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Proc. Fla. State Hort. Soc. 94:321-323. 1981.

POPULATION FLUCTUATIONS OF PLANT-PARASITIC NEMATODES ON BANANAS IN FLORIDA[1]

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Additional index words. plantain, *Musa* spp., *Helicotylenchus multicinctus, H. dihystera, Meloidogyne incognita,* control, population dynamics.

Abstract. **Population levels of plant-parasitic nematodes in soil and roots were monitored for one year in a commercial banana (**Musa x 'Burro'**) planting in south Florida during 1979-80. Common plant parasites included** Helicotylenchus dihystera **(Cobb) Sher,** H. multicinctus **(Cobb) Golden, and** Meloidogyne incognita **(Kofoid & White) Chitwood. Soil populations of** Helicotylenchus **spp. and** M. incognita **showed peaks in Oct.-Dec., which corresponded to the end of the rainy season. Treatment of individual mats with ethoprop at either 6.0 g ai/mat every 6 months or 3.0 g ai/mat every 3 months failed to significantly reduce populations of either nematode genus in soil or roots compared to untreated controls.**

Many different species of plant-parasitic nematodes are associated with bananas and plantains throughout the world, and several of these may adversely affect crop growth (2, 13, 17). As commercial production of bananas and plantains increases in Florida, knowledge of the nematode fauna and its control is essential. The burrowing nematode, *Radopholus similis* (Cobb) Thorne, has been reported from bananas in Florida (4, 8, 11), but in south Florida, the presence of high numbers of other nematode species, particularly *Helicotylenchus multicinctus* (Cobb) Golden, may constitute a more serious threat to commercial production (11). *H. multicinctus* has also been found to be the predominant pest in Cuba (15), Israel (12), Argentina (7), and South Africa (10). For these reasons, it is necessary that the biology and control of these nematodes be better understood.

The present study examines the efficacy of nematode control by ethoprop (Mocap® 10G), the only nematicide currently registered for postplant nematode control on bananas and plantains in Florida. In addition, the seasonal population fluctuations of the more common nematodes associated with bananas in south Florida are investigated.

Materials and Methods

This experiment was conducted in a planting of the banana cultivar *Musa* x 'Burro' (ABB Group), also known as *Musa* x 'Bluggoe' (14). The site was located several miles west of Florida City, Florida, on a Rockdale fine sandy loam soil with pH = 7.6. The bananas had been planted in March 1978, and the first treatments were applied on February 1, 1979. The 6 treatments were as follows:

1) ethoprop at 6.0 g ai/mat
2) ethoprop at 3.0 g ai/mat
3) iron chelate at 85 g/mat
4) ethoprop at 6.0 g ai/mat + iron chelate at 85 g/mat
5) ethoprop at 3.0 g ai/mat + iron chelate at 85 g/mat
6) untreated control

Ethoprop, formulated as Mocap® 10G, was applied within an 0.5 m radius around the base of each mat and lightly incorporated into the top 2-4 cm of soil. The 6.0 g ai treatment of ethoprop was reapplied every 6 months, while the 3.0 g ai treatment was reapplied every 3 months. The iron chelate consisted of Sequestrene 138 Fe Iron Chelate® applied in 13.2 liters of water to the surface of the soil around each mat. This treatment was reapplied in 6 month intervals. The iron chelate was included as a treatment to determine if plant yields would be further enhanced by adding a critical micronutrient in combination with the nematicide. The 6 treatments were applied to individual mats arranged in a randomized complete block design with 6 replications.

Soil and root samples for nematode analysis were collected on February 1, 1979, and at two-month intervals thereafter until April 7, 1980. An individual sample consisted of approximately 1000 cm^3 of soil and 10-20 g of roots taken from a single mat. Each composite sample was obtained from 3 locations around the mat with a hand trowel to a depth of 15 cm. Soil samples were passed through a 4 mm sieve to remove rock, and a 100 cm^3 subsample was then processed by decanting and sieving followed by suspension of the residues in modified Baermann funnels (1, 6). Roots from each sample were washed and cut into 2-cm segments and mixed. A 5 g subsample of fresh roots was placed in 200 ml of water in a 250 ml beaker after counting the root knot galls. A gentle stream of air was passed through the water, and after 7 days at 24°C, the nematodes that had emerged from the roots were counted.

Yield data were collected between September 6, 1979, and March 13, 1980, and the cumulative yield per mat over that time period was determined. Nematode and yield data were analyzed by analysis of variance and Duncan's new multiple range test.

Results and Discussion

The most common plant-parasitic nematodes found in soil samples at the study site were *Meloidogyne incognita* (Kofoid & White) Chitwood, *Helicotylenchus multicinctus,* and *H. dihystera* (Cobb) Sher, and the first two were also isolated regularly from root samples. Roots exhibited galling from *M. incognita* and the cortical lesions attributed

[1]Florida Agricultural Experiment Stations Journal Series No. 3356.

to *H. multicinctus* (13, 17, 18), although root damage at this site was much less severe than that reported from other sites in Florida (11). Low numbers of *Rotylenchulus reniformis* Linford & Oliveira, *Quinisulcius acutus* (Allen) Siddiqi, and *Macroposthonia* spp. were also found at this site, but *R. similis* was absent. Included among genera of non-parasitic nematodes were *Aphelenchus, Tylenchus, Acrobeloides, Rhadbitis, Eudorylaimus,* and *Diphtherophora.*.

Table 1. Yields of plantains by treatment.

Treatment	Yield per mat (kg)[z]
Ethoprop (3.0 g ai/mat)	8.7 a
Ethoprop (6.0 g ai/mat)	10.2 a
Control + Iron chelate	11.0 a
Ethoprop (6.0 g ai/mat) + Iron chelate (85 g/mat)	11.1 a
Control	13.0 a
Ethoprop (3.0 g ai/mat) + Iron chelate (85 g/mat)	14.3 a

[z]Mean of 6 replications for bunches harvested between Sept. 6, 1979, and March 13, 1980. Means followed by the same letter are not significantly (P = 0.05) different, according to Duncan's new multiple range test.

Despite the presence of high numbers of *M. incognita* and *Helicotylenchus* spp. and evidence of root damage, yields of bananas were not significantly improved by applying the various chemical treatments (Table 1). The result is consistent with the fact that no significant (P = 0.05) reductions in populations of either *M. incognita* or *Helicotylenchus* spp. in soil or roots were obtained with treatment at any time during the course of this experiment. Comparisons of nematode population levels in soil under a 6.0 g ai ethoprop/mat regime, a 3.0 g ai ethoprop regime, and untreated controls are illustrated for *Helicotylenchus* spp. (Fig. 1) and larvae of *M. incognita* (Fig. 2). Results were similar for the treatments which included the iron chelate and for populations of these two nematode genera in roots. Although ineffective here, ethoprop had shown some reductions in nematode populations in a previous test conducted on Rockdale soil, although these were not consistent (16). However, on other soil types in Australia, use of ethoprop has led to increased yields of banana, even at 2.0 g ai/mat (3). On Rockdale soils, however, it is difficult to obtain consistent nematode control on bananas

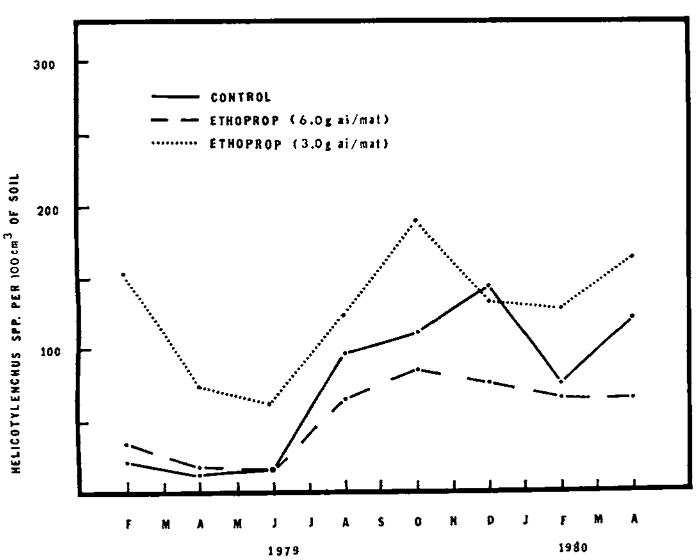

Fig. 1. Population fluctuations of *Helicotylenchus* spp. in soil as influenced by treatment. (Jan. 1979 to April, 1980).

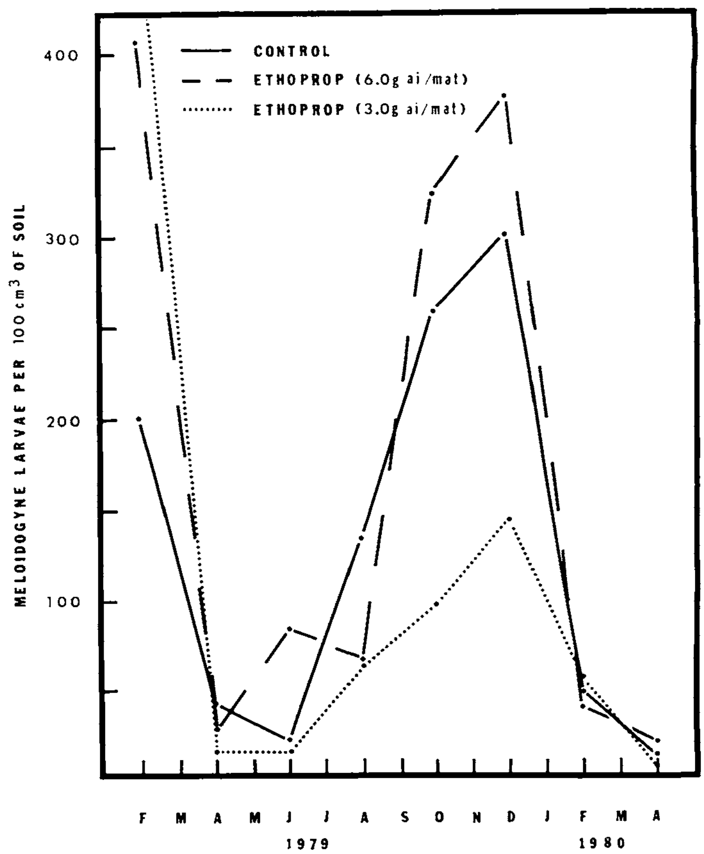

Fig. 2. Population fluctuations of *Meloidogyne incognita* larvae in soil as influenced by treatment. (Jan. 1979 to April, 1980).

and plantains. However, ethoprop is the only nematicide currently registered for post-plant application in the continental United States.

Examination of the nematode population fluctuations in soil (Figs. 1 and 2) reveals some general trends. Soil populations were lowest during March-May and increased to peaks in Oct.-Dec. Patterns in population fluctuations in roots were similar, although the peak in the *M. incognita* population in roots occurred in Aug. In south Florida, March-May ends the dry part of the year, while Oct.-Dec. ends the rainy season. Hutton (9) has pointed out that nematodes associated with plantains, such as *R. reniformis* and *H. multicinctus,* may be correlated with rainfall, and similar correlations have been noted in Nigeria (5). An attempt was made to correlate mean soil populations of *Helicotylenchus* spp. and *M. incognita* in untreated control plots with rainfall data obtained from a weather station in Homestead, Florida (approximately 3.5 miles away). Since Hutton (9) found that nematode population levels correlated with accumulated rainfall totals only after time lags of 2-5 weeks, the nematode counts on a given sampling date (usually near the first day of the month) were correlated with the rainfall accumulated not during the month immediately preceding the sampling date, but during the previous month. For example, nematode counts taken on August 2, 1979, were correlated with the total rainfall accumulated during the month of June, 1979. Such correlations were nonsignificant, with r = –0.040 for *Helicotylenchus* spp. and r = 0.090 for *M. incognita.* However, patterns of accumulated rainfall were distorted by the accumulation of 20.5 cm of rain on April 25, 1979. As Hutton (9) has indicated, heavy rainfall of this type may adversely affect nematode populations. Instead, if nematode counts were correlated with total days on which rainfall (more than 0.25 mm) occurred during the month rather than total amount of rainfall accumulated during the month, the correlation coefficients improved to 0.592 for *Helicotylenchus* spp. and 0.887 for *M. incognita*, the latter figure being highly significant ($P = 0.01$). When nematode populations were correlated with total days of rainfall during the preceding month, rather than during the month before the preceding month, the correlation coefficients were 0.594 and 0.604 for *Helicotylenchus* spp. and *M. incognita* respectively, which, while still substantial, are not statistically significant ($P = 0.05$).

Thus, there are indications that nematode populations on bananas in Florida may follow rainfall-dependent fluctuations similar to those observed in the tropics. This may account for the maximum population levels observed at the end of the rainy season, or during the months of Oct.-Dec. in southern Florida (Figs. 1-2). However, in subtropical Florida, the coolest time of the year will follow these peaks, during which the bananas will experience the temperatures most unfavorable for growth (19). Thus, bananas and plantains in Florida may be subject to the greatest nematode populations at the time of the year during which they are under the greatest climatic stress. If an effective nematicide were available, the optimum time for application on bananas and plantains would probably be immediately after the rainy season, since nematode populations are at their highest points, leaching of materials would be minimized, and plant vigor will be lowest in the coming months. It may be possible to schedule applications to derive the maximum benefit of the material and to avoid applications at those times of the year when they may be less effective.

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Proc. Fla. State Hort. Soc. 94:323-328. 1981.

RAPID PROPAGATION TECHNIQUES FOR FRUIT CROPS

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Abstract. **Rooting of cuttings from seven blueberry** (Vaccinium ashei **Reade) cultivars were tested in winter using 1) Rootone®[2], 2) Hare's powder [0.1% indolebutyric acid (IBA), 0.1% 1-phenyl-3-methyl-5-pyrazolone (PPZ), 2.0% sucrose and 97% talc], 3) Hare's powder without IBA, 4) Hare's powder with 1% saponin, and 5) Hare's powder with 1% lecithin. Summer rooting of 'Tifblue', 'Delight' and 'Woodard' blueberries, 'Valencia' orange** (Citrus sinensis **L. Osbeck), kumquat** (Citrus fortunella), **avocado** (Persea americana **Mill cv. Gainesville), jujube** (Ziziphus jujuba) **and eastern redcedar** (Juniperus virginiana **L.) was tested after cuttings were soaked for 1 hr in either 0, 1 or 2% sucrose solutions with either 0, 10, 30, 100, 300, 500 and 1000 ppm IBA. After soaking, the cuttings were dipped in a 1:99 PPZ-talc mixture. A control of only a H_2O soak was also provided. 'Delight' cuttings produced greater rooting yields in winter, 'Tifblue' cuttings produced greater rooting yields in summer and 'Woodard' cuttings produced abundant rootings in summer or winter with the proper treatment. 'Delight' cuttings had high auxin and sucrose requirements whereas 'Tifblue', 'Gainesville' avocado and 'Valencia' orange had low auxin plus high sucrose requirements for root initiation and growth. Addition of saponin or lecithin generally increased winter rooting in the blueberry cultivars. Exposure of jujube softwood cuttings, innately difficult to root, to 2000 ppm carbon dioxide (CO_2) during the first week after cuttings were taken reduced the time to rooting and increased the final amount of rooting. Avocado and 'Floradagold' peach** (Prunus persica **L. Batch) shoots girdled 2 wk before cutting exhibited increased rooting** ***on treated*** **cuttings.**

[1]Florida Agricultural Experiment Station Journal Series No. 3546.
[2]Rootone® is a commercial formulation and is used here only as a comparison formula. The use does not imply a recommendation.