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Effect of inoculum level of root-knot nematode, *Meloidogyne incognita* on tomato

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Abstract
An investigation was conducted in green house condition to find out the effects of different inoculum levels of *Meloidogyne javanica* on plant growth of tomato and nematode multiplication. After establishment of seedlings 2nd stage juveniles of *M. javanica* were inoculated in the root zone at the rate of 0, 10, 100, 1000 and 10,000 larvae per plant. Significant reduction was shown in the plant growth parameters *viz.* shoot length, shoot weight, root length and root weight with increase the inoculum levels of *M. javanica*. The highest number of galls and egg masses was recorded at inoculums levels of 10000. Total nematode population per plant significantly increased progressively with an increase in nematode inoculum level from 10 to 10000 larvae per plant. The number of eggs and larvae per egg mass were decreased with an increase in inoculum level.

Keywords: Root-knot nematode, *Meloidogyne javanica*, inoculum level, tomato

Introduction
Tomato (*Solanum lycopersicon Mill.*) belongs to the family Solanaceae. The production of tomato is influenced by a number of factors which includes edaphic and environmental factors as well as pests and pathogens. *Meloidogyne* spp. is an important pest of vegetables in subtropical and tropical climates including India and leads to significant yield losses (Akram and Khan, 2006) [1]. More than 80 species belong to genus *Meloidogyne* but four species namely *M. incognita*, *M. javanica*, *M. arenaria*, *M. hapla* are economically most important on global basis (Bajaj and Walia, 2014) [2]. Yield loss of tomato due to *Meloidogyne* spp. in India ranges 40 to 46 percent (Bhatti and Jain, 1997) [3]. Root-knot infection in tomato plants causes stunting, yellowing, wilting and galls and swelling of roots. Roots infected with *Meloidogyne* spp. were severely galled. A pot culture study in green house was undertaken to assess the damage caused by *M. javanica* and also to find out the threshold level in terms of initial inoculum needed to cause significant damage to tomato crop. An attempt was made to evaluate the effect of inoculum levels against the root-knot nematode, *M. javanica* on tomato.

Material and Methods
The experiment was conducted in green house condition where three tomato seedlings were transplanted and maintained in sterilized six inches sized earthen pots. Freshly hatched J_2 of *M. javanica* were inoculated separately in the series of 0, 10, 100, 1000 and 10000 J_2 per plant after establishment of seedlings. At the time of inoculation, the soil around the roots was carefully pulverized so as to partially expose the root system. The J_2 suspension was poured around the roots and covered with sterilized soil. One set of uninoculated pots served as control. For each treatment four replicates were maintained. The pots were maintained in a completely randomized design. Clean tap water was used for irrigating the pots as per requirement. After 60 days of inoculation the experiments were terminated by removing plants after depoting. Roots were gently washed in running tap water. Observations were recorded on shoot length (cm.) and shoot weight (g.), root length (cm.) and root weight (g.). The roots were immediately stained with 0.1 per cent acid fuchsin lactophenol at 80 ^{0}C for 1-2 minutes (McBeth *et al.*, 1941) [10] and kept overnight in pure lactophenol. These stained roots were then examined under stereoscopic binocular microscope for counting the number of galls per pant, number of egg masses per plant, number of eggs and larvae per egg mass.

After removing the plant from each pot except control was mixed well and 200 cc soil sample from each pot washed by Cobb's sieving and decanting technique (Cobb, 1918) and followed by modified Baermann's funnel assembly (Christie and Perry, 1951) for estimation of nematode population in soil at different inoculum level in the experiment.

Result and Discussion

An experiment was conducted to know the effect of different inoculation levels of *M. javanica* on plant growth and nematode multiplication on tomato, under pot conditions. Observations were recorded and result presented in table and also illustrated through fig.

Plant growth characters

The results revealed that the plant growth characters *viz.* the shoot length, shoot weight, root length and root weight of tomato plants were affected by root-knot nematode, *M. javanica*. As the inoculum level increased from 0 to 10000 a gradual significant reduction in plant growth characters was observed. This may be due to difference in number of larvae penetrated and females produced in the roots. As the greater number of larvae infect the plant more damage would be there and subsequently the value of different growth parameter will be reduced. Consequently, these reductions in length and weight of root and shoot were more severe at 10,000 larvae inoculated per plant. Greatest reduction in shoot length (35.50 cm) and root length (10.00 cm) was recorded at 10,000 inoculum level and similarly the lowest shoot weight (5.50 g) and root weight (3.00 g) was recorded at the same level.

The present investigation is similar with the findings of Sivaprakash *et al.* (2008) [13] on *Pongamia pinnata*, Manisha *et al.* (2021) [9] on okra also reported the gradual reduction in plant growth parameters as increased the inoculum levels from 0 to 10000 larvae per plant.

Nematode reproduction: Observation on nematode multiplication revealed the significant effect of different inoculum levels on nematode reproduction. The galls and egg masses per plant increased progressively with the increase in initial inoculum level *i.e.*, from 0 to 10000 larvae per plant. Maximum number of galls (188.50) and egg masses (81.50) were formed at 10000 level while minimum was at 10 level. This proves that gall and egg mass formation dependent on the density of inoculum. Similar results have also been obtained by Ghasolia and Shivpuri (2003) [6] on marigold and Haider *et al.* (2003) [7] on pulses.

Regarding egg content, as inoculum level increased gradual reduction in egg content was observed. The number of eggs and larvae per egg mass was negatively correlated to the increase in initial inoculum levels. The eggs and larvae per egg mass were 350.75, 341.00, 331.00, and 314.75 at the levels of 10, 100, 1000 and 10000 respectively.

The soil population at harvest also increased with an increase in initial inoculum levels. Maximum soil population/200cc soil (691.50) were recorded at 10000 larval levels. Increase in number of egg masses with increasing inoculum might have resulted increase in soil population and the total nematode population at harvest.

It may be possible that at higher inoculum level, on a single site of infection a greater number of nematodes might compete for invasion and only few succeed to entry into the root. On the other hand, at a low inoculum level nematodes get favourable and in competitive atmosphere for entry, development and multiplication resulted increase in number. This can be correlated with study of Jiskani *et al.* (2008) [8] who, investigated that the rate of nematode population was also highest as nematode inoculum level increased and reproduction factor decreased as inoculum level increased on tomato. Similar results have also been obtained by Robab and Azam (2009) [12] on soyabean Meena *et al.* (2016) [11] recorded maximum (7.88) reproduction factor in lower inoculum level *i.e.*, 2000 larvae per pot whereas, minimum (4.43) was obtained in 8000 larvae per pot.

Table 1: Effect of different inoculum levels of root – knot nematode, *M. javanica* on tomato

Treatments (Larvae per plant)	Plant Growth Characters				Nematode reproduction			
	Shoot length (cm)	Shoot weight (g)	Root length (cm)	Root weight (g)	No. of galls/ plant	No. of egg masses/ plant	No. of eggs and larvae/ egg mass	Nematode population /200 cc soil
0	61.00	30.00	18.00	9.75	0.00	0.00	0.00	0.00
10	48.00	23.75	14.50	7.25	40.75	13.00	350.75	599.00
100	44.75	20.00	12.75	6.50	46.50	20.75	341.00	615.75
1000	39.00	9.00	12.25	4.50	138.75	60.75	331.00	652.75
10,000	35.50	5.50	10.00	3.00	188.50	81.50	314.75	691.50
S.Em+	0.28	0.462	0.324	0.31	0.670	0.329	0.308	2.333
CD at 5%	0.85	1.39	0.977	0.95	2.018	0.992	0.93	7.032

Note: (i) Data are average value of four replications.

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