RACHIS

No. 2

Barley, Wheat and Triticale Newsletter May 1983

The International Center for Agricultural Research in the Dry Areas

(ICARDA)

P.O.Box 5466, Aleppo - Syria

Straw is an important animal feed. The front cover shows two farmers from Heish (a village near Ma'aret El-Na'aman, south Aleppo, Syria) while loading the straw as sheep graze the stubble in the background.

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RESEARCH AND PRODUCTION

RECOMMENDATION OF PARENTAL MATERIAL FOR BREEDING CEREALS RESISTANT TO THE BARLEY YELLOW DWARF VIRUS

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Introduction

Barley yellow dwarf virus (BYDV) is a disease of international importance, and many sources of BYDV resistance are useful all over the world.

Efforts to breed cereals resistant to BYDV were initiated in Quebec in 1972. The development of our program led to the testing of part of the CIMMYT material since 1979 and part of the ICARDA material since 1982. Species evaluated include bread wheat, durumwheat, barley, triticale, oats, rye and various interspecific hybrids of cereals. Recommendations are given here for parental lines which may be useful sources of BYDV resistance for each species.

Materials and Methods

We rear one aphid species, *Rhopalosiphum padi,* producing about 10 million viruliferous individuals every year to carry the virus to the field plots. The virus strains used are tested in mixtures every year in growth cabinets, and a mixture qualifying as highly virulent on wheat is selected for use in the field. All field plots are inoculated with viruliferous aphids. The resistance is evaluated by symptom readings and by quantitative measurements such as biomass, grain yield and harvest index (grain yield/biomass). Symptoms may be satisfactory for the evaluation of oats and barley, but biomass is a necessary criterion for triticale. Grain yield and harvest index are also considered necessary criteria for bread wheat and durum.

Each year, the best lines of wheat and triticale are kept as checks for the following year. For barley and oats this is not necessary, because it is very easy to distinguish the levels of resistance and one year of data is considered adequate.

Results and Discussion

The most desirable parents are those that possess the best virus resistance together with agronomic traits such as yield, earliness, short straw, and resistance to other diseases. However, the main criterion remains a high level of BYDV resistance. We hesitate to recommend bread wheat or durum after a single year of testing, because of the difficulties involved in identifying BYDV resistance in wheat, symptoms being less reliable for these two species. A list of the best accessions of various species of cereals evaluated in our 1981 and 1982 trials is given in Table 1. In the case of barley, this list is not complete, since many cultivars with high BYDV resistance due to the Yd_2 gene have been produced in various countries. Minor resistance genes have also been detected in the barley cultivars Midas (U.K.) and Post (U.S.A.). Many BYDV-resistant oat lines are also quoted in our annual project report.

The resistance level found in some recent triticales is very impressive, and apparently expresses itself well in cohabitation with AB genomes. This suggests that hybridization of resistant triticales with bread wheat and durum may transfer the resistance to Triticum and hopefully obtain desirable translocations. We intend to use this approach in our work as there is a definite need for better BYDV resistance in durum and bread wheat.

Acknowledgments

We extend our thanks to the International Development Research Centre (Ottawa) for supporting this research, and to CIMMYT and ICARDA collaborators involved in this work.

Table 1. Sources of BYDV resistance found in various cereal trials for various species[a].

Species	Trial	Accessions found resistant
BARLEY	80-81 Barley Crossing Block (CIMMYT)	32, 49, 56, 92, 106, 110, 155, 166, 167, 179, 199, 237, 340.
	81-82 Barley Crossing Block (CIMMYT)	10, 29, 71, 79, 81, 83, 118, 135, 142, 171, 214, 230, 282, 313, 314, 378, 393.
	80-81 Barley Crossing Block Quality (CIMMYT)	8, 10, 14.
	8th IBON (80-81)	32, 79, 145, 169, 209.
	9th IBON (81-82)	19, 32, 67, 76, 104, 105, 118, 119, 133, 142, 155.
	81-82 Barley Crossing Block Resistance (CIMMYT)	2, 19, 59, 82, 84, 91, 97, 98, 118, 119, 129.
	81-82 Barley PC Cebada (CIMMYT)	32, 34, 35, 36, 61, 73, 81, 95, 111, 148, 155, 156, 157, 158, 159, 160, 162, 242.
	Regional Crossing Block Barley 81-82 (ICARDA)	13, 25, 64, 65, 84, 141, 142.
BREAD WHEAT	14th IBSWN (80-81) (CIMMYT)	6, 38, 44, 45, 182, 183.
	15th IBSWN (81-82) (CIMMYT)	6.
	From Brazil	Maringa (IAC-5)
DURUM WHEAT	12th IDSN (80-81) (CIMMYT)	31, 88, 100, 147, 210, 218, 227.
	Regional Crossing Block Durum 81-82 (ICARDA)	163[b].
TRITICALE	12th ITSN (80-81) (CIMMYT)	168, 169, 170, 267, 269, 271.
	13th ITSN (81-82) (CIMMYT)	66, 90, 106, 142, 147, 153, 169.

[a] After combining all the available information from Quebec and international sources about noteworthy agronomic qualities or resistances a few accessions were underlined as potentially preferable choices.

[b] This line (cv. Boohai) also has aphid resistance in Ethiopia according to ICARDA.

INFESTATION OF WHEAT BY SUNI BUG *(EURYGASTER SPP.)* IN SYRIA

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Infestation of wheat by Suni bug has been widely reported: Turkey (Lodos, 1981), western USSR (Kurin *et al.*, 1980), Yugoslavia (Wetzel, 1978), Spain (Gallego and Sanchez-Boccherini, 1978), France (Force *et al.*, 1978), Italy (Genduso, 1976), Greece (Stavraki, 1979), Pakistan (Ahmad and Moizuddin, 1978), Hungary (Raez, 1976) and Romania (Ionescu, 1978). It might be expected that infestations in Turkey would spread into northern Syria and, indeed, the insect has been identified as a significant field pest in that region for several seasons (Hariri, G., personal communication).

The adult Suni bug, or wheat bug, feeds on developing breadwheat, durum wheat and barley plants by sucking the sap of leaves, or the cell contents of developing grains. To suck the cell contents, the insect secretes into the grain a mixture of enzymes, including a powerful proteolytic enzyme (Gospodinov and Cheleev, 1973). The main results of Suni bug attack are:

1. Due to the removal of cell contents, the cell walls surrounding the area of penetration collapse. When the grain matures, a depression is left around the site of penetration, which appears as a concave area on the side or top of the kernel.

2. The colour of a sound kernel of breadwheat or durum wheat varies from buff to reddish-brown, and the kernels often appear to be almost translucent. Areas of the kernels where extensive cell collapse has occurred do not reflect light in the same way, and much denser, light brown to almost white patches surround the puncture, which can often be seen in the centre of the patch. The Suni bug penetrates the sides and dorsal surface of the kernel since the rachilla and rachis protect the ventral side. Those light-coloured patches which spread upwards from the ventral surface of the kernel (called "mottling" or "yellow berry") are caused by nitrogen deficiency and can easily be distinguished with a little practice from Suni bug patches.

3. The kernel weight is reduced which may significantly reduce the yield. In 47 samples collected from farmers' fields during 1982, kernel weight reduction varied from 7.4 to 36.8%.

4. Protein content is usually slightly reduced (by about 8%). The collapse of many cells causes a reduction in the amount of starch synthesized so that relative protein content of grain is often little affected, although the absolute amount of protein is substantially reduced.

5. The yield of flour is reduced on milling, due to the smaller internal volume and irregular shape of kernels.

6. The baking quality of flour is seriously reduced. The influence of the proteolytic enzymes appears when water is added to the flour, and the doughs become very weak, difficult to handle, and will not ferment properly. The baking of *khobz* or any other type of bread is very difficult. Fig. 1 illustrates the effect of Suni bug damage on *saaj* bread baked at Zahle, Lebanon.

Three sets of samples were studied at the ICARDA quality laboratories, Tel Hadya, Syria:

1. Samples collected from 47 farms during the 1982 harvest.

2. Twenty-four samples from bulk wheat delivered to the flour mills in northern Syria during June-September, 1982.

3. Laboratory-prepared breadwheat samples containing gradually increasing amounts of Suni bug damaged kernels.

The first set was tested for kernel weight, protein content and wheatmeal fermentation time (WMFT). The WMFT is the time necessary for the break-up of a yeasted doughball floated on water. The buoyancy is imparted by the accumulation of carbon dioxide gas inside the doughball, which is trapped by the protein matrix. Strong wheats may float for 6 hours or more, while weak wheats may break down in 15 minutes. Any factor affecting gluten strength will influence WMFT time (Table 1).

Table 1. Mean and standard deviation (SD) of characteristics of Suni-bug damaged and sound wheat kernels.

	Protein %				WMFT (minutes)				Kernel weight				
	damaged		sound		damaged		sound		damaged		sound		
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	N
breadwheat	10.3	1.9	10.6	1.8	36.8	9.9	115.2	48.2	26.6	2.3	34.8	2.9	26
durum	10.5	1.2	10.7	1.2	33.8	3.6	49.1	38.0	33.8	4.1	42.3	4.8	21

Protein content was not greatly reduced, but the proteolytic enzymes very significantly reduced WMFT for both bread and durum wheats, and the standard deviations showed that the natural variance in strength was also reduced. All damaged wheats became weaker and kernel weights were reduced by about 22%.

The second set of samples was used to investigate the distribution of Suni bug infestation in northern Syria. Samples were drawn from silos in Kamishli in the North East, Raqqa in the North Centre, Afrin in the West and Aleppo. The samples were closely inspected for Suni bug damage, and were also tested for protein content (Table 2).

Table 2. Characteristics of commercial wheat samples from Northern Syria.

Area	% of samples with bug damage	Protein %	Protein SD
Kamishli	100	11.5	1.2
Raqqa	100	12.8	1.6
Afrin	75	12.5	1.0
Aleppo	80	12.6	2.5

These results showed that Suni bug was distributed all across the wheat-growing area of northern Syria. The extent of damage varied widely within the 4 districts, but there was no relationship between the proportion of damaged kernels and the protein content.

The third set of samples was adjusted to 14.5% moisture and milled into flour on a Buhler laboratory mill. Flours were tested on the Brabender Farinograph and the 10 GM Mixograph, and the wheat samples were tested for protein and WMFT (Table 3).

The farinograph development time, stability and the WMFT values all fell significantly with as little as 10% of damaged kernels. The delta R increased at the same rate. Flour strength was very much reduced by the presence of Suni bug damaged kernels (Table 4).

Table 4. Mixograph data of sound and Suni-bug damaged wheat flours.

Bug-damage wheat added (%)	Mixograph development time (min)	Delta R (%)
0	3.3	7
2	3.1	9
5	2.8	9
10	2.6	12
20	2.1	16
50	1.3	26

To conclude, Suni bug damage reduced flour strength very significantly, and preliminary baking tests with 2-layered *khobz* showed that dough-handling properties were seriously affected. The small survey indicated that Suni bug damage occurred over a wide region during 1982, and could lead to serious consequences for the Syrian baking industry unless control measures are adopted. The degree of wheat damage can be detected by the wheatmeal fermentation time test; samples floating for less than 50 minutes should be regarded as of doubtful quality for baking. Further investigations are continuing on the early detection of Suni bug damage to wheat, and on corrective measures which may be applied at the bakery level.

Table 3. Quality characteristics of wheats and flours with increasing levels of Suni-bug damage.

Bug-damaged wheat added %	Farinograph				WMFT	Protein	Hectolitre weight
	absorption	devel. time (min)	stability (min)	delta R BU	(min)	%	
0	59.5	5	9.5	50	200	12.6	80
2	60.5	4	9.2	50	176	12.7	79
5	61	4	6	85	56	12.4	79.5
10	61.5	3	4.5	150	40	12.7	77.5
20	62	2.5	2.8	240	41	12.7	76
50	62.5	2	1.4	310	37	12.6	71.5

Delta R = difference between Farinograph resistance after 15 minutes and the 500 Brabender unit line
BU = Brabender Units

Acknowledgments

The cooperation of Messrs. G. Bourahr, B. Adleh and Ms. A. Eskeif of the Aleppo Milling Directorate is greatly appreciated.

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IMPORTANCE OF TILLERING CAPACITY FOR GRAIN YIELD IN TRITICALE UNDER RAINFED CONDITIONS

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Introduction

Selection for high yield is one of the main aims of plant breeders. New varieties with high yield potential that tolerate moisture stress and adverse climatic conditions, will increase farmers' yields and minimize the effects of weather fluctuations in the rainfed areas.

Materials and Methods

Some 800 lines of triticale were planted in 1980-81 season at 2 dry sites in Syria, at Breda (250 mm annual precipitation) and Khanasser (200 mm), and screened for drought tolerance. These same lines were also tested for yield potential under rainfed conditions at the Tel Hadya Experimental Farm (350 mm) and compared with the check variety Beagle; 270 lines, selected from Khanasser and Breda and which produced good grain yields at Tel Hadya, were retested in the 1981-82 season at the same sites. The tested genotypes were divided into 3 yield groups, high, medium (similar to the check) and low. Data were recorded on grain yield, the percentage increase in yield over Beagle, and yield parameters (1000-kernel weight, number of fertile heads/m^2, number of spikelets/ spike and hectolitre weight) (Tables 1 and 2).

The yield experiment was a randomized block design with a plot size of 9 m^2 and 3 replications.

Table 1. Triticale lines selected in Breda and Khanasser under moisture stress (1980-81).

	Source		% of Beagle	Yield kg/ha	1000-kernel weight	Hectoliter weight
a) HIGH YIELDING LINES						
Bgl 'S' /Addax 'S'	(PTYT)	1418	155	3519	49	71
Drira/M2A	(ATYT)	415	143	2992	44	72
Juanillo 92	(PTYT)	710	135	2728	47	75
M2A/Bgl	(ATYT)	411	135	2831	44	77
Ars/Mexipak Muti// Bgl 'S'/Abn 'S'	(PTYT)	1508	115	3439	41	73
b) MEDIUM YIELDING LINES						
Drira outcross	(ATYT)	511	102	2611	48	–
W74.103/Addax 'S'/3/ Bgl 'S'/M2A//IRA	(PTYT)	1314	101	2544	46	–
c) LOW YIELDING LINES						
$M2A^2$/Setts 'S'//IA/Abn	(PTYT)	1215	95	2206	38	75
Panda 'S'/Abn	(PTYT)	1305	83	2106	35	78
Ars/Mexipak Muti//Bgl 'S'/3/Abn 'S'	(PTYT)	1509	77	2322	36	–
Bgl/Iga//FS477	(PTYT)	1209	73	1700	39	74

Table 2. Triticale lines selected in Breda and Khanasser under moisture stress (1981-82).

	Source		% of Beagle	Yield kg/ha	1000-kernel weight	Heads /m²	Spikelets /spike	Hectoliter weight
a) HIGH YIELDING LINES:								
6TA204/6TA210//6TA312 /6TA204/3/Bgl	(PTYT)	503	117	3811	36	257	21	68
Bgl/Huamantla Sel.		519	115	3736	47	199	22	70
Juanillo 90	(ATYT)	815	113	4269	40	270	24	71
H507.7IA/Bgl2		511	111	4138	32	332	20	73
Drira outcross		212	108	4786	45	263	24	71
b) MEDIUM YIELDING LINES:								
7TB219/Bgl 'S'	(PTYT)	508	102	3300	42	210	23	68
Cml/Pato//Bgl	(ATYT)	205	101	4088	41	230	25	72
Drira outcross - 7		211	100	4411	44	252	26	73
Delfin 99//Abn/Cha 2	(PTYT)	902	100	4366	39	258	23	70
TA76/1633//Lynx		903	98	4266	30	273	25	66
c) LOW YIELDING LINES:								
IA/IRA^2	(PTYT)	502	89	2905	42	205	21	68
Drira/FAS204	(ATYT)	214	80	3561	44	207	18	71
Drira/Kang	(PTYT)	204	75	3119	35	278	18	71
Ars/8156//Bgl	(ATYT)	207	73	3251	46	190	26	70
IRA/Bgl		804	71	2669	46	203	20	73

Results and Discussion

The results clearly show the importance of the number of heads/m^2 for yield potential (and as a response to improved environmental conditions). (Figs. 1 - 4). Selection at the dry sites of Breda and Khanasser of the best performing lines showed that tiller number was the yield parameter that was responding most to the improved environment at Tel Hadya. Profuse tillering has also been shown by Hadjichristodoulou (1981) and Hurd (1971) to be important in the case of barley in drylands. The high yielding triticale lines had a relatively high number of heads/m^2, 268 compared with 259 for the medium and 217 for the low yielders.

The second important parameter seems to be the 1000-kernel weight, where the high and medium yielders are about the same, but the low yielder lower. These results are in conformity with those of other workers (Ketata *et al.,* 1976; Hadjichristodoulou, 1981 and Nachit, 1982) which have also indicated that the 1000-kernel weight plays an important role in grain yield in dry environments.

With regard to spike length, the medium and high yielders showed more spikelets/spike than low yielders. No differences were discerned in hectoliter or test weight among the groups, but it has been observed that, when subjected to moisture stress during grain filling, high yielders of triticale tend to show better hectoliter weight than low yielders. The last 2 years in Northern Syria have been wet during the grain filling stage, that is probably why no differences have been found among the 3 genotype groups in hectoliter weight.

The results clearly indicate the important role of tillering capacity and kernel weight in developing suitable triticale germplasm for dry environments.

Conclusions

A high number of fertile heads per unit area is an important parameter for higher yield in triticale under dry environments. High tillering genotypes of triticale give more yield than lower tillering ones (the lines with a higher number of fertile heads per plant showed better grain yield potential under dry environments).

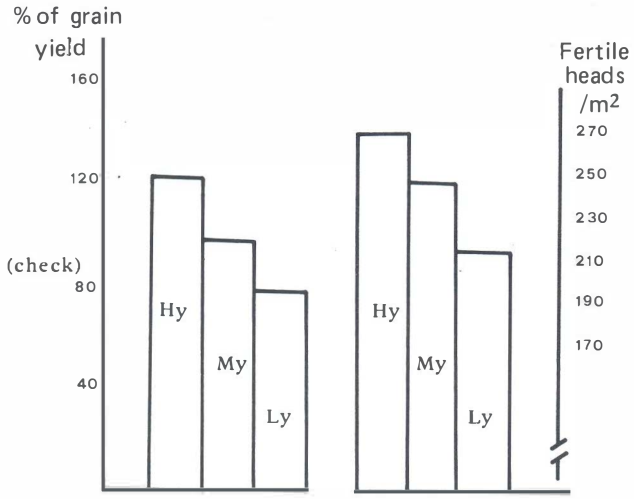

Fig. 1. Comparison between triticale genotypes with different grain yielding levels and their fertile heads $/m^2$.

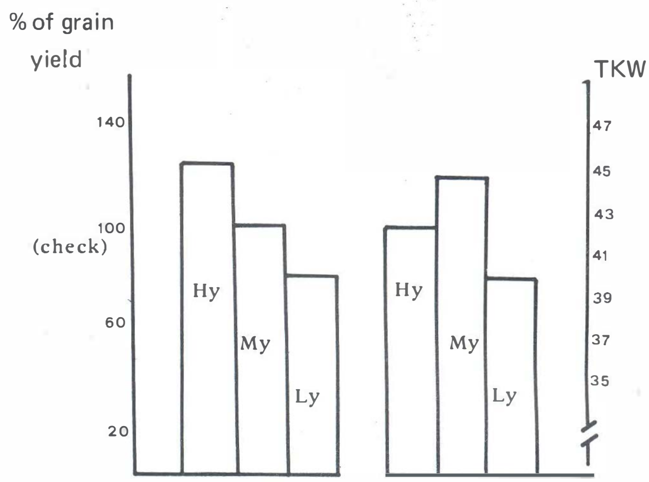

Fig. 2. Comparison between triticale genotypes with different grain yielding levels and their 1000-kernel weight (TKW).

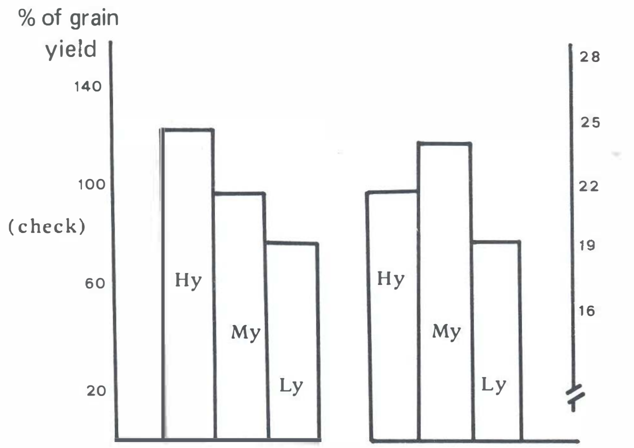

Fig. 3. Comparison between triticale genotypes with different grain yielding levels and their number of spikelets/spike.

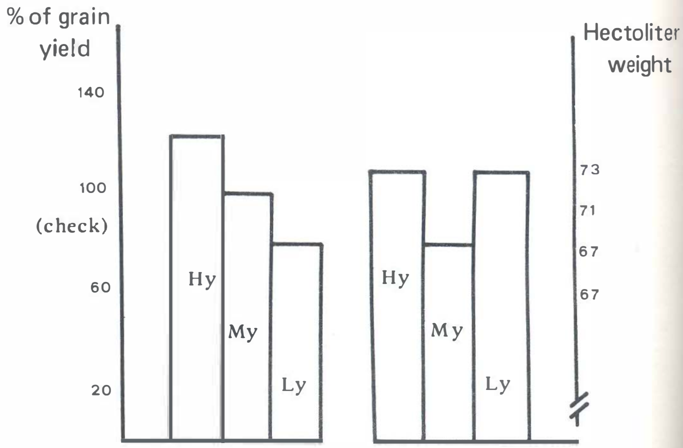

Fig. 4. Comparison between triticale genotypes with different grain yielding levels and their hectoliter weight.

Hy = High yielding genotypes
My = Medium yielding genotypes
Ly = Low yielding genotypes

The 1000-kernel weight and the number of spikelets also seem to be important for breeding of triticale genotypes in drylands.

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HISTOLOGY OF BARLEY RESISTANCE TO LEAF RUST*

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In the barley-leaf rust system two types of resistance are distinguished: hypersensitive resistance (HR) and partial resistance (PR). These types can be regarded as examples of Vanderplank's vertical and horizontal resistance, respectively. The latter type is presumably more durable than HR, but very little is known about the principles underlying it. PR is characterized by a reduced epidemic build-up in spite of the presence of an infection susceptible type; the inheritance of PR is polygenic.

The histology of PR of barley to leaf rust was investigated and compared with that of HR and also with the histology of the resistance of non-host plants such as lettuce and wheat.

Fig. 1 summarizes the results; in barley genotypes lacking resistance to leaf rust, the germinated fungal spores (infection units) formed appressoria over the stomata on the leaf, penetrated into the leaf, formed haustoria in the mesophyll cells, colonized the leaf and formed new spores (Arrow A). In partially resistant genotypes (Arrow B), a substantial part of the infection units aborted just before the formation of the first haustoria. No essential necrosis of barley cells was involved. The infection units that succeeded in forming the first haustoria usually developed normally, albeit at a lower rate than in genotypes lacking PR.

The histology of the HR-reaction is characterized by a normal infection development till after the formation of the first haustoria. Depending on the hypersensitivity gene and the genetic background of the barley genotype, many or all infection units stopped development during the colonization phase (Arrow C). This reaction is always associated with necrosis of barley mesophyll cells. Therefore, PR and HR can be distinguished very well by their histology.

One interesting finding was that the histology of PR resembled that of the non-host reaction of wheat (Arrow D). In wheat the fungus is well able to penetrate the leaf but almost all infection units are arrested just before the formation of haustoria, without having provoked necrosis; a few infection units manage to form a single haustorium associated with cell necrosis.

On a non-host plant with an entirely different epiderm structure such as lettuce, the leaf rust fungus is unable to find leaf stomata and the infection aborts before appressorium formation (Arrow E).

The results indicate that the genes for PR belong to the mechanism that enables a specialized pathogen such as leaf rust to recognize its host. The more genes for PR are present, the less infection units of the pathogen are able to colonize the leaf successfully. Compilation of enough PR genes may render a barley genotype a "non-host" to barley leaf rust, a resistance that may be as durable as the non-host resistance of wheat to the fungus.

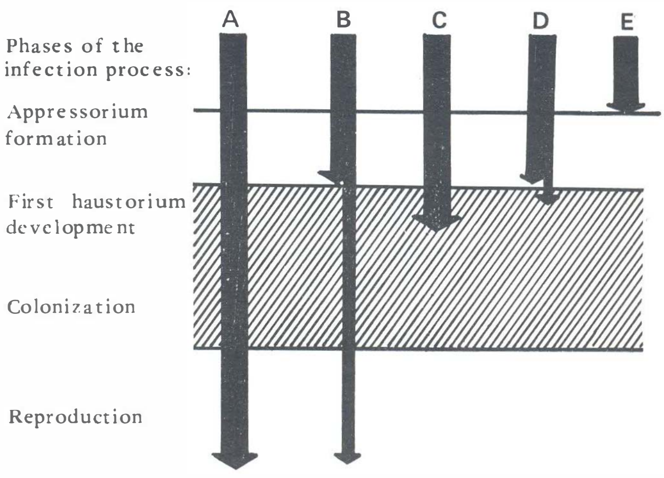

Fig. 1. Diagrammatic representation of the infection process of barley leaf rust in plants with different types of resistance. The widths of the arrows are proportional to the fractions of the colonies encountering the respective barriers.
A: Barley without resistance genes.
B: Barley with partial resistance.
C: Barley with hypersensitive resistance.
D: Wheat (non-host to barley leaf rust).
E: Lettuce (non-host to barley leaf rust).

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* Abstract of Ph.D thesis: Studies on the histology of partial resistance in barley to leaf rust, *Puccinia hordei*, conducted at the Institute of Plant Breeding, Agricultural University, Wageningen, The Netherlands. 1983. 72pp. bibl, tabs, figs.

PRELIMINARY STUDIES ON SOME MORPHOLOGICAL CHARACTERISTICS CONTRIBUTING TO DROUGHT TOLERANCE IN WINTER CEREALS

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Introduction

Under the climatic conditions of the semi-arid regions, the choice of crops that can be grown without irrigation is limited and winter cereals i.e. wheat and barley are not only covering the greatest sown area, but are also the most profitable crops. There is a need to develop suitable disease resistant varieties with yield stability in the highly variable agro-climatic conditions of the semi-arid rainfed regions.

Due to the lack of reliable screening techniques or selection criteria for breeding drought tolerant cereal varieties, (Reitz 1974), grain yield has been primarily used as a measure of varietal drought tolerance. The approach has been to subject large amounts of germplasm and segregating populations to heavy selection pressure under field conditions. Though there has been success with this method in Pakistan, it is slow, cumbersome, expensive and unable to keep pace with the rapidly increasing needs of the extensive rainfed areas. It is, therefore, necessary to develop a technique or identify some parameters in cereals based on agronomic traits, which could be used in screening large amounts of breeding materials as well as developing new drought tolerant varieties possessing those traits.

Studies were initiated on the commercially cultivated cereal varieties to determine some of the characteristics, which probably contributed to drought tolerance.

Materials and Methods

Four varieties of wheat, and one of each of triticale and barley, were used in these studies. Wheat varieties Chenab 70 and Lyallpur 73 were developed for irrigated and moisture stress free areas, whereas Barani 70 and Sannine (wheat), T-157 (triticale), and local barley were commercially cultivated in rainfed areas.

The experiment was conducted at the National Agricultural Research Center (NARC), Islamabad, on a sandy loam soil, with plot sizes of 4 x 1.5m, and 4 replications. In order to study root and shoot development, the same varieties were planted out in 20cm diameter earthen-ware pots filled with sandy loam soil. Rainfall was 250 mm during the crop season.

The data on root and shoot development were recorded 10, 24, 38 and 60 days after emergence, corresponding with growth stages of seedling, tillering and early and late jointing. Data on stomata size, waxiness, spike length, grain yield, and 1000-kernel weight were also recorded.

Results and Discussion

The data in Table 1 indicate the differences in root and shoot growth in the early stages of plant development. At the seedling stage the varieties, i.e. Lyallpur 73, Sannine, T-157 and local barley had faster root development as compared to check variety Chenab 70. However, at later stages the differences in vertical root development decreased. The earlier differences in rate of root development, and the positive correlation (r=0.698) between root and shoot length, explain the advantage possessed by the drought tolerant varieties in plant establishment and moisture use. This is in agreement with the results of Hurd (1974) and Schmidt (1980). Lyallpur 73, although bred for irrigated areas, has consistently been giving better performance in rainfed areas, possibly due to the early development of the deep root system of this variety.

Data on total root weight were not recorded, yet highly profuse lateral root systems were observed in the case of triticale and barley.

Table 1. Average root and shoot length (cm) in winter cereals under rainfed conditions.

Variety	Days after emergence			
	10	24	38	60
		ROOT		
Chenab 70	10.3	35.1	42.3	67.0
Barani 70	9.3	53.5	46.3	57.6
Sannine	11.2	34.8	43.8	64.0
Lyallpur 73	14.3	33.2	40.5	66.6
T-157 (triticale)	19.5	38.0	44.6	44.0
Barley (local)	12.3	35.1	61.1	77.3
		SHOOT		
Chenab 70	6.1	10.6	15.1	24.3
Barani 70	6.0	10.1	11.1	20.6
Sannine	2.6	9.1	9.3	22.0
Lyallpur 73	6.4	8.6	14.3	19.6
T-157 (triticale)	9.1	12.7	11.8	14.3
Barley (local)	5.4	13.1	15.5	19.3
:	**0.698**	**– 0.011**	**0.350**	**0.604**

A strong positive correlation (r=0.807) was found between early root development and yield as well as between root development and 1000-kernel weight (r=0.440). The positive correlations between all the stages (except stage 2) of root and shoot development (r=0.698, – 0.011, 0.350 and 0.604) also highlight the importance of good root systems in breeding varieties for rainfed areas (Table 1).

Though there were significant differences in the spike length of the varieties tested, and the differences within the wheat and the triticale varieties were not statistically significant (Table 2). However, correlation studies revealed that spike length is negatively correlated with yield (r= –0.29) and 1000-kernel weight (r= –0.46) under moisture stress conditions. Significant intervarietal differences in 1000-kernel weight, and a strong positive correlation (r=0.684) with yield indicate that under moisture stress conditions, the lines that have medium-to-short spike length but produce large and heavy grains, perform better.

Studies on stomata size revealed marked differences among the varieties. Varieties that gave higher yields such as Sannine, T-157 and local barley seemed to have smaller stomata. The negative correlation between stomata size and yield (r= –0.59), suggests that stomata size plays a significant role in the drought tolerance of the high yielding varieties. However, measurements of the number of stomata would have allowed the drawing of more soundly based conclusions (Table 3).

Waxiness is another useful trait which has been reported to restrict evapotranspiration in winter cereals, and hence to add to drought tolerance. In these experiments the highest yielding line T-157 had a high degree of waxiness, but the second highest yielding line (local barley) was non-waxy. This indicates that waxiness alone does not play a major role in drought tolerance, but, in combination with other characters, it may enhance drought tolerance in winter cereals.

From these studies, it can be concluded that early root development, high 1000-kernel weight, small stomata size and waxiness contribute to drought tolerance or drought avoidance in cereals, and can be useful traits in developing varieties for rainfed areas. However, further studies are needed in order to determine the interaction of these characteristics with other yield components.

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Table 2. Average spike length, 1000-kernel weight, grain yield, stomata size and waxiness of winter cereals varieties under rainfed conditions.

Variety	Spike length (cm)	1000-kernel weight (gms)	Yield/plot (gms)	Stomata size (μm^2)	Waxiness
Chenab 70	11.5	30.6	1160	4.48	Medium
Barani 70	9.8	29.1	710	4.91	Medium
Sannine	13.3	31.6	1350	3.84	High
Lyallpur 73	12.6	44.6	1407	5.23	Low
T - 157 (triticale)	10.7	38.3	2126	3.81	High
Barley (local)	6.6	48.3	1913	4.20	Nil
L.S.D. 5%	**4.0**	**2.0**	**502**	–	–

Table 3. Correlation coefficient between various agronomic characteristics.

Character	Shoot	Spike length	Yield	1000-kernel weight	Stomata size (μm^2)
Root	0.698	0.043	0.807	0.440	–
Shoot		– 0.261	– 0.081	– 0.116	0.098
Spike length			– 0.29	– 0.460	0.079
Yield				0.684	– 0.59
1000-kernel weight					0.076

THE EFFECT OF CLIPPING,DURING THE TILLERING STAGE,ON TRITICALE

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Introduction

Trials were carried out to assess the effect of clipping (simulating grazing) during tillering, on dual purpose triticale lines (plants grazed early and then left to grow on to produce grain) under north Syrian conditions. A second objective was to determine the importance of the forage dry matter (FDM) and the protein content in the dry matter for the grain yield.

Materials and Methods

Fifteen genotypes (13 of triticale and 2 of barley) were sown at ICARDA's Experimental Station at Tel Hadya, Aleppo, N. Syria, in November, 1980-81 season. Supplementary irrigation was applied after sowing to ensure uniform germination, and again at the grain filling stage (50 mm was applied on each occasion). Nitrogen was applied at 120 kg/ha (60 kg before sowing and 60 kg after clipping), and phosphate was also applied at 60 kg/ha before sowing. Plants were clipped in the first week of February at the end of tillering, and the FDM and the protein content were analysed. A randomized block design was used for the experiments with 3 replications, and a plot size of 4.5 m^2 per variety. The protein content was calculated by multiplying the N content by 6.25.

Results and Discussion

The FDM ranged, at the tillering stage, from 1.97 to 5.58 t/ha in triticale, 3.35 t/ha in the barley cv. Badia (an improved grain variety) and 2.77 t/ha in the local barley cv. Arabi Abied (Table 1). The protein yield ranged from 361 to 985 kg/ha.

The protein content of genotypes increased with the dry matter content. These data confirm the high quality of cereals for grazing during the early stages of plant growth. Similar results were observed by Staten and Heller (1979). The genotypes responded differently to clipping; grain yield reductions ranged from 9.6% to 60.9% . The 2 barley varieties showed the greatest reductions probably because both are grain and not dual-purpose varieties, and also mature early so that late clipping removes a proportionately greater amount of dry matter at the end of tillering (Porter *et al.* 1952). Grain yield reductions of triticales ranged from 9.6% to 50.8% Dry matter protein content of

Table 1. Means for forage dry matter (FDM), FDM protein yield, and grain yield (GY) of triticale in t/ha.

Cultivars	DM	FDM protein yield	GY of clipped treatment	GY of unclipped treatment	% of Reduction by clipping
TRITICALE*					
DKA	5.58	0.98	5.53	7.99	30.8
MBgl	5.10	0.75	4.07	7.07	42.8
MBu1	4.55	0.81	5.73	7.79	26.5
Jllo	4.51	0.84	5.66	6.66	15.0
MBu2	4.21	0.84	5.27	7.53	30.1
6A530/Arm	3.26	0.67	5.40	7.26	25.6
TCCXIII	1.97	0.45	4.80	5.26	9.6
IBgl1	3.34	0.59	5.40	8.53	36.7
DF	3.65	0.73	4.13	8.40	50.8
IBgl2	4.35	0.77	5.00	7.73	35.4
HUM1	2.42	0.46	5.13	7.40	30.6
HUM2	2.17	0.36	4.87	7.13	31.8
KBgl	3.20	0.66	4.60	8.73	47.3
BARLEY					
Badia	3.35	0.53	2.85	6.85	58.3
Arabi Abied	2.77	0.44	2.23	5.72	60.9

triticale increased with the dry matter and both were positively correlated with grain yield in clipped and unclipped treatments (Table 2).

Table 2. Relationships (regression coefficients) between the forage dry matter (FDM), FDM protein yield, and grain yield (GY) of triticale.

	FDM	FDM Prot. yield	GY clipped	GY unclipped
FDM	–			
FDM prot. yield	0.377**	–		
GY clipped	0.287*	0.467***	–	
GY unclipped	0.377**	0.451**	0.398**	–

n = 45
* = 5% level of significance
** = 1% level
*** = 0.1% level

The results show that triticale grain yield was significantly reduced by clipping during tillering. These results confirm those of Skorda (1978). The data also show that both the amount of dry matter and its protein content are important for grain yield formation. However, the FDM protein content is much more related to the grain yield (r= 0.467***) than is the forage dry matter content (r= 0.287*).

Conclusions

The forage dry matter clipped, during the tillering stage, from different triticale and 2 barley cultivars yielded 1.97 - 5.58 t/ha. The protein yield of the forage dry matter was between 361 and 985 kg/ha and the grain yield reduction after clipping ranged from 9.6 to 60.9% . Genotypes with the highest dry matter and protein contents during the early stages of development were the highest grain yielders.

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REACTIONS OF SOME BARLEY AND DURUM VARIETIES TO SPLIT NITROGEN APPLICATION

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Introduction

The results of many experiments and research work have shown that nitrogen fertilizer (N) results in large and profitable increases in yield if it is wisely applied. It is essential for farmers to know how much fertilizer to apply and whether it pays to split the application for efficient economic utilization especially since splitting the N application to cereal crops has the twin advantages of reducing risk of losses in poor seasons and of spreading the cost of fertilizer in good seasons.

Farmers need to know how much fertilizer to apply at sowing and how much at tillering for different crops and genotypes. It is this question that is the main concern of the work reported here.

Materials and Methods

In 1981-82 an experiment was conducted at ICARDA's main research station at Tel Hadya. Four rates of nitrogen fertilizer were applied to both durum wheat (Sahl, Waha, Haurani, Graugans) and barley (Beecher, Martin, Arabi Abied) varieties in 3 ratios of splitting the total N between sowing and tillering applications.

The rates applied were 30, 60, 90 and 120 kg N/ha to the durum wheats and 24, 48, 72 and 96 kg N/ha to the barleys.

The experiment was carried out on soil previously cropped with summer maize, under rainfed conditions where the total rain received was 337 mm during the season.

Ratios of fertilizer splitting between sowing and tillering were 1:2, 1:1 and 2:1 for both crops. The date of topdressing was the 2nd of March, 1982 (tillering stage).

Samples were taken for tissue nitrogen analyses in Sahl (durum) and in Arabi Abied (barley) on 7 occasions between the time of topdressing and harvest. Grain nitrogen and yield were determined at maturity.

Results and Discussion

In general, this preliminary experiment shows that the differences of fertilizer response found between durum wheat and barley could be important for farmers.

The yield of durum wheats, at any given amount of N fertilizer, was not affected by the ratio of splitting the application (Table 1).

Table 1. Average yield of durums (kg/ha).

Ratio of splitting S:T	N Rate (kg/ha) 30	60	90	120	Mean
1:2	1346	1716	2357	2907	2082
1:1	1652	2407	2927	2729	2429
2:1	1351	2232	2596	2980	2290
Mean	**1450**	**2118**	**2627**	**2872**	

SE = ± 325 kg/ha.

However, the average yield of barleys was higher if the ratio of splitting was 2:1 except at the highest N rate (Table 2).

Table 2. Average yield of barleys (kg/ha)

Ratio of splitting S:T	N Rate (kg/ha) 24	48	72	96	Mean
1:2	1490	2378	2707	3921	2624
1:1	1422	2205	2507	3424	2390
2:1	2065	2705	3338	3638	2937
Mean	**1659**	**2429**	**2851**	**3661**	

SE = ± 260 kg/ha.

Analyses of nitrogen harvest index (NHI = grain N/total plant N), show that the ratio of splitting the N application did not affect the proportion of N translocated to the grain in durums (Table 3).

Table 3. Average NHI in durum wheats.

Ratio of splitting S:1	N Rate (kg/ha) 30	60	90	120	Mean
1:2	0.79	0.82	0.80	0.81	0.81
1:1	0.81	0.82	0.82	0.80	0.81
2:1	0.76	0.83	0.82	0.81	0.81
Mean	**0.79**	**0.82**	**0.81**	**0.81**	

However, at a 2:1 splitting ratio, barleys showed a lower average NHI (Table 4), indicating that a lower proportion of the total N was translocated to the grain.

Table 4. Average NHI in barleys.

Ratio of splitting S:T	N Rate (kg/ha) 24	48	72	96	Mean
1:2	0.80	0.83	0.83	0.85	0.83
1:1	0.80	0.83	0.82	0.83	0.82
2:1	0.77	0.84	0.81	0.83	0.81
Mean	**0.79**	**0.83**	**0.82**	**0.84**	

Analyses of the total N uptake by Sahl durum at 90 kg/ha (Fig 1), showed that the 2:1 split gave a much faster N uptake than the 1:2 split, peaking at heading time, while the 1:2 split resulted in a slow increase in N uptake from topdressing to harvest. In this case, the increased earliness in N uptake did not significantly increase grain yield, possibly due to rainfall distribution after topdressing or to some other environmental conditions that may have restricted growth, such as low temperature at the vegetative stage or high temperature at the grain filling stage.

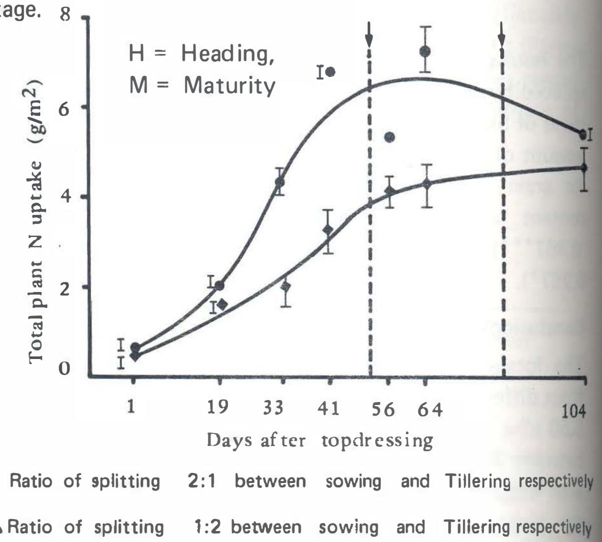

Fig. 1. Total plant N uptake of Sahl durum at 90 kg N/ha with 2 ratios of splitting.
Curves hand fitted - Vertical bars are SE's.

If the results of this experiment prove to be confirmed in subsequent seasons, it may be useful to advise farmers to use a different N fertilizer application strategy for barley than for durum wheat. Further information about the use of N fertilizer that may help in understanding these differences will be investigated in future experiments.

Acknowledgments

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GENETIC VARIABILITY WITHIN PROTEIN CONTENT OF *TRITICUM AESTIVUM, T. DURUM* AND *T. DICOCCOIDES*

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Introduction

The major source of protein in the diets of people of West Asia and North Africa are winter cereals (Nachit 1983), but there is shortage of high-protein winter cereals in the region, particularly in the high-elevation areas. ICARDA's Cereal Improvement Program therefore places considerable emphasis on developing high-protein winter cereals germplasm.

In the high elevation areas of the region, the predominant factors that adversely influence cereal production are cold and moisture stress at critical stages of growth. Selected cold-tolerant lines of *T. durum* and *T. aestivum,* were tested to determine their protein contents. Earlier studies (Sharma *et al.* 1981), indicated that *Triticum dicoccoides* could be a good gene source for high protein, disease resistance and stress (cold and drought) tolerance. Therefore, a research project has been initiated to screen and use *T. dicoccoides,* which is widely spread in the high elevation areas of the Middle East and West Asia, to derive the desirable traits for incorporating into selected *T. durum* and *T. aestivum* lines.

Materials and Methods

Some 356 lines of winter durums, 15 of *T. dicoccoides* and 141 lines/varieties of winter type *T. aestivum,* were evaluated for their protein contents (%) The check varieties were: Waha 'S' (an improved line from ICARDA) and cv. Haurani for durum wheat and cvs. Mexipak and Bezostaya for *T. aestivum.* All lines were planted in the same field under the same fertility level.

Results and Discussion

The data presented in Table 1 indicate that winter durum wheats had higher protein contents (11.80 - 18.57% lines) than winter breadwheats (10.65 - 16.43%). The majority of the durum lines had 13 - 17% protein, only one line had less than 12% protein. However, 32 entries had 17 - 18% protein and only three lines had over 18% compared with values of 15.50% for Waha 'S' and 14.31% for Haurani, the check lines. About 200 lines of durum had higher protein contents than the improved check Waha 'S'. These results indicate the great genetic variability for protein content in the durum germplasm, and the considerable potential for improving it by transferring high protein gene(s) to cultivated varieties.

Winter breadwheat lines also showed considerable genetic variability for protein content; 57 lines possessed equal or more protein than the check Bezostaya (14.24%), and 28 lines had more than 15% protein.

The 15 lines of *T. dicoccoides* germplasm were mainly collected from the high-elevation areas of Syria; their protein contents ranged from 20.43 to 24.98% compared with 15.50% for Waha 'S' and 14.31% for Haurani. These results agree with those of Sharma *et. al.* (1981), who reported protein content up to 30.90% for *T. dicoccoides.*

T. dicoccoides, is mainly distributed in the high elevation areas of West Asia and the Near East, and can tolerate even harsher environments and types of stresses.

From these studies, it appears that *T. dicoccoides* can be a good source of high-protein gene(s) for improving the nutritional quality of durum wheats in the high-elevation areas and, possibly, contributing some other desirable traits such as drought tolerance and disease resistance.

Table 1. Variation in protein content of *T.durum, T.dicoccoides* and *T.aestivum*

Species	Lines Tested	Range percentages	Protein Content (%)								
			10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19
T.durum	356	11.80 - 18.57	–	1	4	51	95	99	71	32	3
T.dicoccoides	15	20.15 - 24.98	–	–	–	–	–	–	–	–	–
T.aestivum	141	10.65 - 16.43	1	9	30	34	39	22	6	–	–
		Protein content									
T.durum cv Waha (check)		15.50									
T.durum cv Haurani (check)		14.31									
T.aestivum cv Mexipak (check)		11.80									
T.aestivum cv Bezostaya (check)		14.24									

Table 2. Protein content (%) in *T.dicoccoides* lines collected from Syria.

Entry No.	Variety or Cross and Pedigree	Origin	Altitude (m)	Protein content %
1	*T.dicoccoides* - SY - 20010	Zabadani	1160	24.06
2	*T.dicoccoides* - SY - 20013	Kurayya (Salkhad)	920	20.79
3	*T.dicoccoides* - SY - 20017	Between Emtan and Salkhad	1180	20.15
4	*T.dicoccoides* - SY - 20021	Nawa	490	20.97
5	*T.dicoccoides* - SY - 20085	Nawa	—	21.52
6	*T.dicoccoides* - SY - 20089	Zabadani	1240	22.07
7	*T.dicoccoides* - SY - 20090	3 km from Zabadani	1160	24.98
8	*T.dicoccoides* - SY - 20096	Zabadani	1180	23.80
9	*T.dicoccoides* - SY - 20101	Zabadani	1390	20.52
10	*T.dicoccoides* - SY - 20110	Zabadani	1200	23.72
11	*T.dicoccoides* - SY - 20121	Sale	1530	20.43
12	*T.dicoccoides* - SY - 20122	Sale	1450	20.43
13	*T.dicoccoides* - SY - 20124	Zabadani	—	22.62
14	*T.dicoccoides* - SY - 20184	Ataren	460	23.57
15	*T.dicoccoides* - 1Q - 55132		—	21.97

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RESISTANCE TO WHEAT STEM SAWFLY (*CEPHUS PYGMAEUS* L.) AND RELATED SPECIES IN CEREALS

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Introduction

Wheat Stem Sawfly (*Cephus* spp.) is one of the most important insect pests of cereals in the ICARDA region. During 1978-83, the Cereal Entomology Unit of ICARDA has been studying barley, durum, breadwheat and triticale cultivars, to identify sources of resistance.

Materials and Methods

Different genotypes were evaluated for resistance under artificial and natural infestations. For the artificial infestation, approximately half a million larvae of the Wheat Stem Sawfly were collected from ICARDA's Experimental Farm at Tel Hadya, N. Syria, and reared in the laboratory until pupation and adult emergence. The adults were then released within cages in which the genotypes, grown in 1-m long rows, had reached the ear stage. This was replicated 3 times until the number of adults released had been adjusted to produce about 1 egg/stem. A check was planted every 9 lines.

At harvest, 60 stems were taken from each replicate at random and examined in the laboratory. The same genotypes were studied under natural infestation in Suran (Hama province, Syria), where high populations occur.

Approximately 1000 genotypes of barley, durum, breadwheat and triticale are evaluated every year, and emphasis is being given to selected lines coming from the breeding programs, and also to those previously found to be promising for insect resistance.

Results and Discussion

Sources of resistance to *Cephus* spp. were detected in all crops (Table 1). Some of the lines showed significantly lower levels of infestation than the checks but most lines have been classified as very susceptible. In general, the most resistant genotypes were found among the durum cultivars and the least among the triticales.

Table 2 shows some of the lines that have been tested for several years and have proved to be highly resistant as compared to the checks.

The results show that lines must be evaluated for several years under artificial and natural infestation and under different climatic conditions before they can be recommended as sources of resistance. The Cereal Breeding Program has initiated work on incorporation of the resistant genes into commercial varieties.

Table 1. Number of lines screened, number of promising lines, and their percentages of infestation by Wheat Stem Sawfly in two locations in Syria, 1982.

Crop	Location	No. of promising lines and % range of infestation		Check (% infestation)	
Barley	Suran[1]	6 out of 108	(3.3 – 8.3)	A. Abied	(38.3)
	Tel Hadya[2]	"	(0 – 5)	MP - 112 (BW)	(20.4)
Durum	Suran	59 out of 351	(0 – 0.6)	Hammari	(5.9)
	Tel Hadya	"	(0.2 – 3.9)	Hammari	(17.4)
Breadwheat	Suran	13 out of 297	(0 – 2.2)	MP - 112	(9.6)
	Tel Hadya	"	(0.5 – 4.4)	MP - 112	(23.6)
Triticale	Suran	3 out of 108	(1.7 – 2.7)	MP - 112	(12.9)
	Tel Hadya	"	(1.7 – 3.9)	MP - 112	(17.1)
Triticale	Suran	10 out of 372*	(0 – 1.7)	Beagle	(28.1)
				Beecher	(23.8)

[1] = Under natural infestation
[2] = Under artificial infestation
* = Single replicate

Table 2. Summary of the evaluation studies of resistance to Wheat Stem Sawfly. 1979 – 1982.

Variety /line	% Infestation by Wheat Stem Sawfly 1978	1979	1980	1981	1982	Average
BARLEY						
Kataja	–	–	–	–	3.9	–
MP - 112 (BW) (check)	–	–	–	–	(20.4)	–
DURUM						
Cr 'S' 21563/61-130 x Lds CM 225-12M-1Y-OM-OY	11.4	0.5	4.1	0.3	1.2	3.5
Corm 'S' Ruff 'S' CD 7476-4Y-3Y-OY	–	1.0	3.1	0.2	0.5	1.2
CI 15258 GERARDO 517	–	–	0.7	0.5	0.2	0.4
Loon 'S' CM 14528					1.1	
Hammari (check)	(56.6)	(10.7)	(16.4)	(15.4)	(17.4)	23.3
BREADWHEAT						
MT-777 CI 9292/Fortuna	1.0	0.7	4.6	0.6	0.5	1.5
MT-773 CI 9294/Fortuna	1.1	0.5	4.7	1.6	3.8	2.3
Fortuna	5.1	0.4	5.0	3.5	2.1	3.2
Limpopo	3.2	2.1	4.8	3.9	2.4	3.3
Sawtana	4.2	0.3	6.2	4.7	3.1	3.7
MT-778 CI 11490/Fortuna	5.2	0.0	7.1	3.6	3.3	3.8
Lew	3.6	2.3	6.8	7.5	2.1	4.5
Sannine (D 6301-Naix WRM/Cno 'S' - Chr) L 932-4L-5AP-OAP-1K-OAP					1.7	
MP-112 (check)	(50.7)	(6.2)	(25.6)	(29.2)	(23.6)	27.1
TRITICALE						
Abn 'R' IM1A/M2A					3.9	
MP-112 (check)	–	–	–	–	(17.1)	–

EVOLUTION OF HIGH YIELDING HUSKLESS BARLEY VARIETIES—AN EVENT IN INDIAN AGRICULTURE

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Barley is considered to be the first cereal grain to be cultivated by man. It is grown in Northern India where it has no substitute in winter on dryland and on saline sodic soils. Barley seemed doomed to remain a marginal crop in India but the turning point came in 1976 with the finding of 2 natural dwarf mutants viz Azma (dwarf) —1 and Azma—13, and the production of an induced mutant RDB—1, the latter possessing poor combining ability (Fig. 1).

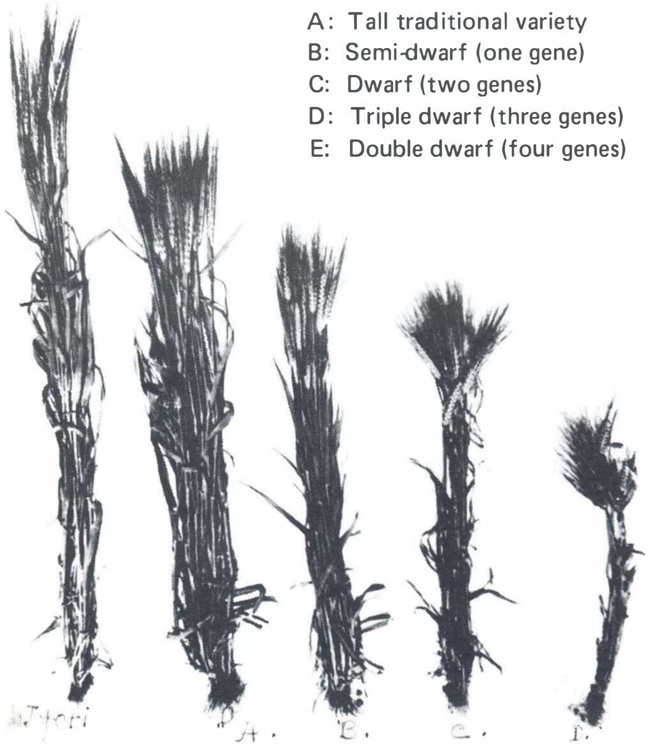

Fig. 1. New "Plant type" in barley resulting in a breakthrough in yield.

When these dwarf mutants were crossed with hull-less germplasm materials such as IB-65, Pushkin, Dilma, EB 7576, EB-7725, EB-7742 etc., a wide range of variability was obtained in the segregating populations. Some semi-dwarf and dwarf plant selections (Karan—3, —4, —16, —18, —19) were evaluated in the AICIP variety trials under rainfed, irrigated, saline-sodic and dryland conditions during the 1980 and 1981 crop seasons. Based on their superior performance for 2 consecutive years, 2 huskless varieties Karan—18 and Karan—19 were recommended for commercial cultivation by the Barley Workshop in September 1981 at IARI, New Delhi. The other 3 varieties are at an advanced stage of evaluation (Fig. 2).

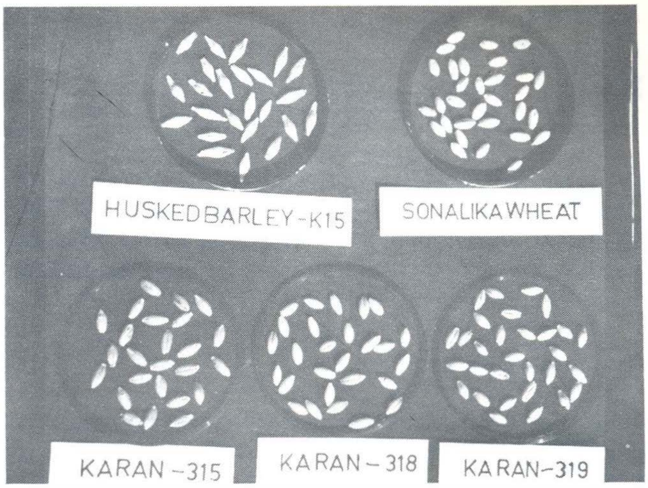

Fig. 2. Comparative look of grains of hulled barley (left) and wheat (right) on top. Below are the grains of new huskless barley lines developed through the current barley breeding program.

Karan 18 is a dwarf, lodging-resistant variety with early maturity and good tillering. It is susceptible to smut and aphids but resistant to yellow rust and *Helminthosporium* leaf spot. It is suitable for irrigated conditions and saline soils. Karan—19 is a semi-dwarf lodging-resistant variety with amber-coloured grain. It takes 120-125 days to mature and is suitable for irrigated or rainfed conditions.

Of the other varieties, Karan—3 takes 115-125 days to mature, and has moderate resistance to diseases mainly *Helminthosporium* and aphids. Karan—4 takes 110-120 days to mature and shows moderate resistance to several diseases and aphids. Karan—16 shows resistance to diseases and aphids.

Performance of Huskless Barleys

Irrigation was applied 30 days after sowing in mid-November and again at flowering in some treatments while others were rainfed. The huskless lines, especially Karan —18 and —19, outyielded traditional hulled barley and the best high yielding variety of wheat (HD-2009), included as checks in the irrigated trials (Table 1). They also outyielded them in rainfed high-rate fertilizer trials in 1981, where nitrogen was applied at 25, 50, 75 and 100 kg N/hectare; the high yielding barley varieties responded to N as well as wheat. In trials on alkaline soils in 1980-81, the high-yielding barleys yielded as much as HD-2009 wheat under irrigated and rainfed conditions but in rainfed trials on saline soil, only Karan—18 outyielded the check barley and did as well as the check wheat (Table 2). Trials were also carried out in 1980-81 and 1981-82 (December sowing) on the Diaraland flood plains where good drainage is lacking; Karan—18 and Karan—19 showed the best potential (Table 2) for supplementing losses incurred during the monsoon season.

Table 1. Performance of huskless barley under irrigated (I) and rainfed (R) conditions in the Gangetic Plain (yield hkg/ha).

Variety	Location												
	Karnal		Bawal	Kanpur		Chandeshwar		Deoria		Pusa	Hissar	Average	
	I	R	I	I	R	I	R	I	R	I	R	I	R
Karan –3	52	49	32	34	18	34	29	28	20	35	23	34	26
Karan –4	45	43	33	35	15	34	19	28	24	38	24	35	25
Karan –16	52	41	35	33	14	35	17	29	23	38	26	35	24
Karan –18	47	45	34	34	15	35	20	30	27	43	23	35	26
Karan –19	53	50	33	35	18	36	21	31	29	38	23	37	28
Jyoti Tall Barley	35	31	29	29	14	26	17	19	19	42	34	32	23
HD - 2009 Wheat	32	45	39	33	18	34	18	19	18	39	37	32	27
At 5%	CD = 3.93 /5.11		CD = 5.13	CD = 3.79 /3.21		CD = 2.10 /2.48		CD = 3.03 /2.9		CD= 5.59	CD=2.76		

Table 2. Performance of hull-less barleys on saline/alkaline soils/Diaraland (yield hkg/ha).

Variety	Alkaline soil Chandeshwar (Azamgarh)		Saline soil Canning Town	Diaraland Deoria (December-sown)	
	I*	R*	R		
	1980 - 81		1980 - 81	1980 - 81	1981 - 82
Karan –3	34	20	15	25	28
Karan –4	34	19	16	25	28
Karan –16	35	17	14	27	29
Karan –18	34	20	18	28	30
Karan –19	36	21	15	31	31
HD - 2009 (wheat)	34	18	19	23	19
Jyoti Tall (barley)	26	17	15	–	–
	CD = 2.10	CD = 2.48	CD = 5.72	CD = 3.03	CD = 5.76

* I = irrigated
* R = rainfed

Cooking Quality

In India, barley is largely consumed in the form of Chapati, Sattu (flour of parched grains) and parched grains. The Chapati making quality was determined from the protein content, Pelshenke value and tyrosine activity (Table 3). The ideal Pelshenke value (determining the gluten strength of the flour) for Chapati making from wheat ranges from 120-125 min. The Pelshenke values of Karan–4, –18 and –19 (115-158 min) were as good as those of the check wheat (221 min) and their nutritive values were also as good. Hulled barley had the lowest Pelshenke value (36 min) of all.

Table 3. Composition of protein and Pelshenke value of hull-less barley.

Variety	Protein (%)	Pelshenke value (min)	Total tyrosine activity unit/g seed
HULL-LESS BARLEY			
Karan –4	13.0	115.3	15
Karan –18	13.1	152.5	10
Karan –19	12.6	128.7	15
Karan –201	16.4	158.5	15
HULLED BARLEY			
Karan –15	9.1	36.0	11
WHEAT			
HD-2009	14.8	221.3	30

Problems in Breeding Hull-less Barley

Selection for easy threshability was made and promising parental stocks were used in further crossing programs. Black grain colour is caused by the opening of glumes at maturity permitting the entry of rain or dew water and stimulating fungal growth. It is only a problem in early-sown crops in north-western India where cold conditions prevail up to March and is not a problem in late-sown crops. Black grain colour has been controlled by selection for the best earhead types. Huskless barleys are susceptible to covered smut *(Ustilago hordei)* and loose smut *(U. nuda)*. Extensive hybridization has been carried out to incorporate multiple resistance in both hulled and huskless barley lines and the new huskless lines (Karan–3, –4, –16, –18 and –19) show high tolerance to 2 or more diseases or pests of barley (Table 4). Major emphasis is being given to identify barley germplasm having resistance to 2 or more diseases and pests.

Efforts are also being made to recycle multiple resistance lines from segregating breeding materials into the high yielding genetic background.

Agronomy

Dwarf varieties of both hulled and huskless barley have shown as good a response to nitrogen fertilizer as the high yielding wheat. P at 25-30 kg/ha and K (if needed) are applied at sowing but N at 50-60 kg/ha is applied in 3 equal split doses; at sowing, at the first irrigation and at flowering. Depending on the winter rains, 2-3 irrigations are applied, 30-35 days after sowing, 60-65 days after sowing and at flowering. Barley grows quickly and so generally suppresses weed growth. A 0.2% solution of Trinunil (methabenzthiazuron), applied 2-3 days after sowing will control *Phalaris minor* and 2,4-D at 0.75 kg/ha, applied 30-35 days after sowing, will control broad-leaved weeds.

Introduction of Huskless Barley in the Existing Cropping System

Huskless barley could replace irrigated wheat grown for making Chapatis especially on fields infected with Karnal bunt *(Neovossia indica)*. Huskless barley is as productive as wheat and is competitive with the support price of 105 rupees/quintal (= hectokilogram). Huskless barley matures in 115-120 days compared with 160-170 days for wheat, uses less soil nutrients and therefore allows the growing of a following crop (summer moong).

Huskless barley can be grown just as well as hulled barley on rainfed and saline sodic soils and so could compete with hulled barley on the 7 million hectares of saline sodic soils on the Gangetic plain. About half a million hectares in Eastern India are affected by monsoon flooding and huskless barley shows potential for growing on these poorly drained and difficult silt soils. Every year, about 25-30% of the land sown late to rice, sugar-cane, mustard and potato is not sown to a following crop because wheat cultivation after mid-December is not economical. Huskless barley could be sown as the following crop.

Utilization

Huskless barley makes good Chapati alone or mixed with wheat. Protein-rich huskless barley can be utilized for making Dalia, Suji and biscuits as well as for the preparation of Balarhar. Huskless barley can also be used for animal feed since it contains negligible amounts of crude fibre.

Table 4. Field reaction of newly developed hull-less barley lines to major diseases and pests.

Varieties		Diseases		Pests
	Yellow-rust	Smut	Helminthosporium	Aphids
Karan –3	MR*	R	R	R
Karan –4	MR	MR	R	R
Karan –16	S	S	R	R
Karan –18	MR	S	R	S
Karan –19	MR	R	R	MR

*MR = Moderately resistant
R = resistant
S = susceptible

MAJOR BARLEY RESEARCH RESULTS IN KOREA

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Research summary

Barley is fall-sown and the second most important food crop grown in the Republic of Korea. Extensive research on food crops has been undertaken to meet the demand of the increasing population. But barley production has been decreasing since 1965 mainly due to low profits for farmers, to labor and to technical constraints to double cropping on rice paddy land.

The highest priorities in barley breeding are given to early maturity, high yield, winter hardiness and wet soil tolerance to facilitate double cropping with rice. A new barley variety "Paldalbori" or "Suweon 213", was developed with dwarf habit and 6 days earlier maturity which produced 3,990 kg/ha in grain yield, 5% more than Olbori the current leading cultivar (see Tables 1 and 2). Many barley germplasm sources from CIMMYT, ICARDA and Japan were used for crossing materials. For waxy and naked barley improvement, the back cross method was used and Waxy-Gangbori was investigated in the advanced yield trial.

In screening tests for disease and lodging resistance, wet soil and cold tolerance, the following lines and cultivars were selected: SB 77232-B-79, 77186-B-84, 77191-B-57, for leaf stripe; SB 77178-B-61, 77220-B-18, Suweon 215, for powdery mildew; Suweon 215, Suweon 213, for lodging resistance; SB 77225-B-61, 77231-B-79, Suweon 214, for wet soil tolerance; Suweon 207, Suweon 215, SB 77193-B-8, 77225-B-61, for cold tolerance. These lines will be used for future crossing blocks. In addition, studies on the day length response were carried out in the greenhouse. It was found that Dongbori 2, Jogangbori, CI5824 and Suweon two-row were not sensitive to short day length (12hr treatment) and would be useful for breeding sources of early maturity.

Production

In the year 1981, there were about 353 thousand hectares planted with (non-malting) barley and 33 thousand with malting barley in the Republic of Korea; the average yield was 3,600 kg and 2,690 kg/ha respectively.

The current leading cultivars are Olbori, Gangbori, Milyang 6, Dongbori 2(covered barley), Sedohadaka, Baegdong, Kwangseong (naked barley), Goldenmelon, Hyangmaeg, Sacheon 2, and Sacheon 6 (malting barley). Olbori occupied 60% of the total area of covered barley, and Sedohadaka 70% of the area of naked barley, while Goldenmelon occupied 53% of the malting barley area.

Table 1. Agronomic traits of Paldalbori (Suweon 213)

Variety	Heading date	Maturing date	Culm length (cm)	Winter hardiness	Lodging resistance	Wet-soil tolerance	Barley stripe	Powdery mildew
Paldalbori	26.IV	29.V	53	Hardy	R	I	R	R
Olbori	30.IV	3.VI	80	I	I	I	MS	MS

R = Resistant
I = Intermediate
MS = Moderately susceptible

Table 2. Yield and yield components of Paldalbori

Variety	No. of Spikes/ m^2	No. of kernels/ head	1,000 grain wt. (g)	Upland Yield (kg/ha)	Upland Index (%)	Paddy Yield (kg/ha)	Paddy Index (%)
Paldalbori	454	37	31.6	4,630	105	3,360	103
Olbori	374	47	34.7	4,400	100	3,270	100

INCIDENCE OF STINKING SMUT (*TILLETIA* spp.) ON COMMERCIAL WHEAT SAMPLES IN NORTHERN SYRIA

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At the request of Mr. G. Bourak, director of flour milling operations in N. Syria, a series of samples of breadwheats delivered to commercial flour mills in 4 areas of N. Syria during 1982 were tested for protein content and inspected for Suni bug (*Eurygaster* spp.) damage. During the investigation, several other types of damage were observed on the wheat. The most important of these was the high incidence of spores and bunt balls of stinking smut in the wheat. Two of the samples were so heavily infected that the entire samples were chocolate-brown in colour, and carried the characteristic "fishy" odour of betaine. Table 1 summarizes the proportion of samples affected in each of the 4 districts.

Tilletia spores reduce flour quality by making the colour darker, and imparting a strong taint to the flour and baked products. The spores can be prevented from reaching the flour by efficient washing of the wheat grain, which is a routine part of the cleaning process at the flour mills. Since the disease is seed-borne, it can easily be controlled by treating the seed with a fungicide such as Vitavax 200 (carboxin). It is understood that the Syrian government is in the process of establishing a seed supply and health system, with the objectives of improving seed quality and in controlling seed-borne diseases.

Table 1. Incidence of stinking smut in commercial wheat samples from N. Syria.

Area	% Incidence of Tilletia	Degree of infection
Kamishli	83	light to medium
Raqqa	67	light to heavy
Afrin	25	light to very heavy
Aleppo	20	light

REMINDER

Readers who did not return the previous questionnaire, are kindly requested to fill in another questionnaire, enclosed in their journals, if they wish to be included in the **RACHIS Directory of Cereal Research** and to continue to receive RACHIS issues regularly.

SHORT COMMUNICATIONS

Studies on the Role of Mass Reservoirs in Genetic Conservation

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The objectives of this research project were to determine the usefulness of heterogeneous populations (e.g. composite crosses, varietal mixtures and landraces) of predominantly self-pollinated species in genetic conservation. Several California workers emphasized the dynamic properties of genetically heterogeneous populations in maintaining genetic variability in a self-renewing fashion and in the development of co-adapted gene complexes. Others have argued that the loss of genetic integrity of accessions and rapid loss of genetic variability by severe intergenotype competition are serious limitations of mass reservoirs in genetic conservation.

Cultivated barley was used as a model in our studies. A comparative assessment of genetic variability for several morphological, agronomic and allozyme characters was made in an early (F_5), intermediate (F_{12}), and late (F_{20}) generations of a composite cross of barley, CCXXI. This cross was developed 24 years ago at Davis, California, by intercrossing 6200 spring barley accessions of the USDA World Collection of barley by means of genetically male sterile stocks. Subsequent generations of this cross were propagated in bulk at Davis, California, Beaverlodge and Saskatoon, Canada. Studies on these populations revealed that, except for days to heading and maturity, the F_{20} generations of each of the three sub-populations (Davis, Beaverlodge and Saskatoon) of CCXXI remained as variable as their respective F_5 generations. The Davis sub-population was considerably more variable than the 2 sub-populations propagated in the temperate northern locations, suggesting that the Mediterranean environment of Davis was more conducive to the maintenance of high levels of genetic diversity in cultivated barley. Thus, these studies provided direct evidence in support of the view that, for several qualitative and quantitative characters, highly heterogeneous populations of barley are capable of maintaining substantial genetic variability despite 15 generations of intergenotype competition under 3 different propagation conditions. On the basis of these results, it can be concluded that composite cross bulk populations of barley are potentially valuable reservoirs of genetic variability.

Experiments are in progress to determine the rate and extent of loss, if any, of genetic variability in the 3 sub-populations relative to the original accessions used in their development.

Dr. M.S. Mekni, Barley Breeder at ICARDA, has been collaborating in morphological and agronomic evaluation of the sub-populations at ICARDA's Experimental Farm, at Tel Hadya, Syria.

Correlation of Quality Characteristics of Local and Improved Wheat Varieties Cultivated in Baluchistan (PAKISTAN)

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The following 8 cultivars viz. Local White, Local Sarkhosha, 398 Improved, 299 Improved, Chenab 70, Khushal, Yecora and Nuri of breadwheat *(Triticum aestivum)* were grown at the Agriculture Research Institute, Sariab, Baluchistan, during the season of 1977-78, in order to study the range of variability with respect to quality.

Flour yield, hardness index, specific sedimentation value, index of gluten quality 1000-kernel weight and test weight, were determined. The studies revealed positive correlations of protein content with sedimentation value, Pelshenke value, specific sedimentation value and index of gluten quality. Flour yield showed a significant negative correlation with protein and Pelshenke value. These studies have thus yielded useful information that can be incorporated in the formulation of an effective breeding program for improvement of yield and quality characteristics of breadwheat in Baluchistan.

Major Wheat and Barley Insect Pests in Syria

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Surveys have been carried out during the last 5 years to identify the major insect pests which cause economic damage to wheat and barley crops in Syria. The results indicate that the following are the most important field insect pests:

The insects are listed in strict taxonomic sequence:

Ear thrips *Haplothrips tritici* Kurd. (Thysanoptera: Phlaeothripidae)

Suni bug *Eurygaster integriceps* Put. (Hemiptera: Pentatomidae)

Pointed wheat shield bug *Aelia* sp. (Hemiptera: Pentatomidae)

The corn leaf aphid *Rhopalosiphum maidis* Fitsh (Homoptera: Aphididae).

The ground pearls *Margarodes* (= *Porphyrophora*) *tritici* Bed. (Homoptera: Margarodidae)

Wheat ground beetle *Zabrus tenebrioides* Geoze. (Coleoptera: Carabidae)

Lined click beetle *Agriotes lineatus* L. (Coleoptera: Elateridae)

Winter wheat scarab *Phyllopertha nazarena* Mars. (Coleoptera: Scarabaeidae)

Wheat leaf beetle *Oulema* (=*Lema*) *melanopus* L. (Coleoptera: Chrysomelidae)

The cereal leaf miner *Syringopais temperatella* Led. (Lepidoptera: Scaythrididae)

The Hessian fly *Mayetiola* (=*Phytophaga*) *destructor* Say. (Diptera: Cecidomyiidae)

The frit fly *Oscinella frit* L. (Diptera: Chloropidae)

Wheat Stem Sawfly *Cephus pygmaeus* L. (Hymenoptera: Cephidae)

Effect of Durum and Breadwheat Stem Solidness on the Percentage of Infestation by Wheat Stem Sawfly (*Cephus* spp.)

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Studies were carried out at Tel Hadya, Aleppo, Syria, mainly to determine mechanisms of resistance in durum and breadwheat lines to Wheat Stem Sawfly infestation.

Durum and breadwheat (195 lines of each) were planted in 3 replications (1m-long rows) under artificial infestation, where the number of adults, released at the ear stage, was adjusted to produce about 1 egg/stem.

At harvest, 4 stems from each replication were taken at random and cut at half of the peduncle, then examined in the laboratory to determine percentages of the stem solidness at the level of the peduncle where most oviposition occurs. To determine levels of infestation, 60 stems were taken at random from each replication and examined in the laboratory.

The results showed that, in general, infestation of durum decreased from 21.2 to 6.4% as stem solidness increased from 39.5 to 100% , and infestation of breadwheat decreased from 16.2 to 11.5% as stem solidness increased from 27.6 to 98.0%; regression analyses confirmed that the relationship was significant.

In general, durum lines seemed to be more resistant than breadwheat lines and additional studies have confirmed this.

The observations also showed that hollow-stemmed or less solid-stemmed lines are more suitable for oviposition by and larval development of Wheat Stem Sawfly.

Virulences in *Puccinia graminis* f. sp. *tritici* in Pakistan During 1982

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The knowledge of the genetics of the rust pathogen cannot be ignored for selecting rust resistant cultivars. To study the virulence factors, field cultures of *Puccinia graminis* f. sp. *tritici* were evaluated on 26 backcross lines carrying single genes for low rust reaction. Thirty-seven percent of the isolates used were virulent on a combination of 7 host genes. Host genes *Sr26, Sr27* and *SrGt* were resistant to all isolates while only 1 isolate was virulent on *Sr24.* Wheat lines with genes *Sr5, Sr9e, Sr10, Sr11, Sr22, Sr24, Sr26, Sr27, Sr29, SrTt2* and *SrGt* were resistant to a great number of isolates, thus providing the best protection against stem rust in Pakistan.

Preliminary Survey of Wheat Stem Sawfly (*Cephus* spp.) Incidence in Syria

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A survey was conducted during the summer of 1978, to determine the geographical distribution of the European Wheat Stem Sawfly in Syria, and also to determine levels of infestation in farmers' fields. Nearly 250 fields planted with rainfed wheat were visited, and from each field, 9 samples (0.25 m^2) were taken at random. The stubble found in each of the sampling units was collected and examined for Wheat Stem Sawfly infestation.

The results indicated that the Wheat Stem Sawfly is widely distributed in Syria, and is particularly important in the Aleppo, Idlib and Hama provinces where the percentages of infestation ranged 0–26.8, 0–55.5 and 0–30.8 respectively.

New Cereal Improvement Effort in Greece

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KYDEP, a consortium of agricultural co-operatives in Greece, is gradually entering the field of small cereal breeding with emphasis on wheat, barley and triticale. This effort, evolved from the cultivar evaluation stage previously carried out, exemplifies the desire of the Greek cooperative movement to produce the quality seeds the members need.

The work is done at two sites: Plati, near Thessaloniki, on rich alluvial soil, and Velestino which has poorer soil. Prof. P.J. Kaltsikes, in cooperation with two agronomists and some support staff, is directing the efforts, and the initial material comes, at present, from the F_2 nurseries of CIMMYT and ICARDA. However, it is hoped that new crosses will be initiated next fall.

Breeding for Resistance in Barley against Cereal-cyst Nematode (*Heterodera avenae*)

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Cereal-cyst nematode is a serious pest in light soils of Rajasthan, Punjab and Haryana states of India where damages up to 87 and 83% have been recorded in barley and wheat respectively. Screening of barley germplasm revealed resistance in 6-rowed, Morocco, Marocaine and PI 253826 as exotic sources and in C-164, DL-69 and PL-101 as indigenous sources. A breeding program was initiated in 1970 with exotic sources and 3 commercial varieties viz. RDB 1, RS 6 and D 359. Combination of Marocaine with RDB 1 resulted in a new variety "Rajkiran" which is resistant to the 5 biotypes of *H. avenae* found in India. "Rajkiran" has a high yield potential in infested fields and with its cultivation, population of the nematode decreases by 50% in one year. Therefore, it has been released for commercial cultivation in infested areas.

ARTICLE AND BOOK REVIEWS

National Council on Gene Resources (NCGR), California Gene Resources Program (CGRP) 1983. **Barley genetic resources-an assessment and plan for California.** CGRP, 190 pp. CGRP, 2855 Telegraph Ave., Suite 216, Berkeley, California 94705, USA.

The CGRP was founded in 1980 because of serious concern in California about reported losses of the genetic resources of animals, plants and micro-organisms vital to the state's economy. A comprehensive assessment was made of the broad range of activities and organizations involved in barley genetic resource management, conservation and use. Based on this assessment, an implementation plan was developed. This is the first comprehensive assessment and plan developed for the genetic resources of a seed propagated crop. Barley uses, importance and institutional setting; the identification and meeting of production challenges; management of barley genetic resources; economic evaluation and institutional options for barley genetic resource management; recommendations; and a plan for implementation are the subjects covered.

Mathre, D.E. (Editor), 1982. **Compendium of barley diseases.** St. Paul, Minnesota 55121; American Phytopathological Society, 80 pp. ISBN: 0-89054-047-0

The Compendium, eighth in a series of disease compendia published by the American Phytopathological Society, is a thorough and authoritative treatment of barley diseases. It is international in scope and has been written to aid all those who deal with barley production problems—including the growers themselves, county extension agents, malting and brewing company field personnel, and hail insurance adjusters as well as agronomists and plant pathologists. The description of each disease includes a brief overview of the prevalence of the disease, the areas where it is found, and the damage it can cause. Symptoms are described in detail, with many color and black-and-white illustrations, and helpful hints in diagnosis are provided to aid in distinguishing diseases with similar symptoms. To help readers understand the suggested control measures, the disease cycle and epidemiologic aspects of each disease are covered. Control measures are discussed for diseases where they have been developed. When pesticides are part of the control program, specific chemicals are not given, because the laws governing their use vary in different countries. Local extension agents or crop protection specialists can provide specific information of this type. Selected references are listed for each disease to enable readers to find more detailed information if needed. A guide to the identification of diseases in the field, glossary of terms, and selective index are included to increase the usefulness of the Compendium.

Barley Genetics IV. Proceedings of the Fourth International Barley Genetics Symposium, Edinburgh, 1981. Nov. 1982, 1008pp. £25 (plus pp. + £7.50 air mail) ISBN 0-9508016-0-7.

This volume constitutes the published proceedings of the Fourth International Barley Genetics Symposium held in Edinburgh, Scotland in July, 1981. The contents include over 130 scientific papers presented in the Symposium covering aspects of the genetics and breeding of barley in all countries of the world.

The proceedings, following the format of the Symposium, are divided into twelve main Sessions, each dealing with a different area of study. Each Session is introduced by a review-type paper that outlines progress over the previous six years and summarizes the current state of knowledge in that area. Other papers describe recent research findings, discuss novel breeding strategies and assess priorities in a wide range of disciplines.

This book should prove of value to all those with an interest in barley, whether as a tool for fundamental scientific research or as an agricultural crop in continual need of improvement.

Baum, B.R.; Thompson, B.K.; Bailey, L. G.; Brown, M. 1981, 300 pp. **Barley register (a first report).** Biosystematics Res. Inst., Res. Branch, Agriculture Canada, Ottawa, Ontario, K1A O6C.

Section 1, the index, is a list of names and synonyms with citations. Section 2 lists pedigrees and contains pedigree charts. Section 3 consists of tables of coefficients of parentage and inbreeding. Section 4 lists references. The report presents information on barley cultivars compiled over several years using computer files; the aim is to produce a comprehensive registry of barley cultivars on a world-wide scale. It is hoped that the registry will become indispensable to national registration authorities and will be used by an international authority for barley cultivars, which it is hoped to establish in the near future.

Field Manual of Common Barley Diseases. Montana Agric. Experimental Station, Bull. No. 734, 1981. 56 pp. Montana St. Univ., Dep. Pl. Path., Bozeman, Montana 59717, USA.

The purpose of this manual is to assist agricultural workers in identifying the common diseases of barley. No specific chemical controls are given, since these may differ from one country to another. Local plant pathologists should be contacted for disease identification and specific control measures. Also included is a section on breeding for disease resistance; back cross, and pedigree breeding methods, and their application are outlined. Germplasm Resource Development and exploitation (varietal development) are also considered.

Dickson, A.D., Harlan, J.R., Klingman, D.L., and others. 1979. **Barley: Origin, Botany, Culture, Winter Hardiness, Genetics, Utilization, Pests.** U.S. Department of Agriculture, Agriculture Handbook No. 338, 154 pp., illus.

This handbook gives a broad overview of barley—its origin, botany, culture, winter hardiness, genetics, utilization, and pests. It describes barley's historical introduction into the United States by the early settlers and the westward trend of production. Theories are given on barley's evolutionary origin derived from historical and prehistorical archeological evidence. Common cultural practices are discussed as well as weed and insect pests that frequently curtail production. The two general classes of leaf disorders, leaf spots and leaf blotches, are identified. The principal barley diseases caused by bacteria, fungi, and viruses and recommended methods for control are discussed. The taxonomical features of barley and some of the more complete and recent taxonomic references are discussed. The seven parts of the cultivated barley plant—roots, stem, leaves, spike (head), spikelet, floret, and kernel—are defined. The manner in which the plant grows—its rate of growth, ability to withstand extremes of temperature and drought, and its response to light—are reported on. The U.S. Department of Agriculture's world collection of cultivated barleys, especially valuable as a potential gene source for disease and insect resistance and for genetic, physiologic, and agronomic characters, is discussed. The wild relatives of barley are described. Information is given on attempts to develop interspecific and intergenetic hybrids and the difficulties involved.

This handbook describes man's role in improving barley by the use of genetics, cytology, physiology, and breeding methods. The industrial uses of barley for malting are discussed, together with the techniques and procedures developed to evaluate varieties for these uses and the food uses of unmalted barley. The complex property of winter hardiness that enables barley plants to survive damage from frost is explained.

Kihara, H. 1982. **Wheat Studies** (Developments in Crop Science, 3) Elsevier xviii + 308 pp. ISBN 0-444-99695-8 US $ 68 (in USA & Canada) Dfl. 160 (Rest of World). Distributed in Japan by Kodansha Ltd.

This authoritative book has been written by a man whose career as an active wheat geneticist has spanned 60 years and has earned him a world-wide reputation as 'the wheat man'. The book contains descriptions and much original data on genetical and cytogenetical findings concerning cultivated wheats and their relatives. It covers chromosomal analyses, genome analyses, ancestors of wheat, artificial synthesis of wheat, evidence of cytoplasmic inheritance and variations of wild species. The author explains how these facts and concepts have been discovered, points out the importance inherent in these discoveries, and shows how they can be utilized in genetical and breeding studies. Special emphasis is placed on the motives, processes and development of the studies.

The book also contains photographic reviews of the author's contributions to scientific studies on higher plants and an appendix of 6 original papers, from which readers may see how a study relates to other fields.

Contents: Introduction. 1. The Birthplace of Genetical Research on Wheat - from Sapporo to Kyoto. 2. The Continuation of Research on Pentaploid Hybrids. 3. Further Studies on Pentaploid Wheat Hybrids. 4. Genome Analysis I. 5. Genome Analysis II. 6. Karyotype Analysis I. 7. Karyotype Analysis II. 8. Research on Cytoplasm I. 9. Research on Cytoplasm II (Nucleo-Cytoplasmic Hybrid). 10. Contributions and the Mode of their Acceptance. Conclusion. Reference. Appendices. Author Index. Subject Index.

Hanson, H.; Borlaug, N.E.; Anderson, R.G. 1982. **Wheat in the third world.** Westview Press, Boulder, Colorado, USA, 174 pp. ISBN: 0-86531-357-1. Many developing countries have adopted new wheat production techniques to expand food supplies, but opportunities for raising output further and improving farmers' livelihoods remain great. In this book, three internationally recognized experts associated with the International Center for Maize and Wheat Improvement (CIMMYT) address decision makers in developing countries and international agencies, providing essential information about the prospects for increasing wheat productivity.

The authors examine the characteristics of the wheat plant as a crop and as a food, explore recent scientific findings related to producing and handling the crop, and suggest important areas for future research. They also look at specific wheat production problems and potentials in eight countries and propose means of organizing and operating an effective national wheat program. The book closes with a forecast of the outlook for food, wheat, and population to the end of the century.

Siniscalco, A.; Casulli, F.; Cariddi, C. *et. al.* 1981. **Field observations on the behaviour of [797] wheats towards rusts, powdery mildew and septoriosis, carried out in 1979-80 and 1980-81.** Istitut Pat. Veg. Univ. Bari e Ist. Sper. Pat. Veg., Roma, 105 pp. (It, en).

Basheer, A.M. **Wheat economics in Egypt.** EMCIP Publ. No. 40, 63 pp.

ICARDA CEREAL IMPROVEMENT PROGRAM. 1983.

Better harvest in dry areas. ICARDA's Cereal Research Program. Brochure, 24 pp. This booklet with excellent colour photographs describes how ICARDA is helping the cereal improvement programs of the region to find solutions to the high priority problems of food production in dry areas.

INTERUNION COMMISSION ON THE APPLICATION OF SCIENCE TO AGRICULTURE, FORESTRY AND AQUACULTURE (CASAFA) was created in 1978 by the International Council of Scientific Unions. Dr. J.H. Hulse is the present chairman. Some of the subjects being considered for study include:

- The influence of plant hormonal balance on the tolerance to drought of cereal grains in the arid and semi-arid tropics.
- Biochemical and physiological characters that influence early seedling vigour in certain food legumes.
- The biochemical nature and mode of action of toxic and anti-nutrient substances in fodder crops.

More information from: Scientific Secretary, CASAFA, P.O. Box 8500, Ottawa, Canada, K1G 3H9.

NEWS OF CEREAL AND OTHER SCIENTISTS

Farewell to:

Walter Nelson, breadwheat breeder in ICARDA's Cereal Improvement Program who is leaving in August 1983 to work with CIMMYT, until November when he will retire. Nelson obtained his M.Sc. degree with the thesis "Selection in F_1 and F_2 yield trials for evaluation of barley population" from Montana State University. He spent 18 years with the Washington State University Experimental Station as a plant breeder for winter wheat and as agronomist for dryland wheat production.

In 1968, he went to Tunisia to work with CIMMYT as an agronomist until 1970 when he moved to Algeria, CIMMYT, as a production agronomist for 6 years then spent 3 years as a breadwheat breeder in Mexico, CIMMYT. In 1980, Nelson came to ICARDA to work in the joint ICARDA/CIMMYT project on developing breadwheat adapted to the rainfed areas of ICARDA, and also on breeding breadwheat for drought tolerance and resistance to diseases, to wheat stem sawfly and also to the Suni bug.

Since 1980, Nelson has proved enthusiastic in his job and his drive for the project has been invaluable. We wish him well, and hope that he will continue to find RACHIS of interest.

And to:

Walter Anderson, agronomist in ICARDA's Cereal Improvement Program, who is returning to Australia in August. He joined ICARDA in 1979 and has carried out research on production practices for grazed barley and on varietal characterization especially with regard to nitrogen response, and also on responses to improved technological inputs in cereal production in general. Anderson graduated in 1968 from Sydney University where he specialized in crop physiology and obtained his M.Sc. His Ph. D. was obtained in 1977 from the University of New England on factors influencing the adaptation of sunflowers. He conducted research on dryland irrigated pasture systems in several parts of Australia with various university and governmental agencies and contributed to various co-operative projects mostly in Jordan and Pakistan. Walter will be returning to Perth, Western Australia to take up research on the nitrogen requirements of wheat. He has contributed a lot to the Cereal Agronomy Program of ICARDA and his efforts are much appreciated. We wish him well in his new job and look forward to receiving his contributions and suggestions for the future issues of RACHIS.

Dr. Habib Ketata from Tunisia who had formerly been a wheat breeder at INRAT and INAT in Tunisia and recently an associate professor and head of laboratory at INAT, has now joined the Cereal Improvement Program of ICARDA as the Cereal Training Officer.

Dr. Ketata obtained both his M.Sc. and Ph. D. from Oklahoma State University in plant breeding and agronomy.

Dr. Mark Winslow from California, has recently joined the Cereal Improvement Program of ICARDA as a physiologist, and his work involves the use of physiological techniques in addressing the problems of stress tolerance (mainly drought) especially in barley. Mark completed his Ph.D. at Michigan State University where he conducted research on nitrogen utilization in wheat cultivars.

Dr. Jitendra Srivastava resumes leadership of the Cereal Improvement Program in August 1983 after a year's sabbatical at Oregon State University, Corvallis. In the USA, he wrote a 4500-word review entitled "Durum-wheat--its world status and potential in the Middle East and North Africa", ICARDA, 1983. The review will be published as a special supplement in RACHIS 3. He also produced and published a 24-page brochure with colour photographs entitled "Better harvests in dry areas—ICARDA's Cereal Research Program", ICARDA, 1983.

Dr. Chapman, IBPGR wheat officer, visited ICARDA from 16 to 19 February, 1983, to discuss germplasm work and related activities with staff members of the Cereal Improvement Program.

Mr. Ahmed Amri, coordinator of the Barley Program in Morocco, visited the ICARDA Cereal Program from March 6 to 17, 1983 and spent part of his time selecting widely adapted disease resistant barley material.

Dr. Farouk Rakha, being a cereal geneticist and a professor at Alexandria University of Egypt, visited the Cereal Improvement Program last April mainly to acquaint himself with the different aspects of the cereal research work done at ICARDA.

Drs. David Sands and Rick Ruff from Montana State University visited the ICARDA Barley Project last April to evaluate the Male Sterile Facilitated Recurrent Selection Populations of barley.

Prof. George A. Stewart, Botany Department, Birbeck College, University of London, visited ICARDA last May to discuss cereal stress research and nitrogen metabolism and also the problems facing agriculture in the ICARDA Region. Prof. Stewart has made a written proposal to the Overseas Development Administration (ODA), UK.

Dr. W.M. Tahir from the Cereal Improvement Office, FAO, Plant Production and Protection Division, Rome, visited the Cereal Improvement Program in May, 1983, and held discussions with the staff members on possible research on salt and water stress and nitrogen efficiency.

Other News

Mr. Eric Sicely from IFAD visited ICARDA last January, accompanied by Charles Meek, to discuss the IFAD-Funded Projects, the faba beans and cereals research projects and the progress and plans for buildings.

Mr. William Gormley, visited ICARDA in January, 1983, to make a critical appraisal of the whole research program, and summarised his findings in a written report.

Dr. Ivan Head, President of IDRC, visited ICARDA in February, 1983, accompanied by Drs. Fawzi Kishk, Regional Representative, IDRC and Dr. Gordon Potts, Agricultural Economist, IDRC Regional Office. While in ICARDA, Dr. Head signed a very significant IDRC/ICARDA document; a contract with Farming Systems Research entitled "Research on Farming Systems in Tunisia".

Dr. Lowell S. Hardin, member of the Board of the International Food Policy Research Institute (IFPRI), visited ICARDA in February, 1983, in conjunction with the IFPRI Board meeting attended by 24 members of the Board including Dr. Mohamad El Khash, Director General of the Arab Center for Studies of Arid Zones and Dry Lands (ACSAD). He was accompanied by Mr. Walid Al Malik, his Director of Foreign Relations.

A group from the General Administration for the Development of the Euphrates Basin (GADEB) headed by Dr. Abdo Quassim, Director General, visited ICARDA in March 1983 to discuss different aspects of the Center's research and possible ways of collaboration between the project and ICARDA.

A group of Sudanese scientists from the Nile Valley, visited ICARDA in April, 1983, to acquaint themselves with the different research work and activities of the Center.

Other visitors to the Cereal Program and ICARDA during the first half of 1983 included: Profs. H. Marschner, Schlichting and Doppler from University of Hohenheim, West Germany; Mr. Richard Young from Boyce Thompson Institute, accompanied by Mr. Richard Staples; Mr. Najem Ben Mohamed from the Ministry of Agriculture and Agrarian Reform, Morocco; Dr. Nuri M. Rahuma, Assistant Director General from the Arab Center for Studies of Arid Zones and Dry Lands, Damascus, Syria; Dr. Robert J. Metzger, senior scientist from USDA, Corvallis, Oregon, USA; Prof. Gunther Franke from the Institute of Tropical Agriculture, Karl-Marx University of Leipzig, GDR.; Dr. Heinrich Notzel, advisor from the Ministry of Agriculture, Amman, Jordan; Dr. M. El Falleh from Tunisia and Prof. A.H. Bunting from Reading University, UK, accompanied by Dr. Curtis Farrar from the CGIAR.

TRAINING, CONFERENCES AND MEETINGS

Training at ICARDA

The annual 7-month Cereals Training Course took place at Tel Hadya Research Station from January to July 1983. The course curriculum covered breeding, pathology, agronomy, physiology, weed control, entomology, grain quality, seed production, research techniques, and basic concepts of genetics. The students who attended were:

AFGHANISTAN	Karimullah M.K. SHEWA, Darul Aman Res. Station, Ministry of Agriculture.
DJIBOUTI	Youssouf D. ROBLE, Service de l'Agriculture et des Forets, B.P. 224 - Djibouti.
EGYPT	Mahroos A.G. ABOSHERIEF, Shandaweel Res. /Ex. Station, Sohag.
	Abd El-Khalek A. KHATTAB, Sids Ext. Cen., Beni Swyef
	Mamdouh S. MORSI, Kafr El Sheikh, Sakha Agric. Research Station.
LIBYA	Abdulsalam S. DAHESH, Cereal Project, Azizieh.
	Muftah H. MAGIG, Sarir Prod. Project, Res. Dept.
PAKISTAN	Mohammed Y. MUJAHID, Nat. Agriculture Res. Cen., Pakistan Agric. Res. Council, P.O.B. 1031, Islamabad.
SOMALIA	Halima E. AWALEH, Inst. of Agric. Res., Central Agric. Res. Station.
SUDAN	Osman M. AHMED, Plant Breeding Section, Agric. Res. Centre of Sudan.

SYRIA	M. Faez M.T. MOZAIK, Res. Centre, Directorate of Agric., Aleppo.
	Abdul Baset S. Al. SABBAGH, Muzaffar WATTAR, Seed Multiplication Organization, Al-Midan , Aleppo.
	Tou'ma S. BADIN, Izraa Res. Station, Damascus.
TUNISIA	Rhouma M. SAYAR, El-Kef Research Station, Tunis.
N. YEMEN	Mansour M. NASSER, Res. Station, P.O.B. 5788, Taiz.
S. YEMEN	Mozaher G. ALI, National Seed Production Project, Ministry of Agric., Aden.
	Ghazi R. Al-KUTHEIRI, Res. Centre Seiyun, P.O.B. 9041.

Some of the cereal trainees inside the ICARDA library

Standing from left to right:
M.M. Nasser (N. Yemen), A.B. Al Sabbagh and T.S. Badin (Syria), M.A. Abo Sherief and A.E. Khattab (Egypt), R.M. Sayar (Tunisia) and M. Wattar (Syria).

Sitting from left to right:
O.M. Ahmed (Sudan), M.G. Ali (S. Yemen), Dr. H. Ketata (Cereal Training Officer, Syria), H.E. Awaleh (Somalia) and G.R. Al-Kutheiri (S. Yemen).

Publications

ICARDA Cereal Training Course Feb-July 1984 6pp.
Curriculum as described above.

ICARDA Food Legume Training Course Feb-July 1984, 7pp.

ICARDA Pasture and Forage Training Course Feb-July 1984, 7pp.

Training opportunities at ICARDA 1984, 16pp.

The brochure defines training for Research Training Scholars, Research Training Fellows, Research Training Associates, Senior Research Fellows, and describes group, long and short courses, as well as the research and support facilities, accommodation and recreation.

Training outside ICARDA

January 9-August 18, 1984
3rd International Course for Development Oriented Research in Agriculture, Wageningen, The Netherlands.

The International Course for development oriented Research in Agriculture (ICRA) gives instruction in the analysis of farming systems and the identification of physical, biological, economic and social constraints limiting their productivity. The overall objective is to arrive at research which is appropriate to the circumstances of farmers.

The course combines theoretical training in Wageningen with a three month's field study in a developing country in which small interdisciplinary teams make a comprehensive study of a farming system.

The course is of 8 month's duration and is divided into three blocks. At its core is the central block of three month's field work. Field studies will be carried out by interdisciplinary groups of 4 - 5 participants in each of a number of developing countries under the guidance of an experienced tutor.

Application should be made to the Director of Studies, ICRA, P.O. Box 88, 6700 AB Wageningen, The Netherlands, **The Board of the course will consider only applications which have been received before 15 August, 1983,** and will inform applicants about its decision around 15 October, 1983. The number of participants will be limited to 25. Admission to the course is competitive.

RECENT CONFERENCES AND MEETINGS

Q.Q.R.

Nine members of the global agricultural scientific community, together with representatives of the TAC and CGIAR secretariats, spent most of April and part of May reviewing ICARDA's technical and management systems.

The Quinquennial Review Panel was appointed by TAC to conduct ICARDA's first comprehensive external review, according to Dr. G.B. Baird, Chairman.

A considerable range of expertise was represented in the panel which concluded meetings with individual ICARDA staff. The panel had a collective look at the Center's mandate, specific programs, and its services.

A full draft of the panel's report has been presented to the center here for further comment. It has also been reviewed by the ICARDA's Board of Trustees when they met in May, and will be reported to TAC in Tunis this summer by the Q.Q.R. chairman. The report, incorporating both the Center's and TAC's comments, is to be presented to the CGIAR next fall.

Members for the review were: Dr. G.B. Baird, chairman, program officer, International Agricultural Development Service, USA; Prof. J.R. Anderson, dean, Faculty of Economic Studies, University of New England, New South Wales, Australia; Dr. C. Charreau, Institut pour la Recherche Agronomique Tropicale, France; Dr. Ahmed Goueli, head, Department of Agricultural Economics, Zagazig University, Egypt; Dr. Norman Halse, chief, Plant Research Division, Western Australian Department of Agriculture; Prof. J.M. Hirst, director, Long Ashton Research Station, Bristol, U.K.; Dr. G. Jenkins, Agricultural Research Council, London; Dr. H.H. Messerschmidt, former director of Animal Production, Federal Republic of Germany; Prof. L. Monti, Istituto di Agronomia, Facolta di Agraria, Universita di Napoli, Italy; L.H.J. Ochtman, senior agricultural research officer, TAC, FAO, Rome, and Dr. D. Plucknett, scientific advisor, CGIAR Secretariat.

REMINDER TO CONTRIBUTORS

We wish to remind our contributors that the next issue of RACHIS Newsletter is due in November 1983, hence, **the deadline for submission of articles for that issue will be September 30th.**

To help speed the production of the newsletter, could contributors then please ensure they send their papers earlier. Thank you.

May 16-19, 1983

European Cooperative Program for the Conservation and Exchange of Crop Genetic Resources (ECP/GR), Barley Working Group, Corrensstrasse 3, 4325 Gatersleben, DDR. The meeting was called to coordinate and rationalize the hitherto independent work on barley germplasm collection, evaluation, documentation and conservation in European countries. Thirty-one countries were invited to participate in the meeting including Turkey and Cyprus. Significant numbers of accessions of wild and primitive cultivated barleys which originate from the Near East and North Africa region are present in European collections. The function of the working group was to produce a plan of work for curators and associated staff to operate during the second phase of the project from January 1983 to December 1985.

May 26, 1983

The Syrian Society of Plant Protection in cooperation with the Faculty of Agriculture, University of Aleppo, held a seminar entitled: "Plant Protection Research in Syria: Past, Present and Future".

Details from: Dr. Bassam Baia'a, Faculty of Agriculture, University of Aleppo, Syria.

Forthcoming Conferences

Aug. 10-11, 1983

International Workshop on Biology and Control of Smut Fungi, Horsham, Victoria.

Contact: D.J. Ballinger, Victorian Crops Research Institute, Private Bag 260, Horsham, Victoria 3400, Australia.

Aug. 17-24, 1983

4th International Congress of Plant Pathology, Melbourne, Australia.

Contact: 4th Int. Congress Pl. Path., P.O. Box 1929, Canberra City, A.C.T. 2601, Australia.

Nov. 20-25, 1983.

Tenth International Congress of Plant Protection. Brighton, U.K.

Contact: Frank Bishop (Conference Planners) Ltd., 144/150 London Road, Croydon, U.K., CRO 2TD.

Nov. 28- Dec. 3, 1983.

Sixth International Wheat Genetics Symposium, Kyoto, Japan.

Contact: Dr. S. Sakamoto, Sixth Inter. Wheat Genetics Symposium, Plant Germ-plasm Inst., Fac. of Agric., Kyoto Univ., Mozume, Muko, Kyoto 617, Japan.

Sept. 4-7, 1984

The Sixth European and Mediterranean Cereal Rusts Conference, organised by the European and Mediterranean Cereal Rusts Foundation, will take place from 4 to 7 September 1984 at Grignon (30 km west of Paris), France.

Contact: Dr. P. Auriau, Laboratoire du Ble, Station d'Amelioration des Plantes, C.R.A., Route de Saite-Cyr, 7800 Versailles, France.

The Foundation also publishes the **Cereals Rust Bulletin,** and seeks publishable material, information and news relating to cereal rusts.

Contact: Dr. N.H. Chamberlain, Nickerson RPB, Joseph Nickerson Research Center, Rothwell, Lincoln LN7 6DT, England.

October 1-6, 1984

Sixth Congress of the Mediterranean Phytopathological Union, Cairo ,Egypt, organized by the Egyptian Phytopathological Society and the Egyptian Academy of Scientific Research and Technology under the auspices of the Egyptian Ministry of Agriculture. The refereed papers will be published before the congress in the form of extended summaries not exceeding 1000 words i.e. 2-3 pages including tables and illustrations. Presentation in English is recommended. The registration fees are US$ 80 for active members and US$ 40 for accompanying members.

Contact Prof. Dr. Moustafa Fahim, P.O. Box 198, Orman, Giza, Egypt.

Oct. 6-11, 1986

Fifth Barley Genetics Symposium, Japan.

Contact: Arne Hagberg, The Swedish Univ. of Agric. Sci., Dept. of Crop Genetics and Breeding, S-268 00 Svalov, Sweden.

RACHIS CONTRIBUTORS' GUIDE

All contributors are requested to use the following guidelines in order to speed editing and to improve communications.

Guidelines
Please include brief details on the soil type and climatic characteristics where these are important to the research. Please indicate the year(s) and place(s) of the research. The article should normally be confined to a single subject and should be of primary interest to cereal workers in research, extension and production and to administrators and policy makers. The aim of RACHIS is to provide a means for the fast publishing of re**cent** research.

Language
The Newsletter will be published in English. ICARDA will endeavour to translate articles which are submitted in Arabic, French or Russian.

Editing
All articles will be edited in order to preserve uniform style. If any contributions must be shortened, the scientific content and meaning will not be changed. If substantial editing is required, ICARDA will send the author a draft for his approval before printing.

Manuscript
Articles are to be typed and double spaced. The original and one legible copy should be submitted. The contributor should include his name, title, program or department, institute and postal address.

The article should normally be confined to a single subject and should be of primary interest to cereal workers in research, extension, production and to administrators and policy makers.

Articles for the **'RESEARCH AND PRODUCTION'** section should be approximately 1000 words in length. A maximum of two well prepared tables/figures/diagrams/ or glossy black and white photos will be reproduced. The photos, figures etc... should be either 9.3 cm wide for a single column or 19.3 cm wide for a double column. Figures and diagrams should be drawn in India ink; if possible send original artwork.

Articles for the **'SHORT COMMUNICATIONS'** section should be up to 500 words in length.

All measurement units are to be in the metric system. Avoid national units e.g. quintals. Report yields as kg/ha. State measurements, time, money and percentages in numbers e.g. 480 g/1, 6 hr, U.S.$ 75, 10%. With chemicals, place the name next to the unit of measure e.g. 50 kg P/ha and not 50 kg/ha P. Convert all national currencies into U.S.$.

All numbers should be written as figures (e.g. 6, 34) not words except at the beginning of a sentence.

Arrange the Reference List alphabetically (not numerically). Give the surname first e.g. SMITH, A.B. 1980...Abbreviate journal titles. Reference information must agree with that in the text. Citations in the text should use "It was found (Jones, 1960) that...' and not "It was found (2) that..." - i.e. do not record references numerically in the text and the list. Provide only directly relevant references.

The editors reserve the right to shorten the text and to alter it should it not conform to the above rules.

The Barley, Wheat and Triticale News Service (RACHIS) is provided by the International Center for Agricultural Research in the Dry Areas (ICARDA), Syria. This Newsletter appears in ICARDA's Scientific Newsletter publication series. For details of other ICARDA publications, please write to:

Communications Dept.,
ICARDA, P.O. Box 5466,
Aleppo, SYRIA.