1986/87, and 1987/88). Average annual rainfall of the region is about 1080 mm. Its lower 'Diara' (fluvisol) soil has a clay-loam texture and a neutral pH, with average initial available N, P_2O_5, and K_2O levels of 179, 15.2, and 278 kg/ha, respectively.

A randomized complete block design was used, with eight treatments (Table 1), three replications, and 9.7x9.6-m plots. The barley cultivar Karan-3 (huskless) was sown at a rate of 100 kg/ha in furrows spaced 30 cm apart, and the fertilizer was placed 2-3 cm below the seeds at sowing. In each plot an area of 8.9x8.4 m was harvested.

Table 1. Average grain yield of Karan-3 barley under different combinations of N, P, and K over three consecutive seasons.

Treatment	Fertilizer (kg/ha)			Grain yield* (kg/ha)
	N	P_2O_5	K_2O	
1	0	0	0	2378 f
2	40	0	0	2922 d
3	0	30	0	2466 f
4	0	0	20	2497 f
5	40	30	0	3524 b
6	40	0	20	3144 c
7	0	30	20	2643 e
8	40	30	20	3742 a
SE				50

* Values followed by the same letter are not significantly ($P<0.05$) different.
SE = standard error.

Results and Discussion

Yield in the control (Table 1) was significantly lower than that in all the other treatments, except treatments 3 (P only) and 4 (K only). The application of each of the three fertilizers, separately or in combination with the other two, resulted in a grain yield increase of 3.7 to 57.4% over the control. The yield obtained in treatment 8 (N, P, and K) was significantly superior to the rest of the treatments.

The partial budget of the experiment is given in Table 2. Treatment 8 (N, P, and K) gave the highest net benefit followed by treatment 5 (N and P), whereas treatments 3, 4, and 7, where only P and/or K were added, gave the lowest net benefit.

Although the highest net benefit was obtained with treatment 8, treatment 6 (N and K) was found to be the best as it gave the maximum marginal rate of return. Therefore, it is recommended that 40 kg N plus 20 kg K_2O/ha be applied to rainfed barley in the 'Diara' area, the second best choice being 40 kg N + 30 kg P_2O_5 + 20 kg K_2O/ha (treatment 8).

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Table 2. Partial budget of fertilizer trial on barley.

Treatment	Net yield[1] (kg/ha)	Gross benefit[2] (Rs/ha)	Variable cost (Rs/ha)			Net benefit (Rs/ha)	Marginal rate of return (%)
			Nutrients[3]	Nutrients application[4]	Total		
1	2140	3959	0	0	0	3959	
2	2630	4865	196	30	226	4639	301
3	2219	4105	225	30	255	3850	-43
4	2247	4157	40	30	70	4087	183
5	3172	5868	421	30	451	5417	323
6	2830	5235	236	30	266	4969	380
7	2379	4401	265	30	295	4106	50
8	3368	6231	461	30	491	5740	363

1. 10% field losses assumed on gross yield.
2. Rs 1.85/kg barley.
3. Based on the prices of urea, single superphosphate, and muriate of potash.
4. Rs 15/day for two days.

Economics of N on Dryland Wheat in Morocco: Soil, Rotation, and Season Effects

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Abstract

The study examined economic returns of N fertilizer on bread wheat as affected by soil type, previous crops, and seasonal or rainfall variation. The experiment was conducted in farmers' fields under rainfed conditions in the Settat area of central Morocco during 1986/87 and 1987/88. One shallow, one medium, and one deep soil types were chosen for the study. The previous crops at the shallow soil were barley, fallow, or legumes, while those at the medium and deep soils were wheat, corn, or legumes. The fertilizer treatments were 0, 30, 60, and 90 kg N/ha as ammonium nitrate for the shallow soil, and 0, 40, 80, and 120 kg N/ha for the two deeper soils. Rainfall at the trial sites varied from a low of 200 mm in 1986/87 to an above-normal 471 mm in 1987/88. On the shallow soil in 1986/87, maximum net revenue was obtained at 30, 60, and 90 kg N/ha for the crop following a legume, fallow, and barley, respectively. In the wet year, net revenue increased with up to 90 kg N/ha for the crop following legume and fallow. On the deep soil in 1986/87, net revenue was maximized with 120, 40, and 0 kg N/ha for the crop after wheat, corn, and legume, respectively. In the wet year, net revenue increased as the N rate was increased for each of the three rotations. Benefit/cost ratios for N application were generally highest after cereal on both shallow and deep soil types, and higher in 1987/88. Favorable benefit/cost ratios were obtained with N application after fallow in the wet year but not in the dry year. In general, N application after a legume gave poor benefit/cost ratios. Implications of these results on N fertilizer use for dryland wheat in Morocco are discussed.

Introduction

While farming in the entire North Africa-West Asia region is plagued by low and erratic rainfall (Cooper *et al.* 1987), deficiency of soil nutrients is of almost equal importance in limiting yields in most countries of this semi-arid dryland zone (Harmsen 1984). With increasing emphasis on raising output of rainfed cereals in Morocco (Shroyer *et al.* 1990; Ouatter and Ameziane 1989), various agronomic trials have underlined the yield increases that can be achieved by using fertilizers, particularly nitrogen (Abdel Monem *et al.* 1990; Soltanpour *et al.* 1989).

Recognizing that few, if any, technological innovations or crop production strategies will become viable or sustainable without due consideration of economic aspects has led increasingly to an incorporation of economics with biological studies (e.g., Guy *et al.* 1989; Legg *et al.* 1989). Agronomists have traditionally sought to achieve maximum biological yields, but such objectives do not necessarily coincide with those of the farmer; he is more interested in maximizing his return on his investment, e.g. fertilizer. However, a quantitative description of crop response to fertilization is a necessary base to estimate relevant economic parameters (Barreto and Westerman 1987).

In Morocco, Soltanpour *et al.* (1987) showed that where significant yield responses occured, the returns on N and P investment were mostly economical. As crop response to N varied greatly with different soils, previous crops, and rainfall (Abdel Monem *et al.* 1988; Soltanpour *et al.* 1989), the economic response is likely to vary similarly. Cooper *et al.* (1987) found that economic response to fertilization varied with agroclimatic zones, i.e., by implication, with varying rainfall. Somel *et al.* (1989) showed that fertilization of rainfed barley in Syria is economic, however, crop response, and thus economic response, is modified by the previous crop or rotation.

While the use of fertilizers in other areas of the world may be compelling, its proposed use in the low rainfall cereal-growing area of Morocco has to be seen in terms of socio-economic factors such as farm size, credit availability, and perception of the risk of crop failure. These factors have no doubt contributed to the reported low use of fertilizers in this area of Morocco (Primov 1987). This study examined economic returns of N fertilizer on wheat as affected by soil type, previous crop, and seasonal or rainfall variation.

Materials and Methods

The trial was conducted in farmers' fields under rainfed conditions with fall-planted spring wheat in the Settat area of central Morocco during the 1986/87 and 1987/88 growing seasons. Details are presented elsewhere (Soltanpour *et al.* 1987; Abdel Monem *et al.* 1990). Three widely occurring soil types in the area, i.e., shallow lithic Rendoll (25-30 cm), a Calcixeroll of medium depth (40-60 cm), and a deep (< 1 m) Chromoxerert, were studied. The previous crops at the shallow soil were barley, fallow, or legumes, while those at the medium and deep soil sites were wheat, corn, or legumes.

The fertilizer treatments were 0, 30, 60, and 90 kg N/ha as amonium nitrate for the shallow soil and 0, 40, 80, and 120 kg N for the two deeper soils. Phosphorus was added as triple superphosphate at 0, 9, 18, and 30 kg P/ha. Both fertilizers were broadcasted by hand and incorporated by the offset disk or "covercrop". The bread wheat cv. Nesma was sown by drill at 70 kg/ha. Carbofuran (Furadan 5G) was drilled with the seed at 1.12 kg a.i./ha to control Hessian fly (*Mayetiola destructor* Say), the most common and devastating insect pest of cereals in Morocco. Each plot was 1.8x10 m, with six rows of wheat spaced 30 cm apart. The experimental design was a randomized complete block with three replications.

Subsequent cultural practices involved spraying with Cetrol H to control weeds (5 l/ha) and with Tilt (0.25 kg/ha) to control leaf diseases. The plots were harvested in late May. Total dry matter and grain yield were measured.

Only the shallow and the deep soil were considered in the economic analysis, as they represent the range in crop response. The retail price of ammonium nitrate (33.5% N) was 124 dirhams (Dh) per 100 kg. Average prices obtained by farmers for grain and straw were 200 Dh/100 kg and 50 Dh/100 kg, respectively. Gross and net revenues were then calculated for each treatment, along with the benefit/cost (B/C) ratios, which were calculated as the marginal net revenue over the control to the marginal cost over the control. A B/C of 2 was adopted as a critical value for fertilizer response in accordance with FAO criteria for small farmers.

As there was no significant response to P in either year, N responses were averaged over all P treatments. Since triple superphosphate was common to all N treatments, its cost was ignored in the calculations, so was the cost of Furadan, herbicide, fungicide, and hand labor. The only variable cost in relation to yield was that of ammonium nitrate.

Results

Rainfall at the trial sites varied from a low of 200 mm in 1986/87 to an above-normal 471 mm in 1987/88. The economic responses varied widely with the crop rotation and between years, while large differences existed between the two contrasting soils.

On the shallow soil in 1986/87, both gross and net revenue increased with increasing N rate following barley. After fallow, net revenue was maximized at the 60 kg rate, whereas following a legume, the 30 kg rate was sufficient for maximum net revenue (Table 1). The highest net revenue was obtained after barley with 90 kg/ha.

In 1987/88 yields without fertilization were 2 to 3 times higher than in 1986/87 (Table 1). In addition, N fertilization had a different effect on revenue compared to the previous dry year. This time, net revenue continued to increase up to the 90 kg N rate where wheat followed the legume and fallow, whereas the 60 kg rate produced the maximum net revenue after barley.

Data from the deep soil (Chromoxerert) exhibited different net revenue pattern (Table 2). For the dry year (1986/87), net profit was maximized with the 120

Table 1. Revenue (Dh/ha) from wheat under four levels of N application following three rotations for two years on a shallow soil.

Rotation	N (kg/ha)	1986/87 Grain	Straw	Gross	Net	1987/88 Grain	Straw	Gross	Net
Barley	0	1020	585	1605	1605	3240	1220	4460	4460
	30	1500	775	2275	2164	4060	1525	5585	5474
	60	1840	975	2815	2593	4500	1695	6195	5973
	90	1960	1055	3015	2683	4242	1585	5825	5492
Fallow	0	1020	725	1745	1745	2600	1210	3810	3810
	30	1200	790	1990	1879	3000	1530	4530	4419
	60	1380	845	2225	2003	3500	1790	5290	5068
	90	1320	845	2165	1832	3660	1955	5615	5282
Legume	0	1180	740	1920	1920	3840	1715	5555	5555
	30	1500	860	2360	2249	1080	1895	5975	5864
	60	1300	805	2105	1883	4220	2040	6260	6038
	90	1320	910	2230	1897	4660	2180	6840	6507

Table 2. Revenue (Dh/ha) from wheat under four levels of N application following three rotations for two years on a deep soil.

Rotation	N (kg/ha)	1986/87 Grain	Straw	Gross	Net	1987/88 Grain	Straw	Gross	Net
Wheat	0	420	285	705	705	4780	2370	7150	715
	40	1080	570	1650	1502	7740	3655	11393	1124
	80	1160	670	1830	1534	8160	3570	11730	1143
	120	1300	755	2055	1611	8800	4325	13125	1268
Corn	0	1520	805	2325	2325	4520	2380	6900	690
	40	1900	1120	3020	2872	5680	3205	8885	878
	80	1840	1160	3000	2704	6400	3475	9875	957
	120	1800	1245	3045	2601	6540	3790	10330	988
Legume	0	1380	815	2195	2195	7180	3300	10480	1048
	40	1380	885	2265	2117	7360	3525	10885	1073
	80	1380	865	2245	1949	7680	3695	11375	1107
	120	1380	875	2255	1811	7680	3885	11565	1112

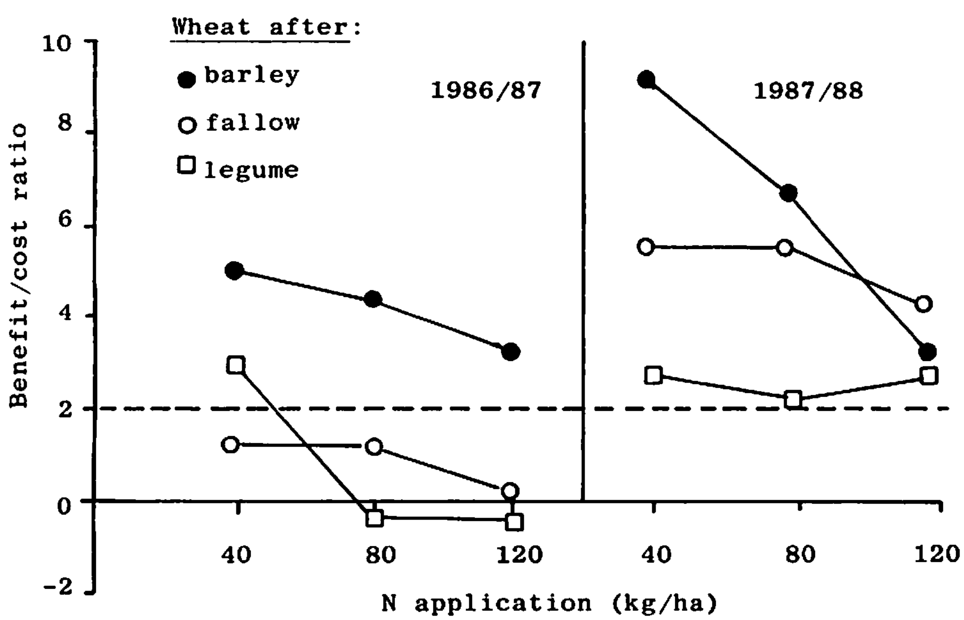

Fig. 1. Benefit/cost ratios for N application following three rotations for a shallow soil in two years.

kg N rate following wheat, whereas the 40 kg rate was adequate after corn. However, N fertilization decreased net revenue following the legume. In the wetter year (1987/88) net revenue was 5 to 10 times higher than in the dry one. For each of the three rotations, net revenue increased as the N rate increased.

On the shallow soil (Fig. 1), B/C ratios were generally highest after barley and higher in the wet year (1987/88) than in the dry one (1986/87). This reflects the lower levels of soil N following a cereal. While N application was profitable after fallow in the wet year, it was not so in the dry year. Adding more than 40 kg N/ha after a legume had a negative return on investment in the dry year. This reflects that adequate N was present in the soil from the previous legume crop. B/C ratios for fertilizer investment followed a similar pattern on the deep soil (Fig. 2). B/C ratios were much greater in the wet year than in the dry one. With increasing increments of N, the B/C ratios decreased consistently.

Discussion

The simple economic analysis of this researcher-controlled on-farm trial has important implications on fertilizer use for dryland wheat in Morocco. As crop yields were highly responsive to N given adequate rainfall, N fertilizer use proved economical, especially in the wet year and on deep soil. In fact, these data to some extent support existing farmer practice in the region, i.e., using little or no N on shallow soils and more on the deeper soils, as well as applying additional N in spring. Though Ryan *et al.* (1990) showed no agronomic advantage of splitting the N rate or applying it in spring, it is wiser from the economic viewpoint to delay N until spring, in order to assess growing conditions.

The analysis presented here suggests that, for a farmer with limited financial resources for fertilizer purchase, it would be advisable to use reduced N rates on all fields rather than heavy application on some and none on others. It also showed how losses can be avoided by not applying N where it is not needed, i.e., after legumes. This highlights the concept of sustainable low input agriculture and the need to incorporate fertilizer use in the entire farming system.

While the present experiment investigated only responses to N, fertilizer use usually involves other nutrients (Aslam and Javed 1986). In addition, the use of fertilizers by farmers involves factors not considered here. However, the study did show circumstances where fertilizer N is likely to be profitable for cereals in Morocco.

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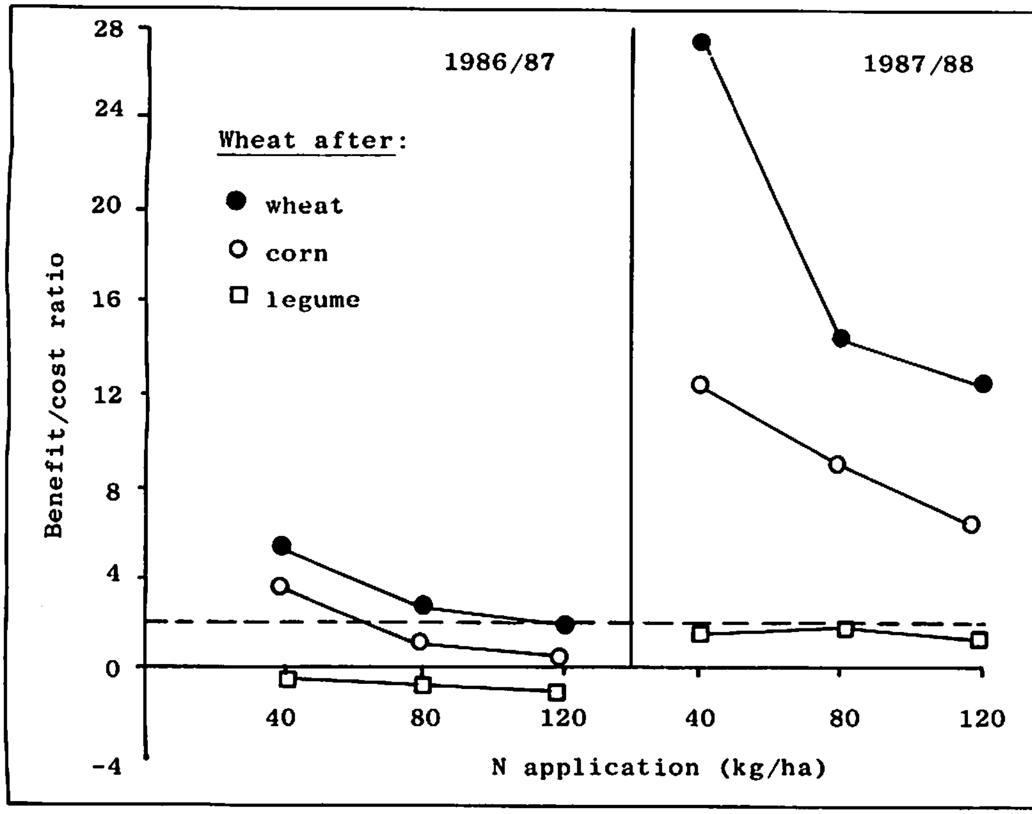

Fig. 2. Benefit/cost ratios for N application following three rotations for a deep soil in two years.

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Short Communications

Potential of Wheat Multilines in Submontane Tract of Northern India

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In the submontane tract of northern India, crops are largely raised under rainfed conditions. The wheat crop is grown in the post-rainy season and its yield depends on the moisture conserved in the soil. Wheat yields are low and unstable due to environmental adversities. In 1987/88, India faced a severe drought, and rainfall was low in this area (Table 1). In contrast, northern India had exceptionally high rainfall (more than twice the long-term average) in 1988/89. The performance of two mixtures of near isogenic lines (NIL) and four pure line varieties of wheat which were grown in this area during the above mentioned two seasons is presented. The objective of growing these lines was to study their agronomic performance and assess their yield stability in contrasting environments.

Two multilines, KSML 3 (a mixture of six NIL in Kalyansona background) and SKAML 1 (a mixture of six NIL in Sonalika background), and four pure line varieties, WL 2265, PBW 54, PBW 65, and PBW 175, were grown at the Regional Research Station for Kandi Area, Balachaur, Hoshiarpur, India, in a randomized complete block design with three replications in both years. Data on plant stand and grain yield/plot were recorded each year. As the plant stand was low and variable in both seasons, a covariance analysis was conducted to adjust grain yield.

In both seasons, the two multilines produced higher yields than the pure line varieties, including PBW 175, a recently bred pure line variety for rainfed conditions of this area (Table 2). Thus, the multiline approach may not be as conservative as stated by Day (1978). These observations suggest that mixtures of NIL, related lines, or varieties may be useful to stabilize and increase wheat production in the submontane tract of northern India, or under similar adverse conditions.

Table 1. Rainfall (mm) in the submontane tract of Punjab, northern India.

Period	1987/88	1988/89	Long-term average
Nov to Apr	103.7	262.7	164.0
12 months	759.8	2064.9	917.0

Table 2. Grain yield (kg/ha) of four pure lines and two multilines of wheat in two years with highly contrasting rainfall.

Variety	Grain yield*	
	1987/88	1988/89
Pure lines		
WL 2265	730±35	1330±21
PBW 54	940±28	1470±19
PBW 65	1420±27	1370±22
PBW 175	1370±24	1250±24
Multilines		
KSML 3	1910±22	2060±19
SKAML 1	1950±19	1830±21
Mean	1390	1550

* Mean grain yield ± standard error.

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Day, P.R. 1978. The genetic basis of epidemics. Pages 263-285 *in* Plant Disease - An Advanced Treatise. Vol. II. How Disease Develops in Populations (Horsfall, J.G. and Cowling, E.B., eds.). Academic Press, 24/28 Oval Road, London, UK. 436 pp.

Modified Scissor Emasculation in Durum Wheat

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Emasculation of wheat is tedious and time consuming. The shortness of the crossing season and involvement of emasculation in various breeding programs prompted breeders in the early 1930s to develop an easier and more efficient emasculation procedure. Suneson (1937) used a freezing temperature technique to destroy immature anthers. Later, Suneson (1940) reported a recessive mutation responsible for rudimentary anthers, and suggested its use to facilitate crossing. The impracticability of this procedure under field conditions necessitated the development of a new emasculation procedure. Wells and Caffey (1956) advocated the scissor emasculation method, which has become the standard technique in wheat and barley.

Three different scissor emasculation procedures were studied in durum wheat (IWP 5308) at Haryana Agricultural University, Hisar, in 1987/88. The conventional emasculation procedure (T1) included using forceps to remove the upper and lower immature spikelets and central florets of the female spike. The upper one-third portion of the glumes of the remaining florets was clipped with scissors and green anthers were picked up with forceps. In the second treatment (T2), the upper and lower immature spikelets and central florets of the spike were removed. The upper half of the remaining florets was clipped with scissors. The third treatment (T3) was similar to T2, with the exception that the central florets were not removed. Florets in T2 and T3 were cut across the filament of the anthers and the remnants of the filaments were left in the florets. Considerable care was taken so that all the anthers were cut and removed, especially in the primary florets which have a lower position than the secondary (central) florets. Each treatment included 15 spikes (five in each replication) of which the upper and lower spikelets were clipped in such a way as to get 42 florets per spike.

In T1, T2, and T3 the average number of grains formed per spike were 27 (64%), 27 (65%), and 26 (61%), respectively. The differences were nonsignificant. A slightly lower number of seeds set per spike in T3 could be attributed to the presence of central florets which might be sterile. Mass pollination in treated spikes resulted in equally good seed set in all three treatments, and there was no seed set in any of the spikes when not pollinated. This demonstrated that the modified emasculation procedures did not cause any injuries to the stigma.

In conclusion, the seed set in all three treatments was equally good, but method T3 involved less labor and time. The removal of the central florets is probably unnecessary to have a good number of crosses and seed set in a short span of time in durum wheat, but its effects on seed size need to be studied.

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Effect of Aqueous Azolla Extract and Sodium Chloride on Wheat Seedling Growth

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Azolla is a small, free-floating aquatic fern which lives in symbiosis with a filamentous blue-green alga, *Anabaena azollae*. The alga is capable of fixing sufficient molecular nitrogen to meet the entire nitrogen requirement of the association. Because of its rapid growth and high N content, azolla has been used as a green manure in rice culture for centuries in Vietnam and China. N fixed by repeatedly harvested azolla (*A. pinnata*) culture can be as high as 500 kg/ha/year (Li 1984). The incorporation of azolla as green manure or dry mass in wheat crop has not been reported. The present work was undertaken to study the effect of an aqueous extract of azolla, in combination with sodium chloride, on the seedling growth of wheat.

A 2.5% azolla extract was prepared by soaking dried powdered azolla in distilled water for 24 hrs. Five ml of the extract was added to a 0.8% sterilized agar gel media adjusted to 0, 0.2, 0.4, or 0.6% NaCl. Four other treatments having the same NaCl levels, but with no aqueous azolla extract, also were prepared. Fifty ml of each of the preparations was then poured into bowls. The treatment with only agar gel, i.e. containing no NaCl and/or aqueous azolla, was considered as the control. Wheat seeds (cv. Sarsabs) were sterilized with 1% sodium hypochlorite solution for 3 minutes and then rinsed with distilled water. Ten healthy seeds were placed on the surface of the solidified agar gel in a circle with the embryo side up and pointing inwards. The bowls were then covered with petri dishes and incubated at 28°C ± 2. The treatments were arranged in a randomized design with four replications. The experiment was repeated once, and the results of the two trials averaged.

Table 1 shows that NaCl had a depressive effect on seedling growth of wheat as shown by Alam and Azmi (1988) and Khan and Ashraf (1988), whereas aqueous azolla extract stimulated shoot growth. With the addition of azolla extract, the shoot length was significantly increased over the control, even in the presence of 0.2% NaCl. At 0.4% NaCl level, shoot length was significantly less than in the control, but the difference was not significant when aqueous azolla extract was added. Although shoot growth was significantly reduced at 0.6% NaCl level both with and without the addition of azolla extract, the reduction in the azolla treatment was less severe. Root length in all treatments was significantly shorter than in the control. In the presence of NaCl, the addition of azolla extract had a slight, but non-significant stimulatory effect on root growth.

Table 1. Effect* of aqueous azolla extract and sodium chloride on seedling growth of wheat.

Treatment	Shoot length (cm)	Root length (cm)
Control	9.64c	11.05a
Azolla alone	14.01a (+45.3)	8.15b (-26.7)
0.2% NaCl alone	9.59c (-0.51)	8.10b (-26.2)
0.4% NaCl alone	7.7d (-20.1)	5.46c (-50.6)
0.6% NaCl alone	5.54e (-42.5)	3.08d (-72.1)
0.2% NaCl + azolla	11.77b (+22.1)	9.10b (-16.8)
0.4% NaCl + azolla	9.52c (-1.24)	5.79c (-47.6)
0.6% NaCl + azolla	7.15d (-25.8)	3.80d (-65.6)

* Values between parentheses indicate % increase (+) or decrease (-) over control. Values followed by the same letter within a column are not significantly different.

Based on these results, experiments will be conducted to determine whether these effects persist until maturity.

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Response of Sprinkler-irrigated Barley to Different Nitrogen Levels

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Barley is important in Oman as a grain crop for feed concentrates. Hence, it is essential to determine the optimum levels of fertilizer to be applied to this crop for obtaining remunerative yields. Previous results indicate that the application of 90 kg N/ha provides maximum grain yield in barley (Anonymous 1983). However, it is observed that N levels beyond 90 kg/ha were not used in that experiment, and a curvilinear response curve was not obtained. In addition, these experiments were conducted under flood irrigation. With the change in the government's policies and the adoption of modern irrigation systems, it has become necessary to develop recommendations for crops grown under sprinkler irrigation. The present experiment was carried out to gather information on the response of two sprinkler-irrigated barley varieties to different nitrogen levels.

Two barley varieties -- Beecher, obtained from ICARDA, and Omani Local (Table 1) -- and four nitrogen levels (50, 100, 150, and 200 kg N/ha) were used in the experiment. The recommended level of phosphorus fertilizer (160 kg P_2O_5/ha) and one quarter of the nitrogen rates were applied at sowing. The full dose of recommended potassium (50 kg K_2O/ha) and another fourth of the nitrogen rates were applied 10 days after sowing. The third split dose of nitrogen was applied at the heading stage and the last at the milky-ripe stage. The other cultural practices followed were as per general recommendations.

The ANOVA on grain yield indicated that variety, nitrogen, and variety x nitrogen effects were all non-significant. Although mean grain yield was not different between the two varieties (Table 2), it was observed that Beecher lodged more than the local variety. Mean grain yield increased up to 100 kg N/ha suggesting that this rate is optimum for grain barley. A similar rate (90 kg N/ha) was recommended under flood irrigation (Anonymous 1983).

Table 1. Characteristics of the two barley varieties used in the experiment.

Variety	Days to flowering	Plant height (cm)	No. of tillers	1000-grain weight (g)	Lodging index
Omani Local	76	78	19	42.9	1.5-2.0
Beecher	80	74	20	35.0	2.0-4.5

Table 2. Grain yield (t/ha) of the two barley varieties under four nitrogen levels.

Variety	N level (kg/ha)				Mean varietal yield
	50	100	150	200	
Omani Local	2.6	3.0	2.8	2.7	2.8
Beecher	2.1	2.7	2.8	3.0	2.7
Mean	2.4	2.9	2.8	2.9	2.7

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Recent Publications

IBPGR (International Board for Plant Genetic Resources). 1989. International crop network series. 1. Report on an international barley working session. International Board for Plant Genetic Resources, Rome. 24 pp. ISBN 92-9043-190-3.

This is a report on an international barley working session that was held at the Zentralinstitute fur Genetik und Kulturpflanzenforschung (ZIGuK), 21 Apr 1989, Gatersleben, German Democratic Republic. The session was convened to strengthen collaboration between the most important barley collections of the world and to explore strategies for building up an international barley network.

Breeze, E.L. 1989. Regeneration and multiplication of germplasm resources in seed genebanks: the scientific background. International Board for Plant Genetic Resources, Rome. 69 pp. ISBN 92-9043-186-5.

Conclusions of a study to assess the scientific validity of methods of regeneration of germplasm used in practice are reported. The author has reviewed the literature extensively, and addressed many important scientific issues. His comments as well as his recommendations on improving standards are also included.

Kaimowitz, D. (ed.). 1990. Making the link. Agricultural research and technology transfer in developing countries. ISNAR/Westview Special Studies in Agriculture Science and Policy, Westview Press, Boulder, Colorado 80301, USA. 278 pp. ISBN 0-8133-7896-6.

While the importance of the impact of technology transfer on agricultural development has been recognized worldwide, establishing the link between scientists, extension workers, and farmers, however, remains a widely debated issue. New ideas and directions for solving this complex problem are presented in seven chapters written by eleven well-known specialists. This book is addressed to agricultural scientists, technology workers, policymakers, and managers engaged in agricultural research and extension in the developing world.

Burnett, P.A. (ed.). 1990. World perspectives on barley yellow dwarf. CIMMYT, Mexico, D.F., Mexico. 511 pp. ISBN 968-6127-39-9

These proceedings contain papers and posters presented at an International Barley Yellow Dwarf Workshop held 6-11 July 1987, in Udine, Italy. Scientists from 35 countries participated and presented their experience. Content has been organized under four chapters: (i) world situation, (ii) virology, (iii) ecology and epidemiology, and (iv) control.

Pinckney, T.C. 1989. The demand for public storage of wheat in Pakistan. Research report 77. IFPRI, Washington, D.C., USA. 110 pp. ISBN 0-89629-079-4.

This book contains the results of a research conducted over three years at the International Food Policy Research Institute (IFPRI). A methodology for estimating total demand for government storage from three different sources -- interannual supply stabilization stocks, seasonal storage, and stocks to ensure a continuous supply of wheat under all circumstances -- has been developed and applied to the case of wheat in Pakistan. Techniques developed in earlier studies have been modified and expanded to clarify which types of trade and price interventions are most suitable for stabilizing consumption.

NARSC/NHCIP/ICARDA/IDRC. 1989. National barley Training Workshop, Feb 24-Mar 2, 1989, Kathmandu, Nepal. Proceedings. National Agricultural Research and Services Centre (NARSC), Kathmandu, Nepal. 159 pp.

The National Barley Training Workshop was held 24 Feb-2 Mar 1989, in Kathmandu, Nepal, where national and international barley scientists from Nepal, IDRC, CIMMYT, and ICARDA met and discussed different aspects of barley. This proceedings is the outcome and is divided into three parts: (i) barley *in Nepal*, (ii) ICARDA/CIMMYT and international barley programs, and (iii) discussions and recommendations.

Cereal News

Dr Samir El-Sebae Ahmed, Coordinator for the Arabian Peninsula Program, ICARDA, visited the Yemen Arab Republic (YAR) 18-26 Oct 1989 to assist the National Agricultural Research System (NARS) in field evaluation and selection of wheat, barley, faba bean, and lentil, and to finalize the YAR component of the 1989-90 work plan for the Arabian Peninsula Regional Program.

During his stay, he toured research stations and on-farm verification trials in Dhamar, Ibb, Taiz, and Sana'a Provinces, and held talks with concerned scientists and officials. On 23 Oct, he presented a seminar entitled "ICARDA and its Role in Strengthening NARSs in West Asia and North Africa." The seminar was attended by more than 50 scientists including the staff of the Agricultural Research Authority (ARA), the Food and Agriculture Organization of the United Nations (FAO), the Arab Center for Studies of Arid Zones and the Dry Lands (ACSAD), the Netherlands project on range and livestock improvement, and both the extension and seed multiplication projects.

In Sana'a, Dr Ahmed discussed with H.E. Dr Naser Abdullah Al-Awlaqi, Minister of Agriculture and Fisheries, and his Deputy Mr Mukbel Ahmed Mukbel, the future direction of cooperation and collaboration between ICARDA and the YAR. He accompanied the Director General of the Agricultural Research Authority (ARA) to the Faculty of Agriculture of the University of Sana'a where he met with Dr Abdullah Mjahed, Dean, Faculty of Agriculture, as well as other staff members. Dr Mjahed expressed great interest in cooperating with ICARDA, especially in the field of research and training.

Drs H. Ketata, Acting Leader, Cereal Improvement Program, and **M. Tahir**, Cereal Breeder, ICARDA, visited the Islamic Republic of Iran 27 Oct-3 Nov 1989 to discuss the program of research for cereal improvement for the 1989-1990 season and the possibility of expanding existing collaborative work in the future. They met with high-level officials and scientists from the Ministry of Agriculture in Teheran, and held talks with the Director Generals of the Seed and Plant Improvement Institute (SPII), the Soil and Water Institute, and the Pest and Diseases Institute. They were also invited to visit the agricultural research stations at Karaj, Hamadan, and Bakhtaran to advise on cereal research in moisture-stressed cold highland areas.

Dr A.B. Damania, Germplasm Scientist, attended the XXXIII National Meeting of the Italian Society of Agricultural Genetics (SIGA) held in Alghero, Italy, 23-26 Oct 1989. He discussed work plans for the 1989-90 season with research associates in the collaborative projects funded by Italy on durum wheat and wild progenitors evaluation and utilization. Ninety-six posters and 60 oral presentations were delivered during the meeting, some of which were relevant to ICARDA's work, as Italy and the WANA region share some of the same constraints to production including heat, drought, and salinity.

On 27 Oct he travelled to Montpellier, France. He met with Dr F. Kaan, director of Research for Cereal Improvement, and discussed soil salinity screening techniques with Dr P. Monneveux from the Ecole Nationale Superieure Agronomique (ENSA), and Dr M. Mekkaoui from the Ecole Nationale d'Agriculture de Meknes, Morocco. He had a brief meeting with Dr A. Conesa, Director, INRA, and toured the Laboratoire de Technologie des Cereales of INRA where he discussed electrophoretic techniques and durum wheat quality with Dr P. Joudrier and his staff. Dr Damania also passed by the genebank at ORSTOM (French Institute of Scientific Research for Cooperative Development), where clonal propagation and *in vitro* storage using embryo culture has been successfully carried out.

Dr Damania transferred from the Cereal Improvement Program to the Genetic Resources Unit on Jan 1990. He will continue to be in charge of the special project funded by the Government of Italy on "Enhancing Wheat Productivity in Stress Environments Utilizing Wild Progenitors and Primitive Forms," and will also act as Germplasm Curator (Cereals) at the Genetic Resources Unit.

Dr K. Sgaier, from the FAO Crop Production Division for the Near East and North Africa, arrived in Aleppo on 21 Nov 1989, for a 3-day visit to the Cereal Improvement Program to review and follow up on the FAO/ICARDA/CIMMYT/Turkey Travelling Workshop which took place 11-16 June 1989, in Turkey. With Dr Habib Ketata he discussed opportunities for further cooperation between FAO and ICARDA on cereal improvement for the drylands of the Near East and North Africa. He also had discussions on the possibility of training national research workers from the region at ICARDA with FAO funding.

The Nile Valley Regional Program (NVRP) Steering Committee Meeting took place on 17-18 Nov 1989, in Cairo. Participants in the meeting included Drs Rashad Abou El-Einein, Abdel Shafi A. Ali, and Shaaban Khalil from Egypt; Drs Seme Debela, Hailu Gebre, and Fekadu Alemayehu from Ethiopia; Mr Erhard Loher from EEC/Egypt; Mr John Blom from the Dutch Embassy in Cairo, and Drs J.P. Srivastava, M. Saxena, H. Ketata, and B.D. Bhardwaj from ICARDA. The main results of the 1988/89 crop season were highlighted, and the work plan/budget of research and training for 1989/90 discussed and approved. It was agreed to hold next season's national coordination meetings on the following dates: 17-20 Apr 1990, Ethiopia; 22-26 July 1990, Sudan; 23-27 Sept 1990, Egypt. It was also agreed to hold travelling workshops in Sudan (4-10 Sept 1990), Egypt (24-30 Mar 1990), and Ethiopia (29 Sept-5 Oct 1990).

Dr R.H. Miller, Cereal Entomologist, ICARDA, travelled to Rabat, Morocco, on 20 Nov 1990, to attend a Workshop on Barley Yellow Dwarf Virus sponsored by the International Development Research Center (IDRC), Canada. A number of researchers from North and South America, Europe, West Asia, and Africa discussed the prevalence of barley yellow dwarf virus worldwide and highlighted past research, future plans, and research techniques.

Drs J.P. Srivastava, S. Ceccarelli, and M. Nachit travelled to the Soviet Union on 20 Nov 1989, for a 9-day tour. They visited the Academy of Sciences in Moscow, the Vavilov Institute of Plant Industry, Leningrad, and spent 3 days at the South-East Institute for Agricultural Research in Saratov. They held discussions on the development of collaborative research on barley, durum wheat, lentil, and chickpea with Soviet scientists who reported having faced severe winter weather with day/night temperatures of -8/-20^{o}C.

Drs A. McCusker and T. Hodgkin, Head, Research Program, and Genetic Diversity Officer, respectively, at the IBPGR, visited ICARDA's Cereal Improvement Program on 5 Dec 1989. They met with Dr H. Ketata, Acting Leader, who presented an overall picture of the Program's research activities, including the close collaboration with the Genetic Resources Unit of ICARDA on wheat and barley germplasm evaluation, utilization, and documentation.

The visitors also met with Dr A.B. Damania, Germplasm Scientist, and discussed the concept of "Core Collection." The IBPGR hopes to identify major problems that have been encountered by scientists working with a small number of entries from a large collection, particularly where IBPGR could initiate research input.

Durum Wheat Germplasm Evaluation Network. Results from durum wheat germplasm evaluation trials carried out in 1989 by Dr John Clark, Research Scientist, Wheat Physiology and Breeding Section, Research Station, Agriculture Canada, at Swift Current, Saskatchewan, Canada, indicated that out of 200 durum wheat lines selected from the ICARDA genetic resources collection, 21 lines outyielded the local (Canadian) checks as well as Cham 1 (ICARDA long-term durum check). On average, Cham 1 performed as well as the local checks and better in some cases. Results obtained with Haurani were also good. These trials are part of an informal network coordinated by Dr A.B. Damania, Germplasm Scientist (Cereals), and Mr Lucciano Peccetti under the overall supervision of Dr J.P. Srivastava and, subsequently, Dr H. Ketata.

Mr Issam Naji, Cereal Agronomist, ICARDA, spent two weeks (25 Nov-11 Dec 1989) in Libya working with national program researchers along with **Dr M. Mekni,** Morocco-based, Cereal Scientist, ICARDA. *They visited* sites at Tajoura, Al-Marj, and Al Fataeh, and discussed the work plan for the 1989/90 season with Libyan officials. Mr Naji was also involved in training and helping national researchers in planting barley and wheat nurseries and on-farm trials.

Dr S. Ceccarelli, Barley Breeder, ICARDA, visited the University of Hohenheim, Germany, on 18 and 19 Dec 1989, to present a seminar on "Breeding Barley for Dry Areas" and review areas of possible future cooperation. On 20 Dec, he called at the Department of Plant and Yield Physiology at the Max-Plank Institut fur Zuchtungforschung (Koln), where he discussed molecular techniques being used in barley and their significance in relation to breeding for stress conditions.

Mr Eric Jansen from the Agricultural University of Utrecht, Faculty of Biology, Department of Plant Ecology, The Netherlands, joined the Cereal Improvement Program in Jan 1990 for a period of 6 months to work on water use efficiency of barley genotypes. Mr Jansen is supervised by Prof Hans Lambers of Utrecht and Dr E. Acevedo, Cereal Agronomist/Physiologist, ICARDA.

Mr David Kleijn, from the Agricultural University of Wageningen, Department of Plant Breeding, joined the Cereal Improvement Program in Jan 1990 to work on indirect selection for stress resistance of barley genotypes under the supervision Drs E. Acevedo and S. Ceccarelli, and in association with Mr Erik van Oosterom, Ph.D. student. Mr Kleijn's supervisor in the Netherlands is Prof Jan Parlevliet.

Dr Naif El Salti, Faculty of Agriculture, Aleppo University, Syria, visited the Cereal Improvement Program on 24 Jan 1990 to discuss collaborative research with Dr R.H. Miller, Cereal Entomologist. Both scientists reviewed the project with Dr H. Ketata, Acting Leader, in the presence of Dr A. El Ahmed, Vice-Dean, Faculty of Agriculture, Aleppo University.

Dr Max Rives, INRA, France, visited the Cereal Improvement Program 22-23 Jan 1990, and discussed with Dr H. Ketata preparation and details of the training workshop on cereal breeding strategies to be jointly conducted by INRA and ICARDA in 1991. Dr Rives also held discussions on the biotechnology project and the French contribution to the project.

Dr Nasri Haddad, West Asia Regional Program Coordinator, ICARDA, visited the Cereal Improvement Program and discussed with Dr H. Ketata some of the aspects of the training course on "Techniques and Methodologies of Barley Improvement" to be conducted in Amman, Jordan, 3-8 Feb 1990. The course is part of the ongoing Mashrek Project activities funded by the United Nations Development Programme/Arab Fund for Economic and Social Development (UNDP/AFESD) and will be attended by 10 participants from Iraq, Jordan, and Syria in addition to two trainees from Egypt.

Dr Theo Jacobs, Wageningen University, during a 5-day visit to ICARDA (21-25 Jan 1990), discussed with cereal scientists the proposal for a joint project on disease resistance in barley landraces of WANA.

A Workshop on Techniques and Methodology of Barley Improvement sponsored by the United Nations Development Programme (UNDP), the Arab Fund for Economic and Social Development (AFESD), and ICARDA was held 3-8 Feb 1990, in Amman, Jordan. The workshop was organized to provide scientific and practical knowledge in improving barley for 15 researcher participants from Syria, Jordan, Iraq, and Egypt. Scientists contributing to the training were Drs M. Duwayri, A. El Tell, and N. Katkhuda from the University of Jordan; Dr A. Hadjichristodoulou from Cyprus; Drs H. Ketata, M. Tahir, S. Ceccarelli, S. Grando, Ir Joop van Leur, and Mr Issam Naji from ICARDA's Cereal Improvement Program; and Dr N. Haddad, West Asia Regional Program Coordinator, ICARDA.

Mr Ali Shehadeh from the Directorate of Agricultural Scientific Research, Douma, Syria, joined the Cereal Improvement Program of ICARDA in Feb 1990 as a visiting scientist. During his 7-month stay at the Program, Mr Shehadeh will work on barley breeding.

Dr Michael Morris, CIMMYT Economist in Mexico, and **Dr A. Belaid,** Economist from Algeria, visited ICARDA 3 Jan-4 Feb for initial discussions on a future CIMMYT/ICARDA joint effort to gather data for the next issue of CIMMYT's World Wheat Facts and Trends, produced every two years, the last being 1987-88. Dr Belaid will act as a consultant on this venture.

Forthcoming Events

Symposium on Cereal Production in the Semi-arid Regions, 29 Apr-5 May 1990, Tunisia. The Symposium, organized by the Institut National Agronomique de Tunisie (INAT), the Insitut National de la Recherche Agronomique de Tunisie (INRAT), the Ecole Superieure d'Agriculture du Kef (ESAK), and Oregon State University (OSU), will be an opportunity for cereal researchers to share information and discuss appropriate strategies that could contribute to increasing cereal production in the semi-arid regions. The following topics will be the main focus of the Symposium: (i) agronomy: soil fertility, tillage practices, weed control, soil and water conservation, etc; (ii) cereal breeding: selection techniques, cultivar development, germplasm enhancement, use and application of engineering in cereal breeding, etc; (iii) disease resistance: importance of cereal diseases in the semi-arid regions, physiological specialization sources of resistance, some insect problems (Hessian fly), etc; (iv) field data management: field plot techniques, use of computers in cereal breeding, etc.

Other related topics which have not been mentioned are also welcome. For further information please contact: Dr A. Daaloul, INAT, 43 Rue Charles Nicole, 1002 Tunis, Tunisia; Tel (01) 280 959, Fax 216 1 189 166. Dr M. Lasram, INRAT, Avenue de l'Independance, 2080 Ariana Tunis, Tunisia: Tel (01) 230 024. Dr A. Yahyaoui, ESAK, 7119 le Kef, Tunis, Tunisia; Tel (08) 21 960. Dr W.E. Kronstad, OSU, Corvallis, Oregon, 97331 USA; Tel (503) 737-3728, Fax (503) 737-2564.

Organization and Management of Agricultural Extension Systems: A New Look at Knowledge Transfer, 3-28 Sept 1990. This 4-week course, to be presented in English, will be taught by members of INTERPAKS, the International Program for Agricultural Knowledge Systems of the University of Illinois at Urbana-Champaign, USA. The course will address the challenges that extension administrators and managers face, and provide training for meeting those challenges. It will improve participants' abilities to: (i) understand the criteria for an effective extension service; (ii) analyze existing systems to determine weakness and to organize remedial actions; and (iii) manage an extension system so that positive relationships and ties with research and other groups are maintained. Certificates will be awarded to participants who successfully complete the course. Individuals wishing to attend the course should apply by letter, telex, or cable to: John W. Santas, Training Officer, INTERPAKS, University of Illinois, 113 Mumford Hall, 1301 West Gregory Drive, Urbana, Illinois 61801, USA. Telephone: (217) 333-3638. Telex: 206957. Cable: INTSOY.

Golden Jubilee Symposium on Genetic Research and Education: Current Trends and the Next Fifty Years, 22-25 Jan 1991, New Delhi, India. The Indian Society of Genetics and Plant Breeding will complete its *fiftieth* year of existence in 1990. A number of activities related to the promotion of genetic research and education will be undertaken throughout the Golden Jubilee Year of 1990. The golden Jubilee Celebration activities will culminate in an International Symposium on Genetic Research and Education: Current Trends and the Next Fifty Years.

Past achievements and present status of genetic research and education will be reviewed, and recommendations for the future -- in the light of latest developments in the biosciences -- will be formulated. The Golden Jubilee Committee has identified the following themes for the Symposium: (i) biological diversity: conservation and utilization; (ii) stress resistance: biotic and abiotic; (iii) improvement of crops and farm animals; (iv) impact of biotechnology: plant and animal sciences (including forestry, fisheries, sericulture, and apiculture); (v) genetics and human health: human genome and organ transplantation; (vi) teaching of genetics: resources and methodology; (vii) genetics and society: ethics, biosafety, and intellectual property rights.

Please address correspondence to the Organizing Secretary: Dr B. Sharma, Organizing Secretary, Golden Jubilee Symposium, Indian Society of Genetics and Plant Breeding, Division of Genetics, Indian Agricultural Research Institute, New Delhi 110012, India.

Fourth International Symposium on Genetic Aspects of Plant Mineral Nutrition, 30 Sept-4 Oct 1991, Canberra, Australia. This symposium is aimed at bringing together scientists engaged in various areas of research to exchange ideas and information on gene systems that influence mineral plant nutrition. Mechanisms underlying genetic variability, as well as methods of recognizing desirable genes and using them for plant improvement, will be the main focus of the symposium. Invited and contributed papers will touch upon all areas of plant nutrition, particularly upon (i) nutrient acquisition, (ii) plant nutrient requirement, (iii) efficiency of nutrient use, (iv) mineral composition related to quality, (v) tolerance of mineral toxicities, and (vi) tolerance of salinity. A book of the symposium's proceedings will be published and will include eligible oral presentations and posters. Address for correspondence: Peter Randall, CSIRO Division of Plant Industry, GPO Box 1600, Canberra ACT 2601, Australia.

International Course for Development Oriented Research in Agriculture. ICRA is a foundation organizing post-academic courses for young agricultural scientists working in developing countries. It aims to prepare them for applying their specialized training to research designed to produce results which are appropriate to the circumstances of farmers and which are compatible with the aims of governments.

ICRA conducts two identical courses yearly, one Anglophone in Wageningen and one Francophone in Montpellier. Courses combine theoretical training with a 3-month field study in a developing country. Foundation scholarships are available. Funding through external sponsoring is possible.

Courses for 1991 will run from 14 Jan to 3 Aug in Wageningen, and from 15 Apr to 26 Oct in Montpellier. Closing date for application for both courses is 1 Sept 1990. Minimum requirements are an M.Sc. or equivalent degree (BAC+4) from a recognized university or educational institution, good knowledge of English or French, and age under 40.

For further information and application form with an indication of course preference, write to ICRA, Central Registration Office, P.O. Box 88, 6700 AB Wageningen, The Netherlands.

CONTRIBUTORS' STYLE GUIDE

Policy

The aim of the newsletter is to publish quickly the results of recent research. Articles should normally be confined to a single subject, short and precise, and be of good quality and of primary interest to research, extension and production workers, administrators and policy makers. Articles submitted to RACHIS should not be simultaneously 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/her approval. Occasionally, papers may be returned for revision. Rejected papers will not be returned, but the author/s will be informed.

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 have an abstract and 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 (=milliliter), m^2.

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

Examples of common expressions and abbreviations

3g, 18 mm, 300 m^2, 4 Mar 1983; 27%; 50 five-day old plants; 1.6 million; 23 µg; 5°C; 1980/81 season; 1981-83; Fig., No.; FAO, USA. *Fertilizers*: 1 kg N or P_2O_5 or K_2O/ha.

Mon, Tues, Wed, Thurs, Fri, Sat, Sun; Jan, Feb, Mar, Apr, May, June, July, Aug, Sept, Oct, Nov, Dec.

Versus = vs, least significant difference = LSD, standard error = SE ±, coefficient(s) of variation = CV(s). *Probability:* Use asterisks to denote probability * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$.

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

Reference

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: Zadoks, J.C. and van Leur, J.A.G. 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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