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

Introduction

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 stripe rust pathotypes and about 61 leaf rust resistance (*Lr*) genes providing resistance world over have been documented (McIntosh, 2008). There are still a large number of undocumented genes which are effective and useful to provide durable rust resistance. However, *Lr*9 and *Lr*19 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 *Yr*9 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, F_1 and F_2 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 rust pathotypes														
		79G 31	203G 15	75G 5	24G 5	5G 19	10G 13	62G 29	62G 69-1	19G 35	38G 18	33G 3	37G 19	7G 11	53G 1	7G 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 testing	Leaf rust pathotypes																		
		1 R 5	49 R 37	69 R 13	5 R 13	45 R 31	109 R 63	109 R 31-1	125 R 23-1	121 R 63-1	121 R 53-1	121 R 127	25 R 31	109 R 23	21 R 31-1	21 R 55	5 R 9	45 R 35	57 R 27	93 R 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

R = Resistant, MR = Moderately resistant, MIX = Mix reaction

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 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, semi-hard 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, semi-hard 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

Table 4. Seedling reaction in parents, F_1 and F_2 generations of a cross (HS 431XAL) against leaf rust pathotype 121R63-1

Parent /Cross	ITP/F_1	Number of F_2 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

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, semi-hard with oblong shape and 38 g thousand grain weight.

***Inheritance of Rust Resistance*:** The test stock, HS 431 showed distinct resistant seedling reaction to the pathotype 121 R63-1, whereas Agra local (landrace) showed high infection type. The cross HS 431 × Agra local showed susceptible reaction in F_1 and F_2 seedlings of this cross showed a segregation of 59 resistant and 202 susceptible with good fit to the expected ratio of 1R : 3S, suggesting 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 *Lr*24+*Lr*26+*Sr*2+*Sr*24+*Sr*31+*Yr*9 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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