EFFICACY OF SELECTED FUMIGANT AND NONFUMIGANT NEMATICIDES TO CONTROL *MELOIDOGYNE JAVANICA* IN FLORIDA TOBACCO[1]

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ABSTRACT

Garcia M., R., and J. R. Rich. 1983. Efficacy of selected fumigant and nonfumigant nematicides to control *Meloidogyne javanica* in Florida tobacco. Nematropica 13:125-134.

Four field trials were conducted over three years to compare the relative efficacy of nematicides, dosages, and application techniques for control of *Meloidogyne javanica* (Treub) Chitwood in flue cured tobacco (*Nicotiana tabacum* L.). Trials were conducted in a Klej fine sand naturally infested with *M. javanica*. Chemicals utilized were 1,2-dichloropropane-1,3-dichloropropene (DD), ethylene dibromide (EDB), ethoprop, phenamiphos, fensulfothion, metalaxyl, aldicarb, and carbofuran. DD and EDB gave the best control of *M. javanica* and increased tobacco yield in most tests while carbofuran, metalaxyl, and aldicarb gave the poorest control. Effectiveness of ethoprop and phenamiphos varied among test years but was improved by utilizing high rates of these materials. The post-plant applications of ethoprop did not significantly increase tobacco yields when compared to similar preplant incorporated dosages. Melalaxyl alone or in combination with nematicides did not significantly increase nematode control or tobacco yield.

Additional key words: fumigants, nonfumigants, application techniques, root-knot nematodes.

RESUMEN

Garcia M., R., y J. R. Rich. 1983. Eficacia de ciertos nematicidas fumigantes y no fumigantes en el control de *Meloidogyne javanica* en tabaco de la Florida. Nematropica 13:125-134.

Cuatro ensayos de campo se llevaron a cabo durante tres años para comparar la efectividad relativa de nematicidas, dosis, y técnicas de applicación en el control de *Meloidogyne javanica* en tabaco estufado. Los ensayos se llevaroa cabo en suelos de arena fina "Klej" infestados con *M. javanica*. Materiales químicos usados fueron: DD, EDB, ethoprop, phenamiphos, fensulfothion, metalaxyl, aldicarb, y carbofuran. DD y EDB dieron el mejor control de *M. javanica* y aumentaron el rendimiento de tabaco en el resto de los ensayos, mientras que carbofuran, metalaxyl, y aldicarb dieron el peor control. La efectividad de ethoprop y phenamiphos fue variable de un año a

otro, pero fueron mayores cuando se usaron altas dosis de esos materiales. Aplicaciones de ethoprop después de la siembra no produjeron aumentos en rendimiento, comparado con dosis iguales aplicadas antes de la siembra. Metalaxyl por sí solo o en combinación con nematicidas no aumentó los rendimientos o el control de nematodos.
Palabras claves adicionales: fumigantes, no-fumigantes, tecnicas de aplicación, nematodos de los nódulos de las raices.

INTRODUCTION

Tobacco (*Nicotiana tabacum* L.) is an important agricultural commodity in the southeastern United States, and root-knot nematodes (*Meloidogyne* spp.) are a major problem in tobacco production (10). Although recognized as an important production problem of tobacco in other areas of the world (12), *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 has only recently been found to be an important parasite of the crop in the U.S. (14).

Rotations and nematicides become particularly significant in control of *M. javanica,* since no resistance is available for *M. javanica* in commercial tobacco cultivars. Both fumigant and nonfumigant nematicides have been found to be useful in reducing *Meloidogyne* spp. damage in tobacco (12). However, differences in effectiveness among nematicides (3, 5, 8, 9, 11), and among root-knot nematode species (2, 13) have been observed. Field observations of failure to control *M. javanica* with nematicides, particularly the nonfumigants, indicated a need to study these chemicals in the deep sands of north Florida.

MATERIALS AND METHODS

Field evaluations of fumigant and nonfumigant nematicides were conducted in an acidic (pH ca. 5.6) Klej fine sand (93% sand, 4% silt, 3% clay) naturally infested with *M. javanica.* Single tests were conducted in 1980 and 1982, and two in 1981. Chemicals tested included: ethoprop, phenamiphos, fensulfothion, metalaxyl, carbofuran, aldicarb, ethylene dibromide (EDB), and 1,2-dichloropropane-1,3-dichloropropene (DD).

The fumigants were applied two to three weeks before planting by injection with a single in-row chisel to a depth of 25 cm below the soil surface. Rows were bedded after fumigant application except in the 1982 test. Nonfumigant nematicides were applied at time of transplanting or one day prior to transplanting the tobacco. Liquid formulations of the nonfumigants, phenamiphos, fensulfothion, metaxyl, and ethoprop, were applied with a CO_2 pressure sprayer fitted with 8004 Teejet® flat fan spray nozzles. Granular formulations of aldicarb and carbofuran were applied manually or with electric granular applicators prior to transplanting. Immediately after application, the nonfumigant nematicides were incorporated 8-12 cm deep by discing twice. Postplant applications of granular ethoprop were applied manually in two 22 cm wide bands placed on either side of the tobacco row. Applications were made 35 and 68 days after transplanting in the 1981 and 1982 tests, respectively. Natural rainfall or irrigation insured movement of the materials into the root zone within five days.

'Hicks' tobacco was planted in the 1980 and 1981 tests and 'Speight G-28' in the 1982 test. Transplants were placed 50 cm apart in rows 1.12 m wide. Plots were 6.7 m in length x two rows, and the experimental design was a randomized complete block with five replications. Standard cultural and irrigation practices were utilized to promote good tobacco growth.

Six soil cores were collected from each plot in the 1980 test at 94 days after transplanting and in the 1981 tests at 82 or 123 days respectively. Cores were collected 30 cm deep in-row and 12 cm from plant crowns. The samples were composited and second-stage juveniles extracted from a 250 cm^3 subsample by a centrifugation sugar flotation technique (7). In the 1980 and one 1981 test, roots from the 250 cm^3 subsample of soil were processed using the sodium hypochlorite technique for egg extraction (6). Root galling data were obtained in all tests and ratings were on a 0-4 scale with 0 equalling no visible galls and 4 equalling 75-100% of the root system galled. Tobacco was harvested and cured leaf weights were recorded.

RESULTS

In 1980, EDB and DD significantly increased cured tobacco yield and reduced nematode numbers as compared to control plots (Table 1). The two phenamiphos treatments significantly reduced nematode numbers but did not increase tobacco yields. All treatments except aldicarb reduced root gall indices, with phenamiphos providing the lowest gall ratings. In 1981, treatments and results were similar to 1980 (Table 2). The fumigants and two of the three treatments involving phenamiphos significantly improved tobacco yield. Gall index ratings were significantly reduced by all treatments while nematode numbers were reduced by all treatments except phenamiphos + metalaxyl. The fumigant nematicide treatments had lowest nematode numbers and gall index ratings.

In the 1981 ethoprop test, higher preplant incorporated rates of ethoprop (13.5 and 17.9 kg a.i./ha) provided significantly greater cured leaf yields than the lower ethoprop rates (9.0 kg a.i./ha) or control plots (Table 3). Use of DD resulted in the lowest nematode numbers and root gall indices but produced lower tobacco yield due to early season phytotoxicity. All treatments significantly reduced nematode numbers. In

Table 1. Influence of nematicides and chemical combinations on nematode numbers, root gall index, and yield of tobacco in a test site infested with *Meloidogyne javanica* - 1980.[w]

Chemical (kg a.i./ha)	Application method[x]	Cured yield in kg/ha	Nematode numbers[y]	Gall index[z]
Ethylene dibromide (33)	IIR	2689 a	31 a	1.4 ab
DD (112)	IIR	2587 ab	133 a	1.4 ab
Phenamiphos (6.7) + Metalaxyl (2.2)	PPI	2387 abc	75 a	0.3 a
Phenamiphos (4.5) + Fensulfothion (4.5) + Metalaxyl (2.2)	PPI	2331 abc	197 ab	0.3 a
Aldicarb (3.4)	24″ Band	2179 c	407 bc	3.0 cd
Carbofuran (6.7)	PPI	2162 c	373 bc	2.3 bc
Control		2067 c	612 c	3.5 d

[w]Column means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

[x]IIR and PPI represent injected in-row and preplant incorporated, respectively.

[y]Total nematodes from roots and soil recovered from 250 cm^3 of soil 94 days after transplanting.

[z]Three root systems from each plot were rated on a 0-4 scale 96 days after transplanting.

Table 2. Effect of nematicides and chemical combinations on tobacco yield, nematode numbers, and root gall index in a site infested with *M. javanica* - 1981.[w]

Chemical (kg a.i./ha)	Application method[x]	Cured yield in kg/ha	Nematode numbers[y]	Gall index[z]
DD (112)	IIR	2880 a	251 ab	0.3 a
Ethylene dibromide (33)	IIR	2828 a	56 a	0.1 a
Phenamiphos (6.7) + Metalaxyl (2.2)	PPI	2800 ab	965 c	1.9 c
Phenamiphos (6.7)	PPI	2730 b	312 b	0.9 b
Phenamiphos (4.5) + Fensulfothion (4.5) + Metalaxyl (2.2)	PPI	2587 bc	488 b	1.0 b
Control	—	2408 c	1108 c	3.4 d

[w]Column means followed by the same letter are not significantly different at the 5% level of significance according to Duncan's multiple range test.

[x]IIR and PPI represent injected in-row and broadcast incorporated, respectively.

[y]Total recovered in soil and roots from 250 cm^3 soil 82 days after transplanting.

[z]Two root systems from each plot were rated on a 0-4 scale 76 days after transplanting.

Table 3. Influence of nematicides on nematode control and yield of tobacco in a test site infested with *M. javanica* - 1981.[w]

Chemical (kg a.i./ha)	Application method[x]	Cured yield in kg/ha	Nematode numbers[y]	Gall index[z]
Ethoprop (13.5)	PPI	3138 a	73 b	0.5 b
Ethoprop (17.9)	PPI	3060 ab	55 b	1.1 c
Ethoprop (9.0 + 4.5)	PPI + PPA	2937 b	73 b	1.2 c
Ethoprop (9.0 + 9.0)	PPI + PPA	2845 bc	76 b	0.5 b
Phenamiphos (6.7)	PPI	2778 c	70 b	0.7 b
DD (112)	IIR	2792 c	9 a	0.1 a
Ethoprop (9.0)	PPI	2743 c	100 bc	0.5 b
Control	—	2632 c	146 c	2.8 d

[w]Column means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.
[x]PPI, PPA, and IIR represent preplant incorporated, postplant application, and injected in-row, respectively.
[y]Represents number of *M. javanica* larvae in 250 cm^3 soil taken 123 days after transplanting.
[z]Two roots systems from each plot were rated on a 0-4 scale 123 days after transplanting.

1982, all treatments except metalaxyl significantly increased tobacco yield and reduced root galling as compared to control plots (Table 4).

DISCUSSION

Many variables affect the ability of nematicides to control *Meloidogyne* spp. in tobacco, and the literature sometimes presents conflicting findings on the relative efficacy of various nematicides. Our tests agree with other studies that show fumigants control *M. javanica* on tobacco more consistently than nonfumigants (5, 9, 16). The relative effectiveness among nonfumigant nematicides, however, may differ greatly as shown in these and other tests (4, 8, 13). Our data indicate that although excellent control may be achieved when using certain nonfumigant nematicides in some years or tests, the chemicals may perform erratically in others. It is suspected that environmental conditions, particularly excessive early season rainfall, may alter the performance of nonfumigant nematicides. In addition, management of *M. javanica* suggests the need for control levels above those satisfactory for less aggressive nematode parasites of tobacco (1, 2). In fact, our data from some heavily infested tobacco fields indicated a need for more complete control than obtained by either in-row fumigation or non-fumigant nematicides.

These tests indicate the usefulness of increasing rates of some nonfumigant nematicides to provide a greater degree of *M. javanica* control in Florida tobacco. In general, higher rates of ethoprop (13.5 kg a.i./ha) and perhaps phenamiphos (6.7 kg a.i./ha) provide more consistent control of *M. javanica*. Problems with phytotoxicity were not encountered with these higher rates in the deep sands in which these tests were conducted.

Metalaxyl alone or in combination with nematicides did not control *M. javanica* in these tests. Although data indicated some effect from use of metalaxyl, little value could be shown in tobacco yield. The metalaxyl-nematicide combinations, however, were not phytotoxic and these may prove valuable in fields containing both black shank fungi and root knot nematodes (15). Use of a phenamiphos-fensulfothion combination did not improve nematode control over that of phenamiphos alone or may have been marginally less effective. Tobacco yields following postplant application of ethoprop were less than or equal to those obtained by preplant incorporated application of an equal total rate of ethoprop.

Damage from *M. javanica* in Florida tobacco is quite extensive, even where nematicides have been used. The optimal integration of suitable nematicides and other control techniques is necessary to reduce damage from this nematode. Results of these studies confirm that fumigant nematicides remain more consistently effective than non-fumigants for control of *M. javanica* in Florida tobacco.

Table 4. Effect of nematicides and chemical combinations on tobacco yield and root gall index in a site infested with *M. javanica* - 1982.[x]

Chemical (kg a.i./ha)	Application method[y]	Cured yield in kg/ha	Gall index[z]
Ethoprop (9.0 + 9.0)	PPI + PPA	2694 a	0.2 a
Ethoprop (13.5)	PPI	2610 a	0.4 ab
Ethoprop (9.0)	PPI	2563 a	0.3 ab
Ethylene dibromide (23.0)	IIR	2540 a	1.0 b
Phenamiphos (2.2) + Fensulfothion (4.5) + Metalaxyl (2.2)	PPI	2471 a	0.6 ab
Phenamiphos (6.7)	PPI	2438 a	0.2 a
Metalaxyl (2.2)	PPI	1572 b	2.8 c
Control	—	1540 b	3.4 c

[x]Column means followed by the same letter are not significantly different at the 5% level of significance according to Duncan's multiple range test.

[y]PPI, IIR, and PPA indicate preplant incorporated, injected in-row and postplant application, respectively.

[z]Four plants from each plot were rated on a 0-4 scale 100 days after transplanting.

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