EFFECTS OF FUMIGANT AND NONFUMIGANT NEMATICIDES ON NEMATODE POPULATIONS AND YIELDS OF BROCCOLI AND SQUASH IN FLORIDA[1]

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ABSTRACT

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Two experiments on broccoli and one on squash were conducted in the spring of 1987 on Myakka fine sand in which soil fumigant nematicides (1,3-dichloropropene and metam-sodium) and nonfumigant nematicides (carbofuran, ethoprop, and fenamiphos) were tested for efficacy in reducing injury from *Belonolaimus longicaudatus, Meloidogyne incognita,* and *Hoplolaimus galeatus,* and increasing crop yields. Both soil fumigants significantly reduced populations of the three nematode species and increased yields. Of the nonfumigants, fenamiphos significantly reduced populations of *B. longicaudatus* and *M. incognita* and increased yields. Carbofuran and ethoprop reduced galling caused by *M. incognita,* but did not consistently reduce populations of *B. longicaudatus;* however, yields were increased. None of the nonfumigants were effective against *H. galeatus.*

Additional key words: Brassica oleracea, Cucurbita pepo, sting nematodes, root-knot nematodes, lance nematodes, chemical control, plant nematode management.

RESUMEN

Rhoades, H. L. 1987. Los efectos de nematicidas fumigantes y no-volatiles sobre las poblaciones de nematodos y rendimiento de broccoli y zapallo en Florida. Nematropica 17:193-198.

En la primavera de 1987, se llevaron a cabo dos experimentos de broccoli y uno de zapallo en suelos de arena fina Myakka en Florida. Nematicidas fumigantes (1-3 dichloropropene y metam-sodium) y nematicidas no-volatiles (carbofuran, ethoprop y fenamiphos) fueron evaluados para determinar su eficacia en la reducción del daño causado por *Belonolaimuis longicaudatus, Meloidogyne incognita* y *Hoplolaimus galeatus,* y sus efectos sobre los incrementos en rendimientos. Ambos fumigantes de suelo redujeron las poblaciones ($P=0.05$) de las tres especies de nematodos e incrementaron los rendimientos. De los nematicidas no-volatiles, fenamiphos redujo las poblaciones ($P=0.05$) de *B. longicaudatus* y *M. incognita* e incrementó los rendimientos. Carbofuran y ethoprop redujeron el agallamiento causado por *M. incognita,* pero no redujeron en forma consistente las poblaciones de *B. longicaudatus.* Sin embargo, los rendimientos fueron incrementados. Ninguno de los compuestos no-volatiles fueron efectivos contra *H. galeatus.*

Palabras claves adicionales: Belonolaimus longicaudatus, Meloidogyne incognita, Hoplolaimus galeatus, control químico, manejo de nematodos, Cucurbita pepo, Brassica oleracea.

INTRODUCTION

Squash (*Cucurbita pepo* L.) is an important commercial vegetable crop in Florida. Approximately 6,400 ha were harvested in the 1985-86 growing season, having a total value of $40.2 million (2). Broccoli (*Brassica oleracea* L.) is much less important commercially, but is becoming more popular and is grown more extensively each year. Both of these crops are produced primarily on fine sandy soils where plant nematodes frequently cause serious reductions in vegetable yields. The sting nematode, *Belonolaimus longicaudatus* Rau, and root-knot nematodes, *Meloidogyne* spp., are particularly injurious to vegetable crops in Florida (1). When concomitant populations of *B. longicauatus, M. incognita* (Kofoid & White) Chitwood, and the lance nematode, *Hoplolaimus galeatus* (Cobb) Thorne, were found in experimental fields of Myakka fine sand (92.2% sand, 5.7% silt, and 2.1% clay) at the Central Florida Research and Education Center, Sanford, nematicide efficacy trials were planned and conducted during the late winter and spring of 1987.

MATERIALS AND METHODS

Two experiments were conducted on broccoli and one on summer squash. The experimental design was a randomized complete block with five replicates for all treatments. Each broccoli plot consisted of two rows 76 cm apart and 12.2 m long and each squash plot contained one row (152 cm spacing) 12.2 m long.

Soil fumigants used in the experiments were 1,3-dichloropropene (1,3-D) applied at 56 L/ha on broccoli and 28 L/ha on squash, and metam-sodium applied at 140 and 280 L/ha on broccoli and 93.5 and 187 L/ha on squash. The soil fumigants were applied as in-row treatments with a hand injector set to deliver the fumigant 20 cm deep 2 wk before transplanting broccoli or seeding squash. 1,3-D was applied in a single line of injections spaced 25 cm apart and metam sodium was applied in a double line of injections spaced 15 cm apart per plot row.

Nonfumigant granular formulations of carbofuran, ethoprop, and fenamiphos were applied in a 38-cm-wide band in-row and incorporated 6-8 cm deep with spiked rotary cultivator wheels one day before planting. Application rates were 2.24 and 3.36 kg ai/ha over the experimental area for each nematicide on broccoli and 1.12 and 2.24 kg ai/ha on squash.

Transplanting dates for 'Atlantic' broccoli were 17 February for the first experiment and 2 March for the second. 'Early Prolific Straight Neck' squash was seeded on 9 March. Normal fertilization and cultural practices for the area were followed. Broccoli was harvested when the diam of heads was 10 cm or greater; there were 6 harvests between 3 March and 5 May for the first experiment and 5 harvests between 28

April and 25 May for the second. Eight harvests of squash (fruit 10 cm or longer) were made between 4 May and 25 May.

Soil samples were collected at the first harvest of each experiment for nematode population assays. The samples consisted of five random cores 2.5 x 18 cm taken from the plot rows. Processing was done by a centrifugal-flotation technique (3). Root-knot nematode galling indices were recorded after the final harvest by examining 6 random root systems from each plot and rating them on a 1-5 scale: 1 = no galling, to 5 = severe galling.

RESULTS AND DISCUSSION

In the squash experiment, stunting, uneven growth, and restricted root systems with typical sting nematode symptoms of discoloration, lesions, and stubby roots occurred in control plots during early growth, and root-knot galling developed as the season progressed. Both soil fumigants and fenamiphos significantly reduced *B. longicaudatus* populations, but ethoprop and carbofuran did not (Table 1). Both soil fumigants also significantly reduced *H. galeatus,* but none of the non-fumigants were effective against this nematode, confirming results of previous studies (4,5). All of the nematicides significantly reduced root-knot galling with 1,3-D being the most effective. Yields were higher for all

Table 1. Effects of fumigant and nonfumigant nematicides on nematode populations, root galling indices, and yield of summer squash.

Treatment	Rate	Nematodes[z]			Yield (kg/ha)
		BL	HG	MI	
Control	—	117	158	3.00	17,788
1,3-D	28.0 L/ha	3	2	1.08	26,892
Metam-sodium	93.5 "	71	14	2.00	26,219
" "	187.0 "	52	8	2.04	27,048
Fenamiphos	1.12 kg ai/ha	56	158	2.16	26,448
"	2.24 "	35	155	1.92	26,580
Ethoprop	1.12 "	121	176	2.16	22,911
"	2.24 "	107	137	2.20	20,740
Carbofuran	1.12 "	168	109	2.36	23,726
"	2.24 "	161	140	2.40	22,906
LSD 0.05		52	61	0.51	3,542
LSD 0.01		70	82	0.68	4,750

[z]Average number of *Belonolaimus longicaudatus* (BL) and *Hoplolaimus galeatus* (HG) extracted from 100 cm^3 of soil at harvest. The root galling index from *Meloidogyne incognita* (MI) was based on a 1-5 scale: 1 = no galling to 5 = severe galling.

Table 2. Effects of fumigant and nonfumigant nematicides on nematode populations and yield of broccoli.

Treatment	Rate	First experiment			Second experiment		
		Nematode populations[z]		Yield	Nematode populations		Yield
		BL	HG	(kg/ha)	BL	HG	(kg/ha)
Control	—	129	337	4,147	230	217	3,640
1,3-D	56 L/ha	0	4	8,606	3	9	10,899
Metam-sodium	140 L/ha	92	90	7,465	141	92	10,362
" "	280 L/ha	59	42	7,825	101	88	10,304
Fenamiphos	2.24 kg ai/ha	35	297	6,069	70	198	9,640
"	3.36 "	31	275	7,094	67	197	11,036
Ethoprop	2.24 "	107	329	5,952	282	174	7,240
"	3.36 "	67	281	5,952	271	224	7,777
Carbofuran	2.24 "	69	216	6,069	287	188	7,533
"	3.36 "	72	294	6,820	330	180	6,733
LSD 0.05		44	132	1,733	124	88	2,202
LSD 0.01		59	177	2,324	167	118	2,953

[z]Average number of *Belonolaimus longicaudatus* (BL) and *Hoplolaimus galeatus* (HG) extracted from 100 cm^3 of soil at harvest.

treatments, except ethoprop applied at 2.24 kg ai/ha, when compared with control plots. The greater yields were obtained from plants in plots treated with the soil fumigants and fenamiphos, all of which reduced populations of *B. longicaudatus.*

There was a distinct improvement in plant growth and vigor of broccoli plots treated with nematicides in both experiments, and symptoms of sting nematode injury were evident on roots in control plots. As in the squash experiment, the soil fumigants and fenamiphos were more effective than carbofuran or ethoprop for controlling *B. longicaudatus* and only the fumigants reduced *H. galeatus* populations (Table 2). Only minor root galling developed on the broccoli plants, indicating that the population of *M. incognita* was too low to be a factor in the experiment or that broccoli is a poor host of this nematode. Plants in all plots treated with nematicides had significantly higher yields than in the untreated control plots.

The results of these experments demonstrate that the soil fumigants, 1,3-D and metam-sodium, were highly effective nematicides that significantly reduced populations of *B. longicaudatus, H. galeatus,* and *M. incognita,* and increased yields of broccoli and squash. Fenamiphos significantly reduced populations of *B.longicaudatus* and *M. incognita,* but was not effective against H. galeatus; however, yields were increased and were similar to those obtained from the soil fumigants. This indicates that *H. galeatus* was probably not a factor in yield reduction. Carbofuran and ethoprop significantly reduced populations of *B. longicaudatus* in the first experment on broccoli, but did not in the second broccoli experiment or the experiment on squash. Neither chemical affected *H. galeatus* populations, but both significantly reduced root galling from *M. incognita.* Yields of both broccoli and squash were significantly higher for treatments with carbofuran and ethoprop when compared with those from untreated control plots. This indicates that, although nematode control was not as good for carbofuran and ethoprop as for the fumigants or fenamiphos, the nematodes had been effectively managed by these chemicals.

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