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Comparative Pathogenicity of the Rootknot nematode *Meloidogyne incognita* to four copwpea varities

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Abstract

The role of the rootknot nematode *Meloidogyne incognita* on nodulation, growth, and grain yield of four cowpea varies were investigated in pot experiments. All the four varieties did not form nodules when inoculated with 4,000 eggs and juveniles per pot. However Vita 5 and II 124-5M form nodules better than Ife-Bimpe and TVX-3236 at lower inoculum levels. Dry shoot weight, root length and plant height varied significantly among varieties and between the levels of rootknot nematode inoculations.

Flowering was delayed for up to 46 days in cvs Vita-5, Ife-Bimpe and TVX3236 depending on the levels of inoculum. Flowering was not significantly delayed in cv IT 124-5M at all inoculum levels. Grain yields were reduced by 41.20%, 85.80% and 96.60% in cvs Vita 5, TVX 3236 Ife-Bimpe respectively. Despite high root gall indices in cv IT 124-5M, it out-yielded all varieties at all inoculum levels in this study.

Introduction

Cowpea, *Vigna unguiculata* (L.) Walp is an important grain legume crop in Nigeria. About 90% of the estimated 4 million hectares of land put under cultivation annually in Nigeria for this crop is in the Savannah zone (Raheja, 19767. Average annual production of cowpea in Nigeria has been estimated at 900,000 tonnes (Singh et all 1983) and this represents about 70% of total world production (Parh, 1983). Yield on traditional farms range between 100 and 250kg ha^{-1} (Jackai and Daoust, 1986) while improved varieties may produce up to 1.20 tonnes ha^{-1} depending on insect pest and disease control. One of the important pests reported on cowpea in Nigeria the root-knot nematode, *Meloidogyne* sp (Caveness, 1967; Amosu, 1974; Olowe, 19767.

The root-knot nematodes, *Meloidogyne* spp are cosmoplolitan pests of crops throughout the world (Jensen, 1972). They are important pests of cowpea throughout Nigeria (Caveness, 1967; Amosu, 1974; Olowe, 1976; Singh and Allen, 1979; Ogunfowora, 1981; Olowe, 1981). Three species of the nematode are known to be widespread in Nigeria with *M. incognita* 38.1% and *M. javanica* occurred least frequently (13.7%) (Caveness, 1976). While Caveness (1976) found that mainly *M. incognita* occurred around Ilorin, Wilson (1962) did not distinguish between the species in the same locality.

Estimated yield losses on cowpea in the West African subregion due to root-knot nematode attack ranged from 30% to 94% (Olowe, 1981). A yield loss of 59.1% was

observed on cv Ife Brown grown on root-knot nematode infested soils (Ogunfowora, 1976). Olowe (1976) also reported a 25%, yield loss on cowpea grown in pots and inoculated with 133 eggs of *M. incognita* per litre of Soil. Yield reduction rose to 94% when inoculum rose to 13,300 eggs per litre of soil in the same experiment.

Field infestations of the root-knot nematodes, *Meloidogyne* spp are manifested in chlorotic unthrifty and wilting patches resulting in early death of stands. Poor flowering usually result in poor pod set and eventually poor yield. Such infected plants show characteristic multiple heavy galls all over the root system (Singh and Allen, 1979).

High yielding varieties which are not necessarily resistant to or tolerant of the root-knot nematode *Meloidogyne* species have been released to farmers and have gained wide acceptance because of their grain quality and palatability. The comparative pathogenicities of *M. incognita* on these varieties are of interest so that varieties can be selected for locations based on the root-knot populations especially for farmers who can not afford chemical control of the nematode pests of cowpea.

Materials and Methods

Effects of root-knot nematode inoculations on nodulation

Four cowpea varieties namely: Ife Bimpe (Ex IART Ibadan), TVX 3236 Vita 5 and IT 124-5M (Ex IITA) were used in these studies. Two seeds of each variety were planted in 500cm^3 air-dried sandy loamy soil in 25 plastic pots. At 5 days after germination 5 pots (replicates) each per variety were inoculated with 0, 500, 1,000, 2,000 and 4,000 eggs of *M. incognita* respectively. The eggs were extracted by the Hussey and Barker (1973) method. Populations wer determined by thoroughly mixing the extract in 100ml of distilled water and counting egg population 1ml aliquots. The seedlings were watered regularly every morning. They were carefully uprooted and washed thoroughly thirty-five days after inoculation. The plant height, root length, dry shot weight, per plant were recorded. The root system were rated for gall indices. The data were subjected to analysis of variance and the mean differences partitioned by the use of the Duncan multiple range test.

Pathogenicity of M. incognita on four cowpea varieties

Eighty black 101. polybags were filled with 71. steam-sterilised sandy loamy soil. Two seeds were planted per polybag and twenty polybags were planted per variety. Five days after germination, five polybags per variety were each inoculated with 0, 10,000, 20,000 and 40,000 eggs respectively. The pots were watered regularly every morning and single superphosphate fertilizer was applied at the rate of 5g per pot 45 days after germination. Cymbush 10EC (Cypermethrin) was sprayed three times at the rate of 4ml. per litre of water at weekly intervals starting from the 6th week.

Records were taken of the 50% flowering date, number of mature pods per pot, dry grain yield and number of dry seeds per pod. The gallings were rated as follows:

0	=	no galls
1	=	1 - 5% of root system galled
2	=	6 - 25% of root system galled
3	=	26 - 50% of root system galled
4	=	51 - 75% of root system galled
5	=	76 - 100% of root system galled

(after Taylor and Sasser, 1978).

Results

Effects of M. incognita on nodulation

All the four varieties of cowpea used in this study failed to nodulate when they were inoculated with 2,000 and 4,000 eggs of *M. incognita* respectively. Ife Bimpe had significantly higher than other varieties followed by TVX 3236 when no nematodes were added to the soil (Table 1). Although leaf number did not vary significantly among the varieties, dry shoot weight, plant height and root length were depressed by the inoculations (Table 1). Ife Bimpe showed reductions of 40.30% in plant height and 93.50% in root length while IT 124-5M showed reductions of 18.60% in plant height and 44.5% in root length when inoculated with 4,000 eggs of *M. incognita* respectively.

Root gall rating increased with increasing inoculum level. Although cv IT 124-5M stored the highest dry matter at all levels of inoculum, all varieties supported populations of *M. incognita* (Table 1).

Pathogenicity of M. incognita on four cowpea varieties

The characteristic general chlorosis and poor growth were manifested by all the four varieties at varying degrees depending on the level of inoculum, although cv Ife Bimpe and TVX 3236 were severely affected. IT 124-5M inoculated with *M. incognita* only showed slight chlorosis when compared with the control. At harvest

TABLE 1: EFFECTS OF VARIOUS POPULATION LEVELS OF *M. INCOGNITA* ON MODULATION AND GROWTH OF FOUR COWPEA VARIETIES THIRTY DAYS AFTER INOCULATION

Varieties	*Levels (Nematode) eggs*	*No.of nodules*	*Dry Shoot wt.(g)*	*Plant ht.(mm)*	*Root length (mm)*	*No. of leaves*	*Root gall index*
Vita 5	0	12de	380d	97.6b	205.80d	6	0.0
	500	9d	325cd	84.5ab	195.5cd	6	2.0
	1000	3b	270c	73.5a	156.75c	6	2.2
	2000	0a	220bc	66.9a	109.25b	5	3.0
	4000	0a	160ab	67.6a	106.25b	5	3.5
Ife Bimpe	0	17f	440d	97.8b	256.0d	7	0.0
	500	10d	350d	81.2ab	215.5d	5	4.0
	1000	4b	265c	69.2a	109.6b	4	5.0
	2000	0a	190bc	60.5a	50.8a	3	5.0
	4000	0a	160ab	58.4a	42.2a	3	5.0
TVX 3236	0	12e	360d	84.8ab	308.0e	9	0.0
	500	8cd	280c	81.9ab	267.8d	8	4.0
	1000	2ab	190bc	73.4a	149.5c	7	4.5
	2000	0a	140a	66.2a	98.4b	7	5.0
	4000	0a	100a	64.6a	99.5b	7	5.0
IT 124-5M	0	11d	740h	110.8c	231.0de	6	0.0
	500	7c	630g	106.5bc	185.2cd	5	4.5
	1000	2ab	510f	101.3b	153.6c	5	4.5
	2000	0a	470ef	91.9ab	141.8b	6	5.0
	4000	9a	440e	90.2ab	128.5b	5	5.0

abde Means within columns with the same superscript are not significantly different (P = 0.05)

however, the roots of this variety manifested severe galling at all levels of inoculum. There were significant differences (P = 0.05) in days to 50% flowering in all the varieties. In cv Vita 5, flowering was delayed for 27 days when inoculated with 10,000 eggs of *M. incognita* and rising to 46 days with 40,000 eggs of *M. incognita* respectively. However, in cv IT 124-5M, 50% flowering did not vary significantly among all the inoculum levels (Tables 2 and 3).

Mean pod number per plant varied significantly in all the four varieties, and at all levels of inoculum. Pod formation was significantly higher in cvs Vita 5 and IT 124-5M. The mean number of grains per pod were also significantly different among the varieties and among the treatments.

In cv Ife Bimpe, although the pod number was highest at 40,000 eggs (2.91) grain number per pod was least (1.44) among all inoculum levels. Hence, many of the pods were not filled with grains. Grain number per pod was highest in cv IT 124-5M. Grain yield was adversely affected in cvs Ife Bimpe, Vita 5 and TVX 3236 (Table 2). In cv IT 124-5M however, grain yield in the control treatment was not significantly better than plants inoculated with 10,000 eggs. At 20,000 eggs however, grain yield was 27.85% better than the control treatment. The 40,000 eggs inoculum resulted in 18.56% yield loss (Table 3).

In all the varietieis, root gall index increased with increasing inoculum level. There were positive correlations between root gall index and inoculum levels in all the varieties. Inoculum levels and grain yield were negatively correlated (Table 3).

TABLE 2: SUMMARY OF YIELD PARAMETERS OF COWPEA VARIETIES INOCULATED WITH *MELOIDOGYNE INCOGNITA*

Variety/ Treatments	*(No.of Nematode eggs)*	*Mean 50% Flowering Days*	*Mean Number of Pods per pot*	*Mean Number of Dry Grain/Pod*	*Mean Dry Weight of Grains (g)per pot*	*Root gall Rating*
Vita 5	0	45.50a	3.51f	7.58f	8.22ef	0.00
	10,000	72.60c	2.49d	6.14e	5.17cd	2.20
	20,000	81.60c	2.32c	5.91de	4.76c	3.80
	40,000	91.20cd	2.21c	5.37d	4.83c	4.40
Ife Bimpe	0	43.20a	2.30c	6.04de	7.36e	0.00
	10,000	65.00c	1.83ab	3.70c	2.26b	4.40
	20,000	74.20d	1.47a	2.24b	0.90a	4.60
	40,000	81.40cd	2.91e	1.44a	0.25a	5.00
TVX 3236	0	52.80ab	2.59d	7.54f	6.20d	0.00
	10,000	64.20c	1.64a	5.16d	2.89b	4.60
	20,000	72.80c	1.80ab	4.29d	2.49b	4.60
	40,000	83.20c	1.77a	2.68b	0.88a	4.80
IT 124-5M	0	52.80ab	3.80g	8.18f	11.31g	0.00
	10,000	54.20ab	3.37f	7.82f	11.06g	5.00
	20,000	56.20b	3.60fg	9.48g	14.46h	5.00
	40,000	55.00b	3.49f	7.91f	9.21f	5.00

abcdefgh - Means within columns with the same superscript are not significantly different (P = 0.05).

TABLE 3: INCREASES IN FLOWERING DAYS AND DECREASES AND INCREASES IN GRAIN YIELD OF FOUR COWPEA VARIETIES INOCULATED WITH *MELOIDOGYNE INCOGNITA*

Variety/ Treatments	*(No. of nematode eggs)*	*Increases in Days to 50% flowering days*	*% Decreases & Increases in Grain Yield*	*Correlation Coefficient Inoculum level/yield*
Vita 5	0	0	0	-0.68
	10,000	27.20	-37.10	
	20,000	36.20	-49.40	
	40,000	45.80	-41.24	
Ife Bimpe	0	0	0	
	10,000	21.80	-69.92	-0.82
	20,000	31.00	-87.77	
	40,000	38.20	-96.60	
TVX 3236	0	0	0	
	10,000	11.40	-5.38	-0.91
	20,000	20.00	-59.84	
	40,000	38.20	-85.80	
IT 124-5M	0	0	0	
	10,000	1.40	-2.21	-0.34
	20,000	3.40	+27.85	
	40,000	2.20	-18.56	

Discussion

The root nematode, ***Meloidogyne incognita*** adversely affected nodulation in the four cowpea varieties. Under high soil populations, nodulation was completely prevented in the cowpea plants. This is apparently due to the hypertrophy and hyperplasia taking place in the infected roots thereby preventing normal activities in such roots. Taha and Kassab (1980) observed hindered nodulation in ***Vigna sinensis*** infected by ***Rotylenchulus reniformis*** especially when rhizobial inoculation is preceded by the nematode infections. Varschney et al (1987) observed reduced nodulation when ***M. incognita*** was inoculated on cowpea. Similar reductions in nodulation on legumes have been reported by Masefield, 1958; Nigh, 1966; Taha and Raski, 1969; Balasubramanian, 1971; Husaini and Seshadri, 1971; and Sharma and Sethi, 1976 due to root-knot nematode infections.

The root-knot nematode infection reduced dry shot weight, root length and plant height. Hence, the nematode affected the plants two dimensions first by reducing growth and secondly preventing nodulation which would improve soil Nitrogen levels. This may have partly accounted for the chlorosis observed on the plants. Both cvs Ife Bimpe and TVX 3236 were more severely affected by the infection while cv IT 124-5M, with very impressive growth and high root gall indices appeared to be most tolerant of the infection. Similar breactions to *M. incognita* were observed by Nandwana and Yadav (1978) in 9 out of 51 local and exotic cowpea varieties while Sharma (1983) also found 5 out of 26 cowpea cultivars to be tolerant. In cv Vita 5 however, the low root gall indices and generally good growth are suggestive of some

levels of resistance. Some levels of resistance in cowpea to root-knot infection have been identified in India (Singh and Reddy, 1982; Dasekar and Patil, 1981; Phukan et all, 1982 and Thakar and Patel, 1983) and in Nigeria (Amosu, 1984; Singh and Allen, 1979; Olowe, 1976 and 1981).

The delayed flowering of cv Vita 5, Ife Bimpe and TVX 3236 is indicative of pathgenic potential of *M. incognita* on the varieties. This is further amplified by their significantly reduced grain yield. Similar observations have been made on Ife Brown (Ogunfowora, 1976). Olowe (1981) also made similar observations on some local accessions.

In cv IT 124-5M however, flowering dates were not affected by the levels of inoculation. The grain yield increased by 27.85% with 20,000 eggs of *M. incognita*. This appears to be a hypersensitive reaction of the variety leading to an over compensation of the level of nematode damage. Similar reactions have been observed on *Amaranthus* sp. inoculated with *Meloidogyne* spp. (Ezekwesili and Ogbuji, 1978; Bafokuzara, 1983). Yield losses of 41.20%, 96.60% and 85.80% were recorded in Vdita 5, Ife Bimpe and TVX 3236 respectively. These yield losses are very high and further indicate the pathogenic potential of the nematode in cowpea yield reductions. The significantly reduced grain number per pod when the cowpea varieties were inoculated with *M. incognita* may relate to reduced pollen fertility as was observed by Khan (1987) on root-knot nematode-infected tomato plants. Caneness (1973) estimated 30% yield loss on cowpea due to *M. incognita* while Ogunfowora (1976) reported a 59.1% yield loss in cowpea grown on nematode-infested soil. Olowe (1976) also reported up to 94% yield loss under 13,300 eggs per litre of soil of *M. incognita* inoculation. The root gall indices recorded for cvs Ife Bimpe, TVX 3236 and IT 124-5M indicated susceptible reactions. However, cc IT 124-5M manifested high tolerance level in terms of good grain yield. The root gall indices of cv Vita 5 and the grain yield indicated some levels of reistance to *M. incognita*.

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