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Effects of Bahiagrass and Nematicides on *Meloidogyne arenaria* on Peanut[1]

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Abstract: A field infested with *Meloidogyne arenaria* and with a history of peanut yield losses was divided into two equal parts. One-half of the field (bahia site) was planted to bahiagrass in 1986 and maintained through 1987. The other half (peanut site) was planted to soybean in 1986 and peanut in 1987 with hairy vetch planted each fall as a cover crop. In 1988 identical nematicide treatments including 1,3-dichloropropene (1,3-D), aldicarb, and ethoprop were applied to the two sites, and the sites were planted with the peanut cultivar Florunner. At mid-season, population levels of *M. arenaria* second-stage juveniles in the bahia site were relatively low, compared with those in the peanut site. At harvest, however, population levels were high in both sites. No nematicide treatment increased yields over the untreated control in either site ($P \leq 0.05$). Bahiagrass alone and the combination of bahiagrass and 1,3-D applied broadcast resulted in 6.6-fold and 9.7-fold increases in yield, respectively, over the untreated control in the peanut site. All treatments in the bahia site resulted in increased vegetative growth and yields, compared with the duplicate treatments in the peanut site.

Key words: aldicarb, *Arachis hypogaea*, bahiagrass, crop rotation, 1,3-dichloropropene, ethoprop, *Meloidogyne arenaria*, nematicide, *Paspalum notatum*, peanut.

Meloidogyne arenaria (Neal) Chitwood race 1 is an important soilborne pest of peanut (*Arachis hypogaea* L.) throughout the southeastern United States (4,9,11). Population densities of this nematode increase rapidly near the end of the peanut growing season (2,5). Peanut quality and yield may be substantially lower because of heavy galling of pegs, pods, and roots (2,5,13). Traditional management of *M. arenaria* in peanut fields in the southeastern United States is with nematicides (6,8,12) and crop rotation (6,10,14,15,18). Chemical control of the nematode in sandy soils in Florida may increase peanut yields by 20-fold, but it is often unreliable when nematode population densities are high (5).

Bahiagrass (*Paspalum notatum* Flugge), a nonhost of *M. arenaria* (17), is one of the best crops to precede peanut in Florida (10). Population densities of *M. arenaria* in the soil were reduced and peanut yields increased after only 1 year of bahiagrass in Alabama (17). Integrating crop rotations with nematicides to control nematodes on peanut is promising and economical (3,17). The objective of this study was to compare the efficacy of fumigant and nonfumigant nematicides for control of *M. arenaria* on peanut following bahiagrass or susceptible host crops grown over a 2-year period.

MATERIALS AND METHODS

The investigation was conducted in 1988 on a commercial peanut farm near Williston, Florida. A field site with a history of peanut yield losses caused by *Meloidogyne arenaria* race 1 was selected. In the fall of 1985 the site was planted in rye (*Secale cereale* L. cv. Wrens Abruzzi). The following year the 0.6-ha field was divided into two equal sections. One section (bahia site) was planted in Pensacola bahiagrass for 2 years. The other section (peanut site) was planted with soybean (*Glycine max* L. cv. Davis) in 1986 and Florunner peanut in 1987 with hairy vetch (*Vicia villosa* Roth) planted each

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fall as a cover crop. The soil was a sandy, siliceous, hyperthermic Grossarenic Paleudult, commonly called Arredondo fine sand (97.5% sand, 1.5% silt, 1.0% clay; 1.0% organic matter; pH 6.5). *Criconemella ornata* (Raski) Luc and Raski was also prevalent (34/250 cm^3) in the field.

The bahiagrass was cross-disked in mid-February 1988 and the 0.6-ha field was moldboard plowed 36-cm deep in March 1988. Fertilizer, 22 kg P_2O_5/ha and 56 kg K_2O/ha, was applied broadcast and disk incorporated. Cultural practices and control of weeds, insects, and foliar diseases of peanut were as recommended for the area (19). The herbicides benefin and vernolate were tank mixed and applied broadcast preplant and incorporated 5–7 cm deep, and the herbicides paraquat plus bentazon were applied postemergence. Chlorpyrifos was applied 21 June to control lesser cornstalk borer (*Elasmopalpus lignosellus* Zeller) and to suppress white mold (*Sclerotium rolfsii* Sacc.). Chlorothalonil or mancozeb were applied at 21-day intervals beginning 57 days after planting to control leafspot (*Cercospora arachidicola* Hori and *Cercosporidium personatum* Berk. & Curt [Deighton]).

Seven treatments, replicated six times, were arranged in the same randomized complete block design in both the peanut and bahia sites. Plots consisted of four 9-m long rows spaced 76 cm apart with only the inside two rows of each plot receiving treatments.

The fumigant 1,3-dichloropropene (1,3-D) was applied 25 cm deep 7 days preplant with swept-back chisels and a positive-flow power takeoff pump applicator. Six chisels spaced 30 cm apart were used for the broadcast application, and two chisels spaced 20 cm apart centered over the row furrow were used for the row application. Chisel slits were sealed with press wheels. Aldicarb was applied at planting in a 30-cm band behind the planter opening disk and in front of the planter shoe with a Gandy applicator (Gandy Company, Owatonna, MN). Southern Runner peanut was planted 25 May.

Aldicarb and ethoprop were applied postplant in a 36-cm band directly over the vines with a Gandy applicator in specified plots at peg initiation on 19 July. A bag weighted at the bottom was dragged over the vines to dislodge granules from the foliage.

Soil samples to estimate initial population densities of *M. arenaria* at both sites were taken 0–15, 30–45, and 60–75 cm deep on 4 February. A sample consisted of five 10-cm-d cores taken at each depth and then mixed. Five aliquants, each 400 cm^3 soil, were placed in 10-cm-d pots and planted with 4-week-old tomato (*Lycopersicon esculentum* L. cv. Rutgers) seedlings. The number of root-knot nematode galls per root system was determined after 30 days (1). Soil samples for nematode extraction also were collected 50 and 137 days after planting. Each sample consisted of a composite of twelve 2.5-cm-d cores (six/row) taken 20 cm deep in the root zone from the inside two rows of each plot. Samples were mixed thoroughly, stored in plastic bags at 10 C, and processed within 5 days after sampling. A 250-cm^3 aliquant of each sample was processed by sugar flotation-centrifugation (7).

Peanut growth was determined 26 July by measuring the height and width of three plants per row chosen randomly from treated rows. The inside two rows of each plot were dug 11 October and the peanuts were combined 3 days later. Peanuts were weighed after drying to 11.5% moisture.

All data were subjected to analysis of variance and treatment means were compared by Duncan's multiple-range test. Nematode data were transformed by $\log_{10}$ (nematode density + 1). Correlation coefficients were calculated between nematode population densities and peanut vine width, height, and pod yield. Student's *t*-test was used to compare differences between the bahia site and peanut site. Unless otherwise stated all differences referred to here were significant at $P \leq 0.05$.

Results and Discussion

Bahia site: On 26 July one treatment, aldicarb at planting with ethoprop at peg-

TABLE 1. Peanut vine width and height at mid-season and yield following 2 years of bahiagrass (bahia site) or of crops susceptible to *Meloidogyne arenaria* (peanut site) as affected by nematicide treatment.

Treatment and broadcast rate (a.i./ha)	Rate† (a.i./30.5 m)	Application method	26 July: Plant width (cm)		26 July: Plant height (cm)		Yield (kg/ha)	
			Bahia site	Peanut site	Bahia site	Peanut site	Bahia site	Peanut site
1,3-D, 84 liters	78 ml/chisel	Broadcast	61 abc	55 ab	20 a	18 a	2,479 a	737 a*
1,3-D, 140 liters	65 ml/chisel	Two chisels/row	57 c	51 b	20 a	17 ab*	1,362 b	575 a
1,3-D, 140 liters +	65 ml/chisel	Two chisels/row						
aldicarb,‡ 6.7 kg	49 g§	35-cm band	65 ab	60 a	20 a	18 a	2,300 ab	705 a**
Aldicarb, 10.0 kg	63 g	30-cm band	65 ab	55 ab**	21 a	18 a*	2,051 ab	451 a***
Aldicarb, 5.0 kg +	31 g	30-cm band						
aldicarb,‡ 5.0 kg	37 g§	35-cm band	67 ab	53 ab**	22 a	17 ab*	2,224 ab	808 a***
Aldicarb, 5.0 kg +	31 g	30-cm band						
ethoprop,‡ 6.7 kg	49 g§	35-cm band	68 a	56 ab**	21 a	17 ab**	1,892 ab	640 a**
Untreated			60 bc	43 c**	20 a	15 b**	1,691 ab	256 a***

Data are means of six replicates. Means with the same letter within a column are not significantly different according to Duncan's multiple-range test ($P \leq 0.05$).
*, **, *** = significantly different from bahia site according to Student's *t* test: $P \leq 0.05$, 0.01, and 0.001, respectively.
† Rates were based on a 91.4-cm row spacing. Fumigants applied 25 cm deep, 7 days preplant; nonfumigants applied in a band over the row at planting or at pegging.
‡ Applied at peg initiation, 19 July.
§ Rates applied in a 35-cm band at pegging were increased in proportion to the rate applied in a 30-cm band.

TABLE 2. Nematodes (no./250 cm^3 soil) at midseason and harvest following 2 years of bahiagrass (bahia site) or of crops susceptible to *Meloidogyne arenaria* (peanut site) as affected by nematicide treatment.

Treatment and broadcast rate (a.i./ha)	Rate† (a.i./30.5 m)	Application method	*Meloidogyne arenaria*				*Criconemella ornata*			
			15 July		11 Oct		15 July		11 Oct	
			Bahia site	Peanut site	Bahia site	Peanut site	Bahia site	Peanut site	Bahia site	Peanut site
1,3-D, 84 liters	78 ml/chisel	Broadcast	72 a	314 bc*	955 c	1,328 a	120 a	175 ab	657 a	561 a
1,3-D, 140 liters	65 ml/chisel	Two chisels/row	19 bc	517 ab**	1,992 ab	955 a*	72 ab	173 ab	365 ab	173 b
1,3-D, 140 liters +	65 ml/chisel	Two chisels/row								
aldicarb,‡ 6.7 kg	49 g§	35-cm band	4 c	15 c	986 c	812 a	26 b	247 a**	446 ab	436 ab
Aldicarb, 10.0 kg	63 g	30-cm band	11 bc	280 bc***	1,493 abc	880 a	25 b	73 b*	202 b	333 ab
Aldicarb, 5.0 kg +	31 g	30-cm band								
aldicarb,‡ 5.0 kg	37 g§	35-cm band	3 c	155 bc***	1,245 bc	1,309 a	16 b	92 b**	353 ab	396 ab
Aldicarb, 5.0 kg +	31 g	30-cm band								
ethoprop,‡ 6.7 kg	49 g§	35-cm band	5 c	321 bc**	1,411 abc	1,332 a	40 b	139 ab*	270 b	289 ab
Untreated			27 b	805 a***	2,229 a	1,354 a	39 b	84 b	250 b	157 b

Data are means of six replicates. Means with the same letter within a column are not significantly different according to Duncan's multiple-range test ($P \leq 0.05$).
*, **, *** = significantly different from bahia site according to Student's t test: $P \leq 0.05$, 0.01, and 0.001, respectively.
† Rates were based on a 91.4-cm row spacing. Fumigants applied 25 cm deep, 7 days preplant; nonfumigants applied in a band over the row at planting or at pegging.
‡ Applied at peg initiation, 19 July.
§ Rates applied in a 35-cm band at pegging were increased in proportion to the rate applied in a 30-cm band.

ging, had vine widths greater than the untreated control (Table 1). There were no differences in vine height. The broadcast application of 1,3-D produced the highest yield, but this yield was greater than the row application of 1,3-D only (Table 1).

Numbers of *M. arenaria* second-stage juveniles (J2) in the soil on 15 July were lower than the untreated control in all plots except aldicarb and 1,3-D applied in the row or broadcast (Table 2). On 11 October the final population densities of *M. arenaria* J2 in the soil were lower, relative to the untreated control, in plots treated with 1,3-D broadcast, 1,3-D in the row with aldicarb at pegging, and aldicarb applied at planting with aldicarb at pegging. The final population densities of *M. arenaria* in the soil were relatively high, 955–2,229 J2/250 cm^3 soil. The population densities of *C. ornata* were not reduced below those in the control at either sampling date by any treatment.

Peanut site: On 26 July all treatments had greater vine widths than the untreated control (Table 1). Vine heights were greater than the untreated control in plots treated with a broadcast application of 1,3-D, 1,3-D in the row with aldicarb at pegging, and aldicarb at planting. There were no differences in yield among treatments (Table 1).

The number of *M. arenaria* J2 in the soil on 15 July was lower than the untreated control in all treatments except 1,3-D applied in the row. Yield was negatively correlated with numbers of J2 on 15 July ($r = -0.38$, $P \leq 0.05$). Final population densities in the soil ranged from 812 to 1,354 J2/250 cm^3 soil. *Criconemella ornata* numbers were not reduced below the level in the control by any treatment.

Vine width and height were generally greater following bahiagrass than peanut. There was no difference in vine widths and heights between the bahia site and the peanut site where 1,3-D was applied broadcast or in combination with aldicarb applied at pegging (Table 1). Vine height was not different where 1,3-D was applied in the row. Yields were 6.6-fold greater in all bahiagrass plots and 9.7-fold greater in bahiagrass plots treated with 1,3-D broadcast than in the untreated continuous peanut plots. The superior peanut growth and higher yields following bahiagrass were caused by the low initial population density of *M. arenaria.* As the season progressed, however, the population density increased to damaging levels that suppressed yields. Consequently none of the treatments produced yields equivalent to those produced in nearby grower fields (> 3,362 kg/ha) where little or no *M. arenaria* occurred following a 4–6-year bahiagrass rotation.

The application rate, placement depth, and sealing of the application slits appear to be critical for 1,3-D in deep sandy soils. Although the fumigant was applied broadcast at the depth reported previously as optimum (16) and well sealed, its performance was inadequate in this test.

Initial numbers of *M. arenaria* J2 in the soil, as determined by bioassay (number of root-knot galls per plant) on 4 February, averaged 23, 33, and 15 in the peanut site and 0.8, 0, and 0 in the bahia site at 0–15, 35–45, and 60–75 cm deep, respectively. The low population density of *M. arenaria* following 2 years of bahiagrass was expected because Pensacola bahiagrass is a nonhost of *M. arenaria.* Average numbers of J2/250 cm^3 soil in the bahia site were much lower than in duplicate treatments in the peanut site at midseason. Final population densities, however, were high in all treatments at both sites.

Meloidogyne arenaria increased rapidly from almost undetectable levels in February in the bahia site. Pods, pegs, and roots of all plants in all treatments were galled by *M. arenaria* at harvest and visual separation of treated and untreated plants was impossible. Yet, vine growth and pod yield in the bahia site were far superior to vine growth and pod yield in the peanut site, where most plants were extremely stunted and there were few or no pods on control plants. Even though the initial J2 population density was very low following bahiagrass, the potential for late season nematode population resurgence is great.

Undoubtedly the relatively long growing period for peanut (from 135 to 175 days) is an important factor in the large late season population density of *M. arenaria.* Therefore, even with the use of the best nematicides available, more than 2 years in a nonhost will be needed to prevent *M. arenaria* from causing serious peanut yield losses.

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