NEW CROPS WITH POTENTIAL FOR MANAGEMENT OF SOYBEAN NEMATODES

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ABSTRACT

Rodríguez-Kabána R., P. S. King, D. G. Robertson, C. F. Weaver, y E. L. Carden. 1988. New crops with potential for management of soybean nematodes. Nematrópica 18: 45-52.

American jointvetch (*Aeschynomene americana*), 'Florida 101' hairy indigo (*Indigofera hirsuta*), and 'Iron' cowpeas (*Vigna unguiculata*) were more effective in reducing root-knot nematodes (*Meloidogyne arenaria* and *M. incognita*) and soybean cyst nematode (*Heterodera glycines*) race 4 in a greenhouse experiment than were alyceclover (*Alysicarpus vaginalis*), Kobe lespedeza (*Lespedeza striata*), Korean lespedeza (*Lespedeza stipulacea*) and 'Davis' soybean (*Glycine max*). The effects of American jointvetch and hairy indigo on soil populations of the three nematode species were also studied in a field in Baldwin County, Alabama. Soil from plots with the two legumes was essentially free of juveniles of root-knot and cyst nematodes throughout the growing season. Juvenile populations in these plots were as low as those in plots planted to 'Pioneer 8222' sorghum (*Sorghum bicolor*). Plots with 'Kirby' soybean had large juvenile populations (150 juveniles/100 cm^3 of soil) of root-knot nematodes 1 month before harvest; numbers of *H. glycines* juveniles averaged 85/100 cm^3 of soil. Results suggest that American jointvetch and hairy indigo may be forage or green manure crops with potential for the management of soybean nematodes in Alabama.

Key words: cowpea, cultural practices, *Glycine max*, hairy indigo, *Heterodera* spp., host range, jointvetch, lespedeza, *Meloidogyne* spp., pest management, rotations, soybean.

RESUMEN

Rodríguez-Kabána R., P. S. King , D. G. Robertson, C. F. Weaver, y E. L. Carden. 1988. Sobre el potencial de ciertos cultivos nuevos para el manejo nematodos de la soya. Nematrópica 18: 45-52.

Un estudio de invernadero reveló que en comparación con la soya (*Glycine max*) 'Davis', la arvejilla americana (*Aeschynomene americana*), el índigo hirsuto 'Florida 101' (*Indigofera hirsuta*), y el frijol de costa 'Iron' (*Vigna unguiculata*) son mas eficaces para disminuir las poblaciones de los nematodos agalladores (*Meloidogyne arenaria* y *M. incognita*) y la raza 4 del enquistador (*Heterodera glycines*) que la lespedeza 'Kobe' (*Lespedeza striata*) o la 'Coreana' (*Lespedeza stipulacea*) o el trebol 'alyce' (*Alysicarpon vaginalis*). Tambień se estudió con un experimento de campo en el condado Baldwin de Alabama, los efectos de la arvejilla americana y del indigo hirsuto sobre las poblaciones de las mismas especies de nematodos. Los suelos de las parcelas con las dos legumbres se mantuvieron practicamente sin larvas de nematodos agalladores o del quiste durante todo el período de producción. En el mismo estudio de campo se observó que las poblaciones larvales en las paracelas con las dos legumbres resultaron tan bajas como las correspondientes a las de las parcelas con sorgo 'Pioneer 8222' (*Sorghum bicolor*). En el experimento se registraron altas poblaciones larvales tanto de *Meloidogyne* spp. (150 larvas/100 cm^3 de suelo) como del *H. glycines* (85 larvas/100 cm^3 de suelo) en las parcelas con la soya 'Kirby' un mes antes de ser cosechada. Los datos obtenidos con estos estudios señalan claramente que tanto la arvejilla americana como el índigo hirsuto podrían utilizarse como cultivos forrajeros o como mejoradores orgánicos para también servir en el manejo efectivo de nematodos de la soya.

Palabras claves: arvejilla americana, frijol de costa, gama de hospederos, *Glycine max*, *Heterodera* spp., índigo hirsuto, lespedeza, manejo de plagas, *Meloidogyne* spp., prácticas culturales, rotaciones, soya.

INTRODUCTION

Root-knot (*Meloidogyne* spp.) and cyst (*Heterodera glycines* Ichinohe) nematodes are important yield-limiting pests in the production of soybean (*Glycine max* (L.) Merr.) in Alabama and other states of the southeastern United States (3,4,16). Management of these nematodes has been based on development of resistant cultivars (4,14,15,21), rotation with nonhost crops or less suitable host plants (4,20), and less frequently on nematicide use (5,6,12). At present, the use of commercially available nematicides is too costly to be practical. Rotation of soybean with corn (*Zea mays* L.) or sorghum (*Sorghum bicolor* Moench) can be effective in reducing populations of *H. glycines* (4). Corn and sorghum are hosts, albeit less suitable than soybean, for *M. arenaria* (Neal) Chitwood and *M. incognita* (Kofoid & White) Chitwood (20) and their use for the management of these nematodes in fields with severe infestations generally is not successful (10,13). In addition, most soybean production fields in Alabama and other southeastern states are not irrigated and corn yields are typically low (<4000 kg/ha) which makes the use of this crop economically unattractive.

Soybean cultivars which have combined resistance to *M. arenaria*, *M. incognita* and several races of *H. glycines* are available; these cultivars although superior to nematode-susceptible cultivars or to others with more limited resistance spectrum, can sustain significant yield losses from nematode attack (12,21). Thus, there is a need to find new and economically acceptable crops for use in rotation with soybean to manage nematode populations. This paper presents results of a study conducted to assess the susceptibility of several legume species to populations of root-knot and soybean cyst nematodes.

MATERIALS AND METHODS

Greenhouse study: A study was conducted to assess the effects of selected legume species on nematode populations typical of soybean fields in Alabama. The legumes were chosen for their potential value as green manure or forage crops in Alabama and were: alyceclover (*Alysicarpus vaginalis* (L.) de Candole), american jointvetch (*Aeschynomene americana* L.), 'Florida 101' hairy indigo (*Indigofera hirsuta* L.), 'Iron' cowpea (*Vigna unguiculata* (L.) Walp.), Kobe lespedeza (*Lespedeza striata* (Thunb.) Hooker & Arnott), and Korean lespedeza (*Lespedeza stipulacea* Maxim.). 'Davis' soybean was included in the study for comparative purposes. This cultivar is a maturity group VI soybean with no resistance to the economically important *Meloidogyne* spp. or to the common races of *H. glycines* (21). Nematode-infested soil used in this study was obtained from a soybean field near Elberta, Alabama, and was a sandy loam with pH = 6.2, organic matter <1.0% (w/w), and cation exchange capacity <10 meq/100 gm soil. The soil was infested with *M. arenaria, M. incognita*, and *H. glycines* race 4. Numbers of *Meloidogyne* juveniles, determined with the "salad bowl" technique (11), were 20/100 cm^3 of soil and the number of *H. glycines* juveniles was 16/100 cm^3 of soil. Other nematode species present in low (<5/100 cm^3 of soil) numbers were *Paratrichodorus christiei* (Allen) Siddiqi, *Pratylenchus brachyurus* Filipjev and Schuurmans Stekhoven, and *Helicotylenchus dihystera* (Cobb) Sher. The field soil was sifted to remove crop debris and large particles and was then mixed in a 50:50 (v:v) ratio with fine (<0.5 mm) buider's sand. This mixture will be referred henceforth in the paper as soil. The soil was apportioned in 1 kg amounts and placed in 1-L-capacity 10-cm-d cylindrical plastic pots. Pots with soil were planted so as to have eight experimental units (pots) for each plant species which were arranged in a randomized complete block design with eight replications on a greenhouse bench. Plants were fertilized, watered and insects controlled as needed for 2 months when the experiment was terminated. At the end of the experiment, plants in each pot were carefully removed from the soil and the roots were weighed and examined for galls caused by *Meloidogyne* spp. The degree of root galling was assessed using an index scale where 0 = no galls and 10 = maximal degree of galling (22). Nematode populations in soil and roots were determined using the "salad bowl" incubation method (11).

Field study: The effects of American jointvetch and 'Florida 101' hairy indigo on juvenile populations of root-knot and soybean cyst nematodes was studied in a field near Elberta, Alabama. The field had been in continuous soybean production for the preceeding 10 years with oats (*Avena sativa* L.) or rye-grass (*Lolium* sp.) planted each winter as cover crops and was infested with *H. glycines* race 4 and both *M. incognita* and *M. arenaria*. The soil was that used for the greenhouse study. The effects of the two forage legumes on nematode populations were compared with those of 'Kirby' soybean and of 'Pioneer 8222' sorghum. 'Kirby' is a maturity group VIII soybean well adapted to the locality of the experiment and is resistant to *H. glycines* race 3, highly tolerant to *M. incognita* and has some tolerance to *M. arenaria* (21). Soybean and sorghum were planted in plots that were each 6-m-long and 36 rows wide on 0.8-m centers. Plots planted to hairy indigo or jointvetch were of the same size, but the legumes were planted broadcast at a rate of 26 kg seed/ha with shallow incorporation. Cultural practices and control of insects, foliar diseases and weeds in soybean were as recommended for the area (2); cultural practices and weed control for sorghum were also followed as recommended for the area, but no attempt was made to control foliar diseases or insects in this crop.

Each crop was represented by 16 experimental units (plots) replicated in a randomized complete block design. Nematode sampling was performed 1 month before soybean harvest to be within the period of maximal population development for root-knot nematodes in 'Kirby' soybean (15). A sample consisted of 16–20 2.5-cm-d cylindrical soil cores collected to a depth of 25 cm and spaced approximately 0.5 m along the center 2 m of each plot. Samples consisted of cores extracted from the root-zone of the plants. Cores from each plot were composited and a 100 cm^3 subsample was processed to determine nematode numbers using the "salad bowl" incubation technique (11). Soybean sorghum yields were determined at maturity of each crop by harvesting the two center rows of each plot. Indigo and vetch yields were from a 6-m^2 area the center of each plot harvested in mid-October.

All data were analyzed using the analysis of variance (19), and means were separated by Fisher's least significant difference at $P = 0.05$.

RESULTS AND DISCUSSION

Greenhouse study: Data from this experiment are presented in Tables 1 and 2. No attempt was made to separate juveniles of *M. arenaria* from those of *M. incognita* in our counts. Numbers of *Meloidogyne* juveniles were highest when the soil was planted with soybean and the two lespedezas but were lowest when planted with alyceclover, jointvetch, or hairy indigo. The soil contained populations of *P. christiei* which were least abundant in pots with either alyceclover, hairy indigo or soybean.

Table 1. Numbers of nematodes in a soybean field soil: sand mixture following cropping for 2 months of selected legumes in a greenhouse.

	Numbers/100 cm^3 of soil		
	Meloidogyne juveniles	*Paratrichodorus christiei*	*Heterodera glycines* juveniles
Glycine max, 'Davis'	43	2	83
Lespedeza stipulacea	35	20	18
Alysicarpus vaginalis	11	6	42
Lespedeza striata	51	32	76
Vigna unguiculata	19	12	23
Aeschynomene americana	11	42	19
Indigofera hirsuta, 'Florida 101'	2	3	15
FLSD (0.05)	19	20	26

Table 2. Nematode populations in roots of selected legumes species in a greenhouse experiment with soil from a soybean field.

	Galls/gm fresh root	Root-knot[z] index	Nematodes/g fresh root			
			Meloidogyne juveniles	*Heterodera glycines* juveniles	*Pratylenchus brachyurus*	*Helicotylenchus dihystera*
Glycine max, 'Davis'	58	6	78	19	23	0
Lespedeza stipulacea	26	5	1 119	16	56	32
Alysicarpus vaginalis	72	3	7	23	9	17
Lespedeza striata	11	4	66	2	19	9
Vigna unguiculata	0	1	3	0	4	3
Aeschynomene americana	0	0	3	4	6	4
Indigofera hirsuta, 'Florida 101'	45	1	173	35	61	23
FLSD (0.05)	16	0.6	56	17	18	11

[z]Root-knot index scale: 0 = no galls and 10 = maximal galling (22).

Populations of *H. glycines* juveniles were highest in soils planted to Kobe lespedeza or 'Davis' soybean and lowest in those with either hairy indigo, jointvetch, or Korean lespedeza.

There were no galls on roots of jointvetch or 'Iron' cowpea. The highest numbers of galls were observed in alyceclover, soybean, and hairy indigo. The root-knot index values paralleled the numbers of galls except for hairy indigo. In this crop galls were very small and dispersed throughout the root system hence the low index value. Root populations of *Meloidogyne* juveniles were highest in Korean lespedeza and lowest in alyceclover, 'Iron' cowpea, and jointvetch. Cowpea roots and those of jointvetch and Kobe lespedeza had either no *H. glycines* juveniles or very few; however, roots of hairy indigo, soybean, and alyceclover contained significant numbers of juveniles. Korean lespedeza and hairy indigo roots had the highest numbers of *P. brachyurus* and *H. dihystera* but very few nematodes were recovered from roots of jointvetch or cowpea.

Results from this study indicated that American jointvetch and 'Iron' cowpea supported the lowest soil and root populations of root-knot and cyst nematodes. The study also revealed that low soil populations of these nematodes were associated with hairy indigo. 'Iron' cowpea is not a good forage legume but would be suitable for green manure. Since our primary interest was to identify suitable forage legumes we chose jointvetch and hairy indigo for field studies.

Field study: Data from the experiment are presented in Table 3. Soils from soybean plots were the only ones with significant populations of root-knot and cyst nematodes. As with the greenhouse study no attempt was made to distinguish between juveniles of *Melidogyne* spp. Soybean yield was typical for 'Kirby' in a field with the high level of nematode infestation present in this study; cultivars with no resistance to the nematodes typically yield <1 000 kg/ha in such fields (21). Yield of jointvetch and hairy indigo was greater than 10 t/ha indicating good potential for development of these legumes as forage crops or as green-manure crops; the protein content of hay from these legumes is comparable to that of alfalfa and other forage legumes (1).

Sorghum yield was very depressed and atypical for the area. The low yield reflected insect damage to the crop that was not controlled because of excessive rainfall.

This study demonstrated clearly that hairy indigo and jointvetch were either not hosts or poor hosts for *H. glycines* and for the populations of *M. arenaria* and *M. incognita* present in the field. These results agree with those of Rhoades who found that hairy indigo and American jointvetch were effective in reducing populations of *M. incognita* and other phytonematodes in Florida (7,8,9). Rhoades' work revealed the possibility of using these legumes as summer cover crops to manage nematode populations in the succeeding winter vegetable crops (9). We

Table 3. Yields of 'Kirby' soybean, 'Pioneer 8222' sorghum, and two forage legumes, and nematode populations one month before soybean harvest in a 1987 field experiment near Elberta, Baldwin County, Alabama.

		Juveniles/100 cm^3 of soil	
Crop	Yield (kg/ha)	*Hederodera glycines*	*Meloidogyne*
Glycine max, 'Kirby'	1 924	85	194
Aeschynomene americana	14 960	2	5
Indigofera hirsuta, 'Florida 101'	12 833	0	6
Sorghum bicolor, 'Pioneer 8222'	293	0	2
FLSD (0.05)		41	72

plan to continue the study to determine the value of these legumes as rotation crops for suppression of nematodes in a soybean production system.

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