CROP BREEDING AND APPLIED BIOTECHNOLOGY

CULTIVAR RELEASE

DBW222 (Karan Narendra): A new high-yielding, lodging-tolerant wheat variety for North Western plains of India

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Abstract: *DBW222 is characterized by potential yield of 8210 kg ha^{-1} under high fertility when sown in timely conditions in North India. It possesses better agronomic attributes and has better adaption to sowing time, high rust resistance, quality attributes, and lodging tolerance because of a shorter 2nd internode and wider diameter.*

Keywords: *Wheat breeding, high yield, lodging tolerance.*

INTRODUCTION

Wheat is one of the most important crops for global food security; it is widely cultivated on more than 200 million ha of land and produces more than 781 million tonnes annually to feed the world (Wheat Initiative 2019). The significant growth of global wheat productivity has been made possible through technological advancements in wheat genetics including semi-dwarf varieties, favourable policies, research programmes and markets, and irrigation infrastructures that ultimately reduce hunger and poverty (Stone 2019). India produces more than 100 million tonnes of wheat annually (MOA/ FW 2019). The most productive region is found in the North West of Indo- Gangetic Plains.

Changing weather patterns such rain, wind, and hailstorms have made the current varieties more susceptible to lodging, leading up to 80% yield losses (Feng et al. 2019). The morphological traits that are most commonly associated with lodging tolerance are plant height, culm diameter and thickness, strength of upper and lower internodes, thickness of stem wall, and others (Feng et al. 2019). There is substantial genetic variability in wheat (Cruz et al. 2005). Multi-environmental evaluation of genotypes provides accurate information regarding performance, adaptability, and stability of the genotypes (Woyann et al. 2019, Singh et al. 2019). During the recent decade, two cultivars (HD2967 and HD3086) were predominant among wheat varieties, covering more than 50%

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of the area growing wheat in Northern India. Recently, HD2967 has become susceptible to yellow rust. The new wheat variety DBW222 is suitable for the irrigated timely sowing conditions of the North Western Plains Zone (NWPZ) that comprises the areas of Punjab, Haryana, Delhi, Rajasthan (except Kota and Udaipur divisions), Western Uttar Pradesh (except Jhansi division), parts of Jammu and Kashmir (Jammu and Kathua districts), and parts of Himachal Pradesh (Una district and Paonta valley) and Uttrakhand (Tarai region).

BREEDING METHODS

DBW222 is a selection from a cross made at CIMMYT, Mexico, during crop season 2009–10 between KACHU/SAUAL as the female parent, and ATTILA*2/PBW65/6/PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1/7/ATTILA/2*PASTOR as the male parent. The selected bulk method was adopted from F_2-F_3 generations, followed by single plant selection in the F_4 generation to develop the line. During 2014–15, this entry was evaluated in the 2nd South Asia Early Sown Yield Trial at ICAR-IIWBR Karnal against the check variety DPW621-50. On the basis of its superior performance, this entry was promoted to the IIWBR station trial during 2015-16 for yield and other morphological traits. The genotype was found promising (4670 kg ha^{-1}), with 10.67% more than the check WH1105 (4220 kg ha^{-1}). During 2016-17, it was evaluated in National Initial Varietal Trial-1A (NIVT) under the All India Coordinated Research Project as DBW222 at eight locations in simple lattice design with plot size (7.2 m^2) under irrigated timely-sown conditions against checks HD2967, WH1105 and DBW88. During 2017-18 and 2018-19, the genotype was evaluated at 25 and 19 locations, respectively, for yield and yield attributes in advanced varietal trials (AVTs) in randomized block design with four replications and plot sizes of 14.4 m^2 against four checks (HD2967, WH1105, DBW88, HD3086). The entry was also characterized in terms of Distinctness, Uniformity and Stability traits as per the standard procedures for varietal identification in wheat (Gupta et al. 2017).

DBW222 and the check varieties were artificially screened for stripe and leaf rust throughout the yield evaluation process. The average coefficient of infection (ACI) for both the rusts was calculated following Saari and Wilcoxson (1974) by multiplying disease severity and constant values of infection type. The constant values for infection types were used based on the following: R = 0.2, MR = 0.4, M = 0.6, MS = 0.8 and S = 1.0. The seedling resistance test against 18 races of stripe rust and 21 races of leaf rust was carried out for gene postulation using pathotype matching techniques. DBW222 was also evaluated for timely, late and very late sown conditions at 10 locations of NWPZ against the check varieties HD3086 and HD3226. Quality attributes such as grain appearance score, hectolitre weight, protein%, sedimentation value, grain hardness, Chapati quality, bread loaf volume, bread quality, biscuit spread factor, wet and dry gluten %, gluten index, Fe and Zn content, and high molecular weight subunits were determined as per standard procedures and protocols (Carlos et al. 2019). To evaluate stem attributes, recordings of lower internodes for length, diameter, dry weight, and internal diameter of second internode were carried out at maturity (Mirabella et al. 2019). Traits such as internode width and hollow diameter (using Vernier callipers) and the length of internodes (using scale) were recorded at the time of maturity. Statistical analysis was carried out using SAS Institute (2011).

PERFORMANCE CHARACTERISTICS

Varietal descriptors

DBW222, a spring wheat variety with semi-erect habit, flowers in around 95 days, matures in 143 days, and is classified as a medium maturity group (Table 1). The variety has dark green foliage and waxy attributes at the time of ear emergence. The ears are tapering and white in colour with medium density, having medium length awns that are white in colour. The peduncle is bent in shape. The non-pubescent glumes have elevated shoulder shape with very long beak lengths. Amber coloured grains having oblong shape tend to have hard texture and are bold in size. The grains have round creases with wide germ width. The brush hair is shorter in length with a weak profile (ICAR 2017, 2018, 2019a)

Yield evaluation

In NIVT-1A, DBW222 with an average yield of 6410 kg ha^{-1} significantly out-yielded all the check varieties *viz.*, HD2967, WH1105 and DBW88 (Table 2). In AVT-I during the year 2017-18, DBW222 recorded yield of 5800 kg ha^{-1} which was significantly superior to all checks of the zone. In the final year of its evaluation, AVT-II (2018-19) the variety (6440 kg ha^{-1}) once again proved its superiority in comparison to all the checks. The average yield of DBW222 (6130 kg ha^{-1}) was

Table 1. Morphological and DUS Traits of DBW222

Ancillary Traits	Description	DUS Traits	Description
Heading Days	95 (89–103)	Growth Habit	Semierect
Maturity Days	143 (139–150)	Anthocyanin pigmentation (Coleoptile, Leaf Sheath, Auricle (at flag leaf stage)	Absent
Plant Height (cm)	103 (98–108)	Foliage Colour Boot Stage	Dark green
1000–grains weight	42 (41–44 g)	Waxiness at ear emergence (Flag leaf, leaf sheath, ear and peduncle	Present
DUS Traits	**Description**	Peduncle Shape	Bent
Awn	Medium length and white colour	Ear	White colour, tapering shape and intermediate density.
Glume	Glumes are non–pubescent with elevated shoulder shape, very long beak length		
Grain	Amber colour, hard texture, oblong shape and bold size. Round crease width and wide germ width. Weak brush hair profile and short brush hair length		

Table 2. Yield Performance of DBW222 in AICRP* Yield Trials (2016-2019)

Item	Year of testing	No. of trials	DBW 222	Check Varieties					C.D.
				HD 2967	WH 1105	DBW 88	HD 3086	DPW 621-50	
Mean yield (kg ha^{-1})	2016-17	8	6410	4870	5800	5270	-	-	260
	2017-18	25	5800	5290	5360	5330	5590	5410	80
	2018-19	19	6440	5830	6270	6100	6280	6110	90
	Weighted Mean	-	6130	5420	5760	5600	5890	5710	
Comparison of mean of DBW222 with checks (Z test)	P (T<=t) two-tail			0.0002	0.043	0.0062	0.215	0.0375	
% Increase / decrease over checks & qualifying varieties	2016-17	-	-	31.6*	10.5*	22.2*	-	-	
	2017-18	-	-	9.6*	8.2*	8.8*	3.75*	7.20*	
	2018-19	-	-	10.5*	2.7*	5.6*	2.54*	5.40*	
	Mean		-	13.1	6.4	9.4	4.0	7.3	
Yield potential (highest yield harvested) (kg ha^{-1})			8210	6920	7590	7730	7320	7220	
Statistically superior group			29/52	9/52	10/52	9/52	14/44	7/44	

* AICRP- All India Coordinated Research Project.

compared with the mean value of the check varieties following z test and it was observed than DBW222 was significantly superior to all the checks except HD3086. It showed a potential yield of 8210 kg ha^{-1} and stable performance across the zone by appearing 29 out of 52 times in the statistically superior group (ICAR 2017, 2018 and 2019a).

Stem attributes for lodging tolerance

Stem traits for DBW222 and those of check varieties HD2967, HD3086, DBW187, and DBW88 were recorded. Among the various traits, high coefficients of variation were observed for dry weights of various internodes. The maximum was for the 2nd internode (Table 3). DBW222 had high dry weight of the 2nd internode (0.35 g) that was significantly higher than those of the check varieties. The variety had a significantly higher 1st (50.0 mm) and 2nd internode diameter (48.67 mm) along with a shorter 2nd internode (8.66 cm) (Figure 1). These traits contribute significantly to the strong stem strength of DBW222. Stem lodging is caused by weak culms that are genetically inherited (Cruz et al. 2005). Morphologically, this can be improved by increased basal stem strength through increased stem diameter and culm wall thickness (Berry et al. 2000). During the 2019-20 season, the seeds of DBW222 were distributed among farmers of NWPZ for popularization of the new variety; the bad weather conditions in India in 2019-20 resulted in lodging of other wheat varieties at the farmers' fields; however, DBW222 showed tolerance to lodging, as demonstrated in a number of publicly available videos (Gosain D 2019, Crops Information 2020a, b, Hi Tech Supar Seed 2020).

Wider sowing window

The performance of DBW222 against the two check varieties *viz.,* HD3086 and HD3226, showed that under timely (6153 kg ha^{-1}), late sown (5019 kg ha^{-1}) and very late conditions (4071 kg ha^{-1}) at 10 locations, DBW222 performed best

Table 3. Stem traits of different varieties in wheat

SN	Trait	DBW222	DBW 88	HD 3086	HD 2967	DBW187	CD	CV
1	1st Internode diameter (mm)	50.00	30.67	31.33	35.00	38.67	0.74	1.5
2	2nd Internode diameter (mm)	48.67	29.33	36.00	41.33	39.67	0.14	2.8
3	1st Internode length (cm)	5.30	6.10	8.17	2.90	5.10	0.53	7.7
4	2nd Internode length (cm)	8.66	9.33	9.83	9.73	9.33	0.66	5.7
5	3rd Internode length (cm)	10.77	16.67	12.83	10.73	11.90	0.97	6.2
6	Dry weight (g) 1st Internode	0.21	0.14	0.23	0.12	0.23	0.03	13.3
7	Dry weight (g) 2nd Internode	0.35	0.29	0.19	0.25	0.27	0.16	46.5
8	Dry weight (g) 3rd Internode	0.30	0.24	0.22	0.28	0.32	0.04	11.8

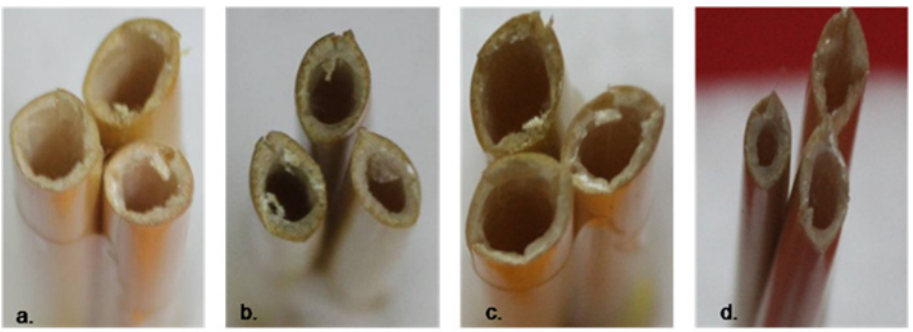

Figure 1. Transverse section of 2nd internodes of a) DBW222, b) HD2967, c) HD3086, and d) DBW88.

under all the three conditions; reduction of only 18.43% was observed when it was sown in the mid-December and reduction of 33.83% was observed when it was sown in the first week of January, values that were lower than both the check varieties. The higher yield in comparison to checks was recorded under all the three conditions indicating wider adaptability of the variety to the variable sowing time (ICAR 2019b).

Resistance to fungal diseases

DBW222 has shown tolerance against natural infection with yellow rust (ACI = 9.0). Under artificial screening, ACI of 14.6 was observed, which was much lower than that of most of the checks (Table 4). At present, wheat variety HD2967 occupies the maximum acreage in India and has now became susceptible to stripe rust (ACI = 42.9). For leaf rust, DBW222 recorded high levels of resistance with low ACIs of 0.3 and 2.5 under natural and artificial screening, respectively. Gene postulation indicated the presence of the *Lr*26 + *Lr*23+ gene combination for leaf rust and *Yr*9+ for

Table 4. Evaluation of DBW222 along with checks for different diseases

Diseases	DBW222	HD2967	WH1105	HD3086	DBW88	DPW621-50
Rusts	*HS (ACI)	HS (ACI)	HS (ACI)	HS (ACI)	HS (ACI)	HS (ACI)
Stripe rust (natural)	40S (9.0)	60S (42.9)	60S (22.7)	60S (9.6)	60S (22.9)	60S (17.9)
Stripe rust (artificial)	60S (14.6)	80S (37.5)	80S (33.2)	40MS (10.0)	80S (43.4)	80S (45.5)
Leaf rust (natural)	tS (0.3)	10S (5.0)	5S(2.0)	20S (7.5)	20S (5.0)	10MS (2.0)
Leaf rust (artificial)	10S (2.5)	30S (6.5)	60S (17.0)	40S (28.1)	20S (4.1)	20S (4.7)
			Gene postulation			
Stripe rust	Yr9+	Yr2+	Yr2+	Yr2+	YrA+	-
Leaf rust	Lr26+23+	Lr23+	Lr13+	Lr13+10+	*Lr13+10+3+*	*Lr13+10+*
			Other Diseases			
Karnal bunt	9.1 (4.0)	16.1 (6.7)	26.4 (10.6)	15.2 (6.7)	17.8 (6.1)	16.7 (5.9)
Loose smut	14.6 (4.9)	51.2 (26.6)	26.9 (15.7)	17.8 (7.6)	36.6 (17.6)	53.1 (29.1)

* HS – Highest Score; ACI – Average Coefficient of Infection.

stripe rust. The variety recorded an average score of <5% infection under artificial screening for Karnal Bunt and loose smut, indicating its higher resistance (ICAR 2019c).

Quality attributes

The quality characteristics of DBW222 and check varieties of the zone were evaluated. The variety recorded better chapatti quality score (7.50), higher loaf volume (648 mL), and higher biscuit spread factor (8.45) than the checks. It had perfect Glu-1 score (10), indicating better protein quality. The other quality parameters of the variety are acceptable as per the prescribed standards (ICAR 2019d).

Notification and seed production

Cultivar Karan Narendra (DBW222) was released and notified by the central sub-committee on crop standards, notification, and release of varieties *vide* notification in the official gazette number S.O.99 (E), dated 6th of January, 2020. The ICAR–Indian Institute of Wheat and Barley Research is the maintainer of this cultivar and the producer of the nucleus and breeder seeds.

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