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VL *Gehun* 953: A high yielding, rust-resistant, winter x spring wheat (*Triticum aestivum* L.) derivative, suitable for organic hills as well as inorganic Plains of Uttarakhand state of India

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Abstract

To VL *Gehun* 953- a high yielding variety was released by *Uttarakhand seed Sub-Committee and notified by Central Sub-Committee on Crop Standards, Notification and Release of Variety* for commercial cultivation under irrigated inorganic production conditions of Uttarakhand Plains and timely sown irrigated organic production situations of Uttarakhand hills. It recorded (3.34 tha^{-1}) 7.46% higher grain yield compared to the best check VL *Gehun* 907 under irrigated organic conditions of Uttarakhand hills. Likewise, it produced (4.47 tha^{-1}) 6.93% higher grain yield compared to the best check PBW 343 under irrigated situations of Uttarakhand Plains. It provided greater level of resistance to both stripe and leaf rust and recorded average coefficient of infection (ACI) of 0.27 for stripe rust and 2.0 for leaf rust under artificial inoculation situations, respectively. It contains 10.4 % average protein and 82.8 kghl^{-1} hectoliter weight, therefore, possessing good quality for chapatti making with good flour recovery. The large scale demonstrations conducted in different districts of Uttarakhand has proved its acceptability among the farmers. The spread of this variety in entire Uttarakhand state (Hills under organic and Plains under inorganic conditions) is anticipated to enhance wheat productivity of the state. In addition, it would also help in curtailing the rust inoculum both in hills as well as plains of Uttarakhand owing to its better resistance.

Keywords: Chapati quality, stripe and leaf rust, VL *Gehun* 953, winter x spring wheat derivative.

1. Introduction

Wheat is the most important winter cereal crop of Northern hills of India comprising the hills of Uttarakhand, Himachal Pradesh, Jammu and Kashmir, West Bengal and North Eastern States. This region has around 1.39 m ha area under wheat cultivation (Gupta and Kant, 2012), which is around 3.7% of the total wheat area in the country. The northern hills are considered as foci of infection for rust diseases and hence, it reckons national significance for their management, although area-wise this is very small. Therefore, cultivation of rust resistant varieties in northern hills zone is the key national strategy in rust management to reduce the inoculum load for the wheat bowl of this country, i.e. north-western plain zone (NWPZ). Among the three main states of Northern hills zone (NHZ) maximum area of wheat is in Uttarakhand (342.1 thha^{-1}). Out of this area, around 50.2% (171.7 thha^{-1}) is under hills and 49.8 % (170.3 th ha^{-1}) is under Plains. The productivity of wheat in Plains (3.5tha^{-1}) is better than the national average of 3.0 tha^{-1}.

Whereas, the productivity of hills (1.02 tha^{-1}) is far below the national average (Anonymous, 2016; Chanda *et al.,*

2016) mainly due to unavailability of inputs (seed, fertilizer *etc.*) at appropriate time and place, small and fragmented land holdings and poor extension of latest technologies. Besides, two widely adapted timely sown varieties acceptable for both irrigated and rainfed conditions of NHZ including Uttarakhand, *viz.* 'HS 507' and 'VL *Gehun* 907', have started showing susceptible reactions to rust diseases, mainly due to emergence of new virulent pathotypes of stripe and leaf rust pathogens and changed climatic conditions. However, farmers are left with no other alternative except to cultivating the above varieties. Moreover, the wheat cultivation in hilly areas may still be considered as organic by default as farmers rarely apply fertilizers and chemicals. On the contrary, though a number of varieties have been recommended for the Plains of Uttarakhand but majority of the farmers in plains still cultivating PBW 343 which has already succumbed to the new pathotypes of rusts.

One of the major causes of low productivity of wheat in hills is losses due to biotic stresses. People in higher altitude of Himalayas cultivate local land races of wheat because of lack of awareness about improved varieties and local preferences (Pal *et al.*, 2007). Invariably these local land races are highly susceptible to the prevalent pathotypes of rusts. During the recent years, *Puccinia striiformis* f. sp *tritici* infected stripe rust has been manifested as the great menace to wheat cultivation in the hilly areas and consequently to the plains as the hill regions are the provider of rust inoculum to the crop in plains. The stripe rust severity recorded up to 40S and 80S on the high yielding varieties not suitable for the region and local genotypes, respectively in Uttarakhand hills in the crop season of 2010-11 (Kant and Jain, 2011). Development and deployment of the improved rust resistant varieties of wheat has been the most effective alternatives to manage the menace of rust diseases. These situations require specific set of varieties, which should have wider adaptability and capability to yield higher under organic as well as inorganic conditions. To meet this demand for a suitable high yielding and rust resistant variety suitable for organic conditions in Hills as well as inorganic conditions in Plains of Uttarakhand, a typical pedigree breeding programme was taken up at the Experimental Farm of ICAR- *Vivekananda Parvatiya Krishi Anusandhan Sansthan* (VPKAS), Hawalbagh, Uttarakhand (1250 m amsl, 29° 36' N and 79° 40' E) in 2002-03.

2. Materials and methods

The winter wheat 'Dorade5' was selected from 10th Facultative and Winter Wheat Observation Nursery (FAWWON) from CIMMYT, Turkey for drought tolerance and higher number of tillers. The rust resistant parent 'VW 0185 (CMH794-955/AGA/PBW 65)', a genetic stock for number of grains developed at ICAR-VPKAS, Almora by crossing 'CMH794-955/AGA' and 'PBW 65'. The F_1 of 'VW 0185' and 'Dorade 5' was selfed and bulked harvested and in subsequent generations' typical pedigree method was followed. In F_6 generation, 3rd promising progeny was harvested as individual bulk and was given number VW 0937. This strain 'VW 0937' was tested under timely-sown, rainfed and irrigated conditions at Experimental Farm, Hawalbagh, Almora, Uttarakhand in Alpha lattice design with 2 replications. Under both the conditions it yielded better than the best check VL *Gehun* 907, therefore, further evaluated as 'VL 953' during 2010-11 under the All India Co-ordinated Wheat Improvement yield evaluation trials at 5 and 3 different locations under both irrigated and rainfed timely sown situations, respectively, in the states of Himachal Pradesh, Jammu and Kashmir and Uttarakhand states of northern hills. During 2010-11, 2011-12 and 2012-13 crop seasons, VL 953 was also tested at 8 locations following randomized complete block design with 4 replicates in Uttarakhand State Varietal Trials (SVT) hills under organic conditions and in 14 locations in SVT Plains under inorganic conditions. The recommended sowing time of November for irrigated conditions was followed. The row to row distance of 23 cm and row length of 3 m with plot of 6 rows were followed uniformly at all the locations. The crop received 20tha^{-1} FYM under organic trials and 60 Kgha^{-1} N, 60 Kgha^{-1} P_2O_5 and 40 Kgha^{-1} K_2O as a basal dose and 30 Kgha^{-1} N as a top dressing each after first irrigation and at the jointing stage under inorganic trials. The crop was not protected against any disease to test the level of resistance of the test entries. In addition, VL 953 was also evaluated along with HPW 349 and HS 536 against the check variety VL 804, VL 907 and HS 507 during 2012-13 at ICAR-VPKAS, Almora under irrigated condition with different sowing dates (normal and late sowing). Yield, ancillary and disease susceptibility data were recorded at individual location and compiled at Indian Institute of Wheat and Barley Research, Karnal, Haryana for All India Trials whereas the SVT data was compiled by Assistant Director, Regional Agriculture Testing and Demonstration Station (RATDS), Haldwani, Uttarakhand. The standard analysis of variance was done for individual location as well as for pooled data.

Disease screening was done under artificial epiphytotic conditions. The Plant Pathological Screening Nursery (PPSN) entries were planted in Dhaulakuan, Gurdaspur,malan, Bajaura, Karna,l Ludhiana, Pantnagar and Durgapura . Infector rows, which are often mixture

Table 1. Performance of VL *Gehun* 953 and checks for grain yield under hills organic and plains inorganic irrigated conditions in Uttarakhand.

Year of testing	Hills organic: No. of trials/ locations	Proposed variety (P) VL 953	Zonal Check 2 VL 907 (C1)	Local check 3 UP 2572 (C2)	CD 5%
1st year (2010-11)	2	3.72	3.45	3.21	6.01
2nd year (2011-12)	3	3.35	2.81	2.73	3.00
3rd year (2012-13)	3	3.08	3.18	3.21	3.22
Weighted Mean	8	3.34	3.11 (7.5)	3.03(10.2)	
Year of testing	**Plains inorganic: No. of trials/ locations**	**Proposed variety (P) VL 953**	**Zonal Check 2 PBW 343 (C1)**	**Local check 3 UP 2338 (C2)**	**CD 5%**
1st year (2010-11)	5	3.71	3.01	3.45	1.37
2nd year (2011-12)	4	4.72	4.18	4.35	6.50
3rd year (2012-13)	5	5.04	5.36	4.56	6.52
Weighted Mean	14	4.47	4.18 (6.9)	4.10 (9.04)	
		Frequency in the top non-significant group			
Hills organic		4/8	4/8	2/8	
Plains inorganic		6/14	2/14	2/143	

Weighted mean % increase over checks is given in parentheses.

of highly susceptible genotypes, were planted in and around the nursery and inoculated with mixture of predominant pathotypes of stripe and leaf rusts. The heavy inoculum load in the infector rows ensured the infection to susceptible genotypes in the nursery. The data on susceptibility to rust was recorded as per Nayar *et al.* (1997) at individual location. The average coefficient of infection (ACI) was calculated as per Logering (1959).

3. Results and discussion

3.1 Adaptability and Grain yield

VL *Gehun* 953 recorded overall 7.46% higher grain yield (3.34 tha^{-1}) compared to the best check VL *Gehun* 907 under irrigated organic conditions of Uttarakhand hills during the 3 years of testing. Likewise, it produced 4.47 tha^{-1} grain, which was 6.93% higher than PBW 343, the best check under the irrigated situations of Uttarakhand plains. VL 953 provided similar results across different locations, occupied top ranking position in the first non-significant group of entries including checks under organic and inorganic irrigated conditions of Uttarakhand hills and plains (Table 1). VL *Gehun* 953 provided potential grain yields of 5.04 and 3.72 tha^{-1} under under inorganic irrigated plain and organic hill situations of Uttarakhand, respectively. It also produced (4.49 tha^{-1}) 7.3% higher grain yield compared to the best check VL *Gehun* 907 under irrigated inorganic condition of Uttarakhand hills. It has shown its flexible adaptation with least reduction (-6.25%) of grain yield under late sowing (27th November) in comparison to checks of timely-sown irrigated organic situation (data not shown). It topped the list and provided significantly higher grain yield compared to all the checks under late sown situation. In the farmers field trials conducted by Department of Agriculture, Uttarakhand, VL *Gehun* 953 yielded 3.0tha^{-1} under organic hills and 5.05 tha^{-1} under inorganic Plains trials.

Table 2. Response of VL *Gehun* 953 and checks to stripe and leaf rusts under artificial inoculation conditions.

Rust/ Condition	Response to stripe and leaf rusts*		
	VL 953	VL 907 (C)	UP 2572 (C)
Stripe rust			
Natural	tR (0.05)	20S (4.1)	30S (12.7)
Artificial	5S (2.9)	60S (9.8)	80S (20.5)
Leaf rust			
Natural	tR (0.07)	10S	20S
Artificial	5MS (2.0)	60S (12.8)	40S (10.4)

*Highest score, average coefficient of infection (ACI) is given in parentheses.

3.2 Response to diseases

VL *Gehun* 953 showed very high degree of resistance to stripe rust compared to checks. It recorded the average coefficient of infection (ACI) of 0.05–2.9 under artificial inoculation situations and has the capability to withstand the pressure of stripe rust. Likewise, the ACI values of 0.07 to 2.0 were recorded for leaf rust under artificial inoculation conditions (Table 2).

3.3. Quality traits

VL *Gehun* 953 possesses 10.4% protein and 82.8 $kghl^{-1}$ hectoliter weight, therefore, good for chapatti quality and good flour recovery.

Table 3. Performance of VL *Gehun* 953 at Farmers Field in FLDs

Year	Area	Demonstration Yield (qha^{-1})	Farmers actual Yield (qha^{-1})	% increase over farmers actual yield
2016-17	05	33.6	24.9	34.9
2017-18	08	31.3	22.2	40.9

Table 4. Economic analysis of wheat varieties under Frontline Demonstration

Year	Cost of Production (Rs/Ha)		Gross Return (Rs/Ha)		Net Return (Rs/Ha)		Benefit Cost Ratio	
	DP	FP	DP	FP	DP	FP	DP	FP
2016-17	27,225	24,660	54,600	40,463	27,375	15,803	2.0	1.64
2017-18	27,977	24,255	54,306	38,517	26,329	14,262	1.94	1.59

DP: Demonstration Plot /FP: Farmers Plot

3.4. Varietal description

VL *Gehun* 953 has semi-erect growth habit, medium compact ear density, tapering ear shape, mean height of 86 cm (hills), 98.7 cm (Plains), and takes 166 (hills) and 137 (plain) days to mature under organic hills and inorganic irrigated plain situation in Uttarakhand, respectively. It has amber grains with 46-48g thousand grain weight.

3.5. Demonstration at farmers' field

Frontline demonstrations were conducted during *rabi* 2016-17 and 2017-18 crop seasons. During *rabi* 2016-17, VL *Gehun* 953 recorded grain yield of 3.36 tha^{-1} which was 34.9% higher than 2.49 tha^{-1} of the undescript local check. These demonstrations were conducted in *Dehradun* and *Bageshwar* districts of Uttarakhand with 56 farmers. During 2017-18 also VL *Gehun* 953 yielded a grain yield of 3.13 tha^{-1} which was 40.9% higher than 2.23 tha^{-1} of the local check. These demonstrations were conducted in Almora district of Uttarakhand with 130 farmers (Table 3). Farmers' response to this variety has been positive and they are very enthusiastic for this variety which led to high farmer to farmer exchange of seed of the variety.

The year wise economics of wheat production under frontline demonstration were estimated and results have been presented in Table 4. Wheat variety VL *Gehun* 953 recorded higher Benefit: Cost (B:C) ratio of 2.0 in demonstration plot than of 1.64 in Farmers' plot and 1.94 in demonstration plot than of 1.59 in farmers' plot, respectively during 2016-17 and 2017-18.

In conclusion, VL *Gehun* 953 is a unique wheat variety which has performed equally well under organic hills and inorganic plains irrigated conditions of Uttarakhand. There is no release of any variety in Uttarakhand for both the production conditions until now. It provided wider adaptability, consistent higher grain yield, good quality and higher levels of resistance to stripe and leaf rusts. The frontline demonstrations conducted in different districts of the Uttarakhand have shown its potential and acceptability among the farmers. It will provide an alternative to wheat variety VL *Gehun* 907 in hills and, PBW 343 and UP 2338 in plains. Large scale cultivation of VL *Gehun* 953 in Hills and Plains will enhance the productivity of wheat in Uttarakhand. Further, it will safeguard the wheat crop of NWPZ from the threat of rusts as it advances from hills to the plains.

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