RESEARCH NOTE/NOTA DE INVESTIGACION

SCREEN HOUSE RESPONSE OF SEVEN ELITE CASSAVA (*MANIHOT ESCULENTA* CRANTZ) VARIETIES TO *MELOIDOGYNE INCOGNITA* INFECTION

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ABSTRACT

Akinsanya, A. K., and S. O. Afolami. 2019. Screen house response of seven elite cassava (*Manihot esculenta* Crantz) varieties to *Meloidogyne incognita* infection. Nematropica 49:91-98.

In this study, seven cassava varieties were evaluated for their response to infection by *Meloidogyne incognita* in a pot experiment using 30-liter plastic pots. The cassava varieties - TMS 98/0505, TMS 01/1368, TMS 98/0510, TMS 30572, TME EB419, TMS 95/0289, and TMS 98/0581 were inoculated with either 30,000 or 0 eggs of *M. incognita* in a 7 x 2 factorial experiment and grown for 6 months in sterilized soil in a randomized complete block design with three replicates. Data were collected on plant height, stem girth, number and weight of root tubers, number of galls on feeder roots and tubers, number of juveniles per gram feeder roots, and foliage weight. Root systems were scored for galling on 1-5 rating scale. Assessment of plant tolerance to the root-knot nematode was based on gall index (GI) and tuber yield. Assessment of plant resistance to the root-knot nematode was based on nematode reproduction factor (RF). Galls were found on feeder roots and storage roots of infected cassava plants. Gall indices varied from 3 to 5 for infected roots. TME EB419 was tolerant to *M. incognita* with average tuber yield of 425 and 352 g/plant for inoculated and nematode-free cassava plants respectively, GI of 3.0 and an R of 2.6. Six of the cassava varieties were susceptible and intolerant to *M. incognita* with RF between 1.2 and 6.0, GI ranging between 4 and 5, and significant yield loss (P<0.05). Nematode infection (P<0.05) reduced plant height and fresh tuber weight in the cassava varieties except for the tolerant TME EB419 variety.

Key words: Cassava, galling, *Manihot esculenta*, *Meloidogyne incognita*, resistant, susceptible, tolerant

RESUMEN

Akinsanya, A. K., y S. O. Afolami. 2019. Respuesta de la casa de detección de siete variedades de élite (*Manihot esculenta* Crantz) a la infección por *Meloidogyne incognita*. Nematropica 49:91-98.

En este estudio, siete variedades de yuca fueron evaluadas por su respuesta a la infección por *Meloidogyne incognita* en un experimento con macetas utilizando macetas de plástico de 30 litros. Las variedades de yuca - TMS 98/0505, TMS 01/1368, TMS 98/0510, TMS 30572, TME EB419, TMS 95/0289, y TMS 98/0581 fueron inoculadas con 30,000 o 0 huevos de *M. incognita* en un factorial de 7x2. Experimente y crezca durante 6 meses en suelo esterilizado en un diseño de bloques completos al azar con tres repeticiones. Los datos se recopilaron sobre la altura de la planta, la circunferencia del tallo, el número

y peso de los tubérculos radiculares, el número de agallas en las raíces y tubérculos alimentadores, el número de juveniles por gramo de raíces alimentadoras y el peso del follaje. Los sistemas de raíces se calificaron para el desgaste en la escala de calificación del 1 al 5 La evaluación de la tolerancia de la planta al nematodo del nudo de la raíz se basó en el índice de agalla (GI) y el rendimiento del tubérculo. La evaluación de la resistencia de las plantas al nematodo del nudo de la raíz se basó en el factor de reproducción del nematodo (RF). Se encontraron bolas en las raíces alimentadoras y en las raíces de almacenamiento de plantas de yuca infectadas. Los índices biliares variaron de 3 a 5 para las raíces infectadas. TME EB419 fue tolerante a *M. incognita* con un rendimiento promedio de tubérculos de 425 y 352 g/planta para plantas de yuca inoculadas y sin nematodos, respectivamente, GI de 3.0 y una R de 2.6. Seis de las variedades de yuca fueron susceptibles e intolerantes a *M. incognita* con RF entre 1.2 y 6.0, GI entre 4 y 5, y una pérdida de rendimiento significativa (P <0.05). La infección por nematodos (P <0.05) redujo la altura de la planta y el peso fresco del tubérculo en las variedades de yuca, excepto la variedad TME EB419 tolerante.

Palabras clave: agallas, *Manihot esculenta*, *Meloidogyne incognita*, resistente, susceptible, tolerante, Yuca

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Cassava (*Manihot esculenta* Crantz.) cultivation is primarily limited to the tropics and subtropics. Upon maturity, roots can remain in the ground and be harvested from between 6 and 48 months after planting (Nweke *et al*., 2002) depending on cultivar and growing conditions. In the humid lowland tropics, roots can be harvested after 6-7 months. In regions with prolonged periods of drought or cold, the farmers usually harvest after 18-24 months (Cock, 1984). Moreover, the roots can remain in the soil without harvesting for a long period of time, making cassava a very useful crop for food security. The importance of cassava as a component of the diet is increasing due to its high-yielding capacity, ability to grow in marginal soils, flexibility for use in different farming systems, and resistance to pests and diseases (FAO, 1989). Although cassava is grown principally for its swollen storage roots, the leaves of cassava are also eaten in parts of Africa, such as in the countries of the Congo Basin, and is referred to as 'Africa's food insurance crop' (Dixon *et al*., 2003). Cassava is recognized as a small farm and subsistence crop. However, to supply increasing consumer demand, and with increased access to mechanized equipment, cassava is being cultivated on an increasingly larger scale (Nweke *et al.*, 2002).

Nevertheless, the principal factors limiting cassava production remain biotic factors such as pests and diseases including nematodes (IITA, 1990). The study of nematodes as pests of cassava has received little attention (Caveness, 1982) until recently. Although comprehensive lists of nematode pests of cassava and their distributions have been compiled (Hogger, 1971; Caveness, 1980; McSorley *et al*., 1983; Jatala and Bridge, 1990; Bridge *et al.*, 1991), nematodes are often disregarded as constraints to cassava production. This is due, in part, to the fact that the damage the nematodes cause regularly goes unnoticed because of the naturally 'knobbly' and rough texture of the roots, which can disguise nematode damage, and the erroneous belief that the crop is too hardy to be damaged by nematodes.

Nigeria is the world's leading cassava producer (FAOSTAT, 2012). Recent studies documented that root-knot nematodes (*Meloidogyne* spp.) are important pests attacking cassava in Africa (Coyne *et al.*, .2000; Akinsanya and Afolami, 2018). Two root-knot nematode species have been associated with cassava in Nigeria (Dickson, 1978; Caveness, 1981; Atu, 1988), *M. incognita* and *M. javanica*. *Meloidogyne incognita* predominates in the southern humid forest, whereas *M. javanica* is the dominant species in the Sudan Savannah of Northern Nigeria. *Meloidogyne arenaria* and *M. hapla* have also been reported (Coyne *et al.*, 2003), although they are not of major concern. Conservative yield loss estimates to root-knot nematodes throughout the tropics are 6%, equivalent to 6 million metric tons (Caveness, 1982). Given current production levels and renewed interest in production of cassava for food and industrial uses, nematode damages and losses are likely to escalate. Symptoms of root-knot nematode infection are galls on the feeder roots, a reduction in weight of storage root, and reduced stalk height and weight (Caveness, 1982; Atu, 1988). This experiment was

conducted to assess the reaction of seven elite cassava (*Manihot esculenta* Crantz) varieties from the International Institute of Tropical Agriculture (IITA) to infection by *Meloidogyne incognita*.

The research was conducted in a screen house at the Department of Crop Protection, Federal University of Agriculture, Abeokuta, Nigeria (Latitude 7°20'N and Longitude 3°23'E, 76 m above sea level). Seven varieties of cassava cuttings — TMS 98/0505, TMS 01/1368, TMS 98/0510, TMS 30572, TME EB419, TMS 95/0289, and TMS 98/0581 — were obtained from IITA, Ibadan, Nigeria. Thirty-liter capacity plastic pots were filled with 30 kg steam-sterilized sandy-loam top soil. One 20-cm-long stem cutting from each of the seven cassava varieties was planted in each pot.

An indigenous population of *M. incognita* isolated from *Celosia argentea* served as an inoculum source. Eggs were extracted using a sodium hypochlorite method (Hussey and Barker, 1973). Three weeks after planting, each pot was inoculated with 21 ml of an inoculum suspension containing approximately 30,000 eggs of *M. incognita*. The inoculum was placed in a depression made in the soil around each plant. Uninoculated plants of each variety served as controls.

The experiment was a randomized complete block design with three replicates. The pots were watered once daily. Plants were grown for 6 months. Data were collected on plant height, plant girth, number of galls on feeder roots per plant, weight of fresh tuber, number of fresh tubers, and top fresh weight. Root galling was scored on a 0-5 scale rating using Taylor and Sasser (1978): 0 = No galls, 1 = 1-2 galls, 2 = 3-10 galls, 3 = 11-30 galls, 4 = 31-100 galls, 5 = >100 galls.

Data were analyzed for variance and when appropriate, means were separated using Least Significant difference (LSD) at 5% level of probability. Afolami's (2000, 2004) modification of the quantitative scheme for resistance rating by Sasser *et al.* (1984) was used for assigning crop varieties into resistance categories based on crop yield, reproduction factor (RF), and gall index (GI).

Generally, *M. incognita* caused stunting of all the cassava varieties by 3 months after planting and became more pronounced at 6 months when compared to respective uninfected controls with the exception of TME EB419 (Table 1, Fig. 1). TMS 30572 had significant girth reduction attributable to the nematode whereas TMS 98/0581 was stunted *(P*≤0.05) (Table 1). Stem girth ranged from 0.87-1.10 cm at 3 months after planting (3MAP) and 1.00-1.13 at 6 months after planting (6MAP). The effect of *M. incognita* on yield of the cassava varieties showed (*P*≤0.05) differences between infected and the uninfected plants in some of the cassava varieties (Table 2). However, no (*P*≤0.05) differences between the infected and uninfected controls were observed in fresh shoot weight and fresh tuber number among the cassava varieties with the exception of TMS 98/0289. TMS 98/0289 is the only variety where

Figure 1. Effect of *Meloidogyne incognita* on growth of infected and non-infected cassava varieties 6 months after planting in a pot experiment. Note the better growth of nematode-free plants (B, D) compared with infected plants (A, C). A = TMS 98/0581 cassava infected with 30,000 *M. incognita* eggs at 3 weeks after planting. B = TMS 98/0581 cassava in sterilized soil devoid of *M. incognita*. C = TMS 30572 infected with 30,000 *M. incognita* eggs at 3 weeks after planting. D = TMS 30572 cassava in sterilized soil devoid of *M. incognita*.

Table 1. Effect of *Meloidogyne incognita* infection on growth parameters of seven cassava varieties at 3 months after planting (MAP) and at harvest (6 MAP) in a pot experiment[w].

Variety	*M. incognita*	Plant height (cm)[x]		Stem girth (cm)[x]	
		3 MAP[y]	6 MAP[y]	3 MAP	6 MAP
TMS 98/0505	Uninfected	65.87	78.10	1.23	1.33
	Infected	48.67	61.83	0.87	1.00
	LSD (0.05)[z]	24.34 (ns)	24.86 (ns)	0.52 (ns)	0.56 (ns)
TMS 01/1368	Uninfected	60.93	76.80	1.00	1.03
	Infected	52.90	60.17	1.10	1.07
	LSD (0.05)	18.55 (ns)	16.80 (ns)	0.35 (ns)	0.49 (ns)
TMS 98/0510	Uninfected	80.10	93.83	1.00	1.07
	Infected	54.50	56.13	0.87	1.03
	LSD (0.05)	50.42 (ns)	71.29 (ns)	0.46 (ns)	0.38 (ns)
TMS 30572	Uninfected	72.60	87.33	1.13	1.23
	Infected	57.17	71.63	0.87	1.00
	LSD (0.05)	27.26 (ns)	36.59 (ns)	0.26 (s)	0.18 (s)
TME EB419	Uninfected	48.97	63.37	0.93	1.13
	Infected	59.73	71.23	0.97	1.10
	LSD (0.05)	31.81 (ns)	24.04 (ns)	0.57 (ns)	0.85 (ns)
TMS 95/0289	Uninfected	74.43	83.40	1.10	1.17
	Infected	41.83	45.97	0.87	1.03
	LSD (0.05)	46.55 (ns)	54.63 (ns)	0.46 (ns)	0.54 (ns)
TMS 98/0581	Uninfected	85.20	101.93	1.37	1.53
	Infected	60.50	75.63	1.10	1.13
	LSD (0.05)	18.89 (s)	18.54 (s)	0.51(ns)	0.41 (ns)

[w]Initial population of *Meloidogyne incognita* = 30,000 eggs/30 kg soil.
[x]Values are means of three replications.
[y]3 MAP= Three months after planting; 6 MAP= Six months after planting.
[z]LSD= Least Significant Difference; ns= not significant; s = significant.

inoculation reduced fresh tuber number (Table 2). Fresh storage tuber number reduction ranged from 14.29% (TMS 98/0510) to 49.91% (TMS 98/0505) (Table 3). *Meloidogyne incognita* generally reduced fresh tuber weight in all the varieties compared to the uninfected plants with the exception of TME EB419. TME EB419 was the only variety found tolerant to the nematode (Table 4). Also, the effect of *M. incognita* on fresh tuber weight showed ($P \leq 0.05$) differences between infected and uninfected cassava varieties TMS 98/0505 and TMS 98/0581 (Table 2). Fresh storage tuber weight reduction ranged from 0.10% (TMS 95/0289) to 63.61% (TMS 30572) (Table 3).

Based on root galling, all the cassava varieties reacted to *M. incognita* with varying intensity ranging from an index of 3-5 (Table 3). Root-knot nematode incited gall formation not only on cassava feeder roots but also on the tubers (Fig. 2). Cassava variety TMS 98/0581 had the highest number of galls per root system whereas TME EB419 had the lowest (Table 3). The resistance rating of the cassava varieties to *M. incognita* based on yield (Afolami, 2000; Afolami *et al.,* 2004) is shown in Table 4. Results indicated that one cassava variety, TME EB419 was tolerant as the nematode seemed to have stimulated better growth and higher yield in the variety. This tolerant variety (TME EB419) also recorded the lowest gall indices. The rest of the varieties, TMS 98/0505, TMS 01/1368, TMS 98/0510, TMS 30572, TMS 95/0289 and TMS 98/0581, were

Table 2. Effect of *Meloidogyne incognita* infection on yield parameters of seven cassava varieties in a pot experiment.[x]

Variety	Treatment	Fresh tuber No.[y]	Fresh tuber wt (g/plant)[y]	Fresh shoot wt [y](g/plant)[y]
TMS 98/0505	Uninfected	5.33	270.95	65.42
	Infected	2.67	126.31	61.14
	LSD (0.05)[y]	3.06 (ns)	114.07 (s)	39.96 (ns)
TMS 01/1368	Uninfected	5.33	260.74	64.87
	Infected	3.00	168.26	59.82
	LSD (0.05)	2.44 (ns)	99.08 (ns)	59.08 (ns)
TMS 98/0510	Uninfected	7.00	447.14	124.06
	Infected	6.00	322.15	85.70
	LSD (0.05)	7.16 (ns)	239.37 (ns)	121.96(ns)
TMS 30572	Uninfected	3.67	257.15	87.48
	Infected	2.33	93.61	63.88
	LSD (0.05)	3.06 (ns)	301.51 (ns)	40.01 (ns)
TME EB419	Uninfected	4.67	352.52	89.70
	Infected	6.00	425.56	101.50
	LSD (0.05)	5.85 (ns)	188.3 (ns)	62.67(ns)
TMS 95/0289	Uninfected	4.33	379.05	143.89
	Infected	7.00	378.67	90.96
	LSD (0.05)	4.89 (s)	224.74 (ns)	67.81 (ns)
TMS 98/0581	Uninfected	7.67	327.39	169.09
	Infected	4.33	191.70	81.85
	LSD (0.05)	4.13 (ns)	90.7 (s)	94.39(ns)

[x]Initial population of *Meloidogyne incognita* = 30,000 eggs/30 kg soil.
[y]Values are means of three replications.
[z]LSD= Least Significant Difference; ns= not significant; s = significant.

categorized as susceptible as they recorded significant ($P \leq 0.05$) yield loss as a result of nematode infection (Table 4). They also presented high gall indices.

Cassava is a host to and damaged by *M. incognita*. Ours is the first record of galls on storage roots of cassava. Caveness (1978) observed that TMS 30572 and TMS 3055 were highly susceptible to *M. incognita* in Ibadan, Southwestern Nigeria. This study confirms that TMS 30572 was damaged by *M. incognita*. Nematode infection caused a decrease in shoot fresh weight, plant height, and tuber weight and tuber number in varieties rated as not tolerant. Root galling by root-knot nematodes impairs vital physiological processes in the plant like water and nutrient transport and photosynthesis (Khan and Khan, 1987; Melakeberhan *et al.*, 1990). This could account for the significant growth and yield decrease in the susceptible varieties. Significant reduction in cassava plant height by *M. incognita* and *M. javanica* on cassava had been reported by Caveness (1981). Cassava variety TME EB419 was galled, but tolerant to root-knot nematode. A plant that survives and gives satisfactory yield at a level of nematode infection that causes economic loss on other varieties of the same species is tolerant (Fassuliotis, 1979). Canto-Saenz (1985) defined a nematode-tolerant plant as an efficient host that suffers no statistically significant growth and yield reduction. Hence, TME EB419 could be judiciously utilized as planting material in soils

Figure 2. Severe galling on cassava feeder roots and tubers.

Table 3. Percentage decrease or increase in yield parameters of seven cassava varieties due to *Meloidogyne incognita* infection in a pot experiment.

Variety	Fresh tuber number (%)	Fresh tuber (g plant) (%)	Mean number of galls/root system	Gall index (GI)[z]
TMS 98/0505	49.91	53.38	22.7	3
TMS 01/1368	43.71	35.47	36.0	4
TMS 98/0510	14.29	27.95	41.3	4
TMS 30572	36.51	63.61	80.7	4
TME EB419	-28.48	-20.72	99.0	4
TMS 95/0289	-61.66	0.10	112.3	5
TMS 98/0581	43.55	41.45	177.7	5

[y]Values are means of three replications. Negative values show percentage (%) increase, positive values show percentage (%) decrease.
[z]Inoculum of *Meloidogyne incognita* = 30,000 eggs/30 kg soil. 1=1-2 galls; 2=3-10 galls; 3=11-30 galls; 4=31-100 galls; 5= >100 galls.

Table 4. Resistance rating of seven cassava varieties based on Gall Index (GI), Reproduction Factor (RF), and tuber yield of inoculated and cassava plants not inoculated with *Meloidogyne incognita*.

			Crop yield (g/plant)			
Variety	GI[x]	RF[y]	Inoculated plants[x]	Control[y]	Yield difference[x,y]	Degree of resistance[z]
TMS 01/1368	4	1.2	168.26	260.74	-92.48*	Susceptible
TMS 98/0505	4	1.4	126.31	270.95	-144.64*	Susceptible
TME EB419	3	2.6	425.56	352.52	73.04ns	Tolerant
TMS 95/0289	4	2.8	378.67	379.05	-0.38*	Susceptible
TMS 30572	4	4.3	93.61	257.25	-163.64*	Susceptible
TMS 98/0510	5	5.8	322.15	447.14	-124.99*	Susceptible
TMS 98/0581	5	6.0	191.70	327.39	-135.69*	Susceptible

[x]GI = Gall Index
[y]RF = Nematode Reproduction Factor
[z]Resistance rating based on modified scheme of Sasser *et al.* (1984) and Afolami (2000).
Initial population of *Meloidogyne incognita* - 30,000 eggs/30 kg soil.
*Susceptible: RF > 1, GI ≥ 2, significant yield loss; Tolerant: RF > 1, GI ≤ 2, no significant yield loss

infested with *M. incognita*.

This study shows that cassava varieties differ in their resistance to the most common root-knot nematodes species in Southwestern Nigeria. This study contradicts the reports by Ogbuji (1978) that the tuber, which is the economic portion, is usually not galled by the nematodes as it is the case with yam (*Dioscorea* spp.). Caveness (1981), Coyne and Talwana, (2000), and Makumbi-Kidza (2001) earlier reported that *Meloidogyne* spp. associated with cassava concerned solely the feeder roots, with reports stating that damage did not occur to storage roots. This experiment showed that storage roots are also galled by root-knot nematodes depending on cassava variety and root-knot nematode species.

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