Plant-parasitic nematodes associated with plantain, *Musa paradisiaca* (AAB), in the Ivory Coast

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SUMMARY

A large scale survey was undertaken, in 1985 and 1986, of plant-parasitic nematodes in the major plantain producing regions of the Ivory Coast. This survey revealed nineteen nematode species belonging to fifteen genera. Thirteen species were associated with plantain for the first time in the Ivory Coast. *Cephalenchus emarginatus, Pratylenchus zeae, Telotylenchus* sp. *and Xiphinema ifacolum* were reported on plantain for the first time in the world. *Helicotylenchus multicinctus, Meloidogyne* spp. and *Radopholus similis* were the most frequent and the most abundant plant-parasitic nematodes. *R. similis* was more prevalent in the traditional plantain producing regions of the South-East than in the more recent plantain areas of the Mid-West. This difference may be due to the presence, in the former orchards, of commercial banana cv. Poyo which is an important source of inoculum of *R. similis.*

RÉSUMÉ

Les nématodes phytoparasites associés au bananier plantain, Musa paradisiaca *(AAB), en Côte d'Ivoire.*

Afin de déterminer la composition de la faune de nématodes phytoparasites associés au bananier plantain, des prospections ont été effectuées, en 1985 et 1986, dans les principales régions productrices de Côte d'Ivoire. Ce travail a mis en évidence la présence de dix-neuf espèces de nématodes appartenant à quinze genres. Treize espèces ont été isolées pour la première fois sur le bananier plantain en Côte d'Ivoire. Cinq d'entre elles, *Cephalenchus emarginatus, Pratylenchus zeae, Telotylenchus* sp. et *Xiphinema ifacolum* ont été observées sur cette plante pour la première fois dans le monde. *Helicotylenchus multicinctus, Meloidogyne* spp. et *Radopholus similis* étaient les espèces les plus fréquentes et les plus abondantes. L'infestation de *R. similis* était plus importante dans les régions traditionnelles de production du Sud-Est que dans les régions récentes de production du Centre-Ouest. Cette situation pourrait s'expliquer par la présence, dans le Sud-Est, des plantations de bananiers cv. Poyo qui sont de véritables sources d'inoculum de *R. similis.*

With an average yield of 1 150 000 T which represents 21 % of the total food crop production (Chataigner, 1979), plantain, *Musa paradisiaca* (AAB), is a major commodity in the Ivory Coast. The use of high yielding cultivars and the production of plantain out of season are being considered in order to supply the increasing demand and to avoid the shortage commonly observed between March and September. Until recently, the South-East was the main plantain producing area (Haeringer, 1979). However, the lack of forest lands in the South-East led to migration of farmers to the West and the Mid-West which are now becoming the new production centers.

Plant-parasitic nematodes are among the most serious pests limiting the production of *Musa* species (Stover, 1972). The few studies dealing with the nematodes associated with plantain in the Ivory Coast remain preliminary (Luc & de Guiran, 1960; Luc & Vilardebó, 1961). Thus, as plantain production systems are improving, it was essential that a new and large scale survey be undertaken to determine the nematode fauna of the crop, and moreover, to assess the infestation of *Radopholus similis,* the most destructive species on *Musa* spp. (Stover, 1972).

Materials and methods

Samples were collected from different types of plantain production system : plantains interplanted with perennial crops, plantains intercropped with other food crops and plantains growing near homesteads. On a given field, composite samples of soil and roots, taken around ten plantain trees, were combined in a polyethylene bag. One hundred and ten fields in the South-East, and 90 in the Mid-West were surveyed in 1985 and 1986 (Fig. 1). Standardized extraction techniques were used for soil (Seinhorst, 1962) and roots (Seinhorst, 1950). For their identification, the nematodes were gently killed by immersion in hot water, then fixed and mounted in glycerin according to Seinhorst's (1959) rapid method.

The importance of each species was determined by its frequency (the number of locations where the species is

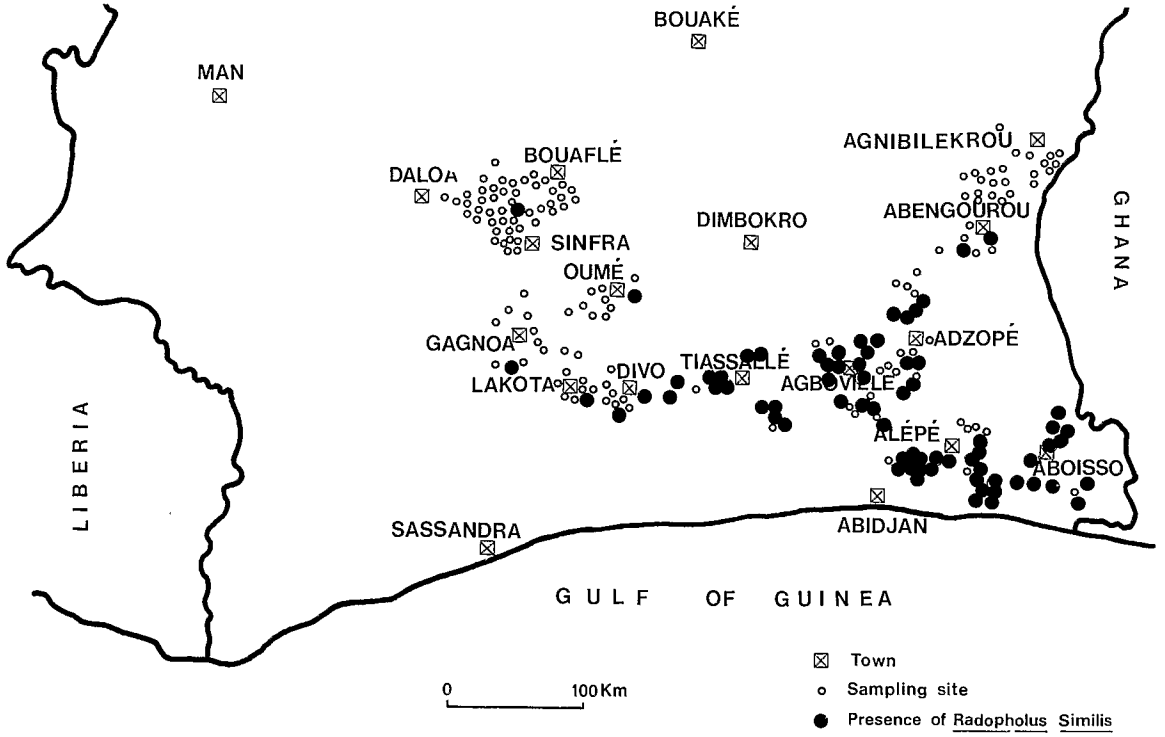

Fig. 1. Map of central and south areas of the Ivory Coast with location of the sampled plantain fields, and indications of the presence of *Radopholus similis*.

found) and abundance (log. average number of the species in the sample) (Fortuner & Merny, 1973). A species was considered frequent when it was present in more than 30 % of the samples. According to Guérout (1972), the threshold of tolerance of banana cv. Poyo to *R. similis* is 1000 individuals per 100 g of roots. We extended this threshold to plaintain and to the other nematodes. Thus, a species was considered abundant when its mean number was greater than 100 individuals per dm^3 of soil (log. 100 = 2) or ten individuals per gram of root (log. 10 = 1).

Results

Nineteen nematode species belonging to fifteen genera were found associated with plaintain (Tab. 1). Based on their frequency and abundance, these nematodes can be classified in three groups (Fig. 2) :

— species frequent and abundant (upper right area of the diagram) : *Helicotylenchus multicinctus, Meloidogyne* spp. and *Radopholus similis;*

— species not frequent and not abundant (lower left area of the diagram) : *Criconemella* sp. and *Scutellonema* sp.;

— species not frequent but abundant (upper left area of the diagram) : *Cephalenchus emarginatus, Ditylenchus* sp., *Hoplolaimus pararobustus, Paratylenchus* sp., *Pratylenchus* spp., *Rotylenchulus reniformis, Telotylenchus* sp., *Tylenchorhynchus* sp. and *Xiphinema* spp.

With the exception of *Scutellonema* and *Xiphinema* found only in the South-East, and *Ditylenchus* and *Telotylenchus* present in the Mid-West, all the other nematode genera occurred in both areas. In general, the populations of endoparasitic nematodes were greater in the rhizosphere than in the roots; only *H. multicinctus* and *Rotylenchus reniformis* were found in large number in the soil as well as in the roots (Tab. 1). Unlike *H. multicinctus* and *Meloidogyne* spp. which were frequently encountered (in more than 90 % of the fields sampled) both in the South-East and the Mid-West, *R. similis* was more prevalent in the former region (52 %) than in the latter (9 %) (Tab. 2; Fig. 1).

Discussion

To the exception of *Helicotylenchus dihystera, Pratylenchus zeae, Scutellonema* sp., *Telotylenchus* sp., *Xiphinema hygrophilum* and *X. ifacolum,* all the nematodes herein reported on plantain, have been isolated on banana cv. Poyo in the Ivory Coast (Luc & de Guiran, 1960; Luc & Vilardebó, 1961; Fargette & Quénéhervé, 1988). *Helicotylenchus multicinctus, Meloidogyne* spp.

Table 1

Species of nematodes associated with plantain in the Ivory Coast

* : new record on plantain in the Ivory Coast,
** : new record on plantain in the world.

1. *Aulosphora*
   A. oostenbrinki (Luc, 1958) Siddiqi, 1980
2. *Cephalenchus*
   C. emarginatus (Cobb, 1893) Geraert, 1962**
3. *Criconemella* sp.
4. *Ditylenchus* sp*
5. *Helicotylenchus*
   H. dihystera (Cobb, 1893) Sher, 1961**
   H. multicinctus (Cobb, 1893) Golden, 1956
6. *Hoplolaimus*
   H. pararobustus (Sch. Stek. & Teun., 1938) Sher, 1963
7. *Meloidogyne* spp.
8. *Paratylenchus* sp.*
9. *Pratylenchus*
   P. brachyurus (Godfrey, 1929) Filipjev & Sch. Stek., 1941*
   P. coffeae (Zimmerman, 1898) Filipjev & Sch. Stek., 1941*
   P. zeae Graham, 1951**
10. *Radopholus*
    R. similis (Cobb, 1893) Thorne, 1949
11. *Rotylenchulus*
    R. reniformis Linford & Olivera, 1940*.
12. *Scutellonema* sp.*
13. *Telotylenchus* sp.**
14. *Tylenchorhynchus* sp.*
15. *Xiphinema*
    X. hygrophilum Southey & Luc, 1973
    X. ifacolum Luc, 1961**

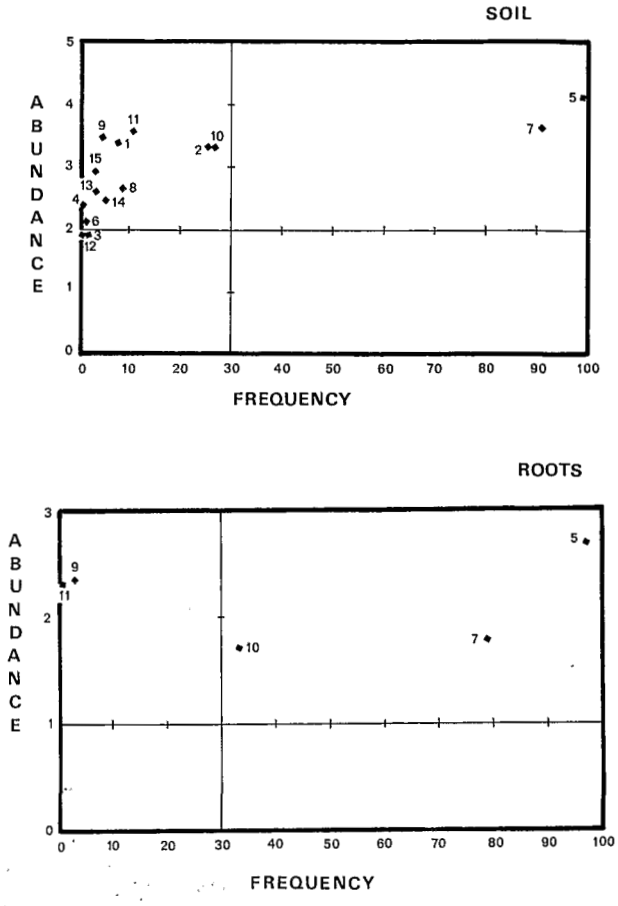

Fig. 2 : Occurrence frequency and abundance indexes of nematode species associated with plantain in the Ivory Coast.

(The figures designating nematode species are those reported in Table 1. *Helicotylenchus dihystera*, present in very few number, in one sample only, is not represented in the diagrams).

and *Radopholus similis*, the most frequent and abundant species, represent the major plant-parasitic nematodes of the plantain crop. In fact, these nematodes are universal parasites of *Musa* species (Blake, 1972; Stover, 1972). Experimental evidence indicates that *H. multicinctus* and *Meloidogyne* spp. cause serious yield decline of plantain (Caveness & Badra, 1980; Badra & Caveness, 1983). On banana these two nematodes appear to be of little economic importance (Stover, 1972).

Spiral nematodes, *Helicotylenchus* spp., are reported damaging only on banana growing in subtropical regions where conditions are marginal for optimum production (Stover, 1972; McSorley & Parrado, 1986). So, the decline of banana plantations in the Jordan Valley of Israel due to *H. multicinctus* (Minz, Ziv & Strich-Harari, 1960) is referred to as exceptional.

The burrowing nematode, *Radopholus similis*, is well established as the major cause of yield loss on both plantain and banana (Stover, 1972; Roman *et al.*, 1976; Vilardebó, 1984). The AAB horn and french groups are considered less susceptible than the cavendish group (AAA) to *R. similis* (Luc & Vilardebó, 1961; Stover & Buddenhagen, 1976). The importance of burrowing nematode infestation in the South-East could be due to the vicinity of commercial banana orchards on which *R. similis* is one of the most abundant nematodes (Fargette & Quénéhervé, 1988). It is not rate to see farmers grow a few banana cv. Poyo along with plantain in the same field for their own consumption. Infestation of plantain could have resulted from this common practice. The subsequent movement and use of infested planting material may also have facilitated the dissemination of the parasite in the entire South-East. In the Mid-West however far away from intensive banana plantations, plantains are established on newly cleared forest sites free from *R. similis*. Nevertheless, in the absence of sanitary measures such as use of clean planting material and clean land programs, *R. similis* and other major nematodes will be distributed in the new production

Table 2

Average density of nematode species associated with plantain in the Ivory Coast

	South-East			Mid-West		
	In soil No/dm³	*In roots* No/gr.	*% of infested fields*	*In soil* No/dm³	*In roots* No/gr.	*% of infested fields*
Aulosphora oostenbrinki	3 700	—	8	213	—	7
Cephalenchus emarginatus	2 122	trace	43	2 144	trace	6
Criconemella sp.	80	—	1	80	—	1
Ditylenchus sp.	—	—	—	260	—	2
Helicotylenchus multicinctus	11 183	472	99	15 175	493	99
Helicotylenchus dihystera	trace	—	—	—	—	—
Hoplolaimus pararobustus	133	trace	3	—	trace	1
Meloidogyne spp.	4 673	73	93	2 332	50	98
Paratylenchus sp.	229	—	12	1 280	—	4
Pratylenchus spp.	3 740	22	7	80	—	2
Radopholus similis	2 127	56	52	960	12	9
Rotylenchulus reniformis	3 863	205	16	2 027	—	3
Scutellonema sp.	80	—	1	—	—	—
Telotylenchus sp.	—	—	—	823	42	8
Tylenchorhynchus sp.	312	—	8	80	—	1
Xiphinema spp.	389	—	6	—	—	—

centers. The hypothesis of the spread of *R. similis* from bananas to plantains could be substantiated by the origin and the dissemination of the parasite and its host, *Musa* spp. *R. similis*, indigenous to Australia and New Zealand, was spread throughout the world by the banana industry (Blake, 1972). Since old plantain cultivars in the forest regions of the Gulf of Guinea are considered indigenous to the region (Champion, 1967), one could assume that these old cultivars were free from, *R. similis* before the recent introduction of the cavendish group (AAA) in Africa. The presence of *Criconemella* sp. and *Scutellonema* sp. which occur sporadically and rarely in plantain rhizosphere could be considered accidental.

Of the nematodes which are abundant but not widespread only *Pratylenchus*, in particular *P. coffeae*, appears as a serious parasite of plantains (Wehunt & Edwards, 1968; Ogier & Merry, 1970; Stover, 1972; Pinochet, 1978). *P. coffeae* which is reported on plantain for the first time in the Ivory Coast was observed exclusively in Aboisso. The confinement of the parasite to that region supports the theory of its entry in the country from Ghana where it had been isolated earlier (Addoh, 1970; Fargette & Quénéhervé, 1988). Data show that *Rotylenchulus reniformis* can cause severe rotting in the feeder roots of banana (Edmunds, 1968; 1971). In the light of its relative abundance in the samples, the reniform nematode is likely to be a threat to plantains as well. In fact, *Meloidogyne* spp. and *R. reniformis* could have been found in larger numbers on plantain. Edmunds (1968) observed that these two nematodes, especially the latter, occur mainly in the secondary and tertiary roots of banana. Since the nematodes were extracted regardless of plantain root types, the primary roots which were predominant biased the results. Thus, the importance of *Meloidogyne* spp. and *Rotylenchulus reniformis* in plantains fields is underestimated.

Most of the plantains, with the exception of those planted near the homesteads, showed poor vegetative growth. Nematode infestations could not, alone, account for that poor growth. The lack of cultural care constitutes an important limiting factor. Indeed, plantains grown in association with coffee- or coconut-trees provide shade to the young coffee-or coconut-trees and receive no particular care. They are cut down as the canopy of the perennial crop is closing. In the case of plantains intercropped with other food crops, the former are abandoned after the harvest of the latter. On the other hand, the good growth of plantains planted according to the compound production system is mainly due to the continuous supply of manure from household organic refuse. Soils supplemented with organic matter have excellent texture, and good water holding capacity. In such organic soils, plants are more competitive. Furthermore, the decomposition of organic matter results in the release of compounds such as acetic, propionic and butyric acids which are toxic to some plant-parasitic nematodes (Dropkin, 1980).

Helicotylenchus multicinctus was found in greater number than *R. similis* on plantain growing near the

homesteads, was also observed by Quénéhervé (1988) on banana cv. Poyo growing in organic soil. *R. similis* may be more affected than *H. multicinctus* by the breakdown products of organic matter. That relative decline of *R. similis* in organic soil may be another cause of the good vegetative growth of plantains planted near homesteads.

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