

Plant-parasitic Nematodes Associated with Cotton in Florida¹

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Abstract: A sampling of 15% of the cotton hectareage in each Florida county was assayed for nematodes and soil particle components following the 1990 harvest. The distribution of juveniles of *Meloidogyne* spp., which were found in 61% of the 178 fields sampled statewide, was not influenced by soil type. *Rotylenchulus reniformis* was more prevalent in the heavier soils and occurred in 15% of the sampled fields. In fields with concomitant infestations (9% of the sampled fields), densities of root-knot juveniles per 10 cm³ soil were negatively related to those of reniform nematodes ($R^2 = -0.32$; $P < 0.02$; $df = 14$). Gall ratings of cotton plants, assayed in sampled soils, were positively related to the densities of root-knot juveniles per 100 cm³ soil ($R^2 = 0.23$; $P < 0.01$; $df = 175$). Other nematode genera and their frequency of occurrence were *Helicotylenchus* (76%), *Paratrichodorus* (57%), *Criconemella* (53%), *Pratylenchus* (42%), *Xiphinema* (7%), *Heterodera* (2%), and *Hoplolaimus* (1%).

Key words: cotton, *Criconemella*, galling, *Gossypium hirsutum*, *Helicotylenchus*, *Heterodera*, *Hoplolaimus*, *Meloidogyne*, nematode, *Paratrichodorus*, *Pratylenchus*, *Rotylenchulus*, soil texture, *Xiphinema*.

Cotton is not new to Florida; however, the distribution of cotton production has changed considerably from its distribution during the period from the 1850's to the arrival of the boll weevil in the 1920's. During that period, most Florida cotton was produced in Madison, Jefferson, Leon, Gadsden, and Jackson counties (5). From a high of 106,436 ha harvested from 29 counties in 1909, cotton hectareage declined each decade through the 1970's. The lowest production was recorded in 1978, when only 1,619 ha were harvested. As production declined, it moved to the west, where Santa Rosa County became the only Florida county with significant cotton hectareage.

The success of the USDA Animal and Plant Health Inspection Service (APHIS) Boll Weevil Eradication Program, favorable cotton prices, and the 1990 Food, Agriculture, Conservation and Trade Act (Public Law 101-624) allowing establishment or expansion of a cotton base, have led to a recent increase in cotton production in Florida. This has occurred mostly at the expense of soybean hectareage. In 1990, cotton was grown in 11 counties. Of

these, Santa Rosa and Escambia Counties, in the western Panhandle, had 70% of the production. The following survey was conducted to determine the incidence of nematodes associated with Florida cotton.

MATERIALS AND METHODS

Procedures were designed to sample at least 15% of the fields in each of the 11 cotton production counties, all of which are in the northern tier of Florida counties stretching east to west. With no emphasis placed on field size, field history, or cotton condition, fields were arbitrarily selected from the records of the Boll Weevil Eradication program. A total of 178 fields were sampled (Table 1). Field size averaged 12 ha (range 1-72 ha).

Soil cores (2.54-cm-d by 23 cm deep) were taken during December 1990-January 1991 following cotton harvest and destruction of stalks. Two to three evenly spaced cores were taken from each hectare, with a minimum of 20 cores taken from each of the smaller fields. Cores from each field were bulked and mixed on site. A 1,000-cm³ sample was removed and stored at 10 C for processing. A 100-cm³ subsample was air-dried and processed to determine its particle component percentages (2). Within 4 days from sampling, nematodes were extracted from another 100-cm³ subsample by sugar flotation and centrifugation (4). Nematodes were dis-

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TABLE 1. Number, hectarage, and average soil particle components of sampled fields in cotton production counties of Florida in 1990.

County†	Sampled fields‡	Sampled hectares	Average components		
			% sand	% silt	% clay
Escambia	30	398	73	15	12
Santa Rosa	98	1,140	77	13	10
Okaloosa	9	102	85	9	6
Walton	4	40	91	7	2
Holmes	4	16	92	6	2
Washington	4	42	85	7	8
Jackson	9	126	88	7	5
Calhoun	13	190	91	5	4
Gadsden	2	29	91	6	3
Jefferson	2	33	92	6	2
Hamilton	3	10	95	5	0
Total	178	2,126	80	11	9

† Counties are ranked with Escambia the westernmost and Hamilton the easternmost.

‡ Representing 15% of each county's total cotton fields.

persed on a gridded dish and counted. The remainder of each sample was potted and seeded with the root-knot nematode susceptible cotton cv. Stoneville 825 and maintained at 25–30 C on glasshouse benches. After 3 months, plants were removed and their roots rated for galling; 0 = no galling, 1 = <25% of the root surface galled, 2 = 26–50%, 3 = 51–75%, and 4 = >75%.

RESULTS

Five soil types were recognized in the survey: sand (54 sites with average components of 91% sand, 6% silt, 3% clay); loamy sand (46 sites averaging 84%, 9%, 7%); sandy loam (67 sites averaging 72%, 16%, 12%); sandy clay loam (10 sites averaging 60%, 19%, 21%); and clay loam (one site of 44%, 28%, 28%).

Meloidogyne spp. second-stage juveniles (J2) were recovered from 108 fields (61% frequency, Table 2). They were found with closely similar frequencies in all soil types. Where present, their population densities averaged 120/100 cm³ soil (10–640); however, their densities were lower in sandy clay and clay loams than in sandier soils. *Rotylenchulus reniformis* was recovered from 26 fields (15% frequency), 22 of which were in Santa Rosa County. Where present, vermiform stages of reniform

nematode averaged 1,160/100 cm³ soil (10–3,490). Numbers and frequencies of occurrence increased with the heavier soils. Concomitant infestations of root-knot and reniform nematodes were found in 16 fields. Among these, numbers of root-knot J2 per 100 cm³ soil were related to numbers of reniform nematodes (X) by:

$$\log Y = 3.052 - 0.491 \log X, \\ (R^2 = -0.32; P < 0.02; df = 14)$$

Helicotylenchus dihystra was the nematode most commonly recovered, occurring in 135 fields (76% frequency, Table 2). Where present, it averaged 240/100 cm³ soil (10–1,390). These nematodes were found only slightly less frequently in sand than in other soil types. *Paratrichodoros* spp. (predominantly *P. christiei*), *Cricone-mella* spp. (predominantly *C. sphaerocephala* and *C. ornata*), and *Pratylenchus* spp. (predominantly *P. scribneri*), each averaging less than 40/100 cm³ soil where present, had distribution frequencies of 57, 53, and 42%, respectively. All were less frequent in the clay soils.

Some nematodes were found at a low frequency (data not tabulated): *Xiphinema* spp. were found at densities of 10–100/100 cm³ soil in 12 fields (7% frequency); *Heterodera* spp. J2, at 10/100 cm³ soil, were found in three fields; and *Hoplolaimus gale-*

TABLE 2. Frequency and abundance of plant-parasitic nematode genera following cotton among four soil types in Florida.

Soil type†	Sites	Meloiodgyme		Pratylenchus		Helicotylenchus		Paratrichodorus		Criconebella		Robylenchulus	
		Freq.	No.‡	Freq.	No.‡	Freq.	No.‡	Freq.	No.‡	Freq.	No.‡	Freq.	No.‡
Sand	54	54%	130	54%	20	65%	80	56%	20	69%	40	2%	210
Loamy sand	46	63%	130	30%	20	83%	220	54%	20	57%	40	9%	950
Sandy loam	67	66%	120	43%	20	78%	330	52%	20	43%	20	25%	1270
Sandy clay & clay loam	11	55%	40	18%	30	91%	370	27%	20	18%	10	36%	2120
All types	178	61%	120	42%	20	76%	240	57%	20	53%	30	15%	1160

† Average particle components: Sands = 90% sand, 6% silt, 4% clay; loamy sands = 84% sand, 9% silt, 7% clay; sandy loams = 72% sand, 15% silt, 13% clay; sandy clay and clay loams = 53% sand, 26% silt, 21% clay.

‡ Average number of nematodes per 100 cm³ soil where present.

atus was found at densities of 40 and 70/100 cm³ soil.

In the glasshouse bioassay, one plant, which was seeded into a soil infested with 70 root-knot nematode J2/100 cm³ soil, died of wilt disease. Among the remaining plants, galling (Y), which averaged 1 on a scale of 0-4, was related to initial numbers of root-knot nematode J2 per 100 cm³ soil (X) by:

$$Y = 0.74 + 0.003X \quad (R^2 = 0.23; \\ P < 0.01; df = 175).$$

Galling, averaging 1.2 (max. 2.0), was observed on 30 plants seeded into soil in which J2 were not detected before planting. Twenty-three plants escaped galling in infested soils, which averaged 50 J2/100 cm³ (range 10-170) at planting.

DISCUSSION

Of the nematodes recovered in this survey, only root-knot and reniform nematodes are considered to be seriously detrimental to cotton (1). Of the three root-knot nematode species that are found in north Florida, only *M. incognita* is a pest of cotton (9). It is likely that the majority of the root-knot nematode J2 recovered in this survey were *M. incognita*. *Meloidogyne javanica* is infrequently found except in tobacco fields in the eastern portion of the survey area (8). With the more prevalent *M. arenaria*, *M. javanica* may have occurred in low numbers in some of the samples that were taken from cotton that followed other crops in rotation. Root-knot nematodes were only slightly more prevalent in Santa Rosa County (67%) than they were in the counties of newer cotton hectarage (58%). Data from this survey indicate that root-knot is likely to be of economic concern wherever cotton is grown in Florida.

The frequency of reniform nematode was much greater in Santa Rosa County (23%) than in the other counties (4%). However, the association between this nematode and heavier soils as found in this and another survey (7), suggests that prob-

lems with this nematode on cotton are more likely to occur in areas such as Escambia County, which has fewer sandy soils than counties in the more easterly regions of the state. The negative relationship between the soil densities of root-knot and reniform nematodes may suggest a competitive relationship, which may explain reduced densities of root-knot nematode J2 in the heavier soils in which reniform nematode is more adapted.

The incidence of root-knot nematodes in Florida cotton fields (61% frequency) is higher than that recently reported from Missouri (30% frequency) (11) and from Arkansas (14% frequency) (6) but similar to that reported from cotton fields in southwest Georgia (58% frequency) (3). Reniform nematodes were more prevalent in Florida cotton fields (15% frequency) than in Missouri (3% frequency) (11) and Arkansas (1% frequency) (6). The high incidence of these nematode pests in Florida cotton will require diligence in monitoring infestation levels and adopting appropriate management schemes. This is especially so because there are no cotton cultivars with adequate resistance to these parasites (1,10).

Root-knot nematode assays usually involve soil sampling and extraction of J2. As indicated, however, by the plant galling assay conducted in this study, infestation levels may be below the detection limit (17% of the samples) and, when recovered, J2 may not be infective (13% of the samples). Monitoring root-knot nematode infestation levels by plant galling bioassays will be appropriate if facilities and sufficient time are available.

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