different, more efficient, root extraction technique was used. The influence of climactic factors and the stage of plant development then became clear. The importance of soil structure and its relation to the persistance of *Radopholus similis* was known but, until now, it had not been adequately evaluated. This paper deals with the influence of climactic factors and plant development on root infection. The monthly average rainfall for a period of 15 yrs in Cameroon, where this study was conducted, shows an increase from January to June, followed by 4 mos with the same high monthly rainfall (350-400 mm). Precipitation levels decrease during November and December (20 mm monthly).

In this study bananas were planted in June. At first, root infection developed slowly and then accelerated rapidly. In one mo (November) *R. similis* increased from 40,000 to 100,000 per 100 g of roots. The peak was reached in December when the bananas started flowering. When the season (and the soil) became very dry, the population declined as quickly as it had risen; the lowest point (18,000/100 g) was in March. Then, as soil moisture became sufficient for plant growth, the numbers of nematodes in the roots increased steadily while the first ratoon was developing. A new population peak occurred in October, 2 mos earlier than in the previous yr. Again it appeared that as flowering began, the nematode populations declined; this too was earlier than in the previous yr but it ended in March as before. The third peak was in August, also earlier than in previous yrs. Again, the population decreased at flowering but this decline lasted for 7 mos, compared with the 2 and 5 mos of the 2 earlier crops. The population low (15,000 *R. similis*/100 g of roots) was also in March when most of the plants of the third ratoon had already flowered. After that the population increased but only for 4 mos. The peak was only 100,000 *R. similis* instead of 130,000 to 140,000/100 g as before. The decline in population began in July but was not as much (30,000/100 g) as in previous yrs.

These results clearly show: a) the dry season is unfavourable and the rainy season favourable to nematode infection, and b) the growing period of the banana plant favours development of populations. The trend is reversed when flowering begins. Amount of precipitation and flowering period are the main factors influencing development of *R. similis* infections. When both factors are favourable simultaneously, the population peak is high. However, minimum population always occurs in March at the end of the dry season. Data show how quickly *R. similis* populations may fluctuate. A further observation is that the highest populations are always found in the roots of plants which have flowered. Consequently, sampling of banana plantations to provide accurate information of the level or degree of nematode infection involves sampling at more than one occasion and the sampling of plants in a similar stage of development.

OTHER CONTRIBUTIONS – – – OTRAS CONTRIBUCIONES

CONTROL OF PLANTAIN NEMATODES WITH CONTACT NEMATICIDES [EL CONTROL DE LOS NEMATODOS QUE ATACAN EL PLATANO CON DOS NEMATICIDAS DE CONTACTO]. Santos Valle-Lamboy and Alejandro Ayala, Assistant Agronomist and Nematologist, Agricultural Experiment Station, College of Agricultural Sciences, Mayaguez Campus, University of Puerto Rico.

ABSTRACT

Nematodes associated with 4.5 mo-old plantains were controlled with carbo-

furan (Furadan 10G) and ethoprop (Mocap 10G) at rates of 22.67 and 45.34 kg/ha (30 and 60 g/plant). The low rate of carbofuran increased plant growth in height, circumference and number of shoots, and significantly (P=0.05) increased fruit yield. The high rate of carbofuran appeared to be phytotoxic. Both rates of ethoprop appeared to increase plant growth and fruit yield.

INTRODUCTION

The damage caused by phytoparasitic nematodes to banana and plantain (*Musa* spp.) roots is a very serious disease distributed throughout the producing areas of the world (1, 2, 4, 7, 9). According to Goodey *et al.* (3), 19 different nematode species are associated to banana roots. Among these, *Radopholus similis, Helicotylenchus multicinctus* and *Meloidogyne* spp. are proven pathogens of economic importance (2).

Radopholus similis causes root deterioration (1, 2, 3, 4, 7). Blake (1) demonstrated that this nematode feeds on parenchyma cells in the cortex. Cavities are formed and enlarged by feeding on peripheral cells and by tunneling the cortex, resulting in a continuous destruction of roots. He also showed that in roots of banana seedlings inoculated with *H. multicinctus* for 36 hrs, the epidermis is penetrated by the anterior end of some adult nematodes. The nematodes feed directly on parenchyma cells. Blake (2) points out that at least 4 species of the root-knot nematode (*Meloidogyne* spp.) have been reported from banana.

Luc and Vilardebo (4) proved that applications of D-D and Dowfume W-85 at the rates of 300 liters/ha and 150 kg/ha, respectively, increased production from 30 to 40%. The same authors demonstrated the effectiveness of DBCP at the rate of 40 liters/ha at planting during May and June, 25 liters/ha in October and 15 liters/ha in March every yr thereafter. Price (6) obtained yield increases of 56% using the 75% EC of DBCP. Minz *et al.* (5) obtained effective control of *H. multicinctus* with DBCP incorporated in irrigation water.

In Puerto Rico, Román *et al.* (7) increased the number of bunches per A after the application of 21.25 g of phenamiphos, 42.52 g of fensulfothion, 28.35 g of ethoprop, aldicarb and carbofuran and two teaspoons per plant of DBCP-70% every 4 and 6 mos.

This study was conducted to determine the effectiveness of 2 different dosages of carbofuran and ethoprop on the control of plantain nematodes after plants are set.

MATERIALS AND METHODS

The experiment was conducted in a 4.5 mo-old plantation located at the College Farm of the Mayaguez Campus of the University of Puerto Rico. The plants growing in the selected site showed poor development. Symptom expression and analysis of soil and root samples indicated a severe nematode infection.

The plantation was divided into 25 plots of 4 plants each, and a randomized block design containing 5 treatments, each replicated 5 times, was employed. The treatments were carbofuran (10G formulation) applied at 30 and 60 g per plant (22.67 and 45.34 kg/ha, respectively), ethoprop (10G formulation) at 30 and 60 g per plant (22.67 and 45.34 kg/ha) and a nontreated control. Nematicides were applied on the soil 3 ft from the plant stem.

Soil (250 cm^3) and root (10G) samples were taken from each plot before applying the treatment, 60 days after initiating the experiment and at harvest

(4 mo after treatment). Nematodes were extracted from soil samples by means of the combination of the Cobb's and Baermann's methods (8). Nematodes were recovered from roots by chopping 10 g of clean roots selected from the whole sample into a Baermann funnel. Nematode counts were made after 24 hrs. Plant height, stem circumference one ft from the soil, number of leaves and shoots were also recorded before applying the treatments and 60 days after initiating the experiment. At harvest, weight of the bunch, number of fruits in the bunch and the average size of fruits were recorded and statistically analyzed.

RESULTS

Analysis of soil and root samples for nematodes indicated that *R. similis, M. incognita, Rotylenchulus reniformis* and *Helicotylenchus* spp. were associated with roots of plantain. The first two species were the most numerous whereas, the occurrence of *R. reniformis* and *Helicotylenchus* spp. was less. Large quantities of *R. reniformis* were recovered from the soil. Root and soil populations associated with the 4 nematicide treatments were greater before chemical application than 60 days after treatment (Table 1).

Plants treated with 30 g of carbofuran grew more rapidly than the non-treated controls (Table 2). At the end of the experiment they were 18.8% taller, had a 10.4% greater circumference and 26.3% more shoots than the control plants. Carbofuran applied at the rate of 60 g per plant did not increase these growth parameters.

Table 1. Effects of two rates of carbofuran and ethoprop on control of phytoparasitic nematodes of plantains.

Treatments (g/plant)	Nematode population / 250 cm^3 soil		Nematode population / 10 g roots	
	Before treatment	60 days after treatment	Before treatment	60 days after treatment
Carbofuran, 30	2,993	408	342	25
Carbofuran, 60	2,095	97	369	28
Ethoprop, 30	1,489	162	3,211	228
Ethoprop, 60	1,127	165	823	2
Control	1,742	671	390	1,249

Plants receiving 60 g of ethoprop increased plant circumference by 20.9% and the number of shoots by 18.2% (Table 2). At the rate of 30 g per plant ethoprop increased circumference by 5.5% and the number of shoots by 19.6% over the controls.

The number of fruits per bunch produced by plants treated with 30 g of carbofuran was significantly greater (P=0.01) than those of other treatments (Table 3). The number of fruits produced by plants treated with nematicides was always higher than in the control plants, although there were no significant differences among the other treatments. There were no significant differences between treatments in regard to average weight per bunch. The size of fruits from plants treated with 60 g of ethoprop per plant was significantly greater than the controls.

DISCUSSION

The experiment was conducted in a 4.5 month old plantation and only one application of nematicides was made. The results indicate that carbofuran applied at the rate of 30 g per plant (22.67 kg/ha) appeared to increase plant height and number of shoots, and significantly (P=0.01) increased the number of fruits per acre. Similar results were obtained by Román *et al.* (7) with the number of fruits per acre. Apparently, Furadan at the rate of 60 g per plant was phytotoxic. This was evidenced by the fact that such values as the height and circumference of the plant were lower than those of the control plants. Moreover, the number of shoots produced by plants receiving such treatment was similar to those produced by nontreated plants.

Table 2. Growth and development of plantain plants treated with 2 rates of carbofuran and ethoprop[1]

Treatment (g / plant)	Plant Height (gain in cm)	Stem Circumference (gain in cm)	Number of Shoots
Carbofuran, 30	92.33	9.65	3.55
Carbofuran, 60	74.43	8.10	2.80
Ethoprop, 30	81.03	9.22	3.35
Ethoprop, 60	80.20	10.57	3.30
Control	78.13	8.74	2.80

[1]Growth measurements recorded 60 days after treatment.

Table 3. Effects of two rates of carbofuran and ethoprop on the weight, number and size of plantain fruits per bunch.

Treatment (g/plant)	Weight of bunch (kg)	No. of fruits per bunch	Size of fruits (in)
Carbofuran, 30	11.82 a[a/]	40.74 a	24.61 bc
Carbofuran, 60	10.86 a	32.10 b	25.70 ab
Ethoprop, 30	10.83 a	31.51 b	20.54 bc
Ethoprop, 60	10.82 a	28.11 b	26.62 a
Control	9.58 a	26.37 b	23.80 bc

[a/] Column means followed by the same letter are not significantly different (P=0.05) according Duncan Multiple Range Test.

In general, both dosages of ethoprop were better than the controls, but no significant differences were obtained in terms of yields. The size of the fruits, however, was significantly greater than that of the controls.

RESUMEN

El nematicida Furadan, usado en dosis de 30 g por planta (22.67 kg/ha), aumentó considerablemente el crecimiento y el número de hijos de las plantas de plátano y produjo un aumento significativo en la producción de frutas por ha. La dósis de 60 g de Furadan por planta aparentemente resultó fitotóxica, ya que los valores obtenidos fueron más bajos que los de las plantas testigos.

El Mocap superó en crecimiento, circunferencia y número de hijos a las plantas testigos, sin embargo no registró diferencias significativas en cuanto a producción.

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