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Short Communication

Near-isogenic lines in NP 4 background carrying the genes *Lr1, Lr2a, Lr2c, Lr3a, Lr9, Lr10, Lr15, Lr17a* and *Lr20* as locally adapted differentials for Indian pathotypes of wheat leaf rust

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Abstract

Wheat leaf rust differentials being used in India include selected near-isogenic *Lr* lines in 'Thatcher' background (set A), some of the historical differentials like Malakoff, Webster, Loros etc. (set B) and IWP 94 (*Lr23*) out of a set of eight Indian wheat genotypes (set 0). The set A lines and most varieties in set B are late maturing as they require long photoperiod for flowering, which limits their utilization in virulence analysis and genetic studies under Indian conditions. A backcross programme was conducted to transfer those *Lr* genes which occur in these lines and varieties in the background of NP 4 having desired agronomic traits. Nine homozygous resistant lines carrying *Lr1*, *Lr2a*, *Lr2c*, *Lr3a*, *Lr9*, *Lr10*, *Lr15*, *Lr17a*, and *Lr20* have been developed through six backcrosses and subsequent selection based on seedling tests with appropriate leaf rust pathotypes of selected BC_6F_3 lines having NP 4 plant type. These lines being locally adapted and early maturing are easy to maintain under Indian conditions, and can be widely used for virulence analysis and genetic studies.

Key words: Near-isogenic lines, *Lr* genes, wheat, leaf rust differentials, *Puccinia triticina*, NP 4

Leaf rust caused by *Puccinia triticina* Eriks. (*Pt*) is most common among three rust diseases of wheat (*Triticum aestivum* L.). Leaf rust differentials being used in India consist of sets 0, A and B which include eight Indian wheat genotypes, eight Thatcher (Tc) backcross lines carrying *Lr14a*, *Lr24*, *Lr18*, *Lr13*, *Lr17a, Lr15*, *Lr10*, and *Lr19*, and seven wheat varieties *viz*., Loros (*Lr2c*), Webster (*Lr2a*), Democrat (*Lr3a*) Thew (*Lr20*) Malakoff (*Lr1*) Benno (*Lr26*) and HP 1633 (*Lr9*), respectively (Nayar et al. 2001). All the lines from sets 'A' and 'B', but only IWP 94 (*Lr23*) from set '0' are being utilized in differentiating the Indian pathotypes of *Pt.* The Tc-backcross lines in set 'A' and most varieties in set 'B' are winter types which require a long photoperiod for flowering. Hence, maintenance of these differentials is difficult, particularly in the plains of India due to their long duration and often there is either seed set failure or production of shriveled grain. Hence, need was felt for developing near-isogenic *Lr* lines in the background of a locally adapted variety. There were four candidates *viz*., NP 4, Pissi Local, Lal Bahadur and Agra Local for the choice of background parent for developing such lines. While Pissi Local had suppressors for leaf rust resistance (Kaushal et al. 1982; Lohani 1983), Lal Bahadur carried the gene *Lr1* (Lohani 1983; Singh et al. 1998). Agra Local showed faster rust development in the field which caused considerable seed damage and was prone to lodging because of weak straw, compared to NP 4 (authors' unpublished observations). Hence, NP 4, not known to carry any *Lr* gene or suppressor factor (Kaushal et al. 1982) for leaf rust resistance, and being early

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Table 1. Comparison of seedling infection types (at 16-20°C) to selected avirulent leaf rust pathotypes of the newly developed near-isogenic lines (KK 1-9) with the corresponding donor *Lr* lines (RL Nos.) and the recurrent parent NP 4

Wheat genotypes	Seedling infection type[1]	Avirulent leaf rust pathotypes used for testing
KK 1 (NP4+*Lr1*)	0;	11, 12, 12-2, 12-1, 12-3, 12-5, 63, 106, 12-8, 162-1, 162A
RL 6003 (Tc+*Lr1*)	0;	
NP 4	3+	
KK 2 (NP4+*Lr2a*)	0;2	11, 12, 12-2, 12-3, 12-5, 12-8, 17, 63, 104-2, 106
RL 6016 (Tc+*Lr2a*)	0;2+	
NP 4	3+4	
KK 3 (NP4+*Lr2c*)	0;1	16, 16-1, 17, 77-9, 77-10, 77-11
RL 6047 (*Lr2c*)	0;1	
NP 4	3+	
KK 4 (NP4+*Lr3a*)	0;	17, 20, 104-1, 106, 107, 108, 108-1
RL 6002 (*Lr3a*)	0;	
NP 4	3+	
KK 5 (NP4+*Lr9*)	0;	11, 12-5, 16, 17, 63, 77-5, 77-9, 77-11, 104-2
RL 6010 (*Lr9*)	0;	
NP 4	3+	
KK 6 (NP4+*Lr10*)	;2	10, 12-2, 12-5, 63, 77, 107, 107-1, 162-3
RL 6004 (*Lr10*)	;2	
NP 4	33+	
KK 7 (NP4+*Lr15*)	0;	10, 11, 20, 63, 104-4, 106, 107, 107-1, 108, 108-1
RL 6052 (*Lr15*)	0;	
NP 4	3+	
KK 8 (NP4+*Lr17a*)	0;2	10, 12, 12-1, 12-3, 63, 106, 107, 107-1
RL 6008 (*Lr17a*)	0;2+	
NP 4	33+	
KK 9 (NP4+*Lr20*)	;1	10, 12-1, 12-2, 12-3, 77-4, 77-6, 104-2, 104B, 162-2, 162-3
RL 6092 (*Lr20*)	;1	
NP 4	3+	

[1]As described by Roelfs et al. (1992)

maturing, slow rusting, lodging-tolerant, non-shattering, heat and drought tolerant, and bold seeded variety was selected as background parent. Out of the above mentioned 16 *Lr* genes, *Lr14a* and *Lr24* have little value as differentials because of their susceptibility and resistance, respectively, to all the known Indian leaf rust pathotypes. Resistance of the line Tc+*Lr14a* to three pathotypes *viz*., 11 (0R8), 63 (0R8-1), and 106 (0R9) is due to their avirulence to the background parent Thatcher (Mishra et al. 2001). Hence, a backcross programme was initiated in 1997-98 for transferring the aforesaid *Lr* genes, except *Lr14a* and *Lr24*, in NP 4 background.

Tc-backcross lines carrying the target *Lr* genes *viz*., RL 6003 (Tc+*Lr1*), RL 6016 (Tc+*Lr2a*), RL 6047 (Tc+*Lr*2c), RL 6002 (Tc+*Lr*3a), RL 6010 (Tc+*Lr*9), RL 6004 (Tc+*Lr*10), RL 6052 (Tc+*Lr*15), RL 6008 (Tc+*Lr*17a) and RL 6092 (Tc+*Lr*20) were used as donors. NP 4, a local Mundia selection released in 1911 by the then Imperial Agricultural Research Institute, Pusa, Bihar (Jain 1994) was used as recurrent parent. Six backcrosses were attempted in succession beginning from 1998-99. Intense selection was made during each generation for NP 4 plant type (awnless spikes and pubescent glumes) coupled with resistance phenotype of the target gene. The latter was identified in the field through syringe inoculation after 30-35 days of sowing with aqueous suspension of the uredospores of an avirulent pathotype. This was done during December-January months when atmospheric temperatures at Indore generally ranged between 10-27°C, quite congenial for leaf rust development. Leaf rust pathotype (pt) 12-2 (1R5) was used for selecting resistant plants carrying singly the genes *Lr1*, *Lr2a*, *Lr15*; pt 12-5 (29R45) for *Lr*9, *Lr10*, *Lr20*; pt 17 (61R24) for *Lr2c, Lr3a* and pt 107 (45R3) for *Lr17a*.

The plants thus developed through six backcrosses and selection putatively carrying the target *Lr* gene and closely resembling NP 4, were selfed for two years in accordance with the standard guidelines (Allard 1960) to ensure uniformity. Selected material was seedling tested for identifying homozygous resistant lines, which were selfed for one more generation to get enough seed. These lines were further seedling tested with several avirulent pathotypes for confirming homozygosity for target *Lr* gene as suggested (D.R. Knott, Pers. comm.). The seedling tests were conducted in a glasshouse under controlled conditions (16-20°C) at ICAR-Indian Institute of Wheat and Barley Research, Regional Station, Flowerdale, Shimla.

Close similarity between seedling infection types of the newly developed backcross lines and the corresponding donor lines confirmed successful transfer of the target *Lr* genes in NP 4 background (Table 1). Homozygous resistant lines carrying singly nine genes *viz*., *Lr1, Lr2a, Lr2c, Lr3a, Lr9, Lr10, Lr15, Lr17a* and *Lr20* have been developed so far. These near-isogenic lines having early maturity and other desired agronomic traits of NP4 are easy to maintain under Indian conditions, and hence, should be widely useful for virulence analysis and genetic studies. Development of NP4 based near-isogenic lines carrying

the remaining five target genes *viz*., *Lr13, Lr18, Lr19, Lr23* and *Lr26* is in the final stage.

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References

Nayar S. K., Nagarajan S., Prashar M., Bharadwaj S. C., Jain S. K. and Dutta D. 2001. Revised catalogue of genes that accord resistance to *Puccinia* species in wheat. Res. Bull No. 3. pp. 48. Directorate of Wheat Research, Regional Station, Flowerdale, Shimla, India.

Kaushal Kamini, Gaur R., Joshi R. and Upadhyaya Y. M. 1982. Genetic diversity for black and brown rust resistance. Indian J. Genet., **42:** 114-118.

Lohani Rashmi. 1983. Identification and isolation of genes for brown rust resistance in *Trticum aestivum* L. Ph D thesis. pp. 241. Devi Ahilya Vishwavidyalaya, Indore.

Singh R. P., Mujeeb-Kazi A. and Huerta-Espino J. 1998. *Lr46:* A gene conferring slow-rusting resistance to leaf rust in wheat. Phytopathology, **88:** 890-894

Mishra A. N., Kaushal Kamini, Jain S. K. and Pandey H. N. 2001. Thatcher avirulent leaf rust pathotypes from India. Wheat Information Service, **93:** 32-34.

Jain K. B. L. 1994. Wheat Cultivars in India : Names, Pedigrees, Origins, and Adaptations. Res. Bull. No. 2. pp. 72. Directorate of Wheat Research, Karnal, India.

Allard R. W. 1960. Principles of Plant Breeding. pp. 485. John Wiley & Sons, Inc., U.S.A.

Roelfs A. P., Singh R. P. and Saari E. E. 1992. Rust Diseases of Wheat: Concepts and Methods of Disease Management. pp. 81. CIMMYT, Mexico, D.F.