Response of tomato cultivars to different inoculum concentrations of root-knot nematode (*Meloidogyne incognita*, Kafoid & White, 1919)

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ABSTRACT

The objective of this study was to investigate the effect of different inoculum concentrations of *Meloidogyne incognita* on 10 elite tomato cultivars. The trial was carried out in pots at the Experimental Farm of the University of Cape Coast, Cape Coast, Ghana, during the 1997 farming season. The root-knot nematode significantly ($P = 0.05$) affected plant height, fresh root length, fresh root weight, and fresh shoot of all cultivars tested. Like other parameters, number of flowers, fruit number, and fruit weight were also reduced significantly ($P = 0.05$) by the nematodes, especially at the highest inoculum density. Cultivars such as Manso 2D, Manso 1B, Laurano, and Anecho whose morphological characters as well as yield were severely affected, were the most susceptible. On the contrary, Fadebegye, Awisa 2E, NR 44, and Wosowoso were tolerant because of their capability to maintain adequate growth parameters, leading to relatively smaller reduction in yield. Yield was highly significant but negatively correlated with root galling. R^2 % values of root galling, fresh root length, fresh shoot weight, and plant height were highly significant. However, the correlations between yield and number of flowers per plant, fresh root weight indicate a very low and non-significant R^2 % values. These provided evidence that root galling was detrimental to yield in these cultivars.

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RÉSUMÉ

Opoku-Asiama, Y. & Yeboah, M. A.: *Réaction des variétés de tomate aux différentes concentrations d'inoculum de nématode de tubercule radical (Meloidogyne incognita,* Kafoid & White, 1919). Le but de cette étude était de faire une enquête sur l'effet des différents niveaux d'inoculum de *Meloidogyne incognita* sur dix variétés de tomate d'élite. L'essai s'est déroulé au champ expérimental de l'Université de Cape Coast, pendant la saison de culture de 1997 en pots. Le nèmatode de tubercule radical affectait considérablement ($P = 0.05$) la taille de plante, longueur de racine fraîche, poids de racine fraîche, et la pousse fraîche de toutes les varietés mises à l'essai. Comme autres paramètres, nombre de fleurs, nombre de fruit et poids de fruit étaient également réduits considérablement ($P = 0.05$) par les nématodes surtout au plus élevé de densité d'inoculum. Les variétés telles que Manso 2B, Manso 1B, Laurano et Anecho dont les caractères morphologiques ainsi que le rendement étaient sévèrement affectés étaient les plus susceptibles. Au contraire, Fadebegye, Awisa 2E, NR44 et Wosowoso étaient tolerantes à cause de leur capacité de maintenir les paramètres de croissance adéquâte, menant aux réductions relativement plus petites en rendements. Le rendement était hautement considérable mais négativement corrélé avec la galle radicale. Les valeurs de R^2 % de galle radicale, longueur de racine fraîche, poids de pousse fraîche et taille de plante étaient hautement considérables. Ce pendant, les corrélations entre le rendement et nombre de fleurs par plante, poids de racine fraîche indiquent les valeurs de R^2 % très basses et non-considérables. Ces donnent la preuve que la galle radicale était nuisible au rendement en ces variétés.

Introduction

Tomato constitutes one of the most important vegetable crops in Ghana and the world at large. Commercially, 7.36 billion t are produced each year from 2.9 million ha of land of which only 15 per cent of the output comes from the tropics (FAO, 1994). In Ghana, about 12 000 ha of land is under tomato cultivation, and it is estimated that more than 60 000 farmers grow tomato during the main season (March-July) or minor season (September-November) (PPME, 1983). In 1987, tomato contributed about 130 000 t to total agricultural production and about ¢13 billion in revenue to the Ghanaian economy (PPME, 1991).

Like other species, tomato crops are infected by many soil-borne pathogens of which root-knot nematodes are among the most devastating (Bridge, 1972). Hemeng (1981) reported 73-100 per cent yield loss in tomato in the Guinea savanna zone of northern Ghana. Losses ranging from 20 to 94 per cent have been recorded in Nigeria (Olowe, 1978). In Ghana, the most predominant species of the root-knot nematode is *M. incognita* which has been identified in almost all the regions (Addo, 1970).

Many workers have investigated the effect of root-knot nematodes on several species. Chineke (1978) observed that growth was significantly reduced when plants were grown on a piece of land infested with root-knot nematodes at the University of Ghana, Legon, Ghana. Oteifa, Barrada & Elgindi (1989) showed that low levels of infestation by *M. incognita* tend to stimulate the growth of new roots in host plants as a form of resistance mechanism. Melakeberhan, Webster & Brooke (1985) also observed a decrease in fresh shoot weight with increasing inoculum concentrations of *M. incognita* which was attributed to significant decrease in total carbon and hydrogen which are components of the main structural element of plants.

The complex mechanisms involved in the response of crops to nematode infestations include phenological, morphological, physiological, and biochemical characters. Therefore, identifying these characters is a prerequisite for using them in breeding programmes.

This study aimed at screening elite cultivars of tomato for their response to *M. incognita* at different inoculum densities.

Materials and methods

Effect of inoculum density of Meloidogyne incognita *on tomato*

Tomato roots infected with galls of *M. incognita* culture in pots were uprooted and egg masses removed with forceps and placed in Petri dishes containing 2 cm^3 distilled water. After every 24 h, juveniles were put into a beaker containing 5 cm^3 distilled water until enough had been collected for inoculation. A pipette was used to draw 2-cm^3 aliquot of juveniles and their population established. A series of 2-cm^3 aliquots suitable for each concentration of juveniles was used to determine inoculum levels needed for inoculation. Tomato seeds used for the study were surface-disinfected in 0.5 % NaOCl for 5 min, and then rinsed three times in distilled water.

Soil from an old refuse dump (with the following properties: 45 % sand, 39 % silt, 16 % clay, *p*H = 5.8, organic carbon (%) = 4.6, and total N (%) = 0.4) was sieved to remove all unwanted materials and then moistened with water before being sterilised in an electric soil sterilizer (Complex model, volt 230/250, watts 1500) at 82 °C for 1½ h. The sterilised soil was poured into a clean rubber container and left overnight to cool. The sterility of the soil was verified by confirming the absence of nematodes through nematode extraction (Christie & Perry, 1951). Black polythene bags, 25 cm × 36 cm in size, were three-quarter filled with 2.5 kg sterilised soil. At 4 weeks, juveniles of *M. incognita* were pipetted into soils in each polythene bag at a depth of 3 cm within the root zone.

The seeds were nursed in the black polythene bags, 3 weeks after germination. Seedlings of almost equal vigour and height were each transplanted in a polythene bag. Treatments consisted of 40 combinations of four levels of inoculum and 10 tomato varieties. The inoculum levels were 0 (T_0), 100 (T_1), 500 (T_2), and 1000 (T_3) juveniles per plant. Local and exotic tomato cultivars were used. The local cultivars were Wosowoso (Woso), Fadebegye (FAD)(Cherry), Awisa 2E (AW2E), Manso 2D (MA2D), Manso 1B (MA1B), NR 44 Local (NR44), and NR 45 Local (NR45). The exotics were Laurano (LAU), Paul (PAU), and Anecho (ANE). Each treatment combination was repeated five times in a factorial experiment with a randomised complete block design (RCBD).

The seedlings were allowed to grow to maturity after which the plants were uprooted and adhering soil thoroughly washed in tap water. Infection caused by root-knot nematode was assessed on the scale of 0-5 modified from Taylor & Sasser, (1987).

0 = No galls or eggmasses = healthy
1 = 0.1-1 galls or eggmasses = highly resistant
2 = 1.1-2 galls or eggmasses = resistant
3 = 2.1-30 galls or eggmasses = moderately resistant
4 = 31-100 galls or egg masses = susceptible
5 = >100 galls or egg masses or dead = highly susceptible

Ripe fruits from plants of each treatment were picked and weighed once a week until the end of harvest, and cumulative yield calculated for each treatment. Plant stem length, fresh weight of shoot, and root length were also measured.

Results

Effect of M. incognita *on height of tomato cultivars*

The effect of *M. incognita* on plant height indicates that for each of the cultivars, an increasing level of inoculum of *M. incognita* caused a corresponding decrease in plant height (Table 1). Plant height reduction after inoculation was least in Awisa 2E but highest in Laurano which was almost up to 50 per cent of the height of the control plants. The reduction in plant height of Awisa 2E and Paul was not significant at the inoculum concentrations studied. But the heights of uninoculated plants (control) of Fadebegye, Wosowoso, Manso 2D, and Manso 1B were significantly different ($P<0.05$) from the inoculated

TABLE 1

Effect of Meloidogyne incognita *on Growth Characteristics of Tomato Cultivars*

Cultivar	Plant height (cm)				Fresh shoot wt (g)				Fresh root length (cm)				Fresh root wt (g)			
	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3
FAD	110.5	79.4	73.8	69.8	149.9	143.4	123.2	100.0	42.6	40.4	35.9	35.8	57.1	56.6	56.7	53.9
NR44	108.6	100.6	82.3	75.8	209.0	199.6	181.0	169.8	38.6	29.8	23.6	22.2	66.3	62.1	62.5	58.7
AW2E	123.0	116.0	111.6	108.0	292.4	233.0	159.4	135.8	31.8	29.4	26.6	21.3	40.2	39.1	38.4	41.6
Woso	113.5	78.4	73.7	65.5	119.4	96.4	85.8	50.2	38.1	21.5	23.3	16.5	62.4	69.2	70.2	70.8
NR45	107.6	99.6	80.2	64.4	204.0	109.4	92.0	76.6	26.9	22.6	17.0	10.4	32.7	43.4	43.2	50.0
PAU	92.8	79.9	68.4	62.6	101.2	78.9	72.6	60.7	34.0	27.4	17.8	15.8	47.2	51.0	50.8	54.5
LAU	88.4	64.8	50.0	*	207.0	181.6	80.0	*	27.6	23.6	18.8	*	39.2	40.6	36.7	*
MA2D	117.7	93.0	67.0	*	210.0	91.8	72.2	*	27.9	23.2	19.0	*	36.6	43.0	32.2	*
MA1B	140.5	103.2	73.2	*	124.4	86.3	64.2	*	26.2	21.8	19.0	*	47.8	50.0	40.8	*
ANE	92.0	78.4	63.0	*	69.8	63.0	54.0	*	21.4	15.4	12.8	*	39.8	42.8	27.4	*
SE ±	2.90				1.37				0.09				0.90			
CV %	12.8				4.4				2.5				6.7			

* = Dead plant

plants. No significant differences in height were observed between plants inoculated with 500 and 1000 juveniles per plant (T_2 and T_3) in Fadebegye, NR 44 Local, Awisa 2E, Wosowoso, NR 45 Local, and Paul. Seedlings of Laurano, Manso 2D, Manso 1B, and Anecho inoculated with the highest inoculum level of 1000 juveniles per plant (T_3) died before the end of the experiment.

Effect of M. incognita *on fresh shoot weight of tomato cultivars*

Table 1 shows the effect of inoculum levels of *M. incognita* on fresh shoot weight of tomato cultivars. Generally, fresh shoot weight decreased with increasing inoculum levels in all cultivars. Except for Fadebegye, NR 44 Local and Anecho, inoculum level of 100 juveniles per plant (T_1) reduced fresh shoot weight significantly in all cultivars. The fresh shoot weights of Awisa 2E, Laurano, and Manso 1B inoculated with 100 juveniles per plant (T_1) were significantly different from the same cultivars inoculated with 500 juveniles per plant (T_2). Fadebegye, Awisa 2E and Wosowoso were the only cultivars whose fresh shoot weights were significantly affected by 500 and 1000 juveniles per plant (T_2 and T_3).

Effect of M. incognita *on fresh root length of tomato cultivars*

Table 1 summarizes the effect of inoculation concentrations of *M. incognita* on fresh root length of tomato cultivars. The results indicate that root length decreased with increasing inoculum levels, except in Wosowoso, in which inoculum level of 500 juveniles per plant (T_2) produced roots longer than 100 juveniles per plant (T_1). The fresh root lengths of Wosowoso, Paul and Anecho inoculated with 100 juveniles per plant (T_1) were significantly shorter than those of the uninoculated plants (T_0). The root lengths of Fadebegye and Paul were not significantly affected when inoculum level was increased from 500 to 1000 juveniles per plant (T_2 to T_3). However, in other cultivars, increasing levels of inoculum resulted in significant decreasing fresh root lengths.

Effect of M. incognita *on fresh root weight of tomato cultivars*

Table 1 presents the effect of inoculum concentrations of *M. incognita* on fresh root weight of tomato cultivars. The inoculum levels studied did not significantly affect the fresh root weights of Fadebegye and Awisa 2E. However, Manso 2D, Manso 1B, and Anecho plants inoculated with 100 juveniles per plant (T_1) produced significantly heavier roots. NR 44 Local and NR 45 local were the only cultivars that were significant in this parameter in T_2 and T_1.

Effect of M. incognita *on number of flowers per plant of tomato cultivars*

Table 2 shows the results of the effect of inoculum levels of *M. incognita* on the number of flowers per plant. Significant differences ($P<0.05$) were observed in number of flowers per plant between uninoculated plants (T_0) and plants infected with 100 juveniles per plant (T_1) in Wosowoso, Manso 2D, NR 45 Local, Laurano, and Anecho. However, no significant differences were observed in this parameter in T_1 and T_2 in Fadebegye, NR 44 Local, Awisa 2E, Laurano, and Manso 2D. Fadebegye, NR 44 Local, and Awisa 2E recorded significant differences ($P< 0.05$) between plants inoculated with 500 and 1000 juveniles per plant (T_2 and T_3) while differences among Wosowoso, NR 45 Local, and Paul were not significant.

Effect of M. incognita *on number of fruits per plant of tomato cultivars*

Table 2 shows the effect of levels of inoculum of *M. incognita* on the number of fruits per plant of tomato cultivars. The results indicate a general decrease in number of fruits per plant with increasing inoculum levels. The Fadebegye cultivar recorded the highest mean number of

TABLE 2

Influence of Meloidogyne incognita *on Yield Components of Tomato Cultivars*

Cultivar	Mean no. flowers per plant T_0	T_1	T_2	T_3	Mean no. fruits per plant T_0	T_1	T_2	T_3	Fruit weight (g) T_0	T_1	T_2	T_3
FAD	72.3	68.7	68.1	49.8	60.4	59.4	57.6	56.6	1.84	1.74	1.54	1.40
NR44	32.8	30.2	27.0	15.6	15.4	14.0	12.6	10.2	37.4	31.0	29.4	30.4
AW2E	21.6	18.0	19.0	13.8	9.8	7.6	7.1	6.7	33.4	30.0	28.9	29.3
WOSO	25.6	17.2	9.4	10.6	12.0	6.8	6.6	6.2	42.2	40.8	40.2	40.6
NR45	24.2	13.0	9.6	7.0	11.4	7.2	5.4	3.2	20.4	19.8	20.1	20.2
PAU	20.2	17.4	10.6	7.2	9.0	8.0	4.8	3.2	48.6	44.4	43.4	43.5
LAU	18.8	9.4	9.0	*	7.4	4.8	3.2	*	44.8	41.8	42.4	*
MA2D	27.0	22.0	22.4	*	9.0	6.2	5.0	*	44.5	42.9	39.4	*
MA1B	35.8	28.7	17.8	*	9.2	6.4	3.6	*	48.2	47.5	47.6	*
ANE	36.9	24.8	19.4	*	8.2	5.8	3.4	*	23.3	22.4	21.9	*
SE ±		0.3					0.12					0.08
CV %		3.2					7.7					1.3

* = Dead plants

fruits per plant while Laurano recorded the least. The highest inoculum level, 1000 juveniles per plant (T_3), resulted in the death of Laurano, Manso 2D, Manso 1B, and Anecho.

Effect of M. incognita *on mean fruit weight of tomato cultivars*

Table 2 shows the observed variations in mean fruit weight of tomato cultivars of *M. incognita.* Generally, across cultivars, uninoculated plants (T_0) recorded the highest mean fruit weight compared to all plants inoculated with *M. incognita*. The Paul cultivar had the highest mean fruit weight of 48.6 g, and the least of 1.40 g was recorded by Fadebegye. All cultivars were not significantly affected at different inoculum levels of *M. incognita*, except NR 44 Local and Paul, which differed significantly from the uninoculated plants (T_0).

Effect of M. incognita *on yield of tomato cultivars*

Table 3 shows the effect of inoculum levels of *M. incognita* on tomato cultivars. Similar to other parameters, yield per plant decreased with increasing inoculum levels. Across cultivars, significant decreases in yield per plant were seen between uninoculated plants (T_0) and all inoculated plants, except for Fadebegye, which was not significantly affected by the different inoculum levels of *M. incognita.*

In spite of the general decrease in yield per plant, reductions in yield at inoculum levels of 500 and 1000 juveniles per plant (T_2 and T_3) in NR 44 Local, Awisa 2E, and Wosowoso were not significantly different ($P<0.05$) from each other as compared to NR 45 Local at the two levels. At the highest inoculum level of 1000 juveniles per plant (T_3) of *M. incognita*, plants showed yield reduction relative to the control plants in the order of Fadebegye, Awisa 2E, NR 44 Local, Wosowoso, Paul, and NR 45 Local. Yield reduction in plants inoculated at1000 juveniles per plant of *M. incognita* for Laurano, Manso 2D, Manso 1B, and Anecho was 100 per cent, because the seedlings died before reaching full maturity.

Effect of M. incognita *on root galling of tomato cultivars*

Table 4 shows the infectivity of tomato cultivars

TABLE 3

Influence of Meloidogyne incognita *on Yield of Tomato Cultivars*

	Treatment							
	T_0		T_1		T_2		T_3	
Cultivar	*Yield/plant (kg)*	*Reduction (%)*	*Yield/plant (kg)*	*Reduction (%)*	*Yield/plant (kg)*	*Reduction (%)*	*Yield/plant (kg)*	*Reduction (%)*
FAD	0.11	-	0.10	9.1	0.09	18.2	0.09	18.0
NR44	0.58	-	0.43	25.8	0.37	36.2	0.30	48.2
AW2E	0.37	-	0.24	35.1	0.21	39.2	0.20	45.9
WOSO	0.51	-	0.28	45.1	0.27	47.1	0.25	50.9
NR45	0.24	-	0.14	41.6	0.11	54.2	0.06	75.0
PAU	0.44	-	0.36	18.2	0.21	52.2	0.14	58.1
LAU	0.33	-	0.20	39.4	0.14	57.6	*	100
MA2D	0.40	-	0.34	15.0	0.19	52.5	*	100
MA1B	0.44	-	0.30	31.8	0.17	61.4	*	100
ANE	0.19	-	0.13	31.6	0.07	63.2	*	100
SE ±				0.04				
CV %				13.5				

* = Dead plants

TABLE 4

Influence of Meloidogyne incognita *on Root Galling of Tomato Cultivars*

	Root galling index rating+			
Cultivar	T_0	T_1	T_2	T_3
FAD	0.0	0.4	0.6	0.8
NR44	0.0	0.8	1.2	1.4
AW2E	0.0	1.2	1.4	1.4
WOSO	0.0	1.8	1.8	2.2
NR45	0.0	3.2	3.4	4.0
PAU	0.0	3.2	4.2	4.9
LAU	0.0	2.8	4.8	*
MA2D	0.0	2.9	4.0	*
MA1B	0.0	2.0	4.2	*
ANE	0.0	3.8	4.4	*
SE ±		0.03		
CV %		3.0		

+ Root galling index: 0 = no galls; = 100 or more galls

* = Dead plants

to *M. incognita.* Root galling increased with inoculum level. No galling was observed on the roots of uninoculated plants (T_0). No significant levels (P<0.05) in galling were observed in Fadebegye, NR 44 Local, Awisa 2E, and Wosowoso at the different inoculum levels. However, with NR 44 Local, Paul, Laurano, Manso 2D and Manso 1B, uninoculated plants (T_0) differed significantly from plants inoculated with 100 juveniles per plant (T_1). The Wosowoso, NR 45 Local, and Paul cultivars which were inoculated with 500 and 1000 juveniles per plant (T_2 and T_3) of *M. incognita* did not differ significantly from each other in root galling. Root galling was not recorded in plants inoculated at 1000 juveniles per plant (T_3) in Manso 2D, Manso 1B, Laurano and Anecho, because the plants died before the end of the experiment.

Relationship between root galling, growth characteristics, and yield of tomato cultivars inoculated with M. incognita

Table 5 shows the correlations among root galling, growth parameters, and yield of tomato cultivars. Yield correlated positively with number of flowers per plant, fresh root weight, fresh root length, fresh shoot weight, and plant height (Tables 1 and 2). Of these parameters, the correlations with the first two were not significant, while with the last four, they were highly significant at $P< 0.01$. Yield was highly significant ($P< 0.01$) but negatively correlated with root galling. R^2 % and R^2 % (adj.) values of root galling, fresh root length, fresh shoot weight, and plant height were highly significant at $P<0.01$. The weak correlations between yield and number of flowers per plant, fresh root weight, indicate very low and non-significant R^2 % and R^2 % (adj.) values.

TABLE 5

Correlation Coefficient, r, and Coefficient of Determination R^2 (%) Values of Root Galling Index and Some Growth Parameters on Yield of Tomato Cultivars Infected with Meloidogyne incognita

Factor	*r*	*R^2 (%)*	*n*
Root galling	-0.209**	4.4**	200
No. flowers/plant	0.118	1.4	200
Fresh root length	0.533**	28.4**	200
Fresh root weight	0.015	0.02	200
Fresh shoot weight	0.514**	26.4**	200
Plant height	0.238**	5.7**	200

* Significant at $P<0.05$
**Significant at $P=0.01$

Level of resistance/ susceptibility of tomato cultivars to M. incognita

Table 6 shows the levels of resistance and susceptibility to *M. incognita* of the various tomato cultivars studied. The Fadebegye cultivar was highly resistant (0-1 gall or egg mass) while Awisa 2E and NR 44 Local were resistant (0.1-2 galls or egg masses). Wosowoso and Paul were moderately resistant (11-30 galls or egg masses) while NR 45 Local and Paul were rated susceptible (31-100 galls or egg masses). Laurano, Manso 2D, Manso 1B, and Anecho, whose seedlings died at the highest inoculum of 1000 juveniles per plant, were considered highly susceptible.

TABLE 6

Levels of Resistance and Susceptibility of Tomato Cultivars to M. incognita

Cultivar	*Root-knot nematode infection index+*	*Level of resistance*
Fadebegye	0.8	Highly resistant
Awisa 2E Local	1.8	Resistant
NR 44 Local	1.4	Resistant
Wosowoso	2.2	Moderately resistant
NR 45 Local	4.0	Susceptible
Paul	4.9	Susceptible
Laurano	*	Highly susceptible
Manso 2D	*	Highly susceptible
Manso 1B	*	Highly susceptible
Anecho	*	Highly susceptible

* = Dead plants
+= Inoculum level of 1000 juveniles/plant

Discussion

The reduction in height of all cultivars, except for Awisa 2E and Paul, when inoculated with *M. incognita* seems to reflect the sensitivity of the tomato cultivars studied to *Meloidogyne* attack. This finding is supported by the report of Chineke (1978) on varieties of tomato in Ghana. He observed that growth was significantly reduced when plants were grown on a piece of land infested with root-knot nematodes. However, the lack of significant reduction in plant height of Awisa 2E and Paul at low levels of *M. incognita* probably suggests some levels of resistance against *M. incognita* attack. This supports work by Oteifa *et al.* (1989) that low levels of infestation by *M. incognita* tend to stimulate the growth of new roots in host plants as a form of resistance mechanism.

The non-significant effect of *M. incognita* on fresh shoot weight of Fadebegye and NR 44 Local might be due to their resistance to this pathogen. This agrees with the findings of Melakeberhan *et* *al.* (1985) who observed a decrease in fresh shoot weight with increasing inoculum level of *M. incognita* and attributed this to significant decrease in total carbon and hydrogen which are components of the main structural element of the plant. The results of this study also agree with the findings of Sariah (1980) who did not find significant difference in fresh shoot weight in tomato plants when inoculated with *M. incognita*.

The significant reduction in root length at high inoculum densities of *M. incognita* probably suggests that only such levels were severest enough to inhibit root elongation. The non-significantly shorter roots in Manso 2D, Manso 1B, Anecho, and Paul could be due to the significantly negative correlation between root galling and fresh root length. The significantly heavier fresh root weight recorded in NR 45 Local, Paul, and Wosowoso in inoculated plants could probably be due to the nematodes inducing growth in the infected roots of these cultivars. Similarly, Sariah (1980) reported an increase in the root weight of tomato plants infected with *M. incognita* as a result of the nematodes inducing galls. The fresh root weights of Fadebegye and Awisa 2E which were unaffected by *M. incognita* might probably be due to the insignificant number and size of galls formed on their roots.

Generally, the number of flowers per plant was reduced in all cultivars studied. However, reduction in number of flowers per plant in Fadebegye and Awisa 2E was not significant. This probably suggests that in spite of *M. incognita* infection, these cultivars were able to carry out metabolic processes which support flowering. This finding agrees with that of Khan, Khan & Singh (1997) who observed significantly fewer numbers of flowers in tomato pl[illegible] oculated with root-knot nematodes than in uninoculated plants.

The insignificant difference in number of fruits per plant between inoculated and uninoculated plants of Fadebegye and Awisa 2E probably indicates their ability to resist attack. These findings agree with that of Sellami & Eddoud (1991) who reported no significant reduction in number of fruits per plant in inoculated plants of nematode-resistant tomato cultivars. With Manso 1B, Manso 2D, Anecho and Laurano, the observed significant difference in number of fruits per plant suggests lack of resistance to *M. incognita*. This might probably be due to their inability to recover from root damage caused by nematode infection.

The highest mean fruit weight observed in the control plants compared to the inoculated plants could be due to competition for inadequate photosynthate by all organs under diseased conditions, which might have prevented the fruits from getting enough photosynthate. The non-significant difference in average weight of fruits of Fadebegye, Wosowoso, and NR 45 Local could possibly indicate their level of resistance to the nematode. Vito *et al.* (1991) confirmed this observation when they found that fruit weight of tomato plants was not significantly affected by *M. incognita*. They attributed this observation to the resistance of cultivars they studied.

The significant reduction in yield of cultivars in Laurano, Manso 2D, Manso 1B, and Anecho suggests that *M. incognita* might have had impact on the yield of these cultivars. It is also possible that the heavy root galls observed in these cultivars might have reduced these yields. This observation is confirmed by the significant negative correlation between yield and root galling index. The significantly high R^2 % and R^2 (adj.)% values provided evidence that root galling was detrimental to yield in these cultivars. In a similar study, Khan *et al.* (1997) indicated reduced yield in tomato plants when inoculated with root-knot nematodes. They attributed this to reductions in plant weight and number of flowers as a result of the host plant being unable to sustain prolonged infestations and at the same time maintain yield.

The relatively higher levels of resistance of Fadebegye, Awisa 2E, and NR 44 Local in the screening test with *M. incognita* might be due to the apparent absence of galls and the lower yield reduction they recorded. Sasser & Taylor (1952) and Roynoid & Carter (1969) have offered physiological explanations for this resistance.

Sasser & Taylor (1952) attributed resistance to root-knot nematodes by tomato plants to the inability of the nematode larvae to penetrate the host plant. Roynoid & Carter (1969) attributed resistance of tomato plants to the inability of the nematode larvae to establish a nutritive relationship with the plant.

Conclusion

Pathogenicity test of *M. incognita* rated Fadebegye as highly resistant, and Awisa 2E and NR 44 Local as resistant cultivars. This suggests the need to incorporate them in breeding programmes to evolve resistant cultivars which are high yielding and adaptable to local conditions.

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