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Effect of Tropical Rotation Crops on *Meloidogyne incognita* and Other Plant-Parasitic Nematodes[1]

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Abstract: In a field experiment conducted on sandy soil in Florida during the 1993 season, rotation crops of castor (*Ricinus communis*), velvetbean (*Mucuna deeringina*), 'Mississippi Silver' cowpea (*Vigna unguiculata*), American jointvetch (*Aeschynomene americana*), 'Deltapine 51' cotton (*Gossypium hirsutum*), and 'SX-17' sorghum-sudangrass (*Sorghum bicolor* × *S. sudanense*) were effective in maintaining low population densities (<12/100 cm^3 soil) of *Meloidogyne incognita* race 1, whereas high population densities (>450/100 cm^3 soil) resulted after 'Clemson Spineless' okra (*Hibiscus esculentus*) and 'Kirby' soybean (*Glycine max*). Following a winter cover crop of rye (*Secale cereale*), densities of *M. incognita* following the six most effective rotation crops (1993 season) remained relatively low (≤32/100 cm^3 soil) through midseason of an eggplant (*Solanum melongena*) crop planted in 1994, but increased by the end of the eggplant crop. The rotation crops planted during 1993 had little effect on yield of eggplant in 1994. Eggplant yield was inversely correlated with preplant densities (Pi) of *Belonolaimus longicaudatus* ($r = -0.282$; $P \leq 0.10$; 46 df), but not with Pi of *M. incognita*. A separate microplot experiment conducted in 1994 revealed that final densities (Pf) of *M. incognita* race 1 following 13 different crop cultivars were lower ($P \leq 0.05$) than Pf following a 'Pioneer X304C' corn (*Zea mays*) control, but only 'Mississippi Silver' cowpea and 'Sesaco 16' sesame (*Sesamum indicum*) resulted in lower ($P \leq 0.05$) Pf of *Paratrichodorus minor* than the corn control. It is critical that rotation crops intended for suppression of individual *Meloidogyne* spp. be evaluated for their response to other nematode pests as well.

Key words: *Aeschynomene americana, Belonolaimus longicaudatus, Criconemella* spp., crop rotation, cropping system, eggplant, *Glycine max, Gossypium hirsutum, Helicotylenchus dihystera, Hibiscus esculentus, Meloidogyne incognita, Mucuna deeringiana,* nematode, nematode management, *Paratrichodorus minor, Pratylenchus* spp., *Ricinus communis, Sesamum indicum, Solanum melongena, Sorghum bicolor,* sustainable agriculture, *Tagetes patula, Vigna unguiculata, Zea mays.*

Crop rotation is useful for limiting nematode population densities in the southeastern United States (7). Recently, there has been much interest in the evaluation and use of tropical crops for suppression of root-knot nematodes (*Meloidogyne* spp.), particularly in Alabama (15–17,19), and Florida (9–11,14). Some crops, such as castor (*Ricinus communis*) or 'SX-17' sorghum-sudangrass (*Sorghum bicolor* × *S. sudanense*), were effective against several different *Meloidogyne* spp. (9), whereas the response of other crops such as sesame (*Sesamum indicum*), cotton (*Gossypium hirsutum*), or jointvetch (*Aeschynomene americana*) varied with the species and race of *Meloidogyne* involved (9). Corn (*Zea mays*), particularly the tropical corn hybrid 'Pioneer X304C,' increased population densities of *M. incognita* in comparison with several sorghum cultivars (13), but new corn hybrids, developed from the inbred line Mp 307, supported less *M. incognita* reproduction than commercial hybrids (20–22).

As more crops and cultivars are evaluated against a range of nematode species, it is likely that available choices of useful rotation crops will increase. Recently, a number of candidate crops were evaluated in field and microplot tests for their ability to suppress population densities of *M. arenaria* race 1 (10,11). The objective of the current study was to determine the effects of selected rotation crops against *M. incognita* race 1 and other plant-parasitic nematodes in the field and in microplots.

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Materials and Methods

A field experiment and a microplot experiment were conducted at the University of Florida agronomy farm located in Alachua County, Florida. The soil type in both experiments was an Arredondo fine sand (92–93% sand, 4% silt, 3–4% clay; 1.2–1.8% organic matter; pH 5.6–5.9).

Field experiment: In 1993, an experiment was initiated with eight crops, as follows: castor, obtained from Bothwell Enterprises (Plainview, TX); velvetbean (*Mucuna deeringiana*, see endnote), obtained from Adams-Briscoe Seed Co. (Jackson, GA); 'Mississippi Silver' cowpea (*Vigna unguiculata*); 'Clemson Spineless' okra (*Hibiscus esculentus*); American jointvetch, obtained from C. M. Payne and Son (Sebring, FL); 'Deltapine 51' cotton; 'SX-17' sorghum-sudangrass; and 'Kirby' soybean (*Glycine max*). Crops were planted 9 June 1993 in six rows (0.76 m apart and 9.2 m long) per plot in randomized complete blocks with six replications. A 6-m clean fallow border was maintained around each plot in the direction of cultivation to reduce possible plot-to-plot contamination. Seeds of castor and velvetbean were planted ca. 30 cm apart in the rows, whereas seeds of other crops were planted 3–5 cm apart. One day before planting, 280 kg/ha of a 13-4-13 (N-P-K) fertilizer was broadcast and incorporated into all plots. On 22 July, 112 kg/ha of KCl was applied to nonlegume plots. Weed control was by mechanical cultivation until late July, and by hand later in the season. The cowpea plots were double-cropped, with the first crop harvested on 20 August and the same cultivar replanted on 23 August. All crops were harvested on 14 October, with the exception of okra, which died prematurely and was removed 5 October. Plots were rototilled and a winter cover crop of 'Wrens Abruzzi' rye (*Secale cereale*) was planted on 21 October.

The rye cover crop was mowed, and the residues were incorporated by rototilling in late February 1994. On 4 April, 1.12 kg a.i./ha of the herbicide N,N-Diethyl-2-(1-naphthalenyloxy)-propionamide and 560 kg/ha of a 13-4-13 (N-P-K) fertilizer were applied to each plot. On 7 April, seedlings (ca. 12 cm tall) of 'Classic' eggplant (*Solanum melongena*) were planted 45 cm apart in three rows (1.5 m apart × 9.2 m long) in each plot. All plots received 280 kg/ha of 13-4-13 (N-P-K) fertilizer on 3 May and again on 26 May, and overhead irrigation was applied to all plots as needed. Heights of the five plants at the center of the middle row of each plot were measured on 6 May, 23 May, and 14 June, and the average plant height per plot computed. All fruit (>12 cm in length) from the center row of each plot were harvested, counted, and weighed seven times between 14 June and 8 August. Smaller fruit were left on the plants until they reached marketable size. On 8 August, six root systems were removed from the center row of each plot and rated for root galling on a 0–10 scale, where 0 = no galls, 1 = 1–10%, 2 = 11–20%, 3 = 21–30%, 4 = 31–40%, 5 = 41–50%, 6 = 51–60%, 7 = 61–70%, 8 = 71–80%, 9 = 81–90%, and 10 = 91–100% of the root system with galls.

Soil samples consisted of six cores (2.5-cm-d × 20 cm deep) collected from the center row (eggplant) or center two rows (rotation crops) of each plot on 9 June 1993, 14 October 1993, 8 March 1994, 20 June 1994, and 9 August 1994. The six soil cores from each sample were mixed, and nematodes were extracted from a 100-cm^3 subsample by sieving and centrifugal flotation (6).

Microplot experiment: This experiment was conducted in 76-cm-d microplots encircled with 60-cm-wide fiberglass sheets inserted 50 cm deep into the soil (8). Microplots were naturally infested with *Paratrichodorus minor* and in May 1993 were planted with three eggplant seedlings (ca. 20 cm tall) infected with *M. incognita* race 1. These seedlings had been maintained in a greenhouse in plastic trays with 5-cm × 5-cm cells containing steam-sterilized soil infected with 1,000 second-stage juveniles per cell (one plant per cell) in early April. Eggplant was grown in the microplots until September, followed by a cover crop of rye during the winter of 1993–94.

In May 1994, 15 treatments were established in the microplots, as follows: 'Pioneer X304C' corn; the corn genotypes Tebeau × Mp 307 and Old Raccoon × Mp 307 (obtained from G. L. Windham, USDA, ARS, Mississippi State, MS); 'SX-17' sorghum sudangrass; American jointvetch; velvetbean; 'Sesaco 16' sesame (*Sesamum indicum*); castor; 'Mississippi Silver' cowpea; 'Zippercream' cowpea; 'Dwarf Primrose' marigold (*Tagetes patula*); 'Deltapine 51' cotton; 'Clemson Spineless' okra; clean fallow; or weeds. The weed treatment consisted of any volunteer weeds (mixtures of *Indigofera hirsuta, Digitaria* spp., *Eleusine indica,* and *Euphorbia maculata*) that grew in the microplots during the experiment. Each treatment was replicated six times in randomized complete blocks.

Each microplot was fertilized with 25 g of 13-4-8 (N-P-K) on 16 May and planted on 17 May 1994. Corn, cotton, castor, sorghum-sudangrass, and velvetbean were planted at a rate of 5–6 seeds per plot and later thinned to three plants per plot. Seeds of cowpea, sesame, okra, and marigold were planted 5 cm apart in rows spaced 12 cm apart, a total of ca. 40 seeds per plot. American jointvetch was broadcast at a rate of about 80 seeds per microplot. One month after planting, all plots were fertilized with 25 g of 13-4-13 (N-P-K). Except for the weed treatment, all plots were maintained free of weeds by hand weeding. Supplementary irrigation was applied as needed through a drip irrigation system. Cowpea plants were removed and replanted on 29 July; thus, each cowpea treatment was a double crop.

All crops were removed on 21 September, and root systems were examined for galling due to *M. incognita.* Because corn roots usually do not show obvious galling from *Meloidogyne* spp. (13), a subsample of 10 g fresh roots was removed from each microplot with corn and extracted in 1% NaOCl (5) to recover nematode eggs. A soil sample consisting of five cores (2.5-cm-d × 20 cm deep) was collected from each microplot on 16 May and again on 21 September. The five soil cores were mixed, and nematodes were extracted from a 100-cm^3 subsample (6).

Data analysis: Nematode count data were transformed to $\log_{10}(x + 1)$ values before analysis of variance and separation of means by the Student-Newman-Keuls test, with the MSTAT-C statistical program (Michigan State University, East Lansing, MI). Untransformed arithmetic means are presented in the tables.

Results

Field experiment: This site contained several plant-parasitic nematode species: *Belonolaimus longicaudatus, Criconemella* spp. (a mixture of *C. sphaerocephala* and *C. ornata*), *Helicotylenchus dihystera, Meloidogyne incognita, Paratrichodorus minor,* and *Pratylenchus* spp. (a mixture of *P. brachyurus* and *P. scribneri*). At the beginning of the experiment (9 June), no differences in nematode numbers existed among plots assigned to different crop treatments ($P > 0.05$) (Table 1). By the end of the season, population densities of *Belonolaimus longicaudatus* were greater following sorghum-sudangrass, cotton, or cowpea than following the other crops ($P \leq 0.05$). *Paratrichodorus minor* densities were greatest following sorghum-sudangrass, and least following cowpea. Final population densities of *Pratylenchus* spp. were unaffected by treatment. Population densities of *Meloidogyne incognita* race 1 were much greater following okra and soybean compared with the other crops ($P \leq 0.05$). Spatial distribution of *Criconemella* spp. and especially *Helicotylenchus dihystera* was highly variable. Maximum densities of *H. dihystera* were restricted to a few replications, making it difficult to obtain meaningful results for this species.

With the exception of *M. incognita,* population densities of plant-parasitic nematodes in the subsequent eggplant crop showed few effects from the rotation crop grown in the previous season ($P \leq 0.05$) (Table 2). High densities of *M. incognita* occurred in eggplant plots following okra or soybean. By the end of the eggplant crop (9 August), population densities following most rotation treatments (except

TABLE 1. Effect of crop treatment on densities of plant-parasitic nematodes in soil in a field experiment in Alachua County, Florida, 1993.

	Nematodes per 100 cm^3 soil											
	Belonolaimus longicaudatus		*Criconemella* spp.		*Helicotylenchus dihystera*		*Meloidogyne incognita*		*Paratrichodorus minor*		*Pratylenchus* spp.	
Crop	9 June	14 Oct.	9 June	14 Oct.	9 June	14 Oct.	9 June	14 Oct.	9 June	14 Oct.	9 June	14 Oct.
Castor	2 a	2 b	3 a	8 a	4 a	1 b	3 a	11 c	17 a	29 bc	2 a	41 a
Velvetbean	2 a	1 b	1 a	32 a	483 a	455 a	8 a	6 c	25 a	28 bc	6 a	30 a
Cowpea	9 a	18 a	5 a	2 a	121 a	2 b	6 a	1 c	19 a	10 c	3 a	23 a
Okra	6 a	3 b	4 a	10 a	99 a	19 ab	4 a	487 b	28 a	55 ab	6 a	12 a
Jointvetch	9 a	5 b	22 a	116 a	64 a	27 ab	2 a	7 c	22 a	51 abc	2 a	10 a
Cotton	9 a	23 a	6 a	14 a	101 a	209 ab	4 a	6 c	22 a	46 abc	2 a	57 a
Sorghum-sudangrass	3 a	34 a	21 a	160 a	18 a	9 b	4 a	11 c	18 a	80 a	4 a	12 a
Soybean	1 a	3 b	14 a	18 a	367 a	187 ab	3 a	1,848 a	21 a	48 abc	1 a	31 a

Data are untransformed arithmetic means of six replications. Means in the same column followed by the same letter are not different ($P \leq 0.05$) according to the Student-Newman-Keuls test performed on data transformed to $\log_{10}(x + 1)$ values before analysis.

TABLE 2. Effect of previous rotation crop (1993 season) on densities of plant-parasitic nematodes in an eggplant crop during the 1994 season in a field experiment in Alachua County, Florida.

	Nematodes per 100 cm^3 soil																		
	Belonolaimus longicaudatus			*Criconemella* spp.			*Helicotylenchus dihystera*			*Meloidogyne incognita*			*Paratrichodorus minor*			*Pratylenchus* spp.			Root gall index[b]
Previous crop (Summer 1993)[a]	8 Mar	20 Jun	9 Aug	8 Mar	20 Jun	9 Aug	8 Mar	20 Jun	9 Aug	8 Mar	20 Jun	9 Aug	8 Mar	20 Jun	9 Aug	8 Mar	20 Jun	9 Aug	
Castor	6 a	24 a	4 a	2 a	1 b	1 a	<1 a	2 b	3 a	1 c	32 abc	314 ab	11 a	46 a	28 a	12 a	7 b	9 a	1.7 ab
Velvetbean	4 a	2 a	1 a	5 a	<1 b	<1 a	121 a	701 a	265 a	6 c	16 abc	139 abc	17 a	52 a	36 a	6 a	26 a	15 a	1.2 ab
Cowpea	13 a	28 a	14 a	1 a	3 b	1 a	<1 a	4 b	17 a	<1 c	2 bc	18 c	15 a	38 a	40 a	10 a	4 b	9 a	0.3 b
Okra	11 a	9 a	8 a	7 a	4 b	4 a	52 a	34 b	73 a	52 b	54 ab	478 a	13 a	46 a	39 a	8 a	1 b	12 a	3.8 a
Jointvetch	7 a	26 a	10 a	13 a	7 b	4 a	12 a	97 b	172 a	1 c	1 c	40 bc	16 a	38 a	33 a	1 a	1 b	6 a	0.4 b
Cotton	23 a	32 a	9 a	6 a	2 b	2 a	31 a	273 ab	60 a	2 c	21 abc	145 abc	10 a	44 a	29 a	5 a	7 b	14 a	1.4 ab
Sorghum-sudangrass	8 a	24 a	7 a	34 a	20 a	10 a	21 a	9 b	20 a	3 c	14 abc	190 ab	21 a	54 a	33 a	15 a	2 b	8 a	1.2 ab
Soybean	6 a	17 a	5 a	7 a	2 b	1 a	49 a	309 ab	230 a	134 a	140 ab	269 ab	13 a	68 a	41 a	7 a	3 b	3 a	3.0 a

Data are untransformed arithmetic means of six replications. Means in the same column followed by the same letter are not different ($P \leq 0.05$) according to the Student-Newman-Keuls test performed on data transformed to $\log_{10}(x + 1)$ values before analysis.

[a] A winter cover crop of rye was maintained on all plots during the winter of 1993–94.

[b] Root galling rated on 0–10 scale, where 0 = 0 galls, 1 = 1–10%, 2 = 11–20%, 3 = 21–30%, 4 = 31–40%, 5 = 41–50%, 6 = 51–60%, 7 = 61–70%, 8 = 71–80%, 9 = 81–90%, and 10 = 91–100% of root system with galls.

for cowpea and jointvetch) were comparable to those following okra or soybean. Root galling on eggplant was lower following cowpea or jointvetch than following okra or soybean ($P \leq 0.05$).

Crop rotation treatments had relatively few effects on growth and yield of the subsequent eggplant crop ($P \leq 0.05$) (Table 3). Plant height of eggplant following cowpea was lower than that of eggplant following velvetbean. On one harvest date, yield of eggplant following velvetbean was greater than yield following any other rotation crop ($P \leq 0.05$). No differences were observed in yield on other harvest dates (data not shown) or in total yield of all harvests ($P > 0.05$). Across plots, total fruit weight from all harvests was inversely correlated with initial population density (Pi; 8 March) (8 March 1994) of *B. longicaudatus* ($r = -0.282$; $P \leq 0.10$; 46 df). Inverse correlations were also obtained between Pi of *B. longicaudatus* and plant height on 6 May ($r = -0.239$; $P \leq 0.10$; 46 df), total number of fruit from all harvests ($r = -0.243$; $P \leq 0.10$; 46 df), number of fruit from the 21 June harvest ($r = -0.304$; $P \leq 0.05$; 46 df), and fruit weight from the 21 June harvest ($r = -0.293$; $P \leq 0.05$; 46 df). No correlations were observed between any yield parameter and density of any other nematode ($P > 0.10$).

Microplot experiment: At the beginning of the experiment (16 May), no differences among plots assigned to various treatments were observed for *M. incognita* race 1 or *P. minor* ($P \leq 0.05$) (Table 4), although distribution of *P. minor* from plot to plot was erratic. Final densities of *P. minor* were highest following Pioneer X304C corn and the sorghum-sudangrass, and lowest following Mississippi Silver cowpea and Sesaco 16 sesame.

Most of the okra plants were dead or dying by 30 June, and their roots were heavily galled by *M. incognita.* Okra was not replanted, which probably resulted in the relatively low final population densities (Pf) following this treatment (Table 4). Final population densities of *M. incognita* following Pioneer X304C corn was at least 10 times as great as Pf following any other treatment. Lowest Pf of *M. incognita* were obtained following Zippercream cowpea or fallow.

With the exception of okra, few galls were observed on the various plants in this experiment. However, galls are not easily observed on corn, even though it is a good host of *M. incognita.* Over 34,000 eggs/10 g root were extracted from Pioneer X304C corn, many more than were obtained from either Tebeau × Mp 307 (1,860/10 g root) or Old Raccoon × Mp 307 (1,070/10 g root)($P \leq 0.01$).

The weed treatment consisted of any plants that colonized a microplot during the course of the experiment. This re-

TABLE 3. Effect of previous rotation crop (1993 season) on height and yield of eggplant during the 1994 season in a field experiment in Alachua County, Florida.

Previous crop (1993)	Plant height (cm)			Number of fruit per plot		Weight of fruit per plot (kg)	
	6 May	23 May	14 June	21 June[a]	Total[b]	21 June[a]	Total[b]
Castor	14 a	22 ab	52 a	17 b	154 a	5.3 ab	37.9 a
Velvetbean	14 a	24 a	59 a	27 a	211 a	8.6 a	57.5 a
Cowpea	11 b	15 b	44 a	7 b	127 a	2.3 b	34.9 a
Okra	12 ab	20 ab	50 a	11 b	134 a	3.8 b	34.0 a
Jointvetch	12 ab	17 ab	47 a	12 b	144 a	3.9 b	39.0 a
Cotton	12 ab	16 ab	46 a	8 b	122 a	2.7 b	31.5 a
Sorghum-Sudangrass	12 ab	17 ab	46 a	10 b	112 a	2.8 b	27.6 a
Soybean	13 ab	18 ab	50 a	12 b	138 a	3.9 b	37.1 a

Data are untransformed arithmetic means of six replications. Means in the same column followed by the same letter are not different ($P \leq 0.05$) according to the Student-Newman-Keuls test performed on data transformed to $\log_{10}(x + 1)$ values.
[a] Significant ($P \leq 0.05$) differences only on 21 June, not on other harvest dates.
[b] Total of seven harvests from 14 June to 8 August.

TABLE 4. Effect of crop treatment on densities of *Meloidogyne incognita* and *Paratrichodorus* minor in microplots in Alachua County, Florida, 1994.

		Nematodes per 100 cm^3 soil			
		Meloidogyne incognita		*Paratrichodorus minor*	
Treatment	Cultivar or genotype	16 May	21 Sept.	16 May	21 Sept.
Corn	Pioneer X304C	406 a	2,353 a	20 a	30 a
Corn	Tebeau × Mp307	159 a	232 b	2 a	11 ab
Sorghum-sudangrass	SX-17	376 a	227 bc	1 a	25 a
Weeds	—	274 a	166 bcd	8 a	4 ab
Corn	Old Raccoon × Mp307	349 a	155 bc	5 a	20 ab
Jointvetch	—	192 a	130 bc	7 a	10 ab
Okra	Clemson Spineless	253 a	128 bc	1 a	2 ab
Velvetbean	—	352 a	54 bcd	4 a	5 ab
Sesame	Sesaco 16	196 a	28 bcd	2 a	1 b
Castor	—	338 a	28 bcd	18 a	8 ab
Cowpea	Mississippi Silver	224 a	16 bcd	2 a	1 b
Marigold	Dwarf Primrose	180 a	13 cd	3 a	6 ab
Cotton	Deltapine 51	201 a	11 cd	1 a	4 ab
Cowpea	Zippercream	225 a	4 d	42 a	9 ab
Fallow	—	200 a	4 d	6 a	12 ab

Data are untransformed arithmetic means of six replications. Means in the same column followed by the same letter are not different ($P \leq 0.05$) according to the Student-Newman-Keuls test performed on data transformed to $\log_{10}(x + 1)$ values.

sulted in mixtures of *I. hirsuta, Digitaria* spp., *E. indica,* and *E. maculata,* which varied from plot to plot. Likewise, *M. incognita* densities varied greatly in this treatment, which probably accounts for its lack of separation from most other treatments.

DISCUSSION

The microplot experiment confirmed previous greenhouse work (9), indicating that lower population densities of *M. incognita* race 1 resulted after SX-17 sorghum-sudangrass, Deltapine 51 cotton, American jointvetch, velvetbean, castor, and Sesaco 16 sesame than after other potential rotation crops. Five of these crops were also effective against *M. arenaria* race 1 in microplots, whereas the performance of sesame was variable (10). In greenhouse studies (12), Dwarf Primrose marigold was an extremely poor or nonhost of *M. incognita* race 1, as well as *M. javanica* and *M. arenaria* race 1. Mississippi Silver cowpea was effective against *M. incognita* race 1 in the field (4), and the current test suggests that the response of Zippercream cowpea may be comparable. Hybrids of Old Raccoon or Tebeau with Mp 307, which have shown a high degree of resistance to Mississippi populations (21) of *M. incognita* (especially *M. incognita* race 4), were also effective against a Florida population of *M. incognita* race 1.

The microplot experiment was useful in identifying rotation crops that may be effective in maintaining low population densities of *M. incognita.* Results for six of these crops were similar in the microplot and the field experiments. Population densities of *M. incognita* race 1 were high following Kirby soybean in the field experiment, in marked contrast to an earlier greenhouse test in which this cultivar did not appear to be a host of *M. incognita* race 1 (9); however, the isolates of *M. incognita* race 1 involved were different. Differing responses of the same plant cultivar to different populations of the same race of *M. incognita* are recognized (18) and emphasize the need for testing candidate rotation crops against local nematode populations before they are widely planted.

Although use of several of the rotation crops resulted in low population densities of *M. incognita* and low levels of galling in the subsequent eggplant crop, eggplant yield was not affected by this management of *M. incognita* densities. Many plants exhibited the root-tip and stubby-root damage typical of *Belonolaimus* spp. or *Paratrichodorus* spp. (2), but yield was inversely and rather weakly correlated only with the population density of *B. longicaudatus*. Both *B. longicaudatus* and *P. minor* reached their greatest densities following SX-17 sorghum-sudangrass, and *B. longicaudatus* also reached similar high levels following cotton. Of the crops tested, Mississippi Silver cowpea resulted in the lowest densities of *P. minor* both in the field and in microplots, but harbored population densities of *B. longicaudatus* that were similar to those on cotton and sorghum-sudangrass.

These results illustrate the dangers of using rotation crops effective against a single key nematode parasite (e.g., *M. incognita*) when other damaging nematode pests are present in the same field. Candidate rotation crops should be evaluated against as many different damaging nematodes as possible, so that those that are effective against several nematode species can be recognized. In our study, castor and velvetbean appeared to be the most effective for preventing increase or reducing population densities of *M. incognita, B. longicaudatus,* and *P. minor* when all three nematode parasites were present together.

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Endnote

Authorities disagree over the scientific name of velvetbean. The plant used here and in our other work (9–11,14) is known as "Florida velvetbean" (3), recognized as *M. deeringiana* by some authors (3). Others consider it a form of the polymorphic species *M. pruriens* (1). Bogdan (1) summarizes the controversy and in reference to *M. pruriens* (and its other synonyms) concludes that "the taxonomy of this variable species is not quite clear."