BAHIAGRASS FOR THE MANAGEMENT OF ROOT-KNOT AND CYST NEMATODES IN SOYBEAN

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Accepted:
13.X.1989
Aceptado:

ABSTRACT

Rodríguez-Kábana, R., D. B. Weaver, R. García, D. G. Robertson, and E. L. Carden. 1989. Bahiagrass for the management of root-knot and cyst nematodes in soybean. Nematrópica 19:185–193.

The effect of rotation with bahiagrass (*Paspalum notatum*) on soybean (*Glycine max*) yields and end-of-season (2 weeks before soybean harvest) soil populations of root-knot (*Meloidogyne arenaria*) and cyst nematode (*Heterodera glycines*, race 4) was studied in a field in Baldwin county, Alabama. Soybean cvs. Braxton, Centennial, Gordon, Kirby, Leflore, Ransom, and Stonewall were planted in plots that had been planted to 'Pensacola' bahiagrass for the previous 2 years and in others that had been in monoculture with soybean. In each of the two cropping systems each cultivar was planted in plots treated at planting with the 15G formulation of aldicarb (41.4 g a.i./100 m of row in a 20-cm-wide band) and without a nematicide. For all cultivars the nematicide treatment did not increase yield or affect second-stage juvenile populations of either *M. arenaria* or *H. glycines*. Yields of all cultivars were higher in the bahiagrass-soybean plots than in those in the soybean monoculture. Yield responses to the bahiagrass rotation ranged from 33% for 'Leflore' to 233% for 'Braxton'; the average percent increase in yield for all cultivars was 110%. Second-stage juvenile populations of *M. arenaria* in soil either were not affected by the cropping system or were lower in the bahiagrass-soybean plots than in the corresponding monoculture plots. The highest numbers of *M. arenaria* J2 were in monoculture plots of 'Leflore'. Numbers of *H. glycines* J2 in soil were lowest in plots of 'Leflore' irrespective of cropping system; however, J2 populations of this nematode in soil were lower than those of *M. arenaria*.

Key words: bahiagrass, cropping systems, cyst nematodes, *Glycine max*, *Heterodera glycines*, *Meloidogyne arenaria*, *Paspalum notatum*, pest management, root-knot nematodes, soybean.

RESUMEN

Rodríguez-Kábana, R., D. B. Weaver, R. García, D. G. Robertson y E. L. Carden. 1989. El pasto bahía para el manejo de los nematodos agalladores y del quiste en soya. Nematrópica 19:185–193.

Se estudiaron en un campo en el condado de Baldwin, Alabama, los efectos de una rotación con pasto bahía (*Paspalum notatum*) sobre el rendimiento de la soya (*Glycine max*) y sobre las poblaciones finales en el suelo del nematodo agallador (*Meloidogyne arenaria*) y del nematodo del quiste (*Heterodera glycines*, raza 4). En el estudio se plantaron los cultivares de soya Braxton, Centennial, Gordon, Kirby, Leflore, Ransom y Stonewall tanto en parcelas que habían estado anteriormente con pasto bahía 'Pensacola' por dos años así como en otras en monocultivo con soya. En cada uno de los dos sistemas de producción cada cultivar se sembró en parcelas tratadas con la formulación 15G de aldicarb (41.4 g i.a./100 m de surco en una franja de 20 cm de ancho) y en otras sin nematicida. El tratamiento nematicida no tuvo efecto sobre el rendimiento de soya o sobre las poblaciones de larvas de *M. arenaria* y de *H. glycines*. Los rendimientos de todos los cultivares fueron más altos en las parcelas con el sistema bahía-soya que en las en monocultivo. El aumento en la producción de soya debido a la rotación con bahía varió entre 33% para 'Leflore' hasta 233% para 'Braxton' siendo el promedio para todos los cultivares 110%. Las poblaciones más altas de larvas de *M. arenaria* se encontraron en las parcelas con 'Leflore' en monocultivo aunque el número más bajo de larvas de *H. glycines* en el suelo se reistró en las parcelas con este cultivar en ambos sistemas de producción. Las poblaciones larvales de *H. glycines* fueron inferiores a las de *M. arenaria* en casi todas las parcelas.

Palabras claves: Glycine max, Heterodera glycines, manejo de plagas, *Meloidogyne arenaria,* nematodos agalladores, nematodos del quiste, *Paspalum notatum,* pasto bahía, sistemas de producción, soya.

INTRODUCTION

Root-knot (*Meloidogyne* spp.) and cyst (*Heterodera glycines* Ichinohe) nematodes are important yield-limiting pests of soybean (*Glycine max* (L.) Merr.) in the southeastern United States (6,7,20,24). In Alabama and especially in the southern counties of the state, there are fields where *H. glycines* is found together with one or more species of *Meloidogyne*. In these fields yield losses to the nematodes can be so drastic that soybean cannot be produced economically (21,26–29). Traditionally, nematode problems in soybean in the southeastern United States have been managed through the use of resistant or tolerant cultivars (16–18,22,23,26,29), rotation with corn (*Zea mays* L.) (4,5,28), or less frequently with the use of nematicides (8,11,15,27). The recent removal of inexpensive fumigants (EDB, DBCP) for use in soybean resulted in the virtual elimination of nematicide applications to soybean fields in Alabama. Nematicides currently available for the crop are too expensive and are effective only under limited conditions (15). The successful incorporation of resistance or tolerance into soybean to races of *H. glycines* and to *M. incognita* and *M. arenaria* provided producers with several cultivars with multiple resistance to the common races of these species (16,17,26,29). Cultivars with multiple resistance produced higher yields than susceptible cultivars and cultivars with resistance to single nematode species, when planted in soils with mixed infestations of cyst and root-knot nematodes (26,27,29); however, their performances in these fields has not been adequate to permit profitable soybean production in a monoculture system. Rotation of soybean with corn resulted in significant improvement of yield performance of soybean cultivars in fields with mixed populations of root-knot and cyst nematodes regardless of the levels of resistance (or tolerance) in the cultivars to the nematodes (28). For some producers, corn is not an acceptable crop to rotate with soybean. Corn can be produced with consistent profitability in Alabama only in irrigated fields or in areas near the Gulf Coast where rainfall is adequate and is distributed evenly throughout the growing season. Thus, there is need to find other crops for use in rotation with soybean (12,13). Bahiagrass (*Paspalum notatum* Flugge) was effective for the management of *M. arenaria* in peanut (*Arachis hypogaea* L.) (19). There is no information on the relative efficacy of this pasture plant in rotation with soybean for the management of nematodes in fields with mixed populations of cyst and root-knot nematodes. This paper presents results of a 3-year study on the effect of bahiagrass on nematode populations and yields of selected soybean cultivars in one such field.

MATERIALS AND METHODS

A study was initiated in 1986 to evaluate the use of bahiagrass as a rotation crop for the management of soybean nematodes. The experiment was in a field near Elberta, Baldwin County, Alabama, infested with cyst (*Heterodera glycines*, race 4) and root-knot (*Meloidogyne arenaria* (Neal) Chitwood) nematodes. The field had been in continuous soybean production for at least 10 years with either ryegrass (*Lolium* sp.) or rye (*Secale cereale* L.) as winter cover crop. The soil was a sandy loam (fine loamy, siliceous thermic, typic Palendults) with pH = 6.0, cation exchange capacity < 10 meq./100 g of soil and organic matter content < 1.0% w/w). In 1986 the field was divided into four sections, each 30 m wide × 100 m long. Two sections were planted broadcast with 'Pensacola' bahiagrass and the other two with 36 rows of 'Kirby' soybean on 0.8-m centers. The sections were arranged to have bahiagrass alternating with soybean. The field was planted again in the same manner in 1987 and was left fallow through the winter both years. In 1988 each land section was divided into eight 6-m-long blocks separated by 6-m alleys. Each block was then divided into 14 two-row plots on 0.8 m centers. Four rows were planted with 'Kirby' on each side of every section to serve as guard rows. Plots were planted with the soybean cvs. Braxton, Centennial, Gordon, Kirby, Leflore, Ransom, and Stonewall from maturity groups (MG) VI, VII, VIII. The responses of the cultivars to *M. arenaria* and races 3 and 4 of *H. glycines* are presented in Table 1. Each cultivar was represented in each block by two plots; one plot was left untreated and the other received an at-plant application of the 15G formulation of aldicarb at 41.4 g a.i./100 m of row in a 20-cm-wide band (8.8 kg a.i./ha broadcast) with light (2–4 cm deep) incorpora-

Table 1. Host response of soybean cultivars to *Meloidogyne arenaria* and *Heterodera glycines*, races 3 and 4.

Cultivar	Maturity Group	*M. arenaria*	*H. glycines* Race 3	*H. glycines* Race 4
Braxton	VII	R[z]	S	S
Centennial	VI	S	R	S
Gordon	VII	R	R	S
Kirby	VIII	R	R	S
Leflore	VI	S	R	R
Ransom	VII	S	S	S
Stonewall	VIII	S	S	S

[z]R = resistant; S = susceptible.

tion into the soil. The nematicide was delivered with a Gandy applicator (Gandy Co., Owatonna, MN, U.S.A). Thus there were 14 treatments arranged in each section in a randomized complete block design.

Soil samples for nematode analysis were collected each year 1–2 weeks before soybean harvest to coincide with the period of maximal population development of second-stage juveniles (J2) of *Meloidogyne* in soil planted to 'Kirby' (MG VIII) (18). In 1986 and 1987 samples were collected from each section from the areas where plots were established in 1988 to have eight samples per section, one per block. The samples for each block consisted of 40 cylindrical (2.5 cm diam) cores collected diagonally from the soybean rhizosphere to a depth of 20–25 cm; sections with bahiagrass were sampled in like manner. Cores from each block were composited and a 100 cm^3 subsample was used for nematode analysis using the "salad bowl" incubation technique (14). In 1988 a sample consisting of 16–20 cores taken at approximately equal spacings from both rows through the length of the plot was collected from each plot. The cores from a plot were composited and the sample was then processed as for previous years. Soybeans were harvested at maturity and yields were determined in 1986 and 1987 by harvesting a 6-m-long section from two rows in each block. In 1988 yields were from the entire plot area. No attempt was made to determine bahiagrass forage production.

Cultural practices, fertilization, and control of weeds and insects in soybean were as recommended for the area (1,3). Bahiarass was planted at a rate of 22 kg/ha and fertilized each year according to recommendations from soil analysis.

Data were analyzed according to standard procedures for analysis of variance (9,25). Fisher's least significant differences were calculated and are included in the tables of results. Unless otherwise stated, differences between means referred to in the text were significant at the 5% or lower level of probability.

RESULTS

Data from 1986 and 1987 are in Table 2. Numbers of *M. arenaria* and *H. glycines* J2 in soil were almost undetectable in bahiagrass sections in 1986 and in 1987 no J2 of either species were detected in soil from these sections. In contrast, *M. arenaria* J2 in sections with 'Kirby' were > 100/100 cm^3 of soil in 1986 and 1987; *H. glycines* J2 in these sections were higher in 1987 than in 1986. 'Kirby' yields in 1986 and 1987 were 1 300 and 1 842 kg/ha, respectively.

Data from 1988 are in Table 3. Soybean yields in 1988 were not affected by aldicarb treatment. The nematicide had no effect on J2 populations of either *M. arenaria* or *H. glycines*. There were no cultivar × nematicide or rotation × nematicide interactions on yield. All cultivars had higher yields following bahiagrass than following 'Kirby' soybean. Yield responses to the bahiagrass-soybean rotation varied according to soybean cultivar and ranged from 33% increase for 'Leflore' to 233% for 'Braxton'. There was no cultivar × cropping history interaction on yield. The average increase in yield for all cultivars in response to bahiagrass was 110%.

Numbers of *M. arenaria* J2 in soil were highest in plots with 'Leflore' but only after soybean and not after bahiagrass. Second-stage juvenile populations of *M. arenaria* in soil either were not affected by the cropping system or were lower in the bahiagrass-soybean plots than in monoculture plots.

The lowest numbers of *H. glycines* J2 were in plots with 'Leflore' regardless of cropping history and the highest numbers in plots with 'Braxton' following bahiagrass. The interaction of cultivar × cropping history on numbers of *H. glycines* was significant. In most plots numbers of *H. glycines* J2 were lower than those of *M. arenaria*.

DISCUSSION

Results showed clearly that bahiagrass can be used to reduce populations of *M. arenaria* and *H. glycines* and increase yields of soybean follow-

Table 2. Effect of 'Pensacola' bahiagrass (*Paspalum notatum*) and 'Kirby' soybean on end-of-season second-stage juvenile populations of *Meloidogyne arenaria* and *Heterodera glycines* (race 4) in 100 cm^3 of soil in 1986 and 1987 in a field near Elberta, Baldwin County, Alabama.

	1986		1987	
	M. arenaria	*H. glycines*	*M. arenaria*	*H. glycines*
Bahiagrass	4	1	0	0
Soybean	119	26	111	205

Differences between populations recovered from each host within each year are significantly different at $P \leq 0.05$ according to Student's *t*-test.

Table 3. Effect of aldicarb application and bahiagrass-soybean rotation on soybean yield and end-of-season second-stage juvenile populations of *Meloidogyne arenaria* and *Heterodera glycines* in soil in a field experiment near Elberta, Baldwin County, Alabama.

Cultivar	Aldicarb application	Continuous soybean			Bahiagrass-soybean		
		Yield (kg/ha)	Juveniles/100 cm^3 of soil		Yield (kg/ha)	Juveniles/100 cm^3 of soil	
			M. arenaria	*H. glycines*		*M. arenaria*	*H. glycines*
Braxton	−	635	21	13	2 441	36	37
Braxton	+	830	14	16	2 441	20	58
Centennial	−	1 221	61	6	2 148	35	22
Centennial	+	1 318	29	10	2 246	59	11
Gordon	−	732	29	14	2 002	28	23
Gordon	+	879	14	18	2 099	28	20
Kirby	−	1 123	33	29	1 806	28	15
Kirby	+	1 221	29	28	2 002	13	11
Leflore	−	1 709	160	3	2 392	46	2
Leflore	+	1 855	174	1	2 441	38	1
Ransom	−	830	49	11	2 392	52	38
Ransom	+	1 025	67	20	2 495	55	15
Stonewall	−	976	33	20	2 734	58	25
Stonewall	+	1 123	62	9	2 880	57	21

FLSD (0.05) values for comparing any two means are 235, 22, and 12 for yield, *M. arenaria* populations, and *H. glycines* populations, respectively.

ing the pasture crop. This confirms our previous work on the effects of the pasture on *M. arenaria* in peanut (19). The nonhost nature of bahiagrass for *M. arenaria* and *H. glycines* is not limited to cv. Pensacola used in this study; our previous work showed that other cultivars of the crop are equally unsuitable hosts for these nematodes (19).

The present study showed that the highest yielding soybean cultivar in the continuous soybean system was 'Lefore'; however, even with this cultivar the yields obtained, while much superior to those of susceptible cultivars (e.g. 'Ransom', 'Stonewall'), would not permit economic production of soybean in a monoculture system in the field used for the study. This situation is typical of fields infested with mixed populations of cyst and root-knot nematodes (16,26,27,29). Yields from the bahiagrass-soybean rotation showed that the field could be put back into profitable soybean production and that yields of all cultivars without exception were improved. This suggests that for maximal yields the choice of cultivars to use in the bahiagrass-soybean rotation could be less dependent on the levels of resistance (or tolerance) to the nematodes present in the field than on the productivity potential present in the cultivars. 'Stonewall', a cultivar susceptible to the nematodes present in the field, was the cultivar with the highest yield potential in the test. This contrasted with the situation in the monoculture system where the profiles for nematode resistance (or tolerance) in the cultivars were critical for maximizing yield.

Nematode populations in soybean plots in 1988 were 4–5 times lower than in previous years for this field. Samples in 1988 were collected after a month-long dry period which probably resulted in a decline in the J2 populations in soil for all plots. However, the nematode data did show that 'Leflore' was indeed resistant to race 4 of the cyst nematode, but that in the monoculture system the cultivar supported the highest J2 populations of *M. arenaria*. We have observed this phenomenon before when cultivars resistant to *H. glycines* races but susceptible to root-knot nematodes, are planted in fields infested with the two types of nematodes (16,27). The bahiagrass-soybean rotation is apparently useful in obviating this problem.

The 1988 nematode data from plots with the rotation system suggest that the beneficial effects of bahiagrass may be short-lived given the exponential nature of root-knot nematode population development (18) and the fact that J2 population levels of both nematodes were almost as high on these plots as in the monoculture plots. We plan to continue the study to determine the long-term effects of the rotation on soybean yields and nematode populations.

The positive effect of the bahiagrass rotation on soybean yield cannot be attributed solely to its effect on nematode populations. Bahiagrass has been shown to improve soil physical properties (2,10). Since the study field had no conspicuous hardpan or other deleterious or yield-limiting physical properties, we interpret part of the yield benefit obtained from the bahiagrass rotation as due to some beneficial secondary effects not yet identified by our group. There also is the possibility that some soilborne fungi pathogenic to soybean may have been suppressed by the bahiagrass rotation (Rodríguez-Kábana, unpubl.).

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Received for publication: *21.IV.1989*
Recibido para publicar: