# Plant Genetic Resources for Improvement of Rust Resistance in Wheat (Triticum aestivum L.)

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Plant genetic resources are most vital for developing high yielding rust resistant cultivars and orienting breeding strategies to cope with the threat posed by rust pathogens in wheat improvement programme. HS 424, developed from a cross [CPAN3004 x HPW(DL) 30 x HS 286], following pedigree method of breeding was resistant against prevalent pathotypes of leaf and stem rusts. It has also shown mean grain yield superiority over check varieties in All India Coordinated wheat trials during 2000-01 and 2001-02. HS 431, a selection from CIMMYT breeding material has shown seedling resistance against leaf and stem rust pathotypes prevalent in India. It carries single recessive gene pair for conferring resistance against 121R63-1 pathotype of leaf rust. WBM 1587 and WBM 1591 were found to be resistant against most virulent pathotype 46S119 of stripe rust. Diversification of germplasm with these genetic stocks of rust resistance and involving them in hybridization would prove useful in wheat improvement programme of India.

#### Key Words: Germplasm, Inheritance, Rust resistance

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The wheat crop is attacked by three different types of rusts (leaf rust, stripe rust and stem rust) all over the world and cause significant loss to the wheat production every year. Developing varieties with diverse rust resistance genes and their strategic deployment in different agro-climatic zones would help in arresting the spread of rusts in major wheat growing areas of the country. About 41 potentially useful genes are known to condition resistance against  $\frac{3}{2}$  stripe rust pathotypes and about 61 leaf rust resistance (Lr) genes providing resistance world over have been <sup>a</sup>documented (McIntosh, 2008). There are still a large number of undocumented genes which are effective and useful to provide durable rust resistance. However, Lr9 and Lr19 providing resistance against all the pathotypes of leaf rust got new virulences (Nayar et al., 2003; Bhardwaj et al., 2005) designated as 121R127 and 253R31, respectively. Recently, a pathotype virulent on Lr 28 has also been identified (Bhardwaj SC, Personal communication). The evolution of stripe rust pathotypes, 46S119 and 78S84 has rendered varieties carrying Yr9 susceptible in India. These newly evolved pathotypes of rusts have created threat to the wheat varieties grown in almost all the zones of the country. Therefore, identifying rust resistance sources effective against virulent pathotypes of rust, provides opportunities to the plant breeders for incorporating viable genes into germplasm pools and

permit the system to release the cultivars carrying diverse resistance genes. The research reported in this paper is a step in this direction.

### **Materials and Methods**

Seedlings of genetic stocks were inoculated with uredospores of rust pathotypes and infection type (IT) was recorded as per the method suggested by Stakman et al. (1962). The seedlings showing infection type 0; (naught fleck); (fleck) and; 1 were regarded as resistant whereas 3 and 4 were graded as susceptible. In order to study the inheritance of leaf rust resistance against pathotype 121R63-1 conferred by the test stock, 'HS 431' was crossed with susceptible landrace 'Agra local'. The material comprised of parents, F1 and F2 generations of this cross were scored and classified for resistance and susceptible reaction. The  $c^2$  test was used to test the goodness of fit of expected ratios in segregating population. The observations on morpho-agronomic traits were recorded as per the descriptors suggested in All India Coordinated Research Project.

# **Results and Discussion**

Response of genetic stocks against different pathotypes of stem, leaf and stripe rusts is presented in Table 1, 2 and 3. All the four genetic stocks as described under have been registered by the Plant Registration Committee of Indian Council of Agricultural Research.

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Table 1. Seedling reaction of genetic stocks against different pathotypes of stem rust

Genotype	Year of testing								Stem r	ust patho	types					
		79G	203G	75G	24G	5G	10G	62G	62G	19G	38G	33G	37G	7G	53G	7G
		31	15	5	5	19	13	29	69-1	35	18	3	19	11	1	43
HS 424	2000-01	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	2001-02	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	2002-03	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	2003-04	R	R	R	R	R	R	R	R	R	R	-	R	R	-	R
	2004-05	R	R	R	-	-	R	R	R	R	R	R	R	R	R	R
	2005-06	R	R	R	-	R	R	R	R	R	R	R	R	R	R	R
HS 431	2001-02	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	2002-03	R	S	R	R	R	R	R	R	R	R	R	MIX	R	R	R

R = Resistant, S = Susceptible, MIX = Mix reaction

Table 2. Seedling reaction of genetic stocks against different pathotypes of leaf rust

Genotype	Year of									Leaf	rust patl	hotype	s							
	testing	1	49	69	5	45	109	109	125	121	121	121	25	109	21	21	5	45	57	93
		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
		5	37	13	13	31	63	31-1	23-1	63-1	53-1	127	31	23	31-1	55	9	35	27	15
HS 424	2000-01	R	R	R	R	R	R	R	R	R	R	R	-	R	R	R	R	R	R	R
	2001-02	R	R	R	R	R	R	R	R	R	R	R	-	R	R	R	R	R	R	R
	2002-03	R	R	R	R	R	R	R	R	R	R	R	-	R	R	R	R	R	R	R
	2003-04	R	R	R	R	R	R	R	R	R	R	R	-	R	R	R	R	-	R	R
	2004-05	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	2005-06	R	R	R	-	R	R	R	R	R	R	-	R	-	R	R	R	R	R	R
HS 431	2001-02	-	R	R	MIX	R	R	R	MIX	R	MIX	R	-	R	R	MR	R	R	R	R
	2002-03	R	R	R	R	R	R	R	R	R	R	R	-	R	R	-	R	R	R	R
Table 3.S	tant, MR = eedling rea f stripe rus	nction	Ĵ					athotyp	es		(exce dia. H	-				-				

Table 3.Seedling reaction of genetic stocks against virulent pathotypes of stripe rust

Genetic stock	Year of testing								
	2004-05	2005-06	2006-07	2007-08					
WBM 1587	;	;C	;	;					
WBM 1591	0;	0;	NR	0;					

Infection type : naught fleck (0;) = immune, fleck (;) = very resistant,; C = Chlorotic fleck, NR = not recorded

HS 424 (INGR 08006): This genetic stock was developed from a cross CPAN 3004/HPW(DL)30/HS286 following pedigree method of breeding. It has shown consistent seedling resistance against all the pathotypes of stem and leaf rusts (DWR, 2005). It has light green foliage at boot stage, 105 cm average plant height, parallel ear shape, brown ear colour and the crop matures in 165 days under northern hills condition. The grains of this stock are amber, soft with ovate shape and 41g thousand grain weight. HS 424 has shown mean yield superiority over all the checks in All India Coordinated Wheat Trials during 2000-01 and 2001-02.

HS 431 (INGR 08007): The genetic stock, HS 431 [V 81623 x (BUC x PVN)], a selection from CIMMYT breeding material has shown seedling resistance against

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stem (except 203G15) and leaf rust pathotypes prevalent in India. HS 431 has shown adult plant resistance with maximum ACI (Average coefficient of infection) 5.3 against leaf rust and maximum ACI 5.4 against stem rust (DWR Report 2002). It has purple coleoptile, 103 cm average plant height, parallel ear shape, brown ear with medium awns and matures in 163 days under northern hills condition. Grains are dark amber, semihard with oblong shape and 45 g thousand grain weight. HS 431 has shown mean yield superiority over all the checks in All India Coordinated Wheat Trials under AVT-Timely Sown Irrigated Condition of Northern Hills Zone during 2001-02 and 2002-03.

WBM 1587 (INGR 07009: The genetic stock, WBM 1587 (MILAN/SHA), a selection from CIMMYT breeding material has shown seedling resistance against most virulent pathotype 46S119 of stripe rust. Average plant height is 108 cm. Flag leaf, leaf sheath, ear and peduncle are waxy, clavate ear shape with white colour and short awns. It matures in 142 days under northern hills condition. The grains of this stock are amber, semihard with ovate shape and 40 g thousand grain weight.

WBM 1591 (INGR 07010): WBM 1591 [(PYN x BAU x MILAN)], a selection from CIMMYT breeding material

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Parent /Cross	ITP/F <sub>1</sub>	Number of	F <sub>2</sub> seedlings	Total	$\chi^{2(3:1)}$	Probability	
		R	S				
HS 431	R	-	-	-	-	-	
Agra local (AL)	S	-	-	-	-	-	
HS 431 X AL	S	-	-	-	-	-	
HS 431 X AL (2005-06)	-	29	102	131	0.57	0.45	
HS 431 X AL (2006-07)	-	30	100	130	0.25	0.62	
(Pooled)	-	59	202	261	0.80	0.37	

Table 4. Seedling reaction in parents, F1 and F2 generations of a cross (HS 431XAL) against leaf rust pathotype 121R63-1

P= Parent, R= Resistant, S= Susceptible, IT= Infection Type,

has shown consistent seedling resistance against most virulent pathotype 46S119. Average plant height is 100 cm. Flag leaf, leaf sheath, ear and peduncle are waxy, tapering ear shape with short awns and white ear colour. It matures in 160 days under northern hills condition. The grains of this stock are amber, semihard with oblong shape and 38 g thousand grain weight.

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Inheritance of Rust Resistance: The test stock, HS 431 gshowed distinct resistant seedling reaction to the pathotype  $\frac{1}{6}$  121 R63-1, whereas Agra local (landrace) showed high infection type. The cross HS 431 × Agra local showed susceptible reaction in F1 and F2 seedlings of this cross showed a segregation of 59 resistant and 202 susceptible with good fit to the expected ratio of 1R : 3S, suggesting 139.224 the presence of single recessive gene pair for the inheritance of leaf rust resistance against the pathotype 121R63-1 (Table 4). The genetic stock, HS 424 was found to possess monogenic dominant control of inheritance against pathotype 121R63-1 (Datta et al., 2007). Based on infection data, inheritance study, morphological - marker genetic linkage and molecular marker analyses, it was indicated that HS 424 carries gene combination of Lr24+Lr26+Sr2+Sr24+Sr31+Yr9 genes. The genetic stocks, WBM 1587 and WBM 1591 reported to possess two dominant complementary genes for controlling the inheritance of resistance against stripe rust pathotype 46S119 (Kumar and Dharam Pal, 2006). Besides, resistance against 46S119, the genetic stock, WBM 1587 is also reported to carry single dominant gene pair for controlling inheritance of resistance against 78S84 pathotype of stripe rust (Dharam Pal et al., 2008). Diversification of germplasm with these genetic stocks of rust resistance and involving them in hybridization would prove useful in wheat improvement programme of India.

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## References

- Bhardwaj SC, M Prashar, S Kumar, SK Jain and D Datta (2005) Lr19 resistance in wheat becomes susceptible to Puccinia triticina in India. Plant Dis. 89: 1360.
- Datta D, SC Bhardwaj and M Prashar (2007) Genetic basis of rust resistance of a high yielding wheat line from Northern Hills Zone. Indian J. Genet. Plant Breeding 67: 221-224.
- Dharam Pal, S Kumar, M Prashar and SC Bhardwaj (2008) Gene sources and inheritance of stripe rust resistance in wheat. SABRAO J. Breeding Genet. 40: 147-152.
- Directorate of Wheat Research (2002) Report of Coordinated Experiments-Vol. III. Crop Protection (Pathology, Nematology and Entomology, Sharma AK, DP Singh, J Kumar, AK Singh, MS Saharan, KS Babu and DS Chauhan (Eds.) All India Coordinated Wheat and Barley Improvement Project, DWR, Karnal, 203p.
- Directorate of Wheat Research (2005) Report of Coordinated Experiments - Vol. III. Crop Protection (Pathology, Nematology and Entomology, Sharma AK, DP Singh, MS Saharan, AK Singh, KS Babu, Jagshoran and B Mishra (Eds.). All India Coordinated Wheat and Barley Improvement Project, DWR, Karnal, 191p
- Kumar S and Dharam Pal (2006) Inheritance of stripe rust resistance against pathotype 46S119 in wheat of the Indian sub-continent. Indian J. Genet. Plant Breed. 46: 231-232.
- McIntosh RA, Y Yamazaki, J Dubcovsky, J Rogers, C Morris, DJ Somers, R Appels and KM Devos (2008) Catalogue of Gene symbols for wheat. Proceedings of 11th International Wheat Genetics Symposium, Brisbane Qld, Australia.
- Nayar SK, SK Jain, M Prashar, SC Bhardwaj, Subodh Kumar and MK Menon (2003) Appearance of new pathotype of Puccinia recondita tritici virulent on Lr9 in India. Indian Phytopathol. 52: 196-198.
- Stakman EC, DM Steward and WO Loegeing (1962) Identification of physiological races of Puccinia recondita var. tritici. Miss. Agri. Exp. Sta. Sci. J. Series.