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Nematode Population Changes and Forage Yields of Six Corn and Sorghum Cultivars[1]

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Abstract: Two temperate corn (*Zea mays*) hybrids (Pioneer 3320 and Northrup King 508), two tropical corn cultivars (Pioneer X304C hybrid and Florida SYN-1 experimental open pollinated cultivar), the sorghum (*Sorghum bicolor*) × sudangrass (*Sorghum sudanense*) hybrid DeKalb SX-17, and the sorghum hybrid DeKalb FS25E were compared for effect on nematode densities and forage yield in three plantings (one single-crop and one double-crop system) in Florida. Final population densities of *Meloidogyne incognita* in the three plantings ranged from 0 to 13/100 cm^3 soil on the two *Sorghum* spp. and were lower ($P \leq 0.001$) than those obtained on the corn cultivars (range 147 to 762/100 cm^3 soil). Early planted temperate corn and sorghum generally gave higher forage yields than did tropical corn. As second crops in double-cropping systems, tropical corn cultivars generally produced greater yields than temperate corn hybrids did. At 35% dry matter, double crop forage corn yield ranged from 51.1 to 64.8 ton/ha, and sorghum ranged from 79.8 to 102.2 ton/ha. Tropical corn, forage sorghum, and sorghum-sudangrass were profitably grown at all planting dates. Late summer planting of temperate corn was unprofitable. DeKalb SX-17 sorghum × sudangrass first crop plus the ratoon double crop gave the highest net return of $1,133/ha. Among the corn cultivars, Florida SYN-1 gave the highest double crop net return of $652/ha.

Key words: corn, *Criconemella ornata, Criconemella sphaerocephala,* cropping systems, double cropping, *Meloidogyne incognita,* nematode, *Paratrichodorus minor, Pratylenchus scribneri, Sorghum bicolor,* sorghum-sudangrass, *Zea mays.*

The 12-month growing season in Florida and other southeastern states allows year-round forage production (2). Because of their tolerance to insects and diseases, tropical corn (*Zea mays* L.) hybrids are adaptable to cropping systems in the southeastern United States and may provide a better quality forage than sorghum (*Sorghum bicolor* (L.) Moench) (4). In selecting candidate crops for a cropping system, the potential of an individual crop to increase populations of damaging plant-parasitic nematodes should be determined (9). For example, the tropical corn hybrid Pioneer X304C can be severely damaged by *Belonolaimus longicaudatus* Rau (6). In cropping systems, both corn and sorghum can increase populations of several nematode species (3,6,8); however, the potential of sorghum for maintaining low population densities of *Meloidogyne* spp. may be a useful feature in some cropping systems (3,7). The objective of the current study was to compare the nematode buildup and forage yields of several selected corn and sorghum cultivars useful as spring and summer crops in north and central Florida.

Materials and Methods

All experiments were conducted in two adjacent fields at the University of Florida Pine Acres Research Farm in Marion County, Florida, during the summer of 1990. During 1989, the west field was planted with the sorghum cultivar Northrup King 300 and the east field with the corn cultivar Northrup King 508. Both fields received a forage crop of Wrens Abruzzi rye (*Secale cereale* L.) during the winter of 1989–90. The soil type was an Arredondo sand–Gainesville loamy sand association (92% sand, 3% silt, 5% clay; pH 5.6; 2.8% organic matter).

In all experiments, the design was a randomized complete block with six treatments and eight replications. The four-row plots were 75 cm wide and 9 m long. Treatments consisted of four corn cultivars (two temperate hybrids, Pioneer 3320 and Northrup King 508; and two tropical hybrids, Pioneer X304C and an experimental open pollinated synthetic, Florida SYN-1),

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the sorghum x sudangrass (*S. sudanense* (Piper) Stapf) hybrid Dekalb SX-17, and the sorghum hybrid DeKalb FS25E.

Plots in the west field were planted on 2 April 1990 under conventional tillage management. These plots were harvested for forage in early June. For double cropping, corn cultivars were planted with a no-tillage planter on 20 July into the corn stubble of the same plots they occupied previously. Sorghum and sorghum × sudangrass were allowed to ratoon for the second crop. The July-planted corn and ratoon crops were harvested in early November. Plots in the east field were planted on 20 May 1990 and harvested in late August. All crops were treated with 1.7 kg a.i./ha of carbofuran at planting for control of lesser cornstalk borer (*Elasmopalpus lignosellus* Zeller). Fertilizer was applied based on soil test and extension recommendations. Irrigation was by low-pressure center pivot irrigation. Weed control on 2 April and 20 May was by use of both cultivation and preemergence applications of atrazine (1.3 kg a.i./ha) and metolachlor (2.2 kg a.i./ha). In addition to the above herbicides, a preemergence application of paraquat (0.16 kg a.i./ha) was used in the 20 July planting. Harvests were taken from the middle two rows from each plot and dried at 70 C to determine dry matter. Forage yields were adjusted to 35% dry matter.

Soil samples for nematode analysis were collected by removing and compositing six cores 2.5 cm d × 20 cm long. Sampling dates for plots in the west field were 17 April, 18 July, and 22 October. The sample collected on 18 July provided both the final nematode population (Pf) from the first planting and the initial population (Pi) for the second planting. Sampling dates for plots in the east field were 5 June and 30 August. Nematodes were extracted from 100-cm^3 soil subsamples with a modified sieving and centrifugation procedure (5).

Yield and nematode data were subjected to analysis of variance, and, where significant ($P \leq 0.05$), differences among means were examined by Duncan's multiple-range test. Nematode data were log-transformed ($\log_{10}[x + 1]$) before analyses. For nematode population density data, single degree of freedom orthogonal contrasts between the corn cultivars and the sorghums were also determined (1,11). Economic evaluations were based on the cost of all inputs, including both variable and fixed costs. Variable cost was applied only to the 2 May planting and not to the succeeding crop planted 20 July in the double-cropping system. Both variable and fixed costs were applied to the 20 May planting in the east field. Value of forage was based on average market prices growers received in Florida in 1990. The difference between cost and return was net return.

Results

Plant-parasitic nematodes in the experimental plots included *Meloidogyne incognita* (Kofoid and White) Chitwood, *Paratrichodorus minor* (Colbran) Siddiqi, *Pratylenchus scribneri* Steiner, and *Criconemella* spp. (= *Macroposthonia* spp.). The latter consisted of a mixture of 84% *C. sphaerocephala* (Taylor) Luc and Raski and 16% *C. ornata* (Raski) Luc and Raski. *Helicotylenchus dihystera* (Cobb) Sher, *Xiphinema* spp., and *Hoplolaimus* spp. were found only occasionally and were not included in the analyses.

Criconemella spp. were more abundant initially in the west field, which had been planted to sorghum the previous season, than in the east field (Table 1). Population increase was lower (all Pf/Pi $\leq$ 1.94) in the west field, where Pi values were higher than in the east field. Although some mean separations in *Criconemella* spp. numbers were observed in the first crop planted in the west field, these trends were not observed in the other two plantings. No differences ($P \leq 0.05$) in *Criconemella* spp. numbers were observed between the corn cultivars and the *Sorghum* spp.

Although initial population densities of *M. incognita* in both fields were low, they increased greatly following corn crops (Table 1). Population densities of *M. incognita* decreased on the second corn crop in the west field from the high densities present

TABLE 1. Final nematode densities on corn and sorghum cultivars in three plantings in Marion County, Florida, in 1990.

Crop	Cultivar	West field, first crop Pf	West field, first crop Pf/Pi	West field, second crop Pf	West field, second crop Pf/Pi	East field Pf	East field Pf/Pi
			Criconemella spp.				
Corn	Pioneer 3320	608 c	0.45	1,182 a	1.94	508 a	1.93
Corn	Northrup King 508	1,047 bc	0.78	1,155 a	1.10	682 a	2.59
Corn	Pioneer X304C	1,002 bc	0.75	637 a	0.64	518 a	1.97
Corn	Florida SYN-1	1,363 ab	1.02	1,292 a	0.95	586 a	2.22
Sorghum	DeKalb SX-17	830 bc	0.62	599 a	0.72	647 a	2.46
Sorghum	DeKalb FS25E	1,799 a	1.34	1,480 a	0.82	894 a	3.40
Corn vs. sorghum:†		NS		NS		NS	
Initial population (Pi):‡		1,341 ± 119		Pf, first crop		263 ± 41.5	
			Meloidogyne incognita				
Corn	Pioneer 3320	437 a	34.98	191 a	0.44	375 a	300.0
Corn	Northrup King 508	409 a	32.72	162 a	0.40	147 a	117.8
Corn	Pioneer X304C	762 a	60.96	234 a	0.31	437 a	350.0
Corn	Florida SYN-1	654 a	52.30	249 a	0.38	306 a	245.0
Sorghum	DeKalb SX-17	6 b	0.44	0 b	0	4 b	2.8
Sorghum	DeKalb FS25E	10 b	0.76	5 b	0.55	13 b	10.6
Corn vs. sorghum:†		*		*		*	
Initial population (Pi):‡		12 ± 2.2		Pf, first crop		1.2 ± 0.62	
			Paratrichodorus minor				
Corn	Pioneer 3320	11 b	11.2	18 a	1.61	22 a	7.33
Corn	Northrup King 508	43 a	43.0	16 a	0.37	22 a	7.40
Corn	Pioneer X304C	18 b	17.5	11 a	0.64	16 a	5.33
Corn	Florida SYN-1	16 b	16.2	19 a	0.17	22 a	7.33
Sorghum	DeKalb SX-17	59 a	58.8	6 a	0.10	36 a	12.00
Sorghum	DeKalb FS25E	44 a	43.8	8 a	0.19	22 a	7.50
Corn vs. sorghum:†		*		NS		NS	
Initial population (Pi):‡		1.0 ± 0.40		Pf, first crop		3.0 ± 0.80	
			Pratylenchus scribneri				
Corn	Pioneer 3320	28 c	1.12	255 a	8.95	952 a	24.05
Corn	Northrup King 508	74 ab	2.88	332 a	4.52	907 a	22.90
Corn	Pioneer X304C	104 ab	4.08	411 a	3.95	1,102 a	27.82
Corn	Florida SYN-1	62 b	2.45	600 a	9.60	998 a	25.20
Sorghum	DeKalb SX-17	166 a	6.50	400 a	2.41	120 b	3.02
Sorghum	DeKalb FS25E	190 ab	7.44	270 a	1.42	204 b	5.15
Corn vs. sorghum:†		*		NS		*	
Initial population (Pi):‡		26 ± 2.1		Pf, first crop		40 ± 10.3	

Data are means of eight replications. For each nematode genus, means in columns followed by the same letter do not differ ($P \leq 0.05$) according to Duncan's multiple-range test. Pf = final nematode population per 100 cm^3 soil.

† Orthogonal contrast of corn vs. sorghum significant at $P \leq 0.001$ (*) or not significant at $P \leq 0.05$ (NS).

‡ Mean initial population per 100 cm^3 soil ± standard error. For the second crop in the west field, Pi is Pf from the first crop.

at the beginning of that planting. In all three plantings, *M. incognita* populations on the sorghums were much lower ($P \leq 0.001$) than those on the corn cultivars.

Densities of *P. minor* were higher ($P \leq 0.001$) on the sorghum cultivars than on corn following the first crop in the west field (Table 1). No differences ($P \leq 0.05$) were observed in subsequent plantings. Trends in *P. scribneri* Pf were inconsistent (Table 1). Following the first crop in the west field, higher Pf were observed on sorghum than on corn, but the reverse was true in the east field.

In the west field, early-planted temperate corn, sorghum x sudangrass, and sorghum generally gave higher forage yields than did tropical corn (Table 2). Tropical corn yields generally exceeded those of temperate corn when planted as second

TABLE 2. Yields, values, and net returns of corn and sorghum cultivars in three plantings in Marion County, Florida, in 1990.

Crop	Cultivar	Yield (ton/ha)†	Value ($/ha)	Production cost ($/ha)	Net return ($/ha)
		West field, first crop			
Corn	Pioneer 3320	38.1 bcd	1,690	1,341	349
Corn	Northrup King 508	41.3 bc	1,818	1,363	455
Corn	Pioneer X304C	34.8 d	1,531	1,314	217
Corn	Florida SYN-1	36.1 cd	1,591	1,324	267
Sorghum	DeKalb SX-17	50.0 a	1,682	1,373	309
Sorghum	DeKalb FS25E	41.5 b	1,371	1,302	69
		West field, second crop			
Corn	Pioneer 3320	12.8 d	563	776	(213)‡
Corn	Northrup King 508	17.9 cd	790	810	(20)‡
Corn	Pioneer X304C	24.2 c	1,067	850	217
Corn	Florida SYN-1	28.7 c	1,265	880	385
Sorghum	DeKalb SX-17	51.3 a	1,697	873	824
Sorghum	DeKalb FS25E	38.3 b	1,267	788	479
		West field, first plus second crop			
Corn	Pioneer 3320	51.1 d	2,253	2,117	136
Corn	Northrup King 508	59.2 cd	2,608	2,173	435
Corn	Pioneer X304C	59.0 cd	2,598	2,164	434
Corn	Florida SYN-1	64.8 c	2,856	2,204	652
Sorghum	DeKalb SX-17	102.2 a	3,379	2,246	1,133
Sorghum	DeKalb FS25E	79.8 b	2,638	2,090	548
		East field			
Corn	Pioneer 3320	33.2 ab	1,462	918	544
Corn	Northrup King 508	33.6 ab	1,660	947	713
Corn	Pioneer X304C	40.8 a	1,798	967	830
Corn	Florida SYN-1	39.5 ab	1,738	959	779
Sorghum	DeKalb SX-17	32.3 b	1,067	835	232
Sorghum	DeKalb FS25E	24.2 c	800	783	17

Values in columns for yield among the six cultivars following by the same letter are not different ($P < 0.05$) according to Duncan's multiple-range test.
† At 35% dry matter.
‡ Net loss for this system.

crops in this double-cropping system. Double-crop combined forage corn yields ranged from 51.1 to 64.8 ton/ha, with the Florida SYN-1 having the highest yield. The double crop of sorghum-sudangrass DeKalb SX-17 produced the highest combined forage yield of all cultivars, with a total of 102.2 ton/ha. Yields of corn crops grown in the east field planted on May 20 were intermediate to the other two plantings. Tropical corn had less drop in yield than temperate hybrids when planted late.

Tropical corn, forage sorghum, and sorghum-sudangrass were profitably grown at all planting dates and locations. Late summer planting of temperate corn was unprofitable. DeKalb SX-17 sorghum x sudangrass first crop plus the ratoon double crop gave the highest net return of $1,133/ha. Among the corn cultivars, Florida SYN-1 experimental open pollinated synthetic gave the highest double-crop net return of $652/ha.

DISCUSSION

In terms of nematode management, the differences among cultivars in final population densities of *P. minor*, *P. scribneri*, and *Criconemella* spp. were probably not great enough nor consistent enough to be of practical significance. Consistently low densities of *M. incognita* were maintained by the sorghum cultivar DeKalb FS25E and by DeKalb SX-17 sorghum-sudangrass, much lower than on the corn cultivars. This is consistent with previous comparisons of corn and sorghum in cropping systems (3) and is not unexpected, given the susceptibility of corn (12) and the relatively low susceptibility of sorghum (7) to *Meloidogyne* spp. Although rotation with corn or sorghum alone may not successfully manage *Meloidogyne* spp. in some systems (10), populations of *M. incognita* remained low on the selected sorghum cultivars under the conditions of this test.

Yield data indicate that corn planted 2 April and 20 May was more profitable than the DeKalb FS25E forage sorghum. Since sorghum and sorghum × sudangrass from the 2 April planting did not need to be replanted in July, profits were greater than for corn at this date. These data show that profits in double cropping of corn, sorghum, or sorghum x sudangrass in the warm season in Florida depend on the choice of crop and cultivar.

Production of several of the cultivars evaluated here would be profitable for forage production in a spring–summer double-crop system. In addition, the sorghum cultivars may provide the additional benefit of maintaining low root-knot nematode densities. Additional studies are needed to determine the effect of specific cultivars on given nematode species and races, as well as to determine whether the effects of sorghum in holding down *M. incognita* populations are sufficient to provide a beneficial effect on subsequent root-knot-susceptible crops in the system.

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