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Inheritance of leaf rust resistance of wheat line Federation *4/Kavkaz

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Abstract

Low seedling reaction of the wheat line Federation*4/ Kavkaz (*Lr10* + *Lr26*) to variant 77-5 of the Indian leaf rust race 77 showing virulence on *Lr10* and *Lr26* and all other known *Lr* genes owing their origin to bread wheat was ascribed to a dominant seedling resistance gene. The low terminal disease severity of Federation*4/Kavkaz in field tests against variant 77-5 was ascribed to two dominant genes. One of these two dominant genes is the dominant seedling resistance gene, which remained effective at adult plant stage also. The second gene is an adult plant resistance gene that became operative at adult plant stage only. Because resistance against variant 77-5 is less frequent in bread wheat, the low seedling and adult plant reaction of Federation*4/Kavkaz to variant 77-5 may find an application in wheat breeding programmes.

Key words : Leaf rust, *Triticum aestivum*, seedling resistance, adult plant resistance

Introduction

Puccinia recondita tritici Roberge ex. Desmaz is an important foliar disease of wheat (*Triticum aestivum* L.) causing significant losses in yield world over. Germplasm collections have been evaluated all over the world and over 40 genes conferring resistance to this disease have been identified and designated as *Lr1* through *Lr49* [1-3]. The gene *Lr26* introgressed to wheat cultivar Kavkaz from *Secale cereale* [4] was added to the Australian Cultivar Federation at the Plant Breeding Institute, University of Sydney, NSW, Castle Hill (now Cobbitty), Australia and the derived line was designated as Federation*4/Kavkaz [1]. The tests conducted earlier at the Punjab Agricultural University, Ludhiana indicated genes *Lr10* and *Lr26* in this line (Saini, unpublished). Variant 77-5 (herein after referred to as race 77- 5) of race 77 is the most virulent component of leaf rust flora of the Indian sub continent [8]. Despite virulence of race 77-5 on the genes *Lr10* and *Lr26* [5, 8], the line Federation*4/Kavkaz has shown resistance to this race both at seedling and adult plant stage. The present report describes the inheritance of leaf rust resistance of the line Federation*4/Kavkaz against race 77-5.

Materials and methods

To determine the nature and number of resistance gene(s) in line the Federation*4/Kavkaz, this line was crossed with a leaf rust susceptible land race Agra Local from Uttar Pradesh and another susceptible cultivar WL711. The F_1, F_2 and F_3 generations from these crosses were raised in such a way that these were available for simultaneous tests in 2000-2001 crop season. Each population (parents, F_1, F_2 generation and each F_3 family) from these crosses was split into two parts. One part was tested for infection types at seedling stage against race 77-5 in a glass house maintained at 20 ± 2°C. The second part was planted in open field and each plant was scored for terminal disease severity in an artificial epiphytotic of race 77-5. The low terminal disease severity recorded on field grown adult plants of the line Federation*4/Kavkaz was presumed to be the cumulative effect of both seedling and adult plant resistance gene(s) carried by this line.

For tests at the seedling stage, the seeds of each of these generations were sown in plastic bread boxes filled with sandy- loam soil. First leaf of seven day old seedlings were inoculated with uredinia spore-talc mixture of race 77-5, incubated in dark at 20 ± 1°C and relative humidity of 100% for 24 h and then shifted to a glass house for recording infection types. The infection types were recorded following the scale described by Stakman *et al.*, [6]. The infection types (ITs), 0;, ;, ;1, 2 and X were regarded resistant and 3 to 3^+ as susceptible.

For field tests the parents, F_1, F_2 and F_3 generation plants were grown in open experimental areas as 2m long paired rows spaced 30 cm apart. One row of F_1, 10-20 rows of F_2 and 100-125 rows

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of F_3 from each cross were planted following the standard agronomic practices. The experimental plots were surrounded by a row each of Agra Local and WL711 which served as infector rows. The uredinia spores of race 77-5 suspended in water were repeatedly sprayed over the experimental material and the suscetible infector rows on alternate days till leaf rust started appearing on the infector rows. The experimental plots were irrigated twice a week to maintain high humidity for optimum rust development. The terminal disease severity on each plant was recorded in the second week of April, 2000-2001 according to modified Cobb scale as described by Peterson *et al.*, [7]. The line Federation*4/Kavkaz showed terminal disease severity of TR, against race 77-5. The terminal disease severity on Agra Local and WL711 varied from 40S to 70S and 40S to 80S respectively. Therefore, plants showing terminal disease severity of 40S/MS/MR and below were regarded resistant. Simple chi-square test was used to test fitness of the segregation ratio.

Results and discussion

When scored on the basis of infection types, the seedlings of the line Federation*4/Kavkaz showed infection types, ; to ;1^- and those of susceptible cultivars showed infection type, 33^+. The infection types on F_1 seedlings from crosses of Federation*4/Kavkaz with Agra Local and WL711 varied from ; to;12. The F_2 seedlings of the cross Federation*4/Kavkaz X Agra Local segregated 118 resistant and 57 susceptible. The F_3 from this cross contained 23 homozygous resistant (HR), 42 segregating (segr.) and 18 homozygous susceptible (HS) families which appear to segregate 1 (HR) : 2 (segr.) : 1 (HS). The F_2 of cross Federation*4/Kavkaz X WL711 segregated 53 resistant : 30 susceptible. Then F_3 from this cross was comprised of 28 HR, 66 segregating and 26 HS families. Although F_2 data of these crosses did not give a good fit for a single gene ratio, the F_3 generations segregated for a single dominant gene. Abnormal genetic ratios are likely to be observed in segregating generations involving 1B/1R translocation because of abnormal pairing behaviour of F_1s between such lines and the susceptible cultivars without 1B/1R translocation. Keeping this in view a slightly higher χ^2 value of F_2 generation has been ignored and it is concluded that a dominant seedling resistance gene confers low reaction to Federation*4/Kavkaz. At the adult plant stage, when the population were scored on the basis of terminal disease severity, F_1s of Federation*4/Kavkaz with the susceptible cultivar Agra Local and WL711 was scored free to traces (TR). The F_2 from the cross of Federation*4/Kavkaz with susceptible cultivar Agra local contained, 199 resistant and 24 susceptible plants. The F_2 from the cross with susceptible cultivar WL711 segregated, 232 resistant and 20 susceptible plants. The F_2 and F_3 generations from the crosses of Federation*4/Kavkaz with both the susceptible cultivars gave a good fit of 15 resistant : 1 susceptible and 7 homozygous resistant (HR) : 8 segregating (segr.) : 1 homozygous susceptible (HS), respectively. The results imply that two dominant genes determine low terminal disease severity of Federation*4/Kavkaz. Because the seedling resistance gene(s) often remain effective through out the plant growth, one of the genes conferring low terminal disease severity of the line Federation*4/Kavkaz at the adult plant is the seedling resistance gene effective against race 77-5. Second resistance gene which, became operative at a later stage is also determining the low terminal disease severity of the line Federation*4/Kavkaz. In contrast to these results, the adult plant resistance of Federation*4/Kavkaz has been reported to be conferred by two dominant complimentary genes [9]. Long *et al.*, [10] also observed leaf rust resistance additional to that conferred by the gene *Lr26* in cultivar Kavkaz but did not report its identity. In this report also the resistance against a race virulent on the gene *Lr26* has been ascribed to two genes as yet undescribed from the line Federation*4/Kavkaz. As resistance against race 77-5 in bread wheat is not common, the two resistance genes reported from the line Federation*4/Kavkaz may find usefulness in developing leaf rust resistant cultivars.

Table 1. Segregation for seedling and adult plant reaction$^+$ in F_2 and F_3 generations from crosses of Federation*4/Kavkaz with Agra Local and WL711

Cross	F_2 Generation				χ^2	F_3 Generation					χ^2
	Res.	Susc.	Total	Expected ratio		Res.	Segr.	Susc.	Total	Expected ratio	
Infection type											
Federation*4/Kavkaz × Agra Local	118	57	175	3:1	5.34*	23	42	18	83	1:2:1	0.56
Federation*4/Kavkaz × WL711	53	30	83	3:1	5.49*	28	66	26	120	1:2:1	1.26
Terminal disease severity											
Federation*4/Kavkaz × Agra Local	199	24	223	15:1	1.24	55	44	7	106	7:8:1	0.21
Federation*4/Kavkaz × WL711	232	20	252	15:1	1.90	60	45	8	123	7:8:1	1.64

$^+$Res. = Resistant, Susc. = Susceptible, Segr. = Segregating, * = significant at 5% level

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