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A Novel Hypersensitive Stripe Rust (*Puccinia striiformis* Westend f. sp. *Tritici*) Resistance Gene in Bread Wheat Cultivar Cook Effective in India

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Summary

An Australian wheat cultivar Cook was studied for the stripe rust resistance both under glass house and field conditions against the most virulent race 46S119 of stripe rust. The inheritance studies showed that stripe rust resistance in cultivar Cook is conditioned by one hypersensitive and one non-hypersensitive genes. Apart from a known non-hypersensitive resistance gene *Yr18*, the cultivar cook also contains a hypersensitive stripe rust resistance gene effective against race 46S119. This gene could be novel and efficiently be utilized across wheat germplasm in building durable resistance against stripe rust in India.

Key Words: Stripe rust, *Triticum aestivum*, Non-hypersensitive resistance

Introduction

In India, stripe rust (*Yr*) of wheat (*Triticum aestivum* L.) caused by *Puccinia striiformis* westend f. sp. *tritici* occurs in severe form on susceptible varieties in North Western Plain Zone (NWPZ) covering states of Punjab, Haryana, Rajasthan, western Uttar Pradesh, Northern Hill Zone (NHZ) covering Himachal Pradesh, parts of Bihar and Nilgiri Hills in Tamil Nadu in Southern Zone (SZ). Identification of diverse sources of resistance and their utilization in wheat improvement is crucial for reducing the losses caused by this disease [1]. Forty-eight genes for resistance to stripe rust, named as *Yr1* through *Yr48* in wheat have so far been identified from different germplasm collections (http://www.intl-pag.org/19/abstracts/P05c_PAGXIX_302.html). Among the already designated genes, *Yr18* is the only gene conditioning non-hypersensitive type of resistance [2] and known for its durability against stripe rust [3, 4]. This gene is linked to a morphological marker "Leaf Tip Necrosis" which is used as a criterion to identify wheats with *Yr18* [5]. Protection from rust infection using genes like *Yr18* is often partial and quantitative in nature [4]. The wheat varieties with wide spread cultivation like PBW343 in India and Inqlab 91 in Pakistan are having *Yr27* based protection and thus these are under potential threat from stripe rust in their respective areas [3]. Therefore, search for novel resistance genes particularly those conferring non-hypersensitive type of resistance has become important for wheat scientists all over the world. The Australian cultivar Cook apart from showing leaf tip necrosis (Ltn) and gene *Yr18* [6] has shown additional resistance in artificial stripe rust epidemics against race 46S119. The present investigation aims to examine the nature and number of genes governing additional resistance of wheat cultivar Cook to stripe rust.

Experimental

In the genetic studies, cultivar Cook (Table 1) was crossed with susceptible bread wheat cultivar WL711 (S308/Chris/Kalyansona). The Indian land race Agra Local (Table 1) was used as disease spreader. The F_1, F_2 and F_3 generations were developed from the cross. The F_1s were obtained during April 2003, which were grown at Regional Wheat Research Station, Directorate of Wheat Research, Dalang Maidan, Lahaul and Sipiti, Himachal Pradesh for generation advancement during May to September 2003 in offseason. The sowing of F_2 generations was done in normal season in the second week of November 2003 at the experimental area of Punjab Agricultural University, Ludhiana, India. Individual plants of F_2 populations of the cross were harvested to raise their respective F_3 families. The experimental material was space planted in 2m long paired rows with row-to-row distance of 30 cm in a pair and 50 cm in between paired rows. After every 20 rows of the experimental material the resistant cultivar and two stripe rust susceptible cultivars WL711 and Agra local were planted for comparison. The susceptible cultivar Agra local was planted all around the experimental plots also to ensure uniform spread of disease. Half of the F_1 and F_2 seed from each cross was saved for simultaneous testing of F_1, F_2 and F_3 generations during normal season 2004-2005. Recommended doses of fertilizers (10 tonnes Farm Yard Manure, 110 kg Urea and 55kg Diammonium Phosphate per acre) as prescribed in package of practices of Punjab Agricultural University, were used to ensure proper growth of crop. Irrigation was done at weekly intervals to delay maturity and maintain high humidity for maximum rust development.

Stripe rust epidemic was created by repeated spray inoculations of the experimental material and infector rows with the urediniospores of *P. striiformis* race 46S119 suspended in light mineral oil Isopar L (Chemicals and Solvents, Inc. Headquarters, 1140 Industry Ave. SE, Roanoke, VA24013 USA www.chemsolv.com), twice a week starting from second week of December till rust started appearing on susceptible cultivars in early February. Inoculum of race 46S119 was obtained from Wheat Rust Research Station, Directorate of Wheat Research, Flowerdale, Shimla and increased by inoculating urediniospores on stripe rust susceptible variety Agra local in glass house. Race 46S119 is the most frequently identified race from the Indian sub-continent and it is virulent on the known stripe rust resistance genes *Yr6*, *Yr7*, *Yr8*, *Yr9*, *Yr11*, *Yr12* and *Yr18*.

The infection type studies at seedling and adult plant stages against race 46S119 were done in glasshouse following the scale proposed by Gassner and Straib [7]. The stripe rust severity of each plant was assessed according to modified Cobb scale as described by Peterson *et al* [8]. The plants within parents, F_1, F_2 and F_3 generations were observed for rust severity when susceptible infector rows recorded severity of 80S to 90S. The plants with disease severity of 70S which is less than lower count of susceptible parent were classified as resistant, while those showing severity levels equal to WL711 or higher were classified as susceptible.

Results and Discussion

The cultivar Cook recorded susceptible infection type at seedling stage, while adult plants showed resistance against stripe rust race 46S119 (Table 1), while the cultivars Agra Local and WL711 recorded susceptible infection type (33^+). Cultivar Cook recorded percent stripe rust severity of 20S, while percent rust severity of 80S to 90S was recorded on susceptible cultivar WL711 and infector rows of Agra Local (Table 1). The F_1 of the cultivar Cook with susceptible cultivar WL711 showed percent disease severity of 30S which may be ascribed to the partially dominant nature of stripe rust resistance gene(s) present in Cook. Since resistance is always comparative, all plants having severity of 70S or lower were considered resistant as compared to 80S reaction of the susceptible parent WL711, which may show severity close to 50S. The F_2 and F_3 generations from the cross Cook x WL711 segregated in two gene ratio [9]. The inheritance studies have indicated two partially dominant genes in cultivars Cook, one of the two genes could be *Yr18* [9] other gene is a novel hypersensitive stripe rust resistance gene effective in India. Singh et al [4] have suggested the usefulness of such genes in development of wheat varieties with durable resistance to rusts, because of their positive effect towards resistance, when these are present in combinations.

Conclusion

Keeping in view the importance of identifying race specific adult plant resistance genes in building a long lasting control against stripe rust, cultivar Cook is demonstrated to carry a hypersensitive adult plant stripe rust resistance gene effective in India. Such genes could be better utilized in widening the genetic base of wheat for defense against stripe rust.

Table 1. Origin, source* and parentage of wheat cultivars used and their reaction to stripe rust race 46S119

S.No.	Cultivar/Reference line	Origin	Source	Parentage	Growth stage and Infection types*		Disease severity**
					Seedlings	Adult Plants	Field
1.	Cook	Australia	RAMC	Timgalen/Condor Sib//Condor	33^+	1	20S
2.	WL711	India	PAU	S308/Chris/Kalyansona	33^+	33^+	80-90S
3.	Agra Local	India	IARI	Land race	33^+	33^+	80-90S

RAMC- Dr R A McIntosh, University of Sydney, Plant Breeding Institute, Cobbitty Road, Cobbitty, NSW 2570, Australia.
PAU- Punjab Agricultural University, Ludhiana-141004, India
IARI- Indian Agricultural Research Institute, New Delhi, India
*According to Gassner and Straib [7].
**According to Peterson *et al* [8].

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