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Results of Annual Phytoparasitic Nematode Surveys of Arkansas Soybean Fields, 1978–1986[1]

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Abstract: Results of surveys from 1978 to 1986 to estimate and identify nematodes in Arkansas soybean fields are presented. The seven most common nematode species in the fields were *Heterodera glycines, Quinisulcius acutus, Pratylenchus scribneri, P. alleni, Helicotylenchus pseudorobustus, Tylenchorhynchus ewingi,* and *Xiphinema americanum.* Other nematodes identified from these fields were *Pratylenchus brachyurus, P. vulnus, P. zeae, Tylenchorhynchus canalis, T. goffarti, T. martini, Helicotylenchus dihystera, Scutellonema bradys, Xiphinema chambersi, X. rivesi, Hoplolaimus galeatus, H. magnistylus, Paratrichodorus minor (P. christiei), Paratylenchus projectus, P. tenuicaudatus, Criconemella macrodora, C. ornata,* and *Meiodorus hollisi.*

Key words: Arkansas, crop loss estimate, *Helicotylenchus pseudorobustus, Heterodera glycines,* infestation estimate, *Pratylenchus alleni, P. scribneri, Quinisulcius acutus,* soybean, *Tylenchorhynchus ewingi, Xiphinema americanum.*

An accurate estimation of crop losses due to phytoparasitic nematodes is difficult to achieve (2). A major difficulty in estimating losses for a large area such as a state is accurately estimating the number of infested hectares and the infestation level of each nematode species. Another difficulty is identifying which nematode species are present and estimating the extent of loss caused by each one.

Annually the Arkansas Agricultural Statistics Service (AASS) estimates the statewide soybean yield by randomly sampling 150 fields. Because of the randomness of the sampling method many different soil types, soil fertility levels, soil moisture levels, soybean varieties, and management systems are involved. In 1978, a joint project was initiated between AASS and the Arkansas Nematode Assay and Diagnostic Lab (ANL). The purpose of the project was to determine the phytoparasitic nematodes present, the proportion of the soybean production area infested, and the levels of infestation (5,7,8).

Materials and Methods

Nematode samples, taken by AASS personnel in late August to early September, consisted of spot soil samples from two prescribed locations in the field (1). Each sample consisted of ca. 475 cm^3 soil taken to a depth of 10–20 cm 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 were extracted from a 236.5-cm^3 (½-pint) subsample removed from each soil sample by the roiling-sieving-Baermann funnel technique (3). The nematodes in each of the two half-pint samples from each field were added together to get the per pint nematode averages for each field. After 7 days incubation on the Baermann funnel the nematodes present were collected, counted, and identified. The first 2 years identification was to general groups of nematodes such as lesion, stunt, spiral, and dagger. Starting in 1980 all phytoparasitic nematodes were identified to species (6–8). The soil sample was also tested for soil fertility by the University of Arkansas Soil Testing Laboratory.

All specific identifications were made from adult specimens at high magnification with a compound light microscope. When moderate to high numbers were present, at least 20 randomly selected specimens of each group were used to make species identifications. When mixtures of species occurred, the number of each species was expressed as a proportion.

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Results

The estimated annual hectares of soybean production in Arkansas from 1978 to 1986 is given in Table 1. The production reached a high of 2,105,000 ha in 1979 and by 1986 had declined to 1,377,000 ha (65.4% of the 1979 production). Also shown in Table 1 are the estimated hectares infested by any phytoparasitic nematodes, soybean cyst, root-knot, lesion, stunt, spiral, dagger, stubby root, pin, lance, ring, and (or) other nematodes. All cyst nematodes recovered from these soybean fields were assumed to be soybean cyst nematode (SCN), *Heterodera glycines.* No attempt was made to identify *Meloidogyne* to species.

The samples containing nematode infestations are broken into four population levels: 1–24 (trace), 25–99 (low), 100–499 (moderate), and 500 or more (high) (Table 2). In nearly all cases the largest number of nematode infestations were at the trace level. The highest percentage (77.7) of SCN infested fields was found in 1979 when the soybean hectarage was highest, whereas the lowest percentage (49.6) was found in 1983 when the soybean hectarage was on the decline. The average annual percentage of hectares infested with SCN was 66.5. Both lesion and stunt nematodes were present in over 40% of the samples for the 9-year period. The averages for spiral, dagger, and pin nematode infestations over the 9-year period were from almost 15% to over 30%. The average occurrence of the other nematode groups was less than 10%.

With the exception of SCN the species found most frequently in soybean fields between 1980 and 1986 were *Quinisulcius acutus,* followed by *Pratylenchus scribneri, Helicotylenchus pseudorobustus, Tylenchorhynchus ewingi, Xiphinema americanum,* and *P. alleni* (Table 3). Although the pin nematode (*Paratylenchus* spp.) was found frequently, identification to species was often impossible because only juveniles were found.

Discussion

Soybean production in Arkansas peaked in 1979. Since that time there has been a

Table 1. The estimated annual hectares of soybean production (thousands) and the hectares infested by several phytoparasitic nematodes in Arkansas from 1978 to 1986.

	Total hectares (× 1,000)		Hectares (× 1,000) for individual nematode groups†										
Year	With soybean	With nematodes	SCN	Root-knot	Lesion	Stunt	Spiral	Dagger	Stubby-root	Pin	Lance	Ring	Other
1978	1,923	1,761	1,465	188	1,102	888	727	512	229	135	121	27	13
1979	2,105	1,937	1,636	152	1,196	711	697	440	318	181	46	0	29
1980	1,943	1,636	1,271	0	894	740	447	140	56	43	84	0	0
1981	1,842	1,669	1,411	15	763	792	359	216	42	87	87	0	0
1982	1,862	1,670	1,123	41	918	918	302	315	28	164	71	0	0
1983	1,579	1,274	783	58	526	772	422	141	93	385	58	12	0
1984	1,640	1,463	872	11	617	663	326	290	57	313	82	0	0
1985	1,518	1,371	1,053	23	635	792	373	203	124	396	79	11	0
1986	1,377	1,086	739	134	576	472	154	92	41	277	21	0	0

† SCN = Soybean cyst nematode, *Heterodera glycines.* Root-knot = *Meloidogyne* spp. Lesion = *Pratylenchus* spp. Stunt—includes *Tylenchorhynchus* spp. and *Quinisulcius* spp. Spiral—includes *Helicotylenchus* spp. and *Scutellonema* spp. Dagger = *Xiphinema* spp. Stubby-root = *Paratrichodorus* spp. Pin = Paratylenchinae. Lance = *Hoplolaimus* spp. Ring = Criconematidae. Others = *Hirschmanniella* sp. in 1978, *Hirschmanniella* sp. and *Meiodorus hollisi* in 1979.

TABLE 2. Percentage of samples with various nematodes falling within different population ranges.

Nematode and year sample taken	Number of fields sampled	Total % with nematodes	Population ranges			
			1–24	25—99	100–499	≥ 500
SCN						
1978	143	76.2	26.6	12.6	16.8	20.3
1979	139	77.7	30.2	9.4	14.4	23.7
1980	139	65.5	30.2	12.9	13.7	8.6
1981	128	76.6	42.2	12.5	7.8	14.1
1982	136	60.3	31.6	9.6	6.6	12.5
1983	135	49.6	29.6	8.1	6.7	5.2
1984	141	69.5	33.3	7.8	9.2	18.4
1985	134	69.4	23.9	6.0	22.4	17.2
1986	134	53.7	22.4	9.4	10.4	11.2
Mean		66.5	29.9	9.8	12.0	14.6
Lesion						
1978	143	57.3	22.3	11.2	14.7	9.1
1979	139	56.8	23.0	10.8	17.3	5.8
1980	139	46.0	27.3	7.2	7.9	3.6
1981	128	41.4	21.9	7.0	7.8	4.6
1982	136	49.3	16.9	8.8	15.4	8.1
1983	135	33.3	21.5	6.7	4.4	0.7
1984	141	37.5	18.4	7.8	9.9	1.4
1985	134	41.8	17.9	9.7	11.2	3.0
1986	134	41.8	21.6	8.2	6.0	6.0
Mean		45.1	21.2	8.6	10.6	4.7
Stunt						
1978	143	46.2	17.5	7.7	11.9	9.9
1979	139	33.8	13.7	7.9	8.6	3.6
1980	139	38.1	12.2	8.6	11.5	5.8
1981	128	43.0	16.4	7.0	8.6	10.9
1982	136	50.0	21.3	11.0	8.8	8.8
1983	135	48.9	23.0	11.1	11.9	3.0
1984	141	40.4	20.6	2.1	12.8	5.0
1985	134	52.2	26.9	9.7	6.7	9.0
1986	134	34.3	17.9	6.7	6.0	3.7
Mean		43.0	18.8	8.0	9.7	7.1
Spiral						
1978	143	36.4	21.7	8.4	5.6	0.7
1979	139	33.1	25.9	4.3	2.9	0
1980	139	23.0	15.1	4.3	2.9	0.7
1981	128	18.8	10.9	6.3	1.6	0
1982	136	16.2	8.8	2.9	2.2	2.2
1983	135	26.7	22.2	3.7	0.7	0
1984	141	19.1	13.5	21.0	4.3	0
1985	134	24.6	19.4	1.5	2.2	1.5
1986	134	11.2	10.4	0.7	0	0
Mean		23.4	16.5	3.8	2.3	0.6
Dagger						
1978	143	26.6	14.0	7.0	2.8	2.8
1979	139	20.1	12.2	3.6	3.6	0.7
1980	139	7.2	5.8	0.7	0.7	0
1981	128	11.7	10.2	0	1.6	0
1982	136	16.9	12.5	2.9	1.5	0
1983	135	8.9	8.1	0.7	0	0
1984	141	17.7	14.2	1.4	0.7	1.4
1985	134	24.6	19.4	1.5	2.2	1.5

TABLE 2. Continued.

Nematode and year sample taken	Number of fields sampled	Total % with nematodes	Population ranges			
			1–24	25—99	100–499	≥ 500
1986	134	6.7	5.2	0	1.5	0
Mean		15.7	11.3	2.0	1.6	0.7
Pin						
1978	143	7.0	7.0	0	0	0
1979	139	8.6	6.5	0.7	0.7	0.7
1980	139	2.2	1.4	0.7	0	0
1981	128	4.7	3.9	0	0.8	0
1982	136	8.8	5.1	2.9	0.7	0
1983	135	24.4	11.1	10.4	3.0	0
1984	141	19.1	10.6	2.8	5.7	0
1985	134	26.1	21.6	2.2	0.7	1.5
1986	134	20.1	12.7	4.5	3.0	0
Mean		13.4	8.9	2.7	1.6	0.2
Stubby-root						
1978	143	11.9	4.9	2.1	4.2	0.7
1979	139	5.1	4.3	2.9	6.5	1.4
1980	139	2.9	2.9	0	0	0
1981	128	2.3	0.8	0.8	0.8	0
1982	136	1.5	0.7	0.7	0	0
1983	135	5.9	3.7	0.7	0.7	0.7
1984	141	3.5	1.4	0.7	0.7	0.7
1985	134	8.2	3.7	1.5	1.5	1.5
1986	134	3.0	1.5	0.7	0.7	0
Mean		6.1	2.7	1.2	1.7	0.6
Lance						
1978	143	6.3	6.3	0	0	0
1979	139	2.2	2.2	0	0	0
1980	139	4.3	3.6	0.7	0	0
1981	128	4.7	3.9	0.8	0	0
1982	136	3.7	2.9	0.7	0	0
1983	135	3.7	3.7	0	0	0
1984	141	5.0	3.5	1.4	0	0
1985	134	5.2	4.5	0	0.7	0
1986	134	1.5	1.5	0	0	0
Mean		3.7	3.6	0.4	0.1	0
Root-knot						
1978	143	10.0	4.9	1.4	3.5	0
1979	139	7.2	3.6	2.2	0.7	0.7
1980	139	0	0	0	0	0
1981	128	0.7	0	0	0.7	0
1982	136	2.2	0.7	1.5	0	0
1983	135	3.7	3.7	0	0	0
1984	141	0	0	0	0	0
1985	134	1.5	0.7	0.7	0	0
1986	134	3.7	1.5	0.7	1.5	0
Mean		3.2	1.7	0.8	0.7	0.1

steady reduction in soybean production in the state. The hectares infested with SCN coincides with the reduction. In the late 1970s and early 1980s the price of land and soybeans was higher than now. During the period of high soybean prices, much land marginal for soybeans was placed into production. Factors that contributed to the

TABLE 3. Annual number of fields from which various phytoparasitic nematodes were identified from 1980 to 1986.

Nematode	Number of fields†						
	1980	1981	1982	1983	1984	1985	1986
Lesion (*Pratylenchus* spp.)‡	64	53	67	45	53	56	56
P. alleni	9	9	19	8	19	12	6
P. brachyurus	4	6	1	2	2	4	3
P. scribneri	29	33	41	28	33	39	37
P. vulnus	0	1	0	0	0	0	0
P. zeae	7	5	20	5	1	8	13
Stunt (*Quinisulcius* spp., *Tylenchorhynchus* spp.)‡	53	55	68	66	57	70	46
Q. acutus	32	37	41	54	43	52	33
T. canalis	0	0	0	0	0	1	0
T. ewingi	15	13	22	15	14	25	4
T. goffarti	1	0	0	0	0	0	2
T. martini	8	8	7	6	4	2	8
Spiral (*Helicotylenchus* spp., *Scutellonema* spp.)‡	32	24	22	36	28	33	15
H. dihystera	2	6	0	6	2	6	1
H. pseudorobustus	14	14	20	28	21	22	13
S. bradys	0	1	0	0	0	0	0
Dagger (*Xiphinema* spp.)‡	10	15	23	12	25	33	9
X. americanum	10	15	22	12	21	17	9
X. chambersi	0	0	1	0	1	0	0
X. rivesi	0	0	0	0	1	1	0
Lance (*Hoplolaimus* spp.)‡	6	6	5	5	7	7	2
H. galeatus	0	0	0	1	0	0	0
H. magnistylus	3	3	3	2	4	7	1
Stubby-root (*Paratrichodorus* spp.)‡	4	3	2	8	5	11	4
P. minor (*P. christiei*)	4	3	2	8	5	11	4
Pin (*Paratylenchus* spp.)‡	3	6	12	33	27	35	27
P. projectus	1	0	2	3	3	2	1
P. tenuicaudatus	0	0	2	0	7	9	7
Ring (*Criconemella* spp.)‡	0	0	0	1	0	1	0
C. macrodora	0	0	0	1	0	0	0
C. ornata	0	0	0	0	0	1	0
Total fields sampled	139	128	136	135	141	134	134

† *Hirschmanella* sp., *Meiodorus hollisi,* and *X. chambersi* were each identified from single fields in 1979. Identifications to species in 1979 were limited.

‡ Total includes fields with multiple species and fields from which only the genus could be identified.

marginality of the land for soybean production were low fertility, poor drainage and flooding, low water holding capacity, and infestation with disease inducing organisms. When marginal land was infested with SCN it soon became unproductive and was often diverted to more profitable uses.

Phytoparasitic nematodes were found in 88% of the samples over the 9-year period. Most samples (55–60%) were found to either lack or have only a trace (1–24) of nematodes present. About 20–25% of the samples had low to moderate (25–499) numbers of nematodes present. If we assume that the infestation level of a nematode species is a good indicator of potential yield loss, with lower numbers causing less damage than higher numbers, then only about 20 to 25% of the fields had levels of nematodes considered to cause significant loss in yield.

Of the nematodes found in the Arkansas survey, SCN causes the greatest damage to soybean statewide, whereas root-knot nematode causes the most damage on an infested field basis (4). Little is known about

the amount of damage caused to soybean by the other species of nematodes. Of the lesion nematodes, *Pratylenchus scribneri, P. alleni,* and *P. brachyurus* were found most often; they probably rank below root-knot nematode and above the other nematode groups in amount of damage caused on an infested field basis to soybean. The single recovery of *P. vulnus* was probably from an old nursery or orchard. The stunt nematodes *Quinisulcius acutus, Tylenchorhynchus ewingi,* and *T. martini* were also recovered frequently. These species, along with the lesion nematodes, will be studied further to determine whether they affect soybean yield. The spiral nematodes and *Xiphinema americanum* are rarely found in high numbers on soybean in Arkansas. The presence of *X. americanum* appears to be related to tillage practices, and this species may become a problem if more growers use minimum tillage. The continuation of annual monitoring of nematodes in Arkansas soybean fields will help researchers quickly recognize changes in nematodes brought about by changes of production practices.

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