Biological and chemical control of nematodes in *Capsicum annuum* L.[1]

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ABSTRACT

A field experiment was conducted at the Isabela substation. The objective of the study was to compare the effect of the fungus *P. lilacinus* (added 1 week before planting or at planting) and the nematicide carbofuran (1X or 2X) on yields of pepper and on the population levels of *M. incognita* and *R. reniformis*. Significantly more and heavier fruits were obtained from fungus (1 week before planting)-and carbofuran 2X-treated plots than from the check. A similar trend was observed in the nematode population dynamics; although the percentage of nematode reduction was high in all treated plots, it was higher in those treated with the fungus 1 week before planting and with carbofuran 2X.

RESUMEN

Control químico y biológico de nematodos en pimiento, *Capsicum annuum* L.

Se realizó un experimento de campo en la subestación de Isabela para comparar el efecto del hongo biocontrolador de nemátodos *P. lilacinus* (aplicado antes de sembrar y al sembrar) y del nematicida carbofuran (1X y 2X) en los rendimientos de pimiento y en los niveles poblacionales de *Meloidogyne incognita* y *Rotylenchulus reniformis*. Se encontraron diferencias significativas en el número y peso de frutas en las parcelas tratadas con el hongo (1 semana antes de sembrar) y con la dosis alta de carbofuran (2X) al comparar con el testigo sin tratar. Un tendencia similar se observó en la dinámica poblacional; ya que aunque el porcentaje de reducción de nemátodos fue alto en todas las parcelas tratadas, fue mayor en los tratados con hongo 1 semana antes o con carbofuran 2X.

INTRODUCTION

Pepper (*Capsicum annuum* L.) is one of the major vegetable crops in the island. Local production during 1989-90 reached 5,250 tons whereas 2,035.5 tons was imported[4]. Therefore, pepper production must be increased. Peppers are subject to attack by various pests, including nematodes, insects, fungi, bacteria and viruses. The root-knot nematode (*Meloidogyne incognita*) and the pepper weevil (*Anthonomus eugenii* Cano) are among the most detrimental (2).

[1]Manuscript submitted to Editorial Board 7 October 1991.

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Varela (10) demonstrated that *M. incognita* caused chlorosis and stunting of cooking peppers cv. Blanco del País and Cubanelle. Abreu and Cruz (1) found that *A. eugenii* Cano can cause considerable losses to cooking peppers in the Isabela area.

Nematode and insect control is a feasible alternative to improve and increase pepper production (2, 5). Román et al (9) obtained yield increases of 66 and 89% in pepper production with applications of phenamiphos at 11.2 and 16.8 kg/ha, respectively. With 1.12 kg/ha of oxamyl, Acosta et al. (2) obtained 81% nematode control, significantly higher yields of *C. annuum*, and significantly lower percentage of fruit damaged by the pepper weevil than with the other treatments. Also the use of biological agents (i.e. *Paecilomyces lilacinus* (Thom) Samson as means of nematode control has proven effective (6,7).

MATERIALS AND METHODS

A field experiment was carried out at the Isabela area on a Coto clay (Typic Eutrustox) soil (pH = 6.2, 1.7% organic matter) heavily infested with the nematodes *Meloidogyne incognita* and *Rotylenchulus reniformis*

The objective of the study was to compare the effect of the fungus *P. lilacinus* and the nematicide carbofuran (Furadan® 10G) on the population levels of *M. incognita* and *R. Reniformis* and on the yield of pepper.

Plots consisted of four rows, 0.30 m wide x 6 m long. Row spacing and plant spacing were 0.90 m and 0.30 m, respectively; 20 transplants per row were planted in holes 30 cm apart along the center of each row. The treatments were fungus (0.5 kg per row) added to the soil a week before planting; fungus added at planting (0.5 kg per row), two rates of carbofuran (0.34 kg per row at planting plus 0.45 kg per row added 4 weeks after planting, and 0.68 kg per row at planting plus 0.91 kg per row 4 weeks after); and a check (without nematicide or fungus).

The rice granules covered with the fungus were added to the row and incorporated 5 and 8 cm deep in the soil before transplanting 5-week-old pepper cv Cubanelle seedlings from a commercial nursery. Carbofuran granules were applied to the row from glass jars by hand and incorporated 5 to 8 cm deep into the soil with a hoe immediately after planting pepper seedlings. Treatments were replicated four times and arranged in a partially-balanced incomplete block design.

Plants were overhead-irrigated immediately after planting and as needed throughout the season. Control of weeds and fertilizer (10-10-8 at 1120 kg/ha) application was that recommended by the Agricultural Experiment Station for the area (3). Soil samples (250 cm^3 per plot) for nematode assays were taken 15 cm deep before nematicide application and at harvest 5 weeks after. Nematodes were extracted by the Christie and Perry technique (4).

To prepare the fungus inocula, we soaked 500 g of commercial polished rice in water for 24 hours. The water was drained off the rice, which was then washed through with sterile water, transferred to a pan and autoclaved at 250°for 50 min., as suggested by P. Jatala from the International Potato Center in Lima, Perú (personal communication). The hot rice was transferred to polyethylene bags, closed and kept on a laboratory bench until cool. The fungus provided by Jatala was originally kept in sterile sand contained in various 10-ml vials. The content of a vial was poured into 125 ml of sterile distilled water. Then a drop of the spore suspension was poured on the rice in each of the plastic bags. The bags with the inoculated rice were kept for 8 to 12 days in an incubator at 28 to 30°C.

The percentage reduction in nematode soil populations (PRNSP) was calculated for each plot (1). PRNSP is a measure of the effect of a treatment reducing nematode population levels within time lapse in the same plot, where PRNSP = $[(P_i-P_f)/P_i] \times 100$. The variable Pi represents the initial nematode larva population in the soil of a plot-treatment: Pf the final population (10 weeks after treatment) from the soil after treatment in the same plot.

TABLE 1.—*Effect of* P. lilacinus *and carbofuran applications on yield and root knot index in pepper*

Treatments	Dosage	Yield/plot[1] Fruit Number	Yield/plot[1] Fruit Weight	Root knot index[2]
			kg	
Fungus, 1 wk before planting	500 g/row	81.38 a	3.70 a	4.65 a
Fungus at planting	500 g/row	28.05 ab	1.60 b	4.50 a
Carbofuran 1X	0.34 kg + 0.454 kg/152 m[3]	37.91 ab	1.98 b	4.30 ab
Carbofuran 2X	0.68 kg + 0.908 kg/152 m[4]	74.71 a	3.98 a	3.10 a
Check	--	9.51 b	0.83 b	5.00 b

[1]Means per columns with the same letter do not differ statistically at P ± 0.05, by Duncan's multiple range test.

[2]Scale of 0-5 where 0 = 0, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100 and 5 = more than 100 root galls/root system

[3]Nematicide dosage: 0.34 kg added at planting plus 0.454 kg applied 4 weeks later.

[4]Nematicide dosage: 0.68 kg added at planting plus 0.908 kg applied 4 weeks later.

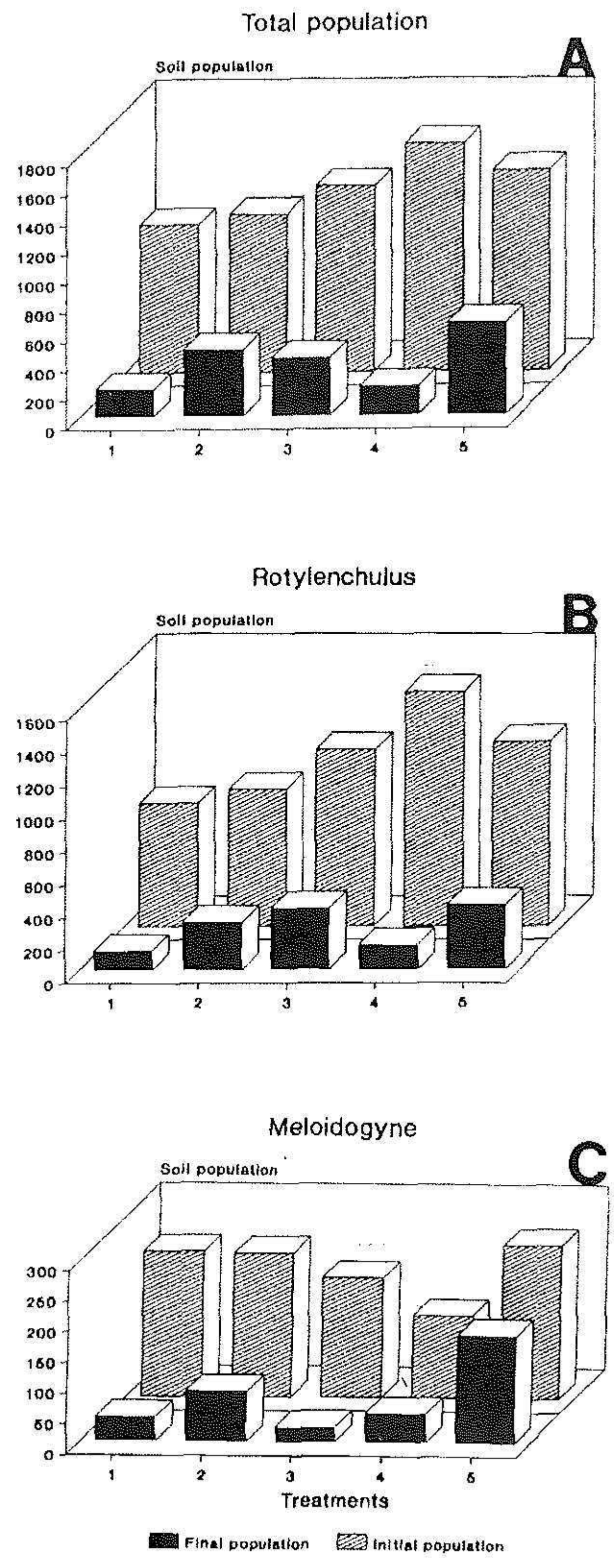

FIG. 1.— (A-C). Fluctuation in nematode population levels in the soil planted to pepper: A) total population, B) *Rotylenchulus reniformis* and C) *Meloidogyne incognita*, recovered from plots treated with 1) fungus added 1 week before planting, 2) fungus added at planting, 3) carbofuran 1X, 4) carbofuran 2X, or 5) check.

Data on number of fruits, fruit weight, and root knot index, with a 0-5 scale, were recorded at harvest: 0 = 0, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100 and 5 = more than 100 root galls per root system. Data were analyzed following standard statistical procedures.

RESULTS AND DISCUSSION

Significantly heavier and more fruits were obtained from fungus-treated (1 week before planting) and carbofuran 2X-treated plots than from the check (table 1). No significant differences were found when comparing these parameters among plots treated with the fungus at planting or with carbofuram 1X and the non-treated; however, values in these treatments were also higher than in the control. These results suggest that the fungus needs more time to become established in the soil before planting in order to give better control. Also in the case of carbofuran, apparently the lower dosage (1X) does not give significant control.

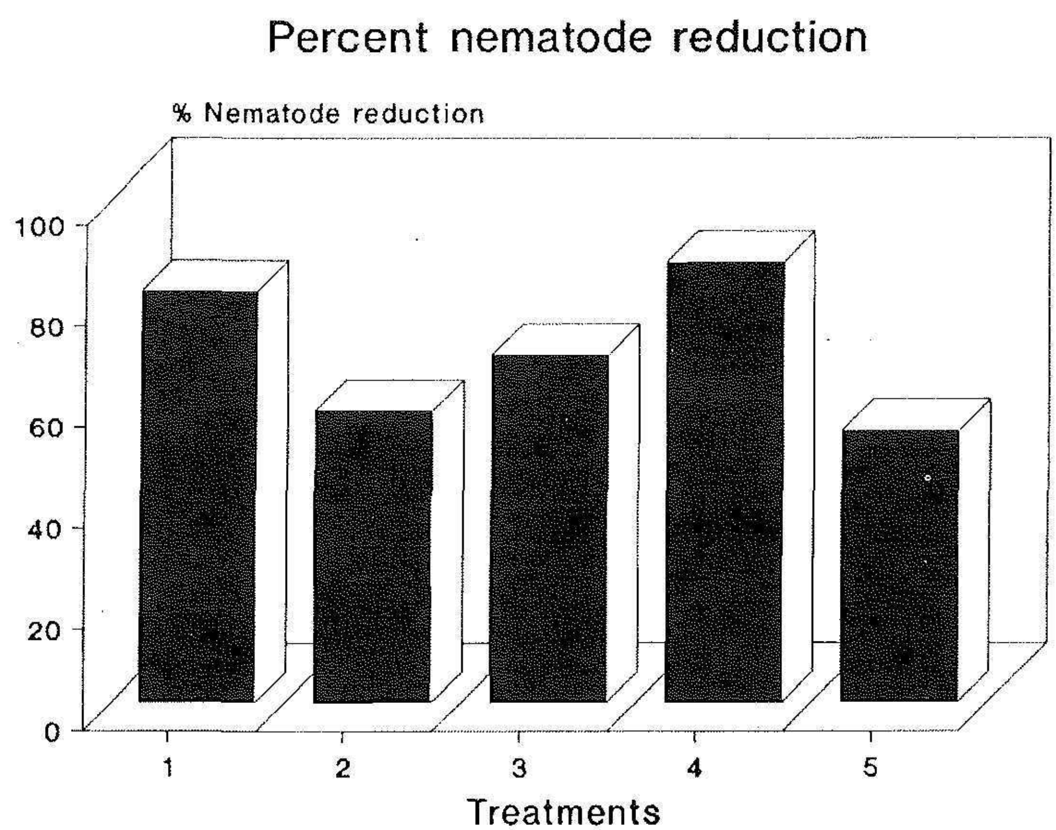

FIG. 2.—Percent reduction in nematode soil populations (PRNSP) is a measure of the effect of a treatment reducing nematode population levels within time lapse in the same plot. PRNSP = [(Pi - Pf)Pi] x 100 recorded from plots treated with 1) fungus added 1 week before planting, 2) fungus added at planting, 3) carbofuran 1X, 4) carbofuran 2X, or 5) check.

A similar trend was observed in the nematode population dynamics. Both treatments, the fungus added 1 week before planting and carbofuran 2X, were the most effective in reducing the total nematode population (fig. 1A) and *R. reniformis* (fig. 1B). The application of fungus 1 week before planting and carbofuran 1X were the most effective treatments against *Meloidogyne* populations (fig. 1C). Significantly lower root-knot indexes were obtained in carbofuran 2X-treated plots than in the check (table 1). The percentage of nematode reduction (fig. 2) was higher in all treated plots than in the non-treated, but much higher in plots treated with the fungus 1 week before planting and carbofuran 2X than in the check. Lara (8) in field studies with *P. lilacinus* found that the reduced number of nematodes in the soil decreased as the time of inoculation of the fungus previous to planting was increased.

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