CORN AND SORGHUM AS ROTATIONAL CROPS FOR MANAGEMENT OF *MELOIDOGYNE ARENARIA* IN PEANUT

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ABSTRACT

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The value of corn (*Zea mays* L.) and sorghum (*Sorghum bicolor* (L.) Moench) as rotational crops for management of *Meloidogyne arenaria* (Neal) Chitwood in peanut (*Arachis hypogaea* L.) was studied in two 3-year experiments. The experiments were conducted in a field near Headland, Alabama, and compared several rotational systems with the performance of continuous peanut. At-plant applications of ethylene dibromide (EDB) were included in some of the systems to determine the value of nematicide use in the rotations. Corn and sorghum reduced juvenile populations in soil; however, the populations recovered quickly when peanut followed either of the 2 other crops. The use of EDB to control *M. arenaria* in a continuous peanut system was not reliable; yield differences between fumigated and unfumigated plots under continuous peanut culture, while significant during the first year, were not so after 3 years. Highest peanut yields were obtained from plots that had been planted with corn or sorghum in the preceeding 2 years and which had been fumigated every year. Results showed that reliance on corn or sorghum rotations as the sole means for managing *M. arenaria* in peanut fields cannot be justified economically.

Additional key words: population dynamics, nonchemical control, ecology, pest management, Soilbrom, halogenated hydrocarbons, cultural practices.

RESUMEN

Rodríguez-Kábana, R., y J. T. Touchton. 1984. El maíz y el sorgo como cultivos de rotación para el manejo de *Meloidogyne arenaria* en el maní. Nematrópica 14:26-36.

Se estudió con 2 experimentos de campo de 3 años de duración la eficacia del maíz (*Zea mays* L.) y la del sorgo (*Sorghum bicolor* (L) Moench) como cultivos de rotación para combatir *Meloidogyne arenaria* (Neal) Chitwood en campos de maní (*Arachis hypogaea* L.). Los experimentos se efectuaron en un campo cercano a Headland, Alabama, y consistieron de comparaciones entre diferentes sistemas de rotación y el monocultivo de maní. También se hicieron tratamientos con bibromuro de etileno (BBE) para determinar la conveniencia del uso del nematicida en las rotaciones. El maíz y el sorgo disminuyeron las poblaciones de larvas en el suelo aunque las mismas se recuperaron rápidamente cuando el maní siguió a cualquiera de los otros 2 cultivos. El uso del BBE como único método para combatir *M. arenaria* en un sistema de

monocultivo de maní no resultó práctico ya que las diferencias en rendimiento de maní en monocultivo entre parcelas fumigadas y otras sin BBE aunque significativas en el primer año no lo fueron después de tres años. Los rendimientos de maní más altos se obtuvieron de parcelas que habían tenido maíz o sorgo por 2 años antes del maní y que habían sido fumigadas cada año con BBE. Los resultados señalan que el uso del maíz o del sorgo como medio único para combatir *M. arenaria* en campos de maní no se puede justificar economicamente.
Palabras claves adicionales: dinámica poblacional, combate sin nematicidas, ecología, manejo de plagas, Soilbrom, hidrocarburos halogenados, prácticas de cultivo.

INTRODUCTION

The peanut plant (*Arachis hypogaea* L.) is subject to attack by a variety of plant parasitic nematodes (6). Principal among these, based on economic importance, are the root-knot nematodes: *Meloidogyne arenaria* (Neal) Chitwood and *M. hapla* Chitwood. *M. arenaria* is the most common of the two species in Alabama peanut fields (4). Previous studies in Alabama have demonstrated a direct relation between peanut yield losses and the size of juvenile populations of *M. arenaria* in soil (8). Traditionally *M. arenaria* has been managed with the use of nematicides. Currently there are no commercially available peanut cultivars resistant to *M. arenaria* and there is evidence that sources of resistance to the nematode are limited (5,6). The use of rotations for control of root-knot nematodes in peanuts has been suggested. Corn (*Zea mays* L.), a nonhost, has been shown to be beneficial in reducing populations of *M. hapla* in peanut (1,2). There is also some evidence that sorghum (*Sorghum vulgare* L.) can be used to reduce populations of *M. arenaria* when used in rotation with Spanish peanut (11). However, there is no information available on the relative values of corn or sorghum as rotational crops to control *M. arenaria* in 'Florunner' peanut. Corn is a host for *M. arenaria* although the degree of susceptibility to the nematode may be expected to vary, as is the case for other root-knot nematode species (9).

This paper presents results of two 3-year experiments conducted to determine the relative values of corn and sorghum as rotational crops for management of *M. arenaria* in peanut fields. The paper also presents comparative data for various crop rotation systems with and without a nematicide.

MATERIALS AND METHODS

The effect of sorghum (*Sorghum bicolor* (L.) Moench) and corn on development of *M. arenaria* was studied in 2 experiments. The experiments were established on the Wiregrass Substation, near Headland, Alabama, in an irrigated field infested with the nematode. The field had been planted with peanut as the summer crop and hairy vetch (*Vicia villosa* Roth) in the winter for the preceeding 8 years. The soil was a Dothan fine sandy loam [Plinthic paleudults, fine-loamy, siliceous; pH 6.2 and organic matter < 1.0% (w/w)]. Plots were 4-rows (0.9 m each) wide and 10 m long. Each treatment in each experiment was represented by 8 replications (plots) arranged in a randomized complete block design. The experiments were initiated in 1981 and studied 3-year rotations of 'Florunner' peanut with either of the 2 Gramineae. One experiment was with Funk® G522 sorghum and the other with Pioneer® 3368A corn. Treatments in each experiment were identical except for the change in cereal corp; Table 1 describes the treatments.

Ethylene dibromide (EDB, formulated as Soilbrom® 90) was injected into the soil at-planting to a depth of 20-25 cm at a rate of 16.8 L ai/ha using 2 injectors/row set 20 cm apart with the seed furrow in the middle.

Soil samples for nematode analysis were collected from the center 2

Table 1. Sequences of crops and fumigation with EDB followed for 3 years in two experiments to determine the effect of corn or sorghum as rotational crops for management of *Meloidogyne arenaria* in a peanut field near Headland, Alabama.

1981	1982	1983
peanut (—)[x]	peanut (—)	peanut (—)
peanut (+)	peanut (+)	peanut (+)
peanut (—)	corn or sorghum (—)	peanut (—)
peanut (+)	corn or sorghum (—)	peanut (+)
peanut (—)	corn or sorghum (+)	peanut (—)
peanut (+)	corn or sorghum (+)	peanut (+)
corn or sorghum (—)	corn or sorghum (—)	peanut (—)
corn or sorghum (+)	corn or sorghum (+)	peanut (+)

[x](+) = treated with 16.8 L ai/ha of EDB; (—) = not treated.

rows of each plot annually at harvest time for each crop to coincide with the period of maximal population development (4). Each sample consisted of 16-20 soil cores (2.5 cm diam) obtained from the root zone to a depth of 18-24 cm using a standard soil auger. Numbers of nematodes in the samples were determined following incubation in water for 72 hr using the "salad bowl" technique (7). Cultural practices and control of foliar diseases and insects were according to recommendations for the area (3). Yield of each crop was obtained at maturity by harvesting the 2 center rows of each plot.

All data were analyzed following standard procedures for analysis of variance and Fisher's least significant differences were calculated following standard procedures (10). Unless otherwise indicated, differences referred to in the text were significant at the 5% or lower level of probability.

RESULTS

Corn experiment. In 1981, the application of EDB resulted in reduced numbers of *M. arenaria* juveniles in peanut but not in corn (Table 2); populations with corn were 25-60 fold smaller than in peanut. Applications of EDB resulted in increased yields of both crops in 1981 (Table 2).

The use of EDB had no effect on juvenile populations in corn in 1982 (Table 3), but reduced number of juveniles in peanut; juvenile populations were lower in corn than in peanut. Yield of peanut was

Table 2. Effect of EDB on soil juvenile populations of *Meloidogyne arenaria* and yields of corn and peanut in the first year (1981) of a 3-year rotation experiment near Headland, Alabama.

Crop (EDB)	Juveniles per 100 cm^3 soil	Yield (kg/ha)
Peanut (—)[x]	650	2091
Peanut (+)	362	2715
LSD (P = 0.05):	129	255
LSD (P = 0.01):	175	346
Corn (—)	14	4003
Corn (+)	11	4904
LSD (P = 0.05):	129	726
LSD (P = 0.01):	175	1074

[x](+) = treated with 16.8 L ai/ha of EDB; (—) = not treated.

higher in EDB-treated plots than in untreated plots (Table 3); however, application of the fumigant did not result in increased yield of corn. There was no significant interaction between nematicide use and the effect of the preceeding 1981 crop on corn yields for 1982. When 1982 corn yields were considered to determine the effect of the preceeding 1981 crop, highest yields were obtained in plots planted to peanut in 1981 regardless of whether they were treated with EDB or not; however, this difference was significant only at P = 0.10.

The interaction of the effect of EDB and cropping history on juvenile populations in 1983 was significant (Table 4). All treatments but one (2 years of corn followed by peanut all with no EDB) resulted in lower numbers of juveniles in the soil than the monoculture of peanut with no nematicide.

In 1983, treatments that included the application of EDB to the preceeding one or two years of corn were the only ones that resulted in higher peanut yields than the yield obtained from the monoculture of peanut without EDB (Table 4); yield differences between treatments that had no EDB in any of the 3 years of the study were not significant.

Table 3. Effect of the preceeding crop and the application of EDB on yields of corn and peanut and on soil juvenile populations of *Meloidogyne arenaria* in the second year (1982) of a 3-year rotation established in a field near Headland, Alabama.

Crop Sequence and EDB		Juveniles per 100 cm^3 soil	Yield (kg/ha)
1981	1982		
Corn (—)[x]	Corn (—)	10	4668
Corn (+)	Corn (+)	2	4869
Peanut (—)	Corn (—)	6	5455
Peanut (—)	Corn (+)	1	5216
Peanut (+)	Corn (—)	7	5305
Peanut (+)	Corn (+)	2	5324
	LSD (P = 0.05):	25	577
	LSD (P = 0.01):	34	776
Peanut (—)	Peanut (—)	232	2170
Peanut (+)	Peanut (+)	35	2973
	LSD (P = 0.05):	25	282
	LSD (P = 0.01):	34	417

[x](+) = treated with 16.8 L ai/ha of EDB; (—) = not treated.

Table 4. Effect of cropping history and applications of EDB on 'Florunner' peanut yields and soil juvenile populations of *Meloidogyne arenaria* in the third year (1983) of a 3-year rotation study in a field near Headland, Alabama.

Crop Sequence and EDB			Juveniles per	Yield
1981	1982	1983	100 cm^3 soil	(kg/ha)
Peanut (—)[x]	Peanut (—)	Peanut (—)	229	2772
Peanut (+)	Peanut (+)	Peanut (+)	136	3125
Peanut (—)	Corn (—)	Peanut (—)	142	3108
Peanut (+)	Corn (—)	Peanut (+)	173	2898
Peanut (—)	Corn (+)	Peanut (—)	154	3282
Peanut (+)	Corn (+)	Peanut (+)	146	3263
Corn (—)	Corn (—)	Peanut (—)	184	2937
Corn (+)	Corn (+)	Peanut (+)	124	3667
		LSD (P = 0.05):	55	436
		LSD (P = 0.01):	74	583

[x](+) = treated with 16.8 L ai/ha of EDB; (—) = not treated.

Sorghum experiment. In 1981, use of EDB had no effect on juvenile populations with either sorghum or peanut (Table 5); however, juvenile populations in sorghum were lower than in peanut. Yields of peanut and sorghum increased in response to application of the fumigant (Table 5).

Use of EDB in 1982 resulted in increased yield of sorghum but not of peanut (Table 6). The interaction between the effects of nematicide use and the effect of the 1981 crop on 1982 sorghum yields was not significant. A significant effect of the 1981 crop on 1982 yields was indicated irrespective of whether sorghum was treated with EDB or not in 1982 (Table 7). Highest sorghum yields were obtained in plots that had been planted with peanuts in 1981 and lowest yields were obtained in plots which had sorghum that year. Applications of EDB did not result in reductions of larval populations in plots with peanuts in 1982 (Table 6); juvenile populations were larger in plots in peanuts than in sorghum.

The interaction between the effects of cropping history and the use of EDB on juvenile populations was significant for the 1983 data (Table 8). No combination of cropping sequence and EDB use reduced juvenile populations below the levels found in unfumigated plots with continuous peanut.

The interaction between the effects of cropping history and EDB use on 1983 peanut yields was significant (Table 8). Applications of

Table 5. Effect of EDB on soil juvenile populations of *Meloidogyne arenaria* and yields of sorghum and peanut in the first year (1981) of a 3-year rotation experiment near Headland, Alabama.

Crop (EDB)	Juveniles per 100 cm³ soil	Yield (kg/ha)
Peanut (—)[x]	391	2240
Peanut (+)	421	2983
LSD (P = 0.05):	124	285
LSD (P = 0.01):	166	382
Sorghum (—)	41	1058
Sorghum (+)	40	2482
LSD (P = 0.05):	124	659
LSD (P = 0.01):	166	975

[x](+) = treated with 16.8 L ai/ha of EDB; (—) = not treated.

Table 6. Effect of the preceeding crop and application of EDB on 1982 yields of sorghum and peanut and on soil juvenile populations of *Meloidogyne arenaria* in the second year (1982) of a 3-year rotation experiment near Headland, Alabama.

Crop Sequence and EDB		Juveniles per 100 cm³ soil	Yield (kg/ha)
1981	1982		
Sorghum (—)[x]	Sorghum (—)	17	3637
Sorghum (+)	Sorghum (+)	7	3895
Peanut (—)	Sorghum (—)	18	3992
Peanut (—)	Sorghum (+)	3	4315
Peanut (+)	Sorghum (—)	36	4328
Peanut (+)	Sorghum (+)	11	4611
	LSD (P = 0.05):	93	303
	LSD (P = 0.01):	125	407
Peanut (—)	Peanut (—)	204	2609
Peanut (+)	Peanut (+)	142	3013
	LSD (P = 0.05):	93	494
	LSD (P = 0.01):	125	733

[x](+) = treated with 16.8 L ai/ha of EDB; (—) = not treated.

Table 7. Effect of the 1981 crop on sorghum yields in the second year (1982) of a 3-year rotation study in a field infested with *Meloidogyne arenaria* near Headland, Alabama.

1981 Crop		Juveniles per 100 cm³ soil	Yield (kg/ha)
Peanut		173	4311
Sorghum		12	3766
	LSD (P = 0.05):	N.S.[a]	303
	LSD (P = 0.01):	N.S.	407

[a]N.S. = not significant at P = 0.05.

EDB to plots under continuous peanut culture with EDB resulted in no yield response. The only treatments that resulted in yields higher than those obtained in unfumigated plots with continuous peanut, were those that contained one or more years with sorghum and were treated 2 or 3 years with EDB.

Table 8. Effect of cropping history and applications of EDB on yield of peanut and on juvenile populations of *Meloidogyne arenaria* in a 3-year rotation study in a field at the Wiregrass Substation, near Headland, Alabama.

Crop Sequence and EDB			Juveniles per 100 cm³ soil	Yield (kg/ha)
1981	1982	1983		
Peanut (—)[a]	Peanut (—)	Peanut (—)	192	2756
Peanut (+)	Peanut (+)	Peanut (+)	310	2783
Peanut (—)	Sorghum (—)	Peanut (—)	197	3195
Peanut (+)	Sorghum (—)	Peanut (+)	265	3247
Peanut (—)	Sorghum (+)	Peanut (—)	326	2758
Peanut (+)	Sorghum (+)	Peanut (+)	229	3312
Sorghum (—)	Sorghum (—)	Peanut (—)	278	2688
Sorghum (+)	Sorghum (+)	Peanut (+)	221	3556
		LSD (P = 0.05):	78	402
		LSD (P = 0.01):	104	536

[a](+) = treated with 16.8 L ai/ha of EDB; (—) = not treated.

DISCUSSION

The 2 experiments of this study were conducted on soils representative of the peanut growing area of Alabama. As many as 41% of the peanut fields in the state are infested with *Meloidogyne* spp., principally *M. arenaria* (4). Recently we have estimated that annual peanut yield losses due to *M. arenaria* in Alabama amount to about 5.3 million U.S. dollars (unpublished data). These losses emphasize the importance of evaluating all means of controlling *M. arenaria* in peanut. Our results indicate that both corn and sorghum can reduce juvenile populations of the nematode in soil to levels 10-20 times below those found with peanut. However, the data also indicated that the nematode recovers quickly when peanut followed corn or sorghum so that even after 2 years on either of the 2 graminaceous crops, juvenile populations in plots with a succeeding peanut crop are equal to or greater than the populations in plots under peanut monoculture.

The continuous use of EDB for managing *M. arenaria* exclusive of any other control measure in a peanut monoculture situation is not reliable. Yield differences between fumigated and nonfumigated plots with continuous peanut disappeared with time so that, while evident in the first year, the differences were not significant in the third year, and even in the second year there was no significant difference in the sorghum experiment.

The value of using a graminaceous crop in rotation with peanut was demonstrated when EDB was included to control *M. arenaria*. Highest peanut yields in 1983 were obtained in plots that had been with sorghum or corn in the preceeding 2 years and that had been fumigated every year. This suggests that the inclusion of a graminaceous crop in a rotation may assure the increase in yield of a succeeding peanut crop treated with EDB.

The effects of EDB on corn or sorghum may not be entirely due to the control of *M. arenaria*. In 1981 applications of EDB resulted in significant yield increases, but there were no significant differences in juvenile populations between treated and untreated plots. EDB is known to be a good inhibitor of nitrification at the rate used in our experiments (12). It is possible that this inhibition may have resulted in yield increases of the two graminaceous crops in 1981. However, this response was not observed in 1982, suggesting also that there may be other effects, or that the effect of EDB on yield of these crops may be dependent on environmental conditions.

Results showed a beneficial effect of peanut on yields of succeeding sorghum ($P = 0.01$) or corn ($P = 0.10$) crops. Both corn and sorghum were provided each year with adequate nitrogen for their development.

Therefore, the effect of a preceeding peanut crop on yield of corn or sorghum cannot be attributed entirely to nitrogen added to the soil by the legume. The beneficial effect of leguminous crops on yield of graminaceous crops has been observed (13); however, the precise nature of this effect remains to be elucidated.

In conclusion, our study shows that reliance on corn or sorghum as the sole means for controlling *M. arenaria* in peanut is not justified, and that the use of either corn or sorghum in rotation with peanut and in conjunction with applications of EDB to the crops results in increased peanut yields as compared with the yields obtained with continuous peanuts with or without EDB.

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