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Effect of different inoculum levels, plant age and multiplication of *Meloidogyne incognita* on growth of tomato

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Abstract
The root knot nematode (*Meloidogyne incognita*) caused reduction in plant height, roots length fresh and dry weights of shoot and roots. Maximum root galls and egg mases were observed with the increasing levels of nematode inoculum. Highest level of nematode inoculum indecated inhibitory and damaging potential on plant growth parameters. One thousand nematode juveniles per 500 g of soil were found to be damaging level of this nematode on Tomato. Significant reduction in plant growth parameters at all stages of plant growth was observed. Maximum numbers of galls were observed at seven days old seedling stage.

Keywords: *M. Incognita*, inoculum levels, plant age, multiplication tomato

1. Introduction
Tomato (*Solanum lycopersicum* L.) is one of the most popular vegetable crops grown in the world, next to potato. It is used as a fresh vegetable and also can be processed and canned as a paste, juice, sauce, powder or as a whole (Barone and Frusciante, 2007) [5]. The ripe fruits are good source of vitamin A, B and C which add wide varieties of colour and flavour to the food. Recently, it started gaining more medicinal value because of the antioxidant property of ascorbic acid and lycopene content (Anon, 2002) [1]. Tomatoes are parasitized by a number of pathogens, including *Fusarim oxysporium* f. sp. *lycopersici* (Sacc. W.C. Snyder *et al*., 2003) [19] the causal agent of fusarium wilt, which is one of the most important pathogen of as tomato pathogen (Jones *et al*., 1982) [10]. Due to high temperature and humidity, *Fusarium oxysporum* f. sp. *lycopersici* can cause significant damage. *Fusarium oxysporum* f. sp. *lycopersici* is soil borne pathogen which can persist for many years in the soil without host. Most infections originate from the population associated with infected tomato debris. Healthy plants can become infected by *Fusarium oxysporum* if the soil, is infested with the pathogen (Farr *et al*., 1989) [7]. Browning of the vascular tissue is strong evidence of Fusarium wilt (Snyder and Hans, 2003) [19]. The Root knot nematode, *Meloidogyne Incognita* is important pest of vegetables in subtropical and tropical climates including india and infict significant yield losses (Akram and Khan, 2006) [2]. *Meloidogyne incognita* is the most dominant species accounting for 64 per cent of total population which is widely prevalent inflicting serious loss to tomato fruit yield (Sasser, 1980) [17]. The fungus also develops synergistic relationship with *Meloidogyne* species leading to root-knot wilt disease complex (Patel *et al*., 2000) [14].

2. Material and methods
Effect of different levels of inocula of *Meloidogyne incognita* on growth of tomato
Seven days old tomato seedlings (var. Pusa Ruby) were inoculated with different treatments. The treatments consisted of an uninoculated control and four levels of inocula viz. 10, 100, 1000 and 10,000 second stage juveniles of *M. Incognita*. The extraction of these nematodes and their disinfestations were carried out as per the technique described earlier and inoculation with appropriate treatments level of inocula were carried out the soil around the seedling in a circumference area of four cm was removed and then dispersing nematodes over this area. After appropriate inoculation, the roots were covered by fresh and sterilized soil. Each treatment was replicated four times and randomized on the glass house bench following complete randomized design (CRD).

The glass house temperature during this period ranged from 21 to 25 °C. The pots were irrigated with 100 ml fresh water every day if needed and there after with equal quantity of water as and when required. The experiment was terminated 45 days after inoculation. The observations on viz., plant height, fresh and dry shoot and root weights, root length, number of galls nematode population in soil and root number of galls and number of egg masses/gall were recorded. The entire root system along with the soil was tapped out of the pot and was washed in a container with a gentle stream of water. For obtaining fresh weight, the roots were pressed gently between two pads of blotting paper and then the weight was recorded using electronic balance.

2. Effect of plant age on growth and multiplication of *Meloidogyne incognita*.

The experiment was conducted in ten cm earthen pots containing 500g steam sterilized soil. The tomato seedlings of three different ages *viz.* 7, 14, 21 and 28 days were chosen for the experiment Each pot had one seedling. Freshly hatched 1000 second stage juveniles of *M. incognita* were inoculated in each pot. An uninoculated control was also maintained. Each treatment was replicated five times and randomized on glass house bench following CRD. The pots were irrigated with 100 ml fresh tap water as and when required. The glass house temperature during ranged from 21 to 26°C. The experiment was terminated 45 days after inoculation. Observations on plant height, root length, number of galls and number of egg masses / gall were recorded at the time of termination of the experiment.

3. Results

1. Effect of different inoculum levels of *Meloidogyne Incognita* on growth of tomato.

The effect of different levels of inocula of *M. incognita* on various growth parameters of tomato is presented in Table 1 It is evident from the table that there was a gradual stunting of plants when inoculated with *M. incognita*. In treatment where highest population (10000 N/plant) of the nematode was added plants showed chlorosis and defoliation of leaves. The plants looked sick and devitalized with marked retarded growth. The plant height in this treatment was noted to be 35.43 cm. Followed by 1000 N/plant where the height was recorded to be 38.27 cm. 10 and 100 nematodes/plant recorded 48.27 and 44.67 cm plant heights respectively. Maximum (61.63 cm) plant height was recorded with control, which was significantly superior over all other treatments.

Similarly there was a gradual decrease in root length as the inoculum levels increased. Maximum (17.3 cm) root length was noted in control, which was significantly superior over all other treatments. Minimum (9.53 cm) root length was noted with 10,000 /plant followed by 1000 N/plant (11.93 cm) and 100 N/plant (13.53 cm). The reduction in the root length (15.07 cm) was also noted in the minimum inoculum level (10 N/plant).There was significant reduction in the fresh shoot weight of tomato plants with increase in inoculum levels. Significantly reduced shoot weight (3.09 g) was noted with 10,000 N/plant followed by 1000 N (3.91 g) and 100 N/plant (4.26 g). ten nematodes/plant recorded (5.14 g) fresh shoot weight Maximum (9.48 g) fresh shoot weight was recorded in control. The fresh root weight of tomato plant was adversely affected by the nematode infestation. Minimum (0.76 g) root weight was recorded with 10,000 N/plant followed by 1000 N/plant (0.77 g). Reduced root weights were also recorded with 10 N/plant (0.99 g) and 100 N/plant (0.84 g). Maximum fresh root weight was recorded with control (1.27 g).

Table 1: Effect of different inoculum levels of *Meloidogyne Incognita* on growth of tomato.

S. No.	Treatments	Plant height cm)	Root length(cm)	Fresh weight (g)		Dry weight (g)		No of galls/plant	No of egg mass/plant
				Shoot	Root	Shoot	Root		
1	Control	61.63	17.3	9.48	1.27	1.79	0.27	0	0
2	10 N	48.27	15.07	5.14	0.99	0.73	0.25	34.67	28.32
3	100 N	44.67	13.53	4.26	0.84	0.58	0.18	71.33	34.00
4	1000 N	38.27	11.93	3.91	0.77	0.62	0.15	113.30	50.00
5	10,000 N	35.43	9.53	3.09	0.76	0.30	0.14	57.67	41.33
	S.E(m)±	5.28	1.411	1.312	0.085	0.179	0.021	18.119	8.701
	CD at 5 %	16.86	4.504	4.189	0.27	0.571	0.066	57.831	27.772

Mean of three replications.
N= Nematodes

On dry weight basis, maximum (1.79 g) weight was recorded with control which was significantly superior over all the treatments. Minimum shoot weight was recorded with 10,000 N/plant (0.30 g) followed by 1000 N/plant (0.62 g). The dry shoot weights recorded at 10 N/plant (0.73 g) and 100 N/plant (0.58 g). Similarly there was a gradual reduction in root weights on dry weight basis as the inoculum level increased. Maximum root weight (0.27 g) was observed with control followed by 10 N (0.25 g), 100 N (0.18 g) and 1000 N (0.15 g) per plant. The root weight declined sharply at 10,000 inoculum level where It was recorded to be 0.14 g. Minimum (34.67) root galls were noted at minimum level of inoculum (10 N/plant). The number of root galls were maximum (113.33) at 1000 N/plant followed by 10,000 N/plant (57.67) and 71.33 galls were noted in the treatment where 100 Nematodes/plant were incorporated. Significantly maximum (50) egg masses /plant were recorded with 1000N followed by 10,000 N/plant (41.33). Minimum (28.32) egg masses were recorded with 10 N/plant followed by 100 N/plant (34) against no egg masses in control.

2. Effect of plant age on multiplication of *MeIoidogyne incognita.*

The effect of inocula on various plant ages of tomato is presented in table 2. The data indicated that all the stages (7, 14, 21 and 28 days) of the plant growth is susceptible to root knot nematode. The plant height was significantly reduced at all the stages of plant growth. The maximum height was recorded in control (45.80 cm) and minimum (29.33 cm) with seven days old seedlings inoculations. There was gradual

reduction in plant height for all stages. An sharp decline was recorded with seven days old inoculation which was significantly lower than control and rest of the treatments.Similarly the root lengths of the seedlings were significantly declined in seven days and 14 days old stages. Maximum root length (16.23 cm) was recorded with uninoculated control and minimum (8.17) with seven days old stage. Significant reduction in root length was noted in all the stages of plant growth inioculated with 1000 N. The lengths were 16.23 cm, 12.53 cm, 11.30 cm and 9.63 cm, followed by for 28, 21, and 14 respectively. There was a gradual decline in shoot weight (fresh) in all stages of plant growth. A sharp decline in fresh shoot weight was noted at 7days old seedling inoculation (1.85 g). Maximum (7.31 g) fresh shoot weight was recorded in un- inoculated control which was significantly superior over rest of the treatments followed by 14 (3.37 g), 21 (3.60 g) and 28 (5.67 g) days old seedling stages.

On dry weight basis, maximum (1.14 g) dry shoot weight was noted in un-inoculated control. Seven days old stage showed sharp decline when compared with 14, 21 and 28 days old stages. Minimum (0.14 g) shoot weight was recorded in 7dys old stage followed by 14 (0.22 g), 21 (0.52 g) and 28 (0.96) days old seedling stages. Minimum fresh root weight (0.53 g) was recorded with 7days old plants. Maximum fresh root weight (1.39 g) was recorded with uninoculated control which was significantly superior over other treatments. Reduced fresh root weight was in recorded in 28 days (1.13), 21 days (0.70 g), 14 days (0.66 g), and 7 days (0.53 g). Similarly dry root weights were gradually declined in all stages. when compared with uninoculated control (1.39).Maximum dry weight of root was recorded with uninoculated control (0.58g) and minimum with 7days old stage (0.10 g). Root weights were 0.30 g, 0.23 g, and 0.17 g, for, 28, 21 and 14 days, old plants respectively.

There was gradual decrease in the number of galls per plant as the stage of plant age increased. Maximum galling was noted at seven days old plant (150.67) minimum galling was noted at 28 days old stage (23.67), followed by 14 days and 21 days old seedling of tomato (45.00) and (41.33). There was no gall formation in un-inoculated control. The number of egg mass per gall gradually decreased with increasing plant age stage. Maximum egg mass/gall was noted at seven days old plants (63), followed by 14 (21.33), 21 (13.67) and 28 (13.62) days old seedlings respectively.

Table 2: Effect of plant age on multiplication of *MeIoidogyne incognita.*

S. No.	Treatments (Age of seedlings)	Plant height (cm)	Root length (cm)	Fresh weight (g)		Dry weight (g)		No of galls/plant	No of egg mass/plant
				Shoot	Root	Shoot	Root		
1	Control	45.80	16.23	7.31	1.39	1.14	0.58	0	0
2	7 days	29.33	8.17	1.85	0.53	0.14	0.10	150.67	63.00
3	14 days	32.07	11.30	3.37	0.66	0.22	0.17	45.00	21.33
4	21 days	32.23	9.63	3.60	0.70	0.52	0.23	41.33	13.67
5	28 days	43.57	12.53	5.67	1.13	0.96	0.30	23.67	13.62
	S.E(m)±	1.294	0.722	0.828	0.163	0.075	0.037	5.814	3.044
	CD at 5 %	4.132	2.305	2.644	0.52	0.241	0.117	18.556	9.716

Mean of three replications

4. Discussion

The destructive plant parasitic nematodes are one of the major limiting factors in production of field crops throughout the country. Roots damaged by the nematodes are not efficient in the utilization of available moisture and nutrients in the soil resulting in reduced reduced functional metabolism. The visible symptoms of nematode attack often include reduced growth of individual plants. The deleterious effects on plant growth result in reduced yield and poor quality of crop.

Root knot disease caused by *Meloidogyne incognita* and Fusarial wilt by *Fusarium oxysporum* f.sp. *lycopersici* are individually important diseases leading to extensive yield losses in tomato. These pathogens when interacting with each other can cause high yield loss due to disease complex and may also lead to breaking of resistance (Ansari *et al*. 2012) [3]. This breaking of resistance by *M. incognita* plays a major role in the etiology of the fusarial wilt in tomato posing a serious problem, particularly in the production of resistant cultivars.

The influence of different of *M. incognita* on the growth of tomato revealed that the nematode mitigated the plant height drastically at higher levels i.e. 10,000 and 1000 nematodes per pot. Similarly significant reduction in root length, fresh and dry root and shoot weights, minimum root galls and egg masses were observed with the increasing levels of nematode inoculum. Highest level of nematode inoculum indicated inhibitory and damaging potential on plant growth parameters of tomato. Similar findings were also brought forward by Hussain and Bora (1995) [9] in case of okra with *M. incognita* and Reddy (1975) [16] in chickpea with *M. javanica* where 1000 and 10,000 juveniles of *Meloidogyne spp*. per pot were applied. Similar inhibitory effects on different crops were also reported by Dhawan and Sethi (1976) [6] and Mani and Sethi (1984) [13]. They reported that on inoculums level of two larvae per g of soil was found to be the damaging threshold level of *M. incognita* on chickpea in accordance with above findings in the present study also 1000 nematode Juveniles per 500g of soil were found to be the damaging threshold level of this nematode on tomato. These results are also in accord with the findings of Bhatt *et al*. (1994) [4].

The effect nematode inoculums on different plant stages were most pronounced when inoculations were carried out on seven and, 14 days old seedlings of tomato. Maximum damage appeared 21 days after inoculation. All the growth parameters were significantly reduced at these two stages of plant growth by 1000 N/plant. The plant growth parameters, at seven, 14 days old seedlings were tend to be completely suppressed and the plants remained stunted and devitaliged. Sharp decline in growth parameters was noticed at seven days old seedling inoculation. There was a gradual increase in the number of galls/plant with decreases the plant age stages. Maximum number of galls was recorded in seven days old seedling stage followed by 14 days and 21 days old seedling. The number of galls significantly reduced at 21 days old seedling inoculation. Which is due to the deterioration in the root system and colonization of nematode population in the peri cycle and subsequently continous feeding by the nematodes. similarly maximum number of egg mass/gall was noted at seven days and 14 days old seedling. 21 days old seedling recovered

correspondingly less number of eggs when compared to other stages of crop growth. These result are in according with the findings of Mishra and Gour (1981) [12] on mothbean, Kalita and on black gram, Gupta and Verma (1990) [8] on mungbeen, Sharma and Bhatti (1992) [18] on peas, okra, tomato and bottle gourd.

5. Conclusion

The studies carried out on the effect of different levels of inoculants on plant growth revealed that 1000 second stage juveniles/g of the soil found to be the damaging threshold on tomato. The nematode continues to penetrate the roots at stages of growth but young seedlings were more susceptible to root knot than mature plants.

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7. References

1. Anonymous. Asian Vegetable Research Development, Taiwan, Annual Report, 2002, 110.
2. Akram MA, Khan MR. Interaction of *Meloidogyne incognita* and *Fusarium oxysporum* f. sp. *Lycopersici* on tomato. Annual Plant Protection Science. 2006; 14(2):448-451.
3. Ansari S, Shahab S, Mazid M, Ahmed D. Comparative study of *Fusarium oxysporum* f sp. *lycopersici* and *Meloidogyne incognita race-2* on plant growth parameters of tomato. Agricultural Sciences. 2012; 3(6):844-847.
4. Bhatt J, Vadhera I, Shukla BN, Tiwari SP. Pathogenicity of soybean cultivars against root knot nematode (*M. incognita*). JNKVV. Research. Journal publication. 1994; 28/299(1-2):71-74.
5. Barone A, Frusciante L. Molecular marker assisted selection for resistance to pathogens in tomato, Marker-Assisted Selection, current status and future perspectives in crops, livestock, forestry and fish. 2007, 153-164.
6. Dhawan SC, Sethi CL. Observation on the pathogenicity of *Meloidogyne incognita* to egg plant and relative susceptibility of some varieties to the nematode. Indian Journal Nematology. 1976; 6:39-46.
7. Farr DF, Bills GF, Chamuris GP, Rossman AY. Fungi on Plants and Plant Products in the United States. APS PRESS: St. Paul, USA, 1989, 1-1252.
8. Gupta DC, Verma KK. Studies on available losses in mung bean due to root and its control under field condition. Indian. Journal Nematology. 1990; 20:148-151.
9. Hussain SKA, Bora BC. Pathogenicity of *Meloidogyne incognita* on Frenchbean. Journal Agriculture Science Society. 1995; 8(2):150-153.
10. Jones JP, Jones JB, Miller W. Fusarium wilt on tomato. Department Agriculture & Consumer Service, Division of plant Industry. Plant Pathology Circular No. 1982, 237.
11. Kalita DN, Phukan PN. Loss in blackgram due to root-knot nematode, *Meloidogyne incognita*. Indian Journal Nematology. 1989; 19:271.
12. Mishra SD, Gaur HS. Pathogenicity of *M. Incognita* and *Rotylenchus reniformis* to Mothebean. aconitifolius. Jacq. Indian Journal Nematology. 1981; 11:228-230.
13. Mani A, Sethi CL. Plant growth of chick pea as influenced by intial inoculums level of *Meloidogyne incognita*. Indian journal Nematology. 1984; 14(1):41-44.
14. Patel BA, Patel DJ, Patel RG. Interaction between *Meloidogyne incognita* and wilt inducing fungus, *Fusarium oxysporum* f. sp. *ciceri* on chickpea cv. Dahod yellow. Indian Journal Nematology. 2000; 30(2):133-135.
15. Patel DB, Patel DJ, Patel NB. Interaction of semiform nematode and *Fusarium oxysporum* f. sp. *lycopersici* in tomato. Annual Plant Protection Science. 2000; 8:209-211.
16. Reddy PP, Govindy HC, Setty KGH. Further studies on the action of DL. Methioline on *Meloidogyne incognita*. Indian Journal nematology. 1975; 5:200-206.
17. Sasser JN. Root-knot nematode a global menace to crop production. Plant Disease. 1980; 64:36-41.
18. Sharma GL, Baheti BL. Loss estimates due to root-knot nematode in peas, okra, tomato and bottle gourd crops in Rajasthan, India. Current Nematology. 1992; 3(2):187-188.
19. Snyder WC, Hans HN. *Fusarium oxysporum* f. sp *lycopersici* (Sacc.) and Prepared by Mui-Yun Wong Soil borne Plant Pathogen Class Project, Spring. 2003, 728.