

Phytoparasitic Nematode Surveys of Arkansas Cotton Fields, 1986-88¹

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Abstract: Surveys from 1986 to 1988 identified 22 phytoparasitic nematode species in Arkansas cotton fields. *Meloidogyne* spp. was found in ca. 15% of the fields sampled. Of these samples ca. 33% were found to have a population density of 106/100 cm³ of soil or more. *Rotylenchulus reniformis* was found in high numbers (5,000+/100 cm³ of soil) in 1% of the fields sampled in 1988. *Heterodera glycines* was found in ca. 22% of the samples, presumably because of past cropping to soybean. Other common species found were *Pratylenchus alleni*, *P. brachyurus*, *P. scribneri*, *Tylenchorhynchus ewingi*, *T. goffarti*, *Quinisulcius acutus*, *Helicotylenchus dihystera*, *H. pseudorobustus*, *Hoplolaimus magnistylus*, *Paratrichodorus minor*, and *Xiphinema americanum*. *Paratylenchus* spp. juveniles were found in ca. 10% of the samples; adults of *P. projectus* and *P. tenuicaudatus* were found in ca. 1% of the samples. Other species found only rarely were *Pratylenchus zeae*, *Merlinius brevidens*, *T. martini*, *Helicotylenchus multinctus*, *Scutellonema brachyurum*, and *X. chambersi*.

Key words: Arkansas, cotton, crop loss estimate, *Gossypium hirsutum*, *Helicotylenchus dihystera*, *Helicotylenchus pseudorobustus*, *Heterodera glycines*, *Hoplolaimus magnistylus*, infestation estimate, *Meloidogyne* spp., *Merlinius brevidens*, *Paratrichodorus minor*, *Paratylenchus projectus*, *Paratylenchus tenuicaudatus*, *Pratylenchus alleni*, *Pratylenchus brachyurus*, *Pratylenchus scribneri*, *Pratylenchus zeae*, *Quinisulcius acutus*, *Scutellonema brachyurum*, survey, *Tylenchorhynchus ewingi*, *Tylenchorhynchus goffarti*, *Tylenchorhynchus martini*, *Xiphinema americanum*, *Xiphinema chambersi*.

Estimations of crop losses due to phytoparasitic nematodes are difficult to achieve (3,4). Major difficulties in estimating losses for a large area such as a state include estimating the infested hectareage, identification of the nematode species present, estimating the infestation level of each nematode species, and estimating the extent of damage caused by each nematode species.

Meloidogyne incognita (Kofoid & White) Chitwood, *Belonolaimus longicaudatus* Rau, *Rotylenchulus reniformis* Linford & Oliveira, and *Hoplolaimus galeatus* (Cobb) Thorne cause serious damage to cotton (*Gossypium hirsutum* L.), with the first three species also being important in disease complexes (6). All these species except *B. longicaudatus* are known to occur in Arkansas. Other species reported (6) to cause less serious damage to cotton that are found in Arkansas include *Pratylenchus brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven, *Paratri-*

chodorus minor (Colbran) Siddiqi (*P. christiei*), and *Tylenchorhynchus claytoni* Steiner.

The Arkansas Agricultural Statistics Service (AASS) annually estimates the statewide cotton yield by randomly selecting 105 cotton fields throughout the state and sampling them for yield. Due to randomness of the sampling method, several different soil types, soil fertility levels, soil moisture levels, cotton cultivars, and man-

TABLE 1. Estimated annual hectares ($\times 1,000$) planted to cotton (in parentheses) and infested by any of several phytoparasitic nematodes in Arkansas, 1986-88.

	1986 (198.3)	1987 (224.6)	1988 (275.2)
With nematodes	163.6	191.9	201.4
<i>Meloidogyne</i> spp.	21.2	32.7	48.2
<i>Rotylenchulus reniformis</i>	1.9	2.2	2.8
<i>Heterodera glycines</i>	40.4	48.0	68.1
<i>Pratylenchus</i> spp.	78.9	85.0	96.5
<i>Tylenchorhynchus</i> spp., <i>Merlinius brevidens</i> , and <i>Quinisulcius acutus</i>	69.3	85.0	56.7
<i>Helicotylenchus</i> spp.	113.6	106.9	90.8
<i>Scutellonema brachyurum</i>	3.9	6.5	0.0
<i>Hoplolaimus</i> spp.	25.0	15.3	5.7
<i>Paratrichodorus minor</i>	15.4	43.6	48.2
<i>Xiphinema americanum</i>	19.3	56.7	62.4
<i>Paratylenchus</i> spp.	21.2	34.9	17.0

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TABLE 2. Number of cotton fields sampled, percentage of fields with the indicated plant-parasitic nematodes, and percentage of each indicated nematode group within each density range† in Arkansas, 1986–88.

	Fields sampled (no.)	With nematodes (%)	Trace (n = 1–24)	Low (n = 25–99)	Moderate (n = 100–499)	High (n = 500+)
<i>Meloidogyne</i> spp.						
1986	103	10.7	6.8	1.0	1.0	1.9
1987	103	14.6	4.9	1.0	7.8	1.0
1988	97	17.5	2.1	2.1	3.1	10.3
Mean		14.3	4.6	1.3	3.9	4.4
<i>Rotylenchulus reniformis</i>						
1986	103	1.0	0.0	0.0	0.0	1.0
1987	103	1.0	0.0	1.0	0.0	0.0
1988	97	1.0	0.0	0.0	0.0	1.0
Mean		1.0	0.0	0.3	0.0	0.7
<i>Heterodera glycines</i>						
1986	103	20.4	12.6	5.8	1.9	0.0
1987	103	21.4	10.7	5.8	4.9	0.0
1988	97	24.7	11.3	8.2	4.1	1.0
Mean		22.2	11.5	6.6	3.6	0.3
<i>Pratylenchus</i> spp.						
1986	103	39.8	26.2	9.7	2.9	1.0
1987	103	37.9	27.2	7.8	2.9	0.0
1988	97	35.1	15.5	11.3	7.2	1.0
Mean		37.6	23.0	9.6	4.3	0.7
<i>Tylenchorhynchus</i> spp., <i>Merlinius brevidens</i> , <i>Quinisulcius acutus</i>						
1986	103	35.0	19.4	5.8	7.8	1.9
1987	103	37.9	18.4	11.7	5.8	1.9
1988	97	20.6	4.1	6.2	9.3	1.0
Mean		31.1	14.0	7.9	7.6	1.6
<i>Helicotylenchus</i> spp.						
1986	103	57.3	35.9	7.8	8.7	4.9
1987	103	47.6	22.3	9.7	10.7	4.9
1988	97	33.0	17.5	5.2	8.2	2.1
Mean		45.9	25.3	7.5	9.2	3.9
<i>Scutellonema brachyurum</i>						
1986	103	1.9	1.0	1.0	0.0	0.0
1987	103	2.9	1.9	1.0	0.0	0.0
1988	97	0.0	0.0	0.0	0.0	0.0
Mean		1.6	1.0	0.6	0.0	0.0
<i>Hoplolaimus</i> spp.						
1986	103	12.6	8.7	3.9	0.0	0.0
1987	103	7.8	3.9	3.9	0.0	0.0
1988	97	5.2	5.2	0.0	0.0	0.0
Mean		8.5	5.9	2.6	0.0	0.0
<i>Paratrichodorus minor</i>						
1986	103	7.8	3.9	1.9	1.9	0.0
1987	103	19.4	10.7	4.9	2.9	1.0
1988	97	14.4	8.2	5.2	1.0	0.0
Mean		13.9	7.6	4.0	2.0	0.3
<i>Xiphinema</i> spp.						
1986	103	9.7	8.7	1.0	0.0	0.0
1987	103	25.2	15.5	4.9	2.9	1.9
1988	97	22.7	17.5	2.1	3.1	0.0
Mean		19.2	13.9	2.6	2.0	0.6

TABLE 2. Continued.

	Fields sampled (no.)	With nematodes (%)	Trace (n = 1-24)	Low (n = 25-99)	Moderate (n = 100-499)	High (n = 500+)
<i>Paratylenchus</i> spp.						
1986	103	10.7	9.7	1.0	0.0	0.0
1987	103	15.5	9.7	2.9	2.9	0.0
1988	97	6.2	5.2	1.0	0.0	0.0
Mean		10.8	8.2	1.6	1.0	0.0

† Density range = n/500 cm³ soil.

agement systems are included in these samples. In 1986 a joint survey project (5) was initiated between the AASS and the Arkansas Nematode Assay and Diagnostic Lab (ANL). The objectives of the project were to determine the phytoparasitic nematode species present in Arkansas cotton fields, to estimate the level of infestation by each species, and to estimate the proportion of the cotton production area infested.

MATERIALS AND METHODS

An average of 101 nematode samples taken each year by AASS personnel in late July to late August consisted of soil samples taken from two prescribed locations in each field (1). Each sample consisted of ca. 500 cm³ soil taken 10-20 cm deep with a spade. The soil was placed in plastic bags and stored in insulated chests out of direct sunlight. The samples were mailed or sent by parcel service to the ANL in Fayetteville, Arkansas, as soon as possible after they were collected.

Nematodes in two 236.5-cm³ subsamples from each field were extracted by the roiling-sieving-Baermann funnel technique (2). After incubation for 7 days on the Baermann funnel, the nematodes were collected, identified, and counted. The nematodes in the two subsamples from each field were added together to estimate the nematode population densities for each field.

Species identifications were made from adult specimens with a compound light microscope. All Heteroderidae second-stage juveniles and males were assumed to be the soybean cyst nematode, *Heterodera glycines* Ichinohe. No attempt was made to speciate

Meloidogyne spp. When moderate-to-high numbers of nematodes other than *H. glycines* and *Meloidogyne* spp. were present, at least 20 randomly selected specimens of each genus or similar genera were used to make species identifications. When mixtures of species occurred, each species was expressed as a proportion of the total.

RESULTS

The number of hectares of cotton planted in Arkansas ranged from 198,300 in 1986 to 275,200 in 1988 (Table 1). Also shown in Table 1 are the estimated hectares infested by each of the following phytoparasitic nematode groups or species: *Meloidogyne* spp.; *R. reniformis*; *H. glycines*; *Pratylenchus* spp.; *Tylenchorhynchus* spp., *Merlinius brevidens* (Allen) Siddiqi, *Quinislucius acutus* (Allen) Siddiqi; *Helicotylenchus* spp.; *Scutellonema brachyurus* (Steiner) Andrassy; *Hoplolaimus* spp.; *P. minor*; *Xiphinema* spp.; and *Paratylenchus* spp.

For this survey, population densities per subsample were divided into five ranges: 0 (none), 1-24 (trace), 25-99 (low), 100-499 (moderate), and 500 or more/500 cm³ soil (high) (Table 2). In most cases the nematode infestation densities were within the trace range. Two serious nematode pests of cotton, *Meloidogyne* spp. and *R. reniformis*, were found in ca. 14 and 1% of the samples, respectively, and more than half of the samples containing these nematodes were within the moderate-to-high range. *Helicotylenchus* spp. were found in over 45% of the samples; however, only about 10% of these samples had high numbers. *Pratylenchus* spp. and the group containing *Ty-*

TABLE 3. Cotton fields (number) in Arkansas from which various phytoparasitic nematodes were identified, 1986-88.

	1986	1987	1988	Total	Average
<i>Meloidogyne</i> spp.	11	15	17	43	14.3
<i>Rotylenchulus reniformis</i>	1	1	1	3	1.0
<i>Heterodera glycines</i>	21	22	24	67	22.3
<i>Pratylenchus</i> spp.	41	39	34	114	38.0
<i>P. alleni</i>	11	6	6	23	7.7
<i>P. brachyurus</i>	15	10	18	43	14.3
<i>P. scribneri</i>	13	24	8	45	15.0
<i>P. zaeae</i>	0	1	0	1	0.3
<i>Tylenchorhynchus</i> spp., <i>Merlinius</i>					
<i>brevidens</i> , <i>Quinisulcius acutus</i>	36	39	20	95	31.7
<i>T. ewingi</i>	11	11	7	29	9.7
<i>T. goffarti</i>	12	11	7	30	10.0
<i>T. martini</i>	2	2	0	4	1.3
<i>M. brevidens</i>	0	0	1	1	0.3
<i>Q. acutus</i>	10	22	5	37	12.3
<i>Helicotylenchus</i> spp.	59	49	32	140	46.7
<i>H. dihystera</i>	26	21	12	59	19.7
<i>H. multicinctus</i>	1	0	0	1	0.3
<i>H. pseudorobustus</i>	29	31	16	76	25.3
<i>Scutellonema</i> spp.	2	3	0	5	1.7
<i>S. brachyurus</i>	2	3	0	5	1.7
<i>Hoplolaimus</i> spp.	13	8	5	26	8.7
<i>H. magnistylus</i>	11	5	5	21	7.0
<i>Paratrichodorus</i> spp.	8	20	14	42	14.0
<i>P. minor</i> (<i>P. christiei</i>)	8	20	14	42	14.0
<i>Xiphinema</i> spp.	10	26	22	58	19.3
<i>X. americanum</i>	9	26	22	57	19.0
<i>X. chambersi</i>	1	0	0	1	0.3
<i>Paratylenchus</i> spp.	11	16	6	33	11.0
<i>P. projectus</i>	1	2	0	3	1.0
<i>P. tenuicaudatus</i>	0	2	1	3	1.0
Total fields sampled	103	103	97	303	101.0

tylenchorhynchus spp., *M. brevidens*, and (or) *Q. acutus* were found in ca. 33% of the samples, but high numbers were found in only ca. 1% of the samples. *Heterodera glycines* was found in ca. 22% of the samples; however, only one sample in 3 years contained relatively high numbers. *Paratrichodorus minor*, *Xiphinema* spp., and *Paratylenchus* spp. were found in an average of ca. 10-20% of the fields and only rarely in high numbers. *Hoplolaimus* spp. and *Scutellonema brachyurum* were found in less than 10% of the samples and only in trace-to-low numbers.

During the sampling period the most frequently encountered nematode species on cotton was *Helicotylenchus pseudorobustus* (Steiner) Golden (ca. 25 fields per year) (Table 3). *Xiphinema americanum* Cobb and

H. dihystera (Cobb) Sher were found in ca. 20 fields per year, whereas *Pratylenchus scribneri* Steiner, *P. brachyurus*, and *Paratrichodorus minor* were found in ca. 15 fields per year. *Quinisulcius acutus*, *Tylenchorhynchus goffarti* Sturhan, *T. ewingi* Hopper, *Pratylenchus alleni* V. Ferris, and *Hoplolaimus magnistylus* Robbins were found in an average of 7-10 fields per year. More than 22 cotton fields each year were found infested with Heteroderidae juveniles or males assumed to be *Heterodera glycines*. *Meloidogyne* spp. were found in ca. 14 cotton fields per year. Unidentified species of juvenile *Paratylenchus* spp. were found in ca. 11 fields per year. *Tylenchorhynchus martini* Fielding, *Paratylenchus projectus* Jenkins, and *P. tenuicaudatus* Wu were found in fewer than two fields per year. *Helicotylenchus*

multicinctus (Cobb) Golden, *Merlinius brevidens*, *Pratylenchus zae* Graham, and *Xiphinema chambersi* Thorne were each found once during the survey.

DISCUSSION

In the two decades between 1969 and 1988, the harvested area of cotton was at its highest in 1972 with 570,600 hectares (7) and lowest in 1983 with 117,400 hectares (9). Since the 1983 low, there has been an increase in cotton harvested to an estimated 221,100 hectares (8) in 1988. Some possible causes for the reduction of cotton production below that of the 1972 season include low market prices, increasing production costs, nematode damage, and soybean production in many areas that had historically been in cotton.

Species of phytoparasitic nematodes were found in ca. 80% of the samples collected from cotton over the 3-year period. Although little research information is available concerning the extent of cotton damage induced by many of the species found, it is known that both *Meloidogyne* spp. and *Rotylenchulus reniformis* are capable of causing considerable damage to cotton (6). In this survey, the 3-year average indicated that ca. 15% of the Arkansas cotton fields are infested with some level of these two nematodes (Table 3). An additional consideration in these fields, although not monitored in this survey, is the disease complex potential with the fungus *Fusarium oxysporum* f. sp. *vasinfectum* (Atk.) Snyder & Hans.

Heterodera glycines is present in over 20% of the cotton production area. Even though cotton is not a host for *H. glycines*, its presence is important when a cotton-soybean rotation is being used. The presence of only one high count in 3 years demonstrates the value of cotton in reducing *H. glycines* numbers in a rotation.

Of the nematodes found in the Arkansas cotton survey, *Meloidogyne* spp. is believed to cause the most damage to cotton statewide. *Rotylenchulus reniformis* has the potential to become a serious pest to cotton as well as other crops in Arkansas. *Rotylen-*

chulus reniformis has been found only in very limited hectarage on cotton in Arkansas, but because of its damage potential it will be monitored closely. The damage caused by the other species of nematodes is not known; however, *P. brachyurus*, *H. magnistylus*, and *P. minor* are believed to cause significant yield loss to cotton in Arkansas (Riggs, unpubl.). The single recovery of *Helicotylenchus multicinctus* was probably originally from ornamental banana grown on an old house site that has been reclaimed as farm land.

The continuation of annual monitoring of nematodes in Arkansas cotton fields will help researchers recognize changes in nematodes brought about by changes in cultural practices and allow for the establishment of research priorities for cotton disease investigations.

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