DAMAGE TO ROOTS OF *MUSA* CULTIVARS BY *RADOPHOLUS SIMILIS* WITH AND WITHOUT PROTECTION OF NEMATICIDES

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ABSTRACT

Fogain, R., and S. R. Gowen. 1997. Damage to roots of *Musa* cultivars by *Radopholus similis* with and without protection of nematicides. Nematropica 27:27-32.

Damage to root systems of five *Musa* cultivars caused by *Radopholus similis* was assessed over two crop cycles. In addition, a comparison was made of the response to two nematicide treatments made during the first cycle, 3 and 6 months after planting. The cultivars differed in their degree of susceptibility. Population levels of *R. similis* were higher on untreated susceptible cultivars than on treated ones. Nematode population densities did not differ among nematicide treatments for the resistant cultivar (Yangambi km5). Population levels from the untreated resistant cultivar were significantly lower than populations from treated susceptible cultivars. The root systems of susceptible *Musa* clones were severely damaged by *R. similis*. On the selected sucker for the second crop, 85% of the entire root system of susceptible cultivars was necrotic, compared to only 5% on the resistant Yangambi km5. The use of nematicide significantly increased the health (more functional roots, less corm damage) of the susceptible cultivars, but this treatment produced no apparent improvement to the health of the root system of the nematode resistant cultivar Yangambi km5.

Key words: bananas, chemical control, nematodes, plantains.

RESUMEN

Fogain, R. y S. R. Gowen. Susceptibilidad de las variedades de Musa al *Radopholus similis*, con y sin la protección de nematicidas. Nematrópica 27:27-32.

El daño causado por *Radophilus similis*, al sistema radícal de cinco variedades de *Musa*, fue estimado durante dos ciclos de cultivo. Además se realizó una comparación de la respuesta a dos tratamientos con nematicida, aplicados durante el primer ciclo a los 3 y 6 meses después de la siembra. Las variedades se diferenciaron significativamente en su grado de susceptibilidad. Los niveles de población de *R. similis* fueron significativamente mayores en las variedades susceptibles no tratadas, en comparación con las tratadas. No se observaron diferencias en las poblaciones de nematodos encontradas en la variedad resistente Yangambi km5 con o sin tratamiento. Los niveles de población en el cultivo resistente no tratado, fueron significativamente menores que las poblaciones encontradas en cultivos susceptibles no tratados. Las observaciones del sistema de raíces en los clones susceptibles de *Musa*, indicaron un daño severo del mismo causado por *R. similis*. En el chupón seleccionado para el segundo cultivo, el 85% de las raíces no eran funcionales (necrosis) en las variedades susceptibles, comparado con solo un 5% de afectación observado en la variedad resistente Yangambi km5. El uso del nematicida incremento significativamente la salud (funcionamiento, no daño de los bulbos) de las raíces en las variedades susceptibles.

Palabras claves: Banana, nematodos, plátano.

INTRODUCTION

Nematodes are major pests of *Musa* cultivars worldwide. They are ranked as the first major constraint of banana production in the Caribbean and as the second constraint after black Sigatoka (*Mycosphaerella fijiensis* Morelet) in West Africa and Latin America (Persley and De Langhe, 1987; Pinochet, 1992). However, their real impact on plantains and many cooking bananas grown for local consumption has never been clearly studied (Persley and De Langhe, 1987). Among the species of nematodes that attack bananas and plantains in Cameroon, the burrowing nematode *Radopholus similis* Cobb is one of the most important (Bridge *et al.*, 1995; Fogain, 1994).

In many parts of the world, nematicide applications have resulted in significant increase in yield of banana. Reports are common of greater than 50% increases in yield of the dessert Cavendish cultivars with the use of nematicides (Gowen and Queneherve, 1990; Sarah, 1989). Similar results were observed in Cameroon (Fogain *et al.*, 1996). Studies on the effect of nematodes on bananas and plantains have focussed mainly on yield reduction. Very little information is available on the extent of root damage caused by this group of pests. This field-based study was conducted to evaluate the level of damage caused by *R. similis* on several *Musa* cultivars with different levels of susceptibility, with and without nematicides, by measuring the root health and the root biomass.

MATERIALS AND METHODS

The study was conducted in Njombé, Cameroon at a site 80 m above sea level on a free draining soil of volcanic origin with annual rainfall of 2 400 mm. The previous crop on this land was the Cavendish cultivar Grande Naine. Five cultivars representing different triploid subgroups (*Musa*, AAA, AAB and ABB) were selected based on their level of susceptibility to *R. similis*. The susceptible cultivars used were: Grande Naine (Cavendish, AAA), French Sombre (Plantain, AAB), Banane Cochon (Lujugira, AAA) and Christine (Monthan, ABB). Cultivar Yangambi km5 (Ibota, AAA) was used as a resistant cultivar (Price, 1994). The planting materials originated from the *Musa* germplasm collection of CRBP (Njombe).

Before planting, the suckers were peeled to remove soil and superficial lesions and disinfected using hot water treatment (55°C for 20 min) (Blake, 1969). The experimental design was a split plot with three replicates. The main plots (cultivars) were split into treated and untreated plots. Each sub-plot had 10 plants. The nematicide used was cadusaphos (Rugby 10 G) which is one of the nematicides most widely used by large scale banana growers in Cameroon. Two nematicide applications were made 3 and 6 months after planting (2.0 g a.i./plant) sprinkled in an area of about 1 m^2 around the growing plants.

Root samples were collected from five plants in each sub-plot 6 and 10 months after planting. Roots were taken to a depth of 20-30 cm from an area 20 × 20 cm adjacent to the plant. All roots exposed when the soil was dug were collected and roots from the five plants from the same sub-plot were pooled in the same bag to make one sample.

At harvest of the first crop, two plants per treatment of the same size (girth measured at 10 cm above the collar) were excavated in each plot. The corms of these plants were washed to remove adhering soil and various observations were made on the mother plant and the follower (selected sucker for the next crop). The total root mass and the percentage of root axes with length greater than 50 cm

(PRA50) per plant were used as root biomass descriptors. The percentage of functional roots (PFR) was estimated from the percentage of root length without necrosis. Corms were peeled and the intensity of necrosis was determined using a 0-4 corm lesion index (CLI) (Pinochet, 1988) in which 0 indicates no lesions and 4 if >25% of the surface is lesioned.

Nematodes were extracted from 25 g aliquots of roots when damage was detected. Roots were macerated in a blender followed by direct sieving using a set of nested sieves of different apertures (250, 125, 80, 50, 32 µm). Nematodes were collected from the two sieves with the smallest aperture.

For statistical analysis, log transformation was applied for nematode populations while the PFR and PRA50 were square-root transformed before analysis of variance was performed. The statistical package used was SYSTAT. The standard error of the difference between any two means (SED) is used to show the significant differences.

RESULTS

Differences occurred between cultivars in their levels of susceptibility to *R. similis* (Fig. 1). Population densities 10 months after planting were as high as 2 000 per 100 grams of roots for Yangambi km5, and between 60 000 and 160 000 for the other cultivars. On some susceptible cultivars, a reduction ($P \leq 0.05$) in nematode population densities was found between treated and untreated plants. There was no significant difference in the population levels of *R. similis* between treated and untreated

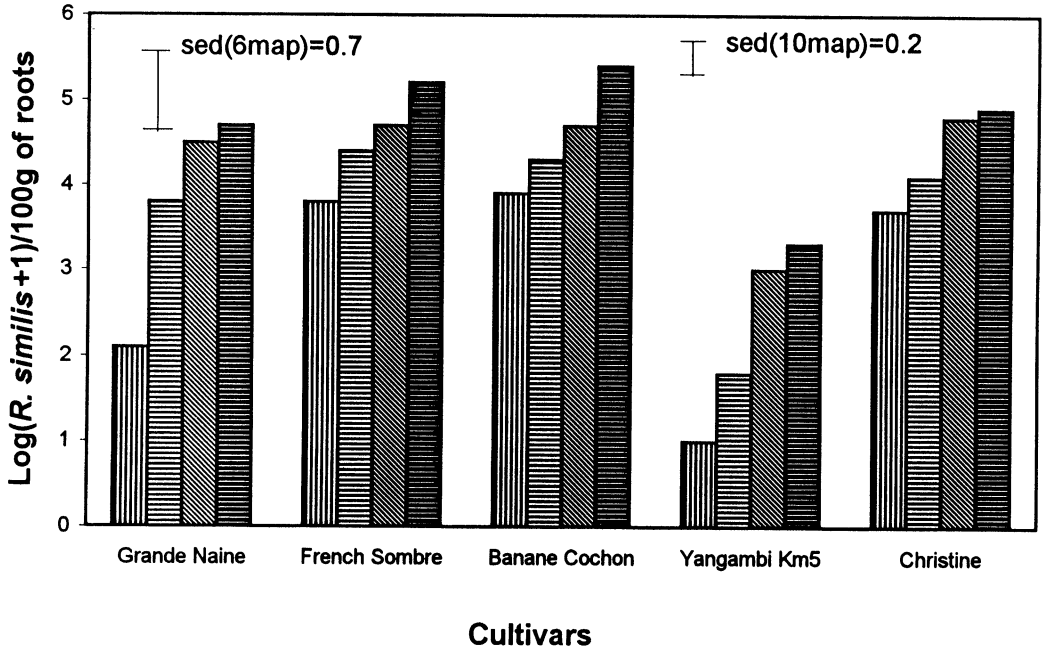

Fig. 1. Nematicide (T = treated, NT = untreated) and host effects on *Radopholus similis* population densities on *Musa* cultivars, 6 and 10 months after planting (map) in nematode-infested field conditions. SED = standard error of difference between means. Symbols within bars: vertical lines = T6map; horizontal lines = NT6map; lines rising left = T10map; and horizontal bars = NT10map.

Table 1. Effect of *Radopholus similis* on the root biomass of *Musa* cultivars grown in a nematode-infested field with and without nematicide treatment.

Cultivars	Nematicide	PRA50[v] 1Y[x]	Root mass (g) 1Y	Root mass (g) 2Y
Grande Naine	NT[y]	6.2(2.4)[z]	271.9	265.9
	T	11.5 (3.4)	460.7	414.5
French Sombre	NT	16.4 (4.0)	550.3	185.3
	T	21.8 (4.6)	757.0	335.6
Banane Cochon	NT	6.0 (2.4)	187.6	159.2
	T	14.3 (3.7)	339.7	317.1
Christine	NT	10.7 (3.2)	502.7	488.6
	T	15.2 (3.9)	633.3	564.6
Yangambi km5	NT	21.6 (4.6)	694.1	741.3
	T	22.2 (4.7)	696.8	740.6
S.E.D. (N = 3)		(0.50)	114.8	107.7

[v]PRA50 = percentage of roots axes with length greater than 50 cm.
[x]1Y = first crop, 2Y = selected sucker.
[y]NT = no nematicide, T = treated with nematicide.
[z]( ) square root transformed data.

plants of Yangambi km5. Nematode population densities from susceptible cultivars treated with the nematicide were significantly higher than populations from the untreated Yangambi km5.

Root mass recovered on the mother plant and the selected sucker varied ($P \leq 0.05$) between cultivars (Table 1). The resistant cultivar (Yangambi km5) had the highest root mass among cultivars untreated by nematicide. On susceptible cultivars, the use of nematicide increased ($P \leq 0.05$) the root mass both on the mother plant and the follower. In contrast, no difference in root mass was found between untreated and treated Yangambi km5. The cultivars also differed significantly in terms of the PRA50. At harvest of the first crop, 21.6% of the roots produced by untreated Yangambi Km5 measured at least 50cm in length. On susceptible cultivars, the PRA50 varied between 6.0 and 16.4%. The nematicide application increased the PRA50 on susceptible cultivars but not on Yangambi km5.

Root systems of the untreated susceptible cultivars exhibited severe damage (PFR) both on the mother plant and the follower (Table 2). At harvest of the first crop, the resistant Yangambi km5 showed between 0 and 5% of its root system damaged by nematodes while susceptible cultivars had in some cases (Banane Cochon) more than 90% of their roots damaged by *R. similis*. The same trend was observed on the follower. An increase in the percentage of functional roots on susceptible cultivars due to the use of nematicide was observed both on the mother plant and on the follower. Corm damage was also higher on susceptible cultivars than on Yangambi km5 (Table 2). The CLI for susceptible cultivars was consistently lower in plants treated with nematicide. Damage level on

Table 2. Nematicide and host effects on the level of damage caused by *Radopholus similis* on *Musa* cultivars.

Cultivars	Nematicide	PFR[x] 1Y	PFR 2Y	CLI[y] 1Y	CLI 2Y
Grande Naine	NT[z]	16.2 (4.0)	21.4 (4.6)	3.3	3.0
	T	22.8 (4.7)	36.5 (6.0)	1.6	2.3
French Sombre	NT	16.7 (4.1)	14.9 (3.8)	2.3	1.3
	T	24.0 (4.8)	35.8 (5.9)	1.3	1.0
Banane Cochon	NT	7.8 (2.8)	13.3 (3.6)	3.0	3.3
	T	27.7 (5.2)	46.3 (6.8)	2.3	1.0
Christine	NT	45.4 (6.7)	32.4 (5.7)	3.0	1.3
	T	66.4 (8.1)	50.6 (7.1)	2.6	1.0
Yangambi km5	NT	93.5 (9.6)	96.6 (9.8)	1.0	1.0
	T	97.9 (9.9)	97.7 (9.8)	1.0	1.0
S.E.D. (N = 3)		(0.61)	(1.00)	0.63	0.43

[x]PFR = percentage of root length functional (without necrosis).
[y]CLI = corm lesion index.
[z]NT = no nematicide T = with nematicide.

the corm was higher on the mother plant than on the follower.

DISCUSSION

The use of nematicides is a common practice where it is necessary to maintain productivity in commercially managed banana plantations. This work demonstrates how nematicides can increase root mass and length in infected nematode-susceptible cultivars and thus improve the functional quality of nematode infected root systems.

Most workers who have studied the effect of nematodes on bananas and plantains have measured yield and nematode populations in roots. This study clearly shows that yield decline is a consequence of a rapid and severe destruction of the root system by nematodes. Although nematodes have been reported to be one of the causes of the rapid yield decline of plantains (Swennen *et al.*, 1988; Wilson, 1987) little evidence of the extent of root damage caused by the nematodes has been available. This study also confirms the variability in susceptibility to nematodes within triploid *Musa* (Price, 1994; Wehunt *et al.*, 1978). A high level of resistance of Yangambi km5 to *R. similis* was demonstrated and the use of nematicides on this cultivar appears to be unnecessary because no significant difference was detected between treated and untreated plants with regard to root mass, PRA50, PFR and CLI, both on the mother plant and the sucker.

Our findings also demonstrate that resistant/tolerant cultivars can be a commercially acceptable means of managing nematodes. Two applications of nematicide on susceptible cultivars did not provide the same level of control of *R. similis* as did the use of the resistant cultivar Yangambi km5.

ACKNOWLEDGMENTS

The authors wish to express thanks to M. M. Ndoumbe Nkeng, biometrician at IRAD (Institut de la Recherche Agro-

nomique pour le Développement), Nkolbisson, Yaoundé. The second author appreciates the support of the UK Department for International Development (formerly ODA) through the Natural Resources Institute projects A0205/A0468 and EU project TS3-CT92-0104.

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Received: *2.XII.1996*

Recivido:

Accepted for publication: *7.VI.1997*

Aceptado para publicación: