Supplement to Journal of Nematology 26(4S):744–748. 1994.

Host Status of 32 Plant Species to *Meloidogyne konaensis*[1]

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Abstract: A host suitability study of 32 plant species to *Meloidogyne konaensis* included 54 vegetable cultivars, 12 field crop cultivars, one *Gardenia* sp., and two weed species. Host suitability was classified according to a *M. konaensis* reproductive factor: final population density (Pf) (eggs + J2) / initial population density (Pi) (eggs). The number of eggs per gram dry root, and a galling index was also included. Reproductive factor ranges and percentages of plants in the ranges were as follows: Pf/Pi > 5.0, 56.5%; 5.0 ≥ Pf/Pi > 1.0, 24.6%; 1.0 ≥ Pf/Pi > 0, 15.9%; and Pf/Pi = 0, 3%. Peanut and 'Decicco' broccoli were nonhosts. Few or no galls were observed on pepper, corn, ginger, waterchestnut, 'Michihili' chinese and 'Marion' market cabbage, although the reproductive factor of *M. konaensis* was above 5 on these plants.

Key words: field crops, gardenia, *Meloidogyne konaensis*, nematode, nonhosts, root-knot nematode, vegetable, weed.

Meloidogyne konaensis (6), first found in 1991, occurs in several coffee plantations on the island of Hawaii (Zhang and Schmitt, unpubl.). This nematode has not been found on plants other than coffee (Zhang and Schmitt, unpubl.), but its high rate of reproduction on tomato, its ability to develop over a wide temperature range (18), and the diversity of crops grown in Hawaii raised concern that a host range evaluation was needed. Knowledge of host suitability among plants should be useful for crop selection in areas adjacent to coffee plantings.

Species of *Meloidogyne* vary in their host ranges. The four common species of root-knot nematode, *M. incognita, M. hapla, M. javanica,* and *M. arenaria,* have wide host ranges across many plant families. Conversely, some species of *Meloidogyne,* such as *M. chitwoodi,* have a comparatively small host range (7), and *M. carolinensis* parasitizes only blueberry (5). The objective of this study was to determine the suitability of 69 plants (mostly cultivars) from 32 species as hosts to *M. konaensis.*

Materials and Methods

The plants evaluated for host suitability to *M. konaensis* included 54 vegetable cultivars grown in Hawaii, 12 field crop cultivars grown world-wide, one *Gardenia* sp. (closely related to coffee), and two weed species (hilograss and nutsedge) common in coffee fields (Table 1). Hilograss and nutsedge seedlings were collected from the Kona Experiment Station on the island of Hawaii and transplanted into pots. *Gardenia* sp. (15 cm tall) was obtained from a commercial garden center. Ginger, waterchestnut, taro, and sweetpotato plants were purchased from a local supermarket and propagated vegetatively. Pineapple originated from tissue culture. All other plants were grown from seeds. Propagation and (or) culture of plants was done in a sterilized soil (clayey, kaolintic, isothermic, Tropeptic Eutrustox, Oxisol) and vermiculite mixture (v:v = 1:1). When plants and seedlings were ca. 10 cm tall, they were transplanted (one/pot) into 7.5-cm-d clay pots filled with 250 cm^3 sterilized silica sand. The plants were inoculated one week after transplanting. The experimental units were divided into three groups: vegetables, field crops, and others. 'Rutgers' tomato was the susceptible standard host in each group.

Received for publication 15 June 1994.

[1] The research reported in this publication was funded in part by Governor's Agricultural Coordinating Committee and Experimental Station of Hawaii. Journal Series No. 3967 of the Hawaii Institute of Tropical Agriculture and Human Resources.

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The authors thank Drs. S. A. Ferreira and D. T. Bowman for providing vegetable and crop seeds on this research.

An isolate of *M. konaensis* from a population on coffee (*Coffea arabica*) in Kealakekua, Hawaii, was cultured on Rutgers tomato and used for inoculum. Nematode eggs were extracted from the gelatinous matrix by a NaOCl-Blender extraction method (2,10). The suspension was adjusted to give an initial population density (Pi) of 2,500 eggs/plant applied in 10 ml tap water. Surface soil was removed to expose some roots to which the inoculum was added, and the soil was replaced.

Pots were completely randomized on a greenhouse bench. Each treatment was replicated three times, and the experiment was repeated once. Plants were watered daily with tap water and fertilized biweekly with a water-soluble N-P-K fertilizer (23-19-17) at a concentration of 0.09% N, 0.08% P, and 0.07% K for 50 pots/3.8 liter solution. Ambient greenhouse temperatures ranged from 27 to 32 C. No supplemental lighting was provided.

Plants were removed from the sand 60 days after soil infestation. Nematodes were extracted from the sand of each pot (250 cm^3) by elutriation and centrifugal flotation (3,11). Roots were washed gently in tap water, galling was rated, and an index assigned to each plant root system (1), and then the roots were cut into 2-cm-long segments. Eggs were extracted from the gelatinous matrix with 0.4% NaOCl (10). The roots were oven-dried at 70 C for 5 days and weighed. Final nematode population densities (Pf) were computed as the total number of second-stage juveniles (J2) and eggs extracted from the sand and roots of each plant, and reproductive factors (Pf/Pi) were calculated. Host suitability was categorized as good when Pf/Pi > 5.0, fair if 5.0 ≥ Pf/Pi > 1, poor if 1 ≥ Pf/Pi > 0, and nonhost when Pf/Pi = 0.

Results and Discussion

Meloidogyne konaensis has a broad host range. The reproductive factor (Pf/Pi) was greater than 1 on 81.2% of the plant cultivars tested (Table 1). Thirty-nine of the cultivars (56.5%) were categorized as good hosts (Pf/Pi > 5.0) and included monocotyledons and dicotyledons. The average Pf on these hosts ranged from 225,884 nematodes in 'Lahaina Nasubi' eggplant to 14,377 in 'Keystone' pepper. The greatest number of nematodes per gram dry root (422,756) was on 'Oriental Explorer' cucumber. Of these good hosts, the lowest number of nematodes per gram dry root (25,426) was on 'Pioneer 3085' corn.

Fair hosts accounted for 24.3% of the cultivars tested and included 13 vegetables, wheat, hilograss, and *Gardenia* sp. Average Pf per plant ranged from 12,297 on 'Golden Acre' cabbage to 2,913 on *Gardenia*. The greatest number of nematodes per gram dry root (94,159) on fair hosts was found on 'Anuenue' lettuce; the lowest was 2,381 on *Gardenia* sp.

Eleven plant cultivars were categorized as poor hosts. The Pf/Pi ranged from 0.97 in 'Okinawa' sweetpotato to 0.01 in 'KC 380' cotton. Neither J2 nor eggs were found on peanut or 'Decicco' broccoli, suggesting that these two plants are nonhosts.

Tomato and cucumber cultivars tend to be excellent hosts for several *Meloidogyne* species, such as *M. incognita, M. javanica,* and *M. arenaria* (8,17). These two plants were also good hosts for *M. konaensis*. The wide range of responses within the species of broccoli, radish, and cabbage indicates the potential presence of resistance genes within their germplasm (9). Root exudates from some plants exert a suppressive effect on root-knot nematodes (16). The factors responsible for the reduced reproduction of *M. konaensis* on some cultivars in these species should be elucidated.

Pepper, corn, ginger, waterchestnut, 'Michihili Chinese' and 'Marion market' cabbage had little or no galling. Lack of gall formation or production of small galls in these cultivars despite nematode reproduction may indicate that suitable feeding sites are established without the typical hyperplasia and hypertrophy. Failure of giant cells to develop has been observed in resistant cultivars (4), in unsuitable hosts

TABLE 1. Final population density (Pf), galling index (GI), and reproductive factor (RF) of *Meloidogyne konaensis* on 69 plant cultivars 2 months after inoculation with an initial population density (Pi) of 2,500 eggs per plant.

Plant species (common name)	Cultivar	Pf† (J2 + eggs) × 1,000	GI††	RF (Pf/Pi)
Ananas comosus (pineapple)	Smooth Cayenne	2.1 ± 0.3	0	0.85
Arachis hypogaea (peanut)		0	0	0
Avena sativa (oat)	Brooks	0.1 ± 0.04	0	0.04
	NK Coker 716	0.1 ± 0.2	0	0.04
Brassica oleracea var. *botrytis* (broccoli)	Chinese	168.3 ± 28.8	8	67.3
	Calabrese	0.4 ± 0.6	1	0.2
	Decicco	0	0	0
Brassica oleracea var. *capitata* (cabbage)	Pak-choi Chinese	147.6 ± 16.6	5	59.2
	Michihili Chinese	43.0 ± 6.1	2	17.2
	Marion Market	18.8 ± 16.8	1	7.5
	Golden Acre	12.3 ± 8.6	4	4.9
	Copenhagen Market	8.6 ± 3.2	4	3.4
Brassica sp. (green mustard cabbage)		27.8 ± 10.1	5	11.1
Capsicum frutescens (pepper)	California Wonder	52.7 ± 8.8	0	21.1
	Keystone	14.4 ± 8.6	0	5.8
Chrysanthemum coronarium (shingiku)		0.2 ± 0.2	1	0.1
Citrullus vulgaris (watermelon)	Extra Sweet	6.6 ± 3.5	4	2.7
	Sweet Ibuki	6.5 ± 5.5	2	2.6
	Charleston Gray	3.2 ± 1.1	8	1.3
Colocasia esculenta (taro)	Bunlong	3.5 ± 1.9	1	1.4
Crotalaria juncea (sunn hemp)		0.6 ± 0.3	1	0.2
Cucumis melo (cantaloupe)	Hales Best Improved	15.5 ± 5.9	10	6.2
	Perlita	9.5 ± 7.1	7	3.8
Cucumis sativus (cucumber)	Burpless F1 Hybrid	107.4 ± 31.8	10	43.0
	Hybrid Lani	95.4 ± 14.8	10	38.1
	Oriental Explorer	60.3 ± 14.4	10	24.1
	Space Master	49.7 ± 21.3	9	19.9
	Yamato Extra Long	41.6 ± 26.2	10	16.6
Cucurbita pepo (pumpkin)	Early Sugar or Pie	137.9 ± 24.8	9	55.2
Cyperus rotundus (nutsedge)		17.6 ± 7.4	2	7.4
Daucus carota var. *sativa* (carrot)	Lady Finger	13.1 ± 5.3	8	5.2
Eleocharis dulcis (waterchestnut)		43.7 ± 42.8	1	17.5
Gardenia sp.		2.9 ± 3.6	2	1.2
Glycine max (soybean)	Holladay	4.5 ± 2.6	4	1.8
	Ciba 3616	3.3 ± 3.0	2	1.2
	Kahala	0.2 ± 0.1	1	0.1
Gossypium hirsutum (cotton)	Deltapine	0.6 ± 0.8	0	0.2
	KC 380	0.03 ± 0.04	0	0.01
Hordeum vulgare (barley)	Pennco	69.8 ± 25.7	5	27.9
	Boone	62.5 ± 19.0	6	25.0
Ipomoea batatas (sweetpotato)	Okinawa	2.4 ± 1.6	0	0.97
Lactuca sativa (lettuce)	Anuenue	4.5 ± 0.6	8	1.8
Lycopersicon esculentum (tomato)	San Marzano	210.4 ± 27.7	7	84.2
	Floramerica	125.6 ± 44.3	9	50.2
	Roma VF	117.1 ± 35.3	8	46.8
	Beefsteak	113.7 ± 40.8	9	45.5
	Villemaele	107.0 ± 31.5	10	42.8
	Bounty	104.8 ± 29.2	8	41.9
	Patio	104.1 ± 14.8	10	41.6
	Pixie Hybrid II	96.0 ± 32.9	8	38.4
	Rutgers	61.8 ± 5.8	9	24.7
	Prichard	38.0 ± 4.7	7	15.2
Paspalum conjugatum (hilograss)		9.7 ± 6.6	2	3.7
Phaseolus vulgaris (pole green bean)	Hawaiian Wonder	6.5 ± 1.3	1	2.6
	Manoa Wonder	1.5 ± 0.5	0	0.6
Pisum sativum var. *arvense* (edible podded pea)	Manoa Sugar	110.6 ± 25.0	6	44.2

TABLE 1. *Continued*

Plant species (common name)	Cultivar	Pf† (J2 + eggs) × 1,000	GI††	RF (Pf/Pi)
Raphanus sativus (radish)	Daikon-Long	25.3 ± 29.0	2	10.1
	Chinese Daikon (Short)	4.8 ± 0.5	1	1.9
Solanum melongena (eggplant)	Lahaina Nasubi Hybrid	225.9 ± 62.9	5	90.4
	Waimanalo Long	192.5 ± 33.9	4	77.0
	Long Purple	76.5 ± 9.0	4	30.6
	Black Beauty	12.1 ± 6.4	1	4.8
Triticum aestivum (wheat)	NK Coker 9835	10.9 ± 4.9	3	4.4
	Pioneer 2548	8.7 ± 4.0	4	3.5
Zea mays (corn)	Hybrid Sweet #10A	61.4 ± 1.7	2	24.6
	Sweet #9A	60.8 ± 55.8	1	24.3
	Pioneer 3085	60.3 ± 25.7	1	24.1
	Dekalb 689	59.8 ± 7.5	1	23.9
Zingiber sp. (ginger)		94.1 ± 29.1	1	37.7

† Data are means ± standard deviations of three replications.
†† GI = galling index (0–10), and data are means of three replications.

(13,15), and in plants treated with antimitotic agents (14). *Meloidogyne graminis* and *M. marylandi* induce slight galling and *M. aquatilis* caused no gall formation on their hosts (12). Histological studies will be necessary to evaluate parasitism by *M. konaensis* on non-gall-forming hosts.

Although many eggs were present, the lack or low number of J2 in the 'pak-choi Chinese' cabbage and eggplant, may be due to the time required for completing the life cycle of *M. konaensis* on a particular cultivar or species. The life cycle of *M. konaensis* required about twice as long on coffee as on tomato (18).

Although *M. konaensis* was found only in a few fields in the Kona area on the island of Hawaii (Zhang and Schmitt, unpubl.), commercial plantings should be monitored because of the wide host range of *M. konaensis*. It has the potential to become a pest of several crops.

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