

Plant Parasitic Nematodes Associated with Plantain (*Musa acuminata* × *M. balbisiana*, AAB) in Puerto Rico¹

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ABSTRACT

A survey was conducted through the five agricultural regions of Puerto Rico to determine distribution and population density of the nematode species associated with plantain. Fourteen genera, represented by 19 species of phytoparasitic nematodes were found in association with the crop: *Ditylenchus*, *Helicotylenchus*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Paratylenchus*, *Pratylenchus*, *Pseudhalenchus*, *Quinisulcius*, *Radopholus*, *Rotylenchulus*, *Tylenchorhynchus*, *Tylenchus*, and *Xiphinema*. *Meloidogyne incognita*, *Helicotylenchus* spp., *Radopholus similis*, and *Rotylenchulus reniformis* were the most widely distributed nematode species throughout the island. On the other hand, *M. incognita*, *P. coffeae*, *R. similis*, *Helicotylenchus* spp., and *R. reniformis* had higher population densities.

INTRODUCTION

Plantain (*Musa acuminata* × *M. balbisiana*, AAB) is one of the most important agricultural crops in Puerto Rico. The gross income derived from plantain has increased steadily from \$5.2 million in 1961 to \$27.8 in 1978 (7). In 1974-75 plantain was second in economic importance among all agricultural crops. Plantain production in Puerto Rico is greatly hampered by three important problems of biological nature: the Sigatoka disease (cause by *Mycosphaerella musicola*), the corm weevil (*Cosmopolites sordidus*), and nematodes.

Plantains have been reported as hosts of approximately 19 nematode genera (1,8,9,12,16,24,27,28) (table 1). Apparently, the first recorded association of a plant-parasitic nematode with a Musaceae was the one reported by Cobb (5) in 1893 when he found *Tylenchus similis* (Cobb, 1893) Thorne, 1949, to be the cause of a serious disease outbreak of bananas in Fiji. In 1915, Cobb (6) found the same nematode species associated with a disease of the Gros Michel banana in Jamaica, referred to later as black head by Ashby and as a toppling disease by Leach (11). In 1951, Plaza (16) reported what seems to be the first recorded association of nematodes with plantain when he found *Meloidogyne* Goeldi, 1887 associated with a disease of *Musa paradisiaca* L.

In Puerto Rico, the first published record of the nematodes of plantain was that of Ayala and Román (3) where they reported plantains among

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TABLE 1.—*Nematodes associated with plantains in various parts of the world*

Nematode species	Location	Reference
<i>Criconema octangulare</i>	Africa	Luc & Villardebó (1961)
<i>Criconemoides</i> spp.	Brazil, Jamaica	Sharma & Sher (1973), Hutton & Chung (1973)
<i>Ditylenchus</i> sp.	Puerto Rico	This report
<i>Helicotylenchus</i> spp.	Africa, Colombia, Puerto Rico, Dominican Republic, Trinidad, Venezuela	Luc & Villardebó (1961), Barriga (1969), Ayala (1969), Smith & Thames (1969), Ogier & Merry (1970), Haddad et al. (1975)
<i>H. dihystra</i>	Puerto Rico, Thailandia, Philippines, Brazil	Ayala & Román (1963), Timm (1963), Sharma and Sher (1973)
<i>H. erythrinae</i>	Brazil	Sharma & Sher (1973)
<i>H. multicinctus</i>	Africa, Ghana, Jamaica, Brazil	Luc & Villardebó (1961), Addoh (1971), Hutton & Chung (1973), Sharma & Sher (1973)
<i>H. pseudorobustus</i>	Puerto Rico	This report
<i>H. truncatus</i>	Puerto Rico	This report
<i>Hemicycliophora oostenbrinki</i>	Africa, Ghana	Luc & Villardebó (1961), Addoh (1971)
<i>Hoplolaimus puertoricensis</i>	Puerto Rico	This report
<i>H. seinhorsti</i>	Philippines	Timm (1963)
<i>Longidorella</i> spp.	Ghana	Addoh (1971)
<i>Longidorus</i> spp.	Jamaica; Puerto Rico	Hutton & Chung (1973); this report
<i>Meloidogyne</i> spp.	Dominican Republic, Ghana, Jamaica, Brazil, Venezuela	Smith & Thames (1969), Addoh (1971), Hutton & Chung (1973), Sharma & Sher (1973) Haddad et al. (1975)
<i>M. incognita</i>	Colombia, Africa, Puerto Rico	Plazas (1951), Luc and Villardebó (1961), Ayala (1969)
<i>M. javanica</i>	Rhodesia and Nyasaland	Martin (1958)
<i>Paratylenchus</i> spp.	Venezuela; Puerto Rico	Haddad et al. (1975); this report
<i>Pratylenchus</i> spp.	Colombia, Dominican Republic, Ghana, Trinidad, Jamaica, Brazil, Venezuela	Barriga (1969), Smith & Thames (1969), Ogier & Merry (1970), Addoh (1971), Hutton & Chung (1973), Sharma & Sher (1973), Haddad et al. (1975)
<i>P. brachyurus</i>	Ghana	Addoh (1971)
<i>P. coffeae</i>	Honduras, Puerto Rico, Colombia	Stover & Fielding (1958), Ayala (1969), Barriga (1969)
<i>Peltamigratus</i> sp.	Brazil	Sharma and Sher (1973)
<i>Pseudhalenchus</i> sp.	Puerto Rico	This report
<i>Psilenchus</i> sp.	Venezuela	Haddad et al. (1975)

TABLE—continued

Nematode species	Location	Reference
<i>Quinisulcius curvus</i>	Puerto Rico	This report
<i>Radopholus</i> spp.	Venezuela	Haddad et al. (1975)
<i>R. similis</i>	Honduras, Africa, Puerto Rico, Colombia, Dominican Republic, Jamaica	Stover & Fielding (1958), Luc & Villardebó (1961), Ayala (1969), Barriga (1969), Smith & Thames (1969), Hutton & Chung (1973)
<i>Rotylenchulus</i> spp.	Thailandia & Philippines, Venezuela	Timm (1963), Haddad et al. (1975)
<i>R. reniformis</i>	Puerto Rico, Ghana, Jamaica, Brazil	Ayala (1969), Addoh (1971), Hutton et al. (1973), Sharma & Sher (1973)
<i>Trichodorus</i> sp.	Venezuela	Haddad et al. (1975)
<i>Trophurus</i> sp.	Brazil	Sharma & Sher (1973)
<i>Tylenchorhynchus</i> spp.	Venezuela; Puerto Rico	Haddad et al. (1975); this report
<i>T. triglyphus</i>	Ghana	Addoh (1971)
<i>Tylenchus</i> spp.	Ghana; Puerto Rico	Addoh (1971); this report
<i>T. costatus</i>	Puerto Rico	This report
<i>Xiphinema</i> spp.	Trinidad, Ghana, Brazil; Puerto Rico	Ogier & Merry (1970), Addoh (1971), Sharma & Sher (1973); this report
<i>X. costaricense</i>	Costa Rica	Lamberti & Tarjan (1974)
<i>X. ensiculiferum</i>	Brazil	Sharma & Sher (1973)
<i>X. setariae</i>	Brazil	Sharma & Sher (1973)

the preferred host plants of the burrowing nematode *Radopholus similis*. Other species included in that report were *Rotylenchulus reniformis* Lindford and Oliveira, 1940; *Helicotylenchus dihystra* (Cobb, 1893) Sher, 1961; *H. multicinctus* Cobb, 1893; and *Meloidogyne* sp. In 1973, Román et al. (18) reported that *R. similis* was the causal organism of the black head or toppling disease of plantains in Puerto Rico. According to Román (19), *R. similis* is the most harmful nematode attacking plantains in the Island. In 1973 Román et al. (17) demonstrated that, with the exception of *P. coffeae*, the most important pathogenic nematodes associated with plantains can be controlled by pangola grass (*Digitaria decumbens*) and that rotation of plantains with pangola grass increased plantain yield significantly. Román et al. (20) indicated that relatively good yields are normally obtained the first year, but yields decline so rapidly thereafter that frequently a second crop is not economically feasible. Even though a great deal of nematological research has been conducted in Puerto Rico the nematode fauna associated with plantain production has not been fully determined. Thus, the study reported herein was undertaken to determine the parasitic nematode species

associated with the crop, their distribution and their density. An abstract of this study was published elsewhere (15).

MATERIALS AND METHODS

Two hundred and fifty grams of soil and 100 grams of roots were collected from 92 five- to 10-acre farms from 28 localities within the five agricultural regions of the Island (fig. 1). Each sample consisted of four

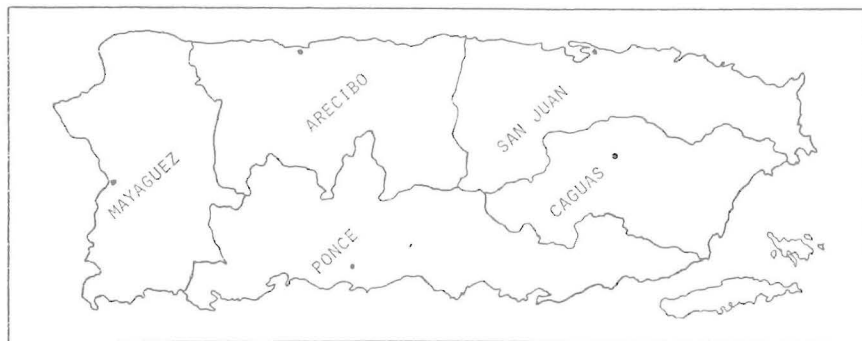


FIG. 1.—Agricultural regions of Puerto Rico.

TABLE 2.—Phytoparasitic nematodes associated with plantains in Puerto Rico

<i>Ditylenchus</i> spp.	<i>Paratylenchus</i> sp.
<i>Helicotylenchus</i> sp.	<i>Pratylenchus coffeae</i>
<i>H. concavus</i>	<i>Pseudhalenchus</i> spp.
<i>H. dysteri</i>	<i>Quinisulcius curvus</i>
<i>H. pseudorobustus</i>	<i>Radopholus similis</i>
<i>H. truncatus</i>	<i>Rotylenchulus reniformis</i>
<i>Hoplolaimus puertoricensis</i>	<i>Tylenchorhynchus</i> spp.
<i>Longidorus</i> sp.	<i>Tylenchus</i> spp.
<i>Meloidogyne incognita</i>	<i>T. costatus</i>
	<i>Xiphinema</i> sp.

subsamples taken at random from August 1976 through April 1978. Soil samples were processed in the laboratory following sieving decanting, Baermann-funnel method. Root samples were comminuted and blended for 15 s and processed with the same method. Nematodes collected were identified and counted under a compound microscope.

RESULTS AND DISCUSSION

Nineteen species of phytoparasitic nematodes, belonging to 14 genera, were found associated with plantains in Puerto Rico (table 2). In addition

to the species mentioned in table 2, members of *Aphelenchoididae*, *Aphelenchidae*, and saprophytic forms were also found around plantain roots. *Meloidogyne incognita*, *Helicotylenchus* spp., *R. similis*, and *R. reniformis* were the most widely distributed species throughout the Island. These were isolated from 100, 92.8, 78.5, and 78.5% of the samples, respectively (table 3). Other well-distributed nematode species were

TABLE 3.—Distribution (percent) of the most important nematodes of plantains in Puerto Rico

Nematode	Distribution
<i>Meloidogyne incognita</i>	100.0
<i>Helicotylenchus</i> spp.	92.8
<i>Radopholus similis</i>	78.5
<i>Rotylenchulus reniformis</i>	78.5
<i>Ditylenchus</i> spp.	57.0
<i>Pratylenchus coffeae</i>	50.0
<i>Tylenchus</i> spp.	46.0
<i>Paratylenchus</i> sp.	32.0
<i>Pseudhalenchus</i> sp.	14.0
<i>Hoplolaimus puertoricensis</i>	10.7
<i>Xiphinema</i> sp.	7.0
<i>Longidorus</i> sp.	7.0
<i>Tylenchorhynchus</i> sp.	7.0
<i>Quinisulcius curvus</i>	3.5

TABLE 4.—Magnitude of population density of nematodes associated with plantains in the five agricultural regions of Puerto Rico

Agricultural region	Nematodes ¹					
	Rad	Mel	Hel	Pra	Roty ²	Para
San Juan	++++	+++	++			+
Arecibo	++	+++	+	++++		
Mayagüez		++++	+++	++	+	
Ponce	+++	++++			++	+ ²
Caguas	++++	++		+	+++	

¹ Rad = *Radopholus*; Mel = *Meloidogyne*; Hel = *Helicotylenchus*; Roty = *Rotylenchulus*; Para = *Paratylenchus*.

² Based on soil samples only.

Ditylenchus spp., *Pratylenchus coffeae*, *Tylenchus* spp, *Paratylenchus* sp., and *Pseudhalenchus* sp. Less common were *Hoplolaimus puertoricensis*, *Xiphinema* sp., *Longidorus* sp., *Tylenchorhynchus* sp., and *Quinisulcius curvus*.

Helicotylenchus spp. were the most predominant. Four species of this genus, namely, *H. dihystra*, *H. pseudorobustus*, *H. truncatus*, and *H.*

concavus, were identified. *H. multicinctus*, an important banana (*Musa acuminata* AAA) pathogen, was not found in any of the fields sampled.

M. incognita, *P. coffeae*, *R. similis*, *Helicotylenchus* spp., and *R. reniformis* had the highest population densities (table 4). A close relationship existed between the previous host planted in a particular field and some of the most numerous nematode species subsequently attacking plantains. *R. similis*, the most important species on plantains, was more numerous in regions where plantains have been grown traditionally, e.g., San Juan and Caguas. In Arecibo, with a large acreage devoted to coffee production, the dominant species was *P. coffeae*. At Ponce and Mayagüez, where sugarcane is the main crop, *M. incognita* was the most numerous nematode (fig. 2).

The highest populations per 100 g of roots for some of the most

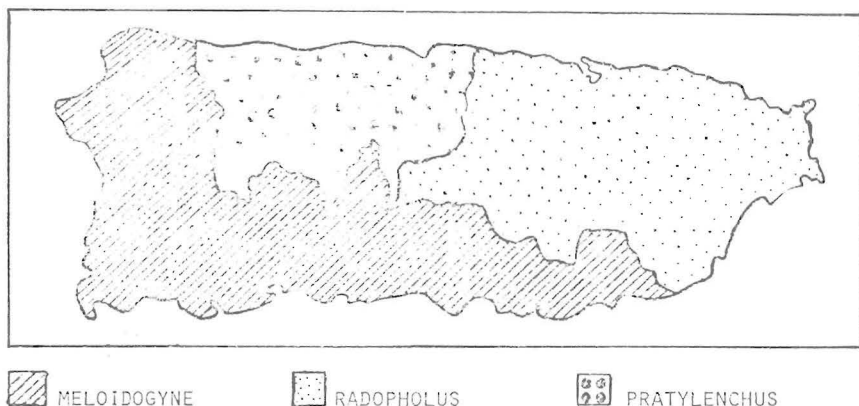


FIG. 2.—Distribution of the most numerous nematodes in plantains in Puerto Rico.

common phytoparasitic nematodes were the following: *P. coffeae*, 70,400; *M. incognita*, 53,000; *R. similis*, 42,880, and *Helicotylenchus* spp., 31,684. High populations of *R. similis* and *P. coffeae* were usually associated with severe root deterioration and poor development of aerial parts. When the two species acted together in the same plant, population densities of *R. similis* were higher in 63.6% of the cases. High nematode population densities were found on farms where nematicides were improperly used or not used at all.

Forty-four percent of the farmers were using nematicides properly, achieving effective nematode control and good yields.

Eight phytoparasitic nematode species not previously reported in association with plantains were isolated: *Ditylenchus* sp., *Helicotylenchus concavus*, *H. pseudorobustus*, *H. truncatus*, *Hoplolaimus puertoricensis*,

Pseudhalenchus sp., *Quinisolcius curvus* and *Tylenchus costatus*. This brings the total number of nematode genera and species associated with the crop to 22.

RESUMEN

Se realizó un estudio de reconocimiento en las cinco regiones agrícolas de Puerto Rico para identificar las especies de nematodos asociados con el plátano, su abundancia y distribución. Se aislaron los siguientes 14 géneros de nematodos fitoparásitos: *Ditylenchus*, *Helicotylenchus*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Paratylenchus*, *Pratylenchus*, *Pseudhalenchus*, *Quinisolcius*, *Radopholus*, *Rotylenchulus*, *Tylenchorhynchus*, *Tylenchus* y *Xiphinema*. Las especies de mayor distribución fueron *Meloidogyne incognita*, *Helicotylenchus* spp., *Radopholus similis* y *Rotylenchulus reniformis*. Los más numerosos fueron *M. incognita*, *P. coffeae*, *R. similis*, *Helicotylenchus* spp., y *R. reniformis*.

LITERATURE CITED

1. Addoh, P. G., 1971. The distribution and economic importance of plant parasitic nematodes in Ghana, *Ghana J. Agri. Sci.* 4: 21-32.
2. Ayala, A., 1969. Nematode problems in Puerto Rican agriculture, In: Proceedings of the Symposium on Tropical Nematology, Ramos, José A. et al. (Eds), Agri. Exp. Stn., Univ. PR.
3. — and Román, J., 1963. Distribution and host range of the burrowing nematode in Puerto Rican soils, *J. Agri. Univ. P.R.* 47(1): 28-37.
4. Barriga Olivares, R., 1969. Nematode problems in Colombia, In: Proceedings of the Symposium on Tropical Nematology, Ramos, José A. et al. (Eds), Agric. Exp. Stn., Univ. P.R.
5. Cobb, N. A., 1893. Nematodes, mostly Australian and Fijian, New South Wales Dep. Agric., Misc. Publ. 13: 252-308.
6. — 1915. *Tylenchus similis*, the cause of a root disease of sugarcane and banana, *J. Agric. Res.* 4: 561-69.
7. Department of Agriculture, 1976. Facts and figures on Puerto Rico's agriculture, Off. Agric. Stat. Econ. Stud. Comm. of Puerto Rico.
8. Hutton, D. G. and Chung, D. C., 1973. Effects of post-planting applications of the nematicide DBCP to plantain, *Nematropica* 3(2): 46-50.
9. Haddad, G. O., Meredith, J. A. y Martínez R., G. J., 1975. Nemátodos parasíticos asociados a cultivares y clones de bananas en Venezuela, *Nematropica* 5(2): 33-39.
10. Lambertí, F. and Tarjan, A. C. 1974. *Xiphinema costaricense* n. sp. (Longidoridae, Nematoda), A new species of dagger nematode from Costa Rica, *Nematología Mediterránea* 2(1): 1-11.
11. Leach, R., 1958. Blackhead-toppling disease of bananas, *Nature*, London 181: 204-05.
12. Luc, M. and Villardebo, A., 1961. Nematodes associés aux bananiers cultivés dans L'ouest Africain, *Fruits* 16(5): 205-219.
13. Martin, G. C. 1958. Root knot nematodes (*Meloidogyne* spp.) in the Federation of Rhodesia and Nyasaland, *Nematologica* 3(4): 332-49.
14. 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(4): 407-12.

15. Oramas, D. and Román, J., 1978. Nemátodos parasíticos asociados con el cultivo del plátano (*Musa acuminata* x *M. balbisiana*, AAB) en Puerto Rico, *Nematrópica* 8(2): 19.
16. Plazas, M., 1951. Una afección de la *Musa paradisiaca* y otras musáceas, *Acta Agron.* 1(3): 33-167.
17. Román, J., Rivas, X. y Rodríguez, T., 1973. El uso de la yerba pangola para el control de los nemátodos del plátano, *Adelanto Científico Núm. 4:1-2*, Esta. Exp. Agri. Univ. P. R.
18. —, 1973. Control de los nemátodos del plátano, *Adelanto Científico Núm. 1: 1-2*, Esta. Exp. Agri. Univ. P. R.
19. —, 1974. Control de los nemátodos del plátano por rotación de la yerba pangola, *Nematrópica* 4(1): 4.
20. —, 1974. Chemical control of the nematodes of plantains, *Nematrópica* 4(1): 5.
21. — and Oramas, D., 1975. The effect of nematicide treatment on yield decline and production of ratoon crops in plantain, *Nematrópica* 5(2): 28.
22. —, 1976. Chemical control of nematodes in plantains (*Musa acuminata* x *M. balbisiana*, AAB), *J. Agri. Univ. P. R.* 60 (1): 36-44.
23. —, 1977. Further experiments on the chemical control of nematodes in plantains (*Musa acuminata* x *balbisiana*, AAB), *J. Agri. Univ. P. R.* 61 (2): 192-199.
24. Sharma, R. D. and Sherd, S.A., 1973. Nematodes associated with banana (*M. paradisiaca* L.) in Bahía, Brazil, *Cienc. Cult.* 25(7): 665-68.
25. Smith, L. R. and Thames, W. H., 1969. Plantains, nematodes, and preliminary crop rotation studies for their control in the Dominican Republic, In: *Proceedings of the Symposium on Tropical Nematology*, Ramos, José A. et al. (Eds), Agri. Exp. Stn. Uni. P. R.
26. Stover, R. H., 1972. Banana, plantain, and abaca diseases, *Comm. Mycol. Inst., Dew, Surrey, England.*
27. — and Fielding, M. J., 1958. Nematode associated with the root injury of *Musa* spp. in Honduran banana soils, *Pl. Dis. Rep.* 42 (8): 938-40.
28. Timm, R. W., 1965. A preliminary survey of the plant parasitic nematodes of Thailand and the Phillipines, Thai Sambhand Printing Press, Bangkok, Thailand.