Distribution of Florida Populations of the Soybean Cyst Nematode with Previously Undescribed Genetic Variation

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ABSTRACT

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Reproduction of 20 Florida populations of the soybean cyst nematode (*Heterodera glycines*) was tested using standard differential cultivars and lines. In addition to race 3, previously known from Florida, races 2 and 4 were found for the first time in Florida. Two additional types or groups of populations were found that differed in response from previously described races.

Additional key words: *Glycine max*, pathotypes, resistance

The soybean cyst nematode (SCN) (*Heterodera glycines* Ichinohe) has been reported from 22 of the 30 states that produce soybeans (6,10). SCN reduced U.S. soybean yields by about 56 million bushels in 1979 (3). It is estimated to have reduced production of soybeans in 16 southern states (including Florida) by an average of 2.6%, or about 17 million bushels (4.64×10^5 tons) in 1983; yield loss in Florida for that year was estimated at 1%, or more than 375,000 bushels (about 1,000 tons) (4).

Early research indicated that some resistance to SCN was available in certain black-seeded varieties, and breeding programs were initiated to incorporate this resistance into commercial cultivars (9). SCN populations from North Carolina and Tennessee were reported in 1962 to vary in their abilities to reproduce on the resistant line PI 88788 (8). It soon became apparent that field populations of the SCN varied in their gene frequencies for parasitism of resistant cultivars and that populations with similar reproduction patterns on resistant cultivars were being characterized in the different states where soybeans were grown. In 1970, populations of SCN were classified as four races based on their abilities to reproduce on four differential hosts (1). A fifth race was reported from Japan in 1979 (2). Other populations that show reproduction patterns different from any of these five races on the standard differentials have also been reported (1,7,11).

SCN was first detected in Florida in 1967, in the westernmost county (5). Since then, it has been found in 18 counties throughout the regions of northern and central Florida where soybeans are grown. It has been accepted generally that only SCN race 3 occurred in Florida, and breeding programs have been oriented primarily toward incorporating resistance to this race. In recent years, there have been field observations of SCN reproducing on cultivars such as Centennial and Foster, which are resistant to race 3 and are widely grown in fields infested with SCN in northwestern Florida. The objectives of this study were to determine if additional SCN races were present in Florida and, if so, if this would necessitate other management considerations and a new direction for soybean breeding programs.

MATERIALS AND METHODS

A total of 20 SCN populations were located in 12 counties with the cooperation of growers, county extension personnel, University of Florida nematologists, and state regulatory personnel. Reproduction

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of these SCN populations was tested on Pickett, Peking, PI 88788, and PI 90763, the four standard differential hosts originally used to define SCN races (1). The SCN-susceptible cultivar Lee was used as a reference cultivar to determine the index of parasitism of the populations on the differentials (1). If reproduction was less than 10% of that on Lee, a negative rating was assigned to that population/differential host combination; if it was 10% or greater, a positive reproductive rating was assigned to the SCN population on the differential host. In addition, SCN reproduction was tested on race 3-resistant cultivars Kirby and Centennial. Three replicates of each host were used, and plants were grown in an air-conditioned greenhouse. Mean daytime temperatures were 26 ± 3 C; mean nighttime temperatures were 19 ± 2 C. Plants were removed from the containers after 30–35 days, and roots were sprayed with sufficient water pressure to dislodge the cysts, which were caught on a 60-mesh screen. Cysts and white females from each plant were counted.

Initial tests were conducted using infested field soil in 10-cm diameter clay pots. If nematode reproduction in initial tests was too low on Lee soybean (less than 30 cysts) to identify the race, the test was repeated as follows: Nematodes were increased on Lee soybean, and eggs collected from cysts removed from these plants were used as inoculum. Emerging soybean seedlings were grown in 100 cm^3 of sand in Cone-Tainers (Ray Leach Cone-Tainer Nursery, Canby, OR).

RESULTS AND DISCUSSION

Florida SCN populations varied considerably on the differential hosts. Eight of the 20 populations were identified as race 3, two populations as race 2, and one population as race 4 (Tables 1 and 2, Fig. 1). Nine populations did not fit the four races previously recognized. These nine populations were characterized into two groups according to reproduction patterns (Table 2). Populations from both groups had high reproduction on Pickett and moderate to low reproduction on Peking. Populations of the type classified as Florida group 1 reproduced on PI 88788 and PI 90763 at less than 10% of their reproduction on Lee. The reproduction pattern of populations of Florida group 2 was similar to that of Florida group 1 populations except that group 2 populations were rated positive on PI 90763.

In a study of 38 populations, Riggs found three basic types of reproductive patterns on the standard host differentials that were different from the patterns of any of the five races that had been described at the time (7). These three responses were designated as types a, b, and c (Table 2). Florida group 1 populations have the same reproduction pattern as Riggs designated type b, which has been reported for populations from Missouri, North Carolina, Virginia, and Japan. The Florida group 2 reproduction pattern has not been reported previously, and we found no populations in this survey that corresponded to the type a and type c reactions observed by Riggs.

Sixteen SCN reproduction patterns are possible with the four standard host differentials (1). Four reproduction responses are now known that differ from the five designated races (Table 2). In most cases, this variation has been observed in four or five geographical areas. Riggs et al (7) separated 38 SCN populations into 25 distinct groups (races) based on their reactions on 13 soybean genotypes, indicating the wide

Table 1. Reproduction of Florida populations of *Heterodera glycines* on differential soybean hosts and other cultivars

County Population	Total cysts on Lee[a]	Percent of total number of cysts on Lee soybean						Race or population group
		Differentials				Other cultivars		
		Pickett	Peking	PI 88788	PI 90763	Centennial	Kirby	
Alachua								
L-2	60	0	0	5	0	5	0	Race 3
Calhoun								
L-1	288	4	0	2	0	9	7	Race 3
L-22	126	26	12	0	5	37	11	FL group 1
Escambia								
L-8	105	40	17	0	14	100	83	FL group 2
L-9	117	115	13	10	13	74	62	Race 4
Gadsden								
L-3	198	0	0	0	0	0	0	Race 3
Holmes								
L-14	141	4	4	2	6	0	2	Race 3
L-15	189	106	22	0	16	...	...	FL group 2
Jackson								
L-18	366	260	51	16	7	152	204	Race 2
L-19	51	53	18	6	18	188	150	FL group 2
L-20	399	0	0	2	0	0	0	Race 3
Lake								
L-25	81	0	0	4	0	...	...	Race 3
Okaloosa								
L-10	252	119	54	7	17	116	108	FL group 2
Santa Rosa								
L-4	36	0	0	0	3	0	0	Race 3
L-23	183	154	56	16	2	84	128	Race 2
Seminole								
L-31	177	0	0	0	0	0	0	Race 3
Walton								
L-12	270	41	12	4	13	69	153	FL group 2
L-13	36	333	14	2	2	64	14	FL group 1
Washington								
L-16	216	159	18	8	1	39	26	FL group 1
L-17	171	66	26	7	2	23	46	FL group 1

[a] Reproduction on other hosts is compared with reproduction on Lee soybean. A value of ≥10% of the number on Lee indicates positive host rating.

Table 2. Responses of designated *Heterodera glycines* races on standard differential hosts compared with the responses of Florida population groups and other groups not designated as races

Race or group	Reactions to differential soybean cultivars and lines				Reference or county of origin in Florida survey
	Pickett	Peking	PI 88788	PI 90763	
Designated race					
1	−	−	+	−	1
2	+	+	+	−	1
3	−	−	−	−	1
4	+	+	+	+	1
5	+	−	+	−	2
FL group 1 or Riggs type b					
VA-2 population	+	+	−	−	1
Camden, NC pop.	+	+	−	−	1
Japan pop. 3BP	+	+	−	−	7
MO pop. 10B	+	+	−	−	7
FL pop. 22	+	+	−	−	Calhoun
FL pop. 13	+	+	−	−	Walton
FL pop. 16	+	+	−	−	Washington
FL pop. 17	+	+	−	−	Washington
FL group 2 type populations					
FL pop. 8	+	+	−	+	Escambia
FL pop. 15	+	+	−	+	Holmes
FL pop. 19	+	+	−	+	Jackson
FL pop. 10	+	+	−	+	Okaloosa
FL pop. 12	+	+	−	+	Walton
Riggs type a					
Japan pop. 3	−	−	−	+	7
IN pop. 12	−	−	−	+	7
NC pop. 13	−	−	−	+	7
NC pop. 13C	−	−	−	+	7
SC pop. 15A	−	−	−	+	7
Riggs type c					
TN pop. 4A	+	−	−	−	7
VA pop. 6	+	−	−	−	7
AL pop. 16B	+	−	−	−	7

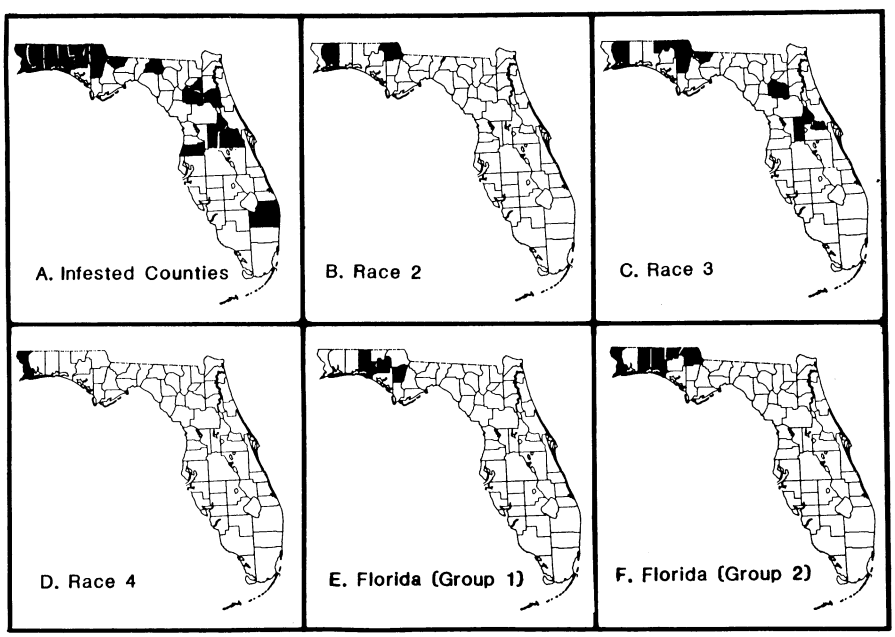

Fig. 1. Distribution of the soybean cyst nematode (SCN) in Florida. **(A)** All counties known to be infested with the SCN as of June 1985, including counties where races have not been identified. **(B–F)** Distribution by county of populations characterized in this study: **(B)** race 2 (Jackson and Santa Rosa counties), **(C)** race 3 (Alachua, Calhoun, Gadsden, Holmes, Jackson, Lake, Santa Rosa, and Seminole counties), **(D)** race 4 (Escambia County), **(E)** Florida group 1 populations (Calhoun, Walton, and Washington counties), and **(F)** Florida group 2 populations (Escambia, Holmes, Jackson, Okaloosa, and Walton counties).

genetic variability of SCN. Field populations of SCN vary qualitatively and quantitatively in their genes for parasitism of resistant cultivars. Continuous cropping of race 3-resistant cultivars in Florida has apparently contributed to the increased frequency of genes for parasitism of that and other sources of resistance such as Pickett, Peking, PI 88788, and PI 90763. Plant breeders need to incorporate broader genetic resistance to SCN in soybean cultivars in the future.

Our investigation has revealed that Florida populations of SCN are more variable than expected. More than half of the populations that were analyzed reproduced on Kirby and Centennial. These and other cultivars that are resistant to race 3 are normally recommended to minimize losses to SCN in Florida and have been in general use where SCN has been found since about 1970. Generally speaking, soybeans have been cultivated longest and most intensively in Florida's westernmost counties. All populations found to have reproductive responses other than those of race 3 have come from this region, where the SCN has apparently been present and subject to selection pressure from race 3-resistant germ plasm for the longest period of time. The presence of these new races and population groups add to the complexity of decisions for Florida soybean growers, who in recent years also have lost their most useful options for chemical control of SCN.

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