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JAU-17: A First High Yielding Malting Barley Variety Suitable for Marginal Lands of Punjab

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Abstract

For the usage of beverages and malting purpose, Wheat Research Institute, Faisalabad, developed the ever first variety of barley crop with the name JAU-17 in Pakistan. It is a two rowed barley variety performed best in a series of irrigated and rain fed yield trials conducted at Wheat Research Institute, Faisalabad and outstation yield trials throughout the Punjab province. During yield trials for three consecutive years from Preliminary to Regular and advanced Yield Trials, it has out-yielded the Check Variety Haider-93 by an average of 23.37% while in Outstation Yield Trials throughout the Punjab province, it produced 11.5% higher grain yield than commercial Check variety Haider-93.

JAU-17 has medium to tall stature of about 99 to 110 cm length, growth habit is semi erect and has medium-length-awned ear which has yellowish white color. It takes 90 to 100 days to complete heading and matures in 140 to 145 days. It bears good tillering capacity (154-160 per m). The seed is amber in color with 1000-grain weight of upto 42 gram. For quality trait evaluation it has good quantity for protein (12.2 to 13.7%) and test weight (52.7 to 54.4 kg/hl) along with opaque seed surface. Its malt making quality is excellent for industrial uses. In 2019 Jau-17 was approved by Punjab Seed Council for general cultivation due to its stable performance over the years for better grain yield, resistance against rusts and nutritional quality.

Keywords: JAU-17; Barley; Moisture stress tolerance; Beverage industry; Irrigated; 2-rowed barley; Malting; Grain yield

Introduction

Barley (*Hordeum vulgare L.*) is the oldest and most widespread cereal grain. It is mostly grown in rainfed areas of Punjab, Balochistan and KPK provinces due to its higher capacity to tolerate unfavorable climatic conditions like drought, salt, heat etc. So, there is a scope for its popularization in irrigated areas also where limited water is available for irrigation. Various environmental and natural processes like spontaneous mutation and selection had contributed wider genetic diversity to barley that enhance its adaptability to adverse environmental conditions [1]. According to IPCC 2007 [2], the global surface temperature would rise by 1.8 to 4.0^0 C during 21st century and world rainfall systems would alter extensively. Decrease in yield with time is the foremost apprehension of plant breeders and they accentuate on yield improvement under less water environment [3-5]. Also Ajalli and Salehi, [6]; Ashraf, [7] described drought tolerance in crops is maybe the most multifaceted feature to appreciate. Yield is linked with varying ecological situation mainly wetness accessibility in soil that affects the development of the crop plants and relations with cultivars [8-11]. Furthermore, in Pakistan barley production has declined resulting in spending large amount of foreign exchange on its import. Beverage industry in Pakistan requires good malting quality 2-rowed barley varieties for the production of better quality products. Unluckily in Pakistan proper attention was not been given in the past for the development of good quality 2-rowed barley varieties. The barley varieties released in the past are 6-row type and are not suitable for

industrial purposes. The advanced line B-09008 (Jue-17) has performed best in a series of irrigated and rainfed yield trials conducted at Wheat Research Institute, Faisalabad and outstation yield trials. The proposed variety is 2-row type and has good yield, lodging resistant, moisture stress tolerant, bold grains and other desirable grain quality attributes therefore, is suitable to be retained as commercial variety. Barley has wider adaptability worldwide but data showed decreasing trend during last decade at international level [12].

Materials and Methods

A new barley genotype having parentage of LEGIA/LAUREL'S'//ALELI/3/ARTA and pedigree as ICB98-1076-32AP-0AP was grown during 2008-09 in nursery of International Barley Crossing Block (IBCB) with the Entry No-79. Its phenotypic performance and yield attributes made a path for inclusion in station yield trials under the code name B-09008 for evaluating yield and yield related traits against commercial check variety Haider-93 during 2009-10. The entry was tested in preliminary Yield Trial (BA Trial) which was laidout in Randomized complete block design in triplicate while individual plot size was set at 6 m^2 (4 rows, 30 cm apart, 5m in length). The entry B-09008 produced 9.2% higher grain yield than commercial check variety Haider-93 and thus it was promoted to Regular Barley Yield Trial (B-Trial) and later to Advanced Yield Trial (C-Trial) during 2010-11 and 2011-12, respectively. The site for the conduction of these trials was field area of Wheat Research Institute (WRI), Faisalabad.

In Out-station Yield Trials it was tested throughout the Punjab province from 2012-13 to 2013-14 and 2015-16 to 2016-17 in Punjab Uniform Barley Yield Trial for four years. This testing provided information related to wider adaptability & yield stability in different locations throughout Punjab province against common commercial check variety Haider-93 for comparison. This entry was also undergone from standard disease screening experiments against local rusts from 2014-15 to 2015-16 in different ecological zones of the country. For three consecutive years from 2014-15 to 2016-17, B-09908 was also tested in rainfed conditions at WRI, Faisalabad. To determine quality traits, the parameters were estimated at Cereal Technology Laboratory of WRI, Faisalabad from seed samples of PUBYT trials under the standard procedures set by American Association of Cereal Chemists and International Association for Cereal Science and Technology [13]. The developmental history in brief is presented in Table 1 below.

S. No	Year	Generation/trial
	2008-09	LEGIA/LAUREL'S'//ALELI/3/ARTA
	2009-10	A-trial Under Code No. B-09008
	2010-11	B-trial Under Code No. B-09008
	2011-12	C-trial Under Code No. B-09008
	2012-13	Punjab Uniform Barley Yield Trial
	2013-14	Punjab Uniform Barley Yield Trial
	2015-16	Punjab Uniform Barley Yield Trial, Rainfed Yield Trial
	2016-17	Punjab Uniform Barley Yield Trial, Rainfed Yield Trial

Table 1 : Development History of B-09008.

Results and Discussion

The proposed variety B-09008 was evaluated for four years in out-station yield trials throughout the Punjab province for yield stability and wider adaptability but was not be tested at national level as ample resources were not available to do that. The variety paved the path of following yield trials throughout the course of approval.

Station Yield Trials

This entry B-09908 was tested in Preliminary, Regular and Advanced Yield trials (BA, BB & BC) for three consecutive years in Station Yield trials. During preliminary yield trial it was tested in sixteen entries trial in triplicate and compared with local check variety Haider-93 in field area of WRI, Faisalabad during 2009-10 (Table 2). It produced 9.2% higher grain yield than commercial check variety Haider-93 and resistance against leaf rust (Lr = 0) and yellow rust (Yr = 0) thus it was promoted to Regular Barley Yield Trial (B-Trial) and later to Advanced Yield Trial (C-Trial) during 2010-11 and 2011-12, respectively, where it produced 77% and 8.5% higher grain yield than Haider-93.

S. No.	Year	Type of trial	Yield kg/ha		Percent Increase over Check
			B-09008	Haider-93	
1	2009-10	A-TRIAL	3278	3002	9.2
2	2010-11	B- TRIAL	2486	1400	77
3	2011-12	C- TRIAL	2442	2250	8.5
Average			**2735**	**2217**	**23.37**

Table 2: Yield Performance Of "B-09008" In Station Yield Trials.

Out-station Yield Trials

After producing 23.37% higher grain yield than commercial check variety in Station Yield Trials, the advanced line B-09008 was selected for Out-station yield Trials throughout the Punjab province for four years and again it out yielded the check variety Haider-93 by 12.07%, 6.13%, 2.6% and 23.34% respectively. The yield data are presented in Table 3.

PUBYT 2012-13			
Sr. No.	**Locations**	**B-09008**	**Haider-93**
1	Wheat Research Institute, Faisalabad	4154	3211
2	Rice Research Station, Bahawalnagar	2567	2096
3	Depalpur	1684	1794
4	Oil Seed Research Sub Station, Piplan	1717	1960
5	Adaptive Research Farm, Vehari	2320	2038
	Average Yield	2488	2220
	% inc over check		**12.07**
PUBYT 2013-14			
1	Wheat Research Institute, Faisalabad	2242	1981
2	Horticultural Garden, Renalakhurd Okara	1701	1714
3	Oil Seed Research Sub Station, Piplan	2234	2124
	Average Yield	2059	1940
	% inc over check	-	**6.13**
PUBYT 2015-16			
1	Wheat Research Institute, Faisalabad	2649	2494
2	Horticultural Garden, Renalakhurd Okara	2838	3327
3	Rice Research Institute, Kala Shah Kaku	2539	2274
4	Gram Research Sub Station, Kallur Kot	2862	2601
5	Adaptive Research Farm, Karor	2732	2584
	Average Yield	2724	2656
	% inc over check	-	**2.6**
PUBYT 2016-17			
1	Wheat Research Institute, Faisalabad	3597	2394
2	Govt. Seed Farm Dhakkar, Pakpattan	4168	2877
3	MMRI, Yousafwala Sahiwal	3022	2969
4	Adaptive Research Farm, Gujranwala	2736	2708
5	Rice Research Institute, Kala Shah Kaku	3097	2528
	Average Yield	3324	2695
	% inc over check	-	**23.34**
	Average Yield (Five Years)	2649	2378
	% inc. over check (Fo Years)	-	**11.4**

Table 3 : Yield Performance Of "B-09008" In Punjab Uniform Yield Trials During Four Years From 2012-13 To 2013-14 & 2015-16 To 2016-17.

Rainfed Yield Trial

The performance of B-09008 was also tested in Rainfed Yield Trial for consecutive two years (2015-16 to 2016-17) to check its performance in water scarce localities where it produced marvellous results against commercial check variety Haider-93. On overall mean basis it produced 14.86% higher grain yield than check variety while in rainfed conditions only the higher grain yield than Haider-93 was 13.8% which is a clear indication of its performance in drought prone areas. These results coincide with the findings of Subhani *et al.*, [14] where B-09008 produced best grain yield as compared all other entries in water stress conditions. Studies of Tokhetova, et al., [15] also found that hull-less barley varieties had higher adaptability to stress environmental conditions particularly water stress. Similarly, studies of Boudiar *et al.*, [16] showed various barley morphological traits (root and shoot) that contribute tolerance of barley in water stress conditions. The results are given in Table 4 below.

Year	2015-16		2016-17	
Name	**B-09008**	**Haider-93**	**B-09008**	**Haider-93**
Normal Irrigation	2509	2696	3459	2454
Rainfed conditions	2381	2226	2811	2339
Average Yield	2445	2461	3135	2397
% inc over check (Two Years)				**14.86**

Table 4: Yield Performance of "B-09006" in Rainfed Yield Trials.

Disease screening studies

This new genotype was screened for determining response against incidence of yellow and leaf rust in Local disease screening nursery (LDSN) at multiple locations (Bahawalpur, Khanewal, Faisalabad, Islamabad, Pirsabak, Peshawar) for two years from 2014-15 and 2015-16. The advanced line did not show any sign of Yellow and leaf rust incidence and hence can be considered as rust tolerant barley variety. These results justify its field adaptation in such a shifting climatic condition and hence it is very important for further use in different barley breeding programs.

Quality parameter

Different quality attributes were tested for this proposed variety B-09008 against other advanced lines and commercial check variety Haider-93. Its grain size is bold with thousand grain weight ranging from 41.53 to 34.43 and protein contents from 13.7 to 12% while Test weight range is from 58 to 52.7 kg/hl. All these quality parameters are better than check variety Haider-93 from commercial view point also as compared in Table 5 below.

Year	2012-13			2013-14	2015-16	
Quality Characteristics	**B-09008**	**Haider-93**	**B-09008**	**Haider-93**	**B-09008**	**Haider-93**
1000 Grain wt. (g)	41.53	36.4	34.43	32.7	36.3	32.0
Test wt. (kg/hl)	58	56.3	52.7	51.8	54.4	53.3
Protein (%)	12	11.7	13.7		12.2	13.7

Table 5: Quality Characteristics Of B-09006 From 2012-13 To 2015-16.

Entry Name	Moisture %	Protein %	Starch %	Hardness HI	Diameter mm	1000 kernel weight g	Pearled grain weight g out of 100 g husked
MB- RWP-A	10.6	10.3	59.3	57	2.71	40.98	71.15
MB-RWP-B	11.2	9.3	59.6	63	2.66	38.06	68.40
Jau-17	10	11.9	58.8	64	2.67	47.86	73.60
Haider-93	11.6	10.87	58.4	60	2.57	33.71	65.70

Table 6: Quality Characteristics Of B-09008 Compared With Commercial Cultivars.

This proposed variety was further tested with 2-rowed head type commercially malt producing cultivars named MB-RWP-A and MB-RWP-B which are presently in use by famous private companies of Pakistan for the purpose of malt production at commercial scale. The quality standards of starch contents & pearled grain weight of B-09008 resemble with the commercial cultivars to a great extent and hence it can be suggested that it is fit for better malt production also which is another plus point for its approval.

Distinctiveness, Uniformity and Stability (DUS) Test & Final approval from ESC and PSC

After successfully Outyielding the commercial check variety Haider-93 in Station and Out-station Yield Trials and proving disease resistance, it was tested in DUS Trials continuously for two years starting from 2015-16 to 2016-17 where it performed well and showed the specific, stable and uniform characteristics. After DUS test the variety Jau-2017 got a successful spot examination by the famous scientists and researchers of the Punjab Agriculture Department and on the basis of that it was promoted to 78th meeting of Experts Sub Committee of Elite Researchers and stakeholders, who recommended it for Punjab Seed Council for final approval as a separate variety. Later it finally got it approval from Punjab Seed Council for general cultivation throughout the Punjab province firstly for two years in 2017 and then finally for continuous cultivation in 2019.

Botanical Attributes of Jau-2017

Jau-17 has medium to tall stature of about 99 to 110 cm length, growth habit is semi erect and has medium-length-awned ear which has yellowish white color. It takes 90 to 100 days to complete heading and matures in 140 to 145 days and bears good tillering capacity (154-160 per m). Its amber colored seed is medium to bold sized and elliptical with deep groove and has opaque surface. The Germ size of the seed is medium. For quality trait evaluation it has good quantity for protein (12.2 to 13.7%) and test weight (52.7 to 54.4 kg/hl) along with opaque seed surface. Its malt making quality is excellent for industrial uses.

Its tolerance against the local rust races with quality malt for industrial use and stability in different agro-ecological zones of irrigated and rainfed areas of Punjab are main factors for its approval, for general cultivation throughout the Punjab province from Punjab Seed Council during the year 2019.

Conclusion

Wheat Research Institute, Faisalabad has already developed four barley varieties upto date but Jau-17 is first 2- rowed barley variety of this institute. A 2-rowed barley variety was direly needed by the beverage industry for malt purpose. Along with fulfilling the demand of local industry its export bill also earned foreign exchange for the country. Its cultivation will be widely spread under areas of water stress as it has tolerance against water stress. The foreign exchange earned for two rowed barley grain for the local industry use will be saved.

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