

Evaluation of Four Nematicides for the Control of Phytoparasitic Nematodes on Sugarcane^{1, 2}

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ABSTRACT

In a greenhouse experiment 22.4 kg of Carbofuran/ha and 186.9 l of dichloropropene-dichloropropane (D-D)/ha controlled sugarcane nematodes effectively in a highly infested sandy soil. A high dosage of 373.9 l of D-D/ha was phytotoxic, whereas Fensulfthion at the rate of 16.8 and 33.6 kg/ha, and Ethoprop at 22.4 and 44.8 kg/ha were ineffective.

INTRODUCTION

A great number of nematode species have been reported to be associated with sugarcane roots (7-10, 13, 15, 18, 19, 24, 25). It has also been demonstrated experimentally (1-3, 7-10, 12, 13, 15, 19, 25) that nematodes damage sugarcane roots by feeding from their cellular contents and by injecting hormones, enzymes and toxins which cause destruction of the roots. Therefore, the plant is forced to produce new roots to replace those damaged by the microorganisms.

Studies by Román (13, 15-17) and miscellaneous samplings by the Nematology Laboratory of the Agricultural Experiment Station of the University of Puerto Rico have shown the following nematode genera parasitizing sugarcane roots: *Meloidogyne*, *Helicotylenchus*, *Pratylenchus*, *Tylenchorhynchus*, *Hoplolaimus*, *Criconemoides*, *Hemicriconemoides*, *Hemicyclophora*, *Paratylenchus*, *Trophurus*, *Ditylenchus*, *Tylenchus*, *Longidorus*, *Xiphinema* and *Trichodorus*. Ayala (4) lists twelve species as the most commonly isolated from sugarcane fields in Puerto Rico.

Chemical control of sugarcane nematodes has been under investigation for many years. Chu and Tsai (6) in Taiwan reported the effectiveness of ethylene dibromide (EDB), methyl bromide (MB), Chlorofin 22 and Agrosan. Similar results were obtained by Bates (5) in British Guiana. Williams (22) in Mauritius corroborated the effectiveness of EDB. Martin et al. (11) in Hawaii demonstrated that the application of 373.9 l of D-D(1-3-dichloropropene,1-2 dichloropropane)/ha increased sugarcane yields in deteriorated areas. Young (25) obtained yield increases of about 22,404.06 kg/ha with preplant application of D-D, EDB or Nemagon (1,2-

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dibromo-3-chloropropane). Winchester (23) in Florida reported on the effectiveness of D-D, EDB and organic phosphate nematicides on growing cane.

In Puerto Rico, Román and Badillo (20) used different dosages of DBCP (Fumazone and Nemagon) in an old sugarcane plantation infected with *Meloidogyne* spp. and *Helicotylenchus* spp. Two nematicide applications per year did not increase sucrose content and cane growth significantly. In another experiment for the control of *Belonolaimus lineatus*, Román (19) obtained slight increases in sugarcane yields with 617 l of D-D/ha. Stubble application with 18.7 to 37.4 l of Nemagon significantly increased yields and cane growth.

The purpose of this study was to evaluate the effectiveness of 2 dosages of D-D, Fensulfothion (0,0-diethyl-o-P-methylsulfinil phenyl phosphorothiate), Ethoprop (0-ethyl-s-s-dipropyl phosphorodithioate), and Carbofuran (1,2,3 dihydro-2,2-dimethyl-7-benzofuranil methylcarbamate) for the control of sugarcane nematodes under greenhouse conditions.

MATERIALS AND METHODS

A greenhouse experiment was conducted to evaluate four nematicides in a sandy soil from a nematode infested field at Isabela, Puerto Rico. The following treatments were evaluated: D-D, 0.35 cm³ and 0.70 cm³ per 3.78-liter metal container (186.9 and 373.9 l/ha); Fensulfothion, 0.2 and 0.4 g per container (16.8 and 33.6 kg/ha); Ethoprop, 0.4 and 0.8 g per container (22.4 and 44.8 kg/ha) and Carbofuran, 0.4 and 0.8 g per container (22.4 and 44.8 kg/ha); and the control (untreated soil). A randomized block design was used with four replicates per treatment. Nematode populations of 100 cm³ soil samples were determined prior to nematicide application, 1 month after planting and at harvest time by means of the Cobb-Baermann method (21).

Single bud cane cuttings from an apparently disease free PR 980 plantation at the Lajas Substation were used. The cuttings were washed in running water and immersed in a 2% calcium hypochlorite solution for 5 min, washed in distilled water and germinated in methyl bromide-fumigated soil. Healthy uniform seedlings were transplanted to the soil 1 week after applying the respective nematicides.

The experiment was harvested 60 days afterwards and the following parameters were statistically evaluated: height of primary shoots; circumference of primary shoots 3 inches above soil level; number of internodes; fresh and dry weight of shoots, leaves and roots; number of tillers; necrosis levels; number of galls; and nematode populations.

The average maximum and minimum temperatures registered in the greenhouse during the experiment at 8:00 a.m. and 12:00 noon were 24° C and 35° C, respectively.

TABLE 1.—Effect of two different dosages of D-D, Fensulfothion, Ethoprop and Carbofuran on the height, circumference and number of internodes of primary shoots, and on fresh and dry weight of shoots, leaves and roots of the sugarcane cultivar PR 980

Treatment	Height	Circumference	Shoots weight		Leaves weight		Roots weight	
			Fresh	Dry	Fresh	Dry	Fresh	Dry
			<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>	<i>G</i>
D-D (186.9 L/ha)	26.7 bc ¹	3.1 ab	14.2 abc	1.9 abc	16.7 ab	3.0 ab	17.2 a	2.1 a
D-D (373.9 L/ha)	24.8 bc	3.0 ab	12.7 bc	1.6 bcd	17.5 ab	3.2 a	14.4 abc	1.9 ab
Fensulfothion (16.8 kg/ha)	25.6 bc	2.8 b	10.6 cd	1.2 cd	14.5 ab	2.1 bc	9.4 bcd	1.2 c
Fensulfothion (33.6 kg/ha)	23.0 c	2.8 b	10.6 cd	1.3 cd	14.1 b	1.8 c	8.2 cd	1.2 c
Ethoprop (22.4 kg/ha)	26.1 bc	2.8 b	11.8 c	1.4 cd	15.2 ab	2.5 abc	13.0 abcd	1.5 abc
Ethoprop (44.8 kg/ha)	25.8 bc	2.9 b	10.9 cd	1.4 cd	14.5 ab	2.0 c	9.6 bcd	1.3 bc
Carbofuran (22.4 kg/ha)	28.9 ab	3.2 ab	15.9 ab	2.3 ab	18.4 a	3.2 a	15.6 ab	1.8 abc
Carbofuran (44.8 kg/ha)	33.1 a	3.3 a	17.8 a	2.4 a	17.5 ab	2.8 abc	11.6 abcd	1.6 abc
Control	23.6 bc	2.4 c	7.4 d	0.8 d	10.3 c	1.9 c	7.2 d	1.2 c

¹ Means in the same column followed by one or more letters in common do not differ significantly at the 5% level according to Duncan's multiple range test.

RESULTS AND DISCUSSIONS

The results obtained are shown in table 1. One-week-old plants growing in Carbofuran-treated soil developed phytotoxicity signs expressed as reddish spots along the edge of the leaf apex (fig. 1); they were more pronounced with the higher dosage. The symptoms disappeared 1 mo after planting and by the end of the experiment, those plants had attained the best aerial growth. However, the plants grown in soil treated with 187 l of D-D/ha developed a healthier and more diffuse root system than the remaining treatments (fig. 2, 3). The roots of plants treated with 22.4 kg/ha of Carbofuran were also relatively healthy and profuse, whereas the

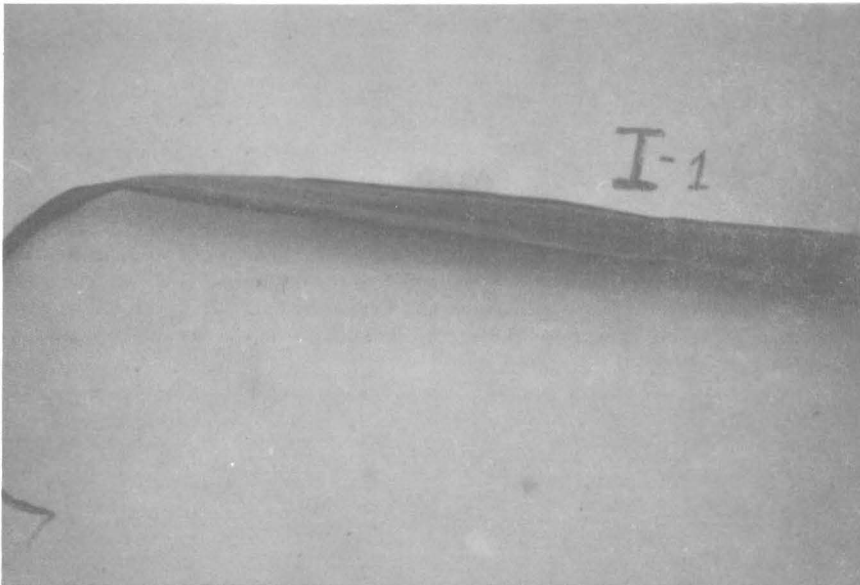


FIG. 1.—Leaf of a 1-mo-old sugarcane plant grown in soil treated with 44.8 kg of Carbofuran/ha, showing reddish spots along the edge of the leaf apex.

roots of plants treated with the higher dosis showed some degree of necrosis. A similar index of necrosis was observed in plants treated with 374 l/ha of D-D. An increase in root development over the higher dosage of Carbofuran was obtained with Ethoprop at the rate of 22.4 kg/ha. Root development was not as good in the remaining treatments which did not prevent gall formation and necrosis. The check plants developed a poor root system, with severe necrosis and were more damaged than those of the remaining treatments (fig. 2, 3, 4, 5).

Carbofuran at the rate of 44.8 kg/ha significantly increased the height, circumference, fresh and dry weight and number of internodes of primary

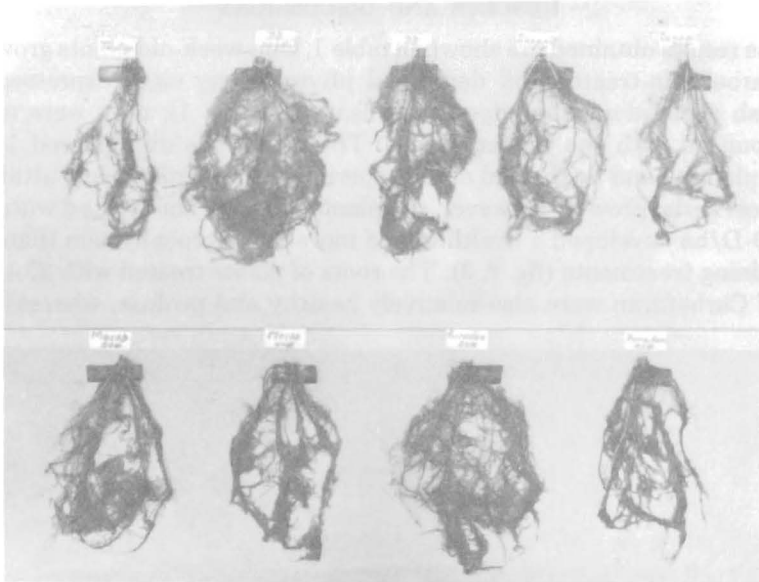


FIG. 2.—Roots of sugarcane plants grown in nematode infested soil treated with two different dosages of each nematicides: Top row (left to right): Control, D-D - 187.0 l/ha, D-D - 374.0 l/ha, Fensulfothion - 16.8 kg/ha and Fensulfothion - 33.6 kg/ha. Lower row: Ethoprop - 22.4 kg/ha, Ethoprop - 44.8 kg/ha, Carbofuran - 22.4 kg/ha and Carbofuran - 44.8 kg/ha.

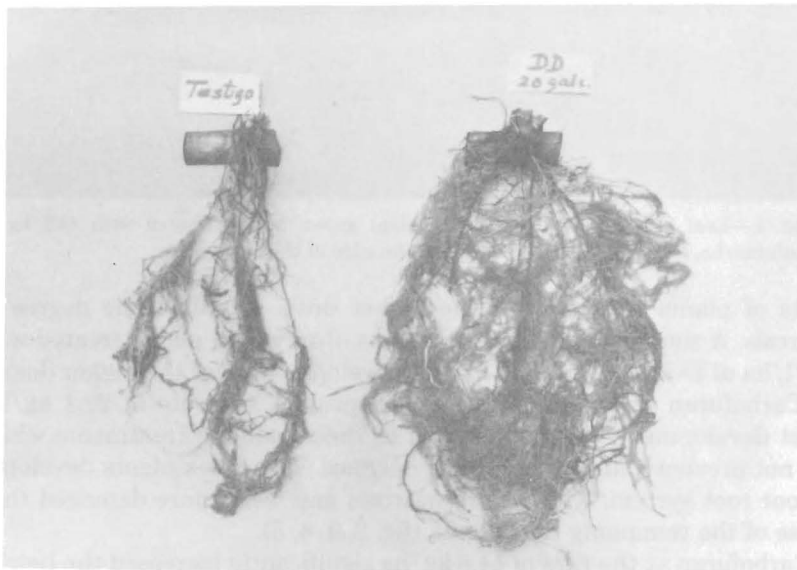


FIG. 3.—Roots of a sugarcane plant grown in soil infested with nematodes (left) compared to those of a plant grown in soil treated with 187 L of D-D per ha.

shoots over those treated with Fensulfothion and Ethoprop and over the controls. The following parameters were increased significantly also with 22.4 kg of Carbofuran/ha: circumference and weight of shoots, weight of leaves and fresh weight of roots. The weight of shoots and the dry weight of leaves were significantly higher in this treatment than those produced by both dosages of Fensulfothion and Ethoprop.

Application of 22.4 kg of D-D/ha significantly increased the circumference and weight of shoots, weight of leaves and fresh weight of roots over the control. The results obtained with some of the parameters were also superior to those obtained with treatments such as 16.8 and 33.6 kg/ha of Fensulfothion and the higher dosage of Ethoprop.

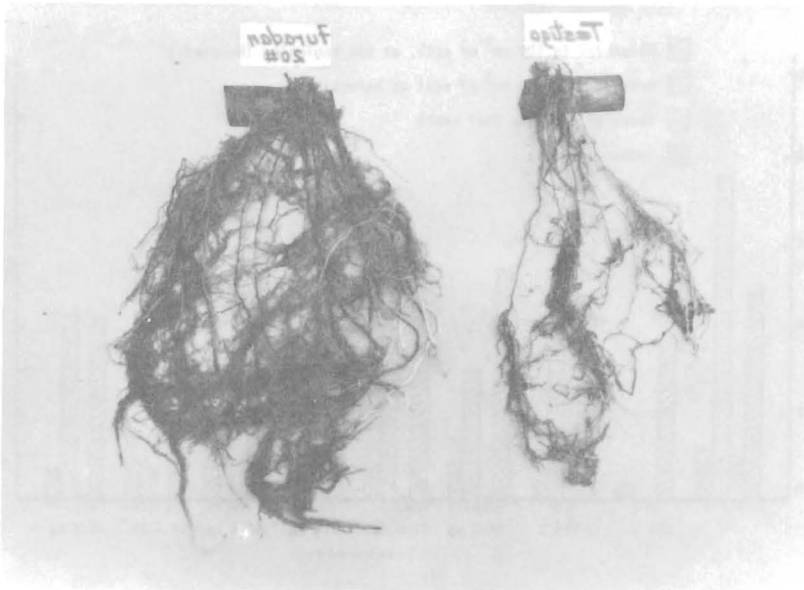


FIG. 4.—Roots of a sugarcane plant grown in nematode infested soil (left) compared to a plant grown in soil treated with 22.4 kg of Carbofuran per ha.

The higher dosage of D-D increased significantly the circumference, fresh weight of shoots and leaves and dry weight of roots over the control even when it caused some root necrosis. The lower dosage of Ethoprop significantly increased the circumference and the fresh weight of shoots.

The effectiveness of chemical control by means of nematicides in light sandy soil was clearly demonstrated. Although results are sometimes sporadic the effectiveness of nematicides for the control of nematodes in sugarcane has been demonstrated by various authors in different parts of

the world (11, 13, 14, 15). In the experiment reported here Carbofuran, with insecticidal properties, was the most effective. It was phytotoxic but this did not appear to be very serious with lower dosages. The higher dosage (44.8 kg/ha) apparently caused considerable root damage because the plants did not recover from the initial toxic effects and the values for root weight and dry weight of leaves remained low. D-D was also effective in Florida (23), Hawaii (11) and Australia (25) where it significantly increased the weight of shoots and dry weight of leaves. However, it is less effective than Carbofuran at the rate of 22.4 kg/ha. Apparently, 187 l of D-D/ha is the optimum dosage because higher dosages were phytotoxic under greenhouse conditions.

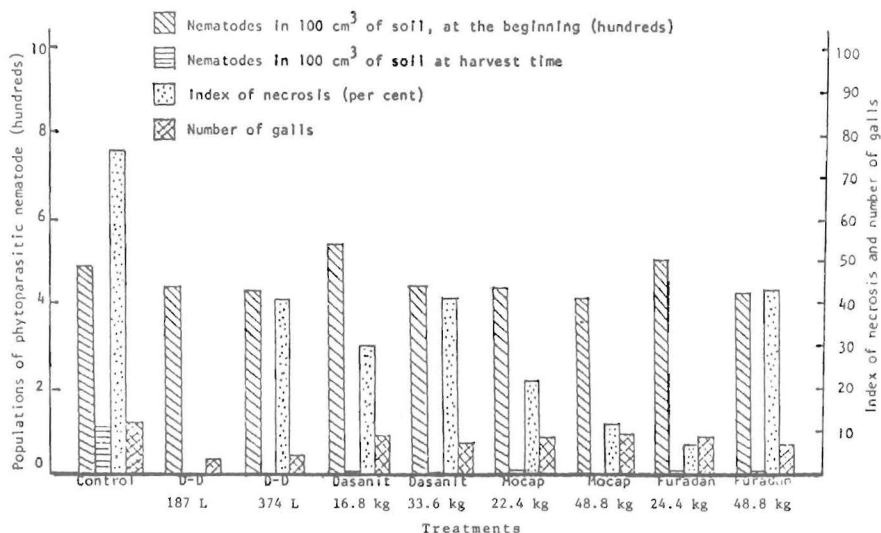


FIG. 5.—Effectiveness of two different dosages per hectare of D-D, Dasanit (Fensulfotion), Mocap (Ethroprop), and Furadan (Carbofuran) on nematode control, formation of galls and index of necrosis in the sugarcane cultivar PR 980.

RESUMEN

El nematicida-insecticida Carbofuran controló eficazmente los nematodos de la caña de azúcar en suelos arenosos en el invernadero. Aplicaciones equivalentes a 22.4 kg/ha aumentaron significativamente la circunferencia, los pesos de los tallos y las hojas y el peso fresco de las raíces. Este nematicida tuvo efectos fitotóxicos iniciales, induciendo la formación de manchas necróticas a lo largo de los márgenes de las

hojas, pero el efecto desapareció y al final las plantas alcanzaron el mejor desarrollo. La fitotoxicidad fue leve a dosis bajas, pero fue detrimental al usarse 44.8/kg del nematicida/ha; las plantas no lograron reponerse del efecto inicial, ya que tanto el peso de las raíces como el peso seco de las hojas permanecieron bajos al compararse con los de la dosis baja.

El D-D también fue eficaz, aumentando significativamente el peso de las cañas y el peso seco de las hojas. Sin embargo, no fue tan eficaz como el Carbofuran. Aparentemente, 187 l/ha es suficiente para producir resultados satisfactorios, pues la dosis alta de 374 l es fitotóxica. El Fensulfotion y el Ethoprop fueron ineficaces al compararse el peso de las cañas con el obtenido con la dosis baja del Carbofuran.

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