Control of Nematodes and Black Weevils in Plantains[1]

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ABSTRACT

The burrowing nematode, *Radopholus similis*, and the black weevil, *Cosmopolites sordidus*, are the most important economic pests of plantain, *Musa acuminata* × *M. balbisiana*, AAB, in Puerto Rico. Research carried out by this Station has demonstrated that chemical control of nematodes increases plantain production and the useful life of the plantation. Similar results have not been obtained with the black weevil even when research has been conducted toward this goal. Several nematicide-insecticides for the control of both pests have been tested. At the Fortuna Substation five pesticides were evaluated: Carbofuran 5G and 10G, Fensulfothion 15G, Ethoprop 10G, and Aldicarb 10G. Carbofuran 5G was evaluated at the rate of 42 g/plant applied every 4 months. The other pesticides were evaluated at 56 g/plant applied every 6 months. At the Corozal Substation Aldicarb 10G was evaluated at 4 doses (10, 15, 30, 45 g/plant) applied every 4 and 6 months. Carbofuran 10G at 56 g/plant applied every 6 months was included for comparison. At the Fortuna Substation, where only one crop was harvested with no significant differences in yields, the majority of the pesticide treatments controlled the nematodes. The black weevil was controlled only with Aldicarb, Ethoprop, and Fensulfothion. At Corozal, where two crops were harvested, all treatments were significantly better than the control; with the control of nematodes and weevils there was an increase in yield and suckers. The most effective doses and frequencies for the control of both pests were Aldicarb 10G at the rate of 30 and 45 g/plant applied every 4 months and at 30 g applied every 6 months.

INTRODUCTION

Plantains (*Musa acuminata* × *M. balbisiana*, AAB) are an important staple food in Puerto Rico. During 1979–80 the gross income increased to $31.7 million or 9% over that of 1978–79.

Plantains are affected by many diseases and pests the most damaging of which are the burrowing nematode, *Radopholus similis* and the black weevil, *Cosmopolites sordidus*. It is assumed that a great majority of the plantain farms are affected by these organisms. Nematodes and black weevils play an important role in yield reduction, premature toppling of the plant, and the inability to produce ratoon crops.

Published literature on plantain nematodes reveal the importance of these parasites. Ogier and Merry (6) and Hutton and Chung (3) related plantain yield decline to nematode attack in Trinidad and Jamaica, respectively. Decker et al. (2) reported that *R. similis* is the main problem

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of plantain production in Cuba. In Puerto Rico, Ayala and Román (1) reported that plantain is very susceptible to the attack of *R. similis*.

Other research conducted in Puerto Rico has demonstrated the importance of *R. similis* in plantain production. Román et al. (8) reported that *R. similis* is the causal organism of the "black head-toppling disease" of plantains. The disease is characterized by heavy necrosis and subsequent rotting of the root system and rhizomes and premature falling of the plants. Román et al. (9) demonstrated that *R. similis* is controlled by pangola grass and that rotation of plantains with pangola grass increased yields significantly. Román (12) reported that Fensulfothion was an effective nematicide-insecticide which increased the yields of plantains significantly. Román et al. (10) published that granular formulations of nematicides provided a fast, easy, and economic method of application, and increased plantain yields significantly, especially in the ratoon crops. Román et al. (13) further demonstrated the effectiveness of granular nematicides, which increase yields of plantains and extend the useful life of the plantations so that three crops were harvested without replanting. Oramas and Román (7) researched the nematode fauna of plantain farms in Puerto Rico. They found that *Meloidogyne*, *Helicotylenchus*, *Radopholus*, and *Pratylenchus* were the most abundant nematode genera in the Island. Román et al. (14) reported that nematicide doses could be lowered and their frequency of application increased for more effective and economic control.

The banning of Aldrin, an excellent insecticide for the control of the black weevil, by the Environmental Protection Agency created an urgent need for the search of substitute materials. Medina-Gaud et al. (4, 5) published preliminary studies on the screening of pesticides. In these studies, among the new materials tested, Carbofuran and Fensulfothion were classified as effective insecticides. Román and Medina (11) concluded that Carbofuran was good not only for the control of *C. sordidus* but also for the control of nematodes attacking plantains. Excellent insecticidal properties of Carbofuran against black weevil were also reported by Valdez (16) in the Dominican Republic. Nevertheless, in spite of the use of these materials by the growers: populations of the black weevil increased rapidly. Thus, the search for other chemicals continued.

In 1980 Román et al. (15) published preliminary results of investigations with Aldicarb, a nematicide-insecticide to control both nematodes and black weevils. The results were encouraging as this product demonstrated a high nematicidal and insecticidal effect. These investigations were in agreement with the policy of this Station that the ultimate goal is to find one pesticide for the control of both destructive organisms.

However, results were limited and additional data were needed to support these findings. Therefore, additional investigations were conducted.

MATERIALS AND METHODS

A field experiment with 10 treatments, replicated 5 times, was established at the Corozal Substation. The treatments were: Aldicarb 10G, 10, 15, 30, and 45 g/plant applied at planting and every 4 months; Aldicarb 10G, 10, 15, 30, and 45 g/plant at planting and every 6 months; Carbofuran 10G, 56 g/plant at planting and every 6 months; and the non-treated control. Non-treated Maricongo corms or suckers were planted 1.37 × 2.44 m. Weeds were controlled with post emergence application of Gramoxone (473 cm^3/ha). The average soil pH was 5.5. The sigatoka disease was controlled with Chlorothalonil (Bravo 500) applied every 21 days at 3.459 L/ha. A 10-5-20 fertilizer with 150 kg/metric ton of Sulfomag was applied at the rate of 0.227 kg/ha the first month, 0.340 kg/ha the 5th month, and 0.454 kg/ha the 9th month. This experiment was carried to the first ratoon to obtain data on two crops.

Another field experiment for the evaluation of the effect of alkaline soils on the nematicides Carbofuran 5G, Carbofuran 10G, Fensulfothion 15G, Ethoprop 10G, and Aldicarb 10G, was established at the Fortuna Substation. This experiment consisted of six treatments replicated six times in a balanced incomplete-block design. The treatments were: Carbofuran 5G, 42 g per plant, applied at planting and every 4 months; Carbofuran 10G, Fensulfothion 15G, Ethoprop 10G, and Aldicarb 10G at 56 g per plant at planting and every 6 months; and the non-treated control. Non-treated suckers of the Enano variety were planted at 1.22 × 3.05 m. The average soil pH at planting was 7.7. Weeds were controlled by hand weeding. Fertilizer 10-0-20 with 100 lb/ton of minor elements was applied at the following times: 1st month—½ lb/plant; 5th month—½ lb/plant; 8th month—¾ lb/plant, and 10th month—½ lb/plant. Data from this experiment was taken only from the plant crop.

In both experiments soil and root samples were taken periodically for nematode analysis. At the time of harvest, data were taken on the number of suckers per plant, weight of bunch, and plantains per bunch. Also harvested plants were cut at soil level and the number of tunnels caused by the black weevil recorded.

RESULTS

Table 1 summarizes the results for the first and second harvests of the Corozal experiment. In general, most chemical treatments controlled significantly *R. similis*, the black weevil, and increased the yields. In the first crop highest nematode control was obtained with Aldicarb applied at 30 and 45 g every 6 months. Black weevil was best controlled with

TABLE 1.—*Average number of tunnels per plant, percent control of nematodes, suckers per plant, and estimated number and weight of marketable fruits per hectare of plantain plants treated with nematicides-insecticides in Corozal, P. R.*

Treatment per plant	Tunnels per plant (*C. sordidus*)	Control of nematodes (*R. similis*)	Suckers per plant	Plantains per ha	Weight
		%			*kg/ha*
		First harvest			
Aldicarb 10G, 10 g/4 M	4.5 bc[1]	59	9.9 abc	112,402 a	32,378 ab
Aldicarb 10G, 15 g/4 M	2.0 ab	77	9.6 abc	110,305 ab	35,286 ab
Aldicarb 10G: 30 g/4 M	1.9 ab	91	9.9 abc	103,502 abc	33,917 a
Aldicarb 10G, 45 g/4 M	0.7 a	93	8.8 bc	115,148 a	35,845 ab
Aldicarb 10G, 10 g/6	4.2 bc	97	10.7 ab	90,303 a	29,330 ab
Aldicarb 10G, 15 g/6 M	5.1 bc	86	10.7 ab	91,557 c	23,308 ab
Aldicarb 10G, 30 g/6 M	3.4 ab	99	8.3 c	110,132 abc	35,527 ab
Aldicarb 10G, 45 g/6 M	2.2 ab	99	11.3 a	102,070 bc	30,535 ab
Carbofuran 10G, 56 g/6 M	5.6 c	78	9.4 bc	88,571 abc	23,848 b
Control	23.2 d	0	4.2 d	49,750 d	6,656 c
		Second harvest			
Aldicarb 10G, 10 g/4 M	7.3 bc	44	5.4 a	69,241 b	13,972 ab
Aldicarb 10G, 15 g/4 M	9.5 cd	58	5.4 a	80,698 ab	16,950 ab
Aldicarb 10G, 30 g/4 M	1.7 ab	99	6.2 a	85,977 ab	25,672 a
Aldicarb 10G, 45 g/4 M	0.0 a	99	6.0 a	106,532 a	26,096 a
Aldicarb 10G, 10 g/6 M	11.0 cd	99	4.9 a	62,006 b	15,849 ab
Aldicarb 10G, 15 g/6 M	6.6 bc	96	5.2 a	60,951 b	10,458 ab
Aldicarb 10G, 30 g/6 M	6.3 bc	98	5.8 a	82,593 ab	20,394 ab
Aldicarb 10G, 45 g/6 M	5.7 bc	100	5.4 a	71,290 ab	15,877 ab
Carbofuran 10G, 56 g/6 M	13.8 d	59	5.3 a	67,502 b	15,623 ab
Control	26.5 e	0	0.3 b	496 c	2,385 b

[1] Values in columns followed by the same letters do not differ significantly at P = 0.05.

Aldicarb applied at 15 g every 4 months, and at 30 and 45 g every 4 and 6 months. The highest number and weight of fruits were obtained when Aldicarb was applied at 45 g every 4 months, but there were no significant differences between this treatment and the majority of the other treatments (table 1).

The results of the second crop are very similar to those obtained in the first, that is, most chemical treatments controlled significantly *R. similis*, the black weevil, and also increased yields. Perfect control of the black weevil was attained with Aldicarb applied at 45 g every 4 months. Thirty grams of Aldicarb applied every 4 months also gave excellent control of *C. sordidus*. As in the first crop, most treatments with Aldicarb were significantly better than those with Carbofuran for the control of

TABLE 2.—*Average number of tunnels per plant, percent control of nematodes, suckers per plant, and estimated number and weight of marketable fruits per hectare of plantain plants treated with nematicides-insecticides in Fortuna, P. R.*

Treatment per plant	Tunnels per plant (*C. sordidus*)	Control of nematodes (*R. similis*)	Suckers per plant	Plantains per ha	Weight
		%			*kg/ha*
1. Carbofuran 5G, 42 g/4 M	1.2 ab[1]	52	13.6 a	108,262 a	31,322 a
2. Carbofuran 10G, 56 g/6 M	4.1 ab	79	13.0 a	97,725 a	29,160 a
3. Fensulfothion 15G, 56 g/6 M	0.6 b	77	13.4 a	104,532 a	30,827 a
4. Ethoprop 10G, 56 g/6 M	0.6 b	69	13.7 a	99,538 a	29,188 a
5. Aldicarb 10G, 56 g/6 M	0.1 b	96	13.8 a	103,900 a	31,243 a
6. Control	6.2 a	0	12.5 a	97,389 a	23,792 a

[1] Values in columns followed by the same letters do not differ significantly at P = 0.05.

nematodes and black weevils. The highest number and weight of fruits were obtained with the application of Aldicarb at 45 g every 4 months. However, as in the case of the first harvest, there were no significant differences between this treatment and the majority of the other treatments (table 1).

Table 2 summarizes the results for the first harvest of the Fortuna experiment. Best control of black weevils was attained with Aldicarb, Ethoprop, and Fensulfothion. Aldicarb was also highly effective for nematode control. There was a trend toward lower yields in the control plots, but differences were not significant.

DISCUSSION

In the experiment at Fortuna, results cannot be compared with those at Corozal due to the fact that higher doses were utilized than at Corozal.

The data indicated that, at least at pH 7.7, the carbamate Aldicarb is as effective as the organophosphates Ethoprop and Fensulfothion. In fact, Aldicarb treatment gave slightly better control of nematodes and black weevils. In this experiment insect and nematode populations were low when compared with those at Corozal. This may have been the reason for the absence of significant differences in yields.

At Corozal, where there is abundant rainfall and plantain is cultivated extensively, high nematode and black weevil population densities create a real problem for the crop. Data gathered for 3 years when two crops of plantains were harvested indicated that, when compared with the control, all pesticide treatments significantly controlled black weevils and nematodes, and also increased yields. Nevertheless, the high efficacy of Aldicarb over Carbofuran was clearly demonstrated. In the plant crop the application of Aldicarb at 45 g every 4 months almost erradicated *R. similis* and the black weevil and increased yields significantly. It is important to note that the yield obtained with this treatment was not significantly different from that obtained with the treatment where the pesticide was applied at 30 g every 6 months.

The data obtained during the second harvest was more dramatic because nematode and black weevil densities increased significantly as observed in the control plots. In spite of the population increase, Aldicarb kept the populations under control. In fact, complete eradication of the weevil and nematode was attained when 45 g of the material was applied every 4 and 6 months, respectively. The next best treatment was 30 g of Aldicarb applied every 4 months, which was similar to 45 g applied every 4 months. In addition, the former treatment yield was not statistically different from that with 30 g applied at 6 months. The number and weight of fruits followed the same trend as for the first crop. Thus, according to the data obtained, the best treatments were 30 to 45 g of Aldicarb applied every 4 months, and 30 g of Aldicarb applied at 6 months. The latter is the more economical treatment.

RESUMEN

El nematodo barrenador, *Radopholus similis*, y el picudo negro, *Cosmopolites sordidus*, son las plagas de mayor importancia económica del platanero en Puerto Rico. Una serie de estudios efectuados por la Estación Experimental Agrícola ha demostrado que el combate químico de los nematodos del platanero aumenta la producción y alarga la vida útil de la plantación. Resultados similares no se han logrado con el picudo negro aun cuando las investigaciones al respecto han sido extensas. Con el propósito de estudiar el efecto de varios productos químicos en el combate de ambas plagas y su efecto en la producción, se realizaron dos experimentos de campo: uno en la Subestación Experimental de Fortuna, en un suelo alcalino (pH 7.7), utilizando la cultivar Enano y otro en la Subestación

de Corozal, en un suelo ácido (pH 5.5), con la cultivar Maricongo. En el experimento de Fortuna se evaluaron cinco plaguicidas: Carbofuran 5G y 10G, Fensulfothion 15G, Ethoprop 10G y Aldicarb 10G. El Carbofuran 5G se aplicó a razón de 42 g por planta cada 4 meses y el resto de los plaguicidas a razón de 56 por planta cada 6 meses. Los tratamientos se repitieron seis veces. En el experimento de Corozal se evaluaron cuatro dosis de Aldicarb 10G (10, 15, 30 y 45 g/planta) aplicados cada 4 y 6 meses. Además, se incluyó el Carbofuran 10G (56 g/planta/6 meses) para comparación. Se utilizaron cinco repeticiones por tratamiento. Los resultados del experimento en Fortuna, donde se evaluó una sola cosecha, en la que no se obtuvieron diferencias significativas en los rendimientos, demostraron que, en general, la mayoría de los tratamientos controló eficazmente los nematodos. El picudo negro fue controlado sólo con las aplicaciones de Aldicarb, Ethoprop y Fensulfothion. En Corozal, donde se evaluaron dos cosechas, todos los tratamientos con nematicidas-insecticidas combatieron eficazmente los nematodos y el picudo negro. También estos tratamientos aumentaron significativamente el número y el peso de los plátanos por hectárea así como el número de hijos por cepa. Las dosis y frecuencias más eficaces fueron 30 y 45 g de Aldicarb cada 4 meses, y 30 g cada 6 meses; este último debe ser el más económico para el agricultor.

LITERATURE CITED

1. Ayala, A. and Román, J., 1963. Distribution and host-range of the burrowing nematode in Puerto Rican soils. J. Agric. Univ. P.R. 47: 28–37.
2. Decker, H., Casamayor-García, R. and Rodríguez-Fuentes, M. E., 1973. Nuevas investigaciones sobre tratamientos de los rizomas del plátano con agua caliente y nematicidas contra nemátodos parasíticos, Cartas ALAF No. 51–52: 7, marzo-abril.
3. Hutton, D. G. and Chung, D. C., 1973. Effect of post-planting applications of the nematicide DBCP to plantain, Nematropica 3: 45.
4. Medina-Gaud, S., García-Tudurí, J., Martorell, L. F. y Rodríguez, J., 1974. Posibles substitutos del aldrin y el dieldrin para el control del gorgojo del guineo y el plátano, Adelanto Científico 11: 1–2, Esta. Exp. Agric., Univ. P.R.
5. ——, ——, —— and ——, 1975. Preliminary screening of pesticides for the control of the banana root-borer, *Cosmopolites sordidus* Germar (Coleoptera: Curculionidae), J. Agric. Univ. P.R. 59: 78–81.
6. Ogier, T. P. and Merry, C. A. A. F., 1970. Yield decline of plantains, *Musa paradisiaca*, in Trinidad associated with the nematode *Pratylenchus* sp., Turrialba 20: 407–12.
7. Oramas, D. and Román, J., 1982. Plant parasitic nematodes associated with plantains (*Musa acuminata* × *M. balbisiana* AAB) in Puerto Rico, J. Agric. Univ. P.R. 66: 52–9.
8. Román, J., Rivas, X. and Rodríguez, J., 1973. Control de los nemátodos del plátano, Adelanto Científico 1: 1–2, Esta. Exp. Agric., Univ. P.R.
9. ——, ——, and ——, 1973. El uso de la yerba Pangola para el control de los nemátodos del plátano, Adelanto Científico 4: 1–2, Esta. Exp. Agric., Univ. P.R.
10. ——, ——, —— and Oramas, D.: 1976. Chemical control of the nematodes of plantains (*Musa acuminata* × *M. balbisiana* AAB), J. Agric. Univ. P.R. 60: 36–44.

11. —— and Medina, S., 1976. Insecticida-nematicida controla eficazmente el piche y los nemátodos del plátano, Adelanto Científico 33: 1–2, Esta. Exp. Agric., Univ. P.R.
12. ——, 1976. Estación Experimental consigue permiso de uso de nematicida que duplica la producción de plátanos, Adelanto Científico 40: 1–2, Esta. Exp. Agric., Univ. P.R.
13. ——, Rivas, X., Oramas, D. and Rodríguez, J., 1977. Further experiments on the chemical control of nematodes in plantains (*Musa acuminata* × *M. balbisiana* AAB), J. Agric. Univ. P.R. 61: 192–99.
14. ——, Oramas, D. and Green, J., 1979. Effect of rate and frequency of application of nematicides in plantain production: Nematropica 9: 107–08.
15. ——, ——, —— y Torres, A., 1981. Combate de los nemátodos y el picudo negro del plátano mediante el uso de carbamatos y organofosforados y su efecto en la producción, Nematropica 11: 90–1.
16. Valdez-R., Fernando J., 1978. Estudio de la incidencia y el control químico del picudo negro del plátano, *Cosmopolites sordidus* Germar (Coleoptera: Curculionidae) en la zona de La Vega, Tesis, Univ. Auton. de Santo Domingo.