THE INFLUENCE OF MORNINGGLORY (*IPOMOEA LACUNOSA*), HEMP SESBANIA (*SESBANIA EXALTATA*), AND JOHNSONGRASS (*SORGHUM HALEPENSE*) ON REPRODUCTION OF *ROTYLENCHULUS RENIFORMIS* ON COTTON (*GOSSYPIUM HIRSUTUM*) AND SOYBEAN (*GLYCINE MAX*)

M. J. Pontif [1]* and E. C. McGawley [2]

[1]Research Associate/Graduate Student, Department of Plant Pathology and Crop Physiology, [2]Professor, Department of Plant Pathology and Crop Physiology, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA 70803. *Corresponding author: mpontif@agctr.lsu.edu.

ABSTRACT

Pontif, M. J. and E. C. McGawley. 2007. The Influence of Morningglory (*Ipomoea lacunosa*), Hemp Sesbania (*Sesbania exaltata*) and Johnsongrass (*Sorghum halepense*) on Reproduction of *Rotylenchulus reniformis* on Cotton (*Gossypium hirsutum*) and Soybean (*Glycine max*). Nematropica 37: 295-305.

Reniform nematodes that parasitize cotton and soybean can also reproduce on a wide spectrum of weed species, thereby maintaining nematode populations during the off-season. Microplot studies were conducted to evaluate the effects of three endemic weed species, morningglory (*Ipomoea lacunosa*), hemp sesbania (*Sesbania exaltata*), and johnsongrass (*Sorghum halepense*), on reproduction of the reniform nematode, *Rotylenchulus reniformis* on cotton (LA. 887) and soybean (Pioneer 96B21). Over two years of microplot trials, the co-culture of cotton with any of the three weed species suppressed numbers of reniform nematode juveniles in soil significantly. When grown singly, reproductive values of *R. reniformis* after 60 days on cotton averaged 69.0, while those for morningglory, hemp sesbania, and johnsongrass averaged 42.0, 23.5, and 18.0, respectively. Reproductive values on cotton co-cultured with morningglory averaged 38.5. Those for the cotton-hemp sesbania and cotton-johnsongrass combinations averaged 23.5 and 26.0, respectively. Nematode reproduction on soybean alone, and co-cultured with each of the three weeds, reduced reproduction of reniform nematode only in the presence of johnsongrass in two trials. Data from two subsequent 45-day duration greenhouse experiments conducted with cotton and leachates from each of the three weed species support the hypothesis that suppression of reniform nematode reproduction likely resulted from the secretion of allelopathic compounds by weed roots.

Key words: allelopathy, cotton, *Glycine max*, *Gossypium hirsutum*, hemp sesbania, *Ipomoea lacunosa*, johnsongrass, morningglory, reniform nematode, reproduction, *Rotylenchulus reniformis*, *Sesbania exaltata*, *Sorghum halepense*, soybean, weeds.

RESUMEN

Pontif, M. J. y E. C. McGawley. 2007. Influencia de *Ipomoea lacunosa, Sesbania exaltata* y *Sorghum halepense* sobre la Reproduccción de *Rotylenchulus reniformis* en Algodón *Gossypium hirsutum* L. y Soya *Glycine max*. Nematropica 37:295-305.

El nematodo reniforme que afecta al algodón y la soya también puede reproducirse en una amplia gama de malezas, manteniendo así las densidades de población durante la ausencia del cultivo. Se llevaron a cabo estudios de microparcelas para evaluar los efectos de tres especies endémicas de malezas, *Ipomoea lacunosa*, *Sesbania exaltata* y *Sorghum halepense*, sobre la reproducción del nematodo reniforme, *Rotylenchulus reniformis,* en algodón (LA. 887) y soya (Pioneer 96B21). Después de dos años en microparcelas, el co-cultivo del agodón con cualquiera de las tres especies de malezas evaluadas redujo la densidad de población de nematodo reniforme en el suelo significativamente. Cultivado de manera independiente, el índice reproductivo de *R. reniformis* después de 60 días en algodón fue de 69.0 en promedio, mientras que en *I. lacunosa*, *S. exaltata* y *S. halepense* los promedios fueron 42.0, 23.5

y 18.0, respectivamente. El ínidice reproductivo en algodón co-cultivado con *I. lacunosa* fue en promedio 38.5. Los promedios para las combinaciones algodón-*S. exaltata* y algodón-*S. halepense* fueron 23.5 y 26.0, respectivamente. La reproducción del nematodo en sólo soya o en combinaciones con las tres malezas se redujo sólo en presencia de *S. halepense* en dos ensayos. Posteriormente, se realizaron dos experimentos de invernadero de 45 días de duración, en donde se evaluó el efecto de las secreciones de las malezas sobre la reproducción del nematodo en algodón . Los resultados de estas pruebas indican que la supresión de la reproducción del nematodo reniforme probablemente se debe a la secreción de compuestos alelopáticos de las raíces de las malezas.

Palabras clave: alelopatía, algodón, *Glycine max*, *Gossypium hirsutum*, *Ipomoea lacunosa*, malezas, nematodo reniforme, reproduccción, *Rotylenchulus reniformis*, *Sesbania exaltata*, *Sorghum halepense*, soya.

INTRODUCTION

The reniform nematode (*Rotylenchulus reniformis*) has become the most economically important pest species associated with upland cotton (*Gossypium hirsutum*) production in the southeast United States, and has been found in all 11 states that comprise the Cotton Belt (Lawrence, 2004). Of the 2.5 million hectares of cotton produced in the southeast, 19 percent is infested with reniform nematode. The infestation percentage ranges from 1.4 to 55 in each state, with the highest occurring in Alabama, Louisiana and Mississippi. Losses to reniform nematode from 2000 through 2003 averaged 5.0%, 6.9%, and 6.0% in Louisiana, Mississippi, and Alabama, respectively. Cotton loss due to reniform nematode in these three states during this period was estimated at 1.14 million bales (Blasingame and Patel, 2001, 2002, 2003, 2004).

Rotylenchulus reniformis was first described in Hawaii in 1940 by Linford and Oliveira. Shortly thereafter, it was reported in the continental United States as a parasite of cotton in Georgia (Smith, 1940) and Louisiana (Smith and Taylor, 1941). It was not until 1965 that reniform was shown to be an important parasite of soybean (Fassuliotis and Rau, 1967). Only the pre-adult females of reniform nematodes infect cotton and soybean roots. Females produce 75-80 eggs per egg mass within 3 weeks of infection. With a relatively short life cycle of only 3 weeks, soil populations increase rapidly during a single growing season (Lawrence and McLean, 2001). During the past 10 years, 26% of cotton fields in which the reniform nematode has been detected have population densities over 10,000 per 500 cm^3 soil, and 10% over 20,000 per 500 cm^3 soil. The most commonly employed methods for management of reniform nematode are nematicides, crop rotation with a nonhost or poor host, and cultivar selection (McGawley *et al.*, 2006). Currently there are no commercially available cotton varieties resistant to reniform nematode (Lawrence and McLean, 2001; Koenning *et al.,* 2004). Rotation with corn and grain sorghum is an excellent, but not widely practiced, management tactic. Nematicides, such as Telone and Temik, are efficacious against reniform nematode, but monetary and environmental costs are usually prohibitive.

Almost 75 million hectares of soybeans (*Glycine max*) were planted in the United States in 2006, a 1.1 million hectare increase from 2005. Although soybean cyst nematode is the primary pathogen attacking soybeans, reniform and root-knot nematodes are being detected more than ever in field surveys (Palmer, 2001). In many fields in the southeast United States, cotton is planted year after year, encouraging reniform populations to build up to highly damaging levels.

Cotton and soybean roots survive for months after harvest. In years when there is a delay in the onset of cool temperatures (<15°C), reniform nematodes can feed and reproduce on stubble and associated weed roots, thus maintaining high population densities through the next planting season (Kinloch and Rich, 2001). Weeds allow the reniform nematodes to survive in the absence or presence of the crop, providing a source of nematode inoculum for the following season (Myers *et al.,* 2004). There are many weeds, particularly broadleaf ones, which are good hosts for reniform nematode (Hollis, 2003). Numerous studies have documented the interaction of nematodes and weeds (McSorley and Campbell, 1980; Inserra *et al.*, 1989; Schroeder *et al.*, 1993; Queneherve *et al.*, 1995; Thomas *et al.*, 1996; Schroeder, 2002; Noling and Gilreath, 2002). Moreover, weeds that are good hosts for nematodes can diminish the nematode-suppressive effect of a rotation crop (Davis, 2004).

Although most weeds are hosts for nematodes, others are known that produce allelopathic substances and suppress reproduction, thereby reducing populations in the soil. Allelochemicals are plant metabolites or their products that are released into the microenvironment or rhizosphere. Allelopathic compounds are released through volatilization, exudation from roots, leaching from plants or residues, and decomposition of residues (Halbrendt, 1996). The possibility of using naturally occurring allelochemicals for nematode control has advantages over the use of nematicides. Many crop and weed species have been evaluated for chemical activity against nematodes and shown to produce nematicidal compounds (Halbrendt, 1996). Plants, such as marigolds (*Tagetes patula*), chrysanthemum (*Chrysanthemum* spp.), velvet bean (*Mucuna pruriens),* and rapeseed (*Brassica napus*), produce nematicidial and nematistatic (suppressive) organic compounds including thiophenes, which have been recovered from marigold root extracts and from undisturbed rhizospheres (Caswell *et al.*, 1991; McGawley *et al.* 1991).

Failure to observe differences in reniform nematode population density and/or life stage distribution in fields known to be infested (in spite of rotation of cotton and soybeans with non-hosts or fallow periods) prompted an evaluation of the impact of indigenous weed species on reproduction of *R. reniformis*. The objective of this research was to evaluate reniform nematode reproduction on cotton and soybean in the presence and absence of morningglory (*Ipomoea lacunosa*), hemp sesbania (S*esbania exaltata*) and johnsongrass (*Sorghum halepense*), three weed species endemic on both crops in Louisiana.

MATERIALS AND METHODS

General Procedures

Cotton cv. LA887 and soybean cv. Pioneer 96B21 were used in all microplot and greenhouse experiments. Monoxenic cultures of reniform nematode were isolated from cotton in Alexandria, Louisiana and maintained in the greenhouse on 'Rutgers' tomato. This reniform population was the source of all inoculum. Seedlings of cotton, soybean and all three weed species were produced in seedling trays in the greenhouse and then transplanted, either a single cotton, soybean or weed seedling, or a single cotton or soybean seedling plus one 1 of the three weeds, into microplots. Microplots consisted of clay pots having top diameters of 30.5 cm with soil capacities of 15 kg. Each pot contained 15 kg of methyl bromide-treated Commerce silt loam soil (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts).

All microplot experiments were established in May or June and harvested 60 days after inoculation. Recommended fertilization and insect management practices were used in microplot and greenhouse experiments. At harvest, plant material was dried at 40°C for 10 days and weighed.

Microplots

This project was initiated with the establishment of a microplot trial with cotton, morningglory, hemp sesbania and johnsongrass. Each microplot was placed into a preformed depression in the soil with only the rim of the pot exposed. The 49 microplots were spaced 1 m apart in a six-by-eight pattern. The entire area was covered with a 14-m-long by 6.5-m-wide aluminum quonset hut frame that was open at both ends and covered with 4-ml polyethylene plastic. Each microplot area was also equipped with overhead fans and an automated micro-mist irrigation system designed to eliminate splashing. Misters delivered 5 L/nozzle twice daily and pots received approximately 250 mls at each interval. Reflective shade cloth was placed over the plastic cover so that soil and air temperatures in microplots were within 2-3°C of those in the field. Light intensity under the reflective cloth was measured as 512 $\mu E \cdot s^{-1} \cdot m^{-2}$, which is approximately 78% of full sunlight. The pH of the soil in all microplot experiments ranged from 6.7-7.2.

Planting and harvest dates for cotton in year 1 and year 2 were 01 June and 10 August. Soybean planting and harvest dates in year 1 were 10 June and 20 August, and 07 June and 17 August in year 2. Treatments were arranged in a randomized complete block design with a factorial treatment structure. Each microplot was infested with approximately 2,000 reniform juveniles. These infestation levels mimic preplant levels of reniform nematodes commonly found in cotton and soybean fields in Louisiana. Inoculum for all tests consisted of juveniles and preadults extracted from greenhouse cultures by wet-sieving through nested 250-µm-pore and 38-µm-pore sieves followed by sugar flotation and centrifugation (Jenkins, 1964). Ten days after transplanting, soil was infested by pipetting reniform nematode suspensions into depressions (1.5 cm-diam. by 3 and 6 cm deep) surrounding the bases of the plants. Seven treatments were employed: 1) cotton; 2) morningglory; 3) hemp sesbania, 4) johnsongrass; 5) cotton and morningglory; 6) cotton and hemp sesbania; 7) cotton and johnsongrass. Each treatment was replicated seven times for a total of 49 microplots. Each microplot trial was run for 60 days, allowing for at least two generations of reniform nematode. When microplot trials were terminated, six soil cores (2.5 cm diam. by 30 cm deep) were collected from each microplot, bulked and mixed thoroughly. Nematodes were extracted from a 150-cm^3 composite subsample with wet-sieving and centrifugal/sugar flotation technique (Jenkins, 1964). Immature life-stages of the reniform nematode were enumerated at 40× using an Olympus CK-2 inverted microscope. Total population density per pot (Pf) and the reproductive values (R, where R = Pf/Pi and Pf = the final population level and Pi = initial infestation level (Oostenbrink, 1966)) were determined. Plant shoots were removed and placed into a paper bag in a drying oven at 40°C for 10 days and weighed. Root systems were removed from the microplots by carefully washing away soil over a 3-cm mesh screen preserving the intact root system. Roots were then placed into paper bags for 10 days at 40°C and weighed. The same experimental design and methodology were employed using soybean.

Greenhouse

The hypothesis that the suppression of reniform reproduction observed in microplots was due to allelopathic compounds was tested in the greenhouse. To evaluate effects of leachates on plant growth, a preliminary 45-day duration experiment was conducted in which leachates from each of the three weeds plus a tap water control were added to 15-cm-diam clay pots with 2 kg of steam sterilized soil containing single LA 887 cotton seedlings. Methods for collection of leachates are described below.

Greenhouse leachate experiments were expanded to evaluate effects of weed root leachates on reproduction of reniform nematode. Fifty clay pots having top diameters of 15-cm, each containing 2 kg of steam-sterilized soil, and representing five replicates of 10 treatments were arranged in a randomized complete block design on a greenhouse bench. Each of the pots was infested with 300 reniform juveniles/2 kg soil, which is equivalent to the infestation level used in the microplot trials. On an adjacent bench, six 30-cm-diam. coco fiber hanging baskets (two each for morningglory, hemp sesbania and johnsongrass) containing 375 g of sterile perlite were suspended 50 cm above the surface of the bench. One hundred seed of each weed species were planted in each basket. A 30-cm-diam. plastic funnel was affixed to the bottom of each basket. A 25-cm length of tubing connected the bottom of the funnel to the mouth of a foil wrapped, sterile 500-ml plastic bottle positioned on the bench below.

Each morning for 45 days, beginning 72 hours after planting, 500 ml of water was added to each of the hanging baskets; providing approximately 1 liter of leachate per weed species. These three leachate sources or regular tap water were added immediately to the clay pots on the adjacent bench at 120 ml per pot. Thirty-five of these pots duplicated the original seven plant, or plant-weed combinations, used in the microplots. The remaining 15 pots contained a single LA 887 cotton seedling and five received leachates from morningglory, five from hemp sesbania and five from johnsongrass. Over the course of this greenhouse trial, temperature and pH of soil, water and leachates was monitored daily. The foil wrapped collecting bottles were autoclaved after each use. The experiment was repeated once and two additional controls, leachate from cotton seedlings and leachate from baskets containing only perlite were included. Planting and harvesting dates were 16 November and 03 January, and 03 March and 29 April, for the first and second experiments, respectively. In experiment one, the average air and soil temperatures ranged from 12-21°C and 14-19°C, respectively. Water and leachate temperatures both ranged from 17-22°C, respectively. The pH of the soil in experiment one ranged from 6.9-7.2 across treatments. The pH values for each of the three leachates used in experiment one were comparable to each other (averaging 6.6 for morningglory, 6.5 for hemp sesbania and 6.8 for johnsongrass) and to the water control that averaged 6.8. In experiment two, the average air and soil temperatures ranged from 25-35°C and 20-30°C, respectively. Water and leachate temperatures both ranged from 25-30°C, respectively. The pH data for experiment two was identical to that for experiment one. Values for the two additional controls in experiment two were within these same temperature and pH ranges.

Statistical Analysis

Analysis of variance and Tukey's HSD means separation procedures were performed on plant and nematode numbers

using the "Fit Model" module of SAS JMP, version 5.0 (SAS Institute, Cary, NC). Differences noted were significant at the 5% level. Since there were year by treatment interactions with the soybean trials, data for each year is presented separately.

RESULTS

Cotton

The absence of year by treatment interactions allowed data for the cotton microplot trials to be combined for analysis and presentation. Over both microplot trials, reniform population density at 60 days on cotton averaged approximately 138,000 individuals per microplot, representing a reproductive factor of 69.0 (Table 1). Numbers of reniform individuals per microplot and reproductive values for morningglory, hemp sesbania and johnsongrass, were 84,000, 47,000 and 36,000 and 42.0, 23.5 and 18.0, respectively. Both population density and reproductive values for morningglory were equal to cotton. For hemp sesbania and johnsongrass, however, these values were both significantly less than cotton.

Relative to cotton alone, the co-culture of cotton with any of the three weeds resulted in a significant decline in reniform population density. The reproductive index data followed the same trend. Cotton root weights, at 60 days after inoculation, were reduced significantly in the presence of each of the three weed species. Weights of weed root systems, however, were not reduced when they were co-cultured with cotton.

Soybean

On soybean, reniform population densities at 60 days in year 1 ranged from a high of almost 300,000 individuals per

Table 1. Influence of 'LA 887' cotton and three cotton-weed combinations on reproduction of *Rotylenchulus reniformis* after 60 days in a microplot environment.

			Root dry weight (g)[y]	
Plant species	Pf[w]	R[x]	Cotton	Weed
Cotton	138 a	69.0 a	26.1 a	—
Morningglory	84 ab	42.0 b	—	26.7 b
Hemp sesbania	47 b	23.5 b	—	41.7 b
Johnsongrass	36 b	18.0 b	—	291.2 a
C[z] + MG	77 b	38.5 b	4.0 b	26.7 b
C + HS	47 b	23.5 b	5.1 b	34.0 b
C + JG	52 b	26.0 b	4.9 b	304.5 a

Data are means of 14 replications over two trials. For each parameter, means followed by the same letter are not significantly different based on ANOVA and Tukey's HSD Tests ($P \leq 0.05$).

[w]Pf = final population density in 1000s per 30-cm-diam. clay pot containing 15 kg of soil.

[x]R (reproductive value) = Pf/Pi where Pf = the final population density and Pi = infestation level of 2000 vermiform nematodes.

[y]Root weights were determined by drying roots for one week at 40°C.

[z]C = cotton, MG = morningglory, HS = hemp sesbania, JG = johnsongrass, C + MG, C + HS, C + JG represent combined plantings.

microplot for soybean alone treatment to a low of 72,000 for johnsongrass alone (Table 2). Theses levels represented a range in reproductive rate of 146.1 to 36.2. Singly, soybean was a significantly better host for *R. reniformis* in both years than was either hemp sesbania or johnsongrass. The same level of reproduction was observed for morningglory in year 1. In year 2, however, reproduction by *R. reniformis* on morningglory was statistically equivalent to that on soybean. In both years of the microplot trial, only the co-culture of johnsongrass with soybean resulted in populations of reniform nematode that were reduced significantly below those for soybean alone.

Greenhouse

A preliminary experiment evaluating leachate effect on cotton growth in the absence of reniform nematode showed no phytotoxic effects (Table 3). Root dry weights at 45 days were not significantly different among treatments. Top weights of cotton plants irrigated with leachates from johnsongrass were reduced significantly, but this did not alter final plant weights, which were statistically equivalent among all treatments.

Data from both greenhouse experiments with cotton supported the allelopathy hypothesis (Table 4). Reniform nematode reproduction, both in the presence of the intact weed or leachates from their roots, was reduced significantly. Moreover, with the single exception of the cotton/johnsongrass leachate treatment in experiment one, nematode populations and reproductive rates were reduced to a greater degree by leachates scollected from multiple seedling roots than by those

Table 2. Influence of 'Pioneer 96B21' soybean and three soybean-weed combinations on reproduction of *Rotylenchulus reniformis* after 60 days in a microplot environment.

	Year 1				Year 2			
			Root dry weight (g)[y]				Root dry weight (g)[y]	
Plant species	Pf[w]	R[x]	Soybean	Weed	Pf	R	Soybean	Weed
Soybean	292 ab	146.1 ab	26.2 a	—	71 ab	35.9 ab	22.9 bc	—
MG	192 c	96.3 c	—	9.1 b	57 b	28.4 b	—	7.8 c
HS	152 cd	70.6 cd	—	10.1 b	34 c	17.2 c	—	25.0 bc
JG	72 d	36.2 d	—	361.2 a	21 c	10.4 c	—	62.5 a
S + MG	374 a	187.1 a	26.5 a	7.8 b	89 a	44.4 a	37.9 ab	5.8 c
S + HS	221 bc	110.6 bc	24.8 a	5.5 b	56 b	27.9 b	42.6 a	20.8 c
S + JG	162 c	71.0 c	35.7 a	374.8 a	32 c	16.0 c	21.9 c	54.8 ab

Data are means of 5 replications. For each parameter, means followed by the same letter are not significantly different based on ANOVA and Tukey's HSD Tests ($P \leq 0.05$).

[w]Pf = final population density in 1000s per 30-cm-diam. clay pot containing 15 kg of soil.

[x]R (reproductive value) = Pf/Pi where Pf = the final population density and Pi = infestation level of 2000 vermiform nematodes.

[y]Root weights were determined by drying roots for 1 week at 40°C.

[z]S = soybean, MG = morningglory, HS = hemp sesbania, JG = johnsongrass, S + MG, S + HS, S + JG represent combined plantings.

Table 3. Effects of leachates from morningglory, hemp sesbania and johnsongrass on dry weight of noninoculated 'LA 887' cotton after 45 days in a greenhouse environment.

	Dry weights (g)[z]		
Cotton irrigated with leachates from:	Root	Top	Plant
Control (tap water)	2.3 a	11.1 a	13.4 a
Morningglory	2.0 a	10.7 ab	12.7 a
Hemp sesbania	2.1 a	10.5 ab	12.6 a
Johnsongrass	2.1 a	10.2 b	12.3 a

Data are means of 14 replications. For each parameter, means followed by the same letter are not significantly different based on ANOVA and Tukey's HSD Tests ($P \leq 0.05$).
[z]Dry weights were determined after 1 week at 40°C

theoretically originating from single, intact plants.

DISCUSSION

Modes of nematode suppression by cover crops or weeds can be categorized as providing a nonhost or poor host environment for nematodes (Rodriguez-Kabana *et al.*, 1988), producing allelochemicals (Halbrendt, 1996) or acting as trap crops to the nematode (Gardner and Caswell-Chen, 1994). Averaged across all four of the microplot trials, morningglory was the best host with an average reproductive value of 58.2. Hemp sesbania and johnsongrass followed with reproductive values at 60 days averaging 38.4 and 23.4, respectively. Data from Carter (1995), who worked with the same three weeds, rated the suitability of these three weeds to *R. reniformis* in the same order at the conclusion of a 76-day duration greenhouse experiment with soybean. A recent report by Lawrence *et al.* (2006) in Mississippi reports that morningglory and hemp sesbania, but not johnsongrass, are hosts of the reniform nematode.

Singly, all three of the weeds used in this research were hosts of reniform nematode. The co-culture of johnsongrass with either cotton or soybean significantly reduced reproduction of the nematode and the co-culture of either morningglory or hemp sesbania reduced reproduction on cotton but not soybean. The two greenhouse experiments, conducted subsequent to the cotton microplot trials, strongly suggested that the reproductive inhibition observed with cotton resulted from an allelopathic, leachable product(s) produced by the three weeds. One greenhouse trial with soybean and leachates from the three weeds, currently being repeated, shows that inhibition of reniform nematode reproduction is suppressed by leachates from johnsongrass as was found when it was co-cultured with soybean in microplots. This data, along with laboratory assays of the influence of leachates on the eclosion and hatch of eggs of *R. reniformis* shows significant inhibition of eclosion of reniform eggs and hatching of juveniles by 0.45-µm filtrates of leachates from each of the three weeds. This data and other studies of reniform egg biology will be detailed in a forthcoming manuscript.

We have demonstrated that the suppression in reproduction of reniform in greenhouse trials resulted largely as the result of allelopathic compounds pro-

Table 4. The influence of plant root leachates on soil populations of *Rotylenchulus reniformis* after 45 days in a greenhouse environment.

	Experiment 1		Experiment 2	
Plant species/Treatment	Pf[w]	R[x]	Pf	R
Cotton	4,756 a	15.8 a	8,899 a	29.6 a
Morningglory	4,537a	15.1 a	7,828 abc	26.0 ab
Hemp sesbania	3,207 b	10.6 b	5,379 d	17.9 cd
Johnsongrass	3,025 b	10.0 b	5,182 d	17.2 cde
Cotton + Morningglory	1,421 cd	4.7 cd	6,778 c	22.5 bc
Cotton + Hemp sesbania	1,731 c	5.7 c	3,476 e	11.5 e
Cotton + Johnsongrass	1,276 cd	4.2 cd	3,717 e	12.3 de
Cotton/MG leachate[y,z]	109 e	0.4 e	1,224 f	4.0 f
Cotton/HS leachate	638 de	2.1 de	1,443 f	4.8 f
Cotton/JG leachate	619 de	2.0 de	1,312 f	4.3 f
Cotton/Cotton leachate	—	—	7,587 bc	25.2 ab
Cotton/Perlite leachate	—	—	8,637 ab	28.7 a

Data are means of 5 replications for each experiment (experiment one ran from 16 November through 03 January and experiment two from 03 March through 29 April). For each parameter, means followed by the same letter are not significantly different based on ANOVA and Tukey's HSD Tests ($P \leq 0.05$).
[w]Pf = final population density per 15-cm-diam. clay pot containing 2 kg of soil.
[x]R (reproductive value) = Pf/Pi where Pf = the final population density and Pi = infestation level of 300 vermiform nematodes.
[y]MG = morningglory, HS = hemp sesbania, JG = johnsongrass.
[z]Indicates cotton plants to which leachate from morningglory plants was added.

duced by the weeds. We strongly suggest that allelopathy is the major factor that limited reproduction of reniform nematodes in our microplot trials. The reduction in cotton root weights at the end of the trial in microplots where they were co-cultured with any of the weeds were the result of reniform nematode pathology on cotton plants already contending with the presence of a concomitant weed species requiring space, water and nutrients. Data for dry top weights and that obtained by adding root and top weights together to determine plant weights (data not shown), follows the same trend as that of root weights.

Caswell (1991) conducted research to assess the influence of several accompanying plant species on the reproduction of *R. reniformis* on tomato. In these experiments, tomato was planted alone or was co-cultured with either rhodes grass or marigold. At 102 days after infestation, reproductive values for reniform nematode, when co-cultured, were significantly reduced relative to those for tomato alone. Inhibition of reproduction by reniform nematode was attributed to allelopathy in the case of marigold, and was unexplained for rhodes grass, although the inhibition was greater even than that of a fallow treatment.

Most plant species that produce allelochemicals, for example *Crotalaria juncea*, *Brassica napus* and *Tagetes patula* (Caswell, 1991; Wang *et al.*, 2001) are poor or non-hosts of the target nematode. Morningglory, hemp sesbania and johnsongrass

along with that documented for African marigold, *Tagetes erecta* (Wang, 2001) constitute some cases in which plants that are hosts of the nematode are also producers of allelochemicals.

This research demonstrates that morningglory, hemp sesbania and johnsongrass, three weed species endemic in cotton and soybean fields in Louisiana and much of the southern U.S., may have a suppressive effect on reproduction of reniform, and possibly other major nematode species. This does not suggest that producers should abandon current weed control practices. However, some level of weed presence in the field, especially that which involves species which are producers of allelochemicals, would reduce both the monetary and environmental costs associated with herbicide use based on the premise that fields should be maintained 100% weed-free.

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Received: 11/IX/2007

Recibido:

Accepted for publication: 23/X/2007

Aceptado para publicación: