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EVALUATION AND SELECTION OF BARLEY LINES FOR THE BALOCHISTAN HIGHLANDS, PAKISTAN

by

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EVALUATION AND SELECTION OF BARLEY LINES FOR THE BALOCHISTAN HIGHLANDS, PAKISTAN

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Balochistan province has the largest area in Pakistan (34.7 million ha). Yet, it has a total cultivated area of only 1.47 million ha out of which 0.68 million ha (46%) are used for irrigated agriculture. The remaining 0.79 million ha (53%) are used for rain-fed agriculture (Nagy et al. 1987). Rain-fed agriculture includes both the "sailaba" and "khushkaba" farming systems. In the "sailaba" farming system farmers preserve moisture from monsoonal rains and then plant cereals (usually wheat) early in the winter on this preserved soil moisture. In the "khushkaba" farming system farmers plant crops after the first rain of the winter season.

Wheat and barley are the main winter cereal crops in Balochistan. Barley grain and straw are mainly used for animal feed. Due to overgrazing of the very large range areas of the province by the rapidly increasing numbers of ruminants (Asif Masood et al. 1988), a large deficit in

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animal feed exists in Balochistan. As a result barley grain and straw are both potentially very important sources of animal feed, especially in the winter season when most of the range vegetation is dormant and the scarcity of green feed is very acute. The majority of the farmers in Balochistan allow their sheep and goats to graze cereal crops in winter and, given good environmental conditions, also hope to get adequate seed and straw from the grazed crop following spring re-growth.

Rainfall and its distribution varies greatly across space and time in Balochistan and is a major factor limiting crop productivity. Other major environmental yield limiting factors are freezing temperatures in winter and high temperatures during the terminal grain filling period, which is usually also associated with drought conditions. In upland Balochistan most cereal growing areas receive less than 250mm rainfall seasonally. Therefore the likelihood of growing wheat successfully with this limited precipitation is small in "khushkaba" farming. Barley, however, might be a more suitable crop than wheat under the prevailing environmental conditions, on the grounds that, barley is more drought tolerant and requires less water to reach maturity than in comparison to wheat (Ceccarelli et al. 1987; and Khalid 1987).

Given the harsh environmental conditions in upland Balochistan, there does appear to be some chance to increase barley production by the introduction of new hardy varieties with improved yield and production stability characteristics. However, a combination of the prevailing socio-economic environment, farmers need for food security, marketing and pricing policies can greatly affect the cropping system in the area (Nagy et al. 1989) and may strongly influence the potential for an increase in barley hectarage.

Materials and Methods

During 1986/87, 142 different lines of barley selected for highland areas were received from the International Center for Agricultural Research in the Dry Areas (ICARDA). These were planted at three different sites: Quetta (altitude 1750m, latitude 30° 14'N, longitude 67° 2' E), Khuzdar (altitude 1250m, latitude 27° 46'N, longitude 66° 39'E) and Kan Mehtarzai (altitude 2250m, latitude 67° 45'N, longitude 31° 00'E). Screening and selection of these lines were made on the criteria of cold and drought tolerance, high yield potential and disease resistance. Only 14 lines were selected on the basis of their desirable characteristics and were promoted to yield trials. These were then planted with 50mm pre-sowing irrigation at Quetta and Kan Mehtarzai in 1987/88 and Quetta and Khuzdar in

1988/89. The design was a randomized complete block with three replications. Plots were 5m long with 6 rows spaced 25cm apart. Nitrogen and phosphate fertilizer were applied at a rate of 60 kg/ha each with the seed at the time of sowing. Seeds were hand drilled at the rate of 100 kg/ha. At maturity the four central rows of each plot were harvested to record the biological and grain yield.

Results and Discussion

Grain yield differences among the entries were significant ($p<0.05$) in 1987/88 and ($p<0.01$) in 1988/89 in Quetta, while at Khuzdar and Kan Mehtarzai the yield differences were not significant (Tables 1 and 2).

The 1987/88 cropping season was comparatively less favorable for crop growth and development. The average rainfall was less than 200 mm, and the rainfall was also very poorly distributed. In this dry year, barley landrace 39-58 and Arabi Abiad (Entries 10 and 13) gave the highest grain yield at Quetta and Kan Mehtarzai, respectively. The 1988/89 season had better rainfall distribution, particularly in Quetta. Rains were received during both the crop vegetative and reproductive growth stages. All the entries had an adequate environment to express genotypic and environmental interactions through their genetic heritability. In this better year barley landrace 39-58 gave a significantly higher grain yield in Quetta than the local barley. From the different site and season combinations it is evident that barley landrace 39-58 and Arabi Abiad have the genetic ability to perform moderately well with poor moisture conditions and can also respond well when environmental conditions are more favorable.

The biological yield differences among the tested entries was significant ($p<0.01$) only at Kan Mehtarzai in the 1987/88 season, while at other sites and years differences for biological yield were not significant (Tables 1 and 2).

Entry Kenya Research/Belle (Entry No.3) gave a significantly higher biological yield than the local check at Kan Mehtarzai in 1987/88. This entry is tall, has a longer maturity period as compared to other tested entries and requires vernalization to complete its life-cycle. The grain yield of this entry, however, was no different than that of the local barley. In Balochistan both the grain and straw yields of the crop are important selection criteria for desirable genotypes. In upland Balochistan farmers prefer to grow varieties with both good straw and grain production characteristics. The importance of straw yields is exemplified by the 30% of years in which it is too dry to expect grain formation.

Harvest index differences were significant ($p<0.05$) in Quetta in both years and were very low in the dry 1987/88 season due to severe drought stress at the grain formation stage. This season of drought resulted in few and very shrivelled grains in some of the entries tested, particularly in Quetta. The differences in the thousand kernel weight were also significant ($p<0.01$) at each site and season (Tables 1 and 2).

Entries of the barley landrace 39-58 and Arabi Abiad had higher harvest index values in comparatively less favorable seasons than the local barley. Singh and Stoskopf (1971) have reported a strong relationship between the harvest index and grain yield in barley. Therefore selection for this trait could be useful in this environment., however, straw considerations are also clearly important. Barley landrace 39-58 and Arabi Abiad also show a greater thousand kernel weight across different environments than the local barley. Knott and Talukdar (1971) have reported that yield could be increased by selecting entries with higher kernel weight.

All selected entries had a high measure of cold tolerance. All were winter types and had a prostrate growth habit. This character clearly differentiated selected lines from cold susceptible genotypes. Ceccarelli et al. (1987) have also confirmed that a prostrate winter growth habit is a desirable characteristic when selecting cold tolerant genotypes. Furthermore, these selection experiments for barley varieties in upland Balochistan have indicated that early growth vigor in spring is an equally important selection criteria if associated with prostrate growth. The prostrate growth habit genotypes usually display very slow vegetative growth in winter, and are thus not profligate with stored soil moisture from monsoonal summer rains. However, such lines are also usually of long maturity type and often can not escape from terminal drought.

Clearly, early maturing varieties would also be at an advantage in this environment given sufficient cold tolerance. Derera et al. (1969) has reported similar findings in which earliness allowed crops to avoid drought during the grain filling period of crop growth.

Therefore, in upland Balochistan for the selection of appropriate winter type varieties, desirable characteristics are cold tolerance, prostrate growth habit, early growth vigor in spring and early maturity with a long vegetative and a short reproductive period. After testing a very large number of exotic genotypes in upland Balochistan under different environmental conditions it has been observed that the probability of finding acclimatized genotypes is very low. However, the Arid Zone Research Institute (AZRI) has managed to select a few barley lines from introduced advanced germplasm which are resistant to environmental stresses, and which possess the ability to increase yield and stability of production.

It is hoped that in the future the release of such improved barley varieties to the farmers of upland Balochistan will help in some degree to overcome the current shortage of animal feed in the Province.

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TABLE 1. Biological yield, grain yield (kg/ha) harvest index and 1000 kernel weight (g) of 14 barley lines tested at two sites in upland Balochistan during 1987/88.

Ent. No.	Biological Yield QTA	Biological Yield K.MEH	Grain Yield QTA	Grain Yield K.MEH	Harvest Index(%) QTA	Harvest Index(%) K.MEH	1000 Kernel Wt. QTA	1000 Kernel Wt. K.MEH
1	3450	4970	356	1211	10	24	28	37
2	3900	6600	224	1560	6	24	30	38
3	3200	7800	24	1092	1	14	31	39
4	2500	4300	33	1084	1	25	20	23
5	2750	5190	319	1623	12	31	23	35
6	4050	6520	406	1390	10	21	26	33
7	3850	6050	233	1592	6	26	30	34
8	3150	3700	338	1009	11	27	20	34
9	4550	4320	608	1533	13	35	29	36
10	3900	4750	874	1310	22	28	29	43
11	3400	4920	374	1229	11	25	26	43
12	2350	3850	520	1038	22	27	29	26
13	3800	6400	537	2488	14	39	31	42
14⊛	6450	5327	597	1463	9	27	17	33
p	>0.05	<0.01	<0.05	>0.05	<0.01	>0.05	<0.01	<0.01
LSD 5%	-	1766	484	-	0.8	-	0.8	0.5

QTA= Quetta
K.MEH= Kan Mehtarzai
⊛ Local check

TABLE 2. Biological yield, grain yield (kg/ha) harvest index and 1000 kernel weight (g) Of 14 barley lines tested at two sites in upland Balochistan during 1988/89.

Ent. No.	Biological Yield QTA	Biological Yield KHZ	Grain Yield QTA	Grain Yield KHZ	Harvest Index(%) QTA	Harvest Index(%) KHZ	1000 Kernel Wt. QTA	1000 Kernel Wt. KHZ
1	9974	2972	1986	889	20	30	27	38
2	7200	3250	1073	441	15	14	22	34
3	8241	4667	799	970	10	21	23	42
4	11289	3222	620	513	7	16	17	27
5	8554	2972	1219	979	14	33	21	34
6	10471	4250	1086	1051	10	25	22	34
7	10808	4861	1120	1422	11	29	21	39
8	7950	2833	2016	755	25	27	22	36
9	8414	2972	1664	858	20	29	26	44
10	10867	3250	2871	1047	26	32	27	38
11	10053	3139	1651	722	16	23	24	43
12	6284	1972	618	576	10	29	20	34
13	8138	4194	1664	1171	20	28	25	40
14⊛	11071	3889	1157	1523	10	39	22	37
P	>0.05	>0.05	<0.01	>0.05	<0.05	>0.05	<0.01	<0.01
LSD 5%	-	-	759	-	0.1	-	4	4

QTA= Quetta
KHZ= Khuzdar
⊛ Local check