THE MART/AZR PROJECT

HIGH ELEVATION RESEARCH IN PAKISTAN

Pakistan Agricultural Research Council

ARID ZONE RESEARCH INSTITUTE

Brewery Road, Quetta, Pakistan.

No. 69

SELECTION OF BREAD WHEAT GENOTYPES FOR SPRING SOWING IN THE ARID HIGHLANDS OF BALOCHISTAN

by

Sarfraz Ahmad, B. Roidar Khan,
Asghar Ali, J.D.H. Keatinge
and Irshad Begum

1991

MART/AZR PROJECT RESEARCH REPORTS

This research report series is issued by the Management of Agricultural Research and Technology Project/Arid Zone Research Component (MART/AZR). This project is sponsored financially by the Mission to Pakistan of the United States Agency for International Development (USAID).

The project contract is implemented by the International Center for Agricultural Research in the Dry Areas (ICARDA) at the Pakistan Agricultural Research Council's Arid Zone Research Institute (AZRI).

This Institute has responsibility for undertaking dryland agricultural research in all provinces in Pakistan through its headquarters in Quetta, Baluchistan and its sub-stations at D.I. Khan (NWFP), Umerkot (Sind) and Bahawalpur (Punjab)

This series of research reports outlines the joint research findings of the MART/AZR Project and AZRI. It will encompass a broad range of subjects within the sphere of dryland agricultural research and is aimed at researchers, extension workers and agricultural policy-makers concerned with the development of the resource-poor, arid areas of West Asia and North Africa.

Libraries, individuals and institutions may obtain single copies of this research report series free of charge and may request that their names be placed on a mailing list for periodic notifications of published papers by writing to ICARDA Office, P.O. Box 362, Quetta, Pakistan.

SELECTION OF BREAD WHEAT GENOTYPES FOR SPRING SOWING IN THE ARID HIGHLANDS OF BALOCHISTAN

SARFRAZ AHMAD[1], BAKHT ROIDAR KHAN[1], ASGHAR ALI[1], J.D.H. KEATINGE[2] AND IRSHAD BEGUM[1]

ABSTRACT

Limited and erratic rainfall is the major environmental factor affecting crop production in the arid highlands of Balochistan. Spring planted wheat crops suffer mainly from drought and heat stresses. Screening studies of spring planting material were started in 1986 at different sites in this area. An initial 104 exotic entries were screened down to nine superior genotypes which had higher yield potential, early maturity, drought and heat tolerance and resistance to yellow rust (*Puccinia striiformis*). Their superior tolerance to drought and heat stresses should enable them to utilize limited rainfall more effectively. These results indicated that improved genotypes could be selected for spring planting in highland Balochistan.

---

1. Arid Zone Research Institute (PARC) P.O. Box 63, Brewery Road Quetta, Pakistan.
2. International Center for Agricultural Research in the Dry Areas, Quetta.

INTRODUCTION

In the arid highlands of Balochistan, environmental stresses are the main yield-limiting factors in crop production. Major stresses which reduce yields are cold and drought in winter, and the combined effects of drought and heat and a short growing season during spring. Annual total rainfall varies from 150 to 300 mm (Rees et al., 1987a). Monsoon rain in the period July-August is the main source of moisture for winter planting, and for these conditions long duration genotypes of wheat are appropriate. However, these ideal conditions occur infrequently in highland areas. In most years, only late winter and early spring rainfall is received requiring crops to be planted in early spring, when short duration, drought and heat tolerant genotypes seem to be useful alternatives to the long maturity local landraces (Kidd et al., 1988, Rees et al., 1987b and Ahmad et al., 1990).

At present, the widely used local wheat landrace in highland Balochistan is quite well adapted to winter planting, being of longer duration, but it is susceptible to yellow rust (*Puccinia striiformis*). Spring planted crops are usually less productive in this area than winter planted crops which are able to use the available soil moisture from monsoon rains, winter rains and snow meltwater. This is because winter planted wheats are able to avoid, to some extent, heat and drought stresses during their reproductive stages, whereas, spring sown crops usually suffer more from terminal drought and high temperatures. These environmental stresses on plants can be lessened by selecting genotypes which are better conditioned to the harsh temperatures and erratic rainfall experienced.

Selection of adapted short maturity genotypes of wheat which are more resistant to drought, heat, and diseases is one of the ongoing research activities of the Arid Zone Research Institute (AZRI), in partnership with the International Center for Agricultural Research in the Dry Areas (ICARDA). This paper reports progress which has been made in the initial screening and selection of desirable wheat genotypes suitable for spring planting.

MATERIALS AND METHODS

In the 1986/87 cropping season a regional bread wheat observation nursery (Low Rainfall areas 1986/87) was received from ICARDA. One hundred and four entries were planted at Khuzdar in spring 1987 for initial screening and selection of desirable genotypes. This nursery was planted in single rows of 5 m length with a row spacing of 25 cm. Fertilizer was applied at the rate of 60 kg/ha N and 60 kg/ha P_2O_5 at the time of sowing. An initial irrigation of 50 mm was applied to give uniform plant establishment and, because only 71.7 mm rainfall was received during the growing season, an additional 100 mm only was applied as irrigation at the grain formation stage (Table 1) so that some seed could be harvested for the next season.

From this observation nursery 19 genotypes were selected on the basis of yield potential, drought and heat tolerance and early maturity. The selected genotypes were promoted to yield trials and during 1987/88 and 1988/89 they were exposed to a wide range of multi-location environmental stresses. The details of the test sites and rainfall are given in Table 1.

Each year sowing took place in early spring (late January to early February) at all sites using a single row hand drill. All trials were laid out as randomized complete block designs with a plot size of 1.5 x 5 m, and 25 cm row spacing. The same fertilizer rate was applied as in the observation nursery. Because of acute drought, 50-100 mm of life-saving water was applied by irrigation at all three sites at grain formation stage in the 1987/88 season, and only at Khuzdar in the 1988/89 season was irrigation water applied. Quetta and Kan Mehtarzai which were selected in the 1988/89 season to examine the performance of germplasm under severe terminal drought conditions. Again, the main reason for applying supplemental irrigation was to avoid the risk of completely losing all seed. The crop was harvested by hand between June and July, depending on elevation. The four middle rows were harvested from each plot to measure total dry matter production and grain yields.

RESULTS AND DISCUSSION

The pedigrees, total dry matter (TDM) production and grain yield of the tested genotypes of wheat are presented in Tables 2 and 3. Grain yield differences among the genotypes were significant ($P<0.05$) when averaged across years, while TDM production did not differ significantly. The exotic entries 2, 3, 5, 6, 7, 8, 10, 18 and 19 significantly outyielded the local check. Their mean grain yields ranged from 515 to 769 kg/ha compared to the yield of local check, 395 kg/ha (Table 3). The total dry matter production of these entries was also better than the local check. These exotic genotypes were better adapted to the harsh environment of highland Balochistan when planted in spring.

Results from three years of testing exotic wheat genotypes in highland Balochistan indicated that the yield potential of spring sown crops was limited mainly by drought, heat and the shortness of the growing season. However, resistance to cold in the early stages of growth is also essential because temperatures below freezing are usually experienced at the tillering stage of the crop; frost or cold damage at this juncture reduces the tillering capacity of the crop, which in turn may reduce the final seed production of spring-planted crops (Nachit, 1984). However, low tillering genotypes are better suited to the short growth cycle in moisture-stressed environments.

Therefore, such genotypes with high kernel weight and/or higher kernel number per spike, would be a more desirable type for spring planting.

The local wheat landrace is highly susceptible to yellow rust. Therefore, screening and selection of improved genotypes for disease resistance particularly yellow rust, must be another important objective in Balochistan. In the 1989/90 season, yellow rust appeared in epidemic form, which provided good natural conditions for screening the material. No disease attack was observed on the selected lines, which indicated that they had good resistance to this pathogen.

The present study indicated that the most important characteristics of the selected genotypes were:- 1. an erect growth habit, as such genotypes usually do not require vernalization and grow faster than types with prostrate growth habits (Ahmad et al., 1990). 2. rapid emergence and early growth, as these genotypes utilize available soil moisture more effectively due to their faster early growth rate. 3. early maturity, which enabled them to escape terminal drought stress (Fischer and Maurer, 1987). These characteristics displayed by the selected genotypes made them better adapted to the prevailing environmental factors during the spring season.

The results of three years of trials indicate that if the rain arrives late in the season, but is abundant, farmers could advantageously use such early maturing genotypes to reduce the risk of crop failure. This research represents a positive step towards increasing the human food and livestock food supply in the arid highlands of Balochistan, through the development of high yielding, disease resistant and short duration varieties suitable for spring sowing.

LITERATURE CITED

Ahmad, S., Keatinge, J.D.H., Ali, A. and Khan, B.R. 1990. Selection of barley lines suitable for spring sowing in the arid highlands of Balochistan. MART/AZR Research Report No. 60, ICARDA, Quetta, Pakistan.

Fischer, R.A. and Maurer, R., 1987. Drought resistance in spring wheat cultivars 1. Grain yield responses. Australian Journal of Agricultural Research 29: 897-912.

Kidd, C.H.R., Rees, D.J., Keatinge, J.D.H., Rehman, F., Samiullah, A. and Raza, S.H. 1988. Meteorological data analysis of Balochistan. MART/AZR Research Report No. 19, ICARDA, Quetta, Pakistan.

Nachit, M.M. 1984. Use of planting dates to select stress tolerant and yield stable triticale genotypes for the rainfed Mediterranean environment. Rachis 3(1): 15-17.

Rees, D.J., Nagy, J.G., Raza, S.H., Mahmood, K., Chowdry, B.A and Keatinge, J.D.H. 1987a. The dryland arable farming system of upland Balochistan: a case study. Proceedings of an international symposium on problems and prospects of winter creals and food legumes production in the high elevation areas of West Asia, Southeast Asia and North Africa. Ankara, Turkey. Pages 81-98.

Rees, D.J., Raza, S.H., Ali, Z., Rehman, F., Islam, M., Samiullah, A., Channa, M. and Shah, S.M. 1987b. Improvement in water use efficiency in Barani arable agriculture in Balochistan. MART/AZR Research Report No. 6, ICARDA, Quetta, Pakistan.

Table 1. Site details and rainfall during the trials in highland Balochistan.

Site	Altitude (m)	Latitude	Longitude
Quetta	1690	30° 07' N	66° 58' E
Kalat	1850	29° 07' N	66° 24' E
Khuzdar	1250	27° 46' N	66° 39' E
Kan Mehtarzai	2250	31° 00' N	67° 45' E

Site	Year	Rainfall (mm)	Supplemental irrigation (mm)
Khuzdar	1986/87	71.7	150
Quetta	1987/88	142.2	50
Kalat	1987/88	39.0	100
Khuzdar	1987/88	31.3	150
Quetta	1988/89	187.0	0
Khuzdar	1988/89	41.0	75
Kan Mehtarzai	1988/89	181.2	0

Table 2. Pedigrees of the genotypes tested in highland Balochistan.

Entry No.	Name/Cross/Pedigree	Seed Source
1	Tsi/Vee S CM 64335-3AP-1AP-1AP-OAP	WAT86 310
2	2CA542C/Skorospelka//Neuzucht/3/Nac76 SWM 08943-1Y-1Y-OY-4AP-OAP	WAT86 603
3	Al-Fon#4//Maya74/Pvn S SWM 10896-8Y-2Y-OY-1AP-OAP	WAT86 613
4	Bb/Pato(B)//Coc CM 49242-2AP-1AP-1AP-2AP-1AP-OAP	WAT86 614
5	Cno/7C//Tob/Cno/3/Pato(B)/4/Emu S CM 49856-2AP-2AP-1AP-2AP-1AP-OAP	WAT86 620
6	Tob//HD832/Bb/3/Mon S CM 56718-5Y-2Y-3M-3Y-1M-OY	WAT86 923
7	Bow S/Tsi CM 64691-14Y-1M-3Y-1M-OY	WAT86 1003
8	Bow S/Prl S CM 70307-9M-3Y-1M-2Y-OM	WAT86 1007
9	Vee S/Tsi CM58943-1AP-1AP-2AP-2AP-OAP	WPT86 1117
10	Yehe/T502//Jun S CM59102-2AP-3AP-2AP-1AP-OAP	WPT86 1216
11	71St2959/Crow S SWM 11623-2AP-2AP-1AP-OAP	WAT86 115
12	Pi/Gb//5661/3/23584/4/Chl/Inia S ICW79-0647-7AP-1AP-1AP-OAP	WAT86 205
13	Ald S/4/Napo/Tob S//8156/3/Kal/Bb ICW79-0728-1AP-1AP-2AP-OAP	WAT86 206
14	71St2959/Crow S SWM 11623-2Y-OY-1AP-OAP	WAT86 320
15	Tow S/Pew S CM 59443-4AP-1AP-4AP-1AP-OAP	WAT86 414
16	BUc S/Flk S CM 50070-24Y-1M-1Y-OY	WAT86 818
17	7C//Tob/Cno S/3?Kal/4/Slavyanka ICW80-0157-1AP-1AP-2AP-OAP	WPT86 313
18	71St2959/Crow S SWM11623-9AP-3AP-7AP-1AP-OAP	WPT86 913
19	Vee S/Tsi CM58943-1AP-4AP-1AP-OAP	WPT86 1118
20	Local White (Check)	

Table 3. Mean total dry matter (TDM) and grain yield (kg/ha) of 20 bread wheat lines tested at different sites in highland Balochistan from 1987 to 1989.

Entry No.	TDM	Grain yield
1	1881	515 bc[1]
2	2557	654 ab
3	2257	688 ab
4	2195	595 abc
5	2271	697 ab
6	2170	728 ab
7	2170	653 ab
8	2461	769 a
9	2081	599 abc
10	2404	690 ab
11	2181	612 abc
12	2542	620 abc
13	2332	558 abc
14	2146	523 bc
15	2152	530 bc
16	2209	578 abc
17	2032	564 abc
18	2275	643 ab
19	2267	715 ab
20 (Local check)	2168	395 c
Mean	2238	616
LSD (5%)	---	226

[1]Means within the same column followed by different letters are statistically different at the P=0.05 level of significance.