DIFFERENCES IN PATHOGENICITY TO BANANA (*MUSA* SP., CV. POYO) AMONG ISOLATES OF *RADOPHOLUS SIMILIS* FROM DIFFERENT PRODUCTION AREAS OF THE WORLD

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ABSTRACT

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The pathogenicity to banana of six isolates of *Radopholus similis*, collected in different banana production areas, was tested in pots under controlled conditions in a climatic chamber. Nematodes that had been reared monoxenically on carrot discs were inoculated to banana plantlets (AAA, cv. Poyo) produced through *in vitro* micropropagation. Isolates from Sri Lanka and Martinique had no significant effect on plant growth whereas isolates from Guadeloupe, Costa Rica, Kenya, and Ivory Coast significantly suppressed growth. The isolate from Ivory Coast was the most pathogenic. These results confirm the existence of large biological variability among geographically separated populations of *R. similis*.

Key words: biological variability, *Musa* sp., pathogenicity, *Radopholus similis*.

RESUMEN

Sarah, J. L., C. Sabatini y M. Boisseau. 1993. Diferencias de patogenicidad en banano (*Musa* sp., cv. Poyo) entre poblaciones de *R. similis* provenientes de diferentes zonas de producción del mundo. Nematrópica 23:75–79.

Seis poblaciones de *Radopholus similis* fueron comparadas por su patogenicidad en banano bajo condiciones controladas en cámaras climáticas. Nematodos obtenidos a partir de cultivos monoxénicos en discos de zanahorias fueron inoculados sobre plántulas de banano (AAA, cv. Poyo) obtenidas por micropropagación *in vitro*. Las poblaciones de Sri Lanka y Martinica no mostraron ningún efecto sobre el crecimiento de las plántulas. En cambio, las poblaciones de Guadalupe, Costa Rica, Kenia y Costa de Marfil redujeron significativamente el crecimiento de las plántulas, siendo la población de Costa de Marfil la más patógena. Esto confirma una marcada variabilidad biológica entre poblaciones de *R. similis*.

Palabras clave: Musa sp., patogenicidad, *Radopholus similis*, variabilidad biológica.

INTRODUCTION

Intraspecific variability of nematodes has mainly been studied for sedentary endoparasites (3), while very few studies have dealt with migratory endoparasites. Among the latter however, *Radopholus similis* Cobb has been studied extensively. Existence of a citrus race was reported in the 1950's (4) but this race was later described as a sibling species, *R. citrophilus* Huettel, Dickson & Kaplan (6). On banana, variability in the pathogenicity of *R. similis* was reported among isolates from Latin America and Carribbean islands (5, 8,9,10,13).

Worldwide assessment of this variability would be highly useful to banana breeding programs for incorporating resistance to nematodes (10). As a first step in this assessment, we conducted a study of the pathogenicity to banana of six isolates of *R. similis* from Africa, Asia, Central America and the Caribbean.

These preliminary studies are being complemented, through international collaboration particularly with the AFRC-

CABI 'Research Group on Tropical Nematodes,' by a systematic screening of isolates from many parts of the world, associated with studies on biology, morphology, enzyme and DNA characteristics.

MATERIALS AND METHODS

Six isolates of *R. similis* (Table 1), all collected on *Musa* sp. cultivars, were received between 1989 and 1991 and maintained monoxenically on carrot discs (7) at 26 °C. Banana plants (AAA, Cavendish, cv. Poyo) were produced through *in vitro* micropropagation (14).

Two experiments were conducted in a climatic chamber (27 °C, 75% relative humidity, 12-hr/12-hr photoperiod). After a 3-week (second experiment) or 4-week (first experiment) period of adaptation to ambient conditions within the climatic chamber, banana plantlets were transplanted into pots containing 800 cm^3 of sterilized mould (ready made substrate containing peat and pozzolane, pH 5.8–6.3). Plantlets were inoculated with *R. similis* 3 weeks after transplanting in the first experiment and 2 weeks after transplanting in the second experiment. Inoculum consisted of a mixture of adults and juveniles in an aqueous suspension applied at the rate of 300 (first experiment) or 200 (second experiment) nematodes per plantlet.

In the first experiment (April–August 1991), four isolates collected in Costa Rica, Guadeloupe, Martinique, and Ivory Coast were studied. Eight replications were inoculated and plants were arranged in a completely randomized design.

In the second experiment (January-May 1992), the four isolates examined in the first experiment and two others (one from Sri Lanka and one from Kenya) were compared. Non-inoculated plants were also included. Eight replications of plants were arranged in a randomized complete block design, with the plants in each block uniform in size.

In both experiments, plant heights, and fresh shoot and root weights were recorded 8 weeks after inoculation. Nematodes were extracted from roots by a centrifugal-flotation technique (1) and counted.

Nematode counts were transformed to $\log_{10}(X + 1)$ before analysis of variance. Means were separated using the Newman and Keuls multiple range test (2).

Table 1. General information on the origin of six isolates of *Radopholus similis* tested on banana (*Musa* AAA cv. Poyo).

Geographical origin			
Country	Locality	Host	Source[z]
Sri Lanka	Hantane	*Musa* sp.	CABI-IIP
Martinique	Rivière-Lézarde	*Musa* AAA cv. Grande Naine	CIRAD-FLHOR
Kenya	Ogembo, Oyugis	*Musa* AAA cv. Kivuvu	CABI-IIP
Guadeloupe	Neufchâteau	*Musa* AAA cv. Poyo	CIRAD-FLHOR
Costa Rica	Talamanca	*Musa* AAA cv. Valery	IRTA
Ivory Coast	Anguédédou	*Musa* AAA cv. Poyo	CIRAD-FLHOR

[z]CABI-IIP = Commonwealth Agricultural Bureau International - International Institute of Parasitology; CIRAD-FLHOR = Centre de Coopération Internationale en Recherche Agronomique pour le Développement - Département des Productions Fruitières et Horticoles; IRTA = Institut de Recerca i Tecnologia Agroalimentàries.

Table 2. Reproduction of six isolates of *Radopholus similis* in roots of banana cv. Poyo 8 weeks after inoculation with 300 nematodes per plant in the first experiment and 200 nematodes per plant in the second.

	Final population per plant		Nematodes per gram of root	
Isolate origin	First experiment	Second experiment	First experiment	Second experiment
Sri Lanka	—	23 200 ab	—	1 700 b
Martinique	23 500 a	47 500 a	1 930 a	4 960 a
Kenya	—	46 500 a	—	6 170 a
Guadeloupe	26 700 a	29 400 ab	2 950 a	4 930 a
Costa Rica	21 900 a	34 800 ab	2 770 a	5 280 a
Ivory Coast	26 900 a	18 400 b	3 360 a	5 000 a

Data are arithmetic means of eight replications. Original data are presented, but data were transformed to $\log_{10}$ (X + 1) for variance analysis. Means in the same columns followed by the same letter do not differ according to Newman and Keuls multiple range test ($P \leq 0.05$).

RESULTS AND DISCUSSION

The first experiment did not show any significant differences among isolates in the total number or density of nematodes in roots (Table 2). In the second experiment, however, the isolates from Martinique and Kenya had significantly higher total numbers of nematodes in roots than the isolate from Ivory Coast, while the three other isolates were intermediate (Table 2). The isolate from Sri Lanka had significantly less nematodes per gram of root than the five other isolates.

Differences in root and shoot growth in the second experiment (Table 3) were generally consistent with those observed in the first experiment. Plants inoculated with the isolate from Ivory Coast had the lowest root and shoot weights; plants inoculated with the isolate from Martinique had the highest; and those inoculated with the isolates from Guadeloupe and Costa Rica were intermediate. Of the two isolates which were tested only in the second experiment, the isolate from Sri Lanka, like the isolate from Martinique, had very low pathogenicity with root and shoot

Table 3. Effects of six isolates of *Radopholus similis* on plant growth of banana cv. Poyo 8 weeks after inoculation with 300 nematodes per plant in the first experiment and 200 nematodes per plant in the second.

	Fresh shoot weight (g)		Fresh root weight (g)	
Isolate origin	First experiment	Second experiment	First experiment	Second experiment
Control	—	56.0 a	—	12.0 a
Sri Lanka	—	51.7 a	—	13.3 a
Martinique	67.0 a	49.8 a	10.2 a	9.7 ab
Kenya	—	29.7 b	—	7.3 b
Guadeloupe	52.2 b	28.8 b	6.7 ab	6.1 bc
Costa Rica	45.8 b	26.8 bc	7.7 ab	6.3 bc
Ivory Coast	34.8 c	19.7 c	5.2 b	3.4 c

Data are arithmetic means of eight replications. Means in the same columns followed by the same letter do not differ according to Newman and Keuls multiple range test ($P \leq 0.05$).

growth not different significantly from non-inoculated plants. The isolate from Kenya affected root and shoot growth similarly to isolates from Guadeloupe and Costa Rica.

The pathogenicity of a nematode to plants may result from two main factors: 1) the reproduction rate, and 2) the intrinsic ability of a given number of nematodes to induce physiological alterations (*e.g.* necrosis). Previous studies in our laboratory have shown that the *R. similis* isolate from Ivory Coast always developed more quickly in banana roots than the isolate from Guadeloupe (12). Studies in Central America also showed that differences in pathogenicity of *R. similis* to banana were related to differences in the rate of nematode population increase within plant tissues (9,13). In the experiments reported here, the dynamics of nematode population increase were not examined as only one observation was made 8 weeks after inoculation. There was no apparent correlation between pathogenicity and the final nematode population because nematode multiplication interacted with root destruction. However, differences in pathogenicity may be interpreted primarily as differences in multiplication rate within banana roots. In the first experiment, in which plants were inoculated 3 weeks after transplanting, there were no significant differences in the final population between the Ivory Coast isolate and the three other isolates. In the second experiment, where plants were younger and smaller when inoculated, a low final population of the Ivory Coast isolate was observed, associated with extensive root destruction. These observations linked with the previous studies on reproduction rate of this isolate (12) lead to the interpretation that the rapid multiplication early during the experiment induced a quick destruction of the limited amount of roots. Therefore, the destruction of host tissue did not allow a high level of nematode numbers to be maintained. In contrast, the absence of detectable root destruction by the isolates from Sri Lanka and Martinique may be interpreted mainly as a result of a slow nematode population increase. In addition, the final population of the latter isolates resulted directly from their multiplication rate since the amount of root tissue was not an important limiting factor for nematode population increase.

In conclusion, the isolates of *R. similis* studied were highly variable in pathogenicity to banana plants. The lowest level of pathogenicity was observed with the isolates from Martinique and Sri Lanka, the latter having the slower rate of multiplication in plant tissue. The four other isolates were more pathogenic, the isolate from Ivory Coast being the most pathogenic. This variability may be due to divergent evolution of populations under different environmental conditions. Variability observed under controlled conditions could partly explain differences in damage caused in the field (9). For instance, the relatively high level of pathogenicity we observed for the isolate from Ivory Coast is consistent with the severe damage reported in Ivory Coast (11).

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