SUPPRESSION OF *MELOIDOGYNE JAVANICA* AND *M. INCOGNITA* ON TOMATO WITH GROUND SEED OF CASTOR, CROTALARIA, HAIRY INDIGO, AND WHEAT†

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ABSTRACT

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Two greenhouse trials were conducted to determine the influence of ground seed of castor (*Ricinus communis*), crotalaria (*Crotalaria spectabilis*), hairy indigo (*Indigofera hirsuta*), and wheat (*Triticum aestivum*) on tomato (*Lycopersicon esculentum*) growth and egg mass production of *Meloidogyne javanica* (test 1) or *M. incognita* (test 2). Ground seed from each plant species was individually mixed with an air-dried, fine sandy soil at rates of 0, 0.5, 1.0, and 2.0% (w/w). The mixtures were placed in one-liter plastic pots, and water was added to bring soil to field capacity. After ten days, 0 or 10 000 *M. javanica* or *M. incognita* eggs and juveniles were added to each pot. A single 'Homestead' tomato seedling was transplanted into each pot and allowed to grow for 70 days in test 1 and 75 days in test 2. Compared to the nonamended control, egg mass production was significantly reduced by all treatments except the 0.5% levels of wheat and castor and the 1.0% castor treatment. The 2.0% levels of ground seed of crotalaria and hairy indigo almost completely suppressed egg mass production of both *M. javanica* or *M. incognita*. With the exception of the 1.0% crotalaria treatment in test 2, total plant weight did not differ among treatments and the control. Levels of the amendments rather than type of amendment had more effect on egg mass production.

Key words: castor, *Crotalaria spectabilis*, hairy indigo, *Indigofera hirsuta*, *Lycopersicon esculentum*, *Meloidogyne incognita*, *Meloidogyne javanica*, nematode management, *Ricinus communis*, root-knot nematode, tomato, *Triticum aestivum*, wheat.

RESUMEN

Rich, J. R. y G. S. Rahi. 1995. Supresión de *Meloidogyne javanica* y *M. incognita* con semillas molidas de crotalaria, higuerilla, indigo pubescente y trigo. Nematropica 25:159-164.

Dos ensayos de invernadero se llevaron a cabo para determinar la influencia de semillas molidas de la higuerilla (*Ricinus communis*), crotalaria (*Crotalaria spectabilis*), indigo pubescente (*Indigofera hirsuta*) y trigo (*Triticum aestivum*), sobre el crecimiento de el tomate (*Lycopersicon esculentum*) y la producción de masas de huevos de *Meloidogyne javanica* (prueba 1) o *Meloidogyne incognita* (prueba 2). Semillas molidas de cada especie fueron individualmente mezcladas con arena fina secada con aire a las proporciones de 0., 0.5, 1.0 y 2.0% (p/p). Las mezclas se colocaron en maceteros de plástico de 1 litro y se regaron hasta capacidad de campo. Diez dias después de 0 a 10 000 huevos y juveniles de *M. incognita* o *M. javanica* se inocularon en cada maceta. Una planta de tomate var. "Homestead" fue transplantada a cada una de las macetas y dejada en crecimiento por 70 días en la prueba 1 y 75 para la prueda 2. En comparasión del control sin enmienda ni inoculado, la producción de huevos se redujo significativamente en todos los tratamientos excepto en los niveles a 5% en trigo e higuerilla 1% también en higuerilla. El nivel de 2% de crotalaria, e indigo pubescente casi suprimió completamente

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la producción de huevos en ambos nematodos. Con la excepción del tratamiento de 1% de crotalaria en la prueba 2, el crecimiento total de las plantas no fue diferente entre los tratamientos y el control. El nivel de la enmienda, más que el tipo de enmienda, tuvo más efecto sobre la producción de huevos.
Palabras clave: *Crotalaria spectabilis*, higuerilla, indigo pubescente, *Indigofera hirsulta*, *Lycopersicon esculentum*, *Meloidogyne incognita*, *Meloidogyne javanica*, manejo de nematodos, *Ricinus communis*, nematodo agallador, tomate, *Triticum aestivum*, trigo.

INTRODUCTION

The use of organic materials as soil amendments to suppress plant-parasitic nematodes has been studied extensively (9,11). Increased interest in this work has resulted from the loss of several nematicides and the search for more environmentally benign alternatives (13). Also, greater interest has been shown in use of cover or rotation crops that actively or passively reduce plant-parasitic nematodes populations (15). Some of the crops grown in the southeastern United States that reduce populations of one or more *Meloidogyne* spp. include sorghum-sudangrass (*Sorghum bicolor* × *S. sudanense*), cotton (*Gossypium hirsutum*), bahiagrass (*Paspalum notatum*), and peanut (*Arachis hypogaea*) (7,14,15). A number of other plants not traditionally grown in rotation systems also can reduce *Meloidogyne* spp. populations. These include castor (*Ricinus communis*), crotalaria (*Crotalaria spectabilis*), and hairy indigo (*Indigofera hirsuta*) (11-13). The potential for reseeding of these plants is high, and plants such as crotalaria can become established as noxious weeds (3).

Seed of crotalaria and castor are highly toxic to mammals (6). Because these two plant species and hairy indigo suppress nematode populations, it is conceivable that chemical constituents in the seed may show activity against nematodes. If activity were sufficiently high, ground seed could be used for more direct nematode suppression, instead of growing these plants on a large scale, risking the development of noxious weed problems. Two studies were conducted to determine the activity of ground seed of castor, crotalaria, hairy indigo, and an organic control (wheat) for suppression of *M. incognita* and *M. javanica* in greenhouse-grown tomato.

MATERIALS AND METHODS

Crotalaria, hairy indigo, and wheat seed (cv. Florida 301) were ground separately in a Wiley® mill and passed through a sieve with 2.0-mm openings. Castor, because of the oily nature, could not be ground satisfactorily in the Wiley® mill and was ground with a mortar and pestle. Each ground seed preparation was added to a methyl bromide-treated, air-dried sandy soil [typic quartzipsamments thermic coated soil (2)] at the rate of 0.0, 0.5, 1.0 and 2.0% (w/w). The ground seed was thoroughly incorporated into the soil by manually mixing. Each ground seed-soil mixture was then placed in one-liter pots, and water was added to bring the soil to field capacity. Six pots of each treatment were placed in the greenhouse in a randomized complete block design, and water was added on alternate days to return the soil to field capacity. Ten days later, a single 2-month-old 'Homestead' tomato seedling (*Lycopersicon esculentum*) was transplanted into each pot. Two days after transplanting, pots were inoculated with *Meloidogyne javanica* in test 1 and *M. incognita* in test 2 at the rate of 0 or 10 000 eggs and second-stage juveniles. Inoculum was obtained from roots of 'Homestead' tomato using a

sodium hypochlorite technique (5). Plants were allowed to grow for 70 days after inoculation in test 1 and 75 days in test 2. At harvest, total plant weight was collected, and roots were rated for galling on a 0-4 scale (0 = no galling; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; and 4 > 76% of the root system galled). Representative samples of 5 g roots were taken from each plant, stained with cotton blue (4), and egg masses counted. Data on total plant weight, root galling, and number of egg masses were analyzed following standard procedures for analyses of variance, and when F values were significant, the means were compared using Fisher's LSD (FLSD) test at $P \leq 0.05$.

To determine carbon to nitrogen ratios (CIN), seed were lyopilized for 12 hrs prior to being ground with a mortar and pestle. The percent carbon, nitrogen, and carbon to nitrogen ratio was calculated after seed (n = 5 to 8) were analyzed on a PE 2400 Series II CHNS/O Analyzer (Perkin Elmer Corp., Norwalk, CT) (1).

RESULTS

Test 1 - M. javanica: Total plant weights among the ground seed treatments and the nematode-inoculated or noninoculated controls were not significantly different, but plants receiving the 0.5 and 1.0% ground seed treatments generally showed higher weights (Table 1). Crotalaria at 2.0% showed some evidence of phytotoxicity. Compared to the control with *M. javanica*, root galling was reduced in all treatments except the 0.5% wheat, 0.5% crotalaria, and the 0.5 and 1.0% castor treatments. All treatments numerically reduced root galling and lower gall indices were related to higher ground seed concentration. Number of egg masses were reduced significantly in all treatments with greatest reduction at the 2.0% levels. No egg masses were found in the 2.0% hairy indigo treatment, and low numbers were present in the 1.0% hairy indigo and 2.0% crotalaria seed treatments. Among the ground seed treatments, the 0.5% wheat and 0.5% hairy indigo resulted in the highest egg mass numbers. Root galling or egg mass numbers in response to the wheat seed treatment differed little from those obtained from the other three treatments, when treatments were used at the same rate.

Test 2 - M. incognita: With the exception of 1.0% crotalaria, total plant weight did not differ among treatments and the nematode-inoculated or noninoculated controls (Table 2). Root galling was significantly reduced compared to the nematode-inoculated control in all but the 0.5% levels of each seed treatment and the 1.0% castor treatment. Galling in response to the wheat seed did not differ from the other amendments when applied at the same rate except for the 2.0% crotalaria and 1.0% hairy indigo, which reduced galling below that of the comparable rate of wheat amendment. No root galling was found in the 2.0% crotalaria treatment, and low galling was observed in the 2.0% hairy indigo treatment. With the exception of castor, root galling decreased as amount of ground seed increased. Compared to the nonamended-inoculated control, numbers of egg masses were significantly reduced by all treatments except the 0.5% wheat, and the 0.5 and 1.0% castor. Lowest numbers of egg masses were present in the 2.0% hairy indigo and 2.0% crotalaria treatments. Number of egg masses generally decreased with increasing rates of ground seed.

C/N Ratios: The mean C/N ratios of the seed were: castor (18.2), crotalaria (9.6), hairy indigo (9.8) and wheat (19.5).

Table 1. Effect of 4 ground seed treatments on plant growth, root galling, and egg mass numbers in tomato inoculated with *Meloidogyne javanica*.[x]

Treatment	Rate[y]	Total plant wt. (g)	Root gall index[z]	No. egg masses/ 5 g root
Wheat	0.5	75.7	3.17	115.5
	1.0	75.4	2.17	62.8
	2.0	83.6	1.00	39.7
Crotalaria	0.5	85.7	3.17	95.5
	1.0	99.8	1.67	58.8
	2.0	47.8	0.83	3.2
Castor	0.5	82.1	3.17	77.7
	1.0	76.4	2.83	72.3
	2.0	70.6	1.67	22.8
Hairy indigo	0.5	90.6	2.33	123.0
	1.0	91.6	0.83	10.0
	2.0	71.3	0.00	0.0
Control + *M. javanica*	0.0	71.2	3.67	181.5
Control	0.0	68.8	—	—
FLSD ($P \leq 0.05$)	—	29.3	1.16	56.2

[x]Data are means of 6 replications of each treatment.
[y]Percent by weight (w/w) of ground seed mixed in a sandy soil.
[z]Root gall index based on a 0-4 scale where 0 = no galling and 4 < 76% of the root system galled.

DISCUSSION

Total fresh weight of tomato generally decreased at the 2.0% concentration of ground seed of castor, crotalaria, and hairy indigo in test 1. These data are consistent with previous findings (Rahi, unpublished) that rates of 4% (w/w) of these seed materials were phytotoxic to tomato. Results from test 1 more clearly indicated this effect than test 2. Tomatoes in test 1 were grown under the more optimal conditions in the fall while tomatoes in test 2 were grown at higher temperatures in the summer, resulting in lower total plant weights.

Ground seed of crotalaria and hairy indigo generally provided somewhat greater suppression of root galling and egg mass production than did the seed of wheat and castor. This possibly could have resulted from their lower C/N ratios. However, the 2.0% levels of all seed resulted in the lowest levels of nematode reproduction. The ground wheat seed treatment was added as an organic control, and most treatment levels resulted in nematode suppression. Nematode suppression by all

Table 2. Effect of 4 ground seed treatments on plant growth, root galling, and egg mass numbers in tomato inoculated with *Meloidogyne incognita*.[x]

Treatment	Rate[y]	Total plant wt. (g)	Root gall index[z]	No. egg masses/ 5 g root
Wheat	0.5	30.1	3.83	220.5
	1.0	35.4	2.50	106.2
	2.0	27.3	1.00	13.0
Crotalaria	0.5	32.3	4.00	166.8
	1.0	39.7	1.83	57.1
	2.0	35.4	0.00	1.6
Castor	0.5	32.1	3.67	222.3
	1.0	34.1	4.00	242.1
	2.0	32.3	2.83	128.2
Hairy indigo	0.5	34.3	3.50	164.5
	1.0	24.2	1.50	64.6
	2.0	33.5	0.50	7.3
Control + *M. incognita*	0.0	28.5	3.67	230.2
Control	0.0	27.4	—	—
FLSD ($P \leq 0.05$)	—	9.2	0.70	57.7

[x]Data are means of 6 replications.
[y]Percent by weight (w/w) of ground seed mixed in a sandy soil.
[z]Root gall index based on a 0-4 scale where 0 = no galling and 4 > 76% of the root system galled.

ground seed are similar to other studies utilizing low C/N ratio organic materials (11).

Castor suppresses nematode populations when grown in the field (13), and the plant contains a compound, ricin, which is highly toxic to mammals (10). Ricin was shown to inhibit motility of *M. incognita* but to a lesser extent than reported for aldicarb and fenamiphos (9). Data from these tests indicated only moderate nematode suppression with ground castor bean when compared to crotalaria and hairy indigo. The possible uneven mixing with this oily material may have affected these results.

The slightly greater activity of crotalaria and hairy indigo in suppressing *Meloidogyne* spp. may be due to both a lower C/N ratio in the seed as well as other chemical constituents directly affecting the nematode. Both plants are effective in reducing nematodes when used as cover crops (8,13). Additionally, crotalaria contains pyrrolizidine alkaloids which have high mammalian toxicity (6), and they

could be toxic to nematodes. Further work would be useful to directly test these compounds.

Data indicate that ground seed at minimum rates of 10-20 mt/ha would be necessary to achieve adequate nematode control. As such, usefulness in commercial agriculture may be limited. Use in potting soil and possibly home gardens could be practical, since higher rates are more applicable in these situations, and the materials could also provide organic matter and nutrients to the soil.

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