Supplement to Journal of Nematology 22(4S):672–675. 1990.

Survey of Soybean Cyst Nematode Races in Tennessee[1]

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Abstract: Cordell soybean is a newly released cultivar resistant to *Heterodera glycines* (SCN) races 3 and 5. The hectarage infested with these races and with other races that can parasitize Cordell in Tennessee is not known. A survey of races in Tennessee soybean fields with sampling weighted by soybean hectarage on a county basis was conducted in 1988. The SCN race plus female development on Bedford and Cordell soybeans were determined in a greenhouse for 21 field populations. Races 2, 3, 4, 5, 6, and 9 were 14%, 5%, 10%, 38%, 19%, and 14% of these populations, respectively. The SCN female indices on the differentials that were sources of SCN resistance in Bedford and Cordell were not accurate indicators of female development on these cultivars. The female index was < 10 on PI 90763 for 19 populations, but four of these populations had an index > 30 on Cordell, which derives SCN resistance from PI 90763. The index was < 10 on PI 88788 for seven populations, but two populations had an index > 40 on Bedford, which derives resistance from PI 88788. When recommending cultivars to be planted by soybean producers, SCN reproduction should be determined on the cultivars, instead of on race differentials.

Key words: Glycine max, Heterodera glycines, host race, soybean, soybean cyst nematode.

The soybean cyst nematode (SCN), *Heterodera glycines* Ichinohe, is a serious pest of soybean, *Glycine max* (L.) Merr. Planting SCN-resistant soybean cultivars has been the primary method of limiting yield losses to this nematode. Mean yield of a resistant cultivar over 3 years was 44% greater than yield of a susceptible cultivar in SCN-infested fields (4). If resistant cultivars are planted for several years, however, there is potential for selection of a SCN population that can reduce yields of the resistant cultivars (13,15). Therefore, new cultivars that are resistant to the selected SCN populations must be developed. Four races of SCN were described by Golden et al. in 1970 (5). Race 5 was described in Japan in 1979 (8). Riggs and Schmitt (12) completed descriptions of the 16 races possible using the four soybean lines on which race differentiation was based originally. Cordell soybean was recently released (7) in anticipation of SCN race 5 as a problem in the southeastern United States, especially in Tennessee; Cordell is resistant to SCN races 3 and 5. In one field in northwest Tennessee, the mean yield of Cordell over 2 years was 640 kg/ha more than the yield of Bedford, which is susceptible to race 5 (16).

Received for publication 10 November 1989.

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The soybean hectarage in Tennessee infested with SCN race 5 is unknown. The objective of this study was to estimate the hectarage in Tennessee infested with each race and to estimate the hectarage on which Cordell soybean would be a suitable cultivar.

Materials and Methods

Twenty-seven sampling sites were selected by dividing the harvested soybean hectarage in each Tennessee county by 20,250 (50,000 acres) and rounding to the nearest whole number (2). Sites within each county were determined by selecting communities at random and sampling, in September and October of 1988, the first soybean field encountered along a chosen road radiating from each community. Twelve liters of soil were obtained by compositing samples from 5–10 locations within an area of approximately 1 ha at each site. Cyst density in each field was determined by extracting cysts from a 225-cm^3 soil sample by elutriation (1). Soil containing fewer than 30 cysts/225 cm^3 was potted and planted with Essex soybean, a susceptible cultivar. After 35 days, the soybean roots were rubbed by hand to remove the adhering females. Cyst density in the soil was again determined. A greenhouse test for SCN race determination was conducted for all sites having at least 20 cysts/225 cm^3 soil. Lee, Peking, Pickett, Bedford, Cordell, PI 88788, and PI 90763 soybeans were

replicated 10 times for each site in individual 7.5-cm-d pots containing 150 cm^3 field soil with two plants per pot and arranged in a randomized complete block design. After 30 days, the cysts and white females were extracted by elutriation. Roots were rubbed during elutriation to remove white females adhering to them. For each soybean at a site, a female index was calculated which equaled 100 times the number of white females on the soybean in each replication divided by the mean number of females on Lee for that site. Analysis of variance was performed on the indices. The race scheme by Riggs and Schmitt (12) was used to characterize the SCN race at each site.

Results and Discussion

Twenty-one (78%) of the 27 sites had sufficient cyst density to conduct the SCN race determination test (Table 1). Two (7%) of the sites did not have any detectable cysts in the collected soil after a susceptible cultivar was grown for 35 days. The survey indicated that most soybean fields in Tennessee are infested with the nematode, although many fields may have low cyst densities. Races 2, 3, 4, 5, 6, and 9 were identified from the 21 sites tested (Table 2).

Table 1. Location and number of cysts detected at field sampling and at planting of race determination tests for samples from 27 soybeans fields used to survey *Heterodera glycines* races in Tennessee.

Site	County	Community	Cysts/225 cm^3 soil	
			Sampling	Planting
1	Hardeman	Grand Junction	45	45
2	Fayette	La Grange	5	NT†
3	Shelby	Collierville	25	330
4	Shelby	Rosemark	20	140
5	Tipton	Atoka	15	470
6	Tipton	Covington	55	75
7	Lauderdale	Henning	10	405
8	Lauderdale	Halls	0	NT
9	Haywood	Nutbush	105	105
10	Haywood	Brownsville	145	145
11	Madison	Huntersville	195	195
12	Dyer	Bonicord	10	115
13	Dyer	Dyersburg	10	60
14	Dyer	Bogota	30	30
15	Lake	Ridgely	10	NT
16	Obion	Push	65	65
17	Obion	Woodland Mills	15	NT
18	Weakley	Dresden	0	25
19	Henry	Henry	10	NT
20	Carroll	Trezevant	15	20
21	Gibson	Milan	5	75
22	Gibson	Humboldt	15	65
23	Henderson	Jacks Creek	5	40
24	McNairy	Milledgeville	10	20
25	Hardin	Adamsville	45	45
26	Robertson	Coopertown	0	NT
27	Franklin	Alto	0	50

† NT = sample not tested for race because of insufficient cyst density (<20 cysts/225 cm^3 soil).

Although the female index is actually a relative measure of host suitability of a soybean for a particular nematode population, it has also been used to describe the vulnerability (resistance or susceptibility) of soybean to damage by the nematode. Dropkin and Nelson (3) described the resistant reaction as the combination of poor parasite growth and good host growth. The susceptible reaction was described as good parasite growth and poor host growth. Nusbaum and Barker (10) endorsed this terminology as an improvement over traditional usage. Use of the female index as an indicator of resistance, as described by Dropkin and Nelson, seems appropriate because soybeans supporting low nematode reproduction yield significantly more than soybeans supporting high nematode reproduction (6,16). It should be recognized that measurement of the female index may be imprecise (14) and that damage on a particular soybean may be related to factors such as sand content of soil within a field (9). Recognizing these limitations, the question becomes what ranges of indices delineate each term. Riggs et al. (11) labeled cultivars with female indices < 10 as resistant, cultivars with indices 10–25 as moderately resistant, and cultivars with indices > 25 as susceptible. These criteria, although debatable and subject to validation by critical research, seem reasonable for initial characterization; however, a fourth class of moderately susceptible, indices > 25 and ≤ 40 might be appropriate. The susceptible class would then be indices > 40. Using these criteria, Cordell was re-

TABLE 2. Mean female indices ± 95% confidence intervals on the soybean differentials used for *Heterodera glycines* race characterization of 21 field populations.

Site	Race†	Lee‡	Pickett	Peking	PI 88788	PI 90763	Bedford	Cordell	LSD§
6	2	75.5 ± 23.9	90.1 ± 34.6	12.6 ± 15.7	20.5 ± 29.6	1.3 ± 2.0	55.6 ± 14.7	25.8 ± 6.1	28.4
18	2	252.2 ± 66.7	62.6 ± 19.1	12.7 ± 6.0	24.4 ± 9.1	5.4 ± 4.6	53.7 ± 15.4	18.2 ± 7.3	17.6
24	2	240.0 ± 63.4	81.5 ± 31.9	17.5 ± 9.4	32.5 ± 9.8	6.7 ± 4.0	51.2 ± 14.8	13.3 ± 6.7	23.2
27	3	516.5 ± 136.4	0.9 ± 8.8	0.3 ± 0.5	0.1 ± 0.2	0.2 ± 0.3	0.3 ± 0.5	0.2 ± 0.3	12.6
14	4	492.0 ± 98.4	90.1 ± 18.5	21.0 ± 4.5	10.3 ± 3.2	20.3 ± 5.3	23.7 ± 11.6	27.3 ± 15.7	16.2
22	4	276.5 ± 83.5	77.0 ± 19.3	23.2 ± 7.7	27.1 ± 11.2	10.0 ± 3.7	38.9 ± 9.0	39.4 ± 10.4	20.6
3	5	794.5 ± 130.6	90.3 ± 20.1	8.7 ± 4.0	14.2 ± 4.4	2.6 ± 1.3	51.7 ± 15.2	31.0 ± 8.3	15.2
4	5	112.5 ± 13.4	78.7 ± 12.0	2.7 ± 3.1	20.4 ± 7.7	4.4 ± 5.0	52.0 ± 11.3	34.7 ± 3.9	9.5
12	5	1,311.0 ± 380.2	65.8 ± 20.1	3.0 ± 1.1	14.1 ± 7.4	0.7 ± 0.4	57.2 ± 24.2	3.7 ± 1.7	20.7
13	5	422.0 ± 113.8	64.7 ± 19.9	4.3 ± 2.4	12.8 ± 5.7	2.5 ± 1.8	72.2 ± 15.4	5.6 ± 1.3	17.1
16	5	865.0 ± 314.9	77.3 ± 38.3	9.6 ± 3.7	15.4 ± 12.1	1.4 ± 0.8	58.5 ± 17.4	11.4 ± 5.5	26.1
20	5	75.5 ± 33.1	64.9 ± 23.5	6.6 ± 5.0	24.5 ± 20.2	1.3 ± 2.0	76.8 ± 36.7	20.5 ± 11.9	30.5
21	5	924.5 ± 238.0	72.1 ± 19.6	6.1 ± 2.7	25.5 ± 11.7	1.6 ± 0.7	46.4 ± 17.4	6.4 ± 5.1	15.8
23	5	1,310.0 ± 256.1	59.3 ± 17.4	9.5 ± 3.0	13.8 ± 8.0	1.2 ± 0.8	36.3 ± 11.8	20.9 ± 5.1	14.1
1	6	354.0 ± 116.0	77.8 ± 17.5	9.8 ± 5.4	3.5 ± 1.9	7.5 ± 3.1	12.0 ± 5.7	75.9 ± 18.5	19.3
5	6	303.5 ± 136.1	69.5 ± 61.1	2.0 ± 1.9	6.6 ± 9.9	2.3 ± 1.8	43.0 ± 33.5	1.5 ± 1.5	41.3
9	6	574.5 ± 142.9	64.6 ± 28.8	3.2 ± 2.8	6.7 ± 4.6	2.0 ± 1.3	40.3 ± 12.8	33.2 ± 6.8	20.5
11	6	388.0 ± 88.8	12.4 ± 3.0	3.3 ± 2.3	2.1 ± 1.3	2.3 ± 1.4	5.2 ± 3.8	3.1 ± 2.0	10.9
7	9	1,033.0 ± 231.6	93.6 ± 25.7	10.5 ± 5.4	1.7 ± 1.0	8.3 ± 4.6	11.4 ± 5.6	29.8 ± 13.7	17.3
10	9	610.0 ± 144.2	74.4 ± 19.7	10.5 ± 5.0	1.5 ± 1.0	4.3 ± 2.6	7.8 ± 3.0	13.4 ± 7.4	14.8
25	9	951.5 ± 279.0	67.8 ± 18.3	13.2 ± 6.5	6.7 ± 3.4	7.5 ± 3.5	28.6 ± 12.8	11.2 ± 4.6	15.9

Female index equals 100 times the number of females on the soybean divided by mean number of females on Lee for that site and is mean of 10 replications.
† Race designation according to Riggs and Schmitt (8).
‡ Values for Lee are actual numbers of females.
§ Least significant differences ($P \leq 0.05$) for comparing female indices within rows; female index of Lee equals 100.

sistant to six SCN populations, moderately resistant to seven, moderately susceptible to seven, and susceptible to one. Cordell probably could be grown successfully at least in soybean fields with indices ≤ 25. Cordell had a significantly lower female index than Bedford for 13 sites, and there were no significant differences in female indices between the two cultivars for six other sites.

There were disparities in female indices between cultivars and their sources of SCN resistance. PI 90763 is the putative source of race 5 resistance in Cordell. Female index on PI 90763 was < 10 for 19 sites; for 13 of these sites the female index on Cordell was > 10 and for six sites the index was > 25. Cordell was specifically developed for resistance to race 5 (7). Eight populations were identified as race 5 in the survey; two of these populations had a female index > 25 on Cordell but < 5 on PI 90763. This means Cordell was susceptible, using the criteria of Riggs et al. (11), to some race 5 populations. PI 88788 is a source of SCN resistance for Bedford. There were five sites where the female index was < 10 on PI 88788 but > 10 on Bedford, and three of these five sites had a female index > 25 on Bedford. There were 11 populations with a female index < 10 on Peking and > 50 on Pickett; Peking was the source of resistance to races 1 and 3 in Pickett. Thus SCN reproduction on PI 90763, PI 88788, and Peking were not always good indicators of reproduction on Cordell, Bedford, and Pickett, respectively. When the intent is to advise growers on which cultivars are suitable for planting in SCN-infested fields, reproduction of a SCN population should be measured on the potential cultivars to be planted, instead of inferring the amount of reproduction on those cultivars from related lines in a race determination test.

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