

## Development and evaluation of high yielding, multiple disease resistant bread wheat variety - Karan Vandana (DBW187)

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### Abstract

Wheat cultivation in India has been primarily dominated by the high productive environments of Indo-Gangetic plains. The North Western and North Eastern Plains are two mega environments for wheat production in the country in terms of area and production. For sustaining the high productivity levels in these areas, a constant demand of improved wheat varieties from the wheat breeding programs is desired. A high yielding bread wheat cultivar DBW187 (Karan Vandana) has been developed and released for cultivation in these areas after testing in trials under AICRP on Wheat and Barley. DBW187 is a high input responsive wheat genotype which has shown a significant yield superiority under early sown irrigated conditions of North Western Plains Zone over the checks HD 2967 and HD 3086 during 2018-19. Average yield of DBW187 during two years of testing was recorded to be 61.28 qha<sup>-1</sup>. Earlier under evaluation in the North Eastern Plains Zone, this variety has shown an average yield of 48.8 qha<sup>-1</sup> with a potential yield of 64.7 qha<sup>-1</sup>. The variety was released by Central Sub-committee on Crop Standards, Notification and Release of variety, Ministry of Agriculture, Government of India *vide* notification No. S.O. 1498(E) dated 01.04.2019 for cultivation in the NEPZ of India and subsequently it was extended to NWPZ *vide* notification S.O. 98(E) dated 06.01.2020. DBW187 is having a high yield potential along with disease resistance and superior grain quality. The ability to adopt across variable growing conditions in two different zones is a huge advantage for this genotype and will also go a long way in sustaining its cultivation in the region.

**Keywords:** DBW187, high yield potential, karan vandana, rust resistance, wheat,

## 1. Introduction

Bread wheat (*Triticum aestivum* L., 2n = 6x = 42, AABBDD) is staple food of 35% of the world's population and provides ~20% of the protein consumed by humans (Shifrew *et al.*, 2013). To meet the growing demand of wheat with shrinking acreage, has been a challenge to sustain wheat production. Estimates are that to feed the increased human population of about 9 billion by 2050, wheat production will need to be increased by more than 60%, which is a huge challenge considering the changing global climate and reducing arable land (Müller *et al.*, 2018). Genetic improvements in wheat play a crucial

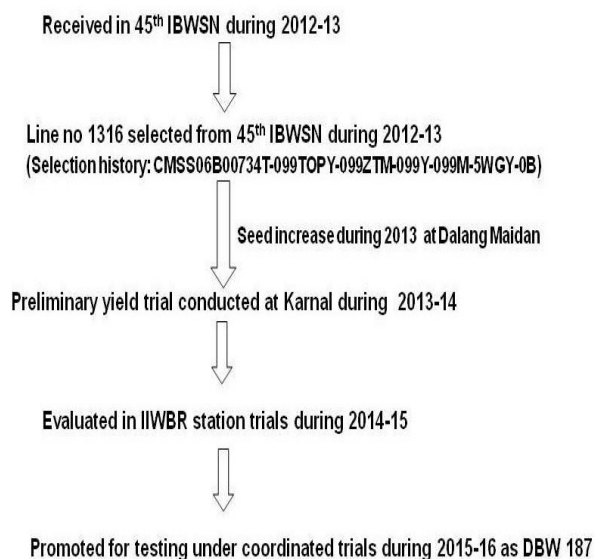
role in enhancing crop productivity and in meeting the current and future food security requirements. Breeders throughout the world including India have succeeded in achieving significant gain in productivity (Rajaram and van Ginkel, 1996). The All India Coordinated Wheat Improvement Project (AICWIP) was started in 1965 is one of the largest crop improvement network projects which set the dawn for the 'Green Revolution' in India. Indian wheat area is divided into five agro-climatic zones due to diverse production environments *viz.*, Northern Hills Zone (NHZ), North Western Plains Zone (NWPZ), North Eastern Plains Zone (NEPZ), Central Zone (CZ)

and Peninsular Zone (PZ). Among all the zones, NWPZ is the largest followed by NEPZ wheat producing zone with respect to area and production. The major challenge in these two zones is to sustain the wheat production by higher yield potential varieties having resistance to major diseases and wide adaptability under changing climate. Some of the landmark wheat varieties released in India are C 306, Kalyansona, Sonalika, HD 2009, WL 711, HUW 234, HD 2189, WH 147, Lok 1, HI 617 (Sujata), UP 262, UP2338, HD 2285, HD 2329, Raj 3765, HD 2733, PBW 343, PBW 550, DBW 17, GW 273 GW 322, HD2967 and HD 3086. India is second largest producer of wheat in the world. The area, production, and productivity of wheat in India in 2018-19 was 29.14 million ha, 102.2 million tons and 33.71 qtls/ha, respectively (ICAR-IIWBR, 2019a). Development and evaluation of disease resistant wheat lines has contributed in successful implementation of breeding goals across wheat improvement programs in the country (Kumar *et al.*, 2014, Yadav *et al.*, 2017). During the last decade, two cultivars HD2967 and HD3086 predominant wheat varieties covering more than 50 *per cent* area under wheat in the Northern India (Yadav *et al.*, 2017). Of late HD2967 has become susceptible to yellow rust of wheat. In this perspective, a new wheat genotype DBW 187 (Karan Vandana) has recently been developed and released for cultivation in NWPZ and NEPZ.

## 2. Materials and methods

The 45<sup>th</sup> IBWSN nursery received in 2012 from CIMMYT, Mexico consisting of 100 genotypes. The nursery was planted during Rabi 2012-13 at IIWBR, Main Research Farm. A selection from entry no. 1316 with pedigree of NAC/TH.AC//3\*PVN/3/ MIRLO/BUC/4/2\*PASTOR/5/KACHU/6/KACHU was made and evaluated in preliminary yield trial during *rabi* 2013-14 in augmented design. This genotype was evaluated in multilocation station trial of IIWBR, Karnal during 2014-15 in simple lattice design. Figure 1 depicts flow chart of details of development and evaluation of DBW 187 in coordinated trials. In 2015-16 the entry was promoted and evaluated in national trial NIVT-1A as DBW 187 at 18 locations in NWPZ and NEPZ. The genotype was promoted to AVT-IR-TS-NEPZ and was evaluated in 12 rows of six metre spaced at 20 cm with four replications in randomized complete block design at 20 locations during 2016-17 and 2017-18. DBW 187 was also evaluated in Special – High Yield Potential Trial during 2018-19 in NWPZ. With the additional application of the NPK (150% of recommended dose) and growth regulators Chlormequat chloride (Lihocin) @ 0.2%+ Tebuconazole (Folicur 430 SC) @ 0.1% of commercial product dose

(Tank mix application) at first node and flag leaf the trial genotypes were evaluated at six locations in randomized complete block design with plot size of 12 rows of 6 metre length 20cm apart. Rust severity and response in the field was scored following Loegering (1959) 0-100 scale. For statistical analysis the rust reactions were converted into a coefficient of infection (COI) as used by Loegering (1959). Gene postulation for rust resistance genes was done after multipathotype testing at seedling stage scoring 0-4 scale



**Fig.1:** Flow chart of details of development of bread wheat variety DBW 187

of Stakman (1962). PPVFRA guideline for the conduct of test for Distinctiveness, Uniformity and Stability (DUS) on wheat (*Triticum aestivum* L.) was followed for characterization of DBW 187.

## 3. Result and discussion

### 3.1. Yield evaluation in NEPZ trials

The performance of DBW 187 was assessed in station trial of IIWBR during 2014-15 wherein this line was tested as RWP 2014-03. It was ranked first with an average yield of 42.6 qha<sup>-1</sup>. Based upon its superiority over checks the genotype alongwith other test entries and check varieties were evaluated for three years i.e. 2015-16 (NIVT-1A), 2016-17 (AVT-IR-TS-TAS-NEPZ) and 2017-18 (AVT-IR-TS-TAS-NEPZ) under All India Coordinated Wheat Improvement Program (AICWIP). DBW 187 showed a superior and stable yielding ability under timely sown conditions at various locations of North-eastern India over the three years (2015-16 to 2017-18) in the coordinated trials as compared to all the checks HD 2733, K 0307, DBW 39, K 1006 and HD 2967 (Table 1). The variety DBW 187

**Table 1:** Performance DBW 187 over checks for grain yield under coordinated trials in NEPZ from 2015-16 to 2017-18

Item	Year of testing	No. of trials	DBW187	HD 2733 (C)	K0307 (C)	DBW 39 (C)	K1006 (C)	HD 2967 (C)	CD
Mean Yield qha <sup>-1</sup>	NIVT 1A (2015-16)	7	48.5(2)*	-	43.9(7)	-	-	45.2(4)	2.5
	AVT I (2016-17)	16	48.8(1)*	45.7(6)	46.1(4)	45.8(5)	46.5(3)	44.7(7)	1.1
	AVT II (2017-18)	13	48.9(1)*	45.5(14)	45.7(11)	47.6(3)	45.6(13)	44.9(15)	0.9
	Weighted Mean	36	48.78	45.61	45.53	46.61	46.10	44.84	
% Increase or decrease over checks and qualifying varieties	NIVT 1A (2015-16)	--	--	-	10.5**	-	-	7.3**	--
	AVT I (2016-17)	--	--	6.8**	5.6**	6.6**	4.9**	9.2**	--
	AVT II (2017-18)	--	--	7.5**	7.0**	4.7**	7.2**	8.9**	--
		--	-	6.8**	7.0**	4.65**	5.81**	8.7**	
Frequency in top NS group	NIVT 1A (2015-16)	--	4/7	-	3/7	-	-	2/7	
	AVT I (2016-17)	--	12/16	7/16	6/16	4/16	7/16	4/16	
	AVT II (2017-18)	--	7/13	3/13	3/13	2/13	1/13	4/13	
	Total	--	23/36	10/29	12/36	6/29	8/29	10/36	

\* indicates the entries in the first non-significant group; values in parentheses is the rank of the entry

\*\*indicates significant superiority of DBW 187 over the entry

was found significantly superior to all the checks during three years of testing with an overall superiority of 8.7 %. The frequency of occurrence of DBW 187 in the top non-significant group was highest amongst all test entries and checks. It was 23/36 in top non-significant group on overall basis of 3 years as compared to HD 2733 (10/29), K 0307 (12/36), DBW 39 (6/29), K 1006 (8/29) and HD 2967 (10/36) (ICAR-IIWBR 2018a, ICAR-IIWBR 2017a, ICAR-IIWBR 2016). The yield potential of DBW 187 under AVT was as high as 64.7qha<sup>-1</sup> at Dumka location during 2017-18 which was highest as compared to all the checks (Table 1).

### 3.2. Yield evaluation in NWPZ trials

During 2015-16 under NIVT-1A, DBW 187 had shown significant yield advantage over the popular variety

HD2967, out yielding this mega variety with an increase of 6.3 %. DBW 187 had frequency of 9 out of 16 times in the first non-significant group during two years of coordinated testing (ICAR-IIWBR, 2019b; ICAR-IIWBR, 2016). DBW 187 was also evaluated in the Special High Yield Potential Trial (HYPT) under early sown irrigated conditions in NWPZ under AICWIP during 2018-19. DBW 187 was found to be high input responsive wheat genotype which has shown a significant yield superiority in HYPT over the checks HD 2967 (19.2%) and HD 3086 (3.9%) during 2018-19 (Table 2). With average yield of 61.3qha<sup>-1</sup>, DBW 187 showed significant yield superiority over all the checks in two years of testing. The highest yield potential of 96.6 qha<sup>-1</sup> of DBW 187 was observed in HYPT breeding trials reported at Karnal during 2018-19. The genotype also showed high potential yield (100.5 qha<sup>-1</sup>

**Table 2:** Performance DBW 187 over checks for grain yield under coordinated trials in NWPZ during 2015-16 and 2018-19

	Year of testing	No. of trials	DBW187	DBW 88(C)	HD 2967(C)	WH 1105(C)	HD 3086(C)	CD
Mean Yield qha <sup>-1</sup>	NIVT 1A (2015-16)	10	50.9(14)	51.3(10)	47.87(33)	51.2(11)	-	1.9
	SPL-HYPT(2018-19)	6	78.6(2)	-	65.9(15)*	-	75.6(7)*	2.2
	Weighted Mean	16	61.28	51.3	54.63	51.2	75.6	
% Increase or decrease over checks and qualifying varieties	NIVT 1A (2015-16)	--	--	-0.77	6.3	-0.5	-	
	SPL-HYPT (2018-19)	--	--	-	19.27	-	3.96	
	Mean	--	--	19.45	12.17	19.68	3.96	
Frequency in top NS group	NIVT 1A (2015-16)	--	5/10	3/10	2/10	2/10	-	
	SPL-HYPT(2018-19)	--	4/6	-	0/6	-	2/6	
	Total	--	9/16	3/10	2/16	2/10	2/6	

\* indicates significant superiority of DBW 187 over the entry; values in parentheses is the rank of the entry

**Table 3:** Gene postulation for rust resistance based on multipathotype testing (2018-19)

Disease	HD 2967	HD 3086	DBW 187
Yellow rust	Yr2+	Yr2+	Yr2+
Brown rust	Lr23+	Lr10+13+	Lr10+23 +
Black rust	Sr8a+11+2+	Sr7b+2+	Sr5+11+

**Table 4:** Reaction to rust diseases in natural and artificial epiphytotic conditions

Disease	Trial year	DBW 187		HD 2967		HD 3086	
		HS	ACI	HS	ACI	HS	ACI
<i>Yellow rust</i>							
Natural	NIVT-1A (2015-16)	0	0.0	60S	20.72	-	-
	SPL-HYPT (18-19)	5S	1.0	60S	19.3	5S	1.5
Artificial	PPSN (2015-16)	20S	3.0	80S	40.0	10S	2.1
	PPSN (2018-19)	30S	6.9	60S	33.4	30S	5.8
<i>Brown rust</i>							
Natural	NIVT-1A (2015-16)	0	0.0	0	0.0	-	-
	SPL-HYPT (18-19)	tS	0.2	10S	2.0	10S	5.0
Artificial	PPSN (2015-16)	10MS	1.1	10S	2.6	30S	7.2
	PPSN (2018-19)	30S	8.3	15S	6.8	60S	16.9

HS = Highest score, ACI = Average coefficient of infection

<sup>1)</sup> at Gurdaspur in agronomic trials with 150% Rec. NPK + Growth Regulators. In agronomical trials conducted during 2018-19, DBW187 ranked first under testing in all the three treatments. The mean yield for all the treatments in agronomic trials showed that this genotype had an advantage of 10.0 % and 5.8% over HD2967 and HD3086 respectively.

### 3.3. Disease Resistance

DBW 187 showed resistance against yellow and brown rust in NIVT- 1A, AVT and SPL-HYPT during 2014-15 to 2018-19 under All India coordinated breeding trials (natural) and artificial epiphytotic in Plant Pathological Screening Nurseries (PPSN). DBW 187 is resistant to important and prevalent pathotypes of brown and yellow rusts (ICAR-IIWBR, 2018b; ICAR-IIWBR, 2019c). Resistance gene *Yr2+* (yellow rust), *Lr10+Lr23+* (brown rust resistance) and *Sr5+Sr11+* (black rust resistance) have been postulated in this variety through multipathotype testing for seedling resistance (Table 3). It also showed high level of adult plant resistance (Table 4) to brown rust (ACI 8.3), yellow rust (ACI 6.9) and black rust (ACI 8.0). It is resistant to most foliar diseases and wheat blast. DBW 187 was also found resistant to powdery mildew (Av. score=2) disease of wheat. It is imperative to identify and evaluate the disease resistant sources for strengthening the wheat breeding programs in their fight against the deadly

**Table 5:** Performance of DBW 187 along with Checks for quality traits under coordinated testing

Quality traits	HD 2967	HD 3086	DBW 187
<i>Grain characteristics</i>			
Protein %	11.6	11.4	11.7
Grain appearance (max score 10)	6.1	5.6	5.6
Hectolitre weight (kg)	79.0	77.1	77.0
Sedimentation value (ml)	51	52	58
<i>HMW subunits</i>			
Glu-D1	5+10	5+10	5+10
Glu-A1	2*	1	2*
Glu-B1	17+18	17+18	17+18
<i>Glu-1</i> Score	10	10	10
<i>Chapati, bread and biscuit quality</i>			
Chapati quality (max score 10)	8.18	8.0	7.67
Bread loaf volume (cc)	575	578	548
Bread quality (max score 10)	6.55	6.92	5.98
Grain hardness (Kg)	76.1	76.9	73.8
Biscuit spread factor	8.37	8.53	8.07
Wet Gluten (%)	27.2	24.4	27.6
Dry Gluten (%)	8.5	7.7	8.8
Gluten Index	61	77	78
Phenol Test	6.7	6.8	7.3

fungal diseases. Multi-environmental evaluation of large sets of wheat germplasm has already led to identification of resistant sources (Kumar *et al.*, 2019) which can further be used in the wheat breeding programs.

### 3.4. Quality traits analysis

The quality analysis showed that DBW 187 is having a good chapati-making score (7.67), high bread loaf volume (548) and excellent quality of protein with a perfect *Glu* score of 10 (Table 5). *Glu-D1* subunits of high molecular weight gluten (HMW) were found to be 5+10 for DBW 187. The protein content was found to be 11.6%. The higher sedimentation value of 58 in DBW 187 reflects its strong gluten and hence better bread making quality (ICAR-IIWBR, 2019d). Biscuit spread factor was found to be 8.07 whereas; grain hardness index was 73.8 in the variety. Wet gluten and dry gluten content was found to be 27.6 and 8.8 respectively whereas, gluten index was 78 in this variety

### 3.5. Performance of DBW 187 for agro-morphologic traits

The new variety DBW 187 exhibited an average plant height of 106 cm in the HYPT trial. It recorded mean days to heading and maturity 103 and 157 days, respectively and high thousand grain weight (49g). Semi erect growth habit, dark green foliage colour and waxiness present on flag leaf, flag leaf sheath, ear and peduncle are the distinct

traits of DBW 187 under DUS criteria. It has tapering, white and long ear head with intermediate density and medium awns. The seeds are oblong in shape, amber coloured, hard in texture and are medium sized (Table 6).

**Table 6:** Performance of DBW 187 for agro-morphological and phenological traits in NWPZ under SPL-HYPT trial 2018-19

Traits	HD 2967	HD 3086	DBW 187
Heading Days	111	100	103
Maturity days	159	154	157
Plant height (cm)	103	100	106
1000 grain wt. (g)	41	45	49
Ear shape	Tapering	Parallel	Tapering
Grain shape	Ovate	Oblong	Oblong

### 3.6. Notification

DBW 187 was notified for cultivation in NEPZ vide notification No. S.O. 1498(E) dated: 01.04.2019 cultivation NEPZ which covers Eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal (excluding hills), Odisha, Assam and plains of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. After its superior performance in HYPT trial this cultivar has also been notified for area extension by CVRC vide notification no. S.O.99(E) dated 06.01.2020 for cultivation in NWPZ comprising Punjab, Haryana, Delhi, Rajasthan (excluding Kota and Udaipur division), Western Uttar Pradesh (except Jhansi division), Jammu and Kathua district of Jammu and Kashmir, Paonta Valley and Una district of Himachal Pradesh and Tarai region of Uttarakhand.

### 4. Conclusion

Karan Vandana (DBW187) is having a high yield potential along with disease resistance and superior grain quality. The ability to adopt across variable growing conditions in two different zones is a huge advantage for this genotype and will also go a long way in sustaining its cultivation in the region.

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