Supplement to Journal of Nematology 25(4S):806–808. 1993.

Summer Cropping Effects on the Abundance of *Meloidogyne arenaria* Race 2 and Subsequent Soybean Yield[1]

R. A. Kinloch and L. S. Dunavin[2]

Abstract: A summer-planted crop of alyceclover significantly ($P < 0.05$) increased the soil abundance of *Meloidogyne arenaria* race 2 juveniles by 3.7-fold when measured in the following spring. Maize, sorghum, and soybean had no significant effects on residual nematode numbers over the same period. Summer plantings of aeschynomene, cotton, hairy indigo, lespedeza, millet, peanut, and sorghum–sudangrass were as efficient as fallow in reducing root-knot nematode population levels. Soybean yields (averaging 2,156 kg/ha) were significantly increased over that of monocultured soybean (1,179 kg/ha) when grown in soil previously fallowed or planted to aeschynomene, hairy indigo, peanut, and sorghum. No significant differences in yields were achieved from soybean when grown in soil previously cropped to alyceclover, cotton, lespedeza, maize, or sorghum–sudangrass. Nematode numbers, which average 2,140 juveniles/100 cm^3 soil following the second year of cropping with soybean, were not related to previous cropping history and had increased an average of 9.3-fold over the course of the study.

Key words: aeschynomene, alyceclover, cotton, fallow, hairy indigo, lespedeza, maize, *Meloidogyne arenaria* race 2, millet, nematode, peanut, root-knot galling, rotation, sorghum, sorghum–sudangrass, soybean, yield.

The root-knot nematode *Meloidogyne arenaria* race 2 has become a prevalent pest of soybean, *Glycine max,* in the southeastern United States (5). A few soybean cultivars have been released recently that have a greater resistance to this nematode than had been available previously (3). However, current levels of resistance are not sufficient to reduce yield losses on soils heavily infested with this nematode (6). Additionally, there are no available nematicides that effectively manage this nematode on soybean. Consequently, if soybean must be grown on infested soil, rotation of resistant cultivars with a less susceptible crop remains the only effective management practice. Alternative summer cropping for managing nematode pests of the major crops in the southern United States has become the subject of increasing research interest (2,7–9).

The following studies were conducted to determine i) the influences of different summer crops on the soil abundance of *M. arenaria* and ii) the influence that the residual populations of this nematode would have on a subsequent soybean crop following a 1-year rotation.

Materials and Methods

An area of Troup loamy sand (70% sand, 15% silt, 15% clay; organic matter >2%; pH 6.0) in Santa Rosa County, Florida, was demarcated to accommodate 120 plots, each 3.75 × 3.75 m, arranged in 10 blocks separated by 3 m-wide alleys. The site was naturally infested with *M. arenaria* race 2. Population densities of second-stage juveniles (J2) were determined from soil samples taken on 25 February 1988. Fourteen soil cores (2.54-cm-d by 23 cm deep) were taken from each plot and mixed. A 100-cm^3 subsample was processed within 24 hours by sieving and sugar flotation–centrifugation (3). The nematodes were counted on a gridded dish and averaged 230/100 cm^3 soil. There were no significant ($P < 0.05$) differences in J2 densities among the plots designated for planting. After appropriate soil preparation and fertilization (1), the crops were hand-planted into 10 randomized complete blocks of 12 treatments each. Maize (*Zea mays*), millet (*Pennisetum glaucum*), sor-

Received for publication 24 March 1993.
[1] Florida Agricultural Experiment Station Journal Series No. R-03053.
[2] University of Florida, Agricultural Research and Education Center, Jay, FL 32565.

ghum (*Sorghum bicolor*), and sorghum—sudangrass (*Sorghum bicolor* × *S. sudanese*) were planted in four rows/plot on 15 April. Cotton (*Gossypium hirsutum*), peanut (*Arachis hypogaea*), and soybean were planted in four rows/plot on 14 June, while aeschynomene (*Aeschynomene americana*), alyceclover (*Alysicarpus vaginalis*), hairy indigo (*Indigofera hirsuta*), and lespedeza (*Lespedeza striata*) were broadcast planted on the same date. One plot from each block was maintained as a weed-free summer and winter fallow through the first year of the study. Plots and alleys were hand-weeded when necessary. The plots were left as undisturbed stubble following each crop through the winter and spring. A nematode assay, as described above, was performed on 25 January 1989, 11 months following the initial sampling. After appropriate soil preparation and fertilization (1), all plots were planted on 13 June 1989 to cv. Kirby, one of the soybean cultivars most resistant to *M. arenaria* (6). Two groups of four plants were removed from the border rows of each plot on 31 August and their roots were rated for root-knot galling as follows: 0 = no galling, 0.2 = <5%, 1 = 6–25%, 2 = 26–50%, 3 = 51–75%, and 4 = >75% of the root system galled. The two center rows of each plot were harvested on 6 November and all plots were assayed for *M. arenaria* J2 on 21 November 1989.

TABLE 1. Influence of summer cropping regimes followed by winter fallow on the abundance of *Meloidogyne arenaria* race 2 second-stage juveniles (J2).

25 Feb. 1988 J2/100 cm³ soil	Crop	25 Jan. 1989 J2/100 cm³ soil	*t*-test
150 a	Aeschynomene	30 c	−*
180 a	Alyceclover	660 a	+**
300 a	Cotton	40 c	−**
150 a	Hairy indigo	20 c	−**
220 a	Lespedeza	50 c	−**
290 a	Maize	110 bc	ns
210 a	Millet	60 c	−**
320 a	Peanut	20 c	−*
250 a	Sorghum	100 bc	ns
190 a	Sorghum–sudangrass	50 c	−*
200 a	Soybean	230 b	ns
250 a	Fallow	20 c	−**

Data are the averages of 10 replicates.
Means followed by the same letter within a column are not significantly different ($P < 0.05$) according to Duncan's multiple-range test.
* = $P < 0.05$; ** = $P < 0.01$.

RESULTS AND DISCUSSION

During the first cropping season, significant increases in soil populations of *M. arenaria* J2 occurred only on alyceclover, on which residual J2 population was higher ($P < 0.05$) than on all other crops (Table 1). There were no significant changes in soil infestation levels of this nematode after 1 year in plots planted to maize, sorghum, or soybean. All other crops suppressed ($P < 0.05$) population levels.

In the second year, when the entire site was planted to soybean, galling (y), which was found in all plots, was significantly correlated with the number of J2/100 cm³ soil (x) on 25 January 1989 by

$$y = 1.4 + 0.002x \ (r = 0.5; \ P < 0.01; \ 118 \text{ df}).$$

Galling was greatest in plots following soybean and alyceclover (Table 2); however, these were not significantly more galled than soybeans grown following lespedeza or maize. There were differences ($P < 0.05$) in seed yields among the plots depending on previous cropping history. Yields ranged from 1,170 kg/ha following soybean to 2,305 kg/ha following hairy indigo. Significant increases in yield compared with monocultured soybean were found in plots following aeschynomene, hairy indigo, peanut, sorghum, sorghum–sudangrass, and fallow. Yields (y) across all plots were significantly negatively correlated with the amount of root-knot galling (x) by

$$y = 3{,}280 - 873x \ (r = -0.8; \ P < 0.01; \ 118 \text{ df}),$$

and to the number of J2/100 cm³ soil on 25 January 1989 by

$$y = 2{,}093 - 1.6x \ (r = -0.4; \ P < 0.01; \ 118 \text{ df}).$$

TABLE 2. Influence of preceding summer cropping regimes on the galling and yield of soybean cv. Kirby grown in soil infested with *Meloidogyne arenaria* race 2.

Preceding crop 1988	Root-knot galling† 31 Aug. 1989	Yield (kg/ha) 6 Nov. 1989	*M. arenaria* J2‡/100 cm^3 soil 21 Nov. 1989
Aeschynomene	1.3 b	2,187 a	1,760 a
Alyceclover	2.3 a	1,231 bc	1,740 a
Cotton	1.4 b	1,912 abc	1,980 a
Hairy indigo	1.4 b	2,305 a	2,040 a
Lespedeza	1.7 ab	1,886 abc	2,850 a
Maize	1.6 ab	1,965 abc	2,200 a
Millet	1.5 b	1,938 abc	1,860 a
Peanut	1.5 b	2,109 a	2,390 a
Sorghum	1.4 b	2,095 a	2,680 a
Sorghum–sudangrass	1.3 b	1,991 ab	2,060 a
Soybean	2.3 a	1,170 c	2,190 a
Fallow	1.2 b	2,082 a	1,950 a

Data are averages of 10 replicates.
Means followed by the same letter within a column are not significantly different ($P < 0.05$) according to Duncan's multiple-range test.
† Rated to the scale of 0 = no galling, 0.2 = <5%, 1 = 6–25%, 2 = 26–50%, 3 = 51–75%, 4 = >75% root-surface galled.
‡ J2 = second-stage juveniles.

There were no significant effects of previous cropping history on the numbers of residual J2, which averaged 2,140/100 cm^3 soil following harvest in the second year (Table 2).

A summer fallow, and the summer planting of differing crops, reduced the soil population levels of *M. arenaria* race 2 to low levels; however, no summer regime reduced nematode populations to a level that would prevent a subsequent soybean crop from suffering root-knot galling and yield loss and leaving a high residual J2 population. Hence, only one crop of a resistant soybean is feasible following the cropping of the alternative summer crops investigated in this study.

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