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Nematode Densities Associated with Corn and Sorghum Cropping Systems in Florida[1]

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Abstract: Final densities (Pf) of *Meloidogyne incognita* and *Pratylenchus* spp. increased more than ten-fold over initial densities (Pi) on corn (*Zea mays*) cultivars grown at three sites in north Florida. The Pf of *M. incognita* following sorghum (*Sorghum bicolor*) were much lower ($P \leq 0.001$) than Pf following corn at the two sites in which sorghum was grown. At one of these sites, Pf of *M. incognita* was $\leq 5/100$ cm^3 soil, and at the other site Pf < Pi. At one site, population densities of *Criconemella sphaerocephala* increased to higher levels on sorghum than on corn, but Pf of *Pratylenchus* spp. were greater ($P \leq 0.01$) on corn. Few differences in nematode densities were observed among the different corn cultivars tested.

Key words: corn, *Criconemella ornata, Criconemella sphaerocephala,* cropping system, double cropping, *Glycine max, Meloidogyne incognita,* nematode, *Paratrichodorus minor,* population density, *Pratylenchus brachyurus, Pratylenchus scribneri, Sorghum bicolor,* soybean, *Zea mays.*

Several plant-parasitic nematodes, particularly root-knot nematodes (*Meloidogyne* spp.), are serious and endemic problems on many crops grown in the southeastern United States (11). Therefore, it is imperative that we learn the effects of different cropping systems on the population densities of these plant-parasitic nematodes (9). Tropical cultivars of corn (*Zea mays* L.) and sorghum (*Sorghum bicolor* (L.) Moench) are important grain and forage crops adapted to cropping systems in this region (4). In north Florida, for example, corn and sorghum are grown as summer crops, with vetch (*Vicia villosa* Roth.) or rye (*Secale cereale* L.) as winter cover crops (3,6). The following studies compare the increases in nematode population densities on corn cultivars in two tests in north Florida, and in two other tests, compare the densities on corn with those on sorghum or with those on sorghum and soybean (*Glycine max* (L.) Merr.).

Materials and Methods

During the summer of 1990, experiments were conducted at three University of Florida research farms in north Florida: the Green Acres Agronomy Research Farm and the Dairy Research Unit in Alachua County, and the Pine Acres Research Farm in Marion County. Soils at the three locations were Arredondo sand (94% sand, 3.5% silt, 2.5% clay; pH 6.7; 2.0% organic matter), Scranton fine sand (90% sand, 3.5% silt, 6.5% clay; pH 6.8; 4.3% organic matter), and Arredondo sand–Gainesville loamy sand association (92% sand, 3% silt, 5% clay; pH 5.6; 2.8% organic matter) for the Green Acres Agronomy Research Farm, Dairy Research Unit, and Pine Acres Research Farm, respectively.

Green Acres Agronomy Research Farm: Plots at this site had been maintained for 14 years as part of a no-tillage double-cropping fertility study involving soybean during summer and rye (cv. Wrens Abruzzi) during the winter. In the spring of the 15th year, a summer crop rotation experiment in a randomized complete block experimental design with five summer crop treatments and five replications was initiated. Treatments consisted of the tropical corn hybrid Pioneer X304C harvested for grain, Pioneer X304C used as silage, forage sorghum DeKalb FS25E, grain sorghum DeKalb BR64, and Centennial soybean. Individual plots (15 m^2) consisted of four rows 5 m long and spaced 75 cm apart.

Plots were planted on 20 May with an in-row subsoil minimum-tillage planter. Corn was planted at 80,000 seeds/ha, sor-

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ghum at 250,000 seeds/ha, and soybean at 515,000 seeds/ha. Fertilizer was applied for each crop based on soil test and extension recommendations. Atrazine (1.3 kg a.i./ha) plus metolachlor (1.1 kg a.i./ha) were applied preemergence for corn, and metolachlor (1.1 kg a.i./ha) plus metribuzin (0.42 kg a.i./ha) for soybean. Paraquat with X77 nonionic surfactant was applied preemergence at 0.32 kg a.i./ha over all crops to kill existing weeds and postemergence at 0.16 kg a.i./ha to soybean. Atrazine (2.2 kg a.i./ha) with crop oil was applied postemergence over the top of sorghum. An 18-cm band of carbofuran at 2.2 kg a.i./ha was applied over the row of all crops at planting for management of lesser cornstalk borer, *Elasmopalpus lignosellus* (Zeller). Methomyl (0.50 kg a.i./ha) was applied postemergence over corn and sorghum once and three times for soybean. Overhead sprinklers provided at least 2.5 cm of water per week when rainfall was insufficient.

Plots were sampled for initial (Pi) and final (Pf) nematode densities on 6 June and 12 September, respectively. Each soil sample consisted of six cores 2.5 cm d × 20 cm deep collected within plant rows in a systematic pattern. From this, a 100-cm^3 subsample was removed for nematode extraction with a modified sieving and centrifugation procedure (5). Nematode count data were log-transformed ($\log_{10} [x + 1]$) before analysis of variance, and single degree of freedom orthogonal contrasts (2,13) were determined for corn vs. soybean, sorghum vs. soybean, and corn vs. sorghum.

Pine Acres Research Farm: Individual plots at this location consisted of 24 rows 90 m long spaced 75 cm apart (1,620 m^2). On 2 May, under conventional tillage management, four replications were planted at 64,000 seeds/ha of each of the four corn cultivars: temperate hybrids Pioneer 3320 and Northrup King 508; tropical hybrid Pioneer X304C; and experimental open pollinated tropical cultivar, Florida SYN-1. Atrazine (1.3 kg a.i./ha) and metolachlor (2.2 kg a.i./ha) were applied preemergence, and the field was also cultivated one time. An 18-cm band of carbofuran at 2.2 kg a.i./ha was applied over the row of all cultivars at planting to suppress lesser cornstalk borer. All crops received one postemergence application of methomyl (0.50 kg a.i./ha). Fertilizer was applied based on a soil test and extension recommendations. Irrigation was by low-pressure center pivot.

Plots were harvested on 10 July by cutting and removing all above-ground material for silage. The same cultivars were then replanted in the plots on 20 July with minimum tillage into the previous crop stubble. Rates of herbicides and insecticides applied to this second planting were the same as for the first, except that methomyl was applied three times and paraquat (0.16 kg a.i./ha) with X77 surfactant was applied preemergence. The entire aboveground crop was harvested for silage in late October.

Nematode samples were collected from the first corn crop on 17 April (Pi) and 18 July (Pf). The latter sample also served as the initial sample (Pi) for the second crop. A final sample was collected from the second crop on 22 October (Pf). Nematode sampling and extraction were similar to that described, except that 12 cores were collected per plot, because of the larger plot size.

Dairy Research Unit: A spring crop of corn for silage was harvested from this site on 5 July. Because the field was heavily infested with johnsongrass (*Sorghum halepense* (L.) Pers.), it was first treated with glyphosate at 1.1 kg a.i./ha. Plots (1,575 m^2) consisted of 30 rows, 70 m long spaced 75 cm apart, and were planted without tillage on 21 July with tropical corn hybrids Pioneer X304C and DeKalb XL678C, Florida SNY-1, and sorghum hybrid FS25E. There were four replications of each cultivar. A corn population of only about 25,000 plants/ha resulted from poor planter operation; however, a sorghum population of approximately 250,000 plants/ha was achieved. Atrazine (1.3 kg a.i./ha) and carbofuran (2.2 kg a.i./ha) were applied preemergence, and the crops

TABLE 1. Initial (Pi) and final (Pf) nematode densities on corn, sorghum, and soybean crops at the Green Acres Agronomy Research Farm, 1990.

		Nematodes/100 cm^3 soil							
		Criconemella spp.		*Meloidogyne incognita*		*Paratrichodorus minor*		*Pratylenchus* spp.	
Crop	Cultivar	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf
Corn (silage)	Pioneer X304C	0	14	4	189	4	14	8	337
Corn (grain)	Pioneer X304C	2	77	1	114	7	5	6	172
Sorghum (forage)	DeKalb FS25E	1	141	1	5	17	15	10	132
Sorghum (grain)	DeKalb BR64	1	314	1	2	9	3	10	112
Soybean	Centennial	15	67	0	69	6	6	4	108
Contrasts:									
Corn vs. soybean		***	NS	NS	NS	NS	NS	NS	**
Sorghum vs. soybean		***	NS	NS	*	NS	NS	NS	NS
Corn vs. sorghum		NS	*	NS	***	NS	NS	NS	**

Data are means of five replications. *, **, *** indicate single degree of freedom orthogonal contrasts significant at $P \le 0.05$, $P \le 0.01$, and $P \le 0.001$, respectively; NS = contrast not significant at $P \le 0.05$.

were treated twice with methomyl at 0.50 kg a.i./ha each time. Fertilizer applications were based on a soil test and extension recommendations. Irrigation was not possible for the first 45 days at this location. However, low-pressure center pivot irrigation was used as needed from about 45 days after planting until crops matured. Silage was harvested in early November.

Soil samples for nematode analysis were collected on 7 August (Pi) and 24 October (Pf). On the latter date, patches of johnsongrass in the field were avoided, but Florida purslane, *Richardia scabra* St. Hil., was abundant in two replications and could not be avoided. Assay procedures for nematode identification and counting were identical to those at the two other locations.

RESULTS

Green Acres Agronomy Research Farm: Densities of *Criconemella* spp. (= *Macroposthonia* spp.) were greater in the soybean plots initially, but Pf (a mixture of 84% *C. sphaerocephala* (Taylor) Luc & Raski and 16% *C. ornata* (Raski) Luc & Raski) were different ($P \le 0.05$) only between corn and sorghum (Table 1). Final densities of *Meloidogyne incognita* (Kofoid & White) Chitwood were much lower on the sorghum cultivars than on the other two crops (Table 1). The Pf of *Pratylenchus* spp. (Pf a mixture of 55% *P. brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven and 45% *P. scribneri* Steiner) were greater ($P \le 0.01$) in corn plots than in sorghum plots (Table 1). There were no differences among crops in the population densities of *Paratrichodorus minor* (Colbran) Siddiqi. Because *Helicotylenchus dihystera* (Cobb) Sher occurred in only one replication and population densities of *Xiphinema* spp. were low throughout the field, data on these genera are not presented.

Pine Acres Research Farm: Densities of *M. incognita, Paratrichodorus minor,* and *Pratylenchus scribneri* increased more than tenfold on all cultivars during the first planting (Table 2). Densities of *M. incognita, P. scribneri,* and *Criconemella* spp. (*C. sphaerocephala* and *C. ornata*) remained high ($\ge$ 288/100 cm^3 soil) following the second planting. Although Pf of *M. incognita* on Pioneer 3320 differed ($P \le 0.05$) from Pf on the other cultivars after the first planting, in general few differences in nematode densities with cultivar were noted.

Dairy Research Unit: High Pf of *C. sphaerocephala* ($\ge$ 362/100 cm^3 soil), of *M. incognita* ($\ge$ 884/100 cm^3) and of *P. scribneri* ($\ge$ 508/100 cm^3) were observed on three corn cultivars at this site (Table 3). Except with *Paratrichodorus minor,* no differences ($P \le 0.05$) in nematode Pf among the three corn cultivars were noted. The Pf of *M. incognita*

TABLE 2. Initial (Pi) and final (Pf) nematode densities on four corn cultivars in two successive plantings at the Pine Acres Research Farm, 1990.

	Nematodes/100 cm^3 soil											
	Criconemella spp.			*Meloidogyne incognita*			*Paratrichodorus minor*			*Pratylenchus scribneri*		
Cultivar	Pi	Pf	Pf2†	Pi	Pf	Pf2†	Pi	Pf	Pf2†	Pi	Pf	Pf2†
Pioneer X304C	631 b	748 a	1,947 a	3 a	658 a	364 a	0 b	22 a	12 a	13 a	282 a	687 a
Florida SYN-1	1,064 a	1,492 a	1,135 a	2 a	498 a	538 a	1 b	34 a	16 a	14 a	147 a	1,016 a
Northrup King 508	1,063 a	2,629 a	1,320 a	5 a	533 a	288 a	0 b	48 a	30 a	8 a	152 a	436 a
Pioneer 3320	983 a	1,302 a	2,182 a	9 a	258 b	393 a	2 a	24 a	36 a	16 a	160 a	584 a

Data are means of four replications. Means in columns followed by the same letter are not different ($P \leq 0.05$) according to Duncan's multiple-range test.
† Pf2 = final population density in the second planting. The initial population density in the second planting is Pf from the first planting.

on DeKalb FS25E sorghum was much lower ($P \leq 0.001$) than Pf on the corn cultivars.

DISCUSSION

Densities of *Criconemella* spp., *M. incognita,* and *Pratylenchus* spp. increased greatly on most crops and cultivars at the three locations. The Pf of *M. incognita* was high following all of the corn cultivars, increasing more than ten-fold over Pi at all three locations, despite differences in cultivars, planting dates, cultural practices, and plot designs. The low rate of carbofuran used for control of lesser cornstalk borer did not prevent these large increases in nematode population densities. At one site, the Pf of *M. incognita* on corn did not differ ($P \leq 0.05$) from that on soybean, usually a highly susceptible host (12), although Centennial, the soybean cultivar used here, has some resistance to *M. incognita* (1). In contrast to observations on the corn cultivars, Pf of *M. incognita* remained relatively low following sorghum. Certain sorghum cultivars are not susceptible to *Meloidogyne* spp. (8), and the lower Pf after sorghum than after corn is consistent with previous observations (3).

When management of *M. incognita* is the primary concern, sorghum may be a better choice than corn as a forage crop in a cropping system. However, if *M. incognita* build-up is not of particular concern, then trop-

TABLE 3. Initial (Pi) and final (Pf) nematode densities on four corn and sorghum cultivars at the Dairy Research Unit, 1990.

		Nematodes/100 cm^3 soil							
		Criconemella sphaerocephala		*Meloidogyne incognita*		*Paratrichodorus minor*		*Pratylenchus scribneri*	
Crop	Cultivar	Pi	Pf	Pi	Pf	Pi	Pf	Pi	Pf
Corn	Pioneer X304C	450	820	128	1,872	27	66	112	1,050
Corn	Florida SYN-1	395	362	42	950	42	36	44	508
Corn	DeKalb XL678C	836	900	93	884	27	11	105	620
Sorghum	DeKalb FS25E	405	855	60	34	46	24	60	343
Contrasts:									
Corn vs. sorghum		NS	NS	NS	***	NS	NS†	NS	NS

Data are means of four replications. *** indicates single degree of freedom orthogonal contrast significant at $P \leq 0.001$; NS = contrast not significant at $P \leq 0.05$.
† For *P. minor* the contrasts of Pioneer X304C vs. DeKalb XL678C and of Florida SYN-1 vs. DeKalb XL678C were significant at $P \leq 0.001$ and $P \leq 0.01$, respectively. The contrast of Pioneer X304C vs. Florida SYN-1 was not significant at $P \leq 0.05$.

ical corn cultivars such as Pioneer X304C provide better quality feed than sorghum (4). If corn is used for silage or grain, any of the corn cultivars tested could be selected, because few differences in nematode densities occurred. The tropical corn Pioneer X304C may be preferable for north Florida because of its tolerance of insects and diseases (4). Damage to this and other corn cultivars can occur if initial densities of certain nematode species are high (7,10); therefore, efforts must continue to identify and develop corn cultivars with resistance or tolerance to plant-parasitic nematodes.

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