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Screening of banana hybrids for resistance to *Pratylenchus coffeae*

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ABSTRACT

The reaction of twenty-four new synthetic banana hybrids to *Pratylenchus coffeae* was studied under artificially inoculated pot conditions. Two banana hybrids, H-04-05 and H-04-06 were found to be resistant and ten hybrids, H-04-01, H-04-03, H-04-04, H-04-07, H-04-09, H-04-11, H-04-16, H-04-19, H-04-21 and H-04-24 were found to be tolerant to the lesion nematode, *Pratylenchus coffeae* and the remaining were rated as susceptible.

Keywords : Resistance, banana, hybrids, *Pratylenchus coffeae*

INTRODUCTION

Crop losses in bananas caused by nematodes are very high, with an average annual yield loss estimated at about 20 per cent worldwide (Sasser and Freckman, 1987). Two of the most widespread and important nematode species associated with bananas and plantains are the burrowing nematode *Radopholus similis* and the lesion nematode *Pratylenchus coffeae*. These lesion-inducing nematodes feed, multiply and migrate inside the roots and corm and cause a necrotic and reduced root system. Hence, it is important to screen the cultivars or hybrids for their reaction to nematodes. In light of the above, the present study was undertaken at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, India.

MATERIAL AND METHODS

Banana hybrids used in the present study were evolved in the institute with the main objective of breeding for resistance/ tolerance to nematodes along with good yield traits. The hybrids were assessed for their reaction to lesion nematode, *Pratylenchus coffeae.* The experiments were conducted in a glass house in potted plants which were inoculated artificially. The experiment was laid out in randomised block design and replicated thrice. The hybrids were evaluated along with the reference cultivars viz., Rasthali (AAB, syn.silk) as the susceptible reference cultivar and *Pisang Lilin* (AA) as the resistant reference cultivar. The screening was done based on the root and corm damage assessment as followed in INIBAP technical guidelines 7 (Carlier *et al*, 2003).

Preparation of plant material

Suckers of uniform size were pared immediately after detaching from the mother plant, and planted in pots filled with sterilized pot mixture. The soil was watered upto field capacity. Four weeks after planting, 8-10 plants of each genotype were inoculated with lesion nematodes (1 nematode per gram of soil), while another set of 8-10 plants were kept as nematode-free control.

Culturing and extraction of nematodes

Carrot disc culture

Surface sterilized carrot was cut into discs and placed in sterile petri dishes. Nematodes extracted from the infected roots through Baermann-funnel method were surface sterilized and transferred to the carrot discs with a sterile micropipette. Small drops of nematode suspension were placed on the margin of the carrot discs. The petri dishes were sealed with parafilm, labelled and stored in an incubator at 28°C. Sub-culturing of nematodes on fresh carrot discs was done periodically and the extracted nematodes were used for inoculation in pot culture experiments (Carlier *et al*, 2003).

Inoculation of nematodes in pots

Nematode suspension obtained from the above method, containing infective juveniles of *Pratylenchus coffeae*, were inoculated into the pots, forty five days after

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planting, @ 1N/ g of soil, by making three deep holes around each sucker. Another set of pots was maintained as uninoculated control. Observations on nematode population in soil and root were made on 45th and 90th day after inoculation. The lesion index in roots and corm were observed while terminating the trial, i.e., at 90th day of inoculation (DAI).

Observations in pot culture

The plant biometric observations viz., pseudostem height, girth, number of leaves, root fresh weight, number of roots, root length and girth, population of nematodes in both soil and roots, root lesion index and corm grade were assessed while screening the banana hybrids. Nematode population in soil was assessed using Cobb's sieving and decanting technique followed by modified Baermann funnel technique (Cobb, 1918; Schindler, 1961). Nematode population in roots was determined by the method of Carlier *et al*, 2003.

RESULTS AND DISCUSSION

Significant differences were observed in the root characters of phase I hybrids namely, number of roots, root length, root girth and root weight under pot culture at 90th DAI (Table 1). Among hybrids the maximum reduction of 46.33% was observed in the number of roots in H-04-10 and the lowest reduction of 7.24% was recorded in H-04-22 as compared to control. The interaction effect between the genotypes and treatments for number of roots was found to be highly significant. The hybrid H-04-20 registered the maximum reduction of 36.28% for root length and H-04-06 registered the minimum of 6.63% among the hybrids. The hybrid H-04-10 recorded the maximum reduction of 33.85% in root weight and H-04-21 recorded the minimum of 5% among the hybrids. There was no significant variation in the interaction of genotype and treatments for both root girth and root weight.

Table 1. Effect of *P. coffeae* on root characters of phase I hybrids on 90 DAI under pot culture

S.No.	Hybrid	Number of roots			Root length (cm)			Root girth (cm)			Root weight (g)		
		C	I	% diff	C	I	% diff	C	I	% diff	C	I	% diff.
1.	H-04-01	37.00	30.20	-18.38	44.50	39.00	-12.36	1.56	1.40	-10.26	91.00	82.75	-9.07
2.	H-04-02	38.16	21.56	-43.50	35.20	26.70	-24.15	1.12	0.75	-33.04	85.50	68.60	-19.77
3.	H-04-03	30.45	24.38	-19.93	47.56	44.00	-7.49	1.65	1.51	-8.48	78.00	70.25	-9.94
4.	H-04-04	34.74	28.66	-17.50	50.25	46.60	-7.26	1.86	1.70	-8.60	95.40	88.33	-7.41
5.	H-04-05	32.00	28.20	-11.88	45.55	41.40	-9.11	1.70	1.61	-5.29	87.66	80.45	-8.22
6.	H-04-06	49.40	42.55	-13.87	56.42	52.68	-6.63	1.95	1.88	-3.59	118.00	106.52	-9.73
7.	H-04-07	38.25	30.75	-19.61	49.00	44.72	-8.73	1.35	1.22	-9.63	89.08	78.65	-11.71
8.	H-04-08	41.49	26.58	-35.94	45.00	34.65	-23.00	1.12	0.76	-32.14	102.72	72.35	-29.57
9.	H-04-09	56.50	50.67	-10.32	36.37	31.26	-14.05	1.25	1.16	-7.20	128.44	115.66	-9.95
10.	H-04-10	24.00	12.88	-46.33	30.33	22.11	-27.10	1.06	0.70	-33.96	64.25	42.50	-33.85
11.	H-04-11	28.25	22.50	-20.35	40.45	35.00	-13.47	1.36	1.28	-5.88	72.00	62.75	-12.85
12.	H-04-12	30.75	25.00	-18.70	44.60	40.20	-9.87	1.58	1.46	-7.59	84.90	76.52	-9.87
13.	H-04-13	38.62	27.73	-28.20	38.75	30.25	-21.94	1.14	0.70	-38.60	80.63	66.47	-17.56
14.	H-04-14	40.00	26.00	-35.00	40.00	32.86	-17.85	1.00	0.65	-35.00	92.40	75.63	-18.15
15.	H-04-15	37.75	23.70	-37.22	34.50	25.72	-25.45	0.98	0.60	-38.78	85.29	70.45	-17.40
16.	H-04-16	26.20	19.40	-25.95	45.00	42.00	-6.67	1.20	1.05	-12.50	68.50	58.00	-15.33
17.	H-04-17	46.10	34.30	-25.60	39.20	30.67	-21.76	1.05	0.78	-25.71	96.00	72.75	-24.22
18.	H-04-18	32.65	20.82	-36.23	41.00	34.80	-15.12	1.00	0.74	-26.00	88.60	67.55	-23.76
19.	H-04-19	39.23	33.45	-14.73	45.75	40.50	-11.48	1.39	1.28	-7.91	90.64	79.39	-12.41
20.	H-04-20	35.00	23.50	-32.86	28.25	18.00	-36.28	1.10	0.68	-38.18	94.36	70.74	-25.03
21.	H-04-21	42.75	38.60	-9.71	44.58	40.69	-8.73	1.78	1.70	-4.49	110.00	104.50	-5.00
22.	H-04-22	38.00	35.25	-7.24	38.14	35.00	-8.23	1.35	1.25	-7.41	93.18	86.60	-7.06
23.	H-04-23	35.33	32.46	-8.12	34.00	30.67	-9.79	1.40	1.32	-5.71	84.00	75.75	-9.82
24.	H-04-24	48.70	43.00	-11.70	55.44	49.90	-9.99	1.88	1.79	-4.79	126.50	116.25	-8.10
Reference cultivars													
1.	Pisang Lilin	30.16	27.37	-9.25	45.08	42.46	-5.81	1.24	1.18	-4.84	62.36	56.44	-9.49
2.	Rasthali	32.62	20.00	-38.69	37.04	29.63	-20.01	1.00	0.56	-44.00	68.09	42.32	-37.85
	Sources	G	T	GT	G	T	GT	G	T	GT	G	T	GT
	SEd	1.631	0.452	2.307	1.978	0.548	2.798	0.067	0.018	0.095	4.155	1.152	5.877
	CD *(P=0.05)*	3.236	0.897	4.576	3.923	1.088	NS	0.134	0.037	0.189	8.241	2.285	NS
	CD *(P=0.01)*	4.281	1.187	6.055	5.191	1.439	NS	0.177	0.049	0.250	10.904	3.024	NS

DAI - Day after inoculation; C - Control; I – Inoculated; % diff – per cent difference over control; NS – Non significant.

Table 2. Population build-up of *P. coffeae* in phase I hybrids on 90th DAI under pot culture

S.No.	Hybrid	Root population (5 g)	Soil population (250 cc)	Total root population
1	H-04-01	220 (2.344)*	140 (2.146)	5881 (3.791)
2	H-04-02	356 (2.551)	212 (2.326)	8276 (3.917)
3	H-04-03	235 (2.371)	150 (2.167)	5702 (3.756)
4	H-04-04	165 (2.213)	114 (2.057)	4739 (3.675)
5	H-04-05	148 (2.170)	100 (2.000)	3981 (3.600)
6	H-04-06	156 (2.193)	108 (2.092)	5051 (3.703)
7	H-04-07	227 (2.382)	132 (2.120)	5683 (3.746)
8	H-04-08	344 (2.536)	204 (2.309)	8242 (3.916)
9	H-04-09	256 (2.408)	125 (2.097)	7922 (3.950)
10	H-04-10	387 (2.578)	246 (2.391)	7226 (3.859)
11	H-04-11	272 (2.434)	165 (2.217)	6054 (3.782)
12	H-04-12	174 (2.240)	128 (2.107)	4711 (3.665)
13	H-04-13	370 (2.568)	218 (2.291)	8407 (3.924)
14	H-04-14	298 (2.474)	142 (2.152)	6780 (3.831)
15	H-04-15	316 (2.499)	177 (2.248)	7284 (3.862)
16	H-04-16	238 (2.376)	126 (2.085)	4777 (3.679)
17	H-04-17	283 (2.446)	137 (2.137)	6310 (3.800)
18	H-04-18	295 (2.470)	143 (2.155)	6273 (3.799)
19	H-04-19	230 (2.361)	111 (2.045)	5428 (3.734)
20	H-04-20	273 (2.430)	122 (2.086)	5814 (3.764)
21	H-04-21	149 (2.173)	102 (2.008)	4746 (3.676)
22	H-04-22	157 (2.196)	117 (2.057)	4591 (3.662)
23	H-04-23	142 (2.148)	100 (2.000)	3751 (3.558)
24	H-04-24	234 (2.369)	139 (2.177)	7665 (3.884)
Reference cultivars				
1	Pisang Lilin	145 (2.161)	98 (1.991)	3205 (3.505)
2	Rasthali	382 (2.582)	243 (2.385)	7121 (3.852)
	SEd	10.194	9.877	467.615
	CD *(P=0.05)*	20.457	19.821	938.342
	CD *(P=0.01)*	27.258	26.411	1250.324

Analysis done after $\log_{10}$ (x+1) transformation
* Values in paranthes are transformed values

Significant differences were observed among the hybrids for root population, soil population and total population of *P. coffeae* at 90th DAI (Table 3). The lowest root population of 142 nematodes per 5 g of root was recorded in hybrid H-04-23, which was lower than the reference cultivar Pisang Lilin (145) and the highest was in H-04-10 (387). The same trend was noticed in soil population also. However, the soil population varied significantly among the hybrids ranging from 100 to 246 in 250 cc of soil. Total final root population was found to vary significantly among the hybrids. The hybrid H-04-23 registered the minimum number of 3751 nematodes while a maximum of 8407 nematodes was recorded by the hybrid H-04-13 which was found to be a susceptible one.

The resistant hybrid H-04-06 registered lesser number of nematodes than the susceptible hybrids. In some of the tolerant hybrids, the nematode population was higher but the growth of plant was not affected. This could be because, these plants allowed entry of the nematodes and their reproduction, but did not support further growth. This is in line with the findings of Janarthani (2002). Binks and Gowen (1997) also found higher weight in primary roots if resistant cultivars as compared to susceptible cultivars.

Based on the intensity of lesions on roots and corm, they were assessed for their level of resistance. The per cent necrosis of roots ranged from 6.00 (H-04-06) to 56.00 (H-04-10) (Table 3). The hybrids, H-04-05, H-04-06, H-04-22 and H-04-23 had no dead roots while 35% of roots were dead in H-04-10. The highest root lesion index scale of 5 was noticed in the hybrids H-04-02, H-04-08, H-04-10, H-04-13 and also in Rasthali. However, the hybrids H-04-05, H-04-06, H-04-12, H-04-21, H-04-22 and H-04-23 recorded the lowest lesion index scale of 1 similar to that of the resistant reference cultivar Pisang Lilin. The highest corm grade of 4 was found in hybrids. H-04-02, H-04-08, H-04-10 and H-04-13 and the lowest corm grade of 0 was recorded by H-04-06 and H-04-22. Among the hybrids, 5 exhibited resistance, 10 exhibited tolerance, 5 were moderately susceptible and 4 were highly susceptible to nematode infestation.

Among the resistant hybrids, H-04-06 recorded more number of functional roots besides bunch yield. Root spread and root thickness was found to be more in H-04-06 than in the other hybrids. This is an important character considered by the breeders in selecting parent materials while breeding for nematode resistance (Gowen, 1993). Regarding the root fresh weight also, the hybrids H-04-09, H-04-06 and H-04-24 weighed more than the susceptible hybrids. Similar findings were reported in field trials conducted by Janarthani (2002). Though the hybrid H-04-05 registered less number of roots, root length and root girth as compared to resistant hybrids, it exhibited tolerance to nematodes due to its higher phenolic content and lignified cells as also confirmed by histological studies.

Vilchez Rojas (1991) observed a negative correlation between *Radopholus similis* population and percentage of functional roots. Some resistant cultivars were found to have higher root weights with greater number of primary roots than those which were susceptible (Binks and Gowen, 1997). Jean *et al* (2002) reported that assessment of root and corm damage will give a better understanding of resistance (or) tolerance of the cultivars under both field and glass house conditions.

Resistance can be considered as the ability of the plant to suppress development of pests or pathogens,

Table 3. Root and corm damage assessment in banana hybrids (Phase I) on 90th DAI caused by *P. coffeae* under pot culture

S.No.	Hybrids	% Root Necrosis (RN)					Total	Total roots		DE %	Root lesion	Corm	Reaction
		1	2	3	4	5	RN %	DE	OK		index	grade	status
1.	H-04-01	3	2	3	3	2	13	3	40	6.98	2	2	T
2.	H-04-02	10	8	9	7	12	46	8	35	18.60	5	4	HS
3.	H-04-03	4	3	2	3	4	16	2	30	6.25	2	2	T
4.	H-04-04	2	3	4	1	2	12	2	36	5.26	2	2	T
5.	H-04-05	2	3	-	2	1	8	0	30	0.00	1	1	R
6.	H-04-06	-	2	-	2	2	6	0	42	0.00	1	0	R
7.	H-04-07	4	2	4	4	4	18	2	38	5.00	2	2	T
8.	H-04-08	8	11	13	5	6	42	8	41	16.33	5	4	HS
9.	H-04-09	5	4	1	5	5	20	3	58	4.92	2	1	T
10.	H-04-10	14	12	10	12	8	56	14	26	35.00	5	4	HS
11.	H-04-11	3	2	3	4	2	14	2	34	5.56	2	2	T
12.	H-04-12	-	3	2	2	3	10	1	36	2.70	1	1	R
13.	H-04-13	10	9	7	8	14	48	10	44	18.52	5	4	HS
14.	H-04-14	5	10	12	8	5	40	7	40	14.89	4	3	S
15.	H-04-15	13	8	7	6	4	38	8	46	14.81	4	3	S
16.	H-04-16	3	4	2	5	5	19	1	28	3.45	2	2	T
17.	H-04-17	8	7	6	11	6	38	16	52	23.53	4	3	S
18.	H-04-18	6	8	9	12	5	40	6	34	15.00	4	3	S
19.	H-04-19	6	5	4	3	-	18	2	43	4.44	2	2	T
20.	H-04-20	11	9	8	4	3	35	7	49	12.50	2	3	S
21.	H-04-21	2	-	2	3	3	10	1	56	1.75	1	1	T
22.	H-04-22	2	3	-	2	1	8	0	27	0.00	1	0	R
23.	H-04-23	-	2	1	2	2	7	0	34	0.00	1	1	R
24.	H-04-24	4	4	2	3	5	18	2	54	3.57	2	2	T
Reference cultivars													
1.	Pisang Lilin	1	2	3	2	2	9	1	45	2.17	1	0	R
2.	Rasthali	10	14	12	9	13	58	12	37	24.49	5	4	HS

DE - dead roots; R - resistant; T- tolerant;
OK - functional roots; S-susceptible; HS - Highly susceptible;

whereas tolerance is the ability of the plant to grow well despite infection by a pathogen (Bos and Parlevliet, 1995). Hybrids H-04-05 and H-04-06 were found to be resistant as they suppressed nematode populations both in the soil and in the roots and had relatively low root lesion indices. Hybrids H-04-01, H-04-03, H-04-04, H-04-07, H-04-09, H-04-11, H-04-16, H-04-19, H-04-21 and H-04-24 were found to be tolerant and not resistant because their population levels in the roots were higher.

Banana hybrids H-04-05 and H-04-06 were thus found to be resistant and hybrids H-04-01, H-04-03, H-04-04, H-04-07, H-04-09, H-04-11, H-04-16, H-04-19, H-04-21 and H-04-24 were found to be tolerant to the lesion nematode, Pratylenchus coffeae, when screened under artificially inoculated conditions. After assessing the performance of these hybrids for yield and quality parameters under field condition, they can be used either as useful breeding material for further breeding programmes or evaluated in multi-location trials before considering for varietal release.

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