

GENES FOR STEM RUST RESISTANCE IN WHEAT VARIETY RAJ 848

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ABSTRACT

Wheat variety 'Raj 848' was genetically analysed against stem rust race 21 and 40. F_1 , F_2 and F_3 seedlings were tested against both the races. It was found that 'Raj 848' carries $Sr11$ plus an additional, new, dominant gene. The latter conditions ($2=$) reaction to race 40 only and is tentatively designated as $Sr848$. $Sr11$ imparts hypersensitive reaction to races 21 and 40.

Out of the three rusts, stem rust (*Puccinia graminis* Pers. f. sp. *Tritici* Eriks. and Henn.) of wheat has long remained a perennial problem which has stimulated intensive research on the wheat plant, the pathogen and their genetical relationship. Wheat variety 'Raj 848' developed at Agriculture Research Station, Durgapura was observed to be highly resistant to stem rust under Indian conditions. The variety was therefore, taken up for genetical analysis to identify the genes for stem rust resistance carried by it.

MATERIALS AND METHODS

'Raj 848' a variety developed at Agriculture Research Station, Durgapura is a selection from a cross (LR 64 \times S 64) Napo 62-22402, which involves varieties Leramarajo 64, Sonora 64 and Napo 62 in its pedigree. It is fully awned, white glumed with amber grains. 'Kharchia' a local wheat cultivar suited to saline wheat tracts in Rajasthan, India, is highly susceptible to large number of stem rust races, including races 21 and 40 used in the present study. Near isogenic lines developed in the back ground of susceptible variety 'Marquis' carrying single known resistant gene were used to identify the genes located in the variety 'Raj 848'. Of these single gene 'Marquis' lines, only those carrying stem rust resistant genes $Sr5$, $Sr8$, $Sr9b$ and $Sr11$ were utilised in crossing due to their resistance to race 21 and 40. In addition to these isogenic lines, 'Mengavi' ($Sr9c$) and 'Yalta' ($Sr11$) were used in crosses with 'Raj 848'. Of the cross 'Raj 848' \times 'Kharchia' F_1 , F_2 and F_3 generations were tested in seedling stage against the races 21 and 40 F_2 populations of the cross 'Raj 848' \times 'Kharchia' with tester lines were also tested.

Initial inoculum of pure single spore culture of race 21 and 40 were obtained from Mycology laboratory, Indian Agriculture Research Institute, Simla (India). Inoculum of these races was increased on variety 'Kharchia' in the Rust Testing Laboratory at Durgapura where temperature was maintained at 70°F during the testing period.

RESULTS AND DISCUSSION

The seedling reaction of parent varieties and tester lines to race 21 and 40 are presented in Table 1. Seedlings of 'Raj 848' were resistant to stem rust races 21 and 40 and gave (0; 1=) reaction to both the races (Table 1). F_1 seedlings of the cross 'Raj 848' \times 'Kharchia' when tested against race 21

*Part of the thesis of the senior author for Ph.D. degree of the University of Udaipur, 1976.

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exhibited reactions similar to 'Raj 848'. This indicated complete dominance of factors entering into the genotype of the F_1 plants of the cross. The F_1 population could not be tested with race 40. However, on the basis of F_2 and F_3 data it can be presumed that similar over all dominance of factors would prevail for race 40 also.

TABLE 1

Seedling reaction of parent varieties and marquis backcross lines carrying known genes to stem rust race 21 and 40

Variety or Line	Race 21	Race 40
Raj 848	0; 1=	0; 1=
Kharchia	4	4++
Marquis ⁶ Sr1 (Now 9d)	3+	3+
Marquis ⁶ Sr5	1-	3++
Marquis ⁶ Sr6	3+	3+
Marquis ⁶ Sr7	3+	3+
Marquis ⁶ Sr8	2=	2=
Marquis ⁶ Sr9a	3+, 4	3±, 4
Marquis ⁶ Sr9b	2±	2±
Mengavi (Sr9c)	1=	1=
Marquis ¹⁰ Sr11	0; 1=	0; 1=
Marquis ⁶ Sr12	4	4
Marquis ⁶ Sr13	3	3
Marquis ⁶ Sr14	3±, 4	3±, 4
Norka Sr15	3	3
Yalta Sr11	0; 1=	0; 1=

The F_2 data of the cross 'Raj 848' × 'Kharchia' show segregation of 3R : 1S and 15R : 1S when tested with race 21 and 40 respectively. It can be interpreted with the reactions of F_2 populations of cross 'Raj 848' × 'Kharchia' that 1 dominant gene govern resistance against race 21 and 2 dominant gene govern resistance against race 40.

The above hypothesis was further confirmed by testing 67 randomly selected F_3 families of the same cross against races 21 and 40. Out of 67 families, 19 families were resistant, 30 segregated for 3R : 1S ratio and 18 were homozygous susceptible for race 21, fitting a ratio of 1R : 2H : 1S (Table 2). This supports the hypothesis derived from the segregating F_2 populations of the cross 'Raj 848' × 'Kharchia' that resistance in variety 'Raj 848' against race 21 is governed by one dominant gene.

The same 67 families were also tested against race 40 (Table 3). 32 families were found homozygous resistant, 15 families were segregating for 15R : 1S ratio, 14 families were segregating for 3R : 1S ratio and 6 families were homozygous susceptible fitting a ratio of 7R : 8H : 1S with 'P' value 0.50-0.30.

The results confirm the findings of F_2 segregation of the cross 'Raj 848' \times 'Kharchia' that 'Raj 848' carried two independent dominant genes for protection against race 40.

TABLE 2

Results of seedling rust tests on F_2 populations from the crosses involving Raj 848

Cross	Race	Number of Seedlings		Expected Ratio	'P' value
		Res.	Sus.		
Raj 848 \times Kharchia	21	295	90	3 : 1	0.50-0.30
	40	442	29	15 : 1	0.95-0.90
„ \times Marquis ⁶ Sr5	21	197	14	15 : 1	0.90-0.80
	40	170	11	15 : 1	0.90-0.80
„ \times Marquis ⁶ Sr8	21	322	24	15 : 1	0.70-0.50
	40	293	7	63 : 1	0.30-0.20
„ \times Marquis ⁶ Sr9b	21	190	13	15 : 1	0.95-0.90
	40	215	4	63 : 1	0.80-0.70
„ \times Mengavi (Sr9c)	21	422	57	15 : 1	0.001
	40	253	10	63 : 1	0.10-0.001
„ \times Marquis ¹⁰ Sr11	21	275	0	—	
	40	242	0	—	
„ \times Yalta (Sr11)	21	284	0	—	
	40	269	0	—	

The interaction data of F_3 families of the cross 'Raj 848' \times 'Kharchia' clearly indicated that one of the two genes imparting high degree of resistance with hypersensitive reaction (0; 1=) in Raj 848 against race 21 is same giving similar reaction to race 40. Another gene in Raj 848 imparting moderate resistance with (2=) reaction exhibited resistance only to race 40.

Single gene lines carrying Sr1, Sr6, Sr7, Sr9a, Sr12, Sr13, Sr14 and Sr15 were susceptible to race 21 and 40 (Table 1). 'Marquis' line carrying gene Sr5 gave resistant (1-) reaction to race 21 but was susceptible (3+) to race 40. Marquis lines carrying genes Sr8, Sr9b and Sr11 were resistant to both the races. Mengavi carrying gene Sr9c (Watson and Luig, 1968) and Yalta carrying gene Sr11 exhibited resistant reaction to both the races 21 and 40.

One of the two dominant genes identified in the present investigation in 'Raj 848' appears to be Sr11 or a closely linked gene with it. Non-segregating F_2 progeny of the cross Raj 848 and isogenic line carrying gene Sr11 (Table 2) confirmed this finding. Sonora-64 one of the parents in Raj 848 was reported to carry Sr11 (CIMMYT Annual Report, 1969-70). Jha (1970b) reported that in Sonora-64, chromosome 6B was found to be involved in conditioning resistance.

Since gene *Sr11* is also located on chromosome 6B, there is every possibility of this gene (*Sr11*) being present in variety Sonora-64 and was also consequently inherited in variety Raj 848.

TABLE 3

Seedling rust reactions of F3 families of the cross Raj 848 × Kharchia for race 21 and 40

Race 40	Race 21 Number of families			Total race 40	Expe- cted 7:4:4:1	'P' value
	Res. (R)	Seg (H) 3:1	Sus. (5)			
Res.	19 (16.7)*	9 (8.4)	4 (4.2)	32	29.3	
Seg 15:1	—	15 (16.8)	—	15 ³	16.7	0.50-0.30
Seg 3:1	—	6 (8.4)	8 (8.4)	14 ²	16.7	
Sus.	—	—	6 (4.2)	6	4.2	
Total race 21	19	30 ¹	18	67		
Expected 1:2:1	16.7	33.4	16.7			
'P' value			0.70-0.50			

¹ Race 21 R 872 : S 305 'P' value for 3R:1S=0.90-0.80

² Race 40 R 455 : S142 'P' value for 3R:1S=0.50-0.30

³ Race 40 R 307 : S16 'P' value for 15R:1S=0.50-0.30

Interaction between race 21 and 40 for 4:2:1:4:2:2:1 ratio=0.95-0.90

* Expected frequency of different classes bracketted.

Another gene in 'Raj 848' imparting moderate resistance (2= reactions) exhibited resistance only to race 40. It was non allelic to all the known genes (*Sr5-Sr15*) and the unidentified genes present in other varieties under investigation, 'Timgalen', 'HD 1799b', 'HD 2028', 'Safedlerma' and 'Tr 373'. Therefore, this gene in Raj 848 is an unidentified gene which is tentatively designated as *Sr 848*.

ACKNOWLEDGEMENT

The authors are grateful to Dr. Sheodhan Singh, Senior Wheat Pathologist, I.A.R.I. Regional Station, Flowerdale, Simla-4 for supplying nucleus inoculation of stem rust race 21 and 40.

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