Supplement to Journal of Nematology 28(4S):661–667. 1996.

Frequency and Geographical Distribution of Plant-Parasitic Nematodes on Cotton in Georgia[1]

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Abstract: A survey was conducted to examine the geographical distribution of plant-parasitic nematodes in Georgia cotton fields. A total of 778 fields in 11 Georgia counties were sampled from 1 September through 15 December 1995. Four nematode genera parasitic on cotton were found in this survey: *Meloidogyne* spp., *Rotylenchulus* sp., *Hoplolaimus* sp., and *Belonolaimus* sp. *Meloidogyne* spp. was present in 9% to 56% of the fields in individual counties. *Rotylenchulus* sp. was found in 10 counties, *Hoplolaimus* sp. was found in 6 counties, and *Belonolaimus* sp. was found in 2 counties. From all of the samples collected for this survey, *Meloidogyne* spp. were found in 31% of the samples, *Rotylenchulus* sp. was found in 14%, *Hoplolaimus* sp. was found in 7%, and *Belonolaimus* sp. was found in 0.3%. Burke County had the greatest number of fields infested by at least one of these genera (67%) and the greatest number of fields above Georgia's action thresholds (38%). Laurens County had the fewest fields where these genera were present (13%), and only 3% of fields had nematode populations above threshold levels. Data from samples collected from cotton fields and submitted by county agents from 1993 through 1994 were compiled to provide historical information about nematode distribution and population density. The results from this survey show that the major nematodes damaging to cotton are not present in all counties in Georgia. Counties in which cotton has historically been a major crop are likely to have higher levels of *Meloidogyne* spp., *Hoplolaimus* sp., and *Rotylenchulus* sp. in current cotton crops. Counties in which soybean has historically been a major crop are likely to have higher levels of *Hoplolaimus* sp. and *Rotylenchulus* sp. in current cotton crops.

Key words: Belonolaimus, cotton, *Gossypium hirsutum, Hoplolaimus, Meloidogyne,* nematode distribution, *Rotylenchulus,* survey.

Approximately 600,000 ha of cotton (*Gossypium hirsutum* L.) was grown in Georgia in 1995 (unpubl., Boll Weevil Eradication Program). Cotton hectarage in Georgia quadrupled during the last 5 years. It is now a major crop in most Georgia counties south of a line from Columbus to Augusta. Many counties in Georgia have had limited cotton production in recent years, and the incidence of nematodes on cotton in many of these counties is unknown. Cotton crop loss due to nematodes in Georgia was estimated to be 5.5% (approximately 126,000 bales) in 1995 (2).

A survey of cotton fields in eastern Georgia in 1974 (12) found *Meloidogyne* spp. in 48% of the fields surveyed, *Hoplolaimus columbus* in 5% of the fields, and *Rotylenchulus reniformis* in 2% of the fields. A similar survey of southwestern counties in 1976 (13) found *Meloidogyne* spp. in 12% of the fields surveyed, *H. columbus* in 5% of the fields, and *R. reniformis* in 0.7% of the fields. In 1994, a survey that sampled a smaller number of cotton fields than the survey reported herein found *M. incognita* in 93% of the fields surveyed, *R. reniformis* in 17% of the fields, and *H. columbus* in 19% of the fields (1). A larger survey and examination of historical data were needed to provide more definitive data. The objective of this project was to examine the frequency and geographical distribution of cotton-parasitic nematodes in Georgia based on a current survey with a large number of samples and on recently compiled records from the University of Georgia Extension Nematology Laboratory.

Materials and Methods

Sampling was conducted from 1 September through 15 December 1995 and represented between 3% and 11% of the cotton hectarage in these counties (Table

Received for publication 15 April 1996.
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1). Eleven of 159 counties in Georgia were selected to represent Georgia's cotton-producing areas based on diversity of cropping histories, historical importance of cotton, and geographic location in the state (Fig. 1). Individual fields within a county were selected arbitrarily from major cotton-production areas within that county. Each sample was a composite of 20 soil cores (2.5-cm-diam. × 20-cm deep) taken from approximately 10-ha sections of each field. Soil cores were collected within 15 cm of weed-free sections of cotton rows. Nematodes were extracted from a-100 cm^3 subsample by centrifugal flotation (8).

Statewide information presented herein was based on all samples collected from cotton fields in Georgia between 1 September and 15 December 1995 and processed by the University of Georgia Extension Nematology Laboratory. Nematode distribution maps were based on recently compiled University of Georgia Extension Nematology Laboratory records for samples collected between 1983 and 1994.

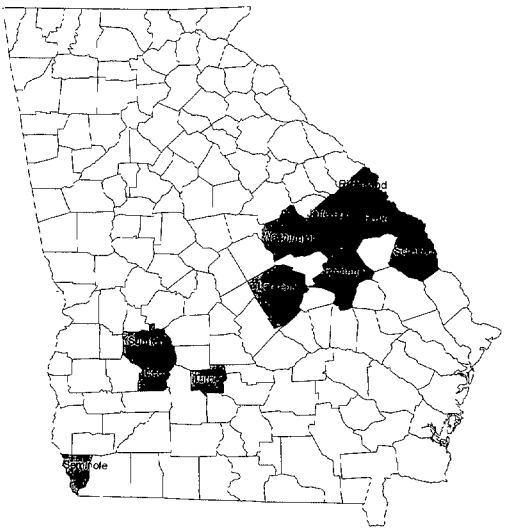

FIG. 1. Georgia counties sampled for nematodes parasitic on cotton in 1995 survey.

RESULTS AND DISCUSSION

Four genera of cotton-parasitic nematodes known to cause yield loss (7,15) were found in this survey (Table 2): *Meloidogyne* spp., *Rotylenchulus* sp., *Hoplolaimus* sp., and *Belonolaimus* sp. Other parasitic nematodes not known to cause yield loss also were found and included (in decreasing order of frequency): *Criconemella* spp., *Helicotylenchus* spp., *Paratrichodorus* spp., *Pratylenchus* spp., *Xiphinema* spp., and *Tylenchorhynchus* spp.

Nematodes were identified to genus under a dissecting microscope. *Meloidogyne* spp. found in weed-free sections of Georgia cotton fields between 1 September and 15 December are believed to be primarily *M. incognita* because other *Meloidogyne* species common in agricultural fields in southern and central Georgia (*M. arenaria*

TABLE 1. Hectarage in counties of Georgia evaluated during the nematode survey from 1 September through 15 December 1995.

County	Hectarage sampled %	Total hectarage sampled	Cotton hectarage 1995	Cotton hectarage 1988	Soybean hectarage 1988
Burke	9.1	1,480	16,212	5,992	15,789
Emanuel	6.5	616	9,547	729	10,121
Jefferson	8.2	666	8,140	3,077	11,336
Laurens	9.3	657	7,120	1,377	9,919
Lee	3.0	448	15,538	2,146	4,656
Richmond	2.9	152	5,213	0	648
Screven	8.6	835	9,852	607	14,777
Seminole	2.9	386	13,333	4,372	1,862
Sumter	3.1	534	17,495	2,186	9,717
Turner	5.8	608	10,560	2,632	1,741
Washington	10.5	295	2,810	850	8,097
Statewide			600,000	141,700	376,518

TABLE 2. Damaging nematodes found in surveyed cotton fields in Georgia from 1 September through 15 December 1995.

County	Fields infested (%)			
	Rotylenchulus sp.	*Hoplolaimus* sp.	*Meloidogyne* spp.	*Belonolaimus* sp.
Burke	23.7	44.7	18.4	0.0
Emanuel	5.6	0.0	39.8	1.9
Jefferson	37.3	26.9	11.9	0.0
Laurens	4.5	1.5	9.0	0.0
Lee	1.4	0.0	36.2	0.0
Richmond	12.5	12.5	25.0	0.0
Screven	0.9	0.0	33.9	0.0
Seminole	2.0	0.0	47.1	0.0
Sumter	23.1	2.2	12.1	0.0
Turner	0.0	0.0	55.6	1.3
Washington	41.7	2.8	55.0	0.0
Statewide[a]	5.1	10.2	37.8	0.3

[a] Based on samples submitted by farmers from all Georgia counties to the University of Georgia Extension Nematology Laboratory between 1 September and 15 December 1995.

and *M. javanica*) do not parasitize cotton. The authors acknowledge that some of the *Meloidogyne* spp. observed may have been *M. javanica* or *M. arenaria*. Both *Hoplolaimus galeatus* and *H. columbus* are parasites of cotton, but *H. galeatus* is rarely found in Georgia cotton fields. Males of *H. columbus* are extremely rare (5,10), whereas males of *H. galeatus* usually constitute approximately one-third of the population (3,10). Males were not observed in our survey, so we believe that all *Hoplolaimus* sp. found were *H. columbus*, though other *Hoplolaimus* spp. that lack males also may have been present. We believe that all *Rotylenchulus* sp. found were *R. reniformis* and all *Belonolaimus* sp. found were *B. longicaudatus* because other species in these genera are not known to occur in agricultural fields in Georgia.

A 1974 survey of 14 counties in eastern Georgia found *Meloidogyne* spp. in 48% of cotton fields sampled, *H. columbus* in 5% of fields, and *R. reniformis* in 2% of fields (12). A 1976 survey of 17 counties in southwestern Georgia found *M. incognita* in 12% of the fields sampled, *H. columbus* in 5% of the fields, and *R. reniformis* in less than 1% of the fields (13). The current survey found *Meloidogyne* spp. in 38% of the fields sampled, *Hoplolaimus* sp. in 10% of the fields, and *Rotylenchulus* sp. in 5% of the fields.

An intensive survey of nematodes in cotton fields was conducted in South Carolina between 1989 and 1992 (11). *Meloidogyne incognita*, *R. reniformis*, and *H. columbus* were the primary nematodes found. Four of the 16 counties included in the South Carolina survey border Georgia counties included in the survey reported herein.

Of the 11 counties surveyed in Georgia, 46% of the fields were infested with cotton-parasitic nematodes. *Meloidogyne* spp. were found in all 11 counties included in this survey and were present in 9% to 56% of the fields in individual counties. *Rotylenchulus* sp. was found in 10 counties, *Hoplolaimus* spp. were found in 6 counties, and *Belonolaimus* sp. was found in 2 counties. *Meloidogyne* spp. were found in 31% of the samples, *Rotylenchulus* sp. was found in 14%, *Hoplolaimus* spp. were found in 7%, and *Belonolaimus* sp. was found in 0.3%. These values are somewhat higher than values reported for cotton fields in Arkansas (16) but lower than values reported for South Carolina (11). A Missouri survey (16) found similar levels of *M. incognita* but fewer *R. reniformis* or *Hoplolaimus* sp. in cotton.

In Georgia, Burke County had the greatest number of fields (67%) infested by at least one of these nematodes and the greatest number of fields (38%) above Georgia's action thresholds. Action thresh-

olds (nematodes/100 cm^3 soil) for cotton in Georgia are 100 or more *M. incognita,* 80 or more *H. columbus,* 250 or more *R. reniformis,* and 1 or more *B. longicaudatus* (4). All thresholds are based on samples collected in the fall before planting cotton the following spring. The fewest nematode problems were identified in Laurens County, where one or more of these genera were present in only 13% of the samples and only 3% were above threshold levels.

Hoplolaimus columbus was known to occur in Georgia and has been reported to be present in at least 50% of cotton fields in South Carolina (9,11). Our study showed that *Hoplolaimus* sp. was common in Burke (45% of fields), Jefferson (27%), and Richmond counties (13%) (Table 2), which are located along the South Carolina border (Fig. 2). The distribution of *Hoplolaimus* sp. extended into southwest Georgia, but its occurrence was infrequent in those counties (9).

Meloidogyne incognita is a widespread pest of cotton in Georgia (Fig. 3). Before this survey, *R. reniformis* was believed to have limited distribution in Georgia and be far less prevalent even in counties where it did occur. The results reported herein showed that *Rotylenchulus* sp. was present in 24% of the fields in Burke County, 37% in Jefferson County, and 42% in Washington County (Table 2). At least in some areas of Georgia, *Rotylenchulus* sp. is more of a problem than previously thought (Fig. 4).

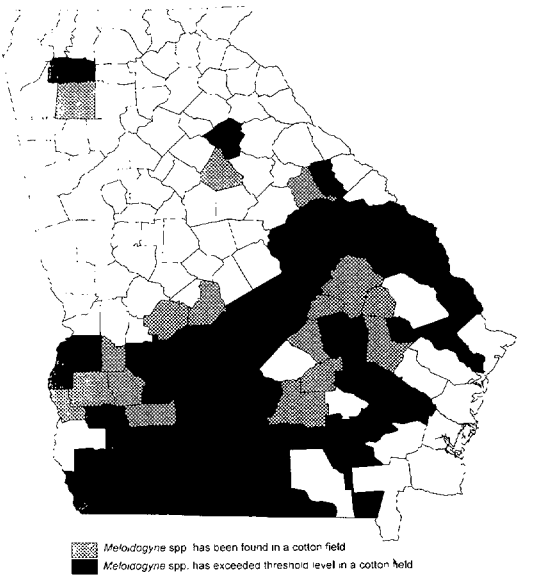

FIG. 3. Statewide distribution of *Meloidogyne incognita* based on Extension Nematology Laboratory records from 1983 through 1994.

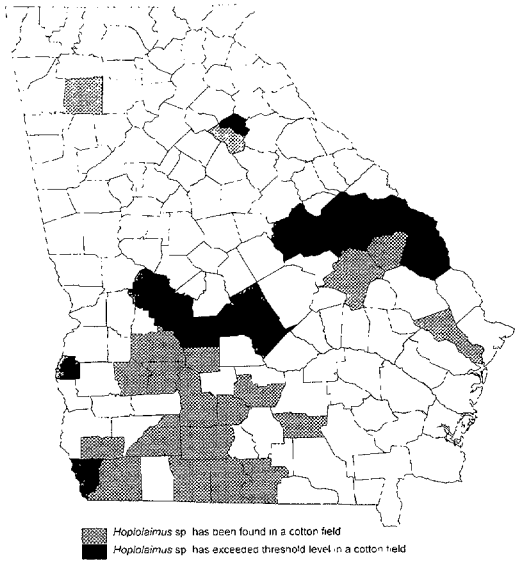

FIG. 2. Statewide distribution of *Hoplolaimus* spp. based on Extension Nematology Laboratory records from 1983 through 1994.

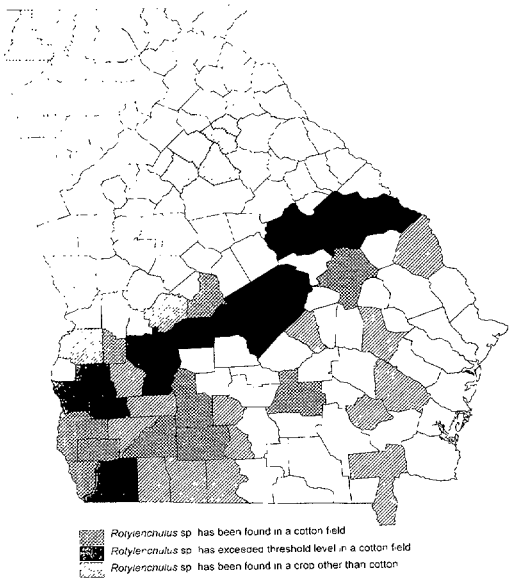

FIG. 4. Statewide distribution of *Rotylenchulus reniformis* based on Extension Nematology Laboratory records from 1983 through 1994.

In a 1989–92 survey (11), South Carolina counties adjacent to Richmond, Burke, and Screven counties had levels of *Meloidogyne* spp. and *Hoplolaimus* sp. similar to levels reported herein, but *Rotylenchulus* sp. was not found in South Carolina counties bordering Georgia. This is in sharp contrast to the relatively frequent occurrence of *Rotylenchulus* sp. in Burke and Richmond counties in Georgia.

Historical laboratory data (Figs. 2–4) provide valuable information about the geographical distribution of nematodes in Georgia, but this survey may provide more accurate data about nematode frequency in the surveyed counties by increasing sample size and decreasing bias toward samples from fields with suspected nematode problems. Additional counties in the cotton production region of Georgia will be sampled intensively during the next several years to increase our knowledge of the frequency of nematode occurrence in southern Georgia. This survey will also provide a baseline measurement to determine if nematode problems are increasing.

Concomitant nematode infestations were as follows: *Hoplolaimus* sp. and *Rotylenchulus* sp. were found together in 15% of the fields sampled in Burke County and 8% of the fields sampled in Jefferson County (Table 3); *Meloidogyne* spp. and *Hoplolaimus* sp. were found together in 5% of the Burke County fields, 2% of the Jefferson County fields, and 1% of the Sumter County fields; and *Rotylenchulus* sp. and *Meloidogyne* spp. occurred together in 2% of the Emanuel County fields and 1% of the Turner County fields. The occurrence of concomitant nematode populations appears to be lower in Georgia than in South Carolina (11). It has been reported from Alabama that *R. reniformis* may become the dominant nematode in a field due to its ability to compete successfully with *M. incognita* (6), and this may be occurring now in Burke, Jefferson, and Washington counties in Georgia.

Percentage of fields with at least one nematode species above threshold levels was greatest in Burke County (38%), followed by Turner County (26%), Jefferson County (26%), and Washington County (25%) (Table 4). Lee, Laurens, and Screven counties had relatively few fields with above-threshold nematode populations. Emanuel, Richmond, Seminole, and Sumter counties were intermediate.

Cotton has had significant hectarage in Burke, Jefferson, Seminole, and Turner counties since at least 1988 (Table 1), and the high percentage of fields with above-

TABLE 3. Number of cotton fields in each surveyed county with concomitant infestations of *Meloidogyne* spp., *Hoplolaimus* sp., and *Rotylenchulus* sp. based on samples collected between 1 September and 15 December 1995.

County	Total fields	Concomitant nematode populations		
		Meloidogyne spp. + *Hoplolaimus* sp.	*Meloidogyne* spp. + *Rotylenchulus* sp.	*Rotylenchulus* sp. + *Hoplolaimus* sp.
Burke	117	6	0	17
Emanuel	108	0	2	0
Jefferson	67	1	0	5
Laurens	67	0	0	0
Lee	69	0	0	0
Richmond	9	0	0	0
Screven	107	0	0	0
Seminole	51	0	0	0
Sumter	75	1	0	0
Turner	72	0	1	0
Washington	36	0	0	0
Statewide[a]	2,941	90	11	22

[a]Based on samples submitted by farmers from all Georgia counties to the University of Georgia Extension Nematology Laboratory between 1 September and 15 December 1995.

TABLE 4. Cotton fields in Georgia with one or more damaging nematodes and fields above action threshold levels based on soil samples collected between 1 September and 15 December 1995.

County	Number fields sampled	Fields with cotton nematodes %	Fields above threshold[a] %
Burke	117	66.7	37.7
Emanuel	108	45.8	12.2
Jefferson	67	60.0	25.7
Laurens	67	13.0	3.0
Lee	69	30.7	0.0
Richmond	8	50.0	12.5
Screven	107	36.9	5.7
Seminole	51	49.0	9.8
Sumter	75	34.1	10.3
Turner	72	55.6	26.4
Washington	36	47.2	25.0
Statewide[b]	2,941	53.5	16.7

[a]Threshold is 250 nematodes in 100 cm^3 soil for *Rotylenchulus reniformis*, 80 for *Hoplolaimus columbus*, 100 for *Meloidogyne incognita*, and 1 for *Belonolaimus longicaudatus*.

[b]Based on samples submitted by farmers from all Georgia counties to the University of Georgia Extension Nematology Laboratory between 1 September and 15 December 1995.

threshold nematode populations may indicate crop rotations and other strategies to manage nematodes are not being used adequately in these counties. Many of the fields recently put into cotton production in Burke, Emanuel, Jefferson, Laurens, Screven, Sumter, and Washington counties were previously in soybean production. Soybean is an excellent host for *M. incognita*, *H. columbus*, and *R. reniformis*, which likely helped to create the current nematode problems in cotton. Cotton has only recently become a major crop in Emanuel, Laurens, Lee, Richmond, Screven, Sumter, and Washington counties.

Based on crops that historically have been grown in a county and on the survey reported herein, we can draw some general conclusions. If cotton has historically been produced on significant hectarage in a county, current cotton fields are more likely to have nematode problems. This appears to be the case in Burke, Jefferson, Seminole, and Turner counties. If soybean was an historically important crop and *H. columbus* or *R. reniformis* is a major nematode in a county, then nematodes are likely to be a problem in current cotton fields. This may be a contributing factor in Burke, Jefferson, Sumter, and Washington counties. *Meloidogyne incognita* has not developed into a significant problem for cotton in fields that previously had been in soybean. Soybean varieties with good resistance to *M. incognita* were grown in fields known to be infested with that nematode, but varieties with resistance to *H. columbus* or *R. reniformis* either were not available or were not planted.

Nematode problems in current cotton production fields are less common in counties where little cotton has been produced in the past. Likewise, counties with limited soybean production (such as Lee and Richmond counties) or soybean production with *M. incognita* as the only significant nematode pest (such as Emanuel, Laurens, and Screven counties) are less prone to nematode problems in current cotton fields.

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