Host plant response of Pisang Jari Buaya and Mysore bananas to *Radopholus similis*

Duong Thi Minh Nguyet, A. Elsen, Nguyen Thi Tuyet and D. De Waele

Plant parasitic nematodes are a major constraint of banana production worldwide (Gowen and Quénéhervé 1990). Nematode infection can interfere with nutrient and water uptake and transportation, resulting in slow growth, reduced fruit filling and sensitivity to wind lodging. Among the nematodes attacking banana, *Radopholus similis* (Cobb) Thorne is considered the most destructive species (Sarah *et al*. 1996).

The possibilities of controlling nematodes in bananas are limited because bananas are usually grown as a permanent crop by small-scale farmers and sources of resistance have proved hard to find. Resistance to *R. similis* has been reported in 'Pisang Jari Buaya' (*Musa* AA—Pisang Jari Buaya group) and 'Yangambi Km5' (*Musa* AAA—Ibota group) (Pinochet 1988, Viaene *et al*. 1998, Fogain and Gowen 1998, Stoffelen 2000). The clone 'SH-3142' derived from a genotype belonging to the Pisang Jari Buaya group and 'SH-1734' was found to be highly resistant to *R. similis* (Pinochet and Rowe 1979, Pinochet 1988). Moreover, some 'Pisang Jari Buaya' expressed favourable agronomic features similar to those of commercial banana.

The Mysore banana (*Musa* AAB) is a very popular and delicious dessert. Information on resistance and/or tolerance to *R. similis* of Mysore bananas is scarce. When testing 17 AAB *Musa* genotypes, Fogain (1996) reported that none of the plants were immune, including 'Pisang Ceylan', the only cultivar belonging to the Mysore group. The objective of our study was to further investigate the host plant response of *Musa* genotypes from the Pisang Jari Buaya and Mysore groups to a *R. similis* population from Costa Rica, to find additional sources of resistance to the burrowing nematode.

Throughout the study, the terminology of Bos and Parlevliet (1995) concerning resistance and susceptibility of host plants to pathogens and the methodology for nematode resistance screening in *Musa* as described by Speijer and De Waele (1997) were used.

Materials and methods

Preparation of banana plants

Thirteen diploid (AA) banana genotypes belonging to the Pisang Jari Buaya group (Experiments 1 and 2, see Tables 1 and Table 2) and five triploid (AAB) banana genotypes from the Mysore group (Experiment 3, see Table 3) were included in the study. Two triploid (*Musa* AAA) bananas, 'Grande Naine' and 'Yangambi Km5', were included as reference genotypes because of their high susceptibility and resistance to *R. similis*, respectively. The *Musa* genotypes used in the experiments were provided by the INIBAP Transit Centre (ITC) at the Catholic University of Leuven. After proliferation, regeneration and rooting (Banerjee and De Langhe 1985), each *in vitro* propagated banana plantlet with 3-4 leaves and 5-6 roots was transplanted in a 1-litre (12 cm-diameter) plastic pot containing about 1000 cm^3 autoclaved substrate of peat and quarts (2:1). To keep a high humidity, the pots were placed under a plastic cover, which was slightly opened after 2 weeks and removed after 4 weeks. The greenhouse conditions were maintained at 25-30°C and 70-80% relative humidity with a 12-hour photoperiod. The pots were irrigated as needed and fertilized with a hydroponics solution (Swennen *et al*. 1986) every 3 weeks after nematode inoculation. The plants were inoculated with nematodes either 4 weeks after planting for the Pisang Jari Buaya group, or 8 weeks after planting for the Mysore group, since the number of nematodes was too low in the experiment with Mysore genotypes.

Preparation of nematode inoculum

The *R. similis* population used in the experiments was obtained from infected banana roots of 'Valery' (*Musa* AAA) at Talamanca in Costa Rica. The population was reared monoxenically on carrot discs and incubated at 28°C in the dark for several generations (Moody *et al*. 1973, Pinochet *et al*. 1995). The carrot discs were blended twice for 10 s (with 5 s interval) and poured through 106 and 25 µm pore sieves. Carrot tissue collected on the 106 µm pore sieve was discarded, while the nematodes were collected from the 25 µm pore sieve.

A suspension of 1000 living vermiform nematodes was poured in three holes made in the substrate around the base of each plant. After inoculation, the holes were covered.

Host plant response observations

Eight weeks after inoculation, the plants were harvested to observe the response of the different banana genotypes to *R. similis*. The following data were recorded:

Root necrosis percentage

The procedure followed was that described by Speijer and De Waele (1997). Five 10 cm-pieces of functional primary roots were collected and sliced longitudinally. The percentage of root cortex showing necrosis was scored for a half of each root. The maximum root necrosis per root half is 20%, giving a maximum root necrosis of 100% for the five root-halves together.

Nematode population densities

The entire root system, including the 5 roots segments observed for necrosis, was weighed and cut into 2 cm-pieces. Fifteen grams of fresh roots were taken randomly and macerated three times for 10 s with 5 s intervals. The mixture was poured through a series of 250-106-40 µm pore sieves and the sieves were rinsed with tap water. Nematodes remaining on the 40 µm pore sieve were collected in a beaker with distilled water. Nematodes were counted in 6 ml aliquots of each sample using a binocular microscope.

Experimental design and data analysis

Three experiments were conducted, based on a completely randomized design, with either eight replicates for each genotype (Pisang Jari Buaya group, Experiment 1, Table 1; Mysore group, Experiment 3, Table 3) or nine replicates (Pisang Jari Buaya group, Experiment 2, Table 2). Prior to statistical analysis, the percentage of root necrosis was transformed to arcsin

Table 1. Reproduction of *Radopholus similis* (Costa Rica population) on 8 diploid (*Musa* AA) banana genotypes belonging to the Pisang Jari Buaya group and on the reference genotype 'Grande Naine' measured 8 weeks after inoculation with 1000 vermiform nematodes per plant.

Musa genotype	Genome	ITC number	Fresh root weight (g)	Root necrosis (%)		Nematodes per 1 g fresh roots		Nematodes per root system	
Huwundu	AA	0308	35.3	22.4	ab	1050	a	36188	a
Morong Datu	AA	0309	41.0	14.5	ab	851	a	33526	a
Morong Princessa	AA	0310	29.9	30.5	b	972	a	26022	a
Pisang Rotan	AA	0313	41.1	16.6	ab	794	a	29033	a
Pisang Tunjiuk	AA	0315	44.2	7.9	a	255	a	10770	a
Saing Todloh	AA	0316	36.0	6.8	a	297	a	10038	a
Unnamed	AA	0318	43.2	11.3	ab	442	a	17151	a
Umbarim	AA	0317	32.6	17.1	ab	495	a	16030	a
Grande Naine	AAA	1256	52.0	9.3	ab	528	a	23052	a

ITC= INIBAP Transit Centre.

Original data are presented, but data of nematode numbers were transformed to $\log_{10}$ (x+1) and data of root necrosis percentage were converted to arcsin (x/100) for statistical analysis. Means in the same column followed by the same letter are not significantly different ($P \leq 0.05$) according to the Tukey HSD test.

Table 2. Reproduction of *Radopholus similis* (Costa Rica population) on 5 Pisang Jari Buaya genotypes, Yangambi Km5 and on the reference genotype 'Grande Naine' measured 8 weeks after inoculation with 1000 vermiform nematodes per plant.

Musa genotype	Genome	ITC number	Fresh root weight (g)	Root necrosis (%)		Nematodes per 1 g fresh roots		Nematodes per root system	
Gabah Gabah	AA	0307	74.4	11	a	588	c	44571	b
Pisang Gigi Buaya	AA	0310	64.0	8.4	a	741	c	45914	b
Pisang Jari Buaya	AA	0312	54.9	11.9	a	1053	c	56541	b
SH-3142	AA	0425	52.7	8.9	a	108	a	5941	a
Pisang Sipulu	AA	1308	60.6	8.9	a	579	bc	34355	b
Yangambi Km5	AAA	1123	57.2	7.8	a	120	ab	6384	a
Grande Naine	AAA	1256	43.9	25	b	2041	c	87763	b

ITC= INIBAP Transit Centre.

See note in Table 1.

Table 3. Reproduction of *Radopholus similis* (Costa Rica population) on 5 triploid (*Musa* AAB) banana genotypes belonging to the Mysore group and on the reference genotype 'Grande Naine' measured 8 weeks after inoculation with 1000 vermiform nematodes per plant.

Musa genotype	Genome	ITC number	Fresh root weight (g)	Root necrosis (%)		Nematodes per 1 g fresh roots		Nematodes per root system	
Thap Maeo	AAB	1301	101.3	17.3	a	852	ab	82849	abc
Gorolo	AAB	0723	45.6	22.8	ab	579	a	32562	a
Pisang Ceylan	AAB	0650	58.3	29.6	abc	804	ab	46827	abc
Lady Finger (South Johnstone)	AAB	0583	51.8	36.9	c	679	a	38616	ab
Lady Finger (Nelson)	AAB	0582	87.8	33.1	bc	1128	ab	99009	bc
Grande Naine	AAA	1256	83.9	42.5	c	1552	b	127439	c

ITC= INIBAP Transit Centre.

See note in Table 1.

(x/100) and the nematode numbers were converted to $\log_{10}$ (x+1). All data were subjected to analysis of variance (ANOVA) and means of the parameters were compared using the Tukey HSD test at $P \leq 0.05$.

Results and discussions

The results obtained from the Pisang Jari Buaya group are presented in Tables 1 and 2. In Table 1, no significant differences were observed in nematode numbers per root system or per 1 g fresh roots and root necrosis percentage between the Pisang Jari Buaya genotypes and 'Grande Naine'. Among the Pisang Jari Buaya genotypes, root necrosis percentage was significantly higher in 'Morong Princessa' compared with 'Pisang Tunjiuk' and 'Saing Todloh'. In Table 2, reproduction of *R. similis* was observed in all the genotypes tested. In general, the nematode populations collected from roots of the Pisang Jari Buaya genotypes, including Pisang Jari Buaya accession ITC0312, were not significantly different from those recovered from 'Grande Naine' but significantly higher compared to 'Yangambi Km5' and 'SH-3142'. Only for 'Pisang Sipulu' was the number of nematodes per 1 g fresh roots not significantly different from 'Yangambi Km5'. The lowest nematode numbers were recorded on 'SH-3142' and 'Yangambi Km5'. The root necrosis percentages of all Pisang Jari Buaya genotypes, 'Yangambi Km5' and 'SH-3142' were significantly lower compared with 'Grande Naine'.

These results show that all Pisang Jari Buaya genotypes tested are as susceptible to *R. similis* as 'Grande Naine'. They confirm a previous report (Wehunt *et al.* 1978) that 'Pisang Jari Buaya', 'Gabah Gabah', 'Pisang Sipulu' and 'Pisang Gigi Buaya' are significantly less sensitive to root damage (expressed as root necrosis percentage) compared with 'Grande Naine'. Surprisingly, 'Pisang Jari Buaya', which has previously been confirmed resistant to *R. similis* (Pinochet 1988, Viaene *et al.* 1998, Fogain and Gowen 1998, Stoffelen 2000), did not appear to be so in our study. Also, 'Pisang Sipulu', considered a promising banana genotype because less susceptible to *R. similis* (Wehunt *et al.* 1978, Binks and Gowen 1996), did not show resistance either to *R. similis* in our study.

The results obtained from the Mysore group are presented in Table 3. The nematode numbers per root system and per 1 g fresh roots of 'Gorolo' and 'Lady Finger' (South Johnstone) were significantly lower compared with 'Grande Naine', while those recovered from the other Mysore genotypes were not significantly different compared with the reference genotype. The root necrosis percentage observed in 'Thap Maeo' and 'Gorolo' was significantly lower compared with 'Grande Naine'. In contrast, the root necrosis percentages of 'Pisang Ceylan', 'Lady Finger' (South Johnstone) and 'Lady Finger' (Nelson) did not differ significantly from those in 'Grande Naine'.

According to Price (1994) and Price and McLaren (1995), AAB *Musa* genotypes are susceptible to *R. similis* when examined in field trials. Unfortunately, genotypes of the Mysore group were not included in their trials. Our study confirms previous reports (Stanton 1994, Fogain *et al.* 1996) that 'Lady Finger'

(Nelson), 'Lady Finger' (South Johnstone) and 'Pisang Ceylan' are susceptible to *R. similis*.

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Duong Thi Minh Nguyet and **Nguyen Thi Tuyet** work at the Vietnam Agricultural Science Institute (VASI), Van Dien, Thanh Tri, Hanoi, Vietnam. Tel: (84) 4 861 43 25, Fax: (84) 4 861 71 67. **Annemie Elsen** and **Dirk De Waele** work at the Laboratory of Tropical Crop Improvement, Catholic University of Leuven, Kasteelpark Arenberg 13, 3001 Heverlee, Belgium. Tel: (32) 16 32 96 03, Fax: (32) 16 32 19 93. Corresponding author: e-mail: nhibiovasi@fpt.vn or anhnguyet1@hotmail.com