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TIJABAN-10 A DROUGHT TOLERANT AND HIGH YIELDING WHEAT VARIETY FOR RAINFED/SAILABA AREAS OF BALOCHISTAN

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Abstract

Tijaban-10 a drought tolerant wheat variety was developed by Arid Zone Research Centre for rainfed (Sailaba/Khushkaba) areas of Balochistan and has been released by Balochistan Seed Council in 2010. Tijaban-10 is a semi dwarf wheat variety with high tillering capacity, high yield, bold grain and improved drought tolerance. The variety posses high protein content (13.29 %), high wet gluten (29.91%) and dry gluten (10.04%). The yield potential of Tijaban-10 was tested (1997-2008) in different yield trials (PYT, AYT) at AZRC, Quetta, micro plot trials and national trials over multiple locations in rainfed areas of Balochistan and Pakistan. The variety showed stability and wide adoptability under prevalent biotic (Rust and Insect/pest) and abiotic (drought and cold) stress of highland Balochistan. The line was tested over wide range of locations with extreme variation (cold and drought) in rainfed/Sailaba areas of Balochistan (Quetta, Mastung, Killa Saifullah and Loralai). Tijaban-10 produced higher yield in National Uniform Wheat Yield Trial (NUWYT) conducted by National Coordinated Program (NARC) Islamabad during 2006-07 in rainfed areas of Pakistan. Tijaban-10 out yielded check cultivars (AZRI-96, Sariba-92 & Local White) during yield trials in different agro-ecological zones of highland Balochistan with an increase of 20-34% over check cultivars. Tijaban-10 also yielded higher in micro plot (2005-2007) yield trials and produced 25-50% increased yield as compared to check cultivars. Tijaban-10 produced 6 % higher grain yield in National Uniform Yield Trial (2006-07) than check genotypes in pooled analysis all over Pakistan with potential yield of 7000 kg ha^{-1}. It showed 5MS-10MS susceptibility to yellow rust strain of highland Balochistan while it showed resistant to leaf rust when tested in natural conditions of rainfed areas. The variety possesses desirable quality characteristics such as better chapatti quality; improved protein (13.29%) and higher harvest index (30-38%). This variety showed high acceptability/popularity among the farming communities of Balochistan and a new addition in genetic diversity of germplasm/cultivars already available in rainfed areas of Balochistan with significant improvement in farmers yield.

Introduction

Limited rainfall, un-predictable distribution, low and high runoff events, low and high extremes of temperatures, and desiccating winds during the grain formation stages are some major constraints of crop growth and production in highlands of Balochistan. Severity, timing and duration of drought vary from year to year and genotypes producing good yield in one dry year may fail in another (Ceccarelli & Grando, 1996). Up to 82% variation in grain yield was determined by seasonal rainfall in the areas receiving 133-455 mm rainfall (Ketata, 1989). Areas of highland Balochistan are more prone to environmental stresses and improvement in crop yield by inputs is generally not a feasible strategy. Three years out of ten are suitable for wheat production in highland Balochistan (Rees *et al.*, 1989). Therefore, evaluation and selection of suitable wheat genotypes resistant to environmental stresses may be another approach to have suitable crop production both in favorable and un-favorable years (Hurd, 1974; Blum, 1982).

The development of drought tolerant cultivars is of global interest due to an increasing population and decreasing water resources (Nguyen, 1999). Improved farm practices are important to achieve higher yields (Anon., 1989). Dryland agriculture is an important component of our national economy of which currently contributes around 15 billion rupees annually. About 12% of the total wheat production is harvested from rain-fed areas, which can be increased considerably with appropriate production technologies (Khan *et al.*, 2001). The drought resistance of a plant is a combination of many physiological and morphological characteristics. Ecological adaptation, early vegetative growth, low leaf area index, root depth, root/shoot ratio, stomatal sensitivity, hydraulic root resistance, early maturity, harvest index are some the desirable parameters of wheat genotypes for arid and semi-arid areas (Bahar *et al.*, 2009, Koc *et al.*, 2003, Yıldırım *et al.*, 2009, Yıldırım *et al*., 2011, Kirkham & Kanemasu, 1983, Passioura, 1983, Fischer, 1981; Hussain *et al*., 2012). Numerous methods of genotype-environment interactions have also been developed and tested (Eberhart & Russell, 1966).

Bread wheat is the main cereal crop in Spate (Sailaba system) irrigation systems of highland Balochistan. Generally, the wheat crop is sown on stored soil moisture from summer rains in the early winter season. Early vegetative growth in winter season is also used for livestock grazing. Although the level of environmental stresses may varies from year to year and season to season. However, grain formation stage is the most critical time. Native wheat landraces are highly adapted to the environmental conditions of the area but susceptible to diseases particularly yellow rust. Wheat varieties for irrigated areas with high inputs resulted increased in yield. However, wheat yields in less favorable areas remained low (Sayar *et al.*, 2005, Garcia Del Marol *et al.*, 2003 and Srivastava 1985). Rajaram *et al.*, 1996., concluded that simultaneous evaluation of the germplasm both under near optimum condition (To utilize high heritability and identify genotypes with high yield potential) and stress conditions (To preserve alleles for drought tolerance) is important to breed for higher yielding and drought tolerant genotypes. Behara (1994) reported that different genotypes of cereal respond differently in agro-climatic conditions of a particular area due to difference in their genetic makeup and

physiological process Increased country population and demand of wheat became a major challenge and need to focus on wheat improvement in the very vast arid and semi-arid areas. Wheat genotypes having potential of disease resistance and environmental stresses would improve the production potential in moisture-limited environments and also alleviate poverty. This paper highlights the development of new wheat variety Tijaban-10 for the rainfed/Sailaba areas of highland Balochistan.

Material and Methods

The line W3918A/Jup was received from ICARDA as Regional Bread Wheat Yield Trial-Semi Arid during 1994-95. It was tested and advanced to Preliminary Yield trial during 96-97 and advanced yield trial during 97-98. The trial was planted in RCB design with three replications with Local white and AZRI-96 used as check. The variety was further tested in different agro climatic zones of highland Balochistan (Mastung, Loralai and Killa Saifullah) during 2005-06 and 2006-07 with Local white, Sariab-92 and AZRI-96 as check. The variety was evaluated in National Wheat Uniform Yield Trial-Rainfed 2006-07 in randomized complete block design to check its performance in different regions of the country. This line was evaluated by Crop Disease Research Program (CDRP) Karachi at Killa Saifullah, Quetta and Loralai in highland Balochistan during 2006-07. Data was recorded on No. of tillers (per m^2), plant height (base of plant to the tip of Spike), spike length, grain yield (kg ha^{-1}), Total dry matter (kg ha^{-1}), harvest index % (Grain yield/TDM * 100) and disease (rust) over testing period and was analyzed by standard statistical methods (Steel & Torrie, 1984) and means from the years is reported in the paper. Quality characteristics were evaluated at National Agricultural Research Centre (NARC) and farmer perception was noted for chapatti quality, taste and bread making.

Results and Discussion

Preliminary and advanced yield trial: The yield performance of variety Tijaban-10 in preliminary and advanced yield trial is presented in (Table 1). Two wheat cultivars (AZRI-96 and Local White) were used as commercial checks. Tijaban-10 showed higher yields as compared to check cultivars (AZRI-96 and Local white) and produced 25 and 41 % more grain yield over checks during 1997-98. In 1998-99 Tijaban-10 was tested in advance yield trial. It produced 46 and 59% higher yields than checks cultivars (AZRI-96 & Local). The year 1999-2000 was a dry year with very low rainfall only 58 mm (Fig. 1) and supplemental irrigation was applied to save the crop from 100% damage. Tijaban-10 showed better performance as compared to checks and produced 1428 kg ha^{-1} grain yield while checks produced 578 and 980 kg ha^{-1} grain yield, respectively (Table 1). Acevedo *et al*., 1991 reported variation in grain yield among sites and growing seasons as a consequence of variation in distribution and amount of rainfall.

Micro plot yield trial: Stability in yield of genotypes over a wide range of environments is of great concern to plant breeders (Arian *et al.,* 2011). During micro plot yield trial 2003-04 Tijaban-10 showed 37 % lower yield as compared to AZRI-96 due to bird damage because of early maturity while it produced higher grain yield (14%) over the local white. During 2005-06 Tijaban-10 produced 26, 4, and 25% more grain yield as compared to local check at Quetta, Killa Saifullah and Mastung while during 2006-07 Tijaban-10 out yielded check cultivars at three locations Killa Saifullah, Loralai and Mastung with an increase of 48% than local white (Tables 2 &3). Arian *et al.,* 2001, Hamam *et al*., 2009 and Sial *et al.,* 2007 reported that grain yield is the function of genotype, environment and genotype x environment interaction. The variety showed increase in yield over years and environment which shows its adoptability and stability over location and years.

National uniform yield trial: Tijaban-10 produced better grain yield during 2006-07 in National Uniform Wheat Yield Trail rainfed conducted at 17 locations in Pakistan. It produced 7400 kg ha^{-1} yield at Nowshehra, Khyber Pakhtunkhawa. It showed lower yield in Balochistan due to extreme drought in the year. Tijaban-10 stood 6^{th} in NUWYT 2006-07 (Table 4 & Fig.2).

Table 1. **Yield performance of Tijaban-10 in advanced nursery, preliminary and advance yield trials at AZRC, Quetta.**

Year	Type of trial	Yield kg ha^{-1}			% Increase over checks	
		Tijaban-10	AZRI-96	Local white		
1996-97	Advanced nursery	2416	1864	1480	23	39
1997-98	Preliminary yield trial	1970	1488	1168	25	41
1998-99	Advance yield trial (A1)	1163	621	480	46	59
1999-2000	Advance yield trial (B-1)	1428	578	980	59	32
2002-03	Advance yield trail (C1)	1911	1357	1477	29	23
2003-04	Micro plot yield trial	1260	1988	1080	-37	14
2005-06	Micro plot trial	1440	1115	1063	23	27
2006-07	Micro plot trial (rainfed)	1922	1829	1194	4	38
	Average	1688	1355	1115		
	% Increase over check		20	34		

The average yield data showed higher yields of Tijaban-10 over AZRI-96 and local check. Tijaban-10 is 34% higher yielding as compared to local white as well as 20% higher than AZRI-96

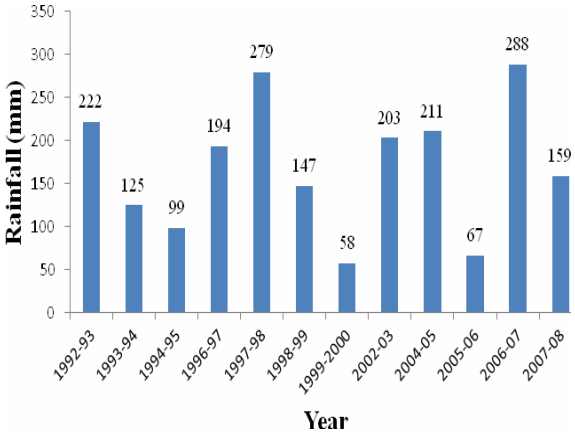

Fig. 1. Seasonal Rainfall during the cropping Seasons (October-June).

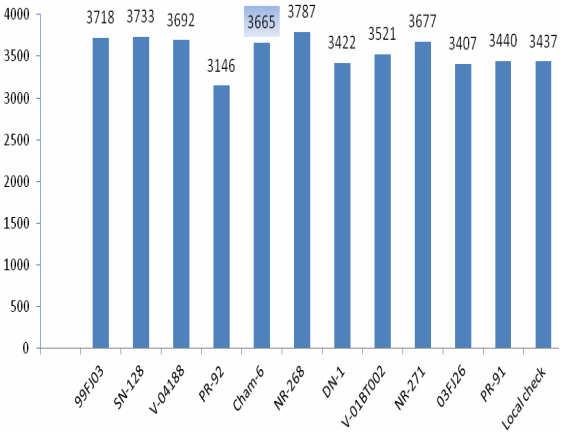

Fig. 2. NUWYT Pooled Analysis (Yield kg ha^{-1}) 2006-07.

Table 2. Yield performance of Tijaban-10 in micro plot trial (2005-06).

S. No.	Location	Tijaban-10	AZRI-96	GA-2002	Local white
1.	AZRC, Quetta	1440	1115	-	1063
2.	Killa Saifullah	1480	1610	1246	1421
3.	Killa Saifullah 2	1369	1900	Damaged by birds	1791
4.	Mastung	647	725	-	486
	Average	1234	1337	-	1190
	% Increase over check	3.7%			

In 2005-2006 severe drought was reported which affected the grain yield of Tijaban-10 at few places. The yield was 3.7% higher as compared to local check

Table 3. Yield performance of Tijaban-10 in micro plot trial during 2006-07.

S. No.	Location	Tijaban-10	AZRI-96	Sariab-92	Local white
1.	AZRC, Quetta	1327	1010	Not tested at location	1284
2.	Killa Saifullah	2973	2613	2320	1210
3.	Killa Saifullah 2	2673	2208	-	1093
3.	Loralai	1667	1530	1430	1142
4.	Mastung	1970	1787	-	1243
	Average	1922	1829	1875	1194
	% Increase over check	48			

The Candidate variety Tijaban-10 yielded 48% higher as compared to local white

Table 4. National uniform wheat yield trials (Rainfed) pooled analysis 2006-2007.

NUWYT. NO	Line Variety	Source	Pakistan
1	99FJ03	BARS-Fatehjang	3718
2	SN-128	ARS-Sarai Naurang	3733
3	V-04188	AARI, Faisalabad	3692
4	PR-92	CCRI-Pirsabak	3146
5	Cham-6 (6th out of 12)	AZRC, Quetta	3665
6	NR-268	NARC, Islamabad	3787
7	DN-1	AZRI-D.I. Khan	3422
8	V-01BT002	AARI, Faisalabad	3521
9	NR-271	NARC, Islamabad	3677
10	03FJ26	BARS-Fateh Jang	3407
11	PR-91	CCRI-Pirsabak	3440
12	-	Local Check	3437
Grand mean			**3576**
CV			**14.0**

Disease screening results

Yellow/stripe rust of wheat, caused by *Puccinia striiformis* Westendorf f. sp. *tritici*, is an important disease and severe infestation has been reported both in Pakistan (Saari *et al*., 1995; Kissana *et al*., 2003) and elsewhere (Zadok & Rijsdijk 1984; Singh *et al*., 2004). Disease data was recorded by Crop Disease Research Program (CDRP) scientist during visit to Killa Saifullah, Loralai and Quetta. The data showed resistance against LR while 10 MS and 5 MS was recorded at Loralai and Killa Saifullah respectively (Table 5)**.** Saifullah et al 2011 reported effective stripe rust score of 5MS which can be evaluated further for adult plant resistance**.**

Table 5. Disease data for wheat variety Tijaban-10.

Variety	Year	Terminal Reaction	
		LR	YR
Cham-6 (Tijaban-10)	2006-2007 (Loralai)	R	10MS
Cham-6	2006-07 (Killa Saifullah)	R	5MS
Cham-6	2006-07 (Quetta)	R	0

R= Resistance

MS=Moderately Susceptible

Quality characteristics of Tijaban-10: Wheat quality depends upon the genetic factors but environmental conditions, growth locations; agronomic practices prevailing during different wheat growth stages greatly alter the wheat quality attributes. Generally wheat quality refers to its suitability for a particular end-use based on physical, chemical and nutritional properties of wheat grain. Protein content is a key quality factor that determines the suitability of wheat for a particular type of product as it affects other factors including mixing tolerance, loaf volume and water absorption capacity (Shah *et al*., 2008). Both protein quantity and quality are considered important in estimating the potential of flour for its end use quality (Farooq *et al*., 2001). The data on quality characters revealed that the seed size of Tijaban-10 is moderate with higher protein content 13.29% with 29.91% wet gluten and 10.04% dry gluten (Table 6). The chapatti quality was also found better with high acceptability by farmers of different locations.

Table 6. Quality characteristics of Tijaban-10.

Quality characteristics	Tijaban-10
1000 KW (grams)	34.73
PSI	41
ASH	1.654
Protein content %	13.29
Wet gluten %	29.91
Dry gluten %	10.04

Source: NARC

The variety has medium spike with amber color and having high more tillers per m^2 (400-450 per square meter). It's RRI (Relative Resistance Index) in 9 and 7 against Leaf Rust and Yellow Rust in Balochistan.

Its prominent character is having medium spike, with oval shaped grain having higher number of grains per spike with increased seed weight. This variety is best to grow in Loralai, Zhob, Barkhan, Musa khail, Pishin and Khuzdar districts. Tijaban-10 can tolerate cold (tolerate up to -15^{0}C) it can be planted late in districts like Quetta, Mastung, and Killa Saifullah.

Tijaban-10 a high tillering, high yielding, drought and cold tolerant variety with resistance to yellow rust strain (*Puccinia striiformis*) prevalent in rainfed areas of Balochistan. It has higher no of tillers from 415 tillers per m^2 in irrigated and 190 m^2 in rainfed areas which helps in increased yield. Late planting can affect tillering capacity of wheat varieties (Baloch *et al*., 2012) with better chapatti (Bread) making quality. Tijaban-10 also has higher grain weight (34-35 grams) with better harvest index (30-38 %) which is important factor for varieties in rainfed areas. Sharma & Bhagava, 1996 revealed that grain yield and harvest index in wheat were found to be the most reliable characters for selection under drought stress conditions. The variety has higher protein content (13.29) with 29.91 % wet and 10.04 % dry gluten which are also important factors in providing nutritional value and making of good quality flat bread. Scientist reports increase in protein during drought stress in wheat x drought interaction (Gooding *et al.*, 2003; Weightman *et al*., 2008; Noorka *et al.*, 2009). In contrast, Pierre *et al.*, 2008 observed decreased value for grain protein in wheat growing under drought stress. Tijaban-10 wheat variety was approved by Balochistan Seed Council during 2010 for commercial cultivation in rainfed areas of Balochistan (Table 7).

Table 7. Important parameters of Tijaban-10

Parameter	Data recorded
Plant height	85-90
Tillers /m^2	190 (rainfed) 415 (irrigated)
1000 Grain weight	34.73
Harvest index	30-38

Conclusion

After evaluation and testing of wheat germplasm under different agro ecological zones of Balochistan during 1997-2008, Arid Zone Research Centre developed

a new high yielding drought tolerant wheat variety Tijaban-10 which showed stability in yield with wide adaptation to different agro ecological zones (Rainfed) of Balochistan. It also showed resistance to prevailing yellow rust strain of wheat and barley which highly infests local wheat landraces during good rainfall year. Due to its higher yield potential of up to 6.5 tones ha^{-1} it can bring major improvement in productivity enhancement of resource poor farmer's of rainfed areas. The variety also performed well in irrigated areas and large scale seed production is under progress with 200 tons produced during 2008-2011.

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