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Host Status of Some Selected Crops to *Meloidogyne Incognita*

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Abstract: **Two screen house experiments were carried out to evaluate the reaction of 26 crops to *Meloidogyne incognita* and their possible effect on nematode population. Two- week old seedlings of each crop were inoculated with 5,000 eggs/second-stage juveniles (J2) of *M. incognita*. The plants were arranged in a completely randomized design with four replicates. The experiment was terminated two months after inoculation and the following data were collected: galling index (GI), number of nematode eggs in roots and nematode population in the soil. The Reproductive Factor (RF) was also calculated for each crop. The tested crops with RF less than one (RF<1.0) and GI less than 2 (GI<2), rated as non-hosts or resistant were, *Tagetes erecta* (marigold), *Sorghum bicolor* (sorghum), *Zea mays* (Oba super 1 maize), *Sesamum indicum* (sesame), *Allium sativum* (garlic), *Moringa oleifera* (moringa), *Occimum grattissimum* (tree basil), *Mucuna pruriens* (velvet beans) and *Capsicum annuum* cv safi (hot pepper). Eight of the crops were susceptible with GI>2 and RF >1 while three crops; *Capsicum annuum* cv Yolo wonder (sweet pepper), *Amarathus crentus* (Green vegetables) and *Curcuma longa* (turmeric) were tolerant with GI<2 and RF ≥1. The result of this study suggests that these resistant crops may be used in a rotation on *Meloidogyne*-infested soil, as an alternative way of managing the root-knot nematode.**

Keywords: **Environment, Moringa, Sesame, *Tagetes*, Root-knot Nematode**

I. Introduction

Meloidogyne spp. are notoriously difficult to control because of their wide host range and high rates of reproduction, with generation times typically between 20 and 30 days in tropical soils and females capable of producing several hundred eggs (18). Root-knot nematodes cause galls on roots of susceptible plants which cause a reduction in water and nutrient uptake. Above-ground symptoms manifest as yellowing of leaves and patchiness in the field, leading to reduction in yield and quality of susceptible crops (15).

Many of the nematicides used for the management of root-knot nematodes are effective but are expensive for small- holder producers, highly toxic, pose human and environmental risk or have been withdrawn from the market (32; 1). Apart from the aforementioned problems, it is not economical where low value crops are involved (9) or in small- scale subsistence farming systems. With the phase-out of broad-spectrum fumigant nematicides and increased need for agricultural producers to improve environmental and food safety, alternatives to the application of fumigant chemicals to the soil is essential. Farming system such as sequential cropping in crop rotation is widely regarded as a good agricultural practice in traditional and modern agriculture (23). Crop rotation systems are useful in maintaining soil fertility, reducing or preventing diseases and pest build up in the soil (16). In nematode management, the principle that guides the use of crop rotation is the reduction of populations of damaging nematode species to levels that allow subsequent crops to complete early growth before being heavily attacked (4). This can be achieved by alternating poor hosts, non-hosts or resistant crops with susceptible crops (2).

The adoption of sequential cropping in root-knot nematode control is restricted among the smallholder farms due to scarcity of arable land, coupled with market-driven demand of particular crops and/or varieties (4). More so, a lot of skill is required to design and implement effective crop cycles to control pathogens such as root-knot nematode that have a wide host range (34). Studies have shown that plants such as *Tagetes* spp. (Marigold), *Crotolaria* spp. (Sunn hemp), *Asparagus* spp., *Sesamum indicum* (sesame), and *Azadirachta indica* (neem) are antagonistic to root-knot nematodes through release of root exudates toxic to the nematodes (31). However, a major hindrance to their adoption in to most cropping systems is low or lack of commercial value of the plants (20). Suitability of crops incorporated into crop rotation systems for nematode management is not only determined by it efficiency in nematode suppression, but also by the economic returns brings to the farmer. The challenge is to identify nematode- suppressive crops that satisfy the economic considerations in crop production systems. Therefore the objective of this study was to screen some plants to *Meloidogyne incognita* in order to select the resistant ones for effective cropping patterns for *M. incognita* management.

II. Materials and Methods

Twenty six plants were evaluated in screen house experiments (Table 1). The seeds of each crop species were obtained from Agrictropic Nig Ltd Seed Store, Ibadan, International Institute of Tropical Agriculture (IITA), Ibadan Federal University of Agriculture, Abeokuta (FUNAAB) and National Horticultural Research Institute (NIHORT), Ibadan; and were sown in 6-litre plastic pots containing steam- sterilized sandy-loam soil. The seedlings were thinned to one plant per pot prior to nematode inoculation.

Meloidogyne incognita inoculum used in the experiment was collected from pure culture of *M. incognita* maintained on *Celosia argentea* and extracted using the 0.5% NaOCl method (11). Ten days after seedling emergence, 5,000 eggs/ juveniles (initial nematode density, Pi) were inoculated around the base of the seedling in each pot. The treatments were arranged in a completely randomized design with four replications. Sixty days after inoculation, the roots were removed from the pots and carefully washed and rated for root galling on a 0-5 scale (27). Eggs were extracted from roots with 0.5% NaOCl as described previously. The soil nematode population was also estimated from 250 ml soil from each pot after extraction using the extraction tray method described by Whitehead and Hemming (33).

The total number of nematodes in the soil was extrapolated from the number of second stage juveniles (J_2) counted. The number of nematodes in the soil was added to the number of eggs extracted from the roots to obtain the final nematode population (Pf). The host efficiency, determined by the Reproductive Factor:

$RF = \frac{P_f}{P_i}$, was then calculated

Where P_f (final population) was the average total egg and juvenile population and P_i = the initial population density (5,000 eggs). A reproductive factor of >1 indicates an increase in nematode reproduction where an RF factor of <1 implies no increase in reproduction. The final assessments of resistance of various crops were based on Canto-Saenz's host designation scheme (30). Plants with Gall index (GI) > 2 are defined as either susceptible (RF >1) or hypersusceptible (RF ≤ 1); plants with GI ≤ 2 are classified either resistant (RF ≤ 1) or tolerant (RF > 1) (Table 1).

All data were transformed using square root transformation and statistically analyzed using the SAS (31) statistical package and the means were separated using the Least Significant Difference (LSD) at a probability level of 5%.

Table1. Plants experimented with for host status to Meloidogyne incognita.

Common Name	Scientific Name	Variety	Source
Marigold (+ Control)	*Tagetes erecta*		NIHORT
Sunflower	*Helianthus annuus*	*Black seeded*	NIHORT
Sorghum	*Sorghum bicolor*	*Local*	IITA
Maize	*Zea mays*	*Oba super1*	IITA
Sweet corn	*Zea mays saccharata*		IITA
Leafy Vegetable	Amaranthus *cruentus*		NIHORT
Jute mallow	*Cochorus olitorus*	*Angbadun*	NIHORT
Jute mallow	*Cochorus olitorus*	*Oniyaya*	NIHORT
Pigeon peas	*Cajanus cajan*	Black seeded	NIHORT
Garden Egg	*Solanum aethiopicum*	Kotobi	Agric Tropic
Exotic Eggplant	*Solanum melongena*	Japanese Eggplant	Agric Tropic
Sessame	*Sesamum indicum*	*E8*	FUNAAB
Sessame	*Sesamum indicum*	*NC 03L*	FUNAAB
Sessame	*Sesamum indicum*	*NCR 01M*	FUNAAB
Sessame	*Sesamum indicum*	*530-6-1*	FUNAAB
Sessame	*Sesamum indicum*	*02M*	FUNAAB
Hot pepper	*Capsicum annuum*	Safi	Agric Tropic
Sweet pepper	*Capsicum annuum*	Yolo wonder	Agric Tropic
Garlic	*Allium sativum*		NIHORT
Water melon	*Citrullus lanatus*	F1 Koloss	Agric Tropic
Lettuce	*Lactuca sativa*	Great lakes	Agric Tropic
Turmeric	*Curcuma longa*	Yellow	NIHORT
Moringa	*Moringa oleifera*		NIHORT
Tree basil	*Occimum grattissimum*	Local	NIHORT
Velvet beans	*Mucuna pruriens*		NIHORT
Cucumber (-control)	*Cucumis sativus*	Marketer	Agric Tropic

III. Results

Significant differences were observed among plants evaluated in terms of root galling and reproductive factor. Ten plants namely Jute mallow cv angbadun, Jute mallow cv awoyaya cucumber, garden eggs cv Kotobi, water melon cv koloss, turmeric (*Curcuma longa*), amaranth (*Amaranthus cruentus*), Sunflower (*Helianthus annuus*), Sweet corn and pigeon peas had significantly higher mean galling index than other plants. Fifteen of the 26 plants screened, marigold (*Tagetes erecta*), sorghum (*Sorghum bicolor*), Oba super 1 maize (*Zea mays*), sesame (*Sesame indicum*), garlic (*Allium sativum*),, moringa (*Moringa oleifera*), tree basil (*Occimum grattissimum*), velvet beans (*Mucuna pruriens*) and hot pepper safi (*Capsicum annuum* were poor hosts with mean gall index value <2) (Table 2). The same trend was observed for the second trial. The highest mean reproductive factor of root-knot nematode was from sunflower (10.54) which was significantly different from other plants. (Table 2)

The highest soil population of root-knot nematode was observed from garden egg but was not significantly different from jute mallow cv awoyaya (Table3). The lowest soil population was observed from all accessions of sesame. maize cv oba super 1 and sorghum cv local and were not significantly different from marigold, tree basil, moringa, velvet beans, garlic, and sesame cv 02M which had no root-knot nematode in the soil (Table 3).

The highest total population of root knot nematode was observed from sunflower (*Helianthus annuus*) sweet corn (*Zea mays saccharata),* jute mallow (*Cochorus olitorus*), pigeon peas (*Cajanus cajan*), garden egg (*Solanum aethiopicum*), exotic egg plant (*Solanum melongena)*, water melon (*Citrullus lanatus*) and cucumber (*Cucumis sativus*) (Table 3).

IV. Discussion

Marigold used in this experiment was highly resistant to *M. incognita*. Marigold is commonly used as an ornamental plant; it has been used in nematode and insect pest management (17). The result of this study also corroborates the findings of Polthanee and Yamazaki (22) in which marigold (*Tagetes patula*) was effective in controlling root-knot nematode (*M. incognita*) of rice. Marigold treatment (grown and incorporated into soil before planting rice) suppressed nematode root galling and increased rice grain yield by 46% over the untreated check. The resistance of marigold to root-knot nematode might be as a result of the presence of alpha-terthienyl, an allelochemical produced by this plant which has adverse effect on populations of root-knot nematodes and may have activity against other plant pests such as fungi, bacteria, and insects (10).

The commonly planted local sorghum used was resistant to *M. incognita*. Similar results were observed by Carneiro *et al*. (5) for *M. incognita* and *M. javanica.* Sorghum rotated with soybeans increased productivity of soybean and effectively controlled *M. arenaria* and various other nematodes (26). Velvet beans (*Mucuna pruriens*) was a poor host of *M. incognita*. Similar results were observed for *M. incognita* (24), *M. arenaria* (25) and *M. ethiopica* (7) on mucuna. Velvet bean had a good antagonistic response when incorporated into the soil due to release of toxic substances during decomposition (17; 12). Five accessions of sesame (*Sesamum indicum*) used were also resistant to *M. incognita. S*esame and some grasses can also be used as cover crops to manage populations of root-knot nematodes Sesame valued for its oil and seed, has suppressive activity against the peanut root-knot nematode (*M. javanica*) it has proven equally if not more effective than bahia grass and cotton in reducing the carryover of peanut root-knot nematode juveniles in the soil in a peanut or soybean production system (29). The status of sesame as a host of other species of root-knot nematode commonly found in Nigeria has not been determined. Sesame may be rotated with peanut, soybean, and possibly cotton (29).

V. Conclusions

The results obtained from these experiments are recommended for translation into field trials. Planting successions of different horticultural crops such as sorghum (*Sorghum bicolor*), Oba super 1maize (*Zea mays*), amaranth (*Amarathus crentus*), sesame (*Sesamum indicum*), garlic (*Allium sativum*), turmeric (*Curcuma longa*), moringa (*Moringa oleifera*), tree basil (*Occimum grattissimum*), velvet beans (*Mucuna pruriens*) and hot pepper safi (*Capsicum annuum*) in rotation with susceptible crops will serve as a tool for the management of root-knot nematodes population below the threshold level.

Table 2**:** Quantitative scheme for assignment of Canto-Saenz's host suitability (resistance) designations (Sasser et al., 1984)

Plant Damage Gall Index (GI)	Host efficiency Reproductive Factor (R_f)	Degree of Resistance
≤ 2	≤ 1	Resistance
≤ 2	≥ 1	Tolerant
≥ 2	≤ 1	Hyper-susceptible
≥ 2	≥ 1	Susceptible

Table 3: Root galling and reproductive factor of Meloidogyne incognita on roots of plants inoculation with 5000 eggs in the pot experiment 60 days after infestation

Crops	1st Trial		2nd Trial		
	Galling Index	RF	Galling Index	RF	Host Rating
Jute mallow cv angbadun	2.35	2.04	2.35	2.22	Susceptible
Cucumber	2.35	2.54	2.35	2.59	Susceptible
Garden eggs cv kotobi	2.35	3.79	2.35	3.52	Susceptible
Jute mallow cv awoyaya	2.35	3.35	2.35	3.39	Susceptible
Water melon	2.35	3.94	2.35	3.86	Susceptible

Pigeon peas	2.35	3	2.35	2.86	Susceptible
Sweet corn	1.65	2.38	1.65	3.62	Susceptible
Sunflower	1.58	10.15	1.58	10.54	Susceptible
Pea nut	1.31	0.86	1.31	0.91	Resistant
Sesame cv E8	1.31	0.72	1.31	0.72	Resistant
Maize cv Oba super 1	1.31	0.85	1.31	0.89	Resistant
Tumeric	1.31	1.08	1.31	1.86	Tolerant
Amaranth	1.22	1	1.22	1.03	Tolerant
Sweet pepper Yolo wonder	1.22	2.98	1.22	2.98	Tolerant
Sesame cv 02M	1.1	0.74	1.1	0.75	Resistant
Sesame cv NCR 01M	0.97	0.71	0.97	0.71	Resistant
Sesame cv 530-6-1	0.71	0.71	0.71	0.71	Resistant
Sesame cv NC 03L	0.84	0.73	0.84	0.74	Resistant
Sorghum Local variety	0.84	0.78	0.84	0.93	Resistant
Local basil	0.71	0.71	0.71	0.71	Resistant
Marigold	0.71	0.71	0.71	0.71	Resistant
Hot Peppercv safi	0.71	0.71	0.71	0.71	Resistant
Garlic	0.71	0.71	0.71	0.71	Resistant
Velvet beans	0.71	0.71	0.71	0.71	Resistant
Moringa	0.71	0.71	0.71	0.71	Resistant
LSD	0.2	0.88	0.2	0.77	

Table 3: Reproduction of *Meloidogyne incognita* on 26 crops two months after infestation.

	First Trial			Second Trial		
Crop Variety	Soil Population	Root Population	Total Population	Soil Population	Root Population	Total Population
Marigold (+ Control)	0.71(0.00)*	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Sunflower	166.46 (28000)	509000 (694.96)	715.55 (537000.00)	127.59 (16875.00)	730.79 (55760.00)	743.57 (574475.00)
Sorghum	5.63 (38.00)	20.39 (481.25)	21.28 (519.25)	16.42 (275.00)	39.17 (1562.50)	42.74 (1837.50)
Maize	4.68 (27.50)	30.82 (1112.50)	31.24 (1140.00)	32.56 (1062.50)	16.03 (267.25)	36.88 (1329.75)
Sweet maize	153.71 (26560)	40.69 (1750.00)	160.13 (28310.00)	48.61 (26560.00)	245.43 (1750.50)	251.32 (28310.00)
Amaranth	48.91 (2400)	7.44 (57.50)	49.97 (2457.50)	49.30 (2450.00)	17.29 (360.63)	53.29 (2810.62)
Peanut	13.12 (178)	31.69 (1008)	34.55 (1198)	13.74 (195)	37.03 (1400)	39.84 (1609)
Jute mallow Angbadun	121.06 (14700)	59.72 (3602.50)	135.53 (231.20)	135.45 (18625.00)	59.72 (3602.50)	148.77 (22227.50)
Jute mallow awoyaya	226.19 (52625)	44.61 (2040.00)	231.20 (54665.00)	226.19 (52625.00)	58.99 (3690.00)	234.60 (56315.00)
Pigeon peas	196.74 (39075)	59.99 (3687.50)	206.35 (42762.50)	184.60 (34950.00)	63.72 (4125.00)	195.84 (39075.00)
Garden Eggs Kotobi	254.12 (67313)	60.11 (4135.00)	263.06 (71447.50)	221.72 (51162.50)	94.05 (9925.00)	243.64 (61087.50)
Sessame *E8*	4.95 (35.00)	6.14 (40.00)	8.34 (75.00)	4.95 (35.00)	7.36 (57.50)	9.38 (92.50)
Sessame *NC 03L*	3.26 (17.50)	11.38 (130.00)	12.03 (147.50)	3.26 (17.50)	13.58 (190.00)	207.50±39.45

Table 3 Contd.: Reproduction of Meloidogyne incognita on 26 crops two months after infestation.

Crop Variety	Soil Population (Juveniles) (J)	Root Population (Eggs) (E)	Total Population of M. incognita (J+E)	Soil Population (Juveniles) (J)	Root Population (Eggs) (E)	Total Population of M. incognita (J+E)
Sessame *NCR 01M*	1.66 (5.00)	6.06 (41.50)	6.43 (46.50)	1.34 (2.50)	6.73 (45.75)	6.96 (48.25)
Sessame *530-6-1*	2.62 (10.00)	19.81 (535.00)	20.13 (545.00)	2.62 (10.00)	22.78 (535.00)	23.09 (545.00)
Sessame *02M*	0.71 (0.00)	14.96 (253.50)	14.98 (253.50)	0.71 (0.00)	15.60 (262.50)	17.68 (320.00)
Hot pepper Safi	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Sweet pepper	64.86 (4250)	194.23 (3785.00)	205.00 (6460.00)	82.54 (7000.00)	186.25 (35165.00)	204.74 (42165.00)
Garlic	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Water Melon	170.05 (33800)	212.35 (47000)	272.64 (80800.00)	198.26 (41800.00)	174.25 (31075.00)	268.31 (72875.00)
Turmeric	12.63 (163)	56.38 (3250.00)	57.88 (3412.50)	17.56 (310.00)	120.12 (14590.00)	121.47 (14900.00)
Moringa	0.71 (0.00)	0.71(0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71(0.00)
Tree basil	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Velvet beans	0.71 (0.00)	0.71(0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71(0.00)
Cucumber (- control)	75.18 (5750)	153.53(24425.00)	172.68 (30175.00)	89.83 (8150.00)	151.58 (23150.00)	176.50 (31300.00)
LSD	36.83 (15481)	54.79 (72383)	63.16 (75504)	29.59 (12271)	52.85 (72073)	54.79 (71453)

Pi = 5000 eggs,. Numbers in parenthesis are means of the transformed data $\sqrt{x+0.5}$, which was used in ANOVA. LSD values are for transformed means.

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