Supplement to the Journal of Nematology 32(4S):508–512. 2000.

A Survey of Plant-Parasitic Nematodes Associated with Cotton in Northeastern Louisiana

K. S. McLean[1] and G. W. Lawrence[2]

Abstract: A survey was conducted in northeastern Louisiana to determine the frequency and abundance of plant-parasitic nematodes associated with cotton. In fall 1997 and 1998, more than 600 soil samples were collected from cotton fields representing 6,200 ha, which is 5.3% of the cotton production hectarage in this region. Composite soil samples were collected from 10 ha in each field. Nematodes were extracted by gravity screening and sucrose centrifugation, identified to genus, and quantified. Nine genera of plant-parasitic nematodes were identified. *Rotylenchulus reniformis* was found in 67% of the fields sampled, with an average population of 12,959 juveniles and vermiform adult stages per 500 cm^3 of soil. *Meloidogyne incognita* was identified in 25% of the fields sampled, with an average population of 998 juveniles per 500 cm^3 of soil. *Hoplolaimus* spp. were identified in 3%, or 155 ha, with an average population of 282 juveniles and adult stages per 500 cm^3 of soil. *Rotylenchulus reniformis* and *M. incognita* occurred at population levels above reported economic thresholds in 49% and 21% of the fields, respectively.

Key words: cotton, *Gossypium hirsutum, Meloidogyne incognita,* nematode, *Rotylenchulus reniformis,* survey.

Cotton *(Gossypium hirsutum)* is one of the major agronomic commodities produced in Louisiana. In the last decade the state averaged 355,000 ha of cotton annually. Although cotton is raised in half of the parishes across the state, the northeastern Mississippi river delta region is historically intensively cropped in cotton. Nine species of plant-parasitic nematodes have been reported associated with cotton and cotton production and three species are considered the predominant economic nematode pathogens in cotton production (Lawrence and McLean, 1995). These include *Meloidogyne incognita* (Kofoid & White) Chitwood, *Rotylenchulus reniformis,* Linford and Oliveira, and *Hoplolaimus columbus* Sher.

A 1961 survey of crop production areas in Louisiana indicated that three parishes in the central cotton-producing region of the state were infested with *Rotylenchulus reniformis* (Overstreet and McGawley, 1997). A more recent survey conducted in 1994 and 1995 that included 200 samples from 20 parishes across Louisiana identified *R. reniformis* and *M. incognita* in 57% and 27% of the samples, respectively (Overstreet and McGawley, 1997). *Helicotylenchus* sp. was found in 67% of the fields surveyed.

Cotton is produced in 30 of the 64 parishes in the state, although Caldwell, Franklin, Ouachita, and Richland parishes in northeast Louisiana produce 33% of the total cotton for the state (Anonymous, 1998). These four parishes consistently produce 5% less cotton lint/ha than the state average (Anonymous, 1998). This survey was conducted to determine the presence, distribution, and abundance of plant-parasitic nematodes in the intensive cotton production areas in the Caldwell, Franklin, Ouachita, and Richland parishes of northeastern Louisiana.

Materials and Methods

Cotton fields in Caldwell, Franklin, Ouachita, and Richland parishes of Louisiana were surveyed for plant-parasitic nematodes in September and October 1997 and 1998. More than 600 soil samples representing 6,200 ha were collected from cotton fields in the four-parish region. Each sample consisted of a composite of 20 soil cores (2.5-cm-diam. × 20-cm-deep) taken in an evenly spaced systematic zigzag sampling pattern from a 10-ha section of each field (Lawrence and McLean, 1999a). Composite soil samples were sealed in plastic bags and stored less than 4 hours in a cooled iced chest for transport from the field and then

Received for publication 20 March 2000.
[1] Department of Entomology and Plant Pathology, Auburn University, Auburn, AL 36849.
[2] Department of Entomology and Plant Pathology, Mississippi State University, Mississippi State, MS 39762.
e-mail: kmclean@acesag.auburn.edu
This paper was edited by T. L. Kirkpatrick.

transferred to a 5 °C refrigerator. Each sample was thoroughly mixed, and a 150-cm^3 subsample was collected for nematode extraction. All samples were processed within 7 days of collection. Nematodes were extracted by gravity screening and sucrose centrifugal-flotation (Jenkins, 1964), and plant-parasitic nematode genera were identified and enumerated using a stereo microscope.

Results and Discussion

The total survey area represented 5.3% of the cotton hectarage in northeastern Louisiana. Soil types sampled in the four-parish area were primarily silty loams, with soil textures ranging from 70 to 90% silt, 20 to 50% sand, and less than 25% clay (Table 1).

Nine genera of plant-parasitic nematodes were identified, including *Criconemella, Helicotylenchus, Hoplolaimus, Meloidogyne, Pratylenchus, Paratrichodorus, Rotylenchulus, Tylenchorhynchus,* and *Tylenchus.*

Of the nematodes recovered in this survey, only *M. incognita* and *R. reniformis* are currently considered to be economically damaging to cotton. *Meloidogyne incognita* is the only species that is a pest on cotton in Louisiana; thus, it is likely that the root-knot second-stage juveniles recovered were *M. incognita* based on the continuous cotton production of the four-parish area.

Helicotylenchus occurred most frequently and was found in 69% of the samples (Table 2). *Rotylenchulus rentformis* was found in 67% of the samples, and *M. incognita* was found in 25% of the samples. All of the other nematode genera occurred in less than 15% of the samples.

Table 1. Number, hectarage, and average soil particle-size distribution of soils sampled in four parishes in northeast Louisiana.

Parish	Sampled fields	Sampled ha	Average components		
			% sand	% silt	% clay
Caldwell	98	941	38	52	10
Franklin	182	1,747	13	66	21
Ouachita	217	2,083	37	52	11
Richland	145	1,392	12	65	23

Thirty-six percent of the soil samples contained only a single genus of plant-parasitic nematodes. Of these, 66% contained only *R. reniformis* and 34% contained only *Helicotylenchus spp.* Sixty-four percent of the soil samples contained multiple populations of plant-parasitic nematodes. Where more than one genus was found, 60% of the samples contained two genera, 29% contained three genera, and 11% contained four or more genera. Similar ratios of single and multiple species of plant-parasitic nematodes were found in a survey of cotton fields conducted in Missouri (Wrather et al., 1992).

Rotylenchulus reniformis was found in 67% of the fields, representing 3,658 ha. Population densities ranged from 85 to 145,000 juveniles and vermiform adults per 500 cm^3 of soil with an average density of 12,520 nematodes (Table 2). The frequency of recovery of this species was similar across the four-parish area. *Rotylenchulus reniformis* was found in 62%, 60%, 70%, and 72% of the samples in Ouachita, Caldwell, Franklin, and Richland parishes, respectively. Forty-nine percent of the fields infested with *R. reniformis* contained population levels above the economic threshold of 1,000 juveniles and vermiform adults per 500 cm^3 of soil established by the Louisiana Cooperative Extension Service (Overstreet, pers. comm.) Yield losses of 19% have been reported due to *R. reniformis* population densities above the economic threshold in Mississippi (Lawrence et al., 1990; Lawrence and McLean, 1999b). The results from this survey indicate that *R. reniformis* is likely to be of economic concern wherever cotton is grown in these four parishes and may be involved with cotton yield suppression in the area. The incidence of 67% of the cotton fields infested with *R. reniformis* in this survey is higher than previously recognized in Louisiana. A 1995 survey reported that 57% of the fields sampled were infested with *R. reniformis* (Overstreet and McGawley, 1997). *Rotylenchulus reniformis* infestations also appear to be higher in Louisiana than in other cotton-producing states that have reported this nematode. The number of *R. reniformis-*

TABLE 2. Frequency of occurrence and average population density of plant-parasitic nematodes associated with cotton in four parishes in northeastern Louisiana.

Nematode genus	No. fields[a]	Freq. of occurrence	Nematodes/500 cm^3 soil	
			Average[a]	Range
Criconemella	17	3	303	0–2,059
Helicotylenchus	437	75	1,101	0–10,896
Hoplolaimus	22	3	257	0–1,029
Meloidogyne	163	25	998	0–8,494
Pratylenchus	51	9	703	0–3,346
Rotylenchulus	424	67	12,520	0–145,000
Tylenchorhynchus	98	15	576	0–9,523

[a] Averages were calculated from samples in which the nematode was found.

infested fields was lower in Mississippi, where 15% of the fields were found to be infested (Lawrence et al., 1997). Incidence of this nematode is also lower in other states in the southeastern United States. *Rotylenchulus reniformis* has been reported in 15% of the cotton fields in Florida (Kinloch and Sprenkel, 1994), 5% in Georgia (Baird et al., 1996), 3% in Missouri (Wrather et al., 1992), and less than 10% in Arkansas (Bateman et al., 2000). *Rotylenchulus reinformis* has been associated with fine textured soils in Texas (Starr, 1993) and has been found in soils having a higher percentage of sand in other regions of the southern United States (Heald and Robinson, 1990). In this survey, *R. reniformis* was found in the silt loam, with an average soil particle distribution of 12% sand, 66% silt, and 22% clay (Table 1).

Meloidogyne incognita was found in 23% of the fields sampled, representing 1,426 cotton-producing ha. Population densities of *M. incognita* ranged from 85 to 8,494 second-stage juveniles per 500 cm^3 of soil, with an average density of 998. Twenty-one percent of the samples contained populations of *M. incognita* that were above the economic threshold of 150 juveniles per 500 cm^3 of soil (Overstreet, pers. comm.). However, *M. incognita* was not evenly distributed across the four parishes. Thirty-nine percent of the samples from Ouachita and Caldwell parishes contained *M. incognita,* while less than 10% of the samples from Franklin and Richland parishes contained *M. incognita.* The highest incidence occurred along the Ouachita River in Ouachita and Caldwell parishes, and soil samples from these locations contained the highest percentage of sand in our silty loam soils with an average soil particle distribution of 37% sand, 52% silt, and 11% clay. This may suggest that there is an influence of soil texture on the distribution of *M. incognita* in Louisiana. Previous surveys indicate that 27% of the samples were infested with *M. incognita* in Louisiana (Overstreet and McGawley, 1997). In Florida, *M. incognita* was found in 61% of the fields infested (Kinloch and Sprenkel, 1994), and in Georgia 38% of the fields were infested (Baird et al., 1996). Typically, Florida and Georgia cotton-production areas are in soils that contain a high percentage of sand. *Meloidogyne incognita* also has been found in 30% of the cotton fields in Missouri (Wrather et al., 1992), 20 to 30% in Arkansas (Bateman et al., 2000), and 10% in Mississippi (Lawrence et al., 1997), respectively.

The lesion nematode *Pratylenchus* spp. was identified in 5.0% (310 ha) of the four-parish region, with a mean density of 703 juveniles and adults (range of 85–3,346) per 500 cm^3 of soil.

The lance nematode *Hoplolaimus* spp. was found in 3% (155 ha) of the hectarage sampled. Two species of *Hoplolaimus*—*H. magnistylus* (Robbins) and *H. galeatus* (Cobb) Thorne—were identified. *Hoplolaimus columbus* was not found in this region although it has been identified in three parishes in south-central Louisiana (Overstreet, pers. comm.). *Hoplolaimus magnistylus* and *H. galeatus* were detected with the high-

est frequency in Franklin Parish, with 5% of the samples infested. Population densities of *H. magnistylus* and *H. galeatus* ranged from 85 to 1,029 per 500 cm^3 of soil, with an average density of 282 juveniles and adults in the fields where it was identified.

Stunt nematodes *Tylenchorhynchus* spp. were found in Ouachita Parish in 41% of the samples, with an average population density of 576 juveniles and adults and a range of 85 to 9,523 per 500 cm^3 of soil. Less than 8% of the soil samples from the other three parishes contained *Tylenchorhynchus* spp.

Nematode infestations are usually polyspecific. However, *R. reniformis* is characteristically monospecific (Starr, 1993; Lawrence et al., 1997). Concomitant infestations of *R. reniformis* and *M. incognita* were found in only 9% of the fields sampled in this survey (Table 3). Population levels of *M. incognita* were above the established economic thresholds in all of the concomitantly infested fields, but population levels of *R. reniformis* were below economic thresholds in all but three of the fields. In Ouachita Parish, 19% of the cotton fields were infested with both *M. incognita* and *R. reniformis*. The soils in Ouachita Parish contained the highest percentages of sand of the silty loam soils. Percentage of sand has an effect on population development of each of these nematode species. Reproduction of *M. incognita* is greater in course-textured soil than in fine-textured soils, while *R. reniformis* reproduction is favored by higher levels of silt and clay (Koenning et al., 1996). This infrequent natural concomitant occurrence of the two species has been observed in Texas (Starr, 1993) and Mississippi (Hankins et al., 1997).

In summary, 82% of the samples from the four-parish survey contained either *R. reniformis, M. incognita,* or both species. These are two economically important nematodes associated with cotton. *Rotylenchulus reniformis* population densities were above the economic threshold in 49% of the samples, and *M. incognita* population numbers were above established threshold levels in all the samples where it was found. A total of 3,038 and 1,426 ha were estimated to be infested with economically damaging levels of *R. reniformis* and *M. incognita,* respectively, in the four-parish area. In the Mississippi delta, economic threshold population levels of *R. reniformis* have been estimated to reduce cotton yields by 19% or approximately 150 kg of lint per ha (Lawrence et al., 1990; Lawrence and McLean, 1999b). Economic infestation levels of *M. incognita* have been estimated to cause a greater-than-23% (182 kg lint/ha) reduction in cotton yield in the Mississippi delta (Lawrence et al., 1990; Lawrence and McLean, 1999b).

Cotton has historically been grown in the majority of the fields in this four-parish survey area. This region accounts for approximately one-third of the state's cotton hectarage each year, but lint yields in the area routinely are below the state average cotton yield. In our survey the reniform nematode was found in two-thirds of the cotton fields surveyed—an increase in incidence over that reported in 1995 (Overstreet and McGawley, 1997). In addition, the root-knot nematode was found in 25% of the

TABLE 3. Occurrence and average density (nematodes/500 cm^3 soil) of *Meloidogyne incognita* (Mi) and *Rotylenchulus reniformis* (Rr) in four parishes in northeast Louisiana.

	Meloidogyne incognita		*Rotylenchulus reniformis*		Concomitant occurence		
Parish	No. fields	Average[a]	No. fields	Average	Mi & Rr	Average[b] Mi	Average Rr
Caldwell	37	2,549	79	18,524	19	913	3,959
Franklin	15	418	103	6,119	4	733	1,180
Ouachita	101	641	133	2,618	12	925	876
Richland	10	385	109	22,816	1	386	1,115

[a] Averages calculated for samples in which the nematode was found.
[b] Averages calculated for samples in which Mi and Rr occur concomitantly.

samples—in all cases at population densities that were above the damage threshold. The presence and prevalence of these two economically important nematodes of cotton in this region may account for some of the widespread yield suppression that has been seen. Strategies for nematode management will be needed to improve the cotton yield in this area.

Literature Cited

Anonymous. Louisiana summary agriculture & natural resources, 1998. Louisiana State University Agricultural Center and Louisiana Cooperative Extension Service Pub. 2382.

Baird, R. E., R. F. Davis, P. J. Alt, B. G. Mullinix, and G. B. Padgett. 1996. Frequency and geographical distribution of plant-parasitic nematodes on cotton in Georgia. Supplement to the Journal of Nematology 28:661–667.

Bateman, R. J., T. L. Kirkpatrick, R. T. Robbins, and G. Lorenz. 2000. The distribution of root-knot and vermiform nematodes in Arkansas, 1990–1999. Pp. 171 *in* P. Duggar and D. A. Richter, eds. Proceedings of the Beltwide Cotton Conferences, San Antonio, TX, 4–8 Jan. 2000. Memphis, TN: National Cotton Council of America.

Hankins, G. W., G. W. Lawrence, and F. Killebrew. 1997. Plant-parasitic nematodes associated with nondelta cotton production in Mississippi. Pp. 100–101 *in* P. Dugger and D. A. Richter, eds. Proceedings of the Beltwide Cotton Production Research Conferences, New Orleans, LA, 6–10 Jan. 1997. Memphis, TN: National Cotton Council of America.

Heald, C. M., and A. F. Robinson. 1990. Survey of current distribution of *Rotylenchulus reniformis* in the United States. Supplement to the Journal of Nematology 22:695–699.

Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Reporter 48:692.

Kinloch, R. A., and R. K. Sprenkel. 1994. Plant-parasitic nematodes associated with cotton in Florida. Supplement to the Journal of Nematology 26:749–752.

Koenning, S. R., S. A. Walters, and K. R. Barker. 1996. Impact of soil texture on the reproductive and damage potentials of *Rotylenchulus reniformis* and *Meloidogyne incognita* on cotton. Journal of Nematology 28:527–536.

Lawrence, G. W., and K. S. McLean. 1995. Distribution of nematodes. Pp. 196 *in* P. Duger and D. A. Richter, eds. Proceedings of the Beltwide Cotton Production Research Conferences, San Antonio, TX, 4–7 Jan. 1995. Memphis, TN: National Cotton Council of America.

Lawrence, G. W., and K. S. McLean. 1999a. Plant-parasitic nematode pests of soybean. Pp. 291–309 *in* L. G. Heatherly and H. F. Hodges, eds. Soybean production in the midsouth. Boca Raton, FL: CRC Press LLC.

Lawrence, G. W., and K. S. McLean. 1999b. Managing the reniform nematode with nematicides. Pp. 100–101 *in* D. Duger and P. A. Richter, eds. Proceedings of the Beltwide Cotton Production Research Conferences, Orlando, FL, 3–7 Jan. 1999. Memphis, TN: National Cotton Council of America.

Lawrence G. W., K. S. McLean, W. E. Batson, D. Miller, and J. C. Borbon. 1990. Response of *Rotylenchulus reniformis* to nematicide applications on cotton. Supplement to the Journal of Nematology 22:707–711.

Lawrence, G. W., K. S. McLean, and G. Hankins. 1997. Root-knot and reniform nematodes associated with cotton production in Mississippi. Pp. 98–99. *in* P. Duger and D. A. Richter, eds. Proceedings of the Beltwide Cotton Production Research Conferences, New Orleans, LA, 6–10 Jan. 1997. Memphis, TN: National Cotton Council of America.

Overstreet, C. 1999. Reniform nematode - an introduction. P. 100 *in* P. Dugger and D. A. Richter, eds. Proceedings of the Beltwide Cotton Production Research Conferences, Orlando, FL, 6–10 Jan. 1999. Memphis, TN: National Cotton Council of America.

Overstreet, C., and E. C. McGawley. 1997. Reniform nematode and its influence on the cotton industry in the United States. P. 92 *in* P. Dugger and D. A. Richter, eds. Proceedings of the Beltwide Cotton Production Research Conferences, New Orleans, LA, 6–10 Jan. 1997. Memphis, TN: National Cotton Council of America.

Starr, J. L. 1993. Root-knot nematodes. Pp. 7–12 *in* The Beltwide Cotton Nematode Survey and Education Committee, eds. Cotton nematodes, your hidden enemies. Memphis, TN: National Cotton Council of America.

Wrather, J. A., T. L. Niblack, and M. R. Milam. 1992. Survey of plant-parasitic nematodes in Missouri cotton fields. Supplement to the Journal of Nematology 24: 779–782.