Plant Archives Vol. 25, No. 2, 2025 pp. 1431-1435 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.2.206

GW 547 A HIGH YIELDING, MULTIPLE DISEASE RESISTANT AND BIOFORTIFIED BREAD WHEAT VARIETY FOR CENTRAL INDIA

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(Date of Receiving-19-06-2025; Date of Acceptance-02-09-2025)

ABSTRACT

A high yielding bread wheat variety GW 547 has been released and notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties, Ministry of Agriculture, Government of India vide notification No. S.O. 1560 (E) dated on 26th March, 2024 for commercial cultivation under timely sown, irrigated conditions of Central Zone (CZ) of the country. GW 547 is a high yielding wheat genotype which has shown significant yield superiority under timely sown irrigated conditions of Central zone over the checks GW 513 during 2021-22. Average yield of GW 547 during three years of testing was recorded to be 58.2 q/ha whereas check varieties GW 513 and GW 322 produced 56.9 and 55.6 q/ha grain yield respectively. It has a potential yield of 74.0 q/ha at vijapur location during 2022-23. It showed high levels of field resistance to black and brown rusts. GW 547 has good levels of protein content (12.6 %). It also showed desired quality traits like good grain appearance (6.9/10), sedimentation value (55.2 ml) and hectoliter weight (80.3 kg/hl). It has high levels of essential micronutrients like iron (~39.8 ppm) and zinc (~40.5 ppm) as compared to the all the check varieties GW 513 and GW 322. This variety has been found promising for timely sown, irrigation areas of CZ; and thus, it will contribute to increase wheat production and will improve the socio-economic status of farmers.

***Key words*:** GW 547, central zone, high yield potential, rust resistance, wheat

Introduction

Cereals play a pivotal role to satisfy the global food demand of growing population, particularly in developing nations where cereal-based production system is the only predominant source of nutrition and calorie intake (Nikos and Jelle, 2012). Wheat (*Triticum aestivum* L.) is one of the principal cereal crops grown worldwide and one of the important staples of nearly 2.5 billion of world population. India is being blessed and enriched with a diverse agro-ecological condition, ensuring food and nutrition security to a majority of the Indian population (Ramadas *et al*., 2019).

Wheat production in India's Central Zone (CZ) has seen improvements due to the introduction of new varieties and better agronomic practices. While the CZ faces challenges like a shorter, hotter winter and limited irrigation compared to the North Western Plains Zone (NWPZ), research and development efforts have led to significant yield gains. These efforts include developing varieties better suited to the CZ's conditions and promoting practices like zero tillage and resource conservation technologies. Genetic improvement in wheat plays 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).

After independence, India was net deficit in food production and had to import wheat for domestic consumption. During 1966–1967, India adopted new strategy which led the 'Green Revolution', especially in the production of wheat and rice. The All India Coordinated Wheat Improvement Project (AICWIP) was started in 1965 is one of the largest crop improvement network projects. In India, there are five mega wheat-growing environments, *i.e.* North-Western Plains Zone

Table 1: Summarized yield data of coordinated trials in Central Zone.

Particulars	Year of testing	Locations	Proposed variety	Check varieties		C D
			GW 547	GW 513	GW 322	(10 %)
Mean yield (Q/ha)	2020-21 (QCWBN)	4	59.4	-	51.7	5.9
	2021-22 (AVT-IR-TS-TAS-CZ)	15	57.5	55.1	56.6	1.1
	2022-23 (AVT-IR-TS-TAS-CZ)	12	57.7	58.7	58.5	1.4
	Mean	58.2	56.9	55.6	-	
	Weighted mean of GW 547 with respective checks		-	**57.6**	**58.2**	
% Increase or decrease over the checks	2020-21 (QCWBN)		-	-	14.9	-
	2021-22 (AVT-IR-TS-TAS-CZ)		-	4.4	1.6	-
	2022-23 (AVT-IR-TS-TAS-CZ)		-	-1.7	-1.4	-
	Weighted Mean		-	**1.2**	**4.7**	-
Frequency in 1st NS group	2021-22 (AVT-IR-TS-TAS-CZ)		8/15	3/15	8/15	-
	2022-23 (AVT-IR-TS-TAS-CZ)		2/12	2/12	6/12	-
	Total		**10/27**	**5/27**	**14/27**	-

(NWPZ), North-Eastern Plains Zone (NEPZ), Central Zone (CZ), Peninsular Zone (PZ) and Northern Hills Zone (NHZ). Under this project, several high-yielding wheat varieties have been developed which became extensively popular and adopted by the farming community. For instance, C 306, HD 2009, WL 711, UP 262, HUW 234, HD 2189, WH 147, Lok 1, HI 617 (Sujata), HD 2285, HD 2329, PBW 343, Raj 3765, PBW 502, HD 2733, HD 2967, HD 3086, DBW 17, PBW 550, GW 273, GW 322, GW 496, DBW 187 and WB 2 in bread wheat were developed and became the popular deliverables of the project. (Sharma *et al.*, 2014).

The Central Zone comprises Madhya Pradesh, Chhattisgarh, Gujarat, Rajasthan (Kota and Udaipur divisions) and Uttar Pradesh (Jhansi division). In the central zone of India, the primary food crops are wheat and rice. In CZ wheat is cultivated in around 6.84 million ha area and estimated production was 22.37 mt with productivity of 2978 kg/ha. CZ is the third largest wheat producing zone of India which occupies 23.15% of total area and accounts for 20.37% of the total production of wheat in the country. The CZ of wheat is known for premium quality bread wheat having typically hard lustrous grains with high gluten strength. Development and evaluation of disease resistant and biofortified 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).

Material and Methods

Development of GW 547

The variety GW 547 was developed through pedigree method from the cross GW 11 / QLD 19 in the year 2010-11 at Wheat Research Station, S.D. Agricultural University, Vijapur. Single plant selection was made in the year 2011-12 and was advanced in further generations. Rust disease was monitored in the segregating generations using susceptible varieties in the border lines which were also inoculated artificially. It was found suitable for timely sown condition promoted to preliminary evaluation trial at three locations during 2018-19. Further it was tested in small scale varietal trial in the year 2019-20 at five locations; simultaneously it was screened for black and brown rust in the IPPSN under artificial inoculations under AICRP approach. In 2020-21 the entry was promoted and evaluated in Quality Component Wheat Biofortification Nursery (QCWBN) at four locations. On the basis of yield and quality traits the genotype was promoted to AVT-IR-TS-CZ as GW 547 and was evaluated in 12 rows of six-meter length spaced at 20 cm with four replications in randomized complete block design at 15 and 12 locations during 2021-22 and 2022-23 respectively (Fig. 1).

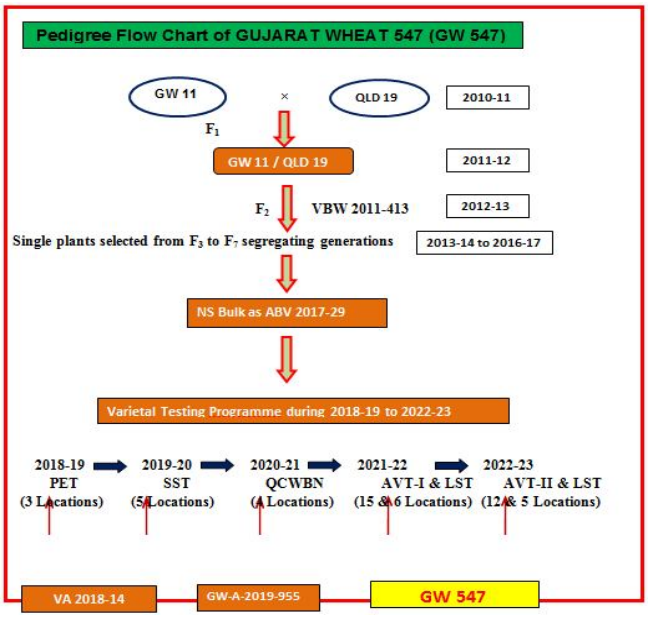

Fig. 1: Flow chart of details of development of Bread wheat variety GW 547.

Table 2: Reaction to rust diseases in natural and artificial epiphytotic condition.

Disease	Year	PV		CV			
		GW 547		GW 513		GW 322	
		HS	ACI	HS	ACI	HS	ACI
Leaf Rust							
Natural condition	2021-22	0	-	0	-	0	-
	2022-23	0	-	0	-	0	-
Artificial condition	2021-22	15MR	1.3	20MS	3.3	30S	14.4
	2022-23	5MR	0.3	TMR	0.1	40S	11.1
Highest Score & Mean ACI		**15MR**	**0.8**	**20MS**	**1.7**	**40S**	**12.8**
Stem Rust							
Natural condition	2021-22	0	-	0	-	0	-
	2022-23	0	-	0	-	0	-
Artificial condition	2021-22	10MR	1.9	10MR	1.5	20S	8.0
	2022-23	20MR	2.1	10MS	3.8	20S	9.0
Highest Score & Mean ACI		**20MR**	**2.0**	**10MS**	**2.7**	**20S**	**8.5**

PV: Proposed variety; **CV:** Check varieties;
HS: Highest score; **ACI:** Average coefficient of infection

Results and Discussion

Yield superiority and variety descriptors

This variety was evaluated in Quality Component and Wheat Biofortification Nursery (QCWBN) at four locations during 2020-21. The yield performance of GW 547 (59.4 q/ha) in QCWBN which has shown significant yield superiority under timely sown irrigated conditions over the check GW 322 (51.7 q/ha) during 2020-21 (Table 1). Based upon its superiority over check the genotype along with other test entries and check varieties were evaluated for two years *i.e.* 2021-22 (AVT-IR-TS-CZ) and 2022-23 (AVT-IR-TS-CZ) under All India Coordinated Wheat Improvement Programe (AICWIP). Under Co-ordinated trials of AICWIP, GW 547 was evaluated at 27 locations during 2021-22 to 2022-23 out of which it occurred 10 times in the first non-significant group indicating its wider adaptability and stable yielding feature (Table 1). GW 547 was significantly high yielding bread wheat genotype (58.2 q/ha) compared to bread wheat check varieties GW 513 (56.9 q/ha) and GW 322 (55.6 q/ha) under timely sown irrigated conditions (ICAR-IIWBR, 2023a, ICAR-IIWBR, 2022a, ICAR-IIWBR, 2021a). It has significant yield advantage of 1.2 % and 4.7 % over the checks GW 513 and GW 322, respectively (Table 1). It has a potential yield of 74.0 q/ha compared to bread wheat check varieties GW 513 (75.1 q/ha) and GW 322 (74.0 q/ha). It also showed wider yield stability across the zone and yielded > 50.0 q/ha at 23 out of 27 locations over two years of testing.

Table 3: Gene postulation for rust resistance based on multi-pathotype testing (2021-22 & 2022-23).

Disease	Proposed variety		Check varieties		GW 322
	GW 547		GW 513		
	21-22	22-23	21-22	22-23	22-23
Black Rust	*Sr2+R*	*Sr30+**	*Sr24+2+*	-*	*Sr11+2+*
Brown Rust	*R*	*Lr13+**	*Lr24+R*	*Lr23+**	-*

***** Different seed lot to that of previous cropping season,
-: Gene not postulated, **R:** resistant to all pathotypes

Table 4: Reaction to other diseases.

Disease	Year	PV		CV			
		GW 547		GW 513		GW 322	
		Av	HS	Av	HS	Av	HS
Leaf Blight (dd)	**2021-22**	57	89	67	89	-	-
	2022-23	46	79	57	89	45	99
	Mean	**52**	**89**	**62**	**89**	**45**	**99**
Karnal Bunt (%)	**2021-22**	4.5	15.9	9.7	31.0	-	-
	2022-23	12.5	48.5	9.1	30.9	15.5	64.4
	Mean	**8.5**	**48.5**	**9.4**	**31.0**	**15.5**	**64.4**
Powdery Mildew (0-9)	**2021-22**	4	7	5	9	-	-
	2022-23	4	7	4	9	3	6
	Mean	**4**	**7**	**5**	**9**	**3**	**6**
Flag Smut (%)	**2021-22**	4.3	9.6	5.0	8.5	-	-
	2022-23	4.6	8.5	4.5	8.6	4.3	10.8
	Mean	**4.5**	**9.6**	**4.8**	**8.6**	**4.3**	**10.8**
FHB (0-5)	**2021-22**	-	4	-	5	-	-
	2022-23	-	4	-	5	-	4
	Mean	**-**	**4**	**-**	**5**	**-**	**4**
Foot Rot (%)	**2021-22**	-	15.0	-	8.3	-	-
	2022-23	-	0.0	-	35.0	-	38.89
	Mean	**-**	**15.0**	**-**	**35.0**	**-**	**38.9**
Loose Smut (%)	**2021-22**	-	-	10.1	30.0	-	-
	2022-23	22.4	75.0	36.4	85.0	-	-
	Mean	**22.4**	**75.0**	**23.3**	**85.0**	**-**	**-**

PV: Proposed variety; **CV:** Check varieties
HS: Highest score; **AV:** Average score

Resistance to major diseases and pests:

Evaluation of GW 547 in various pathological nurseries showed that it has multiple disease resistance *viz.*, resistance to two rusts and other diseases. Under artificial epiphytotic conditions, GW 547 showed superior level of leaf rust resistance (ACI: Max. 1.3; Mean 0.8) as compared to check variety GW 513 (ACI: Max. 3.3; Mean 1.7) and GW 322 (ACI: Max. 14.4; Mean 12.8). It also showed high levels of resistance to stem rust (ACI: Max 2.1; Mean 2.0) as compared to check varieties GW 513 (ACI: Max 3.8; Mean 2.7) and GW 322 (ACI: Max. 9.0; Mean 8.5) (Table 2). Seedling tests were conducted for two years at ICAR-IIWBR, Shimla for testing its resistance against bread wheat virulent leaf rust pathotypes *viz.*, 77-5, 77-9 and 104-2 groups and stem rust pathotypes *viz.*, 11 and 40A groups. GW 547 is

Table 5: Reaction to insect pests.

Insect pests	Year	PV		CV			
		GW 547		GW 513		GW 322	
		Av	HS	Av	HS	Av	HS
SFI	2021-22	10.43	-	9.65	-	-	-
	2022-23	11.82	-	13.21	-	12.37	-
	Mean	**11.13**	**-**	**11.43**	**-**	**12.37**	**-**
BWM	2021-22	14.00	-	8.30	-	-	-
	2022-23	8.67	-	14.00	-	10.67	-
	Mean	**11.34**	**-**	**11.15**	**-**	**10.67**	**-**
WFA	2021-22	5.0	5	5.0	5	-	-
	2022-23	4.0	5	3.5	4	3.5	4
	Mean	**4.5**	**5**	**4.3**	**5**	**3.5**	**4**
RA	2021-22	4.0	-	4.0	-	-	-
	2022-23	4.0	-	4.0	-	4.0	-
	Mean	**4.0**	**-**	**4.0**	**-**	**4.0**	**-**

SFI: Shoot fly incidence (%); **BWM:** Brown wheat mite (no. of mites/ 10cm^2 area); **WFA:** Wheat foliar aphid (Score 1-5); **RA:** Root aphid(Score 1-5)
PV: Proposed variety; **CV:** Check varieties
HS: Highest score; **AV:** Average score

resistant to important and prevalent pathotypes of brown and black rusts (ICAR-IIWBR, 2022b; ICAR-IIWBR, 2023b). Based on comparison of seedling reactions, "GW 547" is postulated to have stem rust resistance gene Sr30+ and leaf rust resistance gene Lr13+ (Table 3). In addition, it showed good levels of resistance (8.5 %) against Karnal bunt as compared with check varieties, whereas, for leaf blight it showed resistance reaction compared to the check varieties (Table 4). For shoot fly incidence (%), GW 547 (11.13) showed better tolerance than check variety GW 513 (11.43) and GW 322 (12.37) (Table 5).

Quality attributes

High grain appearance score (6.9/10) and test weight (80.3 kg/hl) for GW 547 compared to other check varieties indicate that grain was bold, lustrous and non-shriveled. GW 547 showed high protein content (12.6%), protein quality (Glu score of 8/10) for high molecular weight subunits and grain hardness index (78) (Table 6). End product analysis conducted at ICAR IIWBR lab indicated that GW 547 is suitable for *chapatti* making (8.2/10) along with sedimentation value of 55.2 ml, wet gluten (32.8%), dry gluten (10.6%) and gluten Index (60/100), whereas phenol score was 6.9/10 recorded in this variety. It recorded highest score for bread loaf volume (529 cc) and bread quality score (6.5/10) among checks (ICAR-IIWBR, 2023c). Hence, may be considered as a good quality bread wheat genotype. It has good levels of essential micronutrients like iron (39.8 ppm) and zinc content (40.5 ppm) making it rich in nutritional qualities (Table 6).

Table 6: Performance of GW 547 along with checks for quality traits under coordinated trials.

Quality characteristics	PV	CV	
	GW 547	GW 513	GW 322
Grain Characteristics			
Protein (%)	12.6	11.0	10.7
Grain appearance score (Max score 10)	6.9	7.2	6.7
Hectoliter weight (kg/hl)	80.3	82.4	80.4
Sedimentation value (ml)	55.2	42.1	41.4
Grain hardness index	78	80	85
High molecular Weight Glutenin Subunits (HMW-GS)			
GLu-D1	2+12	5+10	2+12
GLu-A1	2*	N	2*
GLu-B1	7+8	17+18	7+8
Score	**8**	**8**	**8**
***Chapatti*, bread and biscuit quality**			
Wet Gluten (%)	32.8	30.9	28.5
Dry Gluten (%)	10.6	9.9	9.3
Gluten Index (max 100)	60	61	60
Bread quality loaf volume (cc)	529	415	468
Bread quality score (max 10)	6.5	4.1	5.5
Chapatti quality score (max 10)	8.2	7.9	7.8
Biscuit quality (Spread Factor)	8.3	8.3	8.7
Phenol Test (Max. Score 10)	6.9	2.3	5.3
Nutritional quality			
Fe (ppm)	39.8	37.4	36.6
Zn (ppm)	40.5	38.0	40.5

PV: Proposed variety; **CV:** Check varieties

Performance of GW 547 for agro-morphological traits

The new variety GW 547 recorded mean days to heading and maturity 70 and 121 days, respectively and high thousand grain weight (47g). GW 547 exhibited an average plant height of 96 cm in the co-ordinated experiments. Dark green foliage colour, medium brush hair length, oblong grain shape and absence of outer glume

Table 7: Performance of GW 547 for agro-morphological and phonological traits in CZ under coordinated testing.

Traits	GW 547	GW 513	GW 322
Days to heading	70	64	70
Days to maturity	121	118	120
Plant height (cm)	96	93	89
1000 grain weight (g)	47	47	43
Foliage colour	Dark green	Pale green	Dark green
Grain shape	Oblong	Oblong	Ovate
Brush hair length	Medium	Medium	Short
Outer glume pubescence	Absent	Present	Absent

pubescence are the distinct traits of GW 547 under DUS criteria (Table 7).

Notification

GW 547 was notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties, Ministry of Agriculture, Government of India vide notification No. S.O. 1560 (E) dated on 26th March, 2024 for commercial cultivation under timely sown, irrigated conditions of Central Zone (CZ) of the country which covers Madhya Pradesh, Chhattisgarh, Gujarat, Rajasthan (Kota and Udaipur divisions) and Uttar Pradesh (Jhansi division).

Conclusion

GW 547 is a high yielding, disease resistant and having good nutritional quality traits bread wheat variety suitable for timely sown and irrigation areas of central wheat growing zone and thus, it will contribute to increase wheat production and will improve the socio-economic status of farmers.

Acknowledgement

This article is based on the Central Varietal release committee (CVRC) proposal and the authors are highly thankful to The Director, IIWBR, PIs of ICAR-IIWBR and co-operators of AICWIP for their contribution.

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