EFFICACY OF SOIL FUMIGANTS AND NONFUMIGANTS FOR CONTROLLING PLANT NEMATODES AND INCREASING YIELD OF SNAP BEAN[1]

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ABSTRACT

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In experiments conducted in 1982 and 1983, the soil fumigant ethylene dibromide (EDB), applied at 26.9 kg/ha in-the-row and 80.6 kg/ha broadcast gave excellent control of *Benololaimus longicaudatus, Meloidogyne incognita,* and *Hoplolaimus galeatus,* and significantly increased yields of snap bean. A combination of EDB + chloropicrin (EDB-CP) applied at in-row rates of 28.3 + 23.3 kg/ha and broadcast rates of 113.2 + 93.1 kg/ha also gave excellent control of these nematodes and increased yields significantly. In-row soil application rates of 2.24 kg/ha and 3.36 kg/ha of the nonfumigant nematicides aldoxycarb, carbofuran, ethoprop, fenamiphos, oxamyl, and terbufos also significantly increased bean yield. However, none of these materials controlled *H. galeatus.* Fenamiphos and oxamyl provided good control of *B. longicaudatus* and *M. incognita;* aldoxycarb and terbufos provided good control of *B. longicaudatus* but only moderate control of *M. incognita*; carbofuran and ethoprop provided only moderate control of *B. longicaudatus* and *M. incognita.* Oxamyl applied as a foliar spray at 0.56 kg/ha per application for four weekly applications provided very little or no control of any of the nematodes and yield was not increased.

Additional key words: Belonolaimus longicaudatus, Hoplolaimus galeatus, Meloidogyne incognita, Paratrichodorus christiei, EDB, EDB-chloropicrin, aldoxycarb, carbofuran, ethoprop, fenamiphos, oxamyl, terbufos.

RESUMEN

Rhoades, H.L. 1983. Efectividad de nematicidas fumigantes y no-fumigantes para aumentar los rendimientos de habichuela y combatir fitonematodos. Nematropica 13:239-244.

La aplicación de bibromuro de etileno (BBE) a razón de 26.9 kg/ha en el surco, o a 80.6 kg/ha en tratamiento de area completa, dió muy buén resultado en el combate contra *Belonolaimus longicaudatus, Meloidogyne incognita,* y *Hoplolaimus galeatus* en experimentos hechos en 1982 y 1983. Los tratamientos también aumentaron los rendimientos de habichuela significativamente. Cuando se utilizó una combinación de BBE + cloropicrina (BBE + CP) en el surco a razón de 28.3 + 23.3 kg/ha o en tratamiento de area completa a dosis de 113.2 + 93.1 kg/ha también se obtuvieron buenos resultados en el combate de los nematodos asi como en el aumento de los

rendimientos. También aumentaron los rendimientos tratamientos en el surco a razón de 2.24 kg/ha o de 3.36 kg/ha con los nematicidas no-fumigantes: aldoxicarb, carbofuran, ethoprop, fenamiphos, oxamilo y terbufos, aunque ninguno de estos tratamientos fué efectivo contra *H. galeatus*. Fenamifos y oxamilo fueron efectivos contra *B. longicaudatus* y *M. incognita*, y aldoxycarb y terbufos lo fueron contra *B. longicaudatus* pero sólo moderadamente efectivos para combatir *M. incognita*. La aplicación foliar de oxamilo a razón de 0.56 kg/ha efectuada 4 veces semanalmente no fué efectiva contra los nematodos y tampoco resultó en aumentos en rendimiento.
Palabras claves adicionales: combate químico, manejo de plagas, nematodo nodulador, Phaseolus vulgaris, hortalizas, nematicidas sistémicos, carbamatos, fosforotioatos, Vydate, Furadán, Nemacur, Temik, Sulfocarb.

INTRODUCTION

Snap bean, *Phaseolus vulgaris* L., is an important vegetable crop in Florida with over 48,000 acres harvested during the 1981-82 season and having a total value of nearly $40 million (2). Approximately 90% of these are bush beans which are grown in nearly all areas of the state, but the largest concentration of production is on the lower east coast. Since a large proportion of the production is on fine sand soils where plant parasitic nematodes are prevalent, a high percentage of the crop is treated with nematicides. Several nonfumigant nematicides (5,7) as well as the fumigant nematicide, DD (1,5), have been reported to give good nematode control and increase yield of snap bean. In recent years, a considerable amount of the production has been treated with multipurpose fumigants to reduce populations of soil-borne pathogens and insects as well as nematodes. Experiments were conducted in the fall of 1982 and the spring of 1983 in which a soil fumigant for nematode control only, a multipurpose fumigant, and several nonfumigant organic phosphorus and carbamate nematicides were compared for their effect on nematode control and yield of snap bean.

MATERIALS AND METHODS

Field experiments were conducted on Myakka fine sand at the Agricultural Research and Education Center, Sanford, Florida. In 1982, the experimental site was infested with *Belonolaimus longicaudatus* Rau, 1958; *Hoplolaimus galeatus* (Cobb, 1913) Filipjev and Shuurmans Stekhoven, 1941; and *Paratrichodorus christiei* (Allen) Siddiqi, 1973. In 1983, the nematodes present were *B. longicaudatus, H. galeatus,* and *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949. The experimental design was a randomized complete block with five replicates of plots consisting of two rows spaced 76 cm apart and 11.6 m long. The soil fumigant ethylene dibromide (EDB) and the multipurpose fumigant

EDB + chloropicrin (EDB-CP) were applied both in-the-row and broadcast in the 1982 experiment and only as in-row treatments in 1983. All nonfumigant materials were applied as in-row treatments in both experiments. The soil fumigants were injected 15 cm deep at 25-cm intervals with a manually operated injector. In-row treatments of the fumigants consisted of a single line of injections, whereas broadcast treatment injections were uniformly spaced at 25-cm intervals. Application rates for EDB were 26.9 kg/ha in-row and 80.6 kg/ha broadcast. EDB-CP was applied at 28.3 + 23.3 kg/ha for in-row application. The broadcast rates were 113.2 + 93.1 kg/ha. In 1982, the only nonfumigant nematicide applied was granular fenamiphos at 2.24 kg/ha. In 1983, the nonfumigants aldoxycarb, carbofuran, ethoprop, fenamiphos, oxamyl, and terbufos were applied. Carbufuran, ethoprop, fenamiphos, and terbufos were applied as granules at rates of 2.24 and 3.36 kg/ha in 38-cm bands incorporated 5-8 cm deep. Oxamyl was applied as granules at 2.24 kg/ha; as granules at the same rate plus two weekly foliar sprays of liquid formulation of 0.56 kg/ha per application beginning at 2 wk after planting; and foliar application only, consisting of 4 weekly sprays of 0.56 kg/ha beginning at 2 wk after planting. Aldoxycarb was applied as a liquid formulation at 2.24 and 3.36 kg/ha sprayed on a 38-cm band in 190 L/ha of water and incorporated 5-8 cm deep. The fumigants were applied 7 days prior to planting in 1982 and 14 days in 1983. The preplant nonfumigants were applied immediately prior to planting. 'Astro' snap beans were planted in both experiments. Normal cultural and fertilizing practices for the area were followed and the snap beans were harvested on December 3, 1982, and May 19, 1983. Soil samples consisting of five 18 cm deep cores per plot were taken after harvest and processed by a centrifugal-flotation technique (3) to recover ectoparasitic nematodes. In 1983, eight plants were dug from each plot and the roots indexed for galling from root-knot nematodes.

RESULTS AND DISCUSSION

In 1982, plant population counts showed that EDB-CP was phytotoxic when applied at 28.3 + 23.3 kg/ha in-row 7 days before planting (Table 1). However, no phytotoxicity was observed in 1983 with a 14-day waiting period. This material did not affect stands after a 7-day waiting period when applied broadcast. This was likely due to the fumigant being applied 10-15 cm to the side of the row instead of directly below it. All materials in 1982 gave excellent control of *B. longicaudatus* with the fumigants giving slightly better control than fenamiphos. Control of *H. galeatus* was much better for the fumigants than for fenamiphos as has been reported before (8,9). Populations of *P. christiei* were higher follow-

Table 1. Effect of fenamiphos, ethylene dibromide, and EDB-CP on nematode populations and yield of snap bean, 1982.

Treatment	Rate (kg/ha)	Plant population[y]	Nematode population[z] BL	HG	PC	Yield (hl/ha)
Check	—	155	200	214	44	109
Fenamiphos	2.24	159	37	177	17	187
EDB (in-row)	26.9	151	3	4	73	181
EDB (broadcast)	80.6	155	0	2	165	165
EDB (in-row) CP	28.3 23.3	110	0	1	104	121
EDB (broadcast) CP	113.2 93.1	152	3	4	105	157
LSD .05		20	32	103	72	37
.01		28	43	140	98	50

[y]Number of plants per plot.

[z]Average number of *Belonolaimus longicaudatus, Hoplolaimus galeatus,* and *Paratrichodorus christiei* extracted from 100 cm^3 of soil after harvest.

ing use of the fumigants, but earlier work (4) has demonstrated that this nematode, although readily killed by soil fumigants, usually returns to high populations by the end of the crop. In contrast to this, application of several nonfumigant materials has been shown to result in longer control of *P. christiei* (6). With the exception of EDB-CP applied in-the-row, all treatments significantly increased yields compared with the untreated check. Yields were not significantly different between fenamiphos and the soil fumigants.

In 1983, the soil fumigants gave good control of *B. longicaudatus, H. galeatus,* and *M. incognita* (Table 2). All of the nonfumigant nematicides gave good control of *B. longicaudatus,* except carbofuran and ethoprop applied as granules, and oxamyl as a foliar spray. However, oxamyl applied as granules to the soil prior to planting did give good control of *B. longicaudatus.* All of the nonfumigant materials gave little or no control of *H. galeatus.* This nematode appears to have very little pathogenicity to snap bean since its control appeared to have no effect on

Table 2. Effect of soil fumigant and nonfumigant nematicides on nematode populations and snap bean yield, 1983.

Treatment	Rate (kg/ha)	Nematode population[y] BL	HG	MI	Yield (hl/ha)
Check	—	171	207	3.36	106
EDB	26.9	23	11	1.34	198
EDB-CP	28.3 23.3	17	13	1.56	204
Fenamiphos	2.24	15	240	1.44	217
"	3.36	0	288	1.36	225
Carbofuran	2.24	104	232	2.58	180
"	3.36	116	281	2.24	182
Terbufos	2.24	8	214	2.70	215
"	3.36	4	193	2.50	207
Oxamyl (granules)	2.24	39	208	1.36	229
" (granules + 2 foliar sprays)	3.36[z]	34	253	1.18	211
Oxamyl (4 foliar sprays)	2.24	131	215	3.28	97
Ethoprop	2.24	153	207	2.22	162
"	3.36	114	191	2.28	184
Aldoxycarb	2.24	53	270	2.08	201
"	3.36	10	172	1.92	213
LSD .05				0.48	55
.01				0.64	72

[y]Average number of *Belonolaimus longicaudatus* and *Hoplolaimus galeatus* extracted from 100 cm^3 of soil; *Meloidogyne incognita* root galling is based on an index of 1, no galling, to 5, severe galling.
[z]Foliar sprays were applied weekly at 0.56 kg/ha.

yield. Of the nonfumigant materials, only fenamiphos and oxamyl applied as granules resulted in control of *M. incognita* equal to that obtained with the soil fumigants. Foliar sprays of oxamyl and all other nonfumigants were considerably less effective in controlling *M. incognita*; nevertheless,

yields were essentially the same for all treatments except oxamyl applied only as a foliar spray. This treatment, which appeared to give little or no control of any of the nematodes, also resulted in no yield improvement.

Under the conditions of these tests, it would appear that although the soil fumigants provided the best nematode control, final crop yield was essentially the same for the fumigant and granular applications of the nonfumigants. This indicates that early season control of the nematodes by the latter was sufficient to allow adequate growth and yield. Fenamiphos, terbufos, and oxamyl were particularly effective in controlling *B. longicaudatus* and fenamiphos and oxamyl also provided good control of *M. incognita*.

LITERATURE CITED

1. CHRISTIE, J.R. 1959. Plant nematodes, their bionomics and control. Fla. Agr. Exp. Sta. 256 pp.
2. FLORIDA AGRICULTURAL STATISTICS. 1982. Vegetable Summary. Florida Crop and Livestock Reporting Service, Orlando, FL.
3. JENKINS, W.R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Reptr. 48:692.
4. PERRY, V.G. 1953. Return of nematodes following fumigation of Florida soils. Proc. Fla. State Hort. Soc. 66:112-114.
5. RHOADES, H.L., and J.F. BEEMAN. 1967. Efficacy of some experimental nematicides applied in-the-row on vegetables. Proc. Fla. State Hort. Soc. 80:156-161.
6. RHOADES, H.L. 1969. Nematicide efficacy in controlling sting and stubby-root nematodes attacking onions in central Florida. Plant Dis. Reptr. 53:728-730.
7. RHOADES, H.L. 1974. Comparison of two methods of applying granular nematicides for control of sting nematodes on snap beans, sweet corn, and field corn. Soil and Crop Sci. Soc. of Fla. Proc. 33:77-79.
8. RHOADES, H.L. 1980. Influence of nematicides and methods of their application on growth and yield of cabbage in sting nematode infested soil. Proc. Fla. State Hort. Soc. 93:246-247.
9. RHOADES, H.L. 1981. Effect of nematicides on yield of pepper in *Belonolaimus longicaudatus* infested soil. Nematropica 11:121-127.

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