RACHIS

Barley and Wheat Newsletter

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The Center and its Mission

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

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

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RACHIS: Barley and Wheat Newsletter is published half-yearly 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.

Cereal researchers and the libraries of institutions conducting research on barley and wheat in West Asia and North Africa may apply for a free subscription by writing to RACHIS, ICARDA. P.O. Box 5466, Aleppo, Syria. Contributions to RACHIS should be sent to the attention of Ms Elizabeth Talmage.

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Breeding strategy for yield potential and stability in fluctuating environments

Commentary by
John Hamblin and Salvatore Ceccarelli, Cereal Program, ICARDA.

Nearly all breeding programs claim that high yield potential and yield stability are important objectives. If true it is important to consider how this might be achieved.

When selecting for yield we take the following criteria to be true.
1. If you want to make genetic progress for a character, then you must apply a selection pressure for that character.
2. There must be adequate genetic variation available for the character.
3. The fewer the genotypes examined the less the chance of making genetic gain for the character.

Certain trends in plant breeding will lower one's chances of making advances for yield and yield stability. These are: (1) excessive concerns with genetic uniformity; (2) delayed testing (say F_7–F_8) for complex characters; and (3) small numbers of genotypes tested over too few sites.

If you are not just paying lip service and are <u>really</u> interested in yield and stability in the highly variable Mediterranean environment then you might like to consider the following approach to selection for yield and stability (a diagrammatic scheme of the procedure outlined is given on the following page).

Yield stability can only be measured by testing genotypes over as many sites as possible. The earliest generation that this can be assessed in realistic plots is the F_4. An effective selection scheme would be spaced F_2 plants, selected on the basis of relatively simple characteristics of high heritability such as height, disease rating, and maturity. Spaced plants mean high individual seed yields. These provide adequate F_3 seed to plant a decent multiplication row. These F_3 rows can be further screened for characters of high heritability.

If we now consider the F_4 seed situation, the selected spaced F_2 plants will produce at least four ears with 20 seeds/ear, or 80 seeds. These will supply sufficient seed for 5 m of row, approximately 6 cm between plants. Each plant should produce at least 5 g of seed. Therefore we should have approximately 400 grams of F_2 derived F_4 seed.

An eight-row (20 cm apart) × 5 m long plot requires 80 grams of seed per plot when seeded at 100 kg/ha. This allows testing at two contrasting sites with two replicates, or at four sites with one replicate. At the same time surplus seed (about 80 g) is space planted for reselection. The plot yield and stability data are used to determine which F_2 derived F_4 populations are now used for single plant F_4 derived reselection.

At 1 t/ha yields the four bordered plots (harvest area 5.6 m^2) will produce in excess of 2 kg of F_5 seed. This is sufficient to test at 10 sites with two replicates, or five sites with four replicates. At the same time F_4 derived F_5 reselected rows are grown. These were chosen on the basis of F_4 plot <u>yield</u> performance as well as other agronomic characteristics which will be expressed in representative plots.

The F_4 and F_5 yield data are now quite extensive and can be used to determine which F_2 derived families have the greatest yield potential and stability. The reselection of the F_4 derived F_6 seed is biased strongly in favor of those F_2 derived families that have high yield potential and stability. The process is repeated for the F_4 derived lines which are yield tested at 2 (or 4) sites in F_6 and at 5 (or 10) sites in F_7.

At this point there are available between 14 and 28 site/years of yield data on the material. These data should provide information on (a) relative performance of lines in contrasting environments, (b) stability across environments, and (c) efficiency of sites used to yield test the F_2 derived F_4 in identifying stable and high yielding F_4 derived F_5. Therefore the system has a built-in mechanism to (a) generate information useful to other breeders and (b) to test its efficiency and indicate possible modifications.

Final seed increase should start from the F_4 row material without reselection. By F_8 there should be sufficient seed and data for the most promising lines to be given to the national testing program for final evaluation (say three years × 20 sites/year), recommendation, and release.

In this scheme the breeder applies considerable selection pressure for yield and yield stability before it reaches national wide-scale testing. This greatly increases the likelihood of successful selection for these characteristics and will be more successful than waiting to yield test in later generations. Implementation of a program similar to this will however require careful thought on allocation of breeding resources in time and space.

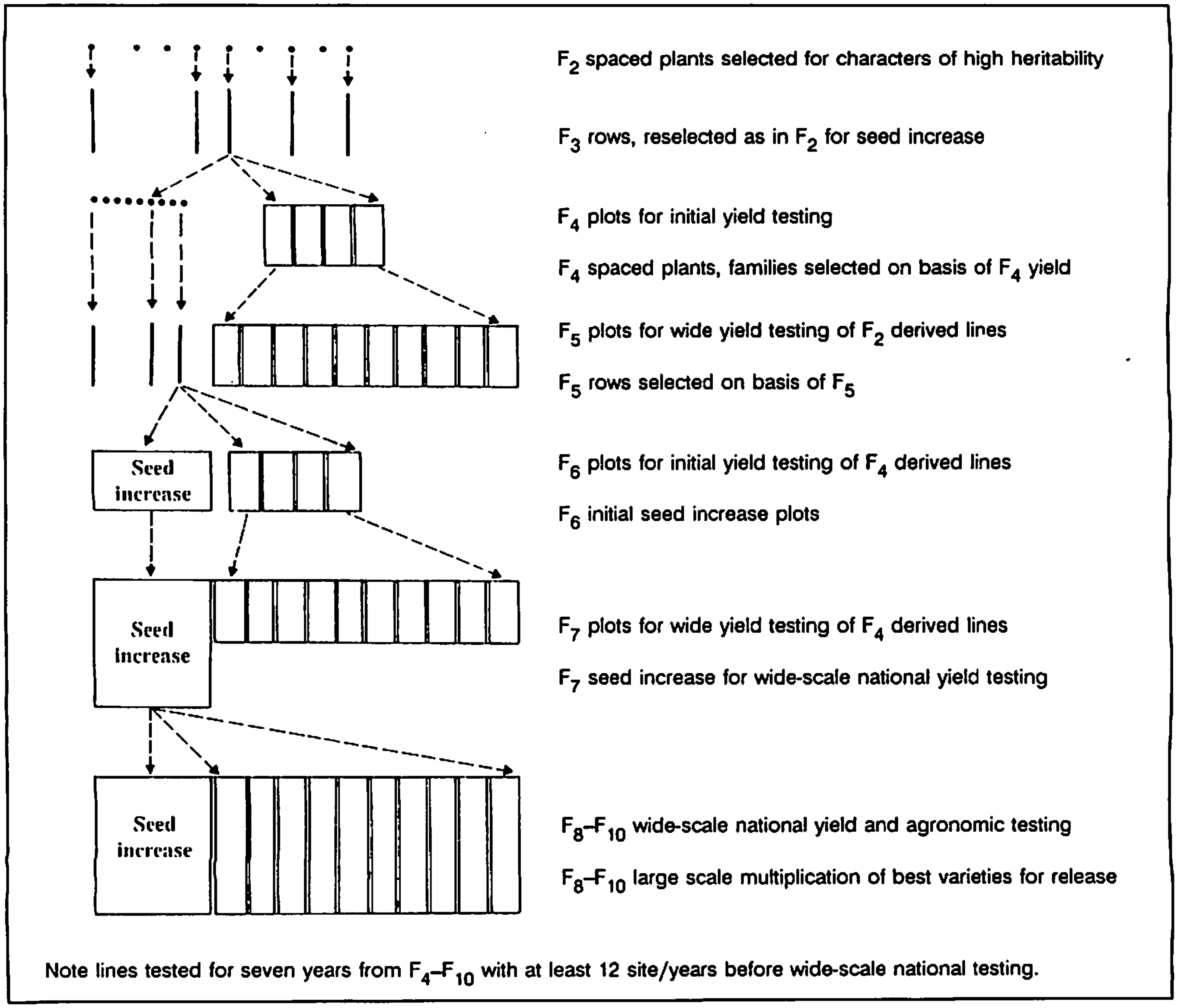

Figure 1: Diagrammatic scheme of selection procedure to maximize yield potential and stability.

Editor's note: RACHIS invites readers to submit commentaries on subjects relating to cereal research.

Research and Production

Impact of Awns on Grain Yield And Its Components in Spring Wheat Under Rain-fed Conditions

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تأثير السفا في الغلة الحبية ومكوناتها في القمح الربيعي تحت الظروف البعلية

الملخص

تمت دراسة تأثير السفا في الغلة الحبية ومكوناتها في هجينين من القمح الربيعي المزروع تحت الظروف البعلية. وتم تصنيف نباتات الجيل الثاني في ثلاث فئات هي ذات السفا، وذات سفيات، وبدون سفا. وفي كلا الهجينين كان متوسط وزن الألف حبة والغلة الحبية/النبتة في النباتات ذات السفا أعلى معنوياً منهما في الفئتين الأخريين أي ذات السفيات وبدون سفا. أما بالنسبة لعدد السنابل/النبتة فلم تكن هناك فروق بين مختلف الفئات. وفيما يتعلق بعدد الحبات/ السنبلة فقد تباينت النتائج بين الهجينين. كما وجد أن إسهام السفا في الغلة الحبية قد بلغ 20٪. وينصح بإيلاء صفة السفا الاهتمام اللازم في عملية الانتخاب لصفة الغلة تحت الظروف البعلية.

Abstract

Impact of awns on grain yield and yield components was studied in two crosses of spring wheat grown under rain-fed conditions. F_2 plants were classified into three categories, i.e., awned, awnletted, and awnless. Awned plants in both crosses had significantly higher mean 1000-grain weight and grain yield/plant than the awnletted and awnless categories. For spikes/plant, there were no differences among various categories. Regarding number of grains/spike, results differed between the two crosses. Contribution of awns toward grain yield was found to be 20%. It is advocated that the awned character be given due consideration in selecting for yield under rain-fed conditions.

Introduction

Awns appear to be equipped with physiological and biological buffers that enable them to adjust to changes in environment. Teich (1982) reported that yield in wheat was influenced by the presence of awns. Saghir et al. (1968) found that clipping awns at anthesis reduced grain yield and kernel weight by 21% and 13%, respectively; while Chhabra and Sethi (1989) observed that awn removal at ear emergence and after anthesis reduced grain yield by 17.31% and 13.49%, respectively, in durum wheat. Results of these studies are based on the principle of mechanical removal of awns. In order to determine the real genetic effect of awns on yield and yield components, the present study was undertaken in spring wheat under rain-fed conditions.

Materials and Methods

Awnless variety CPAN 1922 was crossed to two awned wheat varieties WL 2265 and CPAN 1992. F_2 populations of these two crosses, designated as cross I and cross II, respectively, were raised in plots of 25 m length and 10 m width with uniform spacing of 30 cm × 20 cm under rain-fed conditions at the research farm of Haryana Agricultural University, Hisar (India). From each plot 150 plants were selected separately for awned, awnletted, and awnless categories in each cross. Data on spikes/plants, number of grains/spike, 1000-grain weight (g), and grain yield (g) were recorded on selected individual plants.

Results and Discussion

Mean and range values for grain yield and its components of three categories of awnings in each cross are given in Table 1. The awned category in both the crosses exhibited significantly higher mean grain yield than the awnletted

Table 1. Effect of awns on yield and its components in wheat crosses under rain-fed conditions.

Selection criteria		Spikes/plant	No. of grains/ spike	1000-grain weight (g)	Grain yield/ plant (g)
Cross I:					
Awned	Mean	6.0[a]	58.7[a]	44.0[a]	14.3[a]
	Range	3–17	26–104	35–54	4.5–33.0
Awnletted	Mean	5.6[a]	66.8[ab]	40.7[b]	12.7[b]
	Range	1–15	20–102	33–48	3.3–43.7
Awnless	Mean	5.5[a]	64.0[b]	38.8[c]	12.3[b]
	Range	1–14	35–104	30–52	2.5–37.5
	LSD (5%)	0.7	3.1	1.6	1.5
Cross II:					
Awned	Mean	9.4[a]	57.9[a]	48.4[a]	21.6[a]
	Range	3–29	26–90	38–62	7.5–59.8
Awnletted	Mean	8.6[a]	54.0[b]	45.9[b]	17.9[b]
	Range	2–21	25–83	34–58	6.1–50.5
Awnless	Mean	8.6[a]	50.9[b]	44.4[b]	17.4[b]
	Range	3–22	24–85	39–58	4.3–52.0
	LSD (5%)	0.9	3.6	1.7	2.2

a–c. Means followed by the same letter within each column are not significantly different at $P = 0.05$.

and awnless types. Partitioning the yield into components further revealed that there were no differences for mean number of spikes/plant among the three categories in both crosses. But the awned category had fewer grains/spike in cross I and more grain/spike in cross II as compared to the awnletted and awnless ones. Mean 1000-grain weight was significantly higher in the awned group in both the crosses. The only significant difference between the awnletted and awnless categories was for grain weight in cross I.

Results of this study revealed that fully awned character had its impact on grain weight and grain yield but not on spikes/plant in spring wheat under rain-fed conditions. Theoretically, this was expected as spikes/plants are determined earlier before the awns protrude out. For number of grains/spike the situation was different in both the crosses. Hence further studies may be carried out on a large scale in varying sets of environments to determine the real picture. However, Chhabra and Sethi (1989) observed no effect of awns on number of grains/spike in durum wheat.

Percent contribution of awns (calculated as grain yield over awnless types) was found to be 16.4% and 24.6% in cross I and cross II, respectively, with an overall mean of 20.5%. Sughir et al. (1968) and Chhabra and Sethi (1989) found clipping treatments reduced grain yield by 21% (at anthesis) and 17% (at ear emergence), respectively. It is suggested that fully awned character be given due consideration in selection for yield in wheat breeding programs under rain-fed conditions.

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Grain Yield Response of Durum Wheat To Diverse Environments in Algeria

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استجابة الغلة الحبية للقمح القاسي تحت بيئات مختلفة في الجزائر

الملخص

هدفت هذه الدراسة إلى عقد مقارنة بين استجابات الغلة الحبية لصنفين من القمح القاسي اعتمدا مؤخراً، هما: واحة ومغرس، واستجابة صنف محلي م.ب. بشير تحت ظروف 19 بيئة. ولم يكن الانحراف عن الانحدار معنوياً بالنسبة للأصناف الثلاثة، وكان معادل الانحدار للصنف مغرس مختلفاً معنوياً عن الواحد (1). وكانت الغلة المتنبأ بها للصنف بشير بواسطة الانحدار الخطي أقل من الصنفين واحة ومغرس تحت البيئات المغلالة، لذا يمكن التوصية بزراعة واحة ومغرس تحت البيئات المواتية أكثركالمنطقة الشمالية من النجد المرتفع في الجزائر.

Abstract

The study compared the grain yield responses of two newly released durum wheat cultivars, Waha and Maghress, with that of the local landrace M. B. Bachir over 19 environments. Deviation from regression was nonsignificant for the three varieties, and the regression coefficient of Maghress was significantly different from 1. The predicted yield of M. B. Bachir by the linear regression was lower than both Waha and Maghress under high yielding environments. Thus Waha and Maghress may be recommended for more favorable areas, like the north zone of the High Plateau in Algeria.

Introduction

In Algeria, due to the increased demand for more durum products, breeding efforts to select higher yielding durum lines with a good stability level are important. In 1979–80 two promising lines were detected in the ICARDA-ITGC joint program, and were subsequently released under the name of Waha and Maghress. The present study compared the grain yield response of these two cultivars with the local landrace M. B. Bachir. The objective was to determine the appropriate conditions for the newly released cultivars, for recommendation purpose.

Materials and Methods

Grain yield data taken from 19 trials [(5 years × 1 site) + (2 years × 3 sites) + (1 year × 4 seeding dates × 2 sites)], conducted at the ITGC agricultural research stations from 1980–81 to 1988–89 were analyzed. Generally, seeding was done by the third week of November, and the trials harvested by the end of June–early July. The seeding rate was about 350–400 viable seeds m^{-2} in 6 m^2 plots. Fertilizer recommendation for the region was followed: 100 kg ha^{-1} of super phosphate (46% P_2O_5) just before seeding, and 150 kg ha^{-1} of ammonium nitrate (33.5% N_2) between third leaf stage to the beginning of stem elongation. Weeds were usually controlled with 2,4-D at the rate of 1 l ha^{-1} of commercial formulation in 300 l ha^{-1} of water. The whole plot was harvested with a small plot combine. The method of Eberhart and Russell (1966) was followed to calculate the regression coefficient (b) and deviation from regression (S^2di) for the three varieties.

Results and Discussion

The analysis of variance (Table 1) indicates significant differences among the varieties. Waha had the highest grain yield while M. B. Bachir had the lowest (Table 2). Highly significant differences were found among the 19 environments, with mean yields varying from 5.00 to 52.5 kg ha^{-1}. There was also a significant variety × environment interaction.

Table 1. Analysis of variance for grain yield (q/ha^{-1})† of the three durum wheat varieties grown in 19 environments (fixed model).

Source of variation	df	MS
Total	170	–
Environments (E)	18	1569.84**
Varieties (V)	2	19.14*
EXV	36	38.39**
Block/Environ.	38	10.42
Residual	76	3.59

† 1 (q)uintal = 100 kg.
* Significant at 5% level.
** Significant at 1% level.

Only the regression coefficient of Maghress was significantly different from 1 (Table 2). Deviations from regression were all nonsignificantly different from 0. With a small S^2di and a high coefficient of determination, the linear regression fitted the performance of Maghress the best.

Eberhart and Russell (1966) defined a stable variety as one with $b = 1.0$ and $S^2di = 0$. Accordingly, M. B.

Table 2. Grain yield, regression coefficients (b), deviations from regression (S^2di), and coefficients of determination (R^2) of the three durum wheat varieties grown in 19 environments.

	Yield (kg/ha^{-1})				
Variety	Mean	Range	b ± sd	S^2di	R^2
M. B. Bachir	2010	710–4560	0.90 ± 0.06^{NS}	10.79	0.93
Waha	2200	520–5250	1.02 ± 0.06^{NS}	10.42	0.95
Maghress	2090	500–4830	1.07 ± 0.03*	3.32	0.98

NS Nonsignificant at 5% level from 1.0.
* Significant at 5% level from 1.0.

Bachir and Waha can be stated as stable relatively to Maghress.

To allow a visual assessment of the relative performance of the varieties, mean yields of Waha and Maghress predicted from the linear regression equation were expressed as percentages of the predicted values of M. B. Bachir, and were plotted in Figure 1, following the procedure described by Johnson et al. (1968). This figure shows that both Waha and Maghress are expected to be less adapted to low yielding environments, but are best suited for environments with a mean yield greater than 1500 kg ha^{-1}. It appears that in low yielding environments, M. B. Bachir is still to be preferred over Waha and Maghress.

In the High Plateau of Algeria, Waha and Maghress may be recommended for more favorable environments like the north zone.

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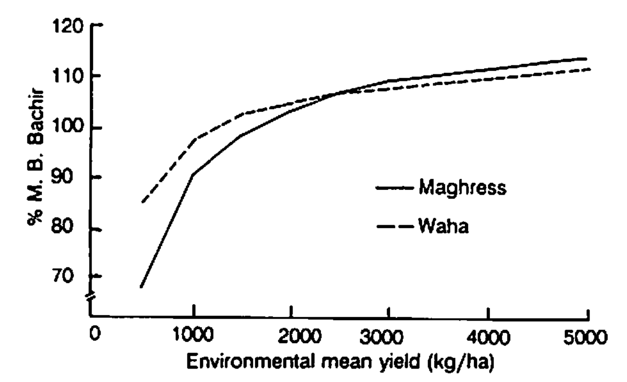

Figure 1. Predicted yield of Waha and Maghress relative to the predicted yield of M. B. Bachir from the linear regression.

Diallel Analysis of Grain Yield and Other Agronomic Traits in Durum Wheat

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تحليل متبادل للغلة الحبية وخصائص زراعية أخرى في القمح القاسي

الملخص

تم باتباع التحليل المتبادل 5X5 دراسة ثلاثة أصناف قمح قاس نمساوية، وصنفين فرنسيين. وجرى خلال 1984-86 تسجيل طول النبات، وطول آخر سلامية، وطول السنبلة، وعدد السنابل في كل نبتة، وعدد السنيبلات الخصبة، وعدد الحبات ووزن الحبة والسنبلة الرئيسية، ووزن الألف حبة، والغلة الحبية للنبات . وقد أظهرت الأصناف فروقاً معنوية بين السنوات بالنسبة لمعظم هذه الخصائص. كما حققت الهجن Miradur x Unidur و Mondur x Arcour حداً أقصى من قوة الهجين للغلة الحبية ومكوناتها مقارنة بمتوسطاتها عند الأبوين. وكانت تأثيرات القدرة التوافقية العامة معنوية بالنسبة لطول النبات، وطول آخر سلامية، وطول السنبلة. وكانت أكبر من تأثيرات القدرة التوافقية الخاصة بالنسبة لعدد السنابل/النبتة، وعدد الحبات/ السنبلة الرئيسية. وبدا أن الصنفين Mondur و Unidur هما أفضل متوافقين عامين. وعلى النقيض من ذلك جمع الصنف Miradur الحد الأقصى من قيم القدرة التوافقية العامة السلبية. وأظهرت الهجن Minadur x Unidur و Mondur x Arcour و Attila x Mondur قيماًايجابية عالية من القدرة التوافقية الخاصة بالنسبة للغلة الحبية ومكوناتها، ولم تكن صفة وزن الألف حبة قابلة للتوريث. وكانت القابلية للتوريث بين المنخفضة والمتوسطة بالنسبة لطول السنبلة، والسنيبلات الخصبة، وعدد الحبات، ووزن الحبة في كل سنبلة رئيسية، وعدد السنابل، والغلة الحبية لكل نبتة. في حين كانت قابلية التوريث متوسطة بالنسبة لطول آخر سلامية، وعالية بالنسبة لطول النبات.

Abstract

In a 5 × 5 half diallel analysis, three Austrian and two French durum wheat cultivars were investigated. Plant height, last internode length, spike length, number of spikes per plant, number of fertile spikelets, kernel number and kernel weight, main spike, 1000-kernel weight, and grain yield per plant were recorded during 1984–86. Cultivars showed significant differences among the years for most of these traits. Crosses Unidur × Miradur and Mondur × Arcour achieved maximum heterosis for grain yield and its components in comparison to their parental means. General combining ability (GCA) effects were significant for plant height, last internode length, and spike length; and were larger than the specific combining ability (SCA) effects for number of spikes/plant and kernel number/main spike.

The cultivars Mondur and Unidur seemed to be best general combiners. Cultivar Miradur, on the contrary, gathered the maximum negative GCA values. The crosses Unidur × Miradur, Mondur × Arcour, and Attila × Mondur showed high positive SCA values for grain yield and its components; 1000-kernel weight was not heritable. Low to moderate heritabilities were calculated for spike length, fertile spikelets, kernel number and kernel weight per main spike, and number of spikes and grain yield per plant. Heritabilities were moderate for last internode length, and high for plant height.

Introduction

Until now more research efforts have been invested in improving the hexaploid bread wheat than in improving the tetraploid wheat. Traditional growing regions of tetraploid durum wheat in Asia and Africa produce low yield per unit area due to stress, environmental conditions, and primitive cultural practices. However, higher yield could be achieved by crop improvement through incorporation of drought and disease tolerance.

The objectives of the present study were to assess genetic variability for grain yield and its components, as well as the general and specific combining ability (GCA and SCA) of five durum wheat cultivars using the diallel analysis.

The diallel analysis is a method to learn about the genetic system controlling a particular trait. By utilizing this technique Quick (1978), Gupta and Ahmad (1979), Singh et al. (1982), Srivastava et al. (1983), De Pace et al. (1985), and Al-Kaddoussi (1987) concluded that GCA is the most important source of genetic variation in grain yield of durum wheat.

Materials and Methods

The research work was conducted from 1984 to 1986 at the Institute of Agronomy and Plant Breeding, University of Agriculture, Vienna, Austria. Five durum wheat cultivars [three from Austria: Attila (ATT), Unidur (UDR), and Miradur (MUR); and two from France: Mondur (MDR) and Arcour (ARC)] were intercrossed in a half diallel system. Experiments were laid out in a randomized block design with four replications. Plots consisted of five rows, with 321 kernels per row and a row-to-row distance of 20 cm. The five parental cultivars in 1984; the 10 F_1s and their parents in 1986; and the five parental cultivars, 10 F_1s, 10 F_2s, and 20 backcrosses (BC) in 1986 were sown manually.

For data analysis, 40 plants from parents and F_1s, and 240 plants from F_2 were randomly drawn. The measured traits were plant height (Pl.Ht.), length of the last internode (L.Int.), main spike length (S.L.), number of spikes/plant (S.N./Pl.), number of fertile spikelets/main spike (F.Spl/M.S.), kernels/main spike (K.No./M.S.), kernel weight/main spike (K.W./M.S.), 1000-kernel weight (TKW) of seed from the main spike, and grain yield/plant (G.Yield/Pl.).

Statistical analyses were performed using computer programs of EDV Center, University of Agriculture, Vienna. GCA and SCA were calculated according to Griffing's (1956) Method 2 and Model 1. Heritabilities in broad (H^2 b.s.) or narrow (H^2 n.s.) sense were estimated after Mahmud and Kramer (1951) and Allard (1960), respectively.

Results and Discussion

The parental cultivars showed significant differences for all the traits under consideration in each year, except for number of spikes/plant and 1000-kernel weight in 1984 and 1985; and number of fertile spikelets/main spike, kernel weight/main spike, and grain yield/plant in 1985. The F_1 in 1985; and F_1, F_2, BC_1, and BC_2 in 1986 were included for analysis. The combined analysis showed that the effects of cultivars, years, and the interaction of cultivars and years were all significant for each trait, except for number of spikes/plant where the interaction of cultivar × year was insignificant.

Heterosis effects for different traits are given in Table 1. Unidur seems to be the best cultivar to produce heterosis in grain yield, followed by Mondur.

Relationships among grain yield and other traits are shown in Table 2. There were positive correlation

Table 1. Percentage of heterosis calculated on the basis of parental means in 1985.

Cross	Height	L.Int.	S.L.	S.No./Pl.	F.Spl./M.S.	K.No./M.S.	K.W./M.S.	TKW	G.Yield/Pl.
ATT × UDR	3.3	6.7	7.8	16.0	5.4	4.1	22.3	18.0	45.0
ATT × MDR	14.7	23.6	6.3	6.1	2.1	7.1	35.3	26.0	41.1
ATT × ARC	1.1	8.8	-1.8	3.1	1.1	-2.7	5.7	8.6	8.2
ATT × MUR	1.2	-2.6	4.8	9.7	8.8	15.4	20.9	6.1	21.7
UDR × MDR	9.9	26.6	1.2	15.1	1.7	6.3	35.5	28.4	40.0
UDR × ARC	7.2	10.9	3.1	16.8	4.3	2.1	30.0	27.6	44.0
UDR × MUR	12.5	4.8	8.1	29.4	7.4	25.9	54.3	22.8	82.0
MDR × ARC	18.1	32.4	5.1	17.0	3.0	11.9	40.2	24.8	44.6
MDR × MUR	-7.3	-12.0	2.8	1.6	1.7	4.0	13.4	8.8	8.5
ARC × MUR	6.1	-4.5	1.3	1.6	5.4	19.1	34.3	12.1	37.0

Table 2. Coefficients of correlation among grain yield/plant and other traits based on the results of 5 parents and their 10 F_1s in 1985.

Traits correlated	Correlation coefficients
Grain yield/plant × F.Spl./M.S.	+0.73**
Grain yield/plant × S.L.	+0.48
Grain yield/plant × S.No./Pl.	+0.64*
Grain yield/plant × L.Int.	+0.28
Grain yield/plant × Height	+0.44
Grain yield/plant × TKW	+0.77**
Grain yield/plant × K.W./M.S.	+0.9**
Grain yield/plant × K.No./M.S.	+0.73**
Spike Length × L.Int.	+0.45
Spike Length × Height	+0.52*
Internode length × S.L.	+0.45
Internode length × Height	+0.9**
Height × S.L.	+0.52*
Height × L.Int.	+0.9**

* Significant at 0.05.
** Significant at 0.01.

coefficients among plant height, last internode length, and spike length. Grain yield/plant was positively correlated with number of spikes/plant, kernel number, kernel weight, number of fertile spikelets per main spike, and 1000-kernel weight.

GCA effects were significant for plant height, last internode length, and spike length (Table 3), and were large as compared to the SCA effects for number of spikes/plant and kernel number per main spike. Similar results were reported by Quick (1978), Gupta and Ahmad (1979), Singh et al. (1982), De Pace et al. (1985), and Al-Kaddoussi (1987). The cultivar Attila had significant positive GCA values for plant height, last internode length, and spike length; and high GCA values for kernel weight per main spike and 1000-kernel weight. Thus it is considered a good parent for long spikes and heavy grains. In contrast, Unidur had significant negative GCA effects for plant height and last internode length, thus is expected to be useful for breeding semidwarf wheat. Mondur had the highest positive GCA effects for kernel number per main spike. In general, Mondur and Unidur could be considered as the two best parental cultivars for breeding desirable durum wheat cultivars.

SCA effects were insignificant for most of the traits under consideration (Table 4) but were numerically larger than the GCA effects for number of fertile spikelets and kernel weight per main spike, 1000-kernel weight, and grain yield per plant. Gupta and Ahmad (1979), Singh et al. (1982), Srivastava et al. (1983), and De Pace et al. (1985) also ascertained the importance of nonadditive effects for these traits.

Out of the 10 studied crosses, only two, ATT × ARC and MDR × MUR, showed negative SCA values for grain yield per plant (Table 4). The combinations UDR × MUR, MDR × ARC, and ATT × MDR attained high SCA values for grain yield per plant and other investigated traits. These results corresponded well with those for heterosis.

Table 3. General combining ability effects for five parents of the 5 × 5 half diallel for different quantitative traits in 1985.

Cultivar	Height	L.Int.	S.L.	S.No./Pl.	F.Spl./M.S.	K.No./M.S.	K.W./M.S.	TKW	G.Yield/Pl.
Attila	3.60*	2.06*	0.29**	-0.48	-0.02	0.10	0.08	2.14	-0.18
Unidur	-5.29**	-2.72**	0.06	0.19	-0.06	0.52	0.04	0.24	0.27
Mondur	5.20**	1.12	0.11	0.02	0.05	2.25	0.05	-1.28	0.11
Arcour	-0.95	0.48	0.00	0.12	0.22	-0.28	-0.03	-0.33	0.15
Miradur	-2.56	-0.95	-0.46**	0.15	-0.18	-2.59	-0.15	-0.77	-0.33
GCA F value	5.81**	3.84**	6.64**	1.09	0.36	1.47	0.93	0.72	0.62
SCA F value	1.59	1.02	0.56	0.31	0.41	0.60	1.55	1.72	1.58
GCA/SCA	3.65	3.77	11.78	3.58	0.89	2.44	0.60	0.42	0.39

* Significant at 0.05.
** Significant at 0.01.

Table 4. Specific combining ability effects for crosses of a 5 × 5 half diallel for different quantitative traits in 1985.

Cross	Height	L.Int.	S.L.	S.No./Pl.	F.Spl./M.S.	K.No./M.S.	K.W./M.S.	TKW	G.Yield/Pl.
ATT × UDR	-0.85	-0.20	0.28	0.16	0.29	-0.01	0.08	2.27	0.63
ATT × MDR	8.34	3.02	0.22	0.03	0.05	1.46	0.33	6.28	0.93
ATT × ARC	-2.58	0.35	-0.22	-0.07	-0.19	-2.09	-0.13	-0.54	-0.40
ATT × MUR	-0.19	-0.38	0.10	0.15	0.63	2.30	0.09	-0.28	0.05
UDR × MDR	2.37	2.29	-0.13	0.15	-0.03	0.48	0.18	4.11	0.36
UDR × ARC	0.48	0.18	0.06	0.24	0.22	-1.06	0.13	5.13	0.55
UDR × MUR	6.54	0.96	0.25	0.72	0.42	4.93	0.41	4.64	1.69*
MDR × ARC	9.05*	4.18	0.22	0.45	0.24	2.94	0.32	4.30	1.03
MDR × MUR	-8.54*	-3.19	-0.01	-0.18	-0.11	-1.63	-0.13	-0.92	-0.55
ARC × MUR	2.19	-0.98	-0.02	-0.18	0.27	3.08	0.20	1.54	0.55

Tables 5 and 6 show that heritability values in broad and narrow senses differ greatly from cross to cross for each trait; 1000-kernel weight was not heritable. Low broad-sense heritabilities were recorded for number of spikes and grain yield per plant, number of fertile spikelets, kernel number and kernel weight per main spike, and spike length (Table 5). Other estimated values were moderate for last internode length and high for plant height. Joppa (1973) reported moderate heritability for number of spikes, and high heritability for both plant height and 1000-kernel weight. Values reported by Dixit and Patil (1983) were moderate for grain yield, number of spikelets and kernel number per main spike, and 1000-kernel weight; and high for spike length, last internode length, and plant height.

Narrow-sense heritability was low for number of spikes per plant and kernel number/main stem; moderate for spike and last internode length, number of fertile spikelets and kernel weight per main spike, and grain yield per plant; and high for plant height (Table 6). Similar results were obtained by Lebsock and Amaya (1969), Srivastava et al. (1983), and Verma et al. (1984).

The present study showed the preponderance of environmental effects on grain yield; however, selection for grain yield per se could be successful in late generations, and recurrent selection is proposed for the early generations.

Table 5. Broad-sense heritability percentages for different quantitative traits in 1986 (negative values assumed to be zero).

Cross	Height	L.Int.	S.L.	S.No./Pl.	F.Spl./M.S.	K.No./M.S.	K.W./M.S.	TKW	G.Yield/Pl.
ATT × UDR	63	39	66	48	45	49	46	0	43
ATT × MDR	60	44	63	6	38	29	21	0	21
ATT × ARC	64	56	53	19	41	30	23	0	0
ATT × MUR	77	51	35	34	18	48	43	15	20
UDR × MDR	71	36	29	21	42	13	35	3	56
UDR × ARC	46	28	21	20	41	11	27	46	20
UDR × MUR	85	55	16	46	30	31	42	7	46
MDR × ARC	66	53	40	0	27	0	0	0	10
MDR × MUR	78	49	0	20	12	22	32	0	22
ARC × MUR	82	61	1	31	31	23	39	30	15
Mean	69	47	32	25	33	26	31	10	25

Table 6. Narrow-sense heritability percentages in narrow sense estimated for different quantitative traits in 1986 (negative values assumed to be zero; value greater than 100 taken as 100).

Cross	Height	L.Int.	S.L.	S.No./Pl.	F.Spl./M.S.	K.No./M.S.	K.W./M.S.	TKW	G.Yield/Pl.
ATT × UDR	45	9	13	0	33	36	24	0	18
ATT × MDR	58	39	71	25	0	0	0	0	22
ATT × ARC	85	16	0	33	53	11	32	0	54
ATT × MUR	79	31	30	0	13	0	0	0	53
UDR × MDR	72	47	0	0	32	43	59	11	42
UDR × ARC	9	24	0	31	20	0	0	0	13
UDR × MUR	73	13	21	0	57	0	72	0	33
MDR × ARC	62	0	37	19	22	13	30	0	51
MDR × MUR	100	88	43	25	21	0	36	0	0
ARC × MUR	90	42	0	0	0	36	15	0	29
Mean	67	31	22	13	25	14	27	1	32

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Dual Purpose Barley[†]

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الشعير الثنائي الغرض

الملخص

تقدم هذه الورقة عرضاً مقتضباً عن الشعير الثنائي الغرض الذي يعني استخدام الشعير لغرضين، هما: الرعي، والحب أوالدريس الناتج عن تجدد نموالشعير. إن أسلوب رعي الأغنام أو الماعز لنباتات الشعير وهي في طور الإشطاء متبع حالياً في العراق وسورية، وكان متبعا في قبرص فيما مضى. ويعتبر الشعير العلفي مغذياً ومتوفرا في وقت تكون فيه الأغنام والماعز في مسيس الحاجة إليه. وقد أظهرت التجارب في قبرص أن رعي الشعير في طور الإشطاء قد أنقص المادة الجافة وغلة البروتين الخام بالمقارنة مع عدم الرعي. ويشكل عام يقلل الرعي الغلة الحبية تحت الظروف الجافة، لكنه يزيدها تحت ظروف الري أوالأمطار الغزيرة. ويختلف هذا التأثير بحسب الصنف، وكثافة الرعي، ومعدل البذار، والتسميد الآزوتي. ويُقترَح أن تتم غربلة السلالات المغلالة لاستخدامها كشعير ثنائي الغرض.

Abstract

The paper presents a brief review on dual purpose barley, which refers to barley crops managed for two uses, namely for grazing, plus grain or hay from the regrowth. The practice of allowing sheep or goats to graze barley crops during tillering is currently followed in Iraq and Syria, and was followed in Cyprus in the past. Barley forage is nutritive and is available at a time when it is most needed by sheep and goats. Experiments in Cyprus showed that grazing barley at tillering stage reduced dry matter and crude protein yield in comparison to no grazing. In general, grazing reduces grain yield under dryland conditions, but increases it under irrigation or high rainfall. The effect varies with cultivars, intensity of grazing, seed rate, and nitrogen fertilization. It is suggested that high yielding lines be screened for dual purpose use.

Introduction

Barley is important in the West Asia and North Africa (WANA) region because of its wide adaptability, the variety of its uses (grain production for feed or malt, hay, or grazing) and its relatively high yield under stress conditions compared to other crops (Hadjichristodoulou 1983). Because of low productivity of natural pastures in the region, sheep and goat largely on barley for grazing. Dual purpose barley refers to crop managed for two uses, namely grazing plus grain from the regrowth, or grazing plus hay from the regrowth. In Syria a large percentage of barley crops is grazed at the tillering stage, and the crop is regrown to be harvested for grain and straw (Anderson 1985). In Cyprus in the past, barley sown early in manure fertilized fields and in years of adequate rainfall early in the season used to be grazed at tillering stage, to avoid lodging at later stages. Farmers obtained higher grain yield from these fields. In Iraq, 1.2 million ha of irrigated barley or barley grown in high rainfall areas is grazed, and grain yields are usually higher in grazed than ungrazed barley (Dr B. Al-Rawal, personal communication). Detailed information on research results from the WANA Region has been published by Skorda (1977), Hadjichristodoulou (1983), and Anderson (1985). A more general review of literature was published by Holiday (1956). The main aspects of breeding and management of dual purpose barley are discussed here.

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Importance of Forage for Grazing

In the rain-fed areas, barley is, perhaps, the fastest growing crop after the first effective rains in autumn. Growth rate of vetches and other legume pasture crops is very low during the cold period of the winter; growth rate of wheat is lower still. The animal carrying capacity of the natural pastures is at its lowest level during autumn and early winter. Therefore, barley comes at a time when it is most needed by sheep and goats requiring improved nutrition, i.e., at lambing period.

When sheep and goats graze barley at tillering stage, they remove the leaves but do not affect the growing points of the shoots. Thus, soon after the animals are removed from the field, regrowth occurs, provided that there is no moisture stress.

Cereals are known to have lower protein content than legumes. However, there is published information that dry matter of forage of barley at the tillering stage is 20%-30%, which is even higher than that of forage legumes (Hadjichristodoulou 1983; Anderson 1985; Droushiotis 1984; Droushiotis and Wilman 1987). Thus, the herbage of barley at grazing stage is at least as nutritious as herbage from legumes, which is considered the best available to ruminants.

Effect of Grazing on Hay Yields

Grazing barley at tillering stage reduced dry matter yield of hay compared to nongrazed plots. In one experiment, the total dry matter yield of forage from clipping at tillering stage plus the dry matter at milk stage (GH) was almost half the yield of barley harvested for hay (H) (Table 1) (Hadjichristodoulou 1983). Crude protein yield of GH was also less than that of H. In another study by Droushiotis (1984) dry matter yield of four varieties was also higher for the H than the GH treatments (Table 2). By contrast, Skorda (1977) in Greece showed that dry matter for the H treatment was the same as that for the GH treatments.

The ratio of GH/H treatment varied with variety (Hadjichristodoulou 1983), from 0.36 to 0.88 for dry matter yield and from 0.61 to 1.32 for crude protein yield (Table 1). Thus it is possible to select varieties in which hay yields are affected by grazing at tillering stage to a lesser extent than that of other varieties.

In an experiment by Hadjichristodoulou (1983), dry matter of crude protein yield of four successive clippings at tillering stage (G) was lower than that of one clipping

Table 1. Yields (kg/ha) of 11 barley varieties with and without clipping at tillering 1973–74 (after Hadjichristodoulou 1983).

Treatment	Dry matter yield		Crude protein yield	
	Mean	Range of variety means	Mean	Range of variety means
GH*	5,885.02	4,652.75–6,758.81	978.35	731.89–1,247.21
H**	10,380.94	7,565.39–13,876.10	1,224.80	941.01–1,598.22
GH/H	0.57	0.36–0.88	0.80	0.61–1.32

* GH = Harvested at 50% heading following a clipping at tillering.
** H = Harvested at 50% heading.

Table 2. Effect of clipping of four barley varieties on yields (t/ha) in 1978–82 (after Droushiotis 1984).

Clipping	Herbage dry matter	Grain yield	Straw yield
No clipping (for grain)	–	3.46	5.04
One clipping + grain	0.81	2.86	3.93
Continuous clipping	3.42	–	–
One clipping + hay	7.50	–	–
No clipping (for hay)	9.46	–	–

at tillering stage followed by hay harvesting at 50% heading stage (GH) (Table 3). There were significant variations among varieties in the ratio of GH/G for dry matter and crude protein yield. Similar results were reported by Droushiotis (1984). Dry matter yield of GH was 7.5 t/ha and of G 3.4 t/ha (Table 2).

Effect of Grazing on Grain Yield and other Traits

Harvesting grain is more common than harvesting for hay, especially in the Middle East. Barley is grazed at the tillering stage and then the regrowth is harvested at maturity for grain and straw. In a review of published work on the effects of grazing on grain yield, Hadjichristodoulou (1983) summarized the conclusions.

1. Under dryland conditions grazing reduced grain yield, sometimes of a high order.
2. Under irrigation or high rainfall conditions grazing increased grain yield.

Table 3. Yields (kg/ha) of 11 barley varieties 1976–77 at two locations (after Hadjichristodoulou 1983).

Treatment	Dry matter yield: Mean	Dry matter yield: Range of variety means	Crude protein yield: Mean	Crude protein yield: Range of variety means
GH*	2,292.77	1,874.54–2,785.68	642.27	500.38–791.64
H**	3,831.24	2,292.77–5,175.53	769.23	537.72–1,045.56
GH/H	1.67	1.18–1.96	1.20	1.07–1.41

* GH = Harvested at 50% heading following a clipping at tillering.
** H = Harvested at 50% heading.

In a study by Hadjichristodoulou (1983) conducted in Cyprus under rain-fed conditions with 24 barley varieties, grain yield was reduced on average by 33% (Table 4). Early varieties were affected more than late varieties, and there were significant differences among varieties (Table 5). Anderson (1985) reported both increases and reductions in grain yield after grazing, depending on variety and year (Table 6).

In Iraq, Dr B. Al-Rawal (personal communication) studied local landraces and other breeding material under irrigation, and selected lines which give higher grain yield after one clipping compared to unclipped barley (Table 7). Thus, in addition to the nutritious forage obtained by clipping, there was an increase in grain yield. He found genetic variation in the response of genotypes to grazing, as reported also by Hadjichristodoulou (1983).

Grazing affects other traits. In the study by Hadjichristodoulou (1983) grazing (or clipping) reduced straw yield by 40%, delayed heading, and reduced plant height and 1000-grain weight (Table 4). Tiller number per m^2, grain number per tiller, harvest index, volume weight, and grain protein content were not affected.

Production Practices and Variety Selection

As pointed out earlier, the effects of grazing on barley grain yield depend on the moisture availability. Under adequate moisture conditions grazing increased grain yields. Anderson (1985) studied the effect of nitrogen fertilizer and seed rate on the production of forage and the subsequent grain yield of grazed barley in rain-fed areas of Syria. Higher nitrogen rates, up to 120 kg N/ha, and higher seed rates, up to 240 kg/ha, were found to increase dry matter yield at tillering. These effects were *influenced* by the environment (season or location). The combination of 120 kg/ha seed rate and 60 kg N/ha gave

Table 4. Effects of grazing on agronomic traits of barley (means of 24 varieties) at Laxia, 1980/81 (after Hadjichristodoulou 1983).

Trait	Management method: No grazing	Management method: One grazing	Significance of difference
Grain yield (kg/ha)	3,293.52	2,203.15	*
Tiller number per m^2	2,128.47	2,135.93	NS
Heading (days after 1 March)	48.54	89.62	*
Plant height (cm)	593.73	455.57	*
Straw yield (kg/ha)	3,226.31	1,941.76	*
1000-grain weight (g)	300.23	262.14	*
Grain number per tiller	235.25	160.57	NS
Harvest index (%)	373.42	395.82	NS
Volume weight (kg/hl)	451.83	436.90	NS
Crude protein in grain (%)	71.17	69.23	NS

* = Significant ($P < 0.05$); NS = not significant.

Table 5. Mean and range of ratio of various characters for grazed over ungrazed treatment for early and late barley varieties (after Hadjichristodoulou 1983).

		Grain yield	Straw yield	Heading date	Plant height	1000-grain weight
Mean	Early	0.66	0.56	2.30	0.77	0.85
	Late	0.77	0.64	1.62	0.79	0.90
Range	Early	0.49–0.88	0.41–0.80	1.6–8.0	0.73–0.88	0.75–0.92
	Late	0.55–0.88	0.50–0.81	1.3–4.5	0.73–0.85	0.83–0.99

Table 6. Effect of grazing on barley grain yield in Syria (after Anderson 1985).

Season	No. of varieties	% of ungrazed
1980–81	3	+10 to +18
1981–82	12	-22 to +25
1982–83	12 (same as 1981/82)	-6 to -43

Table 7. Yield (t/ha) of forage dry matter (FDM) and grain for two dual purpose barleys in Iraq.

	Line 99		Numar (check)	
Clipping	FDM*	Grain	FDM	Grain
No clipping	—	3.93	—	3.85
One clipping	0.45	4.69	0.41	3.85
Two clippings	1.26	3.58	1.25	2.24
Hay (no clippings)	10.10	—	12.5	—

Source: Dr Baha Al-Rawal.
* Crude protein content: 25%. Fertilizer: 150 kg N/ha, 150 kg P_2O_5/ha.

the highest dry matter yield. Grain yields after grazing were also increased by the addition of nitrogen fertilizer. Maximum grain yield in grazed plots required double the nitrogen rates of ungrazed plots. In Iraq high rates of N fertilizer (159 kg N/ha) were applied in irrigated dual purpose barley (Dr B. Al-Rawal, personal communication). Grain yield after grazing is negatively related with the amount of dry matter removed by grazing (Figure 1).

The effect of grazing on grain yield also varies with variety. In addition, there are genetic differences among varieties in the production of forage at tillering and in grain yield without grazing. Thus, one must consider (a) effect of grazing on grain yield; (b) dry matter yield at tillering stage; and (c) grain yield in ungrazed plots.

Based on these criteria, Hadjichristodoulou (1983) selected the best varieties for dual purpose use (Table 8). He showed that high grain yielding lines without grazing also gave high grain yield after grazing ($r = 0.53$; $P < 0.05$). Additionally, grain yield of ungrazed plots was positively correlated with dry matter yield of forage ($r = 0.57$; $P < 0.05$). Thus, high grain yielding lines (ungrazed) from breeding programs could be used as basic material for selecting dual purpose varieties.

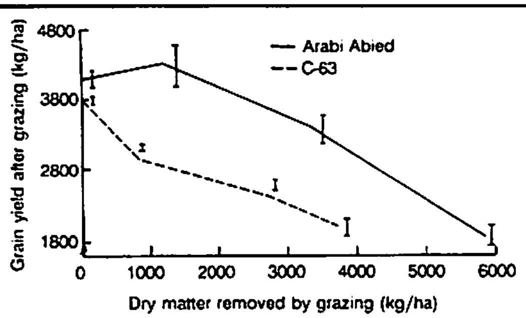

Figure 1. Relationship between dry matter removed by grazing and grain yield after grazing (after Anderson 1985).

Table 8. Grain and dry matter yields (kg/ha) of forage of selected dual purpose barley varieties (after Hadjichristodoulou 1983).

	Grain yield			Dry matter yield
Variety	Ungrazed (A)	Grazed (B)	B/A	
Early group				
Athenais	3,749.09	1,896.95	0.51	679.62
M-Att-73-325-2	3,390.61	2,076.19	0.61	604.93
Range of 12 varieties	2,233.02–3,749.09	1,560.87–2,218.09	0.49–0.88	410.76–679.62
Late group				
Cr 368/4/1	4,017.95	3,039.60	0.76	530.25
Aurore Esperance	3,674.40	2,703.52	0.74	560.12
Kantara	3,554.91	2,673.65	0.75	769.23
Range of 12 varieties	3,032.13–4,017.95	1,926.82–3,039.60	0.55–0.88	433.16–769.23

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Effectiveness of Prochloraz in Controlling Eye Spot of Wheat Caused By *Pseudocercosporella herpotrichoides*

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تأثير المبيد بروكلوراز في مكافحة التبقع العيني على القمح المتسبب عن *Pseudocercosporella herpotrichoides*

الملخص

تمت دراسة قدرة المبيد بروكلوراز Prochloraz على مكافحة مرض التبقع العيني على القمح، المتسبب عن *Pseudocercosporella herpotrichoides*. وجرى عزل وتحديد العامل المُمرض من البقع المصابة الموجودة على ساق نباتات القمح، التي جمعت من 14 و 79 و3 مواقع علي مدى ثلاث سنوات متعاقبة على التوالي. وكان الفطر الذي أخذت منه عينة في السنتين الأوليتين حساساً للبروكلوراز عند مستوى التركيز 5 مغ مادة فعالة/مل باستثناء ثلاثة مواقع، حيث وجدت سلالات حساسيتها له منخفضة. وأظهرت اختبارات انتقاليةpassage على هذه السلالات أن الفطر نو مقاومة تأقلمية لكنها ليست تكوينية، وأثبتت الدراسة ككل فعالية البروكلوراز في مكافحة هذه الآفة الرئيسية.

Abstract

Prochloraz's ability to control eye spot of wheat caused by *Pseudocercosporella herpotrichoides* was studied. The pathogen was isolated and identified from stored stem lesions of wheat collected from 14, 79, and 3 locations over three successive years, respectively. The fungus sampled in the first two years was sensitive to prochloraz at a level of 5 μ g a.i./ml, except at three locations, where reduced sensitivity strains were found. Passage tests conducted on these strains showed that the fungi has adaptive resistance, but not constitutive resistance; and the overall study proved prochloraz's efficiency in controlling this major pest.

Introduction

Wheat is one of the world's most important cereal crops. This crop suffers from many diseases, of which eye spot is one. Eye spot of wheat caused by *Pseudocercosporella herpotrichoides* is a major problem in wheat growing areas in Hessen Province of Germany (Hossain 1987). In the past, eye spot of wheat was controlled with benomyl (carbendazim); but the disease developed resistance against this chemical (Rashid and Schlosser 1977; Brautigum and Schlosser 1984). A new product Sportak with prochloraz (1-{N-Propyl-N-[2-(2, 4, 6-trichlorophenoxy)-carbamoyl] imidazole}) as active ingredient, was introduced in 1983 in Hessen. Now, the same question arises; whether the fungus is becoming resistant against this new fungicide after several years of application in the field. In view of this, the present study was undertaken to determine the efficiency of prochloraz in preventing *P. herpotrichoides* from causing stem lesions of wheat in wheat growing areas of Hessen Province, and to carry out a passage test to determine the type of resistance.

Materials and Methods

Stem lesions of wheat to be analyzed for eye spot pathogen *Pseudocercosporella herpotrichoides* were collected from 14, 79, and 3 locations in three successive years, respectively. The locations were representative of areas where benomyl resistance was earlier detected (Rashid and Schlosser 1977; Brautigum and Schlosser 1984). Isolation and identification of the pathogen was carried out at the Institute of Phytopathology and Applied Zoology, University of Giessen, with two different techniques as described by Rashid and Schlosser (1977). As it was not possible to study all the samples at a time, a series of investigations was carried out using samples stored at -15°C. The eye spot stem lesions were washed under flowing tap water for an hour, and then dissected once either longitudinally or transversely. Thereafter, one-half lesion was placed on water agar medium (Klewitz 1973), and the other half lesion was placed on water agar medium containing 5 μ g a.i. prochloraz/ml. The lesions were observed under microscope after an incubation period of 14 days at 14°C under near UV-light (12/12). From each location, 100 stem lesions were studied. The strains of the fungi that showed reduced sensitivity were isolated by the hyphal tip culture method.

The passage test was carried out by growing reduced sensitivity (RS) strains on water agar medium twice under the same conditions, i.e., under near UV light (12/12) at 14°C for 14 days. Thereafter, the RS strains were grown on PDA medium four times. Then the RS strains were tested against a series of prochloraz concentrations in water agar medium for four and six growing passages. The sensitivity of the pathogenic fungi was determined by measuring the mycelial growth along with the production of conidia.

Results and Discussion

The frequency of *P. herpotrichoides* prevalence from stem lesions of wheat ranged from 0% to 100% during this study (Table 1). Stem lesions from 53 of the locations yielded 25%–75% *P. herpotrichoides,* whereas only 10 of the locations were free from infection. *P. herpotrichoides* from the 14 locations sampled in the first year was found to be sensitive to prochloraz at a level of 5 μ g a.i./ml. The fungi from 79 locations collected in the second year were also found to be sensitive to prochloraz at the same discrimination level except at three locations, where 8%–11% stem lesions yielded RS strains. The growth of the RS strains was abnormal and produced deformed conidia. From the passage test it was evident that the fungi lost its nature of resistance, becoming more sensitive with the increase of passage (Table 2). Out of the 11 RS strains, only 2 could grow on 5 μ g a.i. prochloraz/ml treated plates after four passages, whereas none of the RS strains could grow on 10 μ g a.i. prochloraz/ml treated plates. No growth of any RS strains was recorded after six passages on plates that were treated with 1.0 μ g a.i. prochloraz/ml.

Table 1. Prevalence of *Pseudocercosporella herpotrichoides* from eye spot stem lesions of wheat in Hessen Province, Germany.

Prevalence (%)	Number of locations			Total
	Year I	Year II	Year III	
0	—	10	—	10 (10.4)[a]
1–24	—	20	—	20 (20.8)
25–74	8	40	3	51 (53.1)
75–100	6	9	—	15 (15.6)

a. Data in parentheses indicate % of all locations.

In the third year, stem lesions collected from the three locations which produced RS strains during the second year did not yield any RS strains. The results of the model work of predicting development of resistant strains of *P. herpotrichoides* revealed that during the study no resistant strains of this fungi were recorded in wheat growing areas in Hessen Province of Germany. From the result of the passage test it may be stated that the fungi showed adaptive resistance, but not constitutive resistance. The result of the third year strongly confirmed this finding. The results of the present study clearly proved the efficiency of prochloraz in controlling *P. herpotrichoides,* supporting many authors' similar findings (Ballard and McLaughlan 1982; Blanquat et al. 1980; Fehrmann 1981; Zwatz 1986). Furthermore, this study showed that no resistant strains of this fungi against prochloraz was found in Hessen. Prochloraz has an excellent protective, curative, and local systemic action. Because prochloraz inhibits ergosterol synthesis of the fungi (Buchenauer 1984), the pathogen has little chance of developing resistant strains.

Table 2. Numbers of RS strains of *P. herpotrichoides* that could grow on water agar medium with different concentrations of prochloraz.

Location no. where RS strains occurred	No. of passages				
	0	4		6	
	5.0†	5.0	10.0	0.5	1.0
23	7	1	0	1	0
25	2	0	0	0	0
28	2	1	0	2	0

† Prochloraz concentration in μ g a.i. prochloraz/ml.

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Barley Stripe Disease (*Pyrenophora graminea*) in East Azarbaijan, Iran: Incidence and Yield Loss

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مرض تخطط الشعير *Pyrenophora graminea* باذربيجان الشرقية في إيران: الإصابة والفاقد في الغلة

الملخص

تم في عامي 1986 و 1989حصر مامجمله 93 حقلاً، منها 67 حقلاً مزروعاً بالشعير الشتوي و26 حقلاً مزروعاً بالشعير الربيعي في انربيجان الشرقية التي تشكل الإقليم الشمالي الغربي من إيران. ففي عام 1986 تم حصر 51 حقلاً وفي عام 1989 تم حصر 42 حقلا وذلك لتقدير فاقد الغلة والإصابة بمرض تخطط الشعير المتسبب عن *Pyrenophora graminea*. ولقد لوحظ المرض في 60 حقل شعير شتوي و15 حقلاً مزروعاً بالشعير الربيعي التي شملت 54 من أصل 63 حقل مروي و21 من أصل 30 حقلا بعليا. وقد بلغ متوسط الإصابة بهذاالمرض 16.3٪ في 1986 و12.7٪ في 1989. وكانت نسبة الإصابة الإجمالية 15.9٪ و12.1٪ و 15.2٪ في حقول الشعير الشتوي والربيعي وحقول الشعير الربيعي الشتوي المختلطة على التوالي. وجرت دراسة 28 حقلاً مصاباً لتحديد تأثير المرض في فاقد الغلة. وقد أدى المرض إلى تقليل الإشطاءات الحاملة للسنابل بنسبة 36٪، وطول السنبلة بنسبة 37٪، ووزن السنبلة بنسبة 91٪، وعدد الحبات بنسبة 71٪ ، ووزن الألف حبة بنسبة 79٪. وكانت الغلة الحبية الإجمالية من الإشطاءات المصابة أقل من الغلة في الإشطاءات غير المصابة بنسبة 93٪.

Abstract

In 1986 and 1989, a total of 93 fields, including 67 winter barley and 26 spring barley fields, were surveyed in East Azarbaijan, a northwestern province of Iran. The surveys, 51 in 1986 and 42 in 1989, were conducted to estimate incidence of and yield loss to barley stripe disease, caused by *Pyrenophora graminea*. The disease was observed in 60 winter barley and 15 spring barley fields which included 54 of 63 irrigated fields and 21 of 30 rain-fed fields surveyed. Incidence of this disease averaged 16.3% in 1986 and 12.7% in 1989. Overall disease incidence was 15.9%, 12.1%, and 15.2% in winter, spring, and combined winter and spring barley fields, respectively. Twenty-eight infected fields were studied to determine effect of the disease on yield loss. The disease reduced spike-bearing tillers by 36%, spike length by 37%, spike weight by 91%, grain number by 71%, and 1000-grain weight by 79%. Total grain yield from infected tillers was 93% less than that in noninfected tillers.

Introduction

Stripe disease of barley (*Hordeum vulgare* L.), caused by *Pynophora graminea* Ito & Kurib. [conidial state: *Drechslera graminea* (Rab. ex Schlecht.) Shoemaker, Syn. *Helminthosporium gramineum* Rab., ex Schlecht.], has been reported in many areas causing yield losses up to 100% (Behar and Aulakh 1988; Magnus 1979; Mathre 1982; Mathur et al. 1964; Neergaard 1979; Porta-puglia et al. 1986; Richardson et al. 1976; Suneson 1946). In 1983–89 the disease was commonly observed in farmers' fields in East Azarbaijan, a northwestern province of Iran.

Barley is second to wheat as the most important cereal crop in East Azarbaijan, as well as in the whole of Iran (Anonymous 1988). Each year, approximately 200×10^3 ha of irrigated and rain-fed farmland is sown to winter and spring barley in the province, compared to 1800×10^3 ha in the whole country. Barley yield in the province is about 900 kg/ha, considerably lower than yield reported in other parts of the world; this low yield of barley in the area could be caused by the presence of diseases, particularly barley stripe.

The present investigations were undertaken to estimate incidence of barley stripe disease in East Azarbaijan and impact of the disease on yield.

Materials and Methods

One survey in 1986 and another survey in 1989 were conducted throughout the province of East Azarbaijan to estimate incidence of barley stripe disease and its effect on yield loss. For this purpose 51 barley fields in 1986 (46 winter barley and 5 spring barley fields) and 42 barley fields in 1989 (21 winter barley and 21 spring barley fields) were visited (Table 1). The surveys were carried out during the period from 6 April to 5 July when the plants were between growth stage 7 (second node of stem formed) and 11.2 (mealy ripe) on the Feekes scale (Large 1945). Disease incidence was determined by examining 10 plants at each of 10 plots per field (a total of 100 plants) by walking an M-shaped path through an area of at least 1 ha in the middle of the field. In fields smaller than 1 ha, the whole field was included. Infected plants were easily distinguished from healthy plants by typical disease symptoms of yellow stripes on young leaves and leaf sheaths, necrotic and split leaves, and blighted culms with discolored and twisted spikes. Representative infected plant samples from different regions were examined for the presence of *P. graminea* conidia. Overall percent disease incidence in the surveyed area was determined using the general formula:

$$\frac{\sum_{i=1}^{N} (Di \times Si)}{\sum_{i=1}^{N} Si}$$

where i = field no. (n = 93 in this study), Di = percent disease incidence in field i, and Si size of field i in hectares.

To estimate yield loss, samples of infected and noninfected tillers were collected from 28 previously identified fields (15 fields in 1986 and 13 fields in 1989) in Ardebil, Maraghch, Marand, Meshginshahr, Moghan, and Tabriz, six of the important barley growing regions in the province. The 28 fields included 23 irrigated (flooded or rill) (21 winter barley and 2 spring barley fields) and 5 rain-fed fields (3 winter barley and 2 spring barley fields). Four replicates each consisting of 25 noninfected tillers, growing side by side, were taken at growth stages 11.3 (grains hard) and 11.4 (ripe for cutting) from each field.

The collected tillers were examined for spike presence and lengths of the spikes were measured. After drying, spikes were weighed and the grains were harvested by hand threshing. Weights of harvested grains and 1000-grain weights were measured. Paired T-test comparisons were used to determine statistical significance between yield of infected and noninfected tillers. Also, yields of infected tillers from winter barley and spring barley fields and yields of infected tillers from irrigated and rain-fed fields were compared against each other, respectively.

Results

Barley stripe disease was present in 75 of the 93 barley fields surveyed; 42 had a disease incidence of more than 10% of which 17 fields had a disease incidence greater than 25% (Table 1). In 1986, the disease was found in 42 of 46 winter barley and in only 1 of 5 spring barley fields surveyed. In 1989, the disease was observed in 18 of 21 winter barley and in 14 of 21 spring barley fields visited. Incidence of this disease averaged 16.3% in 1986 and 12.7% in 1989. All together the disease was present in 54 of 63 irrigated fields and in 21 of 30 rain-fed fields surveyed. The highest disease incidence was 57% in an irrigated winter barley field in Moghan in 1986. Overall disease incidence in the total field area (207 ha) surveyed was estimated to be 15.9%, 12.1%, and 15.2% in winter, spring, and combined winter and spring barley fields, respectively.

Number of spike-bearing tillers, length of spikes, weight of spikes, number of grains, total grain weight, and 1000-grain weight in infected tillers were significantly lower than those of noninfected tillers in both 1986 and 1989 (Table 2). This was true for fields in each of the six regions, Ardebil, Maragheh, Marand, Meshginshahr, Moghan, and Tabriz. Spikes failed to emerge in 36% of infected tillers, and emerged spikes were discolored and twisted producing none or few small shrivelled grains. Length and weight of spikes from infected tillers were, respectively, 37% and 91% less than those from noninfected tillers. Number of grains from infected tillers was 71% lower than number of grains from noninfected tillers and 1000-grain weight from infected tillers was reduced by 79%. Total grain yield from infected tillers was reduced by 91%, 97%, and 93% compared to noninfected tillers in 1986, 1989, and overall in 1986 and 1989, respectively. There was no significant difference between yields of infected tillers either from winter barley and spring barley fields or from irrigated and rain-fed fields when compared with each other, respectively.

Table 1. Incidence of barley stripe disease (*Pyrenophora graminea*) in East Azarbaijan, Iran.

Year	Barley type	Water source	Fields surveyed (no.)	Fields surveyed (ha)	No. of fields in each incidence class† 0	1–10	11–25	26–50	51–100	Average % disease incidence by: field no.‡	field area§
1986	-	-	51	144	8	14	17	8	4	16.9	16.3
1989	-	-	42	63	10	19	8	5	0	9.5	12.7
1986 + 1989	Winter	Irrigated	49	136	4	21	11	9	4	17.0	16.4
		Rain-fed	18	33.5	3	3	10	2	0	14.4	13.8
		Subtotal	67	169.5	7	24	21	11	4	16.3	15.9
	Spring	Irrigated	14	21.5	5	5	2	2	0	8.6	15.5
		Rain-fed	12	16	6	4	2	0	0	4.1	7.5
		Subtotal	26	37.5	11	9	4	2	0	6.5	12.1
		Total	93	207	18	33	25	13	4	13.6	15.2

† Incidence class is based in the percent of infected plants. Fields in class 1-10, for example, would have 1%–10% infected plants.
‡ Averaged from percent disease incidence in the fields.
§ Determined using the formula presented in the Materials and Methods section.

Table 2. Yield and yield component data from barley fields with stripe disease (*P. graminea*) in East Azarbaijan, Iran.

Year	Plant sample	No. of samples†	No. of spike bearing tillers /25 tillers‡	Spike length (cm)§	Total spike wt./ 25 tillers (g)‡	Grain no./25 tillers‡	Total grain weight/25 tillers (g)‡	1000-grain wt. (g)‡
1986	Infected	15	21	3.9	5.6	326	3.3	10.0
	Noninfected	15	25	6.1	42.1	800	34.8	40.2
	PRT¶		0.001	0.001	0.001	0.001	0.001	0.001
1989	Infected	13	10	3.7	2.0	137	1.1	7.0
	Noninfected	13	25	5.9	40.0	825	32.9	40.2
	PRT¶		0.001	0.001	0.001	0.001	0.001	0.001
1986 + 1989	Infected	28	16	3.8	3.9	283	2.3	8.6
			(1–25)#	(0.5–9.7)	(0.1–9.8)	(7–507)	(0.1–7.4)	(1.8–14.7)
	Noninfected	28	25	6.0	41.1	811	33.9	40.2
			NA	(2.0–10.6)	(19.1–68.1)	(325–1190)	(15.4–51.3)	(24.2–54.5)
	PRT¶		0.001	0.001	0.001	0.001	0.001	0.001

† Each sample represents one field
‡ Averaged from four replicates.
§ Averaged from spikes produced by 100 tillers.
¶ Paired T-tests.
# Numbers inside parenthesis represent minimum and maximum.

Discussion

Barley stripe disease was widely observed every year from 1983 to 1989 in all barley growing regions throughout East Azarbaijan. Two reasons that may account for wide occurrence of the disease, which is considered to be exclusively seedborne (Mathre 1982), are (1) lack of distribution of healthy seeds in the province and (2) favorable environmental conditions for disease development. The disease was observed in fields sown to seed produced either locally by the farmers or distributed by the official seed producing organization.

In East Azarbaijan, from October until April when winter and spring barley seeds are sown, air temperatures are usually below 15°C, which may favor seedling infection by the fungus. It has been reported that the disease incidence was higher when soil temperatures were below 15°C (Johnson 1925; Prasad et al. 1976).

The disease was present in 58% of spring barley fields compared to 90% of winter barley fields. This may indicate that there is resistance in spring barley types in East Azarbaijan to the stripe disease, as it has been reported in some spring barley cultivars in other barley growing areas in the world (Kline 1972; Mathre 1982). Studies are needed to properly identify the existing cultivars in the province and determine their reaction to the stripe disease.

It has been previously reported that noninfected plants made up for as much as 25% of the yield loss from infected plants in barley fields with leaf stripe (Suneson 1946). However, more recently Porta-puglia et al. (1986) showed that noninfected plants had negligible compensatory yield increase for infected plants. We found a 93% yield reduction in infected tillers. Thus, yield loss was estimated as Y = 0.93 (x) where Y is the percent yield loss and x is percent disease incidence. This relationship between percent disease incidence in the field (x) and percent yield loss (Y) is similar to values reported by researchers in other barley growing areas of the world: 0.75 (x) in California (Suneson 1946), 0.70 (x) in Denmark (Neergaard 1979), 0.86 (x) in India (Behar and Aulakh 1988; Mathur et al. 1964), 0.90 (x) in Italy (Porta-puglia et al. 1986), 0.79 (x) in Norway (Magnus 1979), and 1.0 (x) in Scotland (Richardson et al. 1976).

With overall disease incidence of 15.2% in the province, yield losses in East Azarbaijan were estimated to be 14.1%. Our observations show that the disease occurs widely in the area every year. Thus, barley yields could be significantly increased by controlling this seedborne disease. The establishment and enforcement of seed health testing regulations coupled with planting resistant varieties and development of effective seed treatment are needed to bring this about.

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Short Communications

Wheat Collecting in Southern Algeria

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IBPGR and INRA-Algeria collaborated in a crop collecting mission in the Hoggar mountains of the southern Saharan region of Algeria in Jun 1988. IBPGR has been supporting germplasm collection in Algeria since 1975, and the Hoggar was in fact visited in 1977 by an IBPGR-funded mission involving the Institute del Germoplasma, Italy, and the Institut de Developpement des Grandes Cultrues, Algeria. The main aims of the 1988 mission were to resample wheat for the INRAA collection of Saharan landraces to be used in breeding work, and gain an idea of genetic erosion in the previous 10 years.

The Hoggar mountains (max. alt. 2918 m) are part of a block of Precambrian crystalline rocks. The surface area of the Hoggar itself is about 300,000 km^2. The main town and administrative center is Tamanrasset. The Wilaya of Tamanrasset as a whole counts about 60,000 inhabitants. There are about a dozen other inhabited oases on wadis radiating out from the central heights of the Hoggar, the largest being Silet, Ideles, Abalessa, and In Amguel.

The climate of the Hoggar is hot subtropical desert. The 10 mm isohyet runs through the area between the Hoggar on one side and the Adrar des Iforas and Air on the other. However, at higher elevations in the Hoggar, annual rainfall can exceed 100 mm, and at Tamanrasset (1377 m) it averages about 50 mm.

Agriculture in the Hoggar is confined to the wadis, and is mainly subsistence. The total area of cultivation is probably not much in excess of 1000 ha. Irrigation water is pumped from wells or brought to the surface via underground conduits known as "foggara." Flooded irrigation is also used. In the smaller villages, field crops are grown in conjunction with temperate fruit trees.

The main winter cereals are bread wheat and barley. Durum wheat is rare. Sowing occurs in October–November, harvesting in February–April. Pearl millet, sorghum, and maize are grown in the summer, allowing one or more cuts of green material for fodder before being left to set grain. Another important fodder crop is alfalfa. Lentils, peas, faba beans, a variety of vegetables, and several spice plants, such as coriander and basil, are also grown on a small scale.

At each of the six oases visited (see Table 2), contact was made with the local civic authorities, who provided a guide, usually an elderly man of high standing in the community and extensive local knowledge. It was thus possible to sample all the local wheat landraces known to be currently grown at each oasis, and to limit sampling of crops such as alfalfa, which are regularly brought in from other areas, to local landraces.

The 32 wheat samples collected represented 15 named local landraces. All are quite tall; all are bread wheats except Mekkaoui, which is a durum wheat. Manga and Ghati have been referred to the botanical var. *oasicolum*. Table 1 gives brief data on four spike characters of each wheat sample. There is some evidence from this of some differences among samples given the same name, a problem that will have to be clarified by further characterization.

Table 2 shows, for each of the oases visited in 1988, whether each landrace was sampled in 1977 only (+−), in 1988 only (−+), in both years (++), or in neither year

(—). The 1977 data are from the internal report on IBPGR on the collecting mission (GN 052). Chi-squared analysis of these data showed a significant association between whether a variety was grown at a given site in 1977 and whether it was grown there in 1988. Thus, the number of + + oasis/landrace combinations was greater than expected on a null hypothesis of no association, and the number of −+ and +− combinations smaller than expected. Of the landraces collected in 1977 only Ired was not found again in the six oases visited in 1988. These oases also now apparently grow five landraces which were not grown there in 1977, i.e., Hamircha, Mshaara, Labyad, Sudani, and Fahr houia, though the last was collected in 1977 in other oases. Three landraces collected in 1977 in other villages were not found in 1988 in the six oases visited. Modern varieties are not widely grown. All this suggests that farmers are very conservative in their choice of which landraces to grow and prefer local types to newer varieties, probably because the former have a shorter growing cycle. The loss of local landraces in the area is thus likely to be slow, and more due to the abandonment of subsistence agriculture than to the influx of modern varieties.

Table 1. Spike character data for all wheat samples collected in the Hoggar in 1988.

Acc. no.	Local name	Color	Awns	Spike size	Spike density
1103	Baida	white	none	large	lax
1100	Barudi	red	none	medium	lax
1079	Boumellal	white	short, bl.	large	v. lax
1018	Bourba	red	medium	med	dense
1065	Bourba	red	none–short	med	lax
1135	Bourba	red	none	med	lax
1062	Farh houia	red	none	v. large	v. dense
1051	Farh houia	white	none	large	dense
1016	Ghati	white	short	med	lax
1056	Ghati	white	short	med	lax
1104	Ghati	white	long	med	lax
1117	Hamircha	NA	NA	NA	NA
1013	Hamra	red	none	long, thin	lax
1106	Hamra	red	none	med	med. dense
1132	Hamra	red	none	long, thin	lax
1133	Iskandara	white	none–short	long, thin	lax
1055	Labyad	white	none	large	dense
1066	Labyad	white	short–med.	med	dense
1015	Manga	white	none–short	large	v. lax
1061	Manga	white	none	large	v. lax
1110	Manga	white	short	large	lax
1134	Manga	white	none	long, thin	v. lax
1014	Mekkaoui	red	none	med	dense
1036	Mekkaoui	red	none	med	dense
1050	Mekkaoui	red	none–short	large	dense
1057	Mekkaoui	red	none	med	dense
1082	Mekkaoui	red	short, bl.	med	dense
1101	Mekkaoui	red	none–short	long	dense
1105	Mshaara	white	long	med	dense
1136	Sudani	white	long	med./hairy	dense
1038	Touati	white	none	med	lax

Table 2. Distribution of 16 wheat landraces in six Hoggar oases in 1977 and 1988.

	Oases											
	Abalessa		Ideles		In Amguel		Mertoutek		Tahifet		Tazrouk	
Variety	1977	1988	1977	1988	1977	1988	1977	1988	1977	1988	1977	1988
Baida	–	–	+	–	–	+	–	–	–	–	–	–
Barudi	–	–	+	–	+	+	–	–	–	–	–	–
Boumellal	–	–	–	–	–	–	+	+	–	–	–	–
Bourba	–	+	+	+	–	–	–	–	+	+	–	–
Farh houia	–	–	–	+	–	–	–	–	–	–	–	–
Ghati	+	–	–	+	–	–	–	–	–	+	–	–
Hamircha	–	–	–	–	–	+	–	–	–	–	–	–
Hamra	+	+	+	–	+	+	+	–	–	+	–	–
Ired	+	–	–	–	+	–	–	–	–	–	–	–
Iscandara	+	+	+	–	+	–	+	–	–	–	–	–
Labyad	–	–	–	+	–	–	–	–	–	–	–	–
Manga	+	+	–	+	+	+	–	–	+	+	–	–
Mekkaoui	–	–	+	+	+	+	+	+	+	+	+	+
Mshaara	–	–	–	–	–	+	–	–	–	–	–	–
Sudani	–	+	–	–	–	–	–	–	–	–	–	–
Touati	–	–	+	–	–	–	–	–	–	–	–	+

Performance of ICARDA/CIMMYT's Advanced Barley, Durum, and Bread Wheat Lines in Nanjing, China

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The objective of this study was to evaluate the performance of barley, durum wheat, and bread wheat lines from ICARDA and CIMMYT in Nanjing. Nanjing region is representative of the central and lower Yangtze Valley where 5 million ha winter cereals are grown.

The experiment was conducted in 1987–88 following the rice harvest at the Institute of Agricultural Modernization. There were 17 barley, 25 bread wheat, and 25 durum wheat lines introduced from ICARDA, and 10 durum wheat lines from CIMMYT. These lines were selected from screening nurseries planted in 1985–86 and 1986–87. Seeds were drilled 29 October 1987. Plots consisted of five 1.5 m long rows spaced 23 cm apart, with 160 seeds per row. Basal fertilizers consisted of 1125 kg/ha rape seed cake, 188 kg/ha urea, and 150 kg/ha KCl. Topdressing at tillering and elongation consisted of 150 and 75 kg/ha urea, respectively. Growth development, diseases, number of ears, kernel weight, and yield were recorded.

Most of ICARDA's barley lines headed on 19–23 April and matured around 25 May, slightly later than the local check, advanced two-rowed line no. 1349. The majority of ICARDA barleys had 145–175 ears per meter, and a 1000-kernel weight of 35–40 g, similar to the check. Two sister lines from the cross Aurore/Esp//Alger/Ceres 362-1-1 had equal yield with the local check (6300 kg/ha). These two ICARDA lines were resistant to barley yellow mosaic virus. They headed about one week later than the check, but were able to fill the grains quickly, and thus matured only two days later. They appeared to have potential for high yield production, and were recommended to be released.

Most of CIMMYT/ICARDA's bread wheat lines headed on 29 April, and matured on 2–5 June, comparable to the local check, cv Yangmai No. 5. Due to the low incidence of scab during the season, resistance of the tested entries to the disease was not known. But some of the tested lines were heavily infested with powdery mildew. The majority of the tested lines had a comparable numbers of ear per meter (105–115) to the check, but much lower 1000-kernel weight (30–33 g) and lower yield than the local check (39 g and 5900 kg/ha). The line sprw's'/Prn's' had the highest yield of 8800 kg/ha. Two other lines, Buc's'/4/Tzpp//Irn46/Cno67/3/Prt and Buc's'/Flk's' also were higher yielding than the local check. But these three lines had a low kernel weight, so they needed to be further evaluated. The line Kvz/Pak 20 yielded 5000 kg/ha, but it had an acceptable kernel weight of 36, 36, and 34 g in 1985–86, 1986–87, and 1987–88, respectively. It could be recommended for poor environments.

The majority of the durum wheat lines introduced from CIMMYT/ICARDA headed on 3–5 May, and matured on 7–8 June, about one week later than the bread wheat check, Yangmai No. 5. The growing period was too long, and deemed to be unsuitable for the Nanjing area. All of these lines were also susceptible to scab. As they tillered weakly and grew poorly before winter, most of them had a low number of ears per meter (85–100 ears). Although most of them had a 1000-kernel weight of 35–37 g, they were still lower than the 39 g of the bread wheat check. However, three lines, Cit 71/stk's'//Shwa's', Mal's'= Mexi's'//Chap/21563, and Faja's', yielded above 6400 kg/ha. This was unexpected, and suggested that more attention should be paid to durum wheat's potential in the Nanjing area.

The performance of durum wheat lines from CIMMYT was similar to those from CIMMYT/ICARDA. Sonalike and S-13 were the best lines. Close cooperation with CIMMYT and ICARDA in exploring suitable areas for durum wheat production in Nanjing area should be sought.

In conclusion, many of ICARDA's barley lines were adapted to Nanjing. For bread wheat, the CIMMYT/ICARDA lines generally had too low a kernel weight. Aspects for improvement of durum wheat lines included earliness, scab-resistance, early seedling growth, vigor, and tillering ability.

Inheritance of some Agronomic Characters in Wheat (*Triticum aestivum* L.)

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Crop improvement depends on the magnitude of genetic variability and the extent to which the desirable characters are heritable. The knowledge of the heritability helps the plant breeder in predicting the behavior of the succeeding generations, making desirable selection and assessing the magnitude of genetic improvement through selection. The objective of this study was to estimate the heritabilities of some agronomic characters in bread wheat.

Nine F_2 populations along with the 11 parents were grown in a randomized complete block design with three replications at the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, during 1986–87. The seeds were sown with the help of a dibbler keeping plant-to-plant and row-to-row distances of 22 cm and 30 cm, respectively. From F_2 populations of each cross, 150 plants (50 plants from each replication) and 30 plants from each parent (10 plants from each replication) were selected at random and data were recorded on plant height, numbers of tillers per plant, number of spikelets per spike, number of grains per spike, spike length, 1000-grain weight, grain yield per plant, and protein content of the grain. Heritability was estimated by using the method of Muhmud and Kramer (1951).

The estimates of heritability and genetic advance expressed as percent of mean for eight characters are presented in Table 1. For plant height, all crosses showed high heritability with high genetic advance except the two crosses: DSN 21 × LU 26 and DSN 9 × LU 26, which showed high heritabilities with low genetic advance. In all the crosses high heritability with matching genetic advance was observed for number of tillers per plant.

Table 1. Estimates of heritability (h) and genetic advance as percent of mean (GA%) of various characters.

	Plant Height		No. tillers/plant		No. spikelets/spike		No. grains/spike		Spike length		1000-grain weight		Grain yield/plant		Protein content	
F population	h	GA%	h	GA%	h	GA%	h	GA%	h	GA%	h	GA%	h	GA%	h	GA%
LU 31 × DSN 21	93	28	64	22	96	32	38	16	49	8	93	14	94	32	96	17
LU 31 × DSN 25	94	22	79	25	89	19	29	10	89	23	94	16	96	49	74	5
LU 31 × DSN 78	93	29	63	18	73	11	46	26	63	10	95	14	97	66	94	15
DSN 21 × LU 26	63	9	88	29	81	13	40	16	60	8	94	15	98	49	78	6
DSN 70 × LU 31	97	27	65	21	82	11	43	22	36	5	90	12	98	58	89	9
DSN 9 × LU 26	68	9	94	33	89	16	61	15	66	9	80	12	98	58	88	10
DSN 16 × Shorvaki	90	18	85	23	80	17	64	35	74	11	92	16	90	51	98	18
DSN 71 × LU 31	92	25	92	35	90	19	24	10	68	10	93	15	96	50	94	13
LU 31 × DSN 83	87	17	60	18	84	15	41	18	27	4	92	8	96	55	72	6
Mean	86	20	77	25	85	17	43	16	59	10	91	14	96	52	87	11

High heritability with high genetic advance was also observed for number of spikelets per spike. However, the crosses LU 31 × DSN 78, DSN 21 × LU 26, and DSN 70 × LU 31 showed high heritability values with medium genetic advance. The cross combinations DSN 9 × LU 26 and DSN 16 × Shorvaki had high heritability with moderate genetic advance while all other crosses showed low to medium heritability for number of grains per spike.

For spike length the cross LU 31 × DSN 25 showed high heritability coupled with high genetic gain, while the crosses DSN 70 × LU 31 and LU 31 × DSN 83 showed low heritability estimates with low genetic advance. The cross LU 31 × DSN 21 showed medium heritability with low genetic advance. All other crosses had high heritability with medium to low genetic advance. In the case of 1000-grain weight all the crosses showed high estimates of heritability with medium to high genetic advance except the cross LU 31 × DSN 83, which showed high heritability with low genetic advance.

In all crosses, impressive heritability with conspicuous high genetic gain were observed for grain yield per plant. For protein content of the grain, the heritabilities were high in all the crosses while genetic advance was low to medium for most of the crosses. However, the cross combinations LU 31 × DSN 21 and DSN 16 × Shorvaki had high genetic advance.

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The Activation of Genes for High Molecular Mass Glutenins in Tetraploid Wheat Line 'Resende'

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Resende, a stable line of tetraploid wheat (*Triticum turgidum* var. durum) cv Ld 222, carries a pair of translocated 5B/5D chromosomes. The translocation was the result of recombination which occurred after two separate homologous pairing between chromosomes of homologous group 5 (Mello-Sampayo 1972; Mello-Sampayo and Viegas 1973). Extensive test crosses of Resende with ditelosomic lines of *T. aestivum* cv Chinese Spring confirmed that the line is virtually equal to Ld 222 except for the translocated 5B/5D pair of chromosomes. There are mostly 5B, plus a conspicuous terminally attached piece of 5DL from Chinese Spring which corresponded to its equivalent in 5BL. The 5B/5D chromosome carries the Ph gene, but the translocation brought a significant attenuation to its inhibitory effect in homologous chromosome pairing (Mello-Sampayo and Viegas 1973).

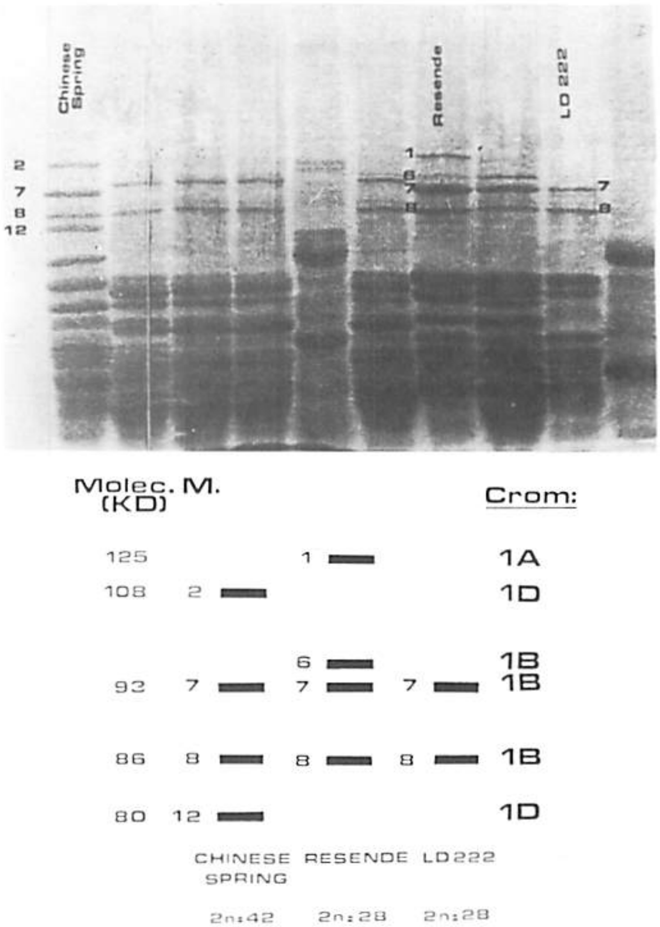

Figure 1. SDS-PAGE patterns of high molecular mass glutenin subunits of bread wheat cv Chinese Spring, and durum wheat line Resende and cv Ld 222. Subunits 1 and 6 are present in Resende, but absent in the other two cvs.

Resende showed both an average number of nucleoli per cell and a uridine absorption rate higher than that of normal Ld 222 (Viegas and Mello-Sampayo 1975). It was subsequently found (Viegas 1980) that Resende carried 50% more rRNA genes per cell than did Ld 222, and a little less than Chinese Spring. The translocated 5B/5D chromosomes of Resende carry, therefore, regulatory mechanisms that upset either the nucleolus organizer structure and expression, or the Ph_1 homologous pairing inhibition.

It was found that the electrophoretic pattern of high molecular mass (h.m.m.) glutenin of seed storage proteins in Resende was significantly different from that of either Chinese Spring or Ld 222, the two cultivars from which the former originated Figure 1 shows SDS-PAGE patterns of h.m.m. glutenin subunits of Chinese Spring, Resende, and Ld 222. Resende, when compared with Ld 222, shows two new subunits (1 and 6). Such subunits are codified in gene loci of chromosomes 1A and 1B, respectively, and they are designated as Glu-A1 and Glu-B1. Although not present in either Ld 222 or Chinese Spring, such subunits, which have been identified in other bread and durum wheat cultivars, contribute to bread-making quality (Payne et al. 1981; Payne and Lawrence 1983). It is suggested that the corresponding alleles might have been activated in Resende by the same translocated 5B/5D chromosome as mentioned before. In this case either repressors for the two alleles were present in the missing part of 5BL or promoters were at work in the translocated piece of 5DL or both events might have been happening simultaneously.

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Branching Wheat in Ethiopia

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The phenomenon of branching spike has been known in some species of the genus *Triticum* both as naturally occurring and spontaneously created by interspecific/intergeneric crosses (Koric 1973). This branching character has long attracted the attention of wheat breeders whose objectives were to increase grain productivity per spike.

While on a trip to Bichena, Gojjam Administrative Region, Ethiopia, in 1989, a lot of branched spikes were encountered in a wheat field which, at first glance, appeared to have remarkably large spikes. A closer observation, however, indicated that the field was planted with a landrace cultivar possessing variations for several phenotypic characteristics, including glume color and seed color. Interestingly enough, in this particular field the branching was manifested only on the purple-seeded types. However, the observation was by no means an exhaustive one. From their morphological characteristics it is firmly believed that wheat plants giving the branched spikes were tetraploids. In this instance, the branching occurred mostly at the lower half of the spike, producing a pair of spikelets side by side, attached at right angles to those normally placed single spikelets. The upper part of the spike was normal with a single spikelet at each notch of the rachis. The secondary ears varied in number, length, and development.

Koric (1973) reported that branching habit is controlled by several genes, but the phenotypic manifestation is repressed by an inhibitor gene. Moreover, he stated that the positive influence of the genes is expressed under high productivity conditions. Percival (1921) also noted that the extent of manifestation of such wheats was influenced by high soil-fertility conditions, warm climate, and low plant density. According to the owner of the field at Bichena, the wheat crop was preceded by a leguminous crop, a practice traditionally carried out by the Ethiopian farmers to improve the fertility of the soils. The plants were also widely spaced in the field.

Koric (1973) also observed that, though the branching genes were repressed by the inhibitor, they still stimulated the productivity of a normal spike. From the observation made at Bichena, this could be supported by the presence of large and highly fertile normal spikes, which plausibly did not branch only because of the presence of the inhibitor gene.

Considering the similarity in observations made at Bichena with those of Koric, it should be possible to increase grain productivity with or without the branching habit by introducing the branching genes to existing varieties.

We crossed these branching type wheats with several nonbranching released cultivars and advanced lines. Their progenies are now in the F_5 generation. Until now there was no segregation observed and all the progenies were nonbranching types. Even the parental branching types did not manifest their branching character again. Our observations are in disagreement with the results of Rao et al. (1988), who reported a monogenic model of inheritance, branching being under recessive genetic control.

Acknowledgement

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Effect of Salinity on Seedling Growth and Solutes Accumulation in Two Wheat Genotypes

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Plants are generally most sensitive to salinity during germination and early seedling growth (Carter 1975). Even in obligate halophytes, reduced salinity is conducive for germination (Chapman 1975). Most of the work on the effect of salinity on wheat is restricted to germination and fresh weight of plants, whereas studies on low-salinity-induced metabolic changes during germination and early seedling growth are meager. We therefore used a physiological-genetic approach to test whether genotypes sensitive and tolerant to salt differ in their solute accumulating capacity.

Caryopses of two wheat genotypes, i.e., T. J.-83 (salt tolerant) and Pavon (salt susceptible) were surface sterilized with 10% solution of sodium hypochlorite for five minutes, washed thoroughly in distilled water, and planted in Plasticon germinators (Naqvi and associates, Annual Report of AEARC, Tando Jam, Pakistan, 1984) containing 20 ml of 0.0% and 1.0% aline solution (two separate solutions were prepared: Solution A contained NaCl 0.12M, Ma_2SO_4, 0.06M, $MgSO_4$, 0.04M, and $NaHCO_3$0.0043M; and Solution B contained $CaCl_2$ 0.03M. They were mixed in the ratio of 1:4 before use). Three replicates of each treatment were kept in a completely randomized block design at 30 ± 2°C in an incubator. Seedling samples were collected after one week to determine dry weight, proline, betaine, and total soluble sugars. Proline was estimated according to the method of Bates et al. (1973), betaine by Grieve and Grattan (1983), and total soluble sugar by Riazi et al. (1985). This experiment was repeated three times and the averages were statistically analyzed.

Salinity reduced the dry matter yield of both the genotypes but the reduction was more pronounced in salt susceptible Pavon (Table 1). Similar genotypic differences have been reported for sorghum (Khan and Ashraf 1988), bean (Ayoub 1974), and rice (Flowers and Yeo 1981).

Proline, betaine, and total soluble sugars increased significantly in the saline treatments. The increase in these solute accumulation was significantly higher ($P = 0.05$) in salt-tolerant T. J.-83 than in the salt-sensitive Pavon. The osmotic potential decreased with increase in salinity in both the genotypes, with the decrease in osmotic potential more pronounced in T. J.-83 compared with Pavon. As reported for triticeae (Gorham et al. 1986) and barley (Riazi et al. 1985), it seems that the solute accumulation started during exposure to stress conditions. Our results are further supported by Khan et al. (1989), who reported that proline, betaine, and reducing and nonreducing sugar accumulated in wheat due to water stress. It may be concluded that accumulation of solutes could be considered as a parameter for screening salinity tolerance.

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Table 1. Salinity effect on growth, osmotic potential, and solute accumulation in two wheat genotypes.

Treatments and Varieties	Dry weight (mg)/10 plants	Osmotic potential (Bars)	Total soluble sugars mg/g fresh wt.	Proline μ mol/gm fresh wt.	Betaine μ mol/gm dry wt.
T_0 (control)					
T. J.-83	77	-11.02	4.33	0.059	1.47
Pavon	78	-10.95	3.99	0.046	1.35
T_1 (1% salinity)					
T. J.-83	61	-16.99	6.97	0.095	2.01
Pavon	30	-12.42	4.32	0.063	1.53
LSD at 5%:					
for treatments	8	0.51	0.42	0.0002	0.03
for varieties	8.7	0.72	0.60	0.0003	0.04

Control of Loose Smut of Wheat with Dichlopentazol

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Loose smut of wheat caused by *Ustilago tritici* (Pers.) Roussel var. *tritici* Jensen is an important disease that causes heavy losses in the northwestern part of India. Joshi et al. (1985) reported that the national average incidence of this disease varies between 3% and 4%. Jhooty (1985) estimated that loose smut caused a yield reduction of 1.3–1.8 million tonnes in India, resulting in a loss of 2,030–2,700 million rupees during the 1984 crop season.

Chemotherapeutic effect of systemic fungicides like carboxin, carbendazim, fenfuram, and triadimenol to the loose smut pathogen has been shown. Recently, dichlopentazol or S-3308 L [E-1-(2, 4-dichlorophenyl)-4, 4-dimethyl-2-(1, 2, 4-triazol)], a new wide-spectrum fungicide, was introduced into India. The objective of this study was to compare dichlopentazol with other fungicides for loose smut control under field conditions.

Plants of the loose smut susceptible wheat cv Sharbati Sonora were artificially inoculated by syringe with a spore suspension of the loose smut pathogen. Infected seed was treated with five different fungicides: flutriafol/PP-450 [2, 4-difluoro-x - (IH-1, 2, 4-trizol-l-yl methyl) Benzhydryl], cercobin/Topsin-M [1, 2-bis (3-ethoxycarbonyl-2-thioureido) benzene], carbendazim/Bavistin (Methyl-2-benzimedazole carbamate) as 25 DS and 50 WP, carboxin/vitavax 75 WP (5, 6-dihydro-2-methyl-1, 4-oxathiin-3-carboxinilide) and dichlopentazol/S-3308 L, all at two rates: 0.1% and 0.2% w/w of the formulated product. Untreated seed was kept as a control. Sowings were done at the Indian Agricultural Research Institute, New Delhi, in four replicated trials during 1986–87 and 1987–88. The recommended agronomic practices were followed. The percentage of infection (Table 1) shows that dichlopentazol (S-3308 L) and carbendazim (Bavistin 50 WP) were the most effective fungicides for controlling loose smut, followed by carboxin (Vitavax 75 WP) and carbendazim (Bavistin 25 DS). The higher dose (0.2%) was more effective than the lower one in all the treatments. Dichlopentazol can be used as a substitute to carboxin or carbendazim which have already been recommended for seed treatment to control loose smut. Dichlopentazol is also highly effective in controlling powdery mildew and rusts of cereals. It is said to possess both curative as well as preventive action in plants (Anonymous 1986).

Table 1. Effectiveness of different fungicide treatments against loose smut of wheat, 1986–87 and 1987–88.

Treatment	Dose (% w/w)	% infected plants 1986–87	% infected plants 1987–88
Dichlopentazol (S-3308 L)	0.1	3.16	0
	0.2	1.20	0
Flutriafol (PP 450 L)	0.1	8.40	11.88
	0.2	4.30	8.42
Carbendazim (Bavistin 25 DS)	0.1	2.86	4.60
	0.2	2.07	1.68
Carbendazim (Bavistin 50 WP)	0.1	0.93	0.74
	0.2	0.00	0.40
Cercobin (Topsin M)	0.1	17.86	33.93
	0.2	5.37	5.64
Carboxin (Vitavax 75 WP)	0.2	1.57	1.57
Control	–	45.06	44.27

References

Anonymous. 1986. S-3308 L: a new fungicide having a wide spectrum. Technical information. Sumitomo Chemical Co. Ltd., Osaka, Japan.

Jhooty, J. S. 1985. Smuts of wheat. *Indian J. Mycol. and Pl. Pathol.* 15:1–41.

Joshi, L. M., D. V. Singh, and K. D. Srivastava. 1985. Status of rusts and smuts during dwarf wheat era in India. *RACHIS Newsletter* 4:10–16.

Recent Publications

Books

Vorst, James J. (ed). 1990. *Experiments in Crop Science.* Crop Science Society of America, 677 South Segoe Road, Madison, Wisconsin 53711-1086 USA. 62 pp.

The overall objective of this publication is to provide teachers with experiments they may use to demonstrate that learning basic plant biology is important, exciting, and relevant to a world that is placing more demands on safe and efficient food and fiber production systems. Student participation in the experiments will encourage the students' interest and retention of information learned.

The experiments were developed through the efforts of the Crop Science Society of America. Each experiment is independent of the other experiments so teachers may select a specific experiment that relates directly to the lesson plan. A teacher guide and student guide are included with each experiment. Students are also presented with a series of questions to assist them in fully understanding each experiment. Teachers will find the list of vendors to be quite useful when ordering supplies.

Westerman, R. L. (ed). 1990. *Soil Testing and Plant Analysis, Third Edition.* Soil Science Society of America, 677 South Segoe Road, Madison, Wisconsin 53711-1086, USA. 812 pp.

Soil testing and plant analyses are invaluable tools in the diagnosing of nutritional deficiencies and problems related to plant growth. Each advance in our basic understanding of plant physiology and soil chemistry, coupled with advances in instrumentation, leads to improvements in methodology and interpretation.

Soil Testing and Plant Analysis was first published in 1967 by the Soil Science Society of America. This edition set the standards for understanding the significance of plant analysis as a diagnostic tool and soil testing as a guide for fertilizer use. In 1973, the second edition further enhanced the overall understanding of soil testing and plant analysis. Since the second edition, there has been tremendous progress in the development of methodology for analysis of soil and plants and interpretation of analytical results for best management practices that promote efficient fertilizer use and optimum yield, yet minimizes the potential of groundwater, lake, and stream pollution.

The third edition summarizes the current knowledge and experiences on the use of soil testing and plant analysis as a diagnostic tool for assessing nutritional requirements of crops, efficient fertilizer use, saline-sodic conditions, and toxicity of metals. Discussions on analytical instrumentation used in soil testing, plant analysis, and data processing are included. In addition to college students and teachers, this edition will also be useful to laboratory personnel, industrial and extension agronomists, and researchers focusing on soils, crops, forestry, horticulture, ecology, botany, and the environment.

Amine, Maria (ed). 1991. *Ley Farming* (in French). Actes Editions, Institut Agronomique et Vétérinaire Hassan II, B.P. 6202, Rabat-Instituts, RABAT (MAROC). 180 pp.

This book contains the proceedings of the National Seminar on ley farming organized by the Moroccan Ministry of Agriculture and Agrarian Reform, Rabat, Morocco, 1–2 February 1990, with financial support from ICARDA. This book should be of interest to anyone exploring the benefits and constraints of ley farming in the semiarid zones.

D. A. Sleeper, T. C. Barker, and P. J. Bramel-Cox (eds). 1991. *Plant Breeding and Sustainable Agriculture: Considerations for Objectives and Methods.* Crop Science Society of America and American Society of Agronomy, 677 South Segoe Road, Madison, Wisconsin, USA 53711-1086. 93 pp.

This publication offers the opportunity for discussion of the important topics related to the contributions of plant breeding under alternative production systems and under selection criteria in which sustainability of the system is paramount. This softcover publication is the result of a symposium designed to address sustainable agriculture issues that affect plant breeding. This will be of interest to plant breeders, agronomists, policymakers, farmers, and others interested in sustainable agriculture.

R. F. Follett, D. R. Keeney, and R. M. Cruse (eds). *Managing Nitrogen for Goundwater Quality and Farm Profitability*. Soil Science Society of America, 677 South Segoe Road, Madison Wisconsin, USA 53711-1086. 378 pp.

The objective of this publication is to present current information and its application to assist managers, producers, agricultural advisers, and others in making appropriate nitrogen management decision. Guidelines and management principles to minimize nitrate nitrogen leaching while optimizing farm profitability with respect to fertilizer, water, and cropping-system-management alternatives are provided. The book also contains procedures to screen for the potential for nitrate nitrogen leaching that are incorporated into a computer software package, NLEAP, Nitrate Leaching and Economic Analysis Package. NLEAP is designed to provide rapid, site-specific estimates of potential for leaching of nitrate nitrogen under agricultural crops along with potential for leaching of nitrate nitrogen under agricultural crops along with potential impacts of nitrate nitrogen leaching on local groundwater resources. The NLEAP package is designed for personal computers and includes optional national soil and climate data bases for model input.

This publication and the accompanying computer software are unique tools especially designed for use by farm advisers and farmers. These will assist agricultural producers to economically and environmentally evaluate various aspects of nitrogen management strategies for individual farms.

Other releases

A new journal *Ecological Engineering — The Journal of Ecotechnology* will be available on a quarterly basis, beginning in 1992. The journal will be read and contributed to by applied ecologists, environmental managers and regulators, natural resource specialists (e.g., foresters, fish, and wildlife specialists), environmental and civil engineers, agroecologists, and landscape planners and designer. It is meant to serve as a bridge between ecologists and engineers, and ecotechnology is not wholly defined by either field. The journal is meant for ecologists who, because of their research interests or occupation, are involved in designing, monitoring, or constructing ecosystems. The journal is also for engineers who, as a result of training and/or experience in biological and/or ecological sciences, are involved in designing and building ecosystems. The journal is of particular interest to practicing environmental managers due to its multidisciplinary approach to practical problems and opportunities.

Ecological engineering has been defined as the design of ecosystems for the mutual benefit of humans and nature. Specific topics covered in the journal include: ecotechnology; synthetic ecology; bioengineering; sustainable agroecology; habitat reconstruction; restoration ecology; ecosystem conservation; ecosystem rehabilitation; biomanipulation; stream and river restoration; wetland restoration and construction, reclamation ecology; non-renewable resource conservation.

For further information, contact: Elsevier Science Publishers, P.O. Box 181, 1000 AD Amsterdam, The Netherlands; or P.O. Box 882, Madison Square Station, New York, NY 10159, USA.

Visuals

ICARDA has recently released the slide-tape module *Hybridization Techniques in Barley*. The 20-minute show discusses flower morphology, crossing block layout and emasculation and pollination techniques. The program is designed as introductory material for junior scientists.

To purchase the module, send a check for US $50 payable to ICARDA for each program to the Training Coordination Unit. The slide set includes 80 slides, a cassette tape, and an accompanying resource book.

Papers

Yau, S. K., G. Ortiz-Ferrara, and J. P. Srivastava. 1991. Classification of diverse bread wheat-growing environments based on differential yield responses. *Crop Science* 31:571-76.

Bread wheat (*Triticum aestivum* L.) environments in West Asia, North Africa, and Mediterranean Europe are highly variable in terms of moisture, temperature, and biotic stresses. The present study attempted to divide this region into relatively uniform subregions by cluster analysis, to reduce the large magnitude of genotype (G) × environment (E) interaction. Grain yield data of 21 to 23 wheat lines in two years were analyzed by a hierarchical agglomerative program with the correlation coefficient as a distance measure and average linkage as the clustering strategy. The large and significant entry × trial interaction detected in the region implied that breeding for wide adaptability for this region would be difficult. Based on differential yield responses of the wheat lines, the cluster analysis showed the differences between the irrigated/high-rainfall (IHR) and rainfed low-rainfall (RLR) sites. Besides moisture supply, winter temperature of the sites appeared to be another determinant of the clusters. The IHR clusters consisted os sites with milder temperatures than sites in the RLR clusters. The presence or absence of diseases also influenced the delineation of the clusters, but photoperiod of the sites did not appear to have a large influence. The greater variability in RLR sites relative to IHR sites indicated that breeding for RLR environments would be more difficult. We conclude that different breeding strategies should be followed within IHR and RLR environments.

Inagaki, Masanori, and Muhammad Tahir. 1991. Effects of semi-dwarfing genes *Rht1* and *Rht2* on yield in doubled haploid lines of wheat. *Japan. J. Breed.* 41:163–67.

Thirty doubled haploid lines of wheat derived from an F_1 hybrid carrying the gibberellin-insensitive semi-dwarfing genes *Rht1* and *Rht2* were used to assess their effects on agronomic traits. The effects of these genes was additive for the reduction of plant height. Semi-dwarf lines carrying either *Rht1* or *Rht2* produced the same grain yield as tall lines did under artificial support to prevent lodging. Dwarf lines carrying both genes showed a remarkable decrease in grain yield. The genotype background in hybrid recombination modified both plant height and grain yield, but did not produce a variation that exceeded the effects of semi-dwarfing genes.

Acevedo, E., P. Q. Craufurd, R. B. Austin, and P. Pérez-Marco. 1991. Traits associated with high yield in barley in low-rainfall environments. *Journal of Agricultural Science* 116:23–36.

Results are reported form nine field trials carried out in 1985–86 and 1986–87 aimed at identifying plant traits which are associated with high yield in barley in low-rainfall Mediterranean areas. Thirty-seven two-rowed and 35 six-rowed genotypes, representing the known diversity in traits considered to be useful, were compared in trials at three sites differing in expected annual rainfall (212–328 mm) in northern Syria, and in droughted and irrigated trials at Cambridge, UK. Yield, its components and other morphological and developmental traits were measured and correlations calculated.

Grain yields of the two- and six-rowed groups of genotypes were similar at all sites except in the irrigated trial in Cambridge, where the six-rowed genotypes gave the highest yield. Aside form the known difference in number of ears and number of grains/ear between two- and six-rowed genotypes, the simple correlations between grain yield and measured traits suggested that important traits for high yield in two- and six-rowed genotypes in dry environments were prostrate habit, vigorous seedling growth, good ground cover, early ear emergence, many ears/m^2 and large grains. In the two-rowed genotypes, short stature and a short grain-filling period were also important, while in the six-rowed genotypes, tall stature, high straw yield, many grains/ear and long peduncles were important. Correlations of these characters with an index of drought susceptibility and with yield adjusted for yield potential and date of ear emergence supported the conclusions based on the simple correlations.

The physiological basis of the correlated traits is discussed and the implications for breeding are considered.

Lashermes, P., G. Engin, and G. Ortiz-Ferrara. 1991. Anther culture of wheat (*Triticum aestivum*) adapted to dry areas of West Asia and North Africa. *J. Genet. & Breed.* 45:33–38.

The anther culture response of wheat genotypes adapted to dry areas of West Asia and North Africa was assessed. Considerable genetic variation was observed. However, the overall response was high enough for considering its practical use in a breeding program. A mean frequency of five green plants per 100 plated anthers was obtained. Genotypes carrying the 1 BL/1 RS translocation resulted the most responsive materials. Temperature growth conditions of anther donor plants influenced the relative appearance of albino plants. The effect of maltose based media was also tested. Benefits from the use of maltose instead of sucrose were found to be genotype dependent. The implications of these results for wheat breeding are discussed.

Yau, S. K. 1991. Need of scale transformation in cluster analysis of genotypes based on multi-location yield data. *J. Genet. & Breed.* 45:71–76.

The application of cluster analysis to classify genotypes based on grain yield responses across different environments is getting breeders' attention. This paper examines whether scale transformation of yield data is needed in genotype clustering and how it should be carried out. Theoretically raw yield data are not suitable for genotype clustering because using them unduly gives more weight to genotype performance in environments having large within-environment phenotypic ranges (WEPR) or standard deviations (WEPSD). Since WEPR and WEPSD tend to be positively correlated with environment mean yield, this means that usually more weight is given to performance in high yielding environments as well. However, in regional testing of varieties or elite lines it is seldom justified to give more weight to environments having high yields, or large WEPR or WEPD. Scale transformation of data is needed to give equal weight to genotype performance in each environment. Standardization of yield within genotypes is inappropriate and noneffective. Range transformation or standardization should be conducted within each environment. These are illustrated by analyzing a set of field data.

Damania, A. B., and S. K. Yau. 1991. Biodiversity for useful traits in a genetic resources collection of barley. In *Barley Genetics VI*, Vol. 1, ed. L. Munck, 9–11. Helsingborg, Sweden.

In any survey of the distribution of genetic variability within a crop species the most obvious pattern which emerges is the variation associated with geographical regions of the world. The Genetic Resources Unit at ICARDA has evaluated over 12,000 barley (*Hordeum vulgare* L.) accessions and produced catalogs of the results. Gene bank managers and germplasm curators usually strive towards assembling a comprehensive germplasm collection of a crop. This study has shown that germplasm from diverse geographical areas is indeed different and hence time and effort spent in collecting from as many countries as possible is well spent and productive. This article also studies the diversity in over 500 accessions grouped in five major barley growing areas of the world and presents results of statistical analyses on five important traits which are useful for crop improvement in the dry areas under ICARDA's mandate.

Damania, A. B. 1991. The use of genetic resources in breeding durum wheat. *Plant Breeding Abstracts* 61(8) (Review Article).

This review examines the use by durum wheat breeders worldwide, but with special emphasis on those working in West Asia and North Africa, of germplasm from a variety of sources. These include old landraces, primitive cultivated wheats such as *Triticum monococcum* and *T. dicoccum*, and related wild species in the Triticeae, such as *Aegilops, Agropyron*, and *T. dicoccoides*. All are seen as sources of valuable genes for durum wheat improvement, including genes for increased protein content, quality, and resistance to pests, diseases, and abiotic stresses such as salinity. Constraints on the use of genetic resources are considered. The role of ICARDA and the other International Agricultural Research Centres in durum breeding and germplasm conservation is discussed.

Damania, A. B., and J. P. Srivastava. 1990. Genetic resources for optimal input technology—ICARDA's perspectives. In *Genetic aspects of plant mineral nutrition*, ed. N. El Bassam, 425–30. Netherlands: Kluwer Academic Publishers.

With steadily increasing population pressure on natural resources, the primary challenge to agricultural research in the drylands will be to generate technologies which can sustain increased yields through judicious use of inputs and without risks of instability of production. The deployment of genetic resources to improve and stabilize crop production in the face of biotic and abiotic stresses is a key component in ICARDA's strategy to develop appropriate technology for stressed areas.

The high input technologies, while effective in areas for which they were developed, i.e., stress-free crop growing conditions, are rarely successful in the more severely stressed environments. Factors which reduce productivity such as drought, temperature extremes, salinity, low soil nutrients, diseases, and pests, are common in West Asia and North Africa. In the past breeders searched for desirable genes in exotic germplasm which may not be adapted to a given target environment. Relatively less effort has been devoted to producing cultivars that can provide stable yields under low to moderate input conditions. Landraces, primitive forms, and wild progenitors could be used in reconstituting genepools of available genetic resources suitable for improving tolerance to stresses and minimizing losses through yield stability in low input dryland agricultural systems. The effects on cereal production of seeding rate, nitrogen fertilizer rate, use of different cultivars and timing of grazing by small ruminants have been studied and responses to various traits within indigenous genetic resources which can fit in a specific agro-ecological zone is also reported here.

Elings, A., and M. M. Nachit. 1991. Durum wheat landraces from Syria. I. Agro-ecological and morphological characterization. *Euphytica* 53:211–24.

A total of 185 durum wheat (*Triticum turgidum* var. *durum* Desf.) landraces was collected from 166 sites in the Syrian Arab Republic. With K-means clustering the collecting sites are grouped based on four climatological variables to create relatively homogeneous regions of origin with respect to agro-ecological characteristics. Stepwise Discriminant Analysis confirmed the minimization of variation within regions.

Regional description with respect to agro-ecological characteristics is given. According to farmers' estimations, average grain yield is lowest in western mountainous regions, and highest in southern parts of the country, which illustrates the tendency of landraces to produce more straw rather than grain dry matter under high rainfall conditions. Other data, however, show that farmers in southern regions supposedly have overestimated yield levels.

Landrace groups as distinguished by farmers are morphologically identified, to provide a systematical description of visible variation. Distribution patterns of the various landrace groups are indicated. Only few landrace groups are widely distributed, whereas most others are regionally concentrated. Genetic diversification is found in the heterogeneous nature of landraces and in the cultivation of different landraces per region or village. Large proportions of *T. aestivum* were found in *T. durum* populations in the mountainous regions in the west of the country, where farmers apparently desire a species mixture.

Damania, A. B. 1990. Evaluation and documentation of genetic resources in cereals. *Advances in Agronomy* 44:87–111.

As a result of concerted effort during the 1970s and 1980s collection and conservation of representative samples of genetic variability in landraces and wild relatives of our major crops have been accumulating in the major gene banks of the world. However, genetic resources merely stored safely are of little value to plant breeders unless they are evaluated and information on their traits is made widely available. Evaluation is, therefore, an essential link between conservation and use. The author has reviewed aspects of evaluation of genetic resources collections of wheat and barley and their wild relatives and discussed the documentation of data resulting from genetic resources conservation work. The article cites 137 references covering more than the last two decades of research carried out on this subject under the following headings: 1. Introduction, 2. Evaluation of cultivated wheat, 3. Evaluation of cultivated barley, 4. Genetic resources from Ethiopia, 5. Evaluation of wild and primitive forms of wheat and barley, 6. Documentation of genetic resources, and 7. Summary and conclusions followed by references.

Makkouk, K. M., O. I. Azzam, J. S. Skaf, M. El-Yamani, C. Cherif, and A. Zouba. 1990. Situation review of barley yellow dwarf virus in West Asia and North Africa. In *World Perspectives on Barley Yellow Dwarf*, ed. P. A. Burnett, p. 61. Mexico: CIMMYT.

Symptoms of barley yellow dwarf (BYD) have been observed on cereals in nearly all countries of West Asia and North Africa. Its incidence, however, has varied during the last 15 years. Observations from field surveys are summarized. Since symptoms of barley yellow dwarf virus (BYDV) are of low diagnostic value, especially in wheat (*Triticum aestivum* L.), more precise qualitative and quantitative detection was derived by vector transmission and serology. In 1985 and 1986, preliminary surveys by enzyme-linked immunosorbent assay (ELISA) indicated that BYDV incidence in the regions surveyed in Syria, Morocco, and Tunisia was around 7%, 22%, and 24%, respectively. By vector transmission PAV-, RPV-, and RMV-like isolates of BYDV were identified in Morocco and the PAV-like isolate in Syria. By serology PAV-like isolates were identified in Ethiopia, Lebanon, Morocco, Syria, and Tunisia, and MAV-like isolates were identified from Morocco and Tunisia. The PAV-like type was the most common in all countries surveyed. Screening for BYDV resistance by natural infection has been carried out in a number of countries of the region during the last few years. Screening for resistance by aphid inoculation was initiated in Syria in 1986 at the International Center for Agricultural Research in the Dry Areas (ICARDA). Such screening is expected to follow in other countries of the region soon.

Forthcoming Events

1991

13th Asian Pacific Weed Science Society Conference Vegetation Management Strategy for Sustainable Development, **Jakarta, Indonesia, 13–20 October 1991.** Contact: The Chairman XIIIth APWSS Conference, AARD, Jl. Ragunan 29, Pasar Minggu, Jakarta 12520, Indonesia.

The Brighton Crop Protection Conference — Weeds 1991, ***Crop Protection with Chemicals — Future Challenges and Constraints*****, Brighton, England, 18–21 November 1991.** "While full recognition is given to legislative, environmental, molecular biological and ecological matters, the conference retains a strong emphasis on practical aspects of weed control, both by chemical and other methods." The 1991 Bawden Lecture, *Crop Protection; Meeting the Challenge*, will be given by Dr E. M. Beyer of Du Pont, USA. All details of the Conference may be obtained from Sherrie Simpson, Conference Associates and Services/BCPC, Congress House, 55 New Cavendish Street, London W1M 7RE, Tel: 071 486 0531; Telex: 934346 CONFAS G, Fax: 071 935 7559. For further information, contact Roger Pierce, Chiltern View Farmhouse, Kingston Stert, Chinnor, Oxon OX9 4NL, Tel: 0844 52427.

First European Symposium on Industrial Crops and Products, **Maastricht, The Netherlands, 25–27 November 1991.** The symposium will address several aspects of industrial crops research, including agronomy, breeding, policy and economics, agrotechnology and industrial processing and utilization. It will focus on existing and new potential industrial crops. Contact: Ms Gerda van der Linden, Secretariat Industrial Crops Symposium, Bernhardstraat 33, 7491 EA Delden, The Netherlands. Tel. and Fax: +31 (05407) 63716.

Systems Approaches for Agricultural Development — An International Symposium on Modeling in Agricultural Research in Developing Countries, **Bangkok, Thailand November 1991.** The objectives of the symposium are (1) to review the status of systems research and modeling in agriculture, with special reference to evaluating their efficacy and efficiency for achieving research goals, and to their application in developing countries; and (2) to promote international cooperation in modeling, and increase awareness of systems research and simulation. Submitted papers, posters, and demonstrations will be arranged according to the themes: *Crop production systems* (genotypic constraints; weather related constraints; soil constraints; and biological constraints); *Farming systems;* and *Training in systems research.* Contact: Dr F. W. T. Penning de Fries or Dr P. S. Teng, IRRI, P.O. Box 933, Manila, The Philippines. Fax: 63 2 8182087; CGNET address: CG1401; Telex: (ITT) 45365 or (RCA) 22456.

3rd International Conference on Plant Diseases, **Bordeaux, France, 3–5 December 1991.** Contact: Catherine Marchais, ANPP, 6 boulevard de Bastille, 75012 Paris, France.

Breeding for Disease Resistance, **University of Newcastle, UK, 16–19 December 1991,** held by the British Society for Plant Pathology. Contact: Dr Richard Shattock, B.S.P.P. Programme Secretary, School of Biological Sciences, University of Wales, Bangor, Gwynedd LL57 2UW, United Kingdom.

1992

International Meetings on Biology Molecular and Cellular Techniques in Plant Breeding, **I. A. M. Z. Zaragoza, Spain, 13–31 January 1992.** Contact: Instituto Agronomico, Mediterraneo de Zaragoza, Apartado 202, 50080, Zaragoza, Spain.

International Drainage Workshop, **Lahore, Pakistan, 8–15 February 1992.** Contact: Tel: 92 42 213775.

Symposium on Durability of Disease Resistence, **Wageningen, The Netherlands, 24–28 February 1992.** Contact: Symposium Durability of Disease Resistence, IAC-section OCC, P.O. Box 88, NL-6700 AB Wageningen, The Netherlands.

International Congress of Integrated Pest Management, **Panamerican School of Agriculture, Tegucigalpa, Honduras, 22–26 April.** Contact: Abelino Pitty Tel: 504/76-6140/6150.

International Symposium on Plant Polymeric Carbohydrates, **Berlin, Germany, 1–3 July 1992.** Contact: Prof. F. Meuser, Department of Food and Fermentation, Technology, Technical University of Berlin, Seestrasse 11, D-W-1000, Berlin 65, Germany.

(Second announcement)
XIIIth EUCARPIA Congress, *Reproductive Biology and Plant Breeding*, **Angers, France, 6–11 July 1992.** For registration and hotel accommodation, contact: XIIIth EUCARPIA Congress, Centre de Congréd d'Angers, France. Tel: (33) 41 60 32 32; Fax: (33) 41 43 42 70. For poster titles and abstracts, contact: XIIIth EUCARPIA Congress, GEVES, La Miniére, 78285 Guyancourt Cedex, France. Fax: (33) 1 30 83 36 29.

First International Crop Science Congress, **Ames, Iowa, USA, 14–22 July 1992.** The program will consist of plenary sessions, symposia, and voluntary poster papers and professional tours organized so as (a) to present knowledge pertinent to crop scientists from all regions of the world, (b) to emphasize integration of knowledge from crop science to solve global and regional problems and issues, and (c) to focus on global research needs. Opportunities for work group sessions will be provided on the congress program. Contact: K. Frey, International Crop Science Congress, c/o Agronomy Department, Iowa State University, Ames, IA 50011, USA.

4th Symposium "Topics in Mycology," — Fungal Dimorphism, **Cambridge, UK, 1–4 September 1992.** Contact: Hugo Banden Bossche, Department of Comparative Biochemistry, Janssen Research Foundation, B-2340 Beerse, Belgium.

6th International Symposium on microbial Ecology (ISME 6), **Barcelona, Spain, 6–11 September 1992.** Contact: Prof. Ricardo Guerrero, ISME-6, Apartado 16009, E-08080 Barcelona, Spain.

Phosphorus Life and Environment — From Research to Application, **University Town Louvain-la-Neuve, Belgium, 8–11 September 1992.** Presented by the World Phosphate Institute (IMPHOS), the aim of the Conference is to stress the primary role of phosphorus in life and to promote agronomic, nutritional and bio-geochemical studies of this element and the possible secondary effects of its utilization. Contact: Mr M. Debbi, World Phosphate Institute, 19, Rue Hamelin 75016 Paris, France. Tel: 33(1) 47.23.72.53.

10th Latin American Weed Science Society Congress, **Chile, November 1992.** Contact: M. Kogan, Universidad Catolica del Chile, Vicuna Mackenna, 4860, Santiago, Chile.

1993

6th International Congress of Plant Pathology, **Montreal, Canada, 28 July–6 August 1993.** Contact: Managing Editor, Bureau of Crop Protection, CAB International, Wallingford, Oxon, OX10 8DE, UK.

15th Congress on Irrigation and Drainage, **The Hague, The Netherlands, 30 August–12 September 1993.** Contact: ICID, 48 Nyaya Marg, Chanakyapuri, New Delhi 110021, India.

XII International Plant Nutrition Colloquium/Symposium — Zinc in Soils and Plants, **Perth, Western Australia, 21–26/27–28 September 1993.** Contact: Plant Nutrition Secretariat, The Conference Office University of Western Australia, Nedlands, WA 6009, Australia.

1994

7th International Congress of Bacteriology, Applied Microbiology and Mycology, **Prague, Czechoslovakia, 3–8 July 1994.** Contact: Dr B. Sikyta, Institute of Microbiology, Czechoslovak Academy of Sciences, Videnska 1083, CS-142 20, Prague 4, Czechoslovakia.

International Workshop

BARLEY LEAF BLIGHTS - IMPORTANCE AND CONTROL

organized by

International Center for Agricultural Research in the Dry Areas

and

Montana State University

sponsored by

United States Agency for International Development

March 1–3, 1993, Aleppo, Syria

Barley (*Hordeum vulgare* L.) is the world's fourth most important grain both in terms of area and production. Because of its resistance to drought and other stresses, its relative importance in marginal arid and semiarid agricultural areas of the world is even larger. There is a growing demand for barley in the developing world that can only be met by increasing production in the countries concerned. A sustainable increase in production is only possible through an increase of yield per unit area, as expansion of the cultivated area may lead to environmental degradation.

Plant pathogenic fungi cause large losses, especially in the developing world. Improved farming systems increase the availability of host tissue for plant pathogens and create a micro-environment conducive to the spread of most barley diseases. Controlling plant diseases through improved resistance is a way to increase crop yields in both traditional and improved farming systems, without additional costs to the farmer.

Leaf blights, scald (*Rhynchosporium secalis*), netblotch (*Pyrenophora teres*) and spot blotch (*Cochliobolus sativus*) and the seedborne barley leaf stripe (*Pyrenophora graminea*) are among the most important barley diseases worldwide. Their significance is likely to increase as intensive cultivation practices are introduced to production areas that were previously under traditional management practices. These pathogens share commonalities in their epidemiology, but have never been addressed as a group in a scientific meeting.

The International Center for Agricultural Research in the Dry Areas (ICARDA) has, within the CGIAR system, a global mandate for the improvement of barley. A collaborative project between ICARDA and Montana State University is aimed at controlling barley diseases, mainly through breeding for disease resistance. As part of this collaborative project an international workshop will be held at ICARDA's headquarters at Aleppo, Syria. Although the workshop will focus on research carried out in the developing world, contributors from the industrialized countries are welcome to attend.

Workshop objectives

1. Catalogue current research projects.
2. Share data on occurrence of barley leaf blights and subsequent crop losses.
3. Gather information on variability in virulence of pathogen populations worldwide.
4. Discuss the use of resistance for disease control, improved screening methodologies, and new sources of resistance.
5. Explore control measures by nongenetic means.
6. Weigh the cost and benefits of using biotechnology to assist resistance breeding.

Presentations in the form of papers or posters will be accepted. The proceedings of the meeting will be published in a special issue of *RACHIS: the Barley and Wheat Newsletter* produced by ICARDA. Funds are available to cover travel and other expenses for a limited number of participants. Planning for the meeting would be greatly facilitated by an early response of those interested in participating. We would therefore appreciate a response before April 1, 1992, indicating type and topic of presentation, and source of funding. Respondents will be sent the second announcement.

J.A.G. van Leur or J.H. Hamblin,
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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.

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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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