ADDITIONAL STUDIES ON THE USE OF BAHIAGRASS FOR THE MANAGEMENT OF ROOT-KNOT AND CYST NEMATODES IN SOYBEAN

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ABSTRACT

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The value of a 2-year rotation to Pensacola bahiagrass (*Paspalum notatum*) for management of nematode problems in three subsequent soybean (*Glycine max*) crops was studied in a field infested with *Meloidogyne arenaria* and *Heterodera glycines*. Five soybean cultivars were selected to represent a range of resistance to each species and grown for 3 years following the bahiagrass rotation, with and without aldicarb application at soybean planting. Bahiagrass reduced populations of both nematode species to nearly undetectable levels. The first year following bahiagrass, rotation plots yielded 114% more than monoculture plots and neither host resistance nor nematicide treatment affected yield substantially. In the second and third years, however, there was a marked decline in yield each year and relative benefits of host resistance and nematicide increased.

Key words: bahiagrass, control, cropping systems, crop rotations, cultural practices, cyst nematode, *Glycine max, Heterodera glycines, Meloidogyne arenaria, Paspalum notatum,* pest management, root-knot nematode, soybean.

RESUMEN

Rodríguez-Kábana, R., D. B. Weaver, D. G. Robertson, E. L. Carden, y M. L. Pegues. 1991. Estudios adicionales sobre el pasto bahía para el manejo de los nematodos agalladores y del quiste en soya. Nematrópica 21:203–210.

Se estudió la eficacia de una rotación de cultivos de dos años con la variedad Pensacola de pasto bahía (*Paspalaum notatum*) para el manejo de problemas causados por nematodos en la soya (*Glycine max*) durante 3 años subsiguientes al pasto en un campo infestado por *Meloidogyne arenaria* y *Heterodera glycines.* Se seleccionaron para el estudio cinco cultivares de soya de manera a tener una gama de resistencia para cada una de las especies de nematodos cuando se plantaron los cultivares con y sin tratamiento nematicida durante la siembra en los 3 años después del pasto. El pasto bahía disminuyó las poblaciones de ambos nematodos a niveles casi indetectables. En el primer año después del pasto las parcelas con la rotación rindieron 114% más que las otras en monocultivo, careciendo de importancia los efectos de la resistencia de los cultivares y del tratamiento nematicida sobre los rendimientos. No fue así en el segundo y tercer años en los cuales se observó una disminución pronunciada en los rendimientos cada año y un aumento en los beneficios derivados de la resistencia en los cultivares y del tratamiento nematicida.

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

INTRODUCTION

Soybean (*Glycine max* (L.) Merr.) is a good host for many nematodes (7,17,26). Root-knot nematodes (*Meloidogyne* spp.) and the soybean cyst nematode (*Heterodera glycines* Ichinohe) are of particular importance to soybean production throughout the world (5,6,7,23,26). They are widely distributed in the southeastern United States and frequently occur in polyspecific infestations (17,30,31,32). Breeding for resistance to root-knot and cyst nematodes in soybean has produced many commercially available cultivars resistant or tolerant to certain races of each species (7,8,16,26). Performance of resistant cultivars in fields with polyspecific nematode infestations, however, is sometimes unsatisfactory (29,30,31,32) because no cultivar is available with combined resistance to all of the species and races of root-knot and soyben cyst nematodes that are present in many polyspecific infestations. In addition, diagnostic services to identify races and species of nematodes present in fields are rarely available to soybean producers.

Crop rotations with corn (*Zea mays* L.) (4,5,17,25,31), sorghum (*Sorghum bicolor* Moench) (21), hairy indigo (*Indigofera hirsuta* L.) and American jointvetch (*Aeschynomene americana* L.) (12,13,20) are useful for the management of problems caused by mixed infestations of *H. glycines* and *M. arenaria* (Neal) Chitwood in soybean fields. The perennial grazing grass known as bahiagrass (*Paspalum notatum* Flügge) is another promising rotation crop. Bahiagrass is a non-host for *H. glycines, M. arenaria,* and *M. incognita* (Kofoid and White) Chitwood (22). In an Alabama soybean field infested with *M. arenaria* race 2 and *H. glycines* race 14, marked increases in soybean yield were obtained the first year following a 2-year rotation to bahiagrass (19). We now have monitored yield and nematode populations after growing selected soybean cultivars for 2 additional years in the same field, to evaluate long term effects of the bahiagrass rotation.

MATERIALS AND METHODS

The soybean field, experimental design, cultural practices, and the methods used for applying the aldicarb, measuring soybean yield, and estimating nematode populations were described in detail previously (19). Briefly, the field had a sandy loam soil, had been planted continuously to soybean for 10 years, and was infested with *M. arenaria* race 2 and *H. glycines* race 14.

The experimental design was a modified split plot, randomized complete block (19), with 16 blocks and 28 treatment plots (6 m long and 2 rows wide) per block. Half of each block was planted to bahiagrass for 2 years (1986–1987) while the other half was planted to 'Kirby' soybean. The following year (1988) the 14 plots of each half were planted to seven soybean cultivars so that there were

Table 1. Host response of soybean cultivars to *Meloidogyne arenaria* race 2 and *Heterodera glycines* races 3 and 14.

Cultivar	Maturity group	*M. arenaria*	*H. glycines* Race 3	*H. glycines* Race 14
Braxton	VII	R[z]	S	S
Brim	VI	S	S	S
Kirby	VIII	R	R	S
Leflore	VI	S	R	R
Ransom	VII	S	S	S
Stonewall	VII	S	R	S

[z]R = resistant; S = susceptible.

two plots per cultivar with one receiving and one not receiving aldicarb band-incorporated at-plant (16.8 g a.i./100 m row). In each of the next two years (1989–1990) plots were again planted (with re-randomization as to cultivar and nematicide treatment) to the same soybean cultivars as in 1988 with the following exceptions. The cultivars 'Centennial' and 'Gordon' were replaced with 'Thomas' and 'Bryan,' and in 1990 the susceptible check 'Ransom' was replaced with 'Brim.' Therefore, data are presented only on the five that were grown continuously throughout the experiment, except for Ransom and Brim which are both susceptible and can be considered one cultivar for the purposes of this study, because of their lack of resistance to any of the nematode species present in the experimental field. The cultivars planted represented a wide range of resistance or tolerance to both nematode species, according to results of USDA uniform regional trials (Table 1).

Nematode populations in the bahiagrass and soybean crops of 1986–1987 were estimated from composite samples taken at crop maturity as previously described (19). In 1988–1990, a composite sample consisting of 15–20, 2.5-cm-diam cores taken 25–30 cm deep was collected from each plot and vermiform nematodes were extracted from a 100-cm^3 random aliquot by the salad bowl method (14). Each year soybean yield was measured by harvesting soybeans from all plants in each plot.

All data were subjected to analysis of variance (9,27) and Fisher's least significant differences were calculated only when F values were significant. Unless otherwise stated all differences referred to were significant at $P \leq 0.05$.

Table 2. End-of-season populations of *Meloidogyne arenaria* race 2 in soybean monoculture and in soybean following bahiagrass in a field infested with *M. arenaria* race 2 and *Heterodera glycines* race 14.

		Juveniles per 100 cm^3 soil					
		Soybean monoculture			After bahiagrass rotation		
Cultivar	Nematicide treatment[x]	1988	1989	1990	1988	1989	1990
Braxton	UT	22	223	422	36	403	165
	T	15	235	404	21	300	179
Kirby	UT	33	327	536	29	528	434
	T	30	349	524	13	384	274
Leflore	UT	161	500	480	46	936	438
	T	174	365	463	38	790	299
Ransom[y]	UT	50	388	363	52	630	253
	T	67	298	320	55	934	171
Stonewall	UT	33	358	458	57	660	381
	T	62	413	409	58	794	300
LSD (P = 0.05)[z]		32	169	78	32	169	78

[x]UT = untreated; T = treated at-plant with aldicarb at 16.8 g a.i./100 m row in a 20-cm-wide band centered on the seed furrow.

[y]In 1990 the cultivar Brim was substituted for Ransom.

[z]Least significant differences are for comparisons between any two means within the same year.

Table 3. End-of-season populations of *Heterodera glycines* race 14 in soybean monoculture and in soybean following bahiagrass in a field infested with *M. arenaria* race 2 and *Heterodera glycines* race 14.

		Juveniles per 100 cm^3 soil					
		Soybean monoculture			After bahiagrass rotation		
Cultivar	Nematicide treatment[x]	1988	1989	1990	1988	1989	1990
Braxton	UT	13	24	49	37	224	87
	T	16	36	92	58	169	124
Kirby	UT	29	35	111	14	96	141
	T	28	33	106	11	117	178
Leflore	UT	3	1	4	2	9	8
	T	2	9	8	1	6	6
Ransom[y]	UT	11	38	56	38	91	103
	T	21	46	64	15	192	58
Stonewall	UT	20	15	42	25	112	144
	T	10	52	54	21	110	89
LSD (P = 0.05)[z]		16	46	36	16	46	36

[x]UT = untreated; T = treated at-plant with aldicarb at 16.8 g a.i./100 m row in a 20-cm-wide band centered on the seed furrow.

[y]In 1990 the cultivar Brim was substituted for Ransom.

[z]Least significant differences are for comparisons between any two means within the same year.

RESULTS AND DISCUSSION

Two years of bahiagrass rotation (1986–1987) reduced populations of juveniles of *M. arenaria* and *H. glycines* to levels that were undetectable by salad bowl extraction at crop maturity (19). Neither species was eradicated, however, and by the end of the first soybean crop following bahiagrass (1988), population densities of both species were again comparable to those in monoculture plots (Tables 2 and 3), with one exception. Densities of *M. arenaria* in Leflore plots following bahiagrass were approximately 25% those in Leflore plots in monoculture. By the end of the second soybean crop (1989), populations of both species were numerically higher for every cultivar in plots that had been in bahiagrass than in corresponding plots in continuous monoculture; in several instances these differences were statistically significant. At the end of the third soybean crop (1990), similar relative differences were observed for *H. glycines*. However, in most cases, populations of *M. arenaria* were significantly lower in plots that had been in bahiagrass than in plots that had not during 1986–1987. This decrease in *M. arenaria* populations in rotation plots in 1990 may be due to marked reduction in plant vigor in those plots, which was reflected by soybean yield data (Table 4). These populations should not be compared with those measured in 1988. Populations detected in soybean monoculture in 1988 were much lower than in monoculture in any previous or subsequent year, which can be attributed to exceptionally dry soil conditions during sampling in 1988.

Table 4. Soybean yields in monoculture and following bahiagrass in 1986 and 1987 in a field infested with *Meloidogyne arenaria* race 2 and *Heterodera glycines* race 14 in Baldwin County, Alabama.

		Soybean yield (kg/ha)					
		Soybean monoculture			After bahiagrass rotation		
Cultivar	Nematicide treatment[x]	1988	1989	1990	1988	1989	1990
Braxton	UT	625	289	161	2448	1224	329
	T	820	343	269	2434	1130	491
Kirby	UT	1116	598	336	1829	1271	793
	T	1190	645	605	1957	1318	1083
Leflore	UT	1688	370	249	2401	1251	464
	T	1863	370	417	2421	1130	753
Ransom[y]	UT	820	161	67	2374	572	114
	T	1022	229	128	2576	598	276
Stonewall	UT	955	175	47	2777	834	134
	T	1143	215	201	2844	827	323
LSD (P = 0.05)[z]		195	229	121	195	229	121

[x]UT = untreated; T = treated at-plant with aldicarb at 16.8 g a.i./100 m row in a 20-cm-wide band centered on the seed furrow.
[y]In 1990 the cultivar Brim was substituted for Ransom.
[z]Least significant differences are for comparisons between any two means within the same year.

Consistent reductions in nematode densities at the end of the season as a result of aldicarb treatment at-plant were detected only in 1990 and only for *M. arenaria*. The cultivars Braxton and Kirby, which were reported resistant or tolerant to *M. arenaria* in USDA uniform regional trials, supported *M. arenaria* populations comparable to or greater than those of susceptible cultivars. Leflore, however, was clearly resistant to *H. glycines* race 14 and consistently supported populations that on the average were only 10% of those measured for other cultivars.

Yields of all soybean cultivars every year (1988–1990) were higher in the plots that were planted to bahiagrass in 1986–1987 than in plots that were not (Table 4). However, there was a marked decline in the average yield for all cultivars in rotation plots from 1988 to 1990 and a corresponding decrease in the benefit of the 1986–1987 bahiagrass rotation. The average yields for rotation plots in 1988, 1989, and 1990 were 2406, 1015, and 476 kg/ha, respectively, whereas average yields in monoculture for the same years were 1124, 339, 248 kg/ha. Thus, the 2-year bahiagrass rotation increased average yields by 1278 kg/ha in 1988, but only by 676 and 228 kg/ha in 1989 and 1990, respectively.

Bahiagrass roots can perforate hardpans and thereby improve conditions for root growth in a manner similar to deep plowing (2,10). The field in our experiment did not have a hardpan; nonetheless we cannot completely discount the possibility that part of the observed yield response to the rotation was due to improved soil friability or increased organic matter. Also, bahiagrass might suppress fungal and bacterial root pathogens, as we have observed (unpublished data) in rotations of bahiagrass with peanut (*Arachis hypogaea* L.).

In rotation plots in 1988, cultivars with limited or no resistance to the nematodes, i.e. Ransom and Stonewall, yielded as well as or better than the resistant or tolerant cultivars Braxton, Kirby and Leflore. Two and 3 years after rotation, however, yields of susceptible cultivars were 60-80% lower than yields of resistant cultivars. Thus, the value of planting a resistant cultivar was critically dependent on the time lapsed since the rotation. Yield response to aldicarb applications changed in a similar fashion. In 1988, some small responses to aldicarb application were detected but only in monoculture plots with Braxton and Ransom. In 1989, nematicide did not increase yields in either the monoculture or the bahiagrass-soybean system. In 1990, however, yields of most cultivars were improved by more than 100% in response to aldicarb in both cropping systems. Therefore, the value of nematicide application, like the value of planting a resistant cultivar, generally increased with the number of years in monoculture. This suggests that nematodes were the primary factor responsible for yield decline.

Given the current costs for soybean production (U.S. $197/ha), no yields of monocultured soybean that we measured in 1989 and 1990 would represent a profitable production (> 975 kg/ha at U.S. $0.202/kg soybean) in a farming operation in the U.S.A. In 1988, only yields of Kirby and Leflore would have been profitable. In contrast, profitable production with the rotation was possible for all cultivars in 1988, and for cultivars Braxton, Kirby, and Leflore in 1989, but for no cultivar in 1990. In no case would the use of aldicarb have been economically justified, given current costs of treatment (U.S. $44/ha).

Our results confirm that bahiagrass is an effective rotation crop to increase soybean yields in fields with bispecific nematode infestations of root-knot and cyst nematodes. Yield benefits obtained from the bahiagrass rotation probably resulted from reductions in primary inoculum early in the season, which may not be reflected in the size of the final juvenile populations at crop maturity as measured in this study (18). Our yield and nematode data show conclusively, however, that the effect of bahiagrass on nematodes is temporary and does not permit planting of soybeans more than 2 years after the perennial pasture crop.

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