Root-Knot Nematode Damage to *Dioscorea rotundata*

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ABSTRACT

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In pot experiments conducted in the glasshouse, white guinea yam cv. Igwe was inoculated with *Meloidogyne incognita* at inoculum levels ranging from 50 to 156,250 eggs per plant. At a soil temperature of 28 C, the economic threshold and economic injury level were fixed at 250 and 1,250 nematodes per plant, respectively. Tubers from pots inoculated with more than 1,250 nematodes per plant were so heavily galled that the market value was reduced by 40%.

The root-knot nematode, *Meloidogyne incognita* (Kofoid & White) Chitwood, is an important pest of white guinea yam, *Dioscorea rotundata* Poir, in parts of southern Nigeria (1–3,8). Infected yam tubers and feeder roots are galled, with some galls being 1 cm or more in diameter. Tubers develop abnormal rootlets. Tubers are deformed and the edible portion reduced.

The purpose of this work was to determine the preplant population of *M. incognita* in the soil that causes economic damage in seed yam as a basis for root-knot nematode control (4,5,7).

MATERIALS AND METHODS

The study was conducted at the National Root Crops Research Institute, Umudike, Umuahia, Nigeria. *M. incognita* inocula were originally obtained from *D. rotundata* and cultured in the glasshouse on a susceptible tomato plant (*Lycopersicon esculentum* Mill. cv. Roma). Heavily galled tomato roots were washed clean with tap water and cut into small pieces. These were placed in a beaker containing 6 L of 0.5% sodium hypochlorite (NaOCl) and stirred for 3 min. The single eggs released from egg masses in the NaOCl solution were poured through nested sieves with pore sizes of 420, 149, 53, and 26 μm. The eggs were collected on the 26-μm sieve and rinsed with tap water to remove the NaOCl. The eggs were concentrated in a 500-ml beaker. The number of eggs per 1 ml of water was counted under a dissecting microscope. Potted sterilized sandy loam soil was inoculated at rates of 50, 250, 1,250, 6,250, 31,250, and 156,250 eggs per pot. The inocula were thoroughly mixed around the planting hole with a hand trowel. Clinging soil on the trowel was washed into the pot.

Yam sets of *D. rotundata* cv. Igwe, each weighing about 120 g, were planted one each in a 10-L plastic bucket. A randomized block design with five replicates was used. The soil temperature averaged 28 C. A bioassay with a susceptible tomato cultivar (Roma) was also planted as an indicator plant. The same nematode inoculum levels were used for the yam sets and the indicator plant. Test plants were scored for galling after 28 days.

Root galls on tubers, feeder roots, and tomato roots were rated according to Sasser and Taylor (6) on a scale of 0–5 (0 = 0, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, and 5 = more than 100 galls).

During the 6 mo of growth, observations were made on the foliar portions of the yam plants. At the termination of the experiment (210 days after planting), harvested tubers were weighed. Postharvest nematode populations in the soils were assessed using the modified Baermann funnel technique (tray method); the jar incubation method was used for extracting nematodes from 20 g of tuber and feeder roots separately (6). The nematodes were counted under a dissecting microscope.

This experiment was repeated two times with comparable results.

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RESULTS AND DISCUSSION

No significant differences were observed in the total fresh tuber weights for the various inoculum levels (Table 1). However, tubers inoculated with more than 1,250 eggs per plant were galled and reduced in grade. This would adversely affect market value. The gall indexes (Table 1) for the tuber and feeder roots in treatments with 250 eggs per plant were 2.0 and 2.2, respectively. These differed significantly from tubers inoculated with 1,250 or more eggs per plant ($P = 0.05$). No significant differences in galling were observed in tubers inoculated with 1,250 eggs per plant and those with the highest inoculum density of 156,250 eggs per plant. *D. rotundata* tolerated high populations of *M. incognita* without appreciable decrease in tuber weights, although the quality of the tubers may be affected. A galled tuber is unappealing to consumers and stores poorly (2).

The bioassay on the indicator plant (Roma tomato) showed that gall indexes on plants inoculated with 1,250 or more eggs per plant were significantly different from those on plants having lower inoculum levels (50 and 250 eggs per plant). These data suggest that a farmer may be taught to use indicator plants to assess the root-knot nematode population in the field before planting.

Yellowing of leaves and termination of vine growth occurred in plants inoculated with 1,250, 6,250, and 156,250 eggs per plant 155 days after planting. These aging conditions were not observed on plants with lower inoculum levels until 185 days after planting. It was thought that early yellowing and leaf fall and termination of vine growth would reduce photosynthesis and result in lower tuber yield, but this did not occur (Table 1).

Nematodes were extracted from the

Table 1. Effects of different inoculum levels of *Meloidogyne incognita* on *Dioscorea rotundata* and on tomatoes

Initial inoculum level (eggs/plant)	Tuber weights of plants[x] (g)			Gall index		
	Infected	Uninfected	Total	Tuber[y]	Root[y]	Tomato
0	0 c[z]	516 a	516 a	0 c	0 d	0 c
50	192 b	249 b	441 a	2.0 c	2.0 c	1.8 b
250	222 b	298 b	520 a	2.2 b	2.2 c	2.0 b
1,250	435 ab	50 c	485 a	4.4 a	4.4 a	4.0 a
6,250	591 ab	0 d	591 a	4.6 a	4.6 a	4.2 a
31,250	558 ab	0 d	558 a	5.0 a	5.0 a	4.2 a
156,250	530 ab	0 d	530 a	5.0 a	5.0 a	4.6 a

[x] Means of five replicates.

[y] Gall index for yam.

[z] Numbers followed by the same letter within each column of data are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

Table 2. *Meloidogyne incognita* infestation of soil, yam tubers, and feeder roots after harvest

	Nematode populations[z]		
Initial inoculum level (eggs/plant)	Soil (400 ml)	Tuber (20 g)	Feeder roots (20 g)
0	0	0	0
50	848 c	2,016 c	3,072 c
250	1,768 b	5,025 b	4,912 c
1,250	1,472 b	10,820 a	13,520 a
6,250	1,686 b	12,124 a	19,748 a
31,250	3,450 a	10,617 a	20,080 a
156,250	1,625 b	6,150 b	19,900 a

[z] Numbers followed by the same letter within each column of data are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

soil after harvest (Table 2), and tuber and feeder roots were assayed for nematodes. More juveniles were extracted from feeder roots than from tubers. There were apparently less favorable conditions for development of sedentary females in feeder roots. Postharvest nematode population is an important factor in a crop rotation program. High populations may affect following crops.

Tolerance limit, the nematode density at which control measures should be initiated to prevent economic damage, was estimated from consumer standards in the local market. In establishing this tolerance, the tuber quality and postharvest nematode infestation were considered, although tuber quality was of primary consideration. In this experiment, the economic threshold or tolerance limit was fixed at 250 eggs per yam plant based on root-knot nematode damage on the tubers and the market value of such tubers.

Table 1 shows the weight of seed yams infested with root-knot at different inoculum levels. Economic threshold was fixed at approximately 40% tuber infection based on differences in market value between infected (galled) tubers and uninfected tubers. This lies between an inoculum level of 50 and 250 eggs per plant. Therefore, the preplant *M. incognita* population likely to cause economic injury to *D. rotundata* cv. Igwe is 1,250 or more nematodes per plant.

In fields where the root-knot nematode population is approaching the economic injury level, control measures such as use of nematicides would be necessary to ensure "clean" tubers. Chemical control of root-knot nematode is not an economic proposition on crops with low hectare value. In seed yam production, starting with seed not infested with root-knot nematode may be considered economic. The concept of economic loss threshold as related to seed yam production has been adopted in Nigeria. An economic loss threshold of 40% of the marketable seed yam was derived from the market value of seed yam and the cost of nematode control with granular carbofuran.

Economic threshold is not absolute. It would vary from crop to crop and from locality to locality. Indicator plants are useful in monitoring field populations. They are designed to help a farmer decide whether or not control measures should be initiated before a major crop is planted in the field.

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