

Three New Physiologic Races of *Phytophthora megasperma* var. *sojae*

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ABSTRACT

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Physiologic races 7, 8, and 9 of *Phytophthora megasperma* var. *sojae* from soybean are reported from their reaction on a new, uniform set of soybean differentials consisting of

Harosoy, Sanga, Harosoy 63, Mack, Altona, P.I. 103.091, and P.I. 171.442.

Additional key words: *Phytophthora* root rot, soybean disease.

Phytophthora root rot of soybean [*Glycine max* (L.) Merr.] incited by *Phytophthora megasperma* Drechs. var. *sojae* A. A. Hildeb. was first reported in 1955 (12) although the disease was observed in 1948 in Indiana and 1951 in Ohio. The disease was reported to be caused by a species of *Phytophthora* (12), which subsequently was referred to as *Phytophthora cactorum* (Leb. & Cohn) Schroet. (5). Kaufmann and Gerdemann (7) considered the organism distinct from described species of *Phytophthora* and suggested the name, *P. sojae*. Hildebrand (6), in 1959, suggested the current trinomial based on morphological similarity to *P. megasperma* and host specificity.

Resistant cultivars were identified, with resistance of cultivar Mukden controlled by a dominant gene (2). Several resistant cultivars were developed for the Midwest using the Mukden gene. In 1965, a second physiologic race was found in Mississippi that was pathogenic to soybean strains D60-9647, D60-11082, FC 31746, and cultivars Harrell and Nansmond (9), all of which were resistant to race 1. Other soybean cultivars resistant to race 1 were resistant to race 2, and cultivars susceptible to race 1 were equally susceptible to race 2. The suggested genotype of the strains and cultivars resistant to race 1 and susceptible to race 2 was $rps^2 rps^2$, which formed an allelomorphous series with *Rps Rps* and $rps rps$ (4). Genotype *Rps Rps* was dominant to $rps^2 rps^2$, and $rps^2 rps^2$ was dominant to $rps rps$. In 1972, a third physiologic race was found in Ohio (10). Cultivars with the Mukden-type resistance were susceptible to race 3, whereas Arksoy and its derivatives, Mack and Lee 68, were resistant to race 3. In 1974, race 4, which was pathogenic to the Arksoy- and Mukden-type resistances was reported (11). Cultivars Altona, Kingwa, Toku, and 92 plant introductions were resistant to race 4 in addition to races 1, 2, and 3 (1). Those cultivars and strains with the $rps^2 rps^2$ allele and 24 plant introductions were resistant to

racess 1, 3, and 4, but susceptible to race 2. Recently, races 5 and 6, to which Altona is susceptible, were reported from Ontario, Canada (3). The two races are differentiated by the susceptibility of Mack to race 5 and its resistance to race 6.

During 1973-1975, we collected a number of isolates in Indiana pathogenic to Altona, and thus indicating a race other than 1, 2, 3, or 4. Mack was susceptible to one of these isolates, suggesting that it was race 5. Mack was resistant and Harosoy 63 and Altona were susceptible to all of the other isolates classified provisionally as race 6. However, when germplasm strains resistant to races 1 through 5 were inoculated with these isolates, some did not react the same to all isolates. A similar situation had been noted by J. H. Haas in Ontario and A. F. Schmitthenner in Ohio (*personal communications*). Plant pathologists and plant breeders interested in *Phytophthora* root rot of soybeans agreed at a meeting at Harrow, Ontario, July 1975, to adopt a uniform set of soybean differentials that consisted of Harosoy, Sanga, Harosoy 63, Mack, Altona, P.I. 103.091, and P.I. 171.442. This is a report of the results of inoculating the above differentials with the isolates from Indiana previously classified as race 6.

MATERIALS AND METHODS

Inoculum was prepared by growing the isolates 2-3 wk at 24 C on oatmeal agar in petri plates. Inoculation was made by the hypocotyl method (8). Ten 10-day-old seedlings of each of the soybean differentials were inoculated with each isolate in the greenhouse at 24-27 C. Harosoy and Tracy were inoculated as susceptible and resistant controls, respectively. Six days after inoculation the plants were classified susceptible (dead) or resistant (no infection).

RESULTS AND DISCUSSION

Harosoy, Harosoy 63, and Altona were susceptible, and Sanga and Mack were resistant to all the Indiana

TABLE 1. Physiologic races of *Phytophthora megasperma* var. *sojae* from soybeans

Differential cultivar	Physiologic race								
	1	2	3	4	5	6	7	8	9
Harosoy	S ^a	S	S	S	S	S	S	S	S
Sanga	R ^a	S	R	R	R	R	R	R	R
Harosoy 63	R	R	S	S	S	S	S	S	S
Mack	R	R	R	S	S	R	R	R	R
Altona	R	R	R	R	S	S	S	S	S
P.I. 103.091	R	R	R	R	R	S	R	S	R
P.I. 171.442	R	R	R	R	R	S	S	R	R
Tracy	R	R	R	R	R	R	R	R	R

^aSymbols: S = susceptible, and R = resistant.

isolates classified as race 6. However, none of our isolates matched race 6 reported from Ontario (3), to which both P.I. 103.091 and P.I. 171.442 are susceptible. Plant introduction P.I. 103.091 was resistant and P.I. 171.442 was susceptible to 15 isolates designated race 7, but P. I. 103.091 was susceptible and P. I. 171.442 was resistant to six isolates designated race 8. Both P.I. 103.091 and P.I. 171.442 were resistant to four isolates designated race 9. Races 5 and 9 are differentiated by the reaction of Mack, which is susceptible to the former and resistant to the latter. The reactions of the uniform set of differentials to the three new races and the six previously reported are presented in Table 1.

Physiologic race 8 also has been found in Ontario, Canada (R. I. Buzzell, *personal communication*), but to our knowledge races 7 and 9 have not been identified elsewhere. Races 2 and 6 have not been found in Indiana.

The differential cultivar Sanga and the soybean strain D60-9647 react the same to all races, being susceptible to race 2 and resistant to the other races. Sanga presumably has the *rps*² *rps*² allele described for D60-9647, although this has not been proven. The question also is raised whether the *Rps Rps* allele ascribed to both the Mukden and Arksoy-type resistances to races 1 and 2 are actually the same allele because of opposite reactions of Mukden and Arksoy to races 3, 6, 7, 8, and 9. Another question concerns the relation of the *Rps Rps* allele in Arksoy to the *rps*² *rps*² allele of D60-9647 or Sanga when races 4 and 5, to which Arksoy is susceptible, are involved; or similarly, the relation of the *Rps Rps* allele of Mukden to the *rps*² *rps*² allele of D60-9647 or Sanga when races other than 1 or 2, to which Mukden is susceptible, are involved.

Genetic studies which we and others are doing should help answer these questions.

Tracy is not a differential cultivar but it is useful as a check because it is resistant to all races. Tracy has D60-9647 and P.I. 171.442 in its pedigree. It was selected for resistance to race 2 (to which D60-9647 is susceptible, but P.I. 171.442 is resistant), but resistance to races 6 and 7 (to which D60-9647 is resistant but P.I. 171.442 is susceptible) was by chance.

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