SOYBEAN-PEANUT ROTATIONS FOR THE MANAGEMENT OF *MELOIDOGYNE ARENARIA* AND *SCLEROTIUM ROLFSII*

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ABSTRACT

Rodríguez-Kábana, R., D. G. Robertson, L. D. Wells, and P. S. King. 1991. Soybean-peanut rotations for the management of *Meloidogyne arenaria* and *Sclerotium rolfsii*. Nematropica 21:147–154.

Crop rotation of 'Florunner' peanut (*Arachis hypogaea*) with the soybean (*Glycine max*) cultivar Kirby was studied for 6 years to evaluate long-term effects on management of *Meloidogyne arenaria* and *Sclerotium rolfsii* in peanut production. Plantings included peanut monoculture, soybean every other year, and soybean 2 of every 3 years; for each, aldicarb was applied at-plant every year or was never applied. After 1 or 2 years of soybean, densities of second-stage juveniles (J2) of *M. arenaria* at peanut harvest were less than 10% of those in peanut control plots. However, populations usually resumed high levels (> 150 J2/100 cm³ soil) after a subsequent peanut crop. Aldicarb increased average yield from peanut monoculture by 20%. In the first 4 years, peanut yields of 1-year and 2-year rotations were comparable to but no better than those from peanut monoculture receiving aldicarb. During the 6-year study, however, monocultured peanut yield decreased by 35% whereas yields from rotation plots remained high. Degeneration of yield in monocultured peanut was associated with a sustained high population of *M. arenaria* and a progressive increase in incidence of southern blight caused by *S. rolfsii*. Thus, long-term rotation of peanut with Kirby soybean postponed peanut yield decline but did not reduce population densities of *M. arenaria* below economically damaging levels.

Key words: chemical control, crop rotation, cultural practice, *Glycine max, Meloidogyne arenaria,* nematicide, pest management, root-knot nematode, *Sclerotium rolfsii,* southern blight, soybean.

RESUMEN

Rodríguez-Kábana, R., D. G. Robertson, L. D. Wells y P. S. King. 1991. Rotaciones de maní con soya para el manejo de *Meloidogyne arenaria* y *Sclerotium rolfsii*. Nematrópica 21:147–154.

Se evaluó por un período de 6 años la rotación de maní (*Arachis hypogaea*) 'Florunner' con la soya (*Glycine max*) 'Kirby' para el manejo de *Meloidogyne arenaria* y de *Sclerotium rolfsii* en la producción de maní. En el estudio se compararon los efectos de maní en monocultivo con los de soya alternada con maní y los de soya por 2 años seguida por maní en un tercer año y de modo que en cada uno de los tres sistemas tanto el maní como la soya se plantaron con y sin aldicarb. En el tiempo de la cosecha de maní las densidades de población de formas juveniles (J2) de *M. arenaria* en el suelo después de 1 o 2 años de soya resultaron ser < 10% de las correspondientes a las de las parcelas con maní en monocultivo aunque las poblaciones en las parcelas con soya recuperaron altos niveles (> 150 J2/100 cm³ suelo) cuando se plantaron con maní. Aldicarb aumentó la producción de maní en monocultivo en un 20%. En los primeros 4 años los rendimientos de maní en las rotaciones con 1 o 2 años de soya fueron equivalentes a los obtenidos con maní en monocultivo más aldicarb. Aún así, se observó una disminución de un 35% en rendimiento de maní en monocultivo durante los 6 años del estudio mientras que la producción del mismo en las parcelas con rotación se mantuvo alta. El decaimiento en rendimiento del maní en monocultivo estuvo relacionado con la presencia constante de altas poblaciones de *M. arenaria* y con un aumento paulatino en la incidencia de la mustia blanca causada por *S. rolfsii*. La rotación de maní con soya Kirby retardó el decaimiento en los rendimientos de maní pero no redujo las poblaciones de *M. arenaria* a niveles inferiores al del umbral económico de este nematodo en maní.

Palabras clave: *Arachis hypogaea,* cambios de cultivo, cacahuete, control químico, *Glycine max,* maní, manejo de plagas, *Meloidogyne arenaria,* mustia blanca, nematodo de los nódulos, prácticas agronómicas, rotación de cultivos, *Sclerotium rolfsii,* soya.

INTRODUCTION

The root-knot nematode *Meloidogyne arenaria* (Neal) Chitwood race 1, is a serious pathogen of peanut (*Arachis hypogaea*) and soybean (*Glycine max*). Yield losses to the nematode can be so severe that economic production of the crops is not feasible in fields with heavy infestations (11,13,25,26,28). The problem is confounded by frequent presence of *Sclerotium rolfsii* (cause of southern blight) which, in combination with *M. arenaria*, synergistically reduces yield. Management of *M. arenaria* in peanut in the southeastern United States has been based on the use of nematicides and crop rotations (4,11,13,30). This management strategy developed from a lack of commercial, resistant cultivars and a low probability that new resistant cultivars would be available to producers in the near future (9,10). The recent removal of inexpensive fumigant nematicides (dibromochloropropane, ethylene dibromide) from the market has increased the costs of nematicide application. Nematicides available for use by producers today are few and less effective than the banned fumigants (1,17).

Traditional rotations of peanut with corn (*Zea mays*) can maintain *M. arenaria* populations within acceptable levels for peanut production in land with moderate infestations of the nematode (15,30); however, effective rotations require that corn be planted for 2 years (15). This option is not attractive to producers in the southeastern United States where average yields of corn are low in value relative to other crops. Corn or sorghum (*Sorghum bicolor*) are not effective rotations for the management of *M. arenaria* in fields with > 150 juveniles (J2)/100 cm³ soil at peanut harvest (22). In peanut fields with severe infestations, rotation with cotton (*Gossypium hirsutum*) (16) or bahiagrass (*Paspalum notatum*) (23) can be used if the producer has specialized equipment required for cotton production, or has cattle to graze the bahiagrass. Several crops uncommon to the southeastern United States also reduce *M. arenaria* populations to acceptable levels when rotated with peanut, and will be future options if markets for them can be developed (18,20,21).

Susceptibility of soybean (*Glycine max*) to *M. arenaria* depends not only on the cultivars but also on the races or isolates of the nematode (2,5,27). In previous work (19) it was shown that Kirby soybean was a poor host of *M. arenaria* isolates present in peanut fields at the Wiregrass substation near Headland, Alabama. A long-term rotation experiment was initiated to explore the possibility of using Kirby soybean as a rotation crop with peanut for the management of *M. arenaria*. This paper presents results from the experiment. A preliminary report was published previously (19).

MATERIALS AND METHODS

The experiment was conducted from 1986 to 1990 in a level field equipped with a center-pivot irrigation system, at the Wiregrass substation, near Headland, Alabama. The field had been in peanut production for the preceding 10 years with hairy vetch (*Vicia villosa* Roth) being planted every year as a winter cover crop. The soil in this field was described previously (19) and was heavily infested with *M. arenaria* (> 150 juveniles/100 cm³ soil at peanut harvest).

The experimental design was a randomized complete block with eight replications of eight treatments. Each experimental unit was an eight-row-wide, 10-m-long plot. Rows were 91 cm wide.

Three planting sequences were included: peanut monoculture (peanut every year); a 1-year rotation (soybean every other year); and a 2-year rotation (soybean 2 of every 3 years). Each planting sequence was represented by plots that received aldicarb every year and by plots that never received aldicarb. The 1-year rotation, in addition, was represented by plots that received aldicarb only to soybean plantings or only to peanut plantings. Aldicarb was band incorporated at-plant at 30.5 g a.i./100 m row.

Soil samples to evaluate nematode populations were collected from each plot every year 2–3 weeks before peanut harvest (6). Southern blight incidence was measured in every peanut plot in 1986 and 1988–1990.

Methods for plot maintenance, collection and processing of soil samples for nematodes, and measurement of southern blight incidence were described previously (14,19). Briefly, plot maintenance was according to recommendations for the area (1,3,4), and soil samples for

nematological analysis were processed with the salad bowl incubation technique (12). Incidence of southern blight was assessed by counting the number of disease loci ("hits") in each plot with peanut (14). Yield was obtained at maturity of the crops by harvesting the center two rows of every plot.

All data were analyzed following standard procedures for analysis of variance (29). Fisher's least significant differences were calculated for variables when F values were significant ($P \leq 0.05$). Curve fitting was according to the least square method (7,8). All differences referred to in the text were significant at $P \leq 0.05$.

RESULTS AND DISCUSSION

At-plant application of aldicarb to peanut monoculture increased yield significantly in 4 of 6 years (Table 1); the 6-year average increase was 20.1%. Yield increases in response to aldicarb in rotation plots usually were smaller than in

Table 1. Yields of 'Florunner' peanut (*Arachis hypogaea*) and 'Kirby' soybean (*Glycine max*) as influenced by aldicarb and crop rotations for management of *Meloidogyne arenaria* race 1.

Cropping sequence and year[x]						Yield (kg/ha)[y]					
1985	1986	1987	1988	1989	1990	1985	1986	1987	1988	1989	1990
P(–)	P(–)	P(–)	P(–)	P(–)	P(–)	2821	2522	1926	2116	2577	1465
P(+)	P(+)	P(+)	P(+)	P(+)	P(+)	3390	2984	2224	2685	2821	2034
S(–)	P(–)	S(–)	P(–)	S(–)	P(–)	*2851*	2875	*1714*	2523	*3104*	2767
S(+)	P(–)	S(+)	P(–)	S(+)	P(–)	*3068*	2848	*2093*	2360	*3302*	2658
S(–)	P(+)	S(–)	P(+)	S(–)	P(+)	*2869*	3228	*1805*	2902	*3158*	3173
S(+)	P(+)	S(+)	P(+)	S(+)	P(+)	*2869*	3038	*2075*	2848	*3248*	3092
S(–)	S(–)	P(–)	S(–)	S(–)	P(–)	*2779*	*1537*	2383	*2314*	*2634*	2685
S(+)	S(+)	P(+)	S(+)	S(+)	P(+)	*2833*	*1736*	2984	*2839*	*3104*	3390
Peanut FLSD ($P = 0.05$)						430	428	401	401	461	450
Soybean FLSD ($P = 0.05$)						NS	NS	*285*	*390*	*328*	—

Data are means of eight replications.
[x]P = peanut; S = soybean; (–) = no aldicarb treatment; (+) = at-plant treatment with aldicarb at 30.5 g a.i./100 m row applied in a 20-cm band.
[y]Yields in italics are for soybean and the other figures are for peanut.

IDENTIFICATION OF SECOND-STAGE JUVENILES OF *TYLENCHULUS* SPP. ON THE BASIS OF POSTERIOR BODY MORPHOLOGY

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ABSTRACT

Inserra, R. N., N. Vovlas, and M. Di Vito. 1994. Identification of second-stage juveniles (J2) of *Tylenchulus* spp. on the basis of posterior body morphology. Nematropica 24:25–33.

Tail lengths of live J2 were measured in two, three, and eight populations of *Tylenchulus graminis*, *T. palustris* and female *T. semipenetrans*, respectively. Except for one population of *T. palustris* from Costa Rica and two populations of female *T. semipenetrans* from Italy, all other populations were from Florida, U.S.A. Ranges in tail length values were 59.5–72.5, 42.0–54.0, and 55.0–70.0 μm for *T. graminis*, *T. palustris*, and female *T. semipenetrans* J2, respectively. The canonical discriminant analysis for this character allows the separation of *T. palustris* J2 from *T. graminis* and female *T. semipenetrans* J2, which did not differ. The nearly hyaline portion of the posterior body without fat globules > 2 μm diam was measured in selected populations of *T. graminis*, *T. palustris*, and female *T. semipenetrans* J2 from Florida. The ranges in values for this class of measurements were 59.0–75.0, 24.5–59.0, and 35.0–60.0 μm for each of the three species, respectively. Another class of measurements of the nearly hyaline portion without fat globules > 3 μm diam was also taken in selected populations of the three species from Florida. The ranges in values for this class of measurements were 64.0–78.0, 42.0–59.0, and 40.0–64.0 for each of the three species, respectively. The canonical analysis for all characters, including tail length, allows the separation of *T. graminis* J2 from *T. palustris* and *T. semipenetrans* J2, which did not differ. The remaining species of the genus, *T. furcus*, has J2 with a characteristic furcate tail tip, unlike the tapered tails of other *Tylenchulus* species.

Key words: citrus nematode, morphology, regulatory nematology, systematics, *Tylenchulus furcus*, *Tylenchulus graminis*, *Tylenchulus palustris*, *Tylenchulus semipenetrans*.

RESUMEN

Inserra, R. N., N. Vovlas y M. Di Vito. 1994. Identificación de juveniles de segundo estadío (J2) de *Tylenchulus* spp. basada en la morfología de la parte posterior del cuerpo. Nematrópica 24:25–33.

Se midió el largo de la cola en juveniles vivos de segundo estadío en dos, tres y ocho poblaciones de *Tylenchulus graminis*, *T. palustris*. y *T. semipenetrans*, respectivamente. Con excepción de la población de *T. palustris* de Costa Rica y las dos poblaciones de *T. semipenetrans* de Italia, todas las otras poblaciones provienen de Florida, U.S.A. La distribución de valores de el largo de la cola obtenidos fueron, 59.5–72.5, 42.0–54.0 y 55.0–70.0 μm para *T. graminis*, *T. palustris* y *T. semipenetrans*, respectivamente. El análisis estadístico canónico discriminante de este carácter, permite, la separación de juveniles de segundo estadío de *T. palustris*, *T. graminis* y *T. semipenetrans*, los cuales no difieren entre si. La porción hialina de la parte posterior del cuerpo sin glóbulos de lípidos > de 2 μm diam fue medida en poblaciones seleccionadas de *T. graminis*, *T. palustris* y *T. semipenetrans*, provenientes de Florida. La distribución de valores para esta clase de medidas fueron 59.0–75.0, 24.5–59.0 y 35.0–60.0 μm para cada una de las tres especies respectivamente. Otra serie de medidas de la misma región del cuerpo, pero sin glóbulos de lípidos de > de 3 um diam fue tomada de poblaciones seleccionadas de las tres

Table 2. End-of-season populations of *Meloidogyne arenaria* juveniles as influenced by aldicarb and rotations of 'Florunner' peanut (*Arachis hypogaea*) with 'Kirby' soybean (*Glycine max*).

Cropping sequence and year[x]						Juveniles/100 cm³ soil[y]					
1985	1986	1987	1988	1989	1990	1985	1986	1987	1988	1989	1990
P(–)	P(–)	P(–)	P(–)	P(–)	P(–)	386	288	198	102	249	330
P(+)	P(+)	P(+)	P(+)	P(+)	P(+)	326	110	210	102	122	415
S(–)	P(–)	S(–)	P(–)	S(–)	P(–)	0	149	4	228	5	362
S(+)	P(–)	S(+)	P(–)	S(+)	P(–)	0	128	9	176	7	483
S(–)	P(+)	S(–)	P(+)	S(–)	P(+)	0	61	11	170	8	310
S(+)	P(+)	S(+)	P(+)	S(+)	P(+)	0	48	10	223	13	477
S(–)	S(–)	P(–)	S(–)	S(–)	P(–)	0	26	87	8	3	265
S(+)	S(+)	P(+)	S(+)	S(+)	P(+)	0	23	97	9	3	338
		FLSD (*P* = 0.05)				252	125	116	127	120	207

Data are means of eight replications.
[x]P = peanut; S = soybean; (–) = no nematicide treatment; (+) = at-plant treatment with aldicarb at 30.5 g a.i./100 m row applied in a 20-cm band.
[y]Nematodes extracted by salad bowl method from soil collected 2–3 weeks before peanut harvest.

monoculture increased 100% (Fig. 2). In 1990, peanut yield and the number of southern blight disease loci were inversely correlated (Fig. 3). Yield decline in peanut monoculture was reported previously (15) and, as in this study, was associated with sustained high populations of *M. arenaria* race 1 coupled to a progressive increase in southern blight.

The first rotation to soybean always reduced the *M. arenaria* J2 population in the succeeding peanut crop. In the long term, however, soybean rotation was not successful in reducing *M. arenaria* populations in peanut. From 1986 to 1990, an exponential increase in nematode population was measured in peanut in every one of the six rotation × nematicide

Table 3. Incidence of southern blight caused by *Sclerotium rolfsii* as influenced by aldicarb and rotations of 'Florunner' peanut (*Arachis hypogaea*) with 'Kirby' soybean (*Glycine max*) for management of *Meloidogyne arenaria*.

Cropping sequence and year[x]						Disease loci/100 m row[y]					
1985	1986	1987	1988	1989	1990	1985[z]	1986	1987	1988	1989	1990
P(–)	P(–)	P(–)	P(–)	P(–)	P(–)		77		59	121	150
P(+)	P(+)	P(+)	P(+)	P(+)	P(+)		72		93	115	128
S(–)	P(–)	S(–)	P(–)	S(–)	P(–)		81		53	—	108
S(+)	P(–)	S(+)	P(–)	S(+)	P(–)		78		56	—	115
S(–)	P(+)	S(–)	P(+)	S(–)	P(+)		56		68	—	95
S(+)	P(+)	S(+)	P(+)	S(+)	P(+)		71		85	—	105
S(–)	S(–)	P(–)	S(–)	S(–)	P(–)		—		—	—	111
S(+)	S(+)	P(+)	S(+)	S(+)	P(+)		—		—	—	91
		FLSD (*P* = 0.05)					23		28	NS	24

Data are means of eight replications.
[x]P = peanut; S = soybean; (–) = no nematicide treatment; (+) = at-plant treatment with aldicarb at 30.5 g a.i./100 m row applied in a 20-cm band.
[y]A disease locus is defined as a length of row ≤ 30 cm with all plants killed by *S. rolfsii*
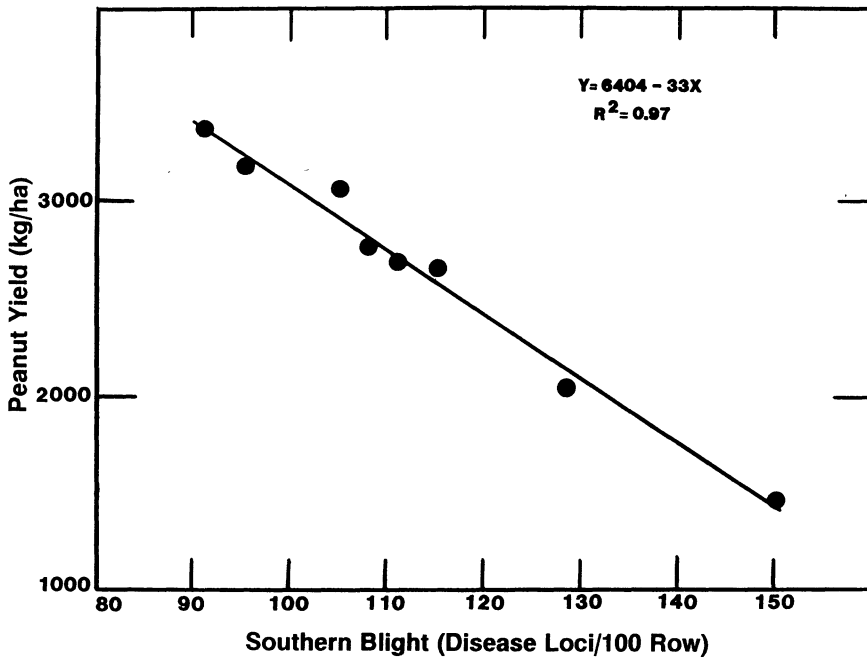[z]Data were not collected in 1985 and 1987.

Fig. 3. Relation between 'Florunner' peanut (*Arachis hypogaea*) yield in 1990 and the incidence of southern blight (*Sclerotium rolfsii*) in a rotation experiment with 'Kirby' soybean (*Glycine max*) at the Wiregrass substation, near Headland, Alabama, U.S.A. Each yield is the mean of eight replications.

treatment combinations; populations doubled every 2 years, on the average. This contrasts with observations of *M. arenaria* in cotton (16), bahiagrass (23), and castor-bean (*Ricinus communis*) (20) and suggests that during soybean rotation adaptive selection occurs and the *M. arenaria* population present in the field acquires the ability to reproduce well on this moderately resistant cultivar. Alternatively, the phenomenon may result from changes in antagonistic microorganisms in the soil. Decline in yield during prolonged peanut monoculture has been observed before (15) and probably reflects an accumulation of soil-borne pathogens as evidenced by the increased incidence of southern blight with time. The density of *M. arenaria* in monoculture soil was maximal (> 150 juveniles/

100 cm³ soil) for a field with a heavy infestation. Consequently, little change was observed with time in monoculture plots for this pathogen. The data in the monoculture system suggest that the initial southern blight inoculum was not at maximal level and it increased with time. In conclusion, our results indicate that Kirby soybean in rotation with peanut may be useful for short-term but not long-term management of *M. arenaria*.

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