Races of *Phytophthora sojae* in Argentina and Reaction of Soybean Cultivars

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ABSTRACT

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Race identification of *Phytophthora sojae* in soybean is reported for the first time in Argentina. Isolates from dying plants and from infested soils were collected during surveys of soybean fields in Pergamino County from 1989 to 1992. Race determination on 46 isolates was made by the hypocotyl puncture method using the North American differential set (Wells, Harlon, Beeson 80, Williams 79, PI 103091, Pella 86, Williams 82, PI 171442, Harosoy, Harosoy 32, and Altona) and two Canadian Harosoy isolines (Harosoy 13 and Harosoy 6272). All the isolates were race 1, virulent only on Harosoy. Most of 25 Argentina-grown cultivars tested by hypocotyl inoculation showed a susceptible reaction. Only Norki 555, Norki 641, Asgrow 2943, and RA 587 were resistant to this race.

Phytophthora root and stem rot of soybean (*Glycine max* (L.) Merr.), caused by *Phytophthora sojae,* is widespread throughout soybean growing areas of the world. This species, formerly named *Phytophthora megasperma* Drechs. f. sp. *glycinea* T. Kuan & D.C. Erwin, exhibits aggressive, race-specific pathogenicity to soybean and causes few or no symptoms on other hosts (4). The population of this pathogen is made up of numerous pathogenic or physiological races described by their virulence on a set of differential soybean varieties (6,7,14,15). According to Athow (2), Keeling (6), and Jimenez and Lockwood (5), the disease is more severe on poorly drained soils. Schmitthenner (12) considered that this pathogen may cause preemergence and postemergence damping-off, gradual killing, seed and stem rot, and infection on leaves and stems. The disease was first observed in Argentina by Hartwig in the 1970s (A. F. Schmitthenner, *personal communication*) and by Martínez and Ivancovich (9).

In 1989, the disease was "rediscovered" by Schmitthenner using the Agridiagnostic (USA) monoclonal antibody assay kits in a field at Pergamino Agricultural Experimental Station (INTA), Argentina. Later, the pathogen was isolated and identified as *P. megasperma* f. sp. *glycinea* (3).

The objectives of this work were to determine the races of *P. sojae* in Pergamino area (Buenos Aires Province) and the reaction of the most common commercial soybean cultivars currently used in Argentina.

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MATERIALS AND METHODS

Isolation of *P. sojae* from plants and soils. Plants with symptoms of stem rot and suspected infested soils were collected from several fields in the Pergamino area from 1989 through 1992.

Isolations of *Phytophthora* from stems with symptoms were made using the methods of Schmitthenner et al. (14).

The pathogen was isolated from soil by a modification of the seedling bait method (14). Soil samples (50 g) were placed in pots flooded with sterile distilled water (8). Aseptically germinated seeds of susceptible soybean cultivar Sloan were placed in the flooded soil samples and incubated at 25 C for 10 days (3).

Race identification. The inoculum was grown in the selective medium VYS-PCNB using 12 g of agar per liter (13). Aggressiveness of the isolates was maintained by passage of cultures through the susceptible cultivar Sloan using the layer method (13) at 3-month intervals. In 1989–90, the North American differential set was used in this study. The seeds were supplied by A. F. Schmitthenner, Ohio State University, Wooster. It included seven differential cultivars: Wells (*Rps*1), Beeson 80 (*Rps*1-c), PI 103091 (*Rps*1-d), Pella 86(*Rps*1-k), PI 171442 (*Rps*3), Altona (*Rps*6), Harosoy (*Rps*7), and the susceptible check Sloan (*rps*).

In 1991–92, cultivars used were Harlon (*Rps*1-a), Harosoy 13 (*Rps*1-b), Williams 79 (*Rps*1-c), PI 103091 (*Rps*1-d), Williams 82 (*Rps*1-k), Harosoy 32 (*Rps*3-a), Harosoy 6272 (*Rps*6 + *Rps*7), Harosoy (*Rps*7), and two susceptible checks: Sloan and Williams. Harosoy 13 (*Rps*1-b) and Harosoy 6272 (*Rps*6 + *Rps*7) were supplied by R. I. Buzzell, Research Station, Harrow, Ontario.

Seeds were sown in a mix of soil and peat in 10-cm-diameter pots (10 seeds per pot) in a greenhouse at 25 to 30°C. The pots were watered with Hoagland nutrient solution 48 h after planting and then with distilled water. At least 10 seedlings per cultivar of 10- to 12-day-old plants were inoculated using the wounded hypocotyl technique (10). This method involves macerating an agar culture through a 10-ml syringe, reloading the syringe with the macerated mycelium, placing a 16-gauge needle on the end of the syringe, making a 1-cm vertical slit with the needle point in the hypocotyl just below the cotyledonary node, placing about 0.2 ml of the mycelial macerate in the slit, incubating the inoculated plants overnight with a plastic bag over them, and incubating 4 to 5 days in a growth chamber at 22 to 25°C with 12 h light/dark.

Soybean seedling hypocotyl reaction was classified resistant (70% or more of the seedlings alive) or susceptible (70% or more of the seedlings killed) (R. I. Buzzell, *personal communication*). Race determination was repeated at least two times with each isolate.

Reaction of commercial cultivars. The responses of 25 commercial cultivars currently used in Argentina to one isolate of *P. sojae* were determined by the hypocotyl puncture method just described. For each cultivar, at least 30 seedlings were tested. The soybean cultivars were classified as resistant, susceptible, or intermediate (60 to 69% of the seedling alive).

RESULTS

Forty-six isolates from 34 plants and from 12 soils in Pergamino County were identified as *P. sojae.*

The cultivar Harosoy (*Rps*-7) was susceptible, and the remaining differential cultivars were resistant to all the isolates (Table 1). These reactions indicate the presence of the race 1 in the area surveyed.

Apparently the composition of *P. sojae* races in Pergamino did not change during the 4 years of this study, as race 1 was the only one isolated in all the samples.

Twenty commercial soybean cultivars commonly grown in Argentina were susceptible to race 1, indicating that they do not contain a resistance gene for this race. Four cultivars—RA 587, Asgrow 2943,

Table 1. Seedling reaction of differential cultivars to hypocotyl inoculation with 46 isolates of *Phytophthora sojae* from Pergamino fields in Argentina from 1989 through 1992

Cultivars	Source[a]	*Rps* gen	Seedling reaction
Sloan	U.S.A.		S
Williams	U.S.A.		S
Wells	U.S.A.	*Rps*1	R
Harlon	U.S.A.	*Rps*1-a	R
Harosoy 13	Canada	*Rps*1-b	R
Beeson 80	U.S.A	*Rps*1-c	R
Williams 79	U.S.A.	*Rps*1-c	R
PI 103091	U.S.A	*Rps*1-d	R
Pella 86	U.S.A.	*Rps*1-k	R
Williams 82	U.S.A.	*Rps*1-k	R
PI 171442	U.S.A.	*Rps*3	R
Harosoy 32	U.S.A.	*Rps*3-a	R
Altona	U.S.A.	*Rps*6	R
Harosoy 6272	Canada	*Rps*6 + *Rps*7	R
Harosoy	U.S.A	*Rps*7	S

[a] The lines from the U.S.A. were sent by A. F. Schmitthenner, and the lines from Canada were sent by R. I. Buzzell.

Norki 555, and Norki 641—showed less than 30% of plants dead (Table 2) and were classified as resistant. On the other hand, Asgrow 4422 showed 37% of plants dead, and it could be considered as having an intermediate reaction.

Other soilborne pathogens isolated from plants with root and stem rot were *Pythium acanthicum* Drechs., *Pythium* sp., *Fusarium solani* (Mart.) Sacc., *Colletotrichum dematium* (Pers. ex Fr.) Grove, *Fusarium equiseti* (Corda) Sacc., *Phoma* sp., and *Macrophomina phaseolina* (Tassi) Goidanich.

DISCUSSION

There was no variability in virulence of the pathogen in the area surveyed. Other studies have shown different physiological races in specific areas. Keeling (6) reported several races in the lower Mississippi River Valley area. Anderson and Buzzell (1) observed that shifts in frequency of races could be partially explained by changes of compatible–incompatible genotypes recommended as cultivars. Schmitthenner et al. (14) founded virulent races in soil before resistant cultivars were grown in the soil.

Table 2. Seedling reactions of 25 soybean cultivars to hypocotyl inoculation with *Phytophthora sojae* race 1

Cultivars	Seedlings inoc.	Dead seedlings	Reaction[a]
Asgrow 2943	111	1	R
Asgrow 3127	98	97	S
Asgrow 4422	126	47	I
Asgrow 5308	34	34	S
Asgrow 5502	48	48	S
Asgrow 5618	40	40	S
Avutarda	81	71	S
Biguá	38	38	S
Carcarañá INTA	33	33	S
Copetona 53	40	39	S
Doña Flor	48	46	S
Federada Casilda	38	38	S
Forrest	53	52	S
Mc 800	63	61	S
Montera 74	84	83	S
Norki 555	64	7	R
Norki 641	86	16	R
Prata	48	43	S
RA 587	109	0	R
Tijereta	94	93	S
Torcaza 63	38	37	S

[a] R = 70% or more of the seedlings survived; I = 60–69% of the seedlings survived; S = 70% or more of the seedlings dead.

Ryley and Obst (11) determined that until 1989, they had only two races in Australia: race 1 (90% of the isolates) and race 15. However, in recent years they have found other races. It may be important to incorporate different sources of field resistance in a breeding program, to ensure that cultivars have a wide genetic base to minimize damage when virulent races become prevalent. Phytophthora rot of soybean should become a problem in the country in the future since most of the commercial cultivars were susceptible to *P. sojae* race 1.

Further studies of *P. sojae* races are in progress to assess prevalence in other soybean regions in Argentina.

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