Cassava Storage Root Yield Losses from Root-Knot Nematode (*Meloidogyne incognita* and *M. javanica*) Parasitism

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SUMMARY

The root-knot nematodes, *Meloidogyne incognita* race 2 and *M. javanica*, significantly ($P = 0.05$) reduced stalk height, stalk weight and storage root ("tuber") weight of two cassava (*Manihot esculenta*) cultivars, TMe 30555 and TMe 30572, after a 15.5-month growing period in the tropical rainforest zone of southern Nigeria.

A slight reduction in mean plant height in conjunction with a severe reduction in stalk weight would provide an inferior and less robust planting stake for the next crop. Nematode galls were not observed on storage roots but only on fine feeder roots. At harvest the feeder roots generally remain unseen in the soil and any yield reduction may be attributed to other causes or the problem may pass unnoticed.

Cassava (*Manihot esculenta*) supplies about 60% of the daily food calories for the majority of people living in the world's tropic zone. Global importance of cassava has greatly increased with the rise in population, its use as a source of animal feedstuffs, and as raw material for industry. Cassava raw root production annually exceeds 100 million tons and in conjunction with the vegetable use of the leaves as a valued protein source, the crop assumes considerable importance in the total world output of foodstuffs. Cassava is also of considerable social, economic and political importance as it is almost wholly a product of developing nations.

The study of nematodes as pests of cassava has received little attention considering that the crop is one of mankind's major sources of carbohydrate and is a major factor in the economies of some countries. However, the fact that nematode infection of cassava is widespread has long been documented (1, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 18, 20). Sasser (17) estimates that about 6% of the world production is lost to nematode attack. A loss of 6 million tons of carbohydrate is highly significant in a food-short world. This paper reports on parasitism of two root-knot nematode species on two cultivars of cassava.

Materials and Methods

Two cultivars of cassava, TMe 30555 and TMe 30572, were planted in microplots at IITA in the rainforest zone of Nigeria. The microplots were formed of concrete pipe and had a surface area of 0.26 m^2 with a soil depth of 1 m. One month prior to planting, each microplot was fumigated with an overdose of D-D Mixture at

600 l/ha to eradicate all nematodes. During fumigation, the soil surface was sealed with black plastic sheeting. Three weeks after planting cassava stakes and when roots had developed, each microplot was inoculated with about 10,000 eggs of Meloidogyne incognita race 2 or M. javanica. Noninoculated control plots were included. The trial was a completely randomized design with 20 replications. The root-knot nematode cultures had been reared on tomato in the greenhouse. Eggs were harvested using the sodium hypochlorite method of Hussey and Barker (8). The cassava stakes were planted at the beginning of the rains and were not irrigated through the 4-month dry season which began 8 months later. The cassava was harvested at 15.5 months and 3.5 months into the rainy season of the second year.

Soil populations of the root-knot nematode juveniles were determined by taking three 100 cm^3 cores from each microplot with a soil sampling tube 2.5x20 cm. Nematodes were isolated from the soil using the modified Baermann funnel method (21) and concentrated by the settling-siphon method (2). The roots were subjectively rated for the degree of gall development.

Results and Discussion

Soil sampling showed a wide variation in root-knot nematode juvenile population levels and populations were grouped according to density for analysis (Table 1). Root-knot index means show greater feeder root-gall expression by M. incognita on both cassava cultivars than by M. javanica. Root-gall expression was about the same on both cassava cultivars for the two nematode species (Table 2). No gall formation was observed on storage roots. Based on egg counts, M. incognita reproduction was not significantly different on the two cultivars while M. javanica showed a greater rate on TMe 30572 (Table 3). M. javanica juvenile populations ranged from low to very high on both cassava cultivars, while M. incognita had juvenile populations up to medium on TMe 30572 and high on TMe 30555. M. incognita juvenile populations did not reach high densities on either cassava cultivar.

Table 1. Categories of soil populations of root-knot nematode juveniles after 15.5 months of parasitism on cassava by Meloidogyne incognita race 2 and M. javanica.

Root-knot nematode population density	Mean number juveniles per liter of soil	Range
None	0	0
Very low	117	200 - 34
Low	450	500 - 400
Medium	950	1,300 - 600
High	2,150	2,500 - 1,800
Very high	5,150	7,500 - 2,800

The grand means of both nematodes on the two cassava cultivars were significantly different (P = 0.05) for each population level for stalk height, stalk weight and storage root weight (Figure 1). The phenomenon of increased plant growth under light nematode parasitism (Figure 1, Table 4) has been reported previously (3, 4, 19).

Table 2. Root-knot index means on cassava feeder roots after 15.5 months of parasitism by Meloidogyne incognita race 2 and M. javanica. Root-knot index scale of 0 = no galling; 4 = maximum galling. Means of 20 replications.

Nematode	Root-knot index		Mean
	TMe 30572	TMe 30555	
M. incognita	2.95	2.7	2.82
M. javanica	1.9	2.2	2.05
Mean	2.42	2.45	

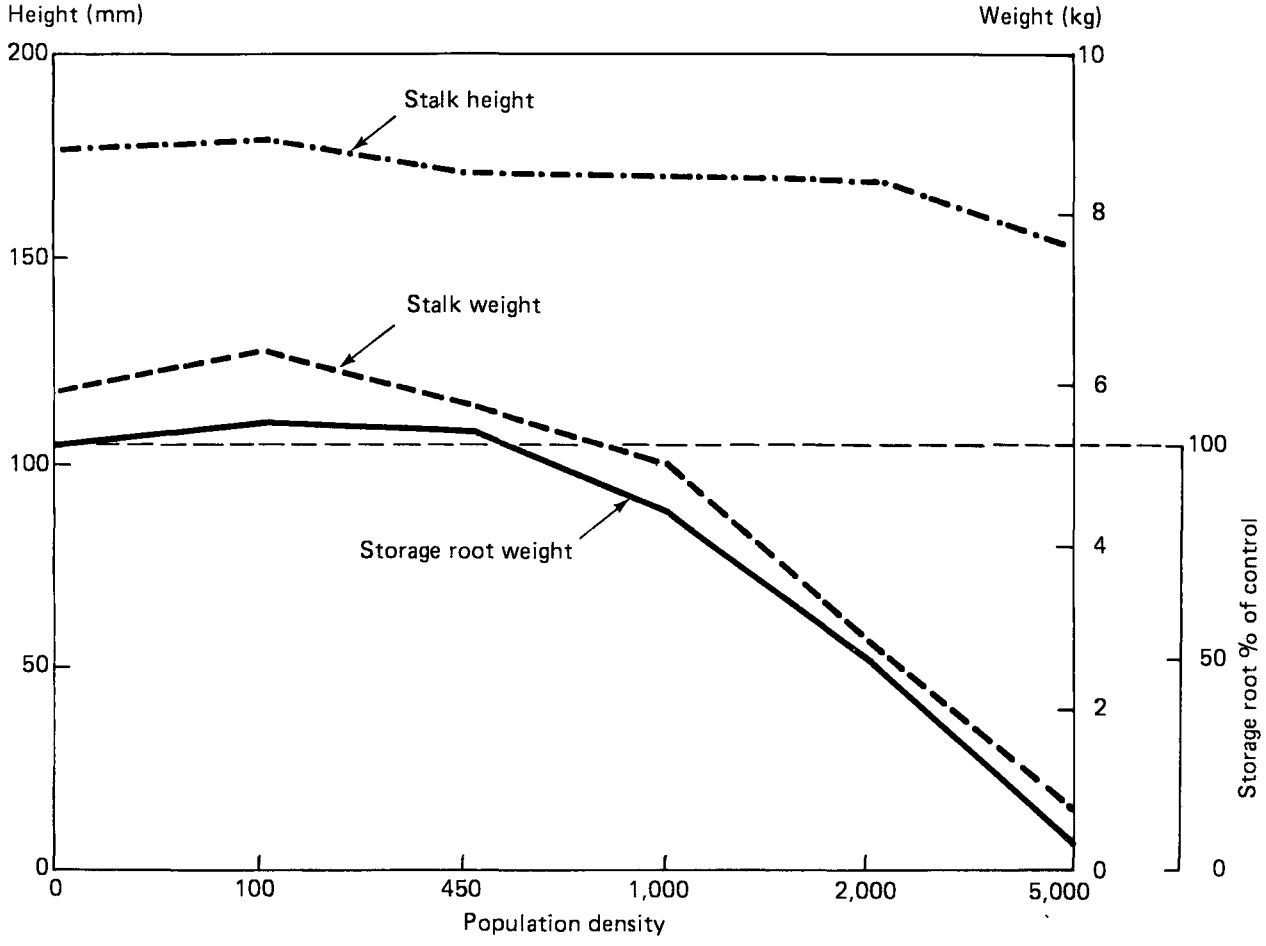
Table 3. Mean numbers of root-knot nematodes eggs/g of cassava feeder root tissue after 15.5 months of parasitism by Meloidogyne incognita race 2 and M. javanica. Means of 20 replications.

Nematode	Number of eggs		Mean
	TMe 30572	TMe 30555	
M. incognita	432	503	467
M. javanica	1,230	112	671
Mean	831	308	

As seen in Figure 1, the slight reduction in mean plant height coupled with the severe reduction in stalk weight would provide an inferior and less robust planting stake for the following crop. The graph shows that a storage root yield reduction of about 17% to 50% can occur without a noticeable decline in plant height. As the root galls are on the fine feeder roots and generally remain unnoticed in the soil, a yield smaller than expected may be attributed to other causes or the problem may pass unnoticed.

Table 4. The grand summary of relative storage root weights of cassava after 15.5 months of parasitism by the root-knot nematodes, Meloidogyne incognita race 2 and M. javanica.

Root-knot nematode population density	Relative storage root weight %
None	100
Very low	106
Low	104
Medium	83
High	50
Very high	2



Root-knot nematode on cassava.

Figure 1. The grand summary of stalk height, stalk weight and storage root weight of two cassava cultivars, TMe 30555 and TMe 30572, after 15.5 months growing period in association with Meloidogyne incognita race 2 or M. javanica.

References

Caveness, F.E. 1967. End of tour progress report on the nematology project. USAID, Lagos, Nigeria (revised).

Caveness, F.E. 1975. A simple siphon method for separating nematodes from excess water. Nematropica 5:30-32.

Caveness, F.E. 1978. Root-knot nematodes on selected food crops in Nigeria, pp. 70-78 In Proc. of the Second IMP Res. Planning Conf. on Root-knot Nematodes, Meloidogyne spp. February 20-24, 1978. Abidjan, Ivory Coast. 93 pp.

Caveness, F.E. 1979. Cowpea, lima bean, cassava, yams and Meloidogyne spp. in Nigeria, pp. 295-300 In Root-knot Nematodes (Meloidogyne Species) Systematics, Biology and Control, eds. F. Lamberti and C.E. Taylor. Academic Press, London. 477 pp.

Deslandes, I.A. 1941. Diseases of cassava in the northeast (Brazil). Boletim do Ministerio da Agricultura 30:23-41.

Dickson, D.W. 1978. Nematode problems on cassava. Proc. 1977 Cassava Production Workshop, Centro Internacional de Agricultura Tropical, Cali, Colombia. Series CE-14:59-63.

Hogger, C.H. 1972. Plant-parasitic nematodes associated with cassava. Tropical Root and Tuber Crops Newsletter 5:4-9.

Hussey, R.S. and K.R. Barker. 1973. A comparison of methods of collecting inocula of Meloidogyne spp., including a new technique. Plant Dis. Reporter 57:1025-1028.

Luc, M. and G. de Guiran. 1960. Les nematodes associes aux plantes de l'ouest African. Liste preliminaire. Agronomie Tropical. Nogent-sur-Marne 15:434-449.

Martin, G.C. 1959. Plant species attacked by root-knot nematodes (Meloidogyne spp.) in the Federation of Rhodesia and Nyasaland. Nematologica 4:122-125.

Neal, J.C. 1889. The root-knot disease of the peach, orange and other plants in Florida due to the work of Anguillula. U.S. Dept. Agr. Div. Entomol. Bull. 20:31.

Niemann, E., M. Lare, J. Tchinde, and I. Zakari. 1972. Contribution to the knowledge regarding diseases and pests of cultivated plants in Togo. Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz 7:595-619.

Nirula, K.K. and R. Kumar. 1963. Collateral host plants of root-knot nematodes. Current Science 32:221-222.

Parris, G.K. 1940. A check list of fungi, bacteria, nematodes and viruses occurring in Hawaii and their hosts. Plant. Dis. Reporter Suppl. 121. 19 pp.

Peachy, J.E. and L. Edmonston-Low. 1967. Plant nematode threats to inter-African phytosanitary barriers. Commonwealth Bur. of Helminthology, St. Albans, Herts., England, Misc. Pub. 1/1967.

Rahm, G. 1928. Alguns nematodes e semiparasitas das plantas culturaes do Brazil. Arq. Inst. Biol. Sao Paulo 1:239-252.

Sasser, J.N. 1979. Economic importance of Meloidogyne in tropical countries, pp. 359-374 In Root-knot Nematodes (Meloidogyne Species) Systematics, Biology and Control, eds. F. Lamberti and C.E. Taylor. Academic Press, London 477 pp.

Steiner, G. and E.M. Buhrer. 1932. A list of plants attacked by Tylenchus dipsaci, the bulb or stem nematode. Plant Dis. Reporter 16:76-85.

Wallace, H.R. 1973. Nematode ecology and plant diseases. Edward Arnold, London. 128 pp.

West Indies University. 1970. Report of the Faculty of Agriculture. St. Augustine, Trinidad. 291 pp.

Whitehead, A.G. and J.R. Hemming. 1965. A comparison of some quantitative methods of extracting small vermiform nematodes from soil. Ann. Appl. Biol. 55:25-38.