# Rates, application intervals and rotation of four granular pesticides to control nematodes and the corm-weevil (*Cosmopolites sordidus* Germar) in plantain[1,2]

*José A. Chavarría-Carvajal*[3] *and Héber Irizarry*[4]

**J. Agric. Univ. P.R. 81(1-2):43-52 (1997)**


## ABSTRACT

The efficacy of the nematicide-insecticides aldicarb, carbofuran, ethoprop and phenamiphos was studied in plantain using recommended and lower label rates, shorter application intervals and rotation. These compounds were effective in reducing *Radopholus similis* and *Pratylenchus coffeae* populations when lower than recommended rates were applied at the shortened interval of four months or when the chemicals were rotated. Except for ethoprop, these compounds were also effective in controlling the corm-weevil when applied at below recommended label rates and intervals. However, the insecticide efficacy of phenamiphos and the rotation of aldicarb, phenamiphos and carbofuran was particularly high when applied at planting time and every six months thereafter. Yield components were not significantly affected by the various nematicide-insecticide treatments in the plant crop.


Key words: plantains, *Radopholus similis*, *Pratylenchus coffeae*, banana corm-weevil


## RESUMEN

**Dosis, intervalos de aplicación y rotación de cuatro plaguicidas granulados, registrados para el control de nematodos y el picudo negro (*Cosmopolites sordidus* Germar) en plátano**

Se estudió la eficacia de los plaguicidas granulados aldicarb, carbofuran, etoprop y fenamifos en plátano, usando las dosis recomendadas en la etiqueta del producto y dosis e intervalos de aplicación más bajos que los


[1]Manuscript submitted to Editorial Board on 11 May 1992.

[2]This paper is part of a thesis submitted by the first author to the Graduate School of the University of Puerto Rico, Mayagüez Campus, in partial fulfillment of the requirements for Master of Science. The work was carried out cooperatively between the Agricultural Research Service-USDA, Mayagüez, Puerto Rico, and the Agricultural Experiment Station, University of Puerto Rico. The authors thank Mr. José A. Rodríguez-García and personnel at Corozal substation for the cooperation received during the development of this research.

[3]Research Assistant in Nematology, Agricultural Experiment Station, University of Puerto Rico, Mayagüez Campus.

[4]Research Horticulturist, Agricultural Research Service-USDA, Tropical Agriculture Research Station, Mayagüez, Puerto Rico.

recomendados. También, se probaron estos plaguicidas en rotación. Todos los compuestos fueron efectivos en reducir las poblaciones de *Radopholus similis* y *Pratylenchus coffeae* cuando se aplicaron en dosis más bajas que las recomendadas en la etiqueta y a intervalos de cuatro meses, o cuando se aplicaron en rotación Excepto por etoprop, los demás compuestos fueron efectivos en reducir el daño causado por el picudo negro, cuando se aplicaron en dosis más bajas y a intervalos más cortos que lo recomendado en la etiqueta, o en rotación. Sin embargo, los tratamientos con mayor eficacia como insecticidas fueron fenamifos y la rotación de aldicarb, fenamifos y carbofuran aplicados a la siembra y a intervalos de seis meses. Ninguno de los tratamientos afectó significativamente los componentes de rendimiento en la cosecha de plantilla.

## INTRODUCTION

Plantains (*Musa acuminata* × *M. balbisiana*, AAB) rank second among crops of economic importance in Puerto Rico. During 1990-91, the farm gate value of the crop was $43.6 million, representing 5.2% of the local gross agricultural income (Ortíz, 1992).

Plantains have many natural enemies, the worst of which are the burrowing nematode, *Radopholus similis* (Cobb) Thorne; the lesion nematode, *Pratylenchus coffeae* (Zimmermann) Filipjev and Schuur-Stekh; and the corm-weevil, *Cosmopolites sordidus* (Germar) (Gowen, 1995; Stover, 1987).

According to Oramas and Román (1978; 1982), *R. similis* is the most damaging nematode attacking plantains in Puerto Rico. Román *et al.* (1973) confirmed that the burrowing nematode is the causal organism of the condition known as "black-head" of plantains. This disease is characterized by heavy necrosis, subsequent rotting and weakening of the root system, which eventually causes toppling of plants (Blake, 1966; Gowen, 1995; Román et al., 1973).

*Pratylenchus coffeae* is another nematode associated with plantain root and corm decay in Puerto Rico and elsewhere in the tropics (Olgier and Merry, 1970; Oramas, 1986; Oramas and Román, 1978; Taylor and Loegering, 1953). In Trinidad and Honduras, this nematode is regarded as the second most important pathogen attacking plantain and bananas (Olgier and Merry, 1970; Stover, 1972; Stover, 1987). Lesions caused by the nematode facilitate the entrance of secondary pathogens which accelerate the death of roots and premature toppling of plants (Román, 1978, 1986; Stover, 1972).

The banana corm-weevil, *C. sordidus*, is a widely disseminated pest in plantain and banana fields (Fenjves and Fernández, 1951; Franzmann, 1972; Gowen, 1995). The larva feeds on the corm tissue, thus producing tunnels that interfere with root initiation and plant nourishment. The insect also contributes to premature toppling of plants (Batchelder, 1954; Montellano, 1954). Infested propagating material and ineffective chemical control are two major factors that favor insect population increases (Trejo, 1966).

At present, the use of chemicals is the most common control measure against nematodes and the corm-weevil. Román et al. (1979) evaluated the effectiveness of various granular formulations of aldicarb and carbofuran against these pests. They suggested lower rates and expanded application intervals to increase effectiveness and to reduce production cost. In Colombia, Cardenas (1984) reduced corm-weevil population with a granular application of phenamiphos at 1.5 g ai/plant. Conversely, the yield was substantially increased. In Puerto Rico, Inglés and Rodríguez (1989) also reported similar findings by applying phenamiphos at the rate of 2.1 g ai/plant at planting and every six months thereafter.

A judicious use of pesticides might reduce the risk of residues in human and animal food and may contribute to decrease environmental contamination. This study reports the efficacy of four granular pesticides applied at lower rates and reduced intervals, and in rotation, for the control of phytonematodes and the corm-weevil in plantain.

## MATERIALS AND METHODS

The experiment was planted in July 1986 at the Corozal substation, located in the north central region of Puerto Rico, at about 200 m. Mean rainfall was 1,825 mm and the average monthly temperature 24.4°C.

The experiment was established on an acid infertile Corozal clay (Ultisol), containing 2 mg/kg of available P (Bray Method 2) and 1.0, 1.5 and 8.7 cmol$^{(+)}$/kg of exchangeable K, Mg and Ca, respectively. Before planting, the soil was plowed and harrowed twice to a depth of about 20 cm and the pH adjusted to 5.3 with the incorporation of ground limestone.

Corms of cv. Maricongo were used as planting material. The propagating suckers were obtained from a plantation with a yielding capacity of 40 or more marketable fruits per bunch, but where *R. similis* and *P. coffeae* were present in populations of 11,870 and 730 nematodes/100 g of fresh roots, respectively. Román et al. (1983) and Román (1986) postulated that the presence of only about 500-1,000 *R. similis* larvae in 100 g of plantain roots is sufficient to cause a severe nematode problem.

Four granular pesticides, carbofuran (Furadan 10G)[5], ethoprop (Mocap 10G), aldicarb (Temik 10G) and phenamiphos (Nemacur 15G) were evaluated on the basis of three rates, two intervals and three ro-

[5]Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of materials by the UPR-Agricultural Experiment Station or the USDA/ARS, nor is this mention a statement of preference over other materials.

tation cycles. Two controls, a pre-planting treatment and an absolute control, were included (Table 1). The nematicide-insecticides were incorporated into the soil with a hand rake.

Seventeen treatments were arranged in a randomized complete block design with five replications. To simplify the presentation of results and discussion, the treatments were organized into five groups based on rates, intervals and application methods (Table 1).

The experimental plots contained six plants spaced at 1.8 × 1.8 m, about 3,000 plants per hectare. Plants were fertilized with a 10-5-20-3 (N, $P_2O_5$, $K_2O$, MgO) fertilizer at 1.5, 4.5, 8 and 11 months after planting. In the first application, the plants received 105, 53 and 210 kg/ha of N, P, K, respectively. Subsequent applications provided 140 kg/ha of N, 70 kg/ha of P and 280 kg/ha of K. All applications were supplemented with 17.5 kg/ha of Mg.

Weeds and the Yellow Sigatoka (*Mycosphaerella musicola* Leach), were controlled by following the Agricultural Experiment Station recommendations (Irizarry et al., 1995).

Four months after planting, and every two months thereafter, root samples were taken from six plants in each experimental plot for nematode extraction, identification and population counts. The nematodes were extracted from 100 g of fresh roots by the method described by Christie and Perry (1951). After harvest, the plant pseudostem was pruned at soil level, the number of tunnels counted, and the percentage of corm-weevil damage estimated by following the method proposed by Vilardebo (1973).

Bunches were harvested about 120 days after bunch-shooting. Number of hands and marketable fruits per bunch and bunch weight were recorded. The data were subjected to an analysis of variance, and means compared using the Dunnett's test (Steell and Torrie, 1980).

## RESULTS AND DISCUSSION

*Radopholus similis* and *P. coffeae* were always present in control plants, e.g., pre-plant treated corms and the absolute control (treatments 16 and 17) at all sampling dates (Table 2). The burrowing nematode, *R. similis*, was the dominant species in the absolute control throughout the experiment. In the pre-plant treatment, this phytonematode was dominant only during the first eight months after planting. *Pratylenchus coffeae* was the dominant species thereafter.

Nematode populations were low and erratic during the first eight months after planting in treatments of groups I through IV (Table 2). Thereafter, nematode populations remained low in treatments 10 through 15 of groups III and IV. These groups were those with the ap-

TABLE 1.—*Rates, intervals of application and rotation of four granular nematicide-insecticides evaluated for the control of nematodes and the corm-weevil in plantains.*

| | | | | Post-plant treatment, months after planting | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
| Group | Treatment | Rate grams ai/plant/year | Pre-plant corm treatment[1] | Grams ai/plant/application | | | | | | |
| I | 1 carbofuran | 9.0 | No | 1.5 | — | 2.5 | — | 2.5 | — | 2.5 |
| | 2 ethoprop | 16.0 | No | 4.0 | — | 4.0 | — | 4.0 | — | 4.0 |
| | 3 aldicarb | 7.0 | No | 1.0 | — | 2.0 | — | 2.0 | — | 2.0 |
| | 4 phenamiphos | 8.0 | No | 2.0 | — | 2.0 | — | 2.0 | — | 2.0 |
| II | 5 carbofuran | 6.5 | No | 1.5 | — | — | 2.5 | — | — | 2.5 |
| | 6 ethoprop | 18.5 | No | 6.0 | — | — | 6.0 | — | — | 6.0 |
| | 7 aldicarb | 9.0 | No | 3.0 | — | — | 3.0 | — | — | 3.0 |
| | 8 phenamiphos | 9.0 | No | 3.0 | — | — | 3.0 | — | — | 3.0 |
| III | 9 carbofuran | 7.5 | Yes | — | 2.5 | — | 2.5 | — | 2.5 | — |
| | 10 ethoprop | 12.0 | Yes | — | 4.0 | — | 4.0 | — | 4.0 | — |
| | 11 aldicarb | 8.1 | Yes | — | 2.7 | — | 2.7 | — | 2.7 | — |
| | 12 phenamiphos | 7.5 | Yes | — | 2.5 | — | 2.5 | — | 2.5 | — |
| IV | 13 Rotation A | 10.5 | No | 2.0e[2] | — | 3.0a | — | 3.0p | — | 2.5c |
| | 14 Rotation B | 7.5 | No | 2.0a | — | — | 3.0p | — | — | 2.5c |
| | 15 Rotation C | 8.5 | Yes | — | 2.5c | — | 3.0p | — | 3.0a | — |
| V | 16 Pre-plant Control | — | Yes | — | — | — | — | — | — | — |
| | 17 Absolute Control | — | No | — | — | — | — | — | — | — |

[1]Pre-plant corm treatment with phenamiphos at 2,500 mg/kg.

[2]Key for pesticides used in rotation: a = aldicarb, c = carbofuran, e = ethoprop, and p = phenamiphos.

TABLE 2.—*Mean number of* R. similis *(R) and* P. coffeae *(P), larvae recovered from root samples of plantains treated with four granular nematicide-insecticide at various rates and application intervals.*

| Group | Treatment | Rate grams ai/plant/ year | Months after planting | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 4 | | 6 | | 8 | | 10 | | 12 | | 14 | |
| | | | R | P | R | P | R | P | R | P | R | P | R | P |
| I | 1 carbofuran | 9.0 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 74 | 732 | 1026 | 74 | 0 |
| | 2 ethoprop | 16.0 | 247 | 0 | 0 | 0 | 0 | 0 | 0 | 366 | 660 | 440 | 148 | 0 |
| | 3 aldicarb | 7.0 | 247 | 247 | 0 | 0 | 0 | 0 | 37 | 0 | 222 | 0 | 0 | 0 |
| | 4 phenamiphos | 8.0 | 0 | 513 | 0 | 0 | 148 | 0 | 184 | 3079 | 2786 | 3372 | 5060 | 0 |
| II | 5 carbofuran | 6.5 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 0 | 732 | 0 | 74 | 0 |
| | 6 ethoprop | 18.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 74 | 660 | 6454 | 0 | 440 |
| | 7 aldicarb | 9.0 | 0 | 0 | 0 | 0 | 0 | 0 | 1083 | 0 | 5720 | 0 | 294 | 74 |
| | 8 phenamiphos | 9.0 | 0 | 487 | 0 | 148 | 0 | 0 | 0 | 1467 | 0 | 4106 | 0 | 586 |
| III | 9 carbofuran | 7.5 | 0 | 0 | 247 | 0 | 0 | 0 | 74 | 2492 | 0 | 0 | 0 | 3814 |
| | 10 ethoprop | 12.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11 aldicarb | 8.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37 | 0 | 0 | 0 | 0 |
| | 12 phenamiphos | 7.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 74 | 0 |
| IV | 13 Rotation A | 10.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 14 Rotation B | 7.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37 | 0 | 293 | 0 | 0 |
| | 15 Rotation C | 8.5 | 0 | 0 | 0 | 148 | 0 | 0 | 0 | 37 | 0 | 37 | 0 | 0 |
| V | 16 Pre-plant Control | — | 724 | 486 | 513 | 74 | 440 | 74 | 220 | 550 | 514 | 2346 | 734 | 1174 |
| | 17 Absolute Control | — | 734 | 74 | 953 | 74 | 1172 | 74 | 844 | 293 | 3738 | 293 | 758 | 366 |

plication of nematicide-insecticides below the recommended rates, shortened intervals of four months, and the rotation of pesticides with and without pre-plant corm treatment. No nematodes were recovered when the pre-plant corm treatment was combined with the application of ethoprop at below the recommended label rate, two months after planting and every four months thereafter (treatment 10). No nematodes were recovered when ethoprop, aldicarb, phenamiphos and carbofuran were rotated in this order and applied at below the recommended rates at planting and every four months thereafter, treatment 13 (Tables 1 and 2). Román et al. (1979) also suggested that nematicide rates and intervals may be reduced below those of the label recommendation and still continue to be effective in the control of phytonematodes in plantain.

Nematode populations increased with plant age in treatments of groups I and II. These groups comprised treatments with the use of rates and intervals of application recommended on the labels or the use of lower rates and reduced intervals, both without pre-plant corm treatment (Tables 1 and 2).

Except for ethoprop applied below the recommended label rate at four months intervals, all treatments in groups I through IV significantly reduced the number of tunnels and percentage of insect damage as compared with the pre-plant corm treatment and the absolute control (Table 3). The pre-plant treatment alone had no significant effect in reducing the corm-weevil damage.

Among the four granular nematicide-insecticides evaluated, phenamiphos in treatments 4, 8 and 12 of groups I, II and III consistently showed a high degree of efficacy as an insecticide, allowing only 0.4 tunnels and 1.7% insect damage per plant (Table 3). Rotation B (treatment 14), which combined applications of aldicarb, phenamiphos and carbofuran at planting and every six months thereafter, was equally effective.

Yield components were not significantly affected by the various treatments. Plants treated with carbamate and organophosphate compounds produced bunches averaging eight hands with 52 marketable fruits and weighing 16.6 kg. Mean fruit weight for all pesticide treatments was 319 g. Bunches from the absolute-control plants had eight hands with 54 marketable fruits and weighed 15.6 kg. Mean fruit weight was 289 g, well over the minimum weight required by the local standard for marketable plantain fruits (Irizarry et al., 1991). These results suggest that under the agronomic conditions in which the experiment was conducted higher initial nematode population and heavy corm-weevil infestations were necessary to reduce yield significantly in the plant crop of plantains. Román et al. (1983) evaluated various rates and frequencies of carbofuran, fensulfothion, ethoprop

TABLE 3.—*Number of corm-weevil tunnels and damage, recorded in plantains treated with four granular nematicide-insecticides at various rates and application intervals.*

| Group | Treatment | Rate grams ai/ plant/year | Number tunnels/ plant | Corm damage (%) |
|---|---|---|---|---|
| I | 1 carbofuran | 9.0 | 1.3** | 5.3** |
| | 2 ethoprop | 16.0 | 3.6 NS[1] | 17.3 NS |
| | 3 aldicarb | 7.0 | 1.9** | 9.3** |
| | 4 phenamiphos | 8.0 | 0.3** | 1.0** |
| II | 5 carbofuran | 6.5 | 1.6** | 5.3** |
| | 6 ethoprop | 18.5 | 1.1** | 3.5** |
| | 7 aldicarb | 9.0 | 1.8** | 6.8** |
| | 8 phenamiphos | 9.0 | 0.3** | 1.3** |
| III | 9 carbofuran | 7.5 | 1.0** | 3.8** |
| | 10 ethoprop | 12.0 | 2.8** | 10.3** |
| | 11 aldicarb | 8.1 | 8.1** | 6.5** |
| | 12 phenamiphos | 7.5 | 0.6** | 2.8** |
| IV | 13 Rotation A | 10.5 | 0.9** | 4.3** |
| | 14 Rotation B | 7.5 | 0.3** | 1.3** |
| | 15 Rotation C | 8.5 | 0.9** | 4.0** |
| V | 16 Pre-plant Control | — | 7.4 NS | 38.8 NS |
| | 17 Absolute Control | — | 5.6 | 32.0 |

Number of tunnels: d = 2.42 (P = 0.05) d = 3.04 (P = 0.01)
Percentage of damage: d = 14.75 (P - 0.05) d = 18.56 (P = 0.01)

**Significantly different to the absolute control at 1% probability level according to Dunnett's test.

[1]NS = not significant.

and aldicarb in the Common Dwarf plantain at the Fortuna substation. These co-workers did not obtain a significant nematicide-insecticide effect on yields in the plant crop harvest.

In the experiment here reported, an attempt was made to continue the pesticide evaluations beyond the plant crop. This effort, however, was discontinued when the field succumbed to the so-called "plantain decline syndrome" or the inability of the plant crop to produce marketable fruits in the ratoon.

## LITERATURE CITED

Batchelder, C. H., 1954. Experimentos con insecticidas para combatir el picudo negro, *Cosmopolites sordidus* (Germar), en plantaciones de abacá. *Turrialba* 4:88-93.

Blake, C. D., 1966. The histological changes in banana roots caused by *Radopholus similis* and *Helicotylenchus multicinctus. Nematologica* 12:129-37.

Cárdenas, R., 1984. El picudo negro del plátano, *Cosmopolites sordidus* (Germar). Cenicafé, Colombia 120:12.

Christie, J. R. and V. G. Perry, 1951. Removing nematodes from the soil. Proc. Herm. Soc. Wash., D.C. 18:106-108.

Fenjves, P. y F. Fernández, 1951. Datos sobre el gorgojo negro del plátano, *Cosmopolites sordidus* (Germar) 1834. Coleoptera: Curculionidae en Venezuela. Agron. Trop. (Venezuela) 1:221-232.

Franzmann, B. A., 1972. Banana weevil borer in North Queensland. *Queensland Agric. J.* 98:321-339.

Gowen, S., 1995. Pests. Pages 382-402 In: Bananas and plantains. Chapman & Hall, London. 612 pp.

Inglés, R. y J. Rodríguez, 1989. Evaluación de plaguicidas y métodos para combatir el picudo negro del plátano, *Cosmopolites sordidus* (Germar). *J Agric. Univ. P. R.* 73:97-107.

Irizarry, H., E. Rivera, A. D. Krikorian and J. A. Rodríguez, 1991. Proper bunch management of the French-type superplantain (*Musa acuminata* × *M. balbisiana*, AAB) in Puerto Rico. *J. Agric. Univ. P. R.* 75:163-171.

Irizarry, H., R. Montalvo-Zapata y J. A. Chavarría-Carvajal, 1995. Conjunto tecnológico para la producción de plátanos y guineos. Public. 97. Estac. Exp. Agríc. Univ. PR. 46 pp.

Montellano, B. C., 1954. Estudios biológicos de *Cosmopolites sordidus* (Germar) que infesta el rizoma de abacá. Tesis Mag. Agr. Turrialba (Costa Rica), Inst. Interam. Cienc. Agric. 71 pp.

Olgier, T. P. and C. A. F. Merry, 1970. Yield decline of plantains, *Musa paradisiaca*, in Trinidad associated with the nematode *Pratylenchus* spp. *Turrialba* 29:407-412.

Oramas, D., 1986. Patogenecidad e interacción de *Radopholus similis, Pratylenchus coffeae, Rotylenchus reniformis* y *Meloidogyne incognita* en el plátano (*Musa acuminata* × *M. balbisiana*, AAB). Tesis M. S., Depto. Prot. Cult. Universidad de Puerto Rico, Recinto de Mayagüez. 119 pp.

Oramas, D. y J. Román, 1978. Nematodos parasíticos asociados con el cultivo del plátano (*Musa acuminata* × *M. balbisiana*, AAB) en Puerto Rico. *Nematropica* 8(2):19 (Abstr.).

Oramas, D. and J. Román, 1982. Plant parasitic nematodes associated with plantains (*Musa acuminata* × *M. balbisiana*, AAB) in Puerto Rico. *J. Agric. Univ. P. R.* 66:52-59.

Ortíz, J., 1992. Plátanos y guineos. En: situación y perspectivas Empresas Agrícolas de Puerto Rico 1989-1990, 1990-1991. C. I. Alamo, ed. Estac. Exp. Agríc., Univ. P. R.

Román, J., 1978. Fitonematología tropical. Universidad de Puerto Rico, Río Piedras. 256 pp.

Román, J., 1986. Plant parasitic nematodes of bananas and plantains. Pages 7-19 In: Plant parasitic nematodes of bananas, citrus, coffee, grapes and tobacco. Union Carbide. 71 pp.

Román, J., D. Oramas and J. Green, 1979. Effect of rate and frequency of application of nematicides in plantain production. *Nematrópica* 9(2):107-117.

Roman, J., D. Oramas, J. Green and A. Torres, 1983. Control of nematodes and black weevils in plantains. *J. Agric. Univ. P. R.* 67:270-277.

Román J, X. Rivas y J. Rodríguez, 1973. Control de los nematodos del plátano. Adelanto Científico 1:1-2, Estac. Exp. Agríc., Univ. P. R.

Steell, R. G. D. and J. H. Torrie, 1980. Principles and procedures of statistics: A biometrical approach. McGraw Hill, New York, NY. 633 pp.

Stover, R. H., 1972. Banana, plantain and abaca diseases. Eastern Pres., London. 316 pp.

Stover, R. H., 1987. Pests. Pages 324-345 In: Bananas. Stover, R. H. and N. W. Simmonds., eds. Wiley & Sons, Inc. New York, NY. 468 pp.

Taylor, A. L. and W. Q. Loegering, 1953. Nematodes associated with root lesions in abaca. *Turrialba* 3:8-13.

Trejo, J. A., 1966. El picudo negro del banano, *Cosmopolites sordidus* (Germar). Agricultura en El Salvador 9:22-25.

Vilardebo, A., 1973. Le coefficient d'infestation, critere d'evaluation de degre d'attaques des bananeraies par *Cosmopolites sordidus* Germ. le charancon noir de bananier. *Fruits* 28:417-427.