Reactions of Some Tomato Cultivars and Hybrids to *Meloidogyne* spp. and Management of *M. incognita* Infection Using Certain Organic Manures and Mineral Fertilizers

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ABSTRACT

Susceptibility of five tomato cultivars and two hybrids to the root-knot nematodes *Meloidogyne arenaria, M. javanica* and *M. incognita* was tested under greenhouse condition. Three tomato cultivars; Hadir, Jannat, Viona and the hybrid 745 were found highly susceptible and two cultivars; Fairuz, Lamour and the hybrid 1077 were found susceptible to the tested nematode species. Efficacy of cattle, pigeon, rabbit and "RIGIR Fit" chicken as organic manures; ammonium sulphate, urea and super phosphate as mineral fertilizers; in addition to the nematicide, Nemacure®10G were assessed against the root-knot nematode, *M. incognita* infected Jannat tomato cultivar grown under greenhouse condition. Application of cattle, chicken, pigeon and rabbit manures in autoclaved and non-autoclaved soils resulted in significant reductions of 67.2-91.4 % in numbers of nematode root galls and egg-masses/root system, and resulted in significant increases in plant growth traits as well as on the major macronutrients; N, P and K in tomato leaves of Jannat cultivar.

Key words: Root-knot nematode, tomato cultivars, organic manures, mineral fertilizers, fenamiphos, control.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is one of the commercial and widely grown vegetable crops in both tropics and sub-tropics, which is often severely attacked by the root-knot nematode, *Meloidogyne incognita*, a predominant and widely prevalent species causing serious loss in tomato (Sasser, 1990; Serfoji *et al.,* 2010). Chemical nematicides that are being used for controlling plant parasitic nematodes are costly and hazardous in nature. High costs, environmental safety and problems regarding nematicides use have encouraged several scientists to look for alternative methods against nematodes control (Aalders *et al.,* 2009). Recently, researchers are occupied in standardizing the nematode management strategies by following non-chemical and eco-friendly approaches such as application of organic soil amendments, biological control agents to stabilize economic crop production (Kantharaju *et al.,* 2005; Rajendran and Saritha, 2005; Sumathi *et al.,* 2006; Oka *et al.,* 2007). Application of organic manures is recognized to have positive influences on soil nutrition, soil physical conditions, soil biological activities and crop performance (Efthimiadou *et al.,* 2010). In addition, these materials have been investigated as an alternative method for nematode management (Akhtar and Mahmood, 1996; Ibrahim *et al.,* 2007). Cultivars can be estimated for root-knot nematode resistance based on the degree of root galling, number of egg mass or total number of eggs collected from plant root system (Hussey and Boerma, 1981).

The present research studies were carried out to study (i) the reactions of five cultivars and two hybrids of tomato to root-knot nematode species *Meloidogyne arenaria*, *M. javanica* and *M. incognita*; (ii) the effects of soil amendments with 4 organic manures (cattle, pigeon, rabbit and "RIGIR Fit" chicken), 3 mineral fertilizers (ammonium sulphate, super phosphate and urea), and the nematicide Nemacure®10G on *M. incognita* infected tomato cv. Jannat under greenhouse condition.

MATERIALS AND METHODS

Root-knot Nematodes Inocula Preparations:

The root-knot nematode species *Meloidogyne arenaria* Chitwood, *M. javanica* (Treub) Chitwood and *M. incognita* Kofoid and White (Chitwood) were obtained from the Plant Nematology Greenhouse, Department of Plant Pathology, Faculty of Agriculture, Alexandria University. Root-knot nematode species were reared on tomato plants (*Lycopersicon esculentum* Mill) cv. Super Marmande in a greenhouse from single egg-masses of adult females previou1sly identified by the morphological characteristics of the female perineal patterns (Taylor and Sasser, 1978; Eisenback and Triantaphyllou, 1991). The root-knot nematode eggs and juveniles were extracted from the infected tomato roots using sodium hypochlorite (NaOCl) solution (Hussey and Barker, 1973).

Organic Manures Preparation:

Four domestic organic manures as follows: cattle was obtained from the Experimental Farm Station of Animal Production Department, Faculty of Agriculture, Alexandria University; pigeon and rabbit were obtained from the Experimental Farm Station, Department of Poultry Sciences, Faculty of Agriculture, Alexandria University and the compressed chicken manure (RIGIR Fit) was obtained from the International El-Salam Egypt Company. Chemical analysis of these organic manures was shown in Table (1).

Organic manures were air dried, homogenized and passed through 20-mesh sieve and then mixed thoroughly with soil at the rate of 25 and 50 g/kg soil. Pots were irrigated daily up to field capacity for 7 days for the decomposition of the organic substances and then cultivated with five-wk uniform and healthy tomato seedlings. Similarly, the three mineral fertilizers e.g. ammonium sulphate, super phosphate and urea were used at the rate of 25 and 50 g / kg soil, two days after nematode inoculation.

Reactions of Five Tomato Cultivars and Two Hybrids to *Meloidogyne arenaria*, *M. javanica* and *M. incognita*

Reactions of five tomato cvs.; Fairuz, Viona, Jannat, Hadir, Lamour, and the two hybrids; 745 and 1077 to *M. arenaria*, *M. javanica* and *M. incognita* infection were studied under greenhouse condition at 35 ± 5°C during the summer season of 2012. Two uniform tomato seedlings of each cultivar were cultivated in plastic pots (30 cm diam.) filled with autoclaved (2:1, v:v) sandy clay soil. A total of 105 plastic pots were used in this experiment, 15 pots for each tomato cultivar. One week after transplanting, pots were inoculated with 4000 nematode eggs and J_2/pot. Plants were irrigated regularly and the experiment was terminated 45 days after nematode inoculation. Plants were harvested and roots were washed by running tap water. Galled roots were placed in aqueous solution of phloxin B (0.15 g/l water) for 15 minutes to show the nematode egg masses (Ayoub, 1980). Numbers of nematode root galls and egg masses were determined. The behaviour of each root-knot nematode species was judged by the number of galls and egg masses produced according to the following index: 0= resistant, 0-10= moderately resistant, 11-50= moderately susceptible, 51-100= susceptible, >100 = highly susceptible.

Effect of Four Organic Manures, Three Mineral Fertilizers and Nemacure®10G on *M. incognita* Infected Tomato Plants cv. Jannat

One hundred and sixty plastic pots, 30 cm diam., were divided into two groups of eighty pots each. Pots of the 1st group were filled with one kg of autoclaved sandy clay soil (2:1, v:v) and with non-autoclaved sandy clay soil (2:1, v:v) for the 2nd group. Pots were transplanted with five-wk-old healthy tomato seedlings cv. Jannat, one seedling/pot and inoculated with a suspension of *M. incognita* containing 2500 eggs and J_2/pot. Treatments were applied as follows: the nematicide, Nemacure®10G (25 mg /kg soil) was applied at the same time of nematode inoculation; organic manures (cattle, chicken "RIGIR Fit", pigeon and rabbit) were applied at the rate of 25 and 50 g /kg soil for each tested manure, 7 days before nematode inoculation. Mineral fertilizers: ammonium sulphate, super phosphate and urea were applied with the same doses (25 and 50g / kg soil) twice, two days after nematode inoculation and one week later. Each rate represents a treatment.

Macronutrients determinations

The major macronutrients; N, P and K were determined in leaves of Jannat cv., (five replicates/treatment) at the harvest time of the experiment. Total N concentration was estimated using micro-kjeldahl technique (AOAC, 1995). Total P concentration was estimated using the calorimetrical method (Jackson, 1973) and K concentration was measured via a flame photometer apparatus (Chapman and Pratt, 1961).

Statistical Analysis

Data obtained were statistically analyzed according to SAS software program (SAS Institute, 1997). Data of the numbers of nematode root galls and egg-masses were transformed to $\sqrt{x+1}$ before statistical analysis. Comparison among means was made via the least significant difference (LSD) at the 5% level of probability.

Table 1: Chemical analysis of the used organic manures

Organic manure	EC $ds.m^{-1}$	pH	% of OM	% of N	% of P	% of K
Cattle	9.3	7.74	15.0	1.2	0.62	0.96
Chicken, "RIGIR Fit"	4.2	8.47	34.3	2.1	2.17	1.48
Pigeon	12.7	6.61	30.2	4.5	0.97	2.11
Rabbit	10.6	7.27	20.6	2.4	1.26	1.14

Chemical analyses were conducted at Soil and Water Science Department, Faculty of Agriculture, Alexandria University.
OM= Organic matter.

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RESULTS

Reactions of Five Tomato Cultivars and Two Hybrids to *Meloidogyne arenaria*, *M. javanica* and *M. incognita*

Data presented in Table (2) showed that all tested tomato cultivars and hybrids were highly susceptible or susceptible. Tomato cvs.; Hadir, Jannat, Viona and the hybrid 745 were highly susceptible while, cvs.; Fairuz, Lamour and the hybrid 1077 were susceptible to the three tested root-knot nematode species.

Effect of Four Organic Manures, Three Mineral Fertilizers and Nemacure®10G on *M. incognita* Infected Tomato Plants cv. Jannat

Data listed in Table (3) showed that treatment of Nemacure®10G (25 mg /kg soil) caused the highest reductions (99.2-99.4%) in number of nematode root galls and egg-masses/root system. Results showed that the higher concentration (50 g) of manures resulted in the highest reductions in nematode galls and egg masses and application of the tested organic manures resulted in the highest reductions of nematode galls and egg masses compared with the three tested mineral fertilizers (Table 3).

The highest nematode reductions were recorded with chicken, pigeon and rabbit manures with 87.8-89.6 % and 89.6-91.4 % reductions of nematode galls and egg masses, respectively. Cattle manure resulted in 75.8 and 76.6 % reductions of nematode galls and egg masses, respectively. Results obtained from non-autoclaved soil indicated that cattle, chicken, pigeon and rabbit manures caused reductions of 83.9- 87.2 % and 85.5- 87.6 % of nematode galls and egg masses, respectively. Results also indicated that the tested mineral fertilizers resulted in reductions in number of nematode root galls and egg-masses/root system with 46.2-50.9% and 61.0-70.6 % in autoclaved and non-autoclaved soil, respectively (Table 3).

Data of Table (4) showed that all treatments resulted in significant increases in plant length and fresh and dry weights of shoot and root systems compared to the check treatment.

Among the tested mineral fertilizers, super phosphate at the dose of 50 g/kg soil significantly enhanced all measured of tomato growth parameters compared with the check treatment (Table 4). Treatment with 25 mg/kg soil of Nemacure®10G gives the highest increases of 64.6 and 67.4% in shoot and root lengths, respectively. Results in Table (4) showed increases of 50.3-64.8% in both shoot and root lengths of tomato with the application of 50 g/kg soil of rabbit and chicken manures. While, 50 g/kg soil of pigeon manure resulted in 43-86.3% increases in fresh and dry weights of shoot and root systems.

Table 2: Reactions of five tomato cultivars and two hybrids to *M. arenaria, M. javanica* and *M. incognita* infection

Tomato cultivar/ hybrid	Nematode species	No. of Galls	No. of Egg Masses	Reaction
Hadir	*M. arenaria*	222	194	Highly susceptible
	M. incognita	166	120	Highly susceptible
	M. javanica	171	122	Highly susceptible
Jannat	*M. arenaria*	108	104	Highly susceptible
	M. incognita	117	111	Highly susceptible
	M. javanica	110	105	Highly susceptible
Fairuz	*M. arenaria*	70	80	Susceptible
	M. incognita	78	83	Susceptible
	M. javanica	87	82	Susceptible
Viona	*M. arenaria*	105	108	Highly susceptible
	M. incognita	119	110	Highly susceptible
	M. javanica	125	121	Highly susceptible
Lamour	*M. arenaria*	93	90	Susceptible
	M. incognita	98	91	Susceptible
	M. javanica	97	91	Susceptible
745	*M. arenaria*	135	117	Highly susceptible
	M. incognita	177	170	Highly susceptible
	M. javanica	126	105	Highly susceptible
1077	*M. arenaria*	93	97	Susceptible
	M. incognita	98	94	Susceptible
	M. javanica	99	91	Susceptible

The gall and egg masses ratings were made according to the following index: 0 = Resistant, 0-10 = moderately resistant, 11-50 = moderately susceptible, 51-100 = susceptible, >100 = highly susceptible. Data are averages of 5 replicates

Table 3: Effect of four organic manures, three mineral fertilizers and Nemacure®10G on numbers of galls and egg masses of *M. incognita* infected tomato plants cv. Jannat

Treatment	Autoclaved soil				Non-autoclaved soil			
	No. of galls	Reduction %	No. of EM	Reduction %	No. of galls	Reduction %	No. of EM	Reduction %
Check*	805.8 a	-	783.2 a	-	794.8 a	-	790.0 a	-
Organic manure (g/kg soil):-								
Cattle								
25 g	259.6 de	67.8	251.8 fg	67.8	153.8 ef	80.7	147.2 e	81.4
50 g	195.4 e	75.8	183.4 h	76.6	128.2 f	83.9	114.6 ef	85.5
Chicken								
25 g	264.6 d	67.2	253.9 f	67.6	197.0 e	75.2	188.5 d	76.1
50 g	98.4 f	87.8	81.3 i	89.6	119.6 fg	85.0	104.2 ef	86.8
Pigeon								
25 g	208.0 e	74.2	194.0 g	75.2	189.0 e	76.2	180.4 de	77.2
50 g	83.5 f	89.6	69.5 i	91.1	101.5 g	87.2	98.3 f	87.6
Rabbit								
25 g	206.8 e	74.3	189.5 h	75.8	175.0 ef	78.0	163.0 de	79.4
50 g	87.6 f	89.1	67.2 i	91.4	121.6 f	84.7	110.7 ef	86.0
Mineral fertilizer (g/kg soil):-								
Ammonium sulphate								
25 g	588.4 bc	27.0	571.6 bc	27.0	324.0 bc	59.2	318.0 bc	59.7
50 g	421.3 cd	47.7	414.8 de	47.0	310.3 c	61.0	298.5 c	62.2
Super phosphate								
25 g	655.2 b	18.7	623.0 b	20.5	397.2 b	50.0	381.8 b	51.7
50 g	435.5 c	46.0	421.4 d	46.2	261.5 de	67.1	249.2 cd	68.5
Urea								
25 g	541.2 bc	32.8	538.5 c	31.2	279.8 d	64.8	273.0 cd	65.4
50 g	395.5 cd	50.9	387.2 e	50.6	241.5 de	69.6	232.4 cd	70.6
Nemacure®10G								
25 mg /kg	6.2 g	99.2	4.8 j	99.4	8.4 g	98.9	5.3 g	99.3

* = Check= *M. incognita* alone. Data are averages of 5 replicates. Values, within a column, followed by the same letter(s) are not significantly different at (*P*=0.05).

Treatment with 50 g/kg soil of chicken manure showed superior effect regarding plant growth traits in non-autoclaved soil. It gave 65.8-87.9 % increase in plant length, fresh and dry weights of shoot and root systems, followed by treatments of 50 g/kg soil of pigeon and rabbit manures and 25g/kg soil of chicken manure. The best enhancement of tomato plants growth parameters (54.8-84.2%)was obtained with 50 g/kg soil of super phosphate in non-autoclaved soil compared with the check treatment. While, ammonium sulphate treatment with both concentrations; 25 and 50 g/kg soil resulted in 61.0-70.0 % increases in both shoot and root lengths, respectively (Table 5).

Treatments with 25 mg /kg soil of Nemacure®10G showed significant increases (41.9-79.1%) in plant length, fresh and dry weights of shoot and root systems (Table 5).

Regarding the effect of organic manures, mineral fertilizers and Nemacure®10G on N, P and K concentrations measured in tomato leaves of cv. Jannat, data in (Table 6 & 7) showed that the highest increase in N and K values concentrations (74.8 & 195.5 %) and (80.6 & 193.2 %) were recorded in autoclaved and non-autoclaved soils treated with 50 g of rabbit manure /kg soil, respectively. The higher dose of super phosphate (50 g/kg soil) leads to the maximum increase in P concentration (65.4 & 67.9%) in autoclaved and non-autoclaved soils, respectively.

Treatments with 50 g/kg soil of chicken and rabbit manures and 25 mg Nemacure®10G /kg soil lead to high increase values of P concentration (50.0-61.5%) compared to the check treatment. Meanwhile, treatments with 50 g/kg soil of pigeon manure, ammonium sulphate and urea resulted in high increase values of N concentrations (55.3-70.4%) in autoclaved and non-autoclaved soil, compared to the check treatment. The high increase values of K concentrations (103.0-175.9%) in autoclaved and non-autoclaved soils were obtained with the application of chicken and pigeon manures as well as super phosphate fertilizer at a dosage of 50 g/kg soil; 25 g/kg soil of chicken and rabbit manure and 25 mg Nemacure®10G /kg soil (Table 6 & 7).

Table 4: Effect of four organic manures, three mineral fertilizers and Nemacure®10G on growth parameters of tomato plants cv. Jannat infected by *M. incognita* and cultivated in autoclaved soil

Treatment	Plant length (cm)		Fresh weight (g)		Dry weigh (g)	
	Shoot	Root	Shoot	Root	Shoot	Root
Check *	30.0 f (0.0)**	14.8 e (0.0)	12.9 e (0.0)	6.9 d (0.0)	7.6 d (0.0)	1.1 e (0.0)
Organic manure (g/kg soil):-						
Cattle						
25 g	38.8 e (22.7)	20.4 cd (27.5)	18.1 cd (28.7)	11.9 bc (42.0)	9.9 cd (23.2)	6.3 bc (82.5)
50 g	46.0 cd (34.8)	23.0 cd (35.7)	20.2 bc (36.1)	12.0 bc (42.5)	10.9 c (30.3)	4.2 c (73.8)
Chicken						
25 g	54.5 bc (44.9)	27.8 c (46.8)	17.7 cd (27.1)	11.8 bc (41.5)	11.0 bc (30.9)	5.6 bc (80.4)
50 g	60.4 bc (50.3)	36.0 b (58.9)	19.8 bc (34.8)	13.6 b (49.3)	12.4 bc (38.7)	7.8 ab (85.9)
Pigeon						
25 g	41.0 d (26.8)	19.2 d (22.9)	20.9 bc (38.3)	11.9 bc (42.0)	12.6 bc (39.7)	5.2 bc (78.8)
50 g	53.3 cd (43.7)	28.8 c (48.6)	29.6 ab (56.4)	12.1 bc (43.0)	14.2 b (46.5)	8.0 ab (86.3)
Rabbit						
25 g	46.8 cd (35.9)	25.3 cd (41.5)	16.8 d (23.2)	13.5 b (48.9)	9.6 cd (20.8)	6.4 bc (82.8)
50 g	69.9 b (57.1)	42.0 ab (64.8)	20.8 bc (38.0)	12.0 bc (42.5)	12.0 bc (36.7)	7.3 b (84.9)
Mineral fertilizer (g/kg soil):-						
Ammonium sulphate						
25 g	41.9 d (28.4)	21.9 cd (32.4)	18.5 c (30.3)	11.6 bc (40.5)	10.1 cd (24.8)	6.3 bc (82.5)
50 g	46.6 cd (35.6)	23.2 cd (36.2)	23.3 bc (44.6)	12.7 bc (45.7)	13.6 bc (44.1)	8.2 ab (86.6)
Super phosphate						
25 g	57.4 c (47.7)	30.6 bc (51.6)	20.3 bc (36.5)	12.8 bc (46.1)	10.6 c (28.3)	7.6 ab (88.2)
50 g	81.3 a (63.1)	44.0 a (66.4)	31.9 a (59.6)	16.2 a (57.4)	17.8 a (57.3)	9.5 a (88.4)
Urea						
25 g	45.5 cd (34.1)	21.6 cd (31.5)	18.2 cd (29.1)	10.1 c (31.7)	10.6 c (28.3)	4.2 c (73.8)
50 g	46.2 cd (35.1)	25.0 cd (40.8)	21.0 bc (38.6)	11.1 bc (37.8)	12.7 bc (40.2)	5.1 bc (78.4)
Nemacure®10G						
25 mg /kg soil	84.7 a (64.6)	45.4 a (67.4)	24.7 b (47.8)	15.6 a (55.8)	13.4 bc (43.3)	7.9 ab (86.1)

* = Check = *M. incognita* alone. ()** = increase %= (check- treatment)/check × 100. Data are averages of 5 replicates. Values within a column followed by the same letter(s) are not significantly different at (P=0.05).

Table 5: Effect of four organic manures, three mineral fertilizers and Nemacure®10G on growth parameters of tomato plants cv. Jannat infected by *M. incognita* and cultivated in non-autoclaved soil

Treatment	Plant length (cm)		Fresh weight (g)		Dry weight (g)	
	Shoot	Root	Shoot	Root	Shoot	Root
Check*	18.1 f	9.9 g	6.9 f	7.5 d	3.2 d	2.5 d
	(0.0)**	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Organic manure (g/kg soil):-						
Cattle						
25 g	41.0 de	13.8 e	17.3 de	12.0 bc	11.1 bc	9.4 ab
	(55.9)	(28.3)	(60.1)	(37.5)	(71.2)	(73.4)
50 g	57.4 bc	16.6 d	23.2 cd	13.7 bc	12.1 bc	8.3 bc
	(68.5)	(40.4)	(70.3)	(45.2)	(73.6)	(69.9)
Chicken						
25 g	63.3 b	17.5	24.3 cd	13.3 bc	12.5 bc	8.7 bc
	(71.4)	(43.4)	(71.6)	(43.6)	(74.4)	(71.3)
50 g	99.6 a	38.0 a	57.1 a	21.9 a	19.9 a	11.1 a
	(81.8)	(73.9)	(87.9)	(65.8)	(83.9)	(77.5)
Pigeon						
25 g	40.8 de	11.0 f	16.4 de	10.5 c	11.0 bc	8.4 bc
	(55.6)	(10.0)	(57.9)	(28.6)	(70.9)	(70.2)
50 g	59.8 c	17.8 cd	25.3 cd	16.7 bc	12.8 bc	8.7 bc
	(69.7)	(44.4)	(72.7)	(55.1)	(75.0)	(71.3)
Rabbit						
25 g	53.4 c	12.8 e	19.1 d	12.8 bc	11.4 bc	8.6 bc
	(66.1)	(22.7)	(63.9)	(41.4)	(71.9)	(70.9)
50 g	58.8 bc	23.0 cd	30.3 c	17.1 b	13.5 b	9.4 ab
	(69.2)	(57.0)	(77.2)	(56.1)	(76.3)	(73.4)
Mineral fertilizer (g/kg soil):-						
Ammonium sulphate						
25 g	46.4 d	32.8 ab	14.2 de	10.9 c	8.9 c	9.2 ab
	(61.0)	(69.8)	(51.4)	(31.2)	(64.0)	(72.8)
50 g	52.0 cd	33.0 ab	14.2 de	11.0 c	10.9 bc	9.8 ab
	(65.2)	(70.0)	(51.4)	(31.8)	(70.6)	(74.5)
Super phosphate						
25 g	61.7 bc	19.8 cd	26.1 cd	13.1 bc	13.9 b	8.0 bc
	(70.7)	(50.0)	(73.6)	(42.7)	(77.0)	(68.7)
50 g	80.2 ab	26.0 c	43.8 b	16.6 b	16.2 ab	11.1 a
	(77.4)	(61.9)	(84.2)	(54.8)	(80.2)	(77.5)
Urea						
25 g	33.8 e	18.2 cd	12.7 e	10.3 c	10.6 bc	5.5 c
	(46.4)	(45.6)	(45.7)	(27.2)	(69.8)	(54.5)
50 g	61.6 bc	30.0 b	17.4 de	12.3 bc	11.4 bc	8.5 bc
	(70.6)	(67.0)	(60.3)	(39.0)	(71.9)	(70.6)
Nemacure®10G						
25 mg /kg soil	86.6 ab	31.3 ab	21.3 cd	12.9 bc	13.4 b	9.1 ab
	(79.1)	(68.4)	(67.6)	(41.9)	(76.1)	(72.5)

Legend as in Table 4.

Table 6: Total N, P and K concentrations in tomato leaves of Jannat cv., infected with *M. incognita*, grown in autoclaved soil

Treatment	Nutrient %

	N	Increase %	P	Increase %	K	Increase %
Check*	1.03 f	-	0.26 d	-	1.33 f	-
Organic manure (g/kg soil):-						
Cattle						
25 g	1.30 def	-	0.34 bcd	-	2.13 c-f	-
50 g	1.47 b-e	42.7	0.36 abc	38.5	2.30 c-f	-
Chicken						
25 g	1.33 cde	29.1	0.39 abc	50.0	2.80 a-d	110.5
50 g	1.40 cde	35.9	0.42 ab	61.5	3.13 abc	135.3
Pigeon						
25 g	1.53 a-e	48.5	0.35 a-d	-	2.73 a-e	105.3
50 g	1.60 abc	55.3	0.33 bcd	-	2.83 a-d	112.8
Rabbit						
25 g	1.57 a-d	52.4	0.38 abc	46.2	3.67 ab	175.9
50 g	1.80 a	74.8	0.40 abc	53.8	3.93 a	195.5
Mineral fertilizer (g/kg soil):-						
Ammonium sulphate						
25 g	1.27 ef	-	0.32 cd	-	1.83 def	-
50 g	1.60 abc	55.3	0.38 abc	46.2	2.53 b-f	-
Super phosphate						
25 g	1.37 cde	33.0	0.39 abc	50.0	2.47 b-f	-
50 g	1.50 b-e	45.6	0.43 a	65.4	2.97 a-d	123.3
Urea						
25 g	1.47 b-e	42.7	0.33 bcd	-	1.57 ef	-
50 g	1.73 ab	67.9	0.38 abc	46.2	2.60 b-e	95.5
Nemacure®10G						
25 mg/kg soil	1.60 abc	55.3	0.40 abc	53.8	3.03 a-d	127.8

Legend as in Table 4.

DISCUSSION

Our present data showed that all tested tomato cvs. were highly susceptible to susceptible to the three tested root-knot nematodes. The three tomato cvs.; Hadir, Jannat, Viona and the hybrid 745 were found highly susceptible; whereas, the two cvs.; Fairuz, Lamour and the hybrid 1077 were found susceptible. These results could be expected based on genetic variability among the tested tomato cultivars (Christos *et al.,* 2011; Kamran *et al.,* 2011). The tested tomato cvs. lack root-knot nematode resistant genes so genotypes were unable to stop the nematode penetration, development and reproduction. These results are in harmony with those of other workers (López-Pérez *et al.,* 2006; Cortada *et al.,* 2009).

The present results revealed that treatments with the four tested organic manures and three tested mineral fertilizers resulted in significant reductions in nematode reproduction and enhanced growth parameters of tomato plants. These results can support the findings of Kaskavalci (2007) and Pakeerathan *et al.* (2009), who indicated that treatments with organic soil amendments increase not only the growth of tomato plant but also useful to be eco-friendly management for root-knot nematode. Also, similar results were obtained by Farahat *et al.* (2012), who found that all organic and inorganic fertilizers exhibited potential activity against the root-knot nematodes and improved growth criteria of tomato irrespective of their origin or concentration. Previous reports indicated that treatment with chicken manure encourages the vegetative growth of tomato plants to go forward and accelerate the photosynthetic rate (Ahmed and Abdelnaser, 2010; Mehdizadeh *et al.*, 2013).

Superior effect of super phosphate fertilizer on plant growth parameters and P concentration in leaves tissues may be explaining on the basis that P as phospholipids is a major component of cell membrane requires by the plant. It is usually concentrated in the fast growing parts of the plants, chiefly in the root tips. Also, P speeds up the maturation of crops and stimulates good root development (Idowu *et al.,* 2013).

Table 7: Total N, P and K concentrations in tomato leaves of Jannat cv., infected with *M. incognita*, grown in non-autoclaved soil

Treatment	Nutrient %

	N	Increase %	P	Increase %	K	Increase %
Check*	0.98 f	-	0.28 e	-	1.33 h	-
Organic manure (g/kg soil):-						
Cattle						
25 g	1.30 de	32.7	0.38 bcd	35.7	1.97 e-h	-
50 g	1.37 cde	39.8	0.32 de	-	1.70 fgh	-
Chicken						
25 g	1.20 ef	-	0.39 a-d	39.3	3.11 bcd	133.1
50 g	1.47 bcd	50.0	0.42 abc	50.0	3.27 abc	145.9
Pigeon						
25 g	1.47 bcd	50.0	0.38 bcd	35.7	2.40 def	80.5
50 g	1.67 ab	70.4	0.45 ab	60.7	2.97 bcd	123.3
Rabbit						
25 g	1.60 abc	63.3	0.38 bcd	35.7	3.67 ab	175.9
50 g	1.77 a	80.6	0.43 ab	53.6	3.90 a	193.2
Mineral fertilizer (g/kg soil):-						
Ammonium sulphate						
25 g	1.17 ef	-	0.34 cde	-	1.50 gh	-
50 g	1.53 a-d	56.1	0.38 abc	35.7	2.43 def	82.7
Super phosphate						
25 g	1.40 cde	42.9	0.42 abc	50.0	2.13 efg	60.2
50 g	1.30 de	32.7	0.47 a	67.9	2.70 cde	103.0
Urea						
25 g	1.50 bcd	53.1	0.33 de	-	1.63 gh	-
50 g	1.67 ab	70.4	0.41 abc	46.4	2.50 de	88.0
Nemacure®10G						
25 mg/kg soil	1.40 cde	42.9	0.44 ab	57.1	3.07 bcd	130.8

Legend as in Table 4.

The present work proved that the highest reductions in galls and egg masses of root-knot nematode were achieved by treatment with the nematicide, Nemacur®10G. This result is agreed with those of Farahat *et al.* (2012) and Tibugari *et al.* (2012). Tibugari *et al.* (2012) mentioned that Nemacure®10G as Nemacur's active ingredient like Nemacur® 400 EC is a systemic organophosphorous chemical that offers contact activity and inhibits the enzyme cholinesterase (an enzyme important in the transmission of neuron-signals) and interferes with root-knot nematodes nervous system. Moreover, Farahat *et al.* (2012) reported that the nematicide Nemacur®10G protects the roots from nematode invasion, which resulted in sharp reduction in either the numbers of galls or egg-masses/root system.

The present analysis data of the four tested organic manures indicated that chicken and pigeon manures contained high values of organic matter followed by that in rabbit manure. However, pigeon manure has higher concentration values of N and K compared with the other tested manures, while chicken manure has high values of P followed by that in rabbit manure.

The enhancement in N, P and K concentrations of tomato leaves through application of rabbit, pigeon and chicken manures might be due to large increases in soil microbial biomass after application of such organic supplies, leading to formation of hormones, acting as plant growth regulators independent from nutrient supply (Tu *et al.,* 2006; Mehdizadeh *et al.,* 2013). These results imply that the non-amended check tomato plants were easily attacked by root-knot nematodes as they exhibited stunted plant growth derived from root-knot nematode infection and subsequent prevention of water and nutrient uptake by the roots (Gaillaud *et al*., 2008; Tibugari *et al.,* 2012).

Finally, this study suggests that transfer of resistant genes to such tomato genotypes is prerequisite to avoid root-knot nematode infection. Since our data of nematode management, from pot experiments, are very promising, further investigations are necessary, especially under open field conditions. Such studies could help growers in controlling hazardous plant-parasitic nematodes, particularly the root-knot nematodes.

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الملخص العربى

تقييم حساسية بعض أصناف وهجن الطماطم للإصابة بنيماتودا تعقد الجذور ومكافحة *Meloidogyne incognita* بإستخدام بعض المخلفات العضوية والأسمدة المعدنية

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تمت دراسة قابلية خمسة أصناف وهجينين من الطماطم للإصابة بثلاثة أنواع لنيماتودا تعقد الجذور وهى *Meloidogyne arenaria, M. javanica* and *M. incognita* تحت ظروف الصوبة الزراعية. أوضحت النتائج أن ثلاثة من أصناف الطماطم المختبرة وهى هدير، جنات، فيونا وكذلك الهجين 745 كانت عالية القابلية للإصابة وأظهرت أن صنفى الطماطم فيروز، لامور وكذلك الهجين 1077 كانت قابلة للإصابة بأنواع نيماتودا تعقد الجذور المختبرة. تم إجراء تجربة أصص لإختبار كفاءة أربعة مخلفات عضوية وثلاثة أسمدة معدنية بالإضافة إلي المبيد النيماتودى Nemacure®10G فى خفض أعداد نيماتودا تعقد الجذور *M. incognita* على صنف الطماطم "جنات" عالى القابلية للإصابة، وجد أن معاملة نباتات الصنف جنات بأى من السماد العضوى للأبقار، الدواجن، الحمام والأرانب في التربة المعقمة وغير المعقمة أدت الى انخفاض معنوي مقداره 67.2- 91.4% لأعداد العقد الجذرية النيماتودية وأكياس البيض المتكونة على المجموع الجذري، وصاحب هذا الانخفاض زيادة معنوية في نمو المجموع الخضرى للنباتات وكذلك في تركيزات العناصر المعدنية الكبرى (النيتروجين، الفوسفور والبوتاسيوم) في أوراق الطماطم. كذلك ازدادت قيم تركيزات النيتروجين، الفوسفور والبوتاسيوم فى كل المعاملات المختبرة مقارنة بقيمها فى معاملة المقارنة (الكنترول).