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A NEW BARLEY VARIETY RAKHSHAN-10 (AZ-96) FOR BALOCHISTAN

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The Rakhshan-10 (AZ-96) barley variety was first tested at AZRC, Quetta during 1986-87 in a nursery of 100 lines (IBON). The higher yielding and disease resistant genotypes were advanced to preliminary/advanced yield trial-A1, B1, C1 and micro plot trials. The line was tested in different regions of rainfed Balochistan in yield trials. The variety showed excellent drought tolerance and produced higher number of tillers with bold grain. Rakhshan-10 (AZ-96) showed excellent results in NUBYT trails conducted by National Coordinated Program Islamabad during 1997-2000. Rakhshan-10 produced the highest grain yield in pooled analysis of NUBYT trial with 2nd position in rainfed and 1st in irrigated with grain yield of 2244 (-3%) and 3560 kg/ha (12%) during 1997-98, respectively. In year 1998-99 Rakhshan-10 toped in pooled analysis of NUBYT trial with 1st position in rainfed and 5th in irrigated with grain yield of 2430 (+27%) and 2553 (+2%) kg/ha, respectively. During 1999-2000 cropping season it ranked 2nd both in rainfed and irrigated trials under NUBYT with 9% and 7% increase over local check. It has excellent resistance against yellow rust and has 14.40 crude proteins which is an added advantage as feed for livestock. It also has good capability to survive at low temperature (-10°C) and can be planted in February if farmers receive late rainfall. In Balochistan only three barley genotypes were released (Soorab-96, Sanober-96 and Awaran-2002) which were mostly winter types. Rakhshan-10 (AZ-96) is excellent for planting in both winter and spring and it can replace the local barley (rust susceptible and low harvest index) and can produce higher grain yield in spring.
Keywords: Rakhshan-10, barley, rainfed, grain yield, highlands

INTRODUCTION

The highland Balochistan experience a principally continental Mediterranean climate with monsoonal influence in some years. Rain is scarce, irregularly distributed and variable from one year to another and is the main constraint in the region. In West Asia and North Africa (WANA) barley is the predominating crop, grown in areas receiving less than 300 mm of annual rainfall. After wheat, barley is second most important dual purpose crop in Balochistan, grown at elevations and under rainfed and salt affected areas. After summer harvest of wheat and barley the demand of green fodder for livestock increases in winter due to non availability of forage in range lands and farmer graze their livestock in barley fields (Khan *et al*., 1999). If farmers are unable to harvest the crop for seed in a dry season, stubbles of the crop are of considerable value as a source of animal feed. The main constraints towards improved production are environmental stresses (especially drought and cold), insect pests and diseases.

Because of its wide range of geographical distribution, barley has accumulated a vast array of genetic variability, which was maintained by landraces grown across the globe. Over the past hundred years, these heterogeneous landraces have gradually been replaced by homogeneous pedigreed lines in industrialized countries. However, landraces are still widely grown in developing countries, particularly in harsh environments. Due to seasonal variation in rainfall distribution crop yield is also variable from year to year. Severity, timing and duration of drought will vary from year to year, and cultivar successful in one dry year may fail in another (Ceccarelli and Grando, 1996). Due to above facts high yielding cultivar which can give good production both in winter and spring (late rainfall) could be useful alternatives to the current practices which are dominated by long duration winter wheat and barley.

Local barley is well adapted in highland Balochistan but highly susceptible to yellow rust with low harvest index. Development of varieties for highland Balochistan is difficult due to extreme and variable environmental conditions (Ahmad *et al*., 1992). Moreover, breeding for drought resistance made more complex by the interactions of drought with other stresses. Understanding plant responses to drought is of great importance and also a fundamental part of making crops stress tolerant (Reddy *et al*., 2004; Zhao *et al*., 2008). The relative yield performance of genotypes in drought-stressed and favorable environments seems to be a common starting point in the identification of desirable genotypes for unpredictable rainfed conditions (Mohammadi *et al*., 2010). Some researchers believe in selection under

favorable conditions (Betran *et al*., 2003), others in a target stress condition (Rathjen, 1994) while others yet have chosen a mid-point and believe in selection under both favorable and stress conditions (Byrne *et al*., 1995; Rajaram and van Ginkel, 2001). Arid zone research centre is working on wheat, barley and lentil improvement for highland Balochistan and released three varieties of wheat (AZRI-96), barley (Sanober-96) and lentil (Shir-Az-96). After many years rigorous research, current barley variety Rakhshan-10 (AZ-96) is developed for rainfed areas of highland Balochistan with capability of sowing in winter and spring season.

BARLEY (Rakhshan-10)
Parentage and pedigree
WI2291/WI2269
ICB78-0594-8AP-3AP-2AP-2AP-0AP

Genotype AZ-96 is a short duration barley, which can be planted from end October to End of November (winter) and Mid of January to Mid of February (Spring). The growth habit is erect. Plant height reaches to 90 cm with excellent tillering capacity of 25-27 tillers per plant. The crop take 120 days to get 50% heading in winter while it take only 75 to 80 days to head in spring plantation. The seed is bold with 1000 kernel weight ranges from 35 to 40 g in rainfed conditions. The genotype AZ-96 is also resistant to leaf and stripe rust tested at NARC by Crop Disease Research Institute (0-R for both pathogens).

MATERIALS AND METHODS

Genotype AZ-96 is product of WI2291 and WI2269 combination made at Australia. The line was first received from ICARDA in 1986-87 and selected from International Barley Observation Nursery (IBON) as high yielding drought tolerant genotype. The nursery was planted at Khuzdar as a single row 5 m with row to row distance of 25 cm. It was retested in preliminary and advanced yield trials in four rows 5 meters at AZRC, Quetta during 1987-1997 and also at five other locations of highlands of Balochistan in RCBD design with three replications. The entry was tested in years 1988, 1992, 1996 (preliminary and advanced yield trails) and 1997-2000 (NUBYT). It was tested for three consecutive years in National Uniform Barley Yield Trail (rainfed and irrigated) at different locations of Pakistan.

RESULTS

The yield performance of Rakhshan-10 (genotype AZ-96) in preliminary and advanced yield trial is reported in Tables 3-7. Two barley cultivars (Sanober-96, local) were used as commercial checks. Rakhshan-10 (AZ-96) showed greater yield than the check and produced 14% more grain yield over check during 1986-1987. In 1987-88 advance trial was replicated over four locations (Quetta, Kalat, Khuzdar and Kan Mehtarzai). Local Barley was used as check to evaluate the performance of the variety in RCBD with three replications. The year 1987-88 was a dry year with very low rainfall and supplemental irrigation was applied to save the crop from 100% damage. Rakhshan-10 (AZ-96) out yielded local cultivar at three locations (Quetta, Khuzdar and Kan Mehtarzai) with 46, 63 and 59% increased grain yield over check (Table 3), while it yielded lower than check at Kalat (13%) due to extreme drought and cold. Due to extreme variation in environmental conditions of highland Balochistan high variation was recorded in data of all the genotypes tested during various years. Rakhshan-10 produced higher grain yield at two locations in 1988-89 with 13% and 20% increase than local but at Kan Mehtarzai it was below the local check with 20% decrease (Table 3). In year 1992-93 genotype AZ-96 was tested at two locations Quetta and Surab. Rakhshan-10 (AZ-96) produced higher grain yield at Surab (18.3%) while it was below local check at Quetta (-14.5%). This high yielding genotype was retested again in micro plot trial in 1996-97 at two different locations (Quetta and Loralai) to check its stability and adoptability to different agro climatic conditions of highland Balochistan. Rakhshan-10 produced 36.8 and 23.8% higher grain yield over local check at two locations respectively. Rakhshan-10 (AZ-96) showed excellent results in NUBYT trails conducted by Coordinated Program Islamabad during 1997-2000. Genotype AZ-96 (Rakhshan-10) was tested in 36 locations all over Pakistan. Rakhshan-10 produced the highest grain yield during 1997-98 in pooled analysis of NUBYT trail with 2nd position in rainfed and 1st in irrigated with maximum grain yield of 2244 (-3%) and 3560 kg/ha (12%), respectively. In year 1998-99 AZ-96 (Rakhshan-10) toped in pooled analysis of NUBYT trail with 1st position in rainfed and 5th in irrigated with grain yield of 2430 (+27%) and 2553 (+2%) kg/ha, respectively. During 1999-2000 cropping season genotype AZ-96 ranked 2nd both in rainfed and irrigated trails under NUBYT with 9% and 7% increase over local check. The disease reaction of Rakhshan-10 to yellow rust (YR) and Leaf rust (LR) was recorded by CDRI at NARC, Islamabad. YR is predominant disease of barley in Balochistan which damage crop in high rainfall years (three out of 10). Rakhshan-10 showed terminal resistance to yellow rust in two different years with no leaf rust problem and RRI of 9. Chemical analysis of Rakhshan-10 showed 14.40% crude protein, 4.49% crude fiber, 90.89% dry matter and 2.52% ash.

DISCUSSION

Rakhshan-10 (AZ-96) is high yielding barley variety developed by AZRC, Quetta. Rakhshan-10 is two rowed barley, high tiller producing variety with higher grain weight as compared to local check which is six rowed, facultative

Table 1. Selection history of genotype AZ-96

Year	Trial	Entry No.	AZ-96 (Grain Yield Kg/ha)	
1986-87	ISBON	6	2486	
1987-88	Preliminary Barley Yield Trial-A1 (Avg. Three Locations)	6	269	
1988-89	Advanced Barley Yield Trial-B1 (Avg. Three locations)	6	515	
1992-93	Advanced Barley Yield Trial-C1	20	2179	
1996-97	Micro Plot Yield Trial	23	1692	**AZRC, Quetta ↓**
1997-98	NUBYT	6	2902	952
1998-99	NUBYT	4	2491	2073
1999-00	NUBYT	3	2590	2317

Table 2. Rainfall during the reported years (1986-2000)

Year	Rainfall (mm)			
	Quetta	**Kuzdar**	**Kalat**	**K.M Kan Mehtarzai**
1986-87	191	71	-	-
1987-88	142.2	31.3	39.0	31.2
1988-89	187.0	41.0	-	181.2
1992-93	222			
1996-97	194.6			
1997-98	279			
1998-99	147			
1999-2000	58			

Table 3. Yield performance of genotype AZ-96 during 1986-99 [Biological and Grain Yield (kg ha^{-1})]

Year	Location	AZ-96		Local Check		% increase over
		TDM	**G.Y**	**TDM**	**G.Y**	**check G.Y**
1986-87	Khuzdar	8310	2486	8060	2142	14
1987-88	Qutetta	1267	58	900	31	46
	Kalat	1380	458	805	520	-13
	Khuzdar	1420	338	838	125	63
	Kan Mehtarzai	2133	223	2123	93	59
1988-89	Quetta	1268	365	1802	319	13
	Khuzdar	1470	400	1383	320	20
	Kan Mehtarzai	2333	782	2833	944	-20
1992-93	Quetta	15200	3196	13400	3694	-14.5
	Surab	3400	1162	2350	950	18.3
1998-99	Quetta	6900	1665	5800	1051	36.8
	Loralai	7100	1720	6400	1310	23.8

Table 4. National Uniform Barley Yield Trials Pooled Analysis during 1997-1998

NUBYT. No	Line/ Variety	Source	NWFP	Balochistan	Pakistan	
			Irrigated (2 sites)	**Barani (2 sites)**	**Barani (4 sites)**	**Irrigated (3 sites)**
1	B-94057	AARI-Faisalabad	3170	2146	1756	3143
2	NRB-4	NARC-Islamabad	3108	1854	1956	2932
3	BVT	ARI-Tandojam	2790	1760	1550	2557
4	B-93143	AARI-Faisalabad	3033	1948	1976	2610
5	NRB-9	NARC-Islamabad	2982	1740	1872	2830
6	AZ-96	AZRC-Quetta	3767	2135	2244	3560
7	BR-01	WRI-Sakrand	3067	1865	1551	2788
8	L-Check		3281	2521	2306	3428
		Grand Mean	**3143**	**1996**	**1901**	**2981**
		C.V	**15.7**	**12.1**	**13.2**	**13.4**
% Increase over Local Check					**-2.69↓**	**3.7↑**

Table 5. National Uniform Barley Yield Trials Pooled Analysis during 1998-1999

NUBYT. No	Line/Variety	Source	Punjab Irrigated		NWFP	Balochistan	Pakistan	
			Barani	Irrig.	Irrig. (2 sites)	Barani 2 (sites)	Barani 4 (sites)	Irrig. 6 (sites)
1	PRB-15	CCRI-Pirsabak	2806	2429	2842	1041	1924	2569
2	B-94057	AARI-Faisalabad	2429	2736	3042	1289	1859	2816
3	AZ-96	AZRC-Quetta	3177	2399	2848	1682	2430	2553
4	NRB-14	NARC-Islamabad	2503	2268	2731	867	1685	2429
5	PRB-14	CCRI-Pirsabak	2925	2826	2829	1263	2094	2797
6	V-6	ARI-Quetta	2719	2396	2915	1236	1978	2566
7	B-93143	AARI-Faisalabad	3192	2796	2775	1045	2118	2731
8	L-Check		2213	2512	2552	1368	1790	2522
		Grand Mean	**2745**	**2545**	**2817**	**1224**	**1985**	**2623**
		C.V	**12.6**	**11.5**	**12.0**	**19.7**	**14.9**	**10.9**
	% increase over Local check						**26.34↑**	**1.20↑**

Table 6. National Uniform Barley Yield Trials Pooled Analysis during 1999-2000

NUBYT.No	Line/Variety	Source	Punjab (4 sites)	Pakistan (6 sites)
1	B-96038	AARI-Faisalabad	3196	2632
2	PRB-15	CCRI-Pirsabak	2849	2295
3	AZ-96 (2010)	AZRC-Quetta	3073	2590
4	NRB-10	NARC-Islamabad	2552	2045
5	PRB-14	CCRI-Pirsabak	2832	2356
6	V-1	ARI-Quetta	2320	2009
7	B-92044	AARI-Faisalabad	2988	2408
8	L-Check		2822	2403
		Grand Mean	**2829**	**2342**
		C.V	**8.4**	**9.9**
	% increase over Local check		**8.17↑**	**7.3↑**

Table 7. Summary of National Uniform Barley Yield Trial (rainfed & irrigated) during 1997-2000

Entry	Year	Avg. Yield (Kg/ha)	Location
AZ-96 (2010)	1997-98	2215	11 (all over Pakistan in NUBYT Rainfed)
Local	1997-98	2122	
% Increase over Check		**4.2**	
AZ-96 (2010)	1998-99	2283	13 Sites
Local		2080	
% Increase over Check		**8.90**	
AZ-96 (2010)	1999-2000	2224	12 sites
Local		1945	
% Increase over Check		**13**	

*Local check different at different sites

type with more height and susceptibility to yellow rust. Rakhshsan-10 produced high yield over the years (range 500-3000 kg ha^{-1}) and produced better yield when planted late in the season. Same results were recorded by Jones and Singh (2000), Olesen *et al*. (2000) and Wheeler *et al*. (2000), who reported that factors like weather and soil are important cause for crop yield variability in different barley genotypes. The variety also produced better protein content (14.40% crude protein) which is important parameter for barley variety development as feed. It is reported by Kilic *et al.* (2010) that quality of malt and animal feed correlated with the protein content of grain. For better quality of feed increased protein content is required while for malt >12% protein is required (Home, 1991; Home and Elamo, 1993). Briggs (1998) reported that protein content of barley depends on the growing conditions (precipitations and temperature). The higher plant height of local barley also cause lodging during good years. Akıncı and Yildirim

(2009) studied barley accessions from South East region of Turkey and reported a decrease in grain yield at high rainfall environment due to lodging. Rakhshan-10 has an edge over check in yield and also in utilizing higher rainfall with more harvest index as compared to local checks which produced low harvest index due to less 1000 kernel weight. Riggs *et al*. (1981) also reported a positive relation between harvest index and grain yield about barley per unit area. Rakhshan-10 (AZ-96) has excellent yield potential in both spring and winter plantation. The variety was approved from provincial seed council during 2010 with the name of Rakhshan-10 and the seed is available to growers of highland Balochistan.

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