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Resistance and Host-response of Selected Plants to *Meloidogyne megadora*[1]

A. M. S. F. de Almeida[2] and M. S. N. de A. Santos[3]

Abstract: Fourteen plant species, including 30 genotypes, were assessed for host suitability to *Meloidogyne megadora* in a growth room at 20 to 28 °C. Host suitability was based on the gall index (GI) and the reproduction factor (Rf):final population density (Pf)/initial population density (Pi). The presence of distinct galling was observed on roots of six plant species, and reproduction occurred on five of the 14 species tested. Three cultivars of cantaloupe (cvs. Branco do Ribatejo, Concerto, and Galia), three of cucumber (cvs. LM 809, Half Long Palmetto, and Market More), six of banana (cvs. Maçã, Ouro Branco, Ouro Roxo, Prata, Pão, and Valery), and one of broad bean (cv. Algarve) were considered susceptible (Pf/Pi > 1). Resistant cultivars (Pf/Pi = 0) included beet (cv, Crosby), pepper (cv. LM 204), watermelon (cvs. Black Magic and Crimson Sweet), tomato (cvs. Moneymaker and Rossol), radish (cv. Cherry Belle), and corn (cv. Dunia); sunn hemp and black velvetbean genotypes were also resistant. All *Brassica* cultivars were galled, although no egg masses were observed (Pf/Pi = 0), and classified as resistant/hypersensitive.

Key words: Convolvulaceae, Cucurbitaceae, Fabaceae, host range, *Meloidogyne megadora,* Musaceae, nematode, root-knot nematode.

Meloidogyne megadora Whitehead, 1968, first found in coffee plants in Angola, is the most important nematode pathogen affecting coffee plants in the Democratic Republic of S. Tomé and Príncipe (Abrantes et al., 1995a, 1995b; Rodrigues and Santos, 1993; Whitehead, 1968, 1969). Other known hosts include banana (*Musa* sp. and *Musa paradisiaca* L. var. *sapientum*) and some others (Decker et al., 1980; Yassin and Zeidan, 1982; Zhang and Weng, 1991).

Resistance to *M. megadora* exists in several plant cultivars from the following species: *Brassica oleracea, Capsicum annuum, Carica papaya, Citrullus vulgaris, Impatiens balsamina, Lactuca sativa, Petroselinum crispum, Solanum melongena,* and *Solanum tuberosum.* Eleven other plants (including *Beta vulgaris, Brassica napus, B. oleracea, Cucumis melo, Glycine max,* and *Raphanus sativus*) appeared to be resistant/hypersensitive and exhibited galling but did not support reproduction (Almeida et al., 1997).

The objective of this research was to extend previous information on host status and relative resistance of plants to *M. megadora* (Almeida et al., 1997). The research reported here includes assessment of the host status of 14 plant species.

Materials and Methods

A population of *M. megadora,* collected in S. Tomé, Democratic Republic of S. Tomé and Príncipe (Abrantes et al., 1995a, 1995b), was cultured on bean plants (*Phaseolus vulgaris* L. cv. Bencanta Trepar) in the greenhouse at ca. 26 °C. Roots of 6 to 7-week-old plants were rinsed free of soil, and eggs and second-stage juveniles (J2) were collected using a 0.53% NaOCl solution (Hussey and Barker, 1973).

Thirty genotypes from 14 plant species were assessed (Table 1). Banana was propagated from shoot apices isolated from suckers collected in the Democratic Republic of S. Tomé and Príncipe; the other plants were grown from seeds germinated on filter paper. Young plants and seedlings were transplanted into individual 10-cm-diam. pots filled with a 1:2 mixture of steam-sterilized sand:sandy loam soil to give a final mixture of 80% sand, 15% silt, and 5% clay. The initial population (Pi) consisted of 5,000 eggs and J2 in 5 ml aqueous suspension, which was poured into four holes about 3 cm deep in the soil around the base of each plant, at transplanting. There were five replicates of each genotype, with bean cv. Bencanta Trepar included as a susceptible check. Pots were arranged in a randomized complete block design with five replicates and maintained in a growth room at 20 to 28 °C with a 14-hour photoperiod. Plants were watered daily and fertilized weekly with 25 ml Hyponex®, a water-soluble fertilizer (5% N, 6% P, 19% K).

After 60 days, roots were carefully rinsed free of soil, and egg masses were stained with Phloxine B (Hartman, 1982). Numbers of galls (gall index = GI) and egg masses per root system were assessed using a 0–5 index, with 0 = no galls or egg masses, 1 = 1 or 2, 2 = 3 to 10, 3 = 11 to 30, 4 = 31 to 100, and 5 = >100 galls or egg masses per root system (Taylor and Sasser, 1978). Nematode eggs were extracted from the entire root system of each plant with 0.53% NaOCl (Hussey and Barker, 1973). Final nematode population densities (Pf) were estimated as the total number of J2 and eggs extracted from the roots of each plant, and the reproduction factor (Pf/Pi) was calculated. After root ratings were completed, root systems with galls but no eggs were stained with acid fuchsin to evaluate nematode development in the roots (Byrd et al., 1983).

Host status was based on the gall index (GI) and the reproduction factor (Rf = Pf/Pi) according to the modi-

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[2] Graduate Research Student and [3]Professor, Department of Zoology and Institute of Environment and Life, University of Coimbra, Portugal.

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E-mail: nemz@zoo.uc.pt

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TABLE 1. Host status of selected plants to *Meloidogyne megadora,* measured 60 days after infestation of soil with 5,000 juveniles (J2) + eggs per plant.

Plant species (common name)	Cultivar or genotype	GI[a]	Pf[b] ×1,000	Rf[c]	Host status[d]
Beta vulgaris L. (beet)	Crosby	0	0	0	R
Brassica oleracea L.					
var. *botrytis*	Maresma	3.0	0	0	R^H
(cauliflower)	Temporão	2.8	0	0	R^H
var. *capitata*	Savoron	4.0	0	0	R^H
(cabbage)					
var. *gemmifera*	De La Halle	3.0	0	0	R^H
(Brussels sprouts)					
var. *italica*	Roxo	3.0	0	0	R^H
(broccoli)	Verde	3.2	0	0	R^H
	Violeta	3.2	0	0	R^H
Capsicum annuum L. (pepper)	LM 204	0	0	0	R
Citrullus lanatus L.	Black				
(T. Hunb. Matsum	Magic	0	0	0	R
& Nak.	Crimson				
(watermelon)	Sweet	0	0	0	R
Cucumis melo L.	Branco do				
(cantaloupe)	Ribatejo	4.0	7.8a	1.6	S
	Concerto	5.0	56.6b	11.3	S
	Galia	5.0	55.6b	11.2	S
Cucumis sativus L.	LM 809	5.0	48.5a	9.7	S
(cucumber)	Half Long				
	Palmetto	5.0	16.5b	3.3	S
	Market More	5.0	21.7c	4.3	S
Crotalaria juncea L. (sunn hemp)		0	0	0	R
Lycopersicon esculentum Mill.	Moneymaker	0	0	0	R
(tomato)	Rossol	0	0	0	R
Mucuna pruriens (L.) DC. var. *utilis* (black velvetbean)		0	0	0	R
Musa paradisiaca L. (banana)	Pão	5.0	47.3	9.5	S
Musa sapientum L.	Maçã	5.0	11.8a	2.4	S
(banana)	Ouro				
	Branco	5.0	50.7b	10.1	S
	Ouro				
	Roxo	5.0	12.9a	2.6	S
	Prata	5.0	49.0b	9.8	S
	Valery	5.0	36.0c	7.2	S
Raphanus sativus L.	Cherry				
(radish)	Belle	0	0	0	R
Vicia faba L. (broad bean)	Algarve	5.0	75.3	15.1	S
Zea mays L. (corn)	Dunia	0	0	0	R

[a] GI = gall index (0–5): 0 = no galls, 1 = 1 to 2 galls, 2 = 3 to 10 galls, 3 = 11 to 30 galls, 4 = 31 to 100 galls, 5 = >100 galls per root system.
[b] Pf = final population density (J2 + eggs). Data are means of five replicates.
[c] Rf (reproduction factor) = Pf/initial population.
[d] Host status categories: R = Resistant – Rf ≤ 1 and GI ≤ 2; S = Susceptible – Rf > 1 and GI > 2; R^H = Resistant/hypersensitive – Rf ≤ 1 and GI > 2.
In each column means, within a plant species, followed by the same letter do not differ ($P \leq 0.05$) according to k-ratio Duncan's multiple-range test.

fied scheme of Canto-Saenz (Almeida et al., 1997; Sasser et al., 1984). Plants with GI > 2 are defined as either susceptible (Rf > 1) or resistant/hypersensitive (Rf ≤ 1); plants with GI ≤ 2 are defined either as resistant (Rf ≤ 1) or tolerant (Rf > 1). The data were analyzed with STATISTICA 1996 Version 5 software, and the mean Rf values were compared using k-ratio Duncan's multiple-range test at $P \leq 0.05$.

RESULTS

Plant species and genotypes differed in their abilities to support *M. megadora* (Table 1). Distinct galling was observed on roots of six plant species, and reproduction occurred on five of the 14 species tested.

The Rf (Pf/Pi) was greater than 1 on 13 of the 30 genotypes. These were classified as susceptible and included three cultivars of cantaloupe, three of cucumber, six of banana, and one of broad bean (Table 1). The Pf of these hosts varied from 75,300 in broad bean cv. Algarve to 7,800 in cantaloupe cv. Branco do Ribatejo. The bean cv. Bencanta Trepar, included as a susceptible host, had a Pf of 264,000.

Eight plants were classified as resistant including one cultivar each of beet, pepper, radish, and corn, and two cultivars each of watermelon and tomato. Sunn hemp and black velvetbean genotypes also were resistant (Table 1).

The *Brassica* cultivars had an average gall index ranging from 2.8 to 4.0; however, no egg masses or eggs were found (Pf/Pi = 0). They were categorized as resistant/hypersensitive. Either J2, females without egg masses, and(or) necrotic galls were found. Females without egg masses were found in roots of cabbage cv. Savoron, Brussels sprouts cv. De La Halle, and in three broccoli cultivars (Table 2).

DISCUSSION

Some genotypes exhibited a different response from that reported in earlier work (Almeida et al., 1997). There were significant differences ($P \leq 0.05$) in egg production among cantaloupe cultivars (Branco de Ribatejo, Concerto, and Galia), although they were all susceptible; however, cv. Pele de Sapo was reported as resistant/hypersensitive in a previous test (Almeida et al., 1997). Beet (cv. Crosby) and radish (cv. Cherry

TABLE 2. Developmental stages of *Meloidogyne megadora* present in roots of resistant/hypersensitive plants at 60 days after inoculation with 5,000 juveniles (J2) + eggs per plant.

Plant species (cultivars)	Numbers per root system[a]	
	J2	Females without egg masses
Brassica oleracea		
var. *botrytis* (Maresma)	16	0
(Temporão)	13	0
var. *capitata* (Savoron)	13	11
var. *gemmifera* (De La Halle)	10	3
var. *italica* (Roxo)	11	7
(Verde)	6	10
(Violeta)	15	8

[a] Data are means of five replicates.

Belle) were resistant, although other cultivars were resistant/hypersensitive (Almeida et al., 1997). All *Brassica* cultivars were resistant/hypersensitive; in previous work, the cv. Tronchuda Portuguesa was found to be resistant (Almeida et al., 1997).

Sixty days after inoculation, nematode development was delayed in cultivars that gave a hypersensitive reaction. It could be argued that insufficient time was allowed for the nematode to complete its life cycle. However, this seems unlikely as the life cycle of *M. megadora* in bean requires only 48 days at 21 °C (Almeida and Santos, unpubl.), but 60 days was allowed for egg production.

The host range of *M. megadora* includes Rubiaceae (Whitehead, 1968, 1969); Musaceae (Zhang and Weng, 1991); and possibly Apiaceae, Asteraceae, Euphorbiaceae, Myrtaceae, and Solanaceae (Decker et al., 1980; Yassin and Zeidan, 1982). Experimental host preferences in Convolvulaceae, Cucurbitaceae, Fabaceae, and Musaceae were found in previous work (Almeida et al., 1997).

Sunn hemp, black velvetbean, and all resistant plants have potential use in nematode management. They are the safest crops to grow in infested fields because no plant damage is expected and they reduce nematode population density.

In the Democratic Republic of S. Tomé and Príncipe, *M. megadora* has been found only on coffee plantations, some of which are replacing coffee with horticultural crops. Bananas, propagated vegetatively, also have a wide distribution as they represent a staple food for the country's residents. Crop rotation with non hosts will be an important means of limiting damage by *M. megadora.* Based on our results, some potential exists for using some of the crops examined as rotation crops. Future experiments should include different initial nematode infestation levels, and critical environmental conditions for nematode development, reproduction, and survival need to be determined. It is necessary to evaluate the susceptibility of the same plant species and genotypes to other species of root-knot nematodes, especially *M. incognita* and *M. javanica,* already found in the country (Santos, unpubl.).

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