Inheritance and Race Reaction of a New Soybean *Rps1* Allele

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ABSTRACT

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A new soybean (*Glycine max*) allele, *Rps1-d*, for resistance to *Phytophthora megasperma* f. sp. *glycinea* was identified. A backcross-derived *Rps1-d* isogenic line of Harosoy, HARO 16, gave resistant reactions to races 1–7, 9–11, 13–16, 18, 21–22, 24, and 25 and susceptible reactions to races 8, 12, 17, and 19, the same as PI 103091, the source of *Rps1-d*.

A number of *Rps* alleles of soybean (*Glycine max* (L.) Merr.) for resistance to *Phytophthora megasperma* Drechs. f. sp. *glycinea* T. Kuan & D. C. Erwin have been reported (7). PI 103091 was included in a differential set of soybean cultivars or lines for distinguishing races of *P. m. glycinea* (5), although the genetics of the resistance in PI 103091 were not known. K. L. Athow (*personal communication*) indicated that an allele at the *Rps1* locus was involved, but no data were published. This paper reports on the inheritance of resistance from PI 103091 and the response to inoculation with currently available races of *P. m. glycinea*.

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MATERIALS AND METHODS

Resistance was transferred from PI 103091 to Harosoy by backcrossing. A pure-breeding line, designated as OX642, was composited in the BC_5F_3 generation. OX642 and PI 103091, along with other *Rps* lines, were inoculated with *P. m. glycinea* races 1–11, 13–15, 17, 21–22, 24, and 25. In addition, OX642 and PI 103091 were inoculated with races 12, 16, 18, and 19. Seedlings were grown in the greenhouse in 1:1 mixture of sand/peat (v/v) with a 14-hr day length. Inoculum of *P. m. glycinea* was produced in 10% V8 juice or on Difco lima bean agar (11 g in 1,000 ml of water) at 25 C in the dark for 7–10 days. Mycelium from 10% V8 juice was inserted into wounded hypocotyls with tweezers (4) or inoculum produced on lima bean agar was applied to wounded hypocotyls as a mixture of mycelium and agar with a syringe. Hypocotyls were wounded by making a slit 1–2 cm long with a needle approximately 1 cm below the cotyledons. Inoculated seedlings were covered with plastic bags for 24 hr. Plants were classified as resistant (alive) or susceptible (dead) 4–5 days after inoculation.

OX642 was crossed with a Harosoy isogenic line, HARO 15XX, that is *Rps1-k Rps1-k* (3). F_2 plants derived from one F_1 plant were grown, but seed supply was inadequate for screening so six F_3 plants of each of the 43 F_2 plants were grown for seed.

The 43 F_2 lines were screened with races 1 and 17 using hypocotyl inocu-

Table 1. Reaction of soybean *Rps* Harosoy lines and PI 103091 to races of *Phytophthora megasperma* f. sp. *glycinea*

Line tested[a]	Gene	Source of gene	No. of crosses[b]	Race[c]																	
				1	2	3	4[d]	5	6[d]	7[d]	8	9	10	11	13	14[d]	15	17	21	22	24	25
PI 103091	*Rps1-d*	...	...	R[e]	R	R	R	R	R	R	S	R	R	R	R	R	R	S	R	R	R	R
OX642 (HARO 16)	*Rps1-d*	PI 103091	6	R	R	R	R	R	R	R	S	R	R	R	R	R	R	S	R	R	R	R
HARO (1-6) 1XX	*Rps*?	Harosoy	...	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
HARO 12XX	*Rsp1-a*	Blackhawk	8	R	R	S	S	S	S	S	S	S	R	R	R	S	R	R	S	S	R	S
HARO 13	*Rps1-b*	PI 84637	7	R	S	R	R	R	R	R	R	R	S	S	R	R	R	S	R	R	S	S
OX682	*Rps1-c*	PI 54615-1	2	R	R	R	S	S	R	R	R	R	R	R	R	S	R	R	R	S	R	S
HARO 15XX	*Rps1-k*	Kingwa	7	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S
HARO 32XX	*Rps3-a*	PI 171442	7	R	R	R	R	R	S	S	R	R	S	R	R	R	S	S	S	S	S	R
PRX146-36[f]	*Rps3-b*	PI 172901	1	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R
PRX145-48[f]	*Rps3-c*	PI 300046	1	R	R	R	R	S	S	S	S	S	R	R	R	R	R	S	R	R	R	R
HARO 42XX	*Rps4*	PI 86050	7	R	R	R	R	S	S	S	S	S	R	S	R	R	R	S	R	S	S	R
HARO 52XX	*Rps5*	PI 91160	8	R	R	R	R	R	S	S	R	R	S	R	R	R	S	S	S	S	S	R
HARO 62XX	*Rps6*	Altona	7	R	R	R	R	S	S	S	S	S	R	S	S	R	R	S	R	S	S	R

[a]With the HARO lines, the first digit is the *Rps* locus, the second digit is the allele with *rps* being 1, and XX indicates the possible presence of *Rps*? (Harosoy).
[b]Number of crosses (initial cross and backcrosses) with Harosoy in the development of lines.
[c]Races 12, 16, 18, and 19 are not included because *Rps*? (Harosoy) could be present.
[d]Currently available isolates of races 4 and 6 do not differ in reaction from those of 14 and 7, respectively.
[e]Soybean seedling hypocotyl reaction: R = resistant (>70% alive); S = susceptible (>70% dead).
[f]Lines from K. L. Athow.

lation of six seedlings per race for each of the six F_3 plants for each line. Race 1 was used to test for allelism at the *Rps1* locus, and race 17 was used to verify that the material was from a cross and not a self.

RESULTS AND DISCUSSION

OX642 gave the same pattern of race reactions as PI 103091 (Table 1). Thus, OX642 appeared to have the same genetic makeup for resistance as PI 103091. Inoculations resulting in an intermediate reaction (30–70% of plants dead) were repeated until the line could be classified as resistant (>70% alive) or susceptible (>70% dead). Inoculation with the original isolate of race 6 resulted in a resistant reaction with PI 103091 and OX642, which is contrary to the report that indicates PI 103091 was susceptible to race 6 (2,4). The inconsistency may be the result of variability in the PI 103091 reactions and/or a lack of stability in race 6. The reactions with the other races agree with those reported by Athow (2).

Both OX642 and HARO 15XX are resistant to race 1. If resistance to race 1 was controlled by *Rps* alleles at different loci in these two lines, an F_2 segregation of 15 resistant to one susceptible would be expected. All of the 42 F_2 families were resistant to race 1; the lack of segregation for susceptibility to race 1 indicated that OX642 had an allele at the *Rps1* locus. HARO 15XX is resistant to race 17, and OX642 is susceptible. Inoculation of the $F_{2:3}$ with race 17 resulted in nine homozygous resistant to 27 segregating resistant and susceptible to seven homozygous susceptible, which gave a good fit ($P = 0.30$–0.20) to a 1:2:1 ratio expected for the segregation of alleles for resistance and susceptibility.

OX642 has a new *Rps* allele which is designated as *Rps1-d*. The pattern of race reactions from hypocotyl inoculation for *Rps1-d* differs from that of each of the other known *Rps* alleles (Table 1).

OX642 is susceptible to races 12 and 19, as is PI 103091, which indicates that it does not have the *Rps*? (Harosoy) allele (6) of the Harosoy recurrent parent. This is consistent with the hypothesis that *Rps*? (Harosoy) is linked with the *Rps1* locus (1). As noted by Athow (2), with races 12 and 19 giving the same reaction (susceptible) to PI 103091, it is impossible at present to distinguish two different races.

As a Harosoy *Rps* isogenic line, OX642 is designated as HARO 16, i.e., it has the sixth allele that has been identified at the *Rps1* locus. Like PI 103091, HARO 16 is resistant to races 16 and 18.

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