Indian J. Genet., **67**(3): 290-292 (2007)

Short Communication

Rust resistance in newly bred lines of wheat (*Triticum aestivum* L.)

Rajbir Yadav[1], M. Prashar, Jag Shoran, J. Kumar and S. C. Bhardwaj

Directorate of Wheat Research, Karnal 132 001

(Received: May 2006; Revised: December 2007; Accepted: December 2007)

Of the three rusts, leaf rust caused by *Puccinia triticina* is the most important because of its wide spread nature [1]. A total of 60 genes conferring resistance to leaf rust have been identified and designated as *Lr1* through *Lr60* [2]. The best strategy for the control of leaf rust lies in combining the genes with major and minor effects. Many virulent races of brown rust have rendered the resistance provided by *Lr26* ineffective. The confinement of epidemic outbreak was largely due to the presence of alien genes like *Lr26* which combines well with adult plant resistance gene like *Lr34* [1, 3] or some unidentified genes with minor effects. Alien genes like *Lr9*, *Lr19*, *Lr24* etc. with effective resistance against most of the leaf rust races available in India have been utilized only in a few of genotypes grown commercially [4]. At the same time, the appearance of new race like 77-7 with combined virulence on *Lr9* and *Lr26* has risked the durability of individual alien genes. It is, therefore, high time to pyramid genes which have been knocked down by a single virulence with some of the adult plant resistance genes like *Lr34.* Some of these alien genes have already been pyramided in a few popular wheat cultivars through backcrossing [5].

The major problem encountered in most of the conventional breeding programmes is the inability to select for combinations of alien effective genes in the absence of suitable differentiating race(s) and non-integration of suitable molecular markers into the breeding programme. However, the reaction pattern of these genes against a wide spectrum of races and their linkage with other resistance genes of yellow rust, black rust and powdery mildew can be helpful. A similar approach has been followed to exploit and identify some of the alien genes in newly bred lines utilizing a single donor carrying the alien genes.

The released wheat variety WH542 was crossed with CMH 79A-955/AGA carrying leaf rust resistance genes *Lr9*, *Lr19* and *Lr24*. The F_1s were screened both at the seedling and adult plant stages by inoculating with mixture of inoculum of leaf rust races 77-5, 104B and 104-2 and stripe rust races, 46S103 and 46S119. All the F_1s showed resistance to mixture of races in seedling as well as in adult plant stages. Selection was exercised in segregating generation and only leaf rust resistant plants were carried forward by taking off-season crop at IARI, Regional Station, Wellington (TN). One hundred and eighty single plant progenies in F_7 generation were tested at DWR, Karnal and its Regional Station, Flowerdale for seedling reaction against the individual races of leaf rust *viz.*, 77-5, 104B 104-2, 77-7 and 77-8, stripe rust, namely, 46S103, 46S119 and stem rust, 40A and 40-1. The reactions were recorded on the first leaf of ten seedlings per entry using the scale of Nayar *et al.* [6]. The same lines were planted in the field in two rows of 3.5 m each providing spreader rows after every 20 rows and also around the each block at Karnal in two consecutive crop seasons. The adult plant response (pustule type) and severity (per cent infection) were recorded as per standard procedure. The presence of leaf tip necrosis (LTN) was recorded on the flag leaf.

Out of 180 F_7 progenies tested, 13 progenies were sorted out to have complete resistance against tested races of leaf rust. The reaction types on these lines observed at the seedling stage against the selected races of leaf, stripe and stem rusts on these lines are presented in Table 1. Adult plant responses were recorded in the field. Genetic stock carrying *Lr9* (HP 1633) and *Lr19* (Cook*6/C 80-1) were used as checks. All the lines listed in the Table1 showed 0; (naught fleck) response against 77-5, 104B and 104-2. Since WH 542 carries leaf rust resistance genes *Lr26, Lr23* and *Lr34* [6], hypersensitive reaction against leaf rust races 77-5 and 104-2 in the advance lines has probably been contributed by the donor CMH 79A-955/AGA. Race specific resistance with few exception is generally

[1]Present address: Division of Genetics, Indian Agricultural Research Institute, New Delhi 110 012

not durable if used continuously and singly and this is amply demonstrated by the breakdown of PBW 343 resistance within 3-4 years after its release [7].

Hence, the pyramiding of the resistance genes (both major and minor) emphasized by several rust geneticists and pathologists [8] will prove more effective and durable. Selection for *Lr34*, a well known adult plant resistance gene in the presence of hypersensitive genes like *Lr9*, *Lr19* and *Lr24* by host pathogen interaction is difficult. *Lr34* is reported to be linked with the leaf tip necrosis and stripe rust resistance gene *Yr18* [9], which has been used as marker for selection in the field. The usefulness of these linked genes is well known. The presence of *Lr34/Yr18* in the reported lines is expected as WH 542 is known to carry *Lr34* [6, 10]. However, its presence is always proved by leaf tip necrosis [9]. In the lines numbering 2, 7, 8 and 10, low infection against 46S119 indicated the presence of additional gene(s) besides *Yr9* (Table 1). The low average coefficient of infection (ACI) score under field conditions at adult plant stage against the mixture of inoculum of yellow rust further indicated that though it has lost its effectiveness in many countries including India. From the results we can presume the presence of either of *Lr19* or *Lr9* + *Lr19* or *Lr9+Lr19+Lr24* with *Lr26* and *Lr34* in lines nos 1 to 4, 7, 9 and 10 (Table 1). The lines 5, 6, 8, 11, 12 and 13 showed 0; infection type against all the tested races except 77-7 which indicated that these lines carry *Lr9*. Since these showed susceptible reaction against 77-7, the possibility of *Lr19* and or *Lr24* is ruled out. The presence of *Yr18* in all the lines reported is postulated on the basis of presence of leaf tip necrosis. Breeding to pyramid the hypersensitive genes along with adult plant resistance genes is very difficult to achieve through conventional breeding techniques due to inability for selection of suitable segregants in the segregating generations. However, at present number of resistance genes have been tagged with molecular markers and therefore effective genes can be pyramided. Since marker assisted selection is not yet commercially feasible, the linkage between the genes and the reaction pattern against rust pathogens can be a useful methodology to pyramid some of these genes in suitable

Table 1. Seedling reaction and adult plant response of selected wheat genotypes against leaf, stripe and stem rusts

S. No.	Name of the test entry	Seedling reaction									Adult plant response (Average coefficient of infection)	
		Leaf rust					Stripe rust		Stem rust		Leaf rust	Stripe rust
		77-5	104B	104-2	77-7	77-8	46S103	46S119	40A	40-1		
1	RRW99871	0;	0;	0;	0	0	0;	3	1	1	0	15.0
2	RRW99872	0;	0;	0;	0;	0;	0;	1	1	1	0	2.1
3	RRW99888	0;	0;	0;	0;	0:	0;	3	0	0	0	12.0
4	RRW99889	0;	0;	0;	0:	0:	0;	2	0	0	0	14.0
5	RRW99890	0;	0;	0;	3C	0;	0;	3	2	2	0	12.0
6	RRW99891	0;	0;	0;	3C	0;	0;	3	2	2	0	15.0
7	RRW99893	0;	0;	0;	0;	0;	0;	1	1	1	0	3.0
8	RRW99894	0;	0;	0;	3C	0;	0;	1	2	2	0	0.5
9	RRW99896	0;	0;	0;	0;	0;	0;	3	1	1	0	12.0
10	RRW99897	0;	0;	0;	0;	0;	0;	1	1	1	0	2.1
11	RRW99969	0;	0;	0;	2+C	0;	0;	3	2	2	0	4.5
12	RRW99972	0;	0;	0;	2+C	0;	0;	3	1	1	0	12.0
13	RRW99974	0;	0;	0;	3	0;1	0;	3	2	2	0	12.0
14	WH 542	3+	0;	3+	3	0;	0;	2+	1	1	15.0	5.0
15	HP 1633	0;	0;	0;	3c	0;	1+	2+	2	2	0	20.0
16	Cook*6/C-80-1	0;	0;	0;	;1	3c	-	1	1	1	0	15.0
17	Agra local	3+	3+	3+	3+	3+	3+	3+	3+	3+	70	70.0

these line presumably carry *Yr9+* resistance. Since *Yr9* along with *Lr26*, and *Sr31* are present on wheat rye translocated chromosome (1BL/1RS), the presence of *Lr26* and *Sr31* can be easily presumed. The 1B/1R translocation is most widely exploited source of resistance against leaf, stripe and stem rusts even genetic background. The newly constituted lines can be either used as donors for leaf rust resistance or as cultivars after testing their agronomic suitability.

References

1. **Sawhney R. N.** 1998. Genetic analysis of wheat-rust interactions and strategies to breed for durable resistance. Indian J. Genet., **58**: 391-416.
2. **McIntosh R. A., Devos K. M., Dubcovsky J., Rogers W. J., Morris C. F., Appels R., Somers D. J. and Anderson O. D.** 2007. Catalogue of gene symbols for wheat (Supplement). Annual Wheat Newsletter, **53**: 159-175.
3. **Sawhney R. N.** 1992. The role of *Lr34* in imparting durable resistance to wheat leaf rust through gene interaction. Euphytica, **61**: 9-12.
4. **Tomar S. M. S. and Menon M. K.** 2001. Genes for resistance to rusts and powdery mildew in wheat. Indian Agriculture Research Institute, New Delhi, pp. 152.
5. **Tomar S. M. S., Menon M. K., Bojan S. and Sinha V. C.** 2006. Stable linked genes for rust and powdery mildew resistance in wheat (*Triticum aestivum*). Indian J. of Agric. Sci., **76**(12): 721-5.
6. **Nayar S. K., Tandon J. P., Kumar J., Prashar M., Bhardwaj S. C., Goel L. B. and S. Nagarajan.** 1994. Basis of rust resistance in Indian wheats. Research Bulletin No.1., Regional Station, DWR, Flowerdale, Shimla 171 002, India, pp. 32.
7. **Anonymous.** 1999. Annual Report (1997-1999). Directorate of Wheat Research, Karnal.
8. **Watson I. A. and Singh D.** 1952. Future for rust resistance wheat in Australia. J. Aust. Agric. Sci., **18**: 190-197.
9. **Singh R. P.** 1992. Genetic association between gene *Lr34* for leaf rust resistance and leaf tip necrosis in bread wheat. Crop Sci., **32**: 874-878.
10. **Roelfs A. P., Singh R. P. and Saari E. E.** 1992. Rust diseases of wheat: Concepts and Methods of Disease Management. Mexico, DF, CIMMYT. 81 pp.