

Pathogenicity of root-knot nematode, *Meloidogyne incognita* on tuberose (*Polianthes tuberosa* L.)

ABSTRACT

A pot experiment was carried out in the net house of Department of Nematology, Assam Agricultural University, Jorhat to study the pathogenicity of root-knot nematode, *Meloidogyne incognita* on tuberose. In the experiment it was observed that there was a progressive decrease in all plant growth parameters of tuberose with the increasing inoculum level of *M. incognita* from 10 to 10,000 second stage juveniles per pot containing 1 kg sterilized soil. At the highest inoculum level, plants were very much stunted, chlorotic and with very few bulblets. It was observed that at the highest inoculum level, the root systems were very much reduced with the galls which were bigger in size and mostly coalescent in the root. The treatments with no nematode (Check and associated check) were free from galls and eggmasses. An initial inoculum level of 100 J₂ of *M. incognita* per kg of soil caused significant reduction in all growth parameters and proved to be pathogenic to the tuberose plants. The number of galls and eggmasses increased gradually in the plants with an initial inoculum level of 10 to 1000 J₂ of *M. incognita* per kg of soil, but it declined at highest inoculum level of 10,000 J₂ per kg of soil. The study also documented changes in the nematode population in the soil, reproductive rates, and other growth parameters. These findings can help in developing targeted strategies for managing nematode induced losses in tuberose cultivation.

Keywords: *Tuberose, Pathogenicity, Root-knot nematode, Meloidogyne incognita, Inoculum*

1. INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) is one of the popular bulbous ornamental crops. It is perennial in nature and belongs to the Amaryllidaceae family. Tuberose is native of Mexico. There are about fifteen species under the genus *Polianthes*, out of which twelve species have been reported from Mexico and Central America. Out of these, nine species possess white flowers; one is white tinged with red and two are red. Except *P. tuberosa* L., all other species found growing wild. In India, tuberose is popularly known as Rajanigandha or Nishigandha. Tuberose is commercially used both as loose and cut flowers. The spikes of tuberose remain fresh for longer times which fetch a distinct place in the flower market. The flowers of tuberose are also used for making artistic garlands, bouquets, floral ornaments, buttonholes, gajras and extraction of

essential oil. Tuberose is commercially cultivated from bulbs. There are three types of tuberose in cultivation viz., 'single', 'semi double' and 'double' (Sandhu and Bose, 1973) [1]. Single flowers bear pure white flowers with one row of corolla segment. These are mostly used as loose flower. Semi double flowers consist of two to three rows of corolla segment and double flowers consist of more than three rows of corolla segment on straight spikes. Single flowers possess more fragrance than double ones. The crop is infested by a number of insects, fungi as well as plant parasitic nematodes; which leads to the reduction in the quality of flowers to the complete destruction of the crop. Among plant parasitic nematodes, mostly three nematodes are found to be pathogenic to the crop viz., root-knot nematode (*Meloidogyne* spp.), reniform nematode (*Rotylenchulus reniformis*), foliar nematode (*Aphelenchoides besseyi*) (Singh, 2006) [2].

For the first time, Melis (1959) [3] reported *Meloidogyne* spp. as an important pathogen of tuberose. Jayaraman *et al.* (1975) [4] reported the presence of *M. javanica* and *M. incognita* in the tuberose growing fields of Tamil Nadu. Khan and Reddy (1992) [5] found that *M. incognita* alone was responsible for reduction in plant weight, number of flowers, spike length, spike weight and number of bulblets respectively. Ravichandra (2008) [6] found that *M. incognita* causes yield loss upto 13-14% in tuberose. Gall formation in the roots is the diagnostic symptom of root-knot nematode infestation. Besides direct damage, it also forms disease complex with other pathogens and enhance the severity of the disease. Affected tuberose plants exhibit stunting, yellowing and drying up of leaves, dwarf tip, rotting of bulbs and withering with delayed emergence of spikes. In general, *M. incognita* produces egg masses on galls and it contains more than 250-500 eggs. The reproduction of *M. incognita* is influenced by many factors like susceptible host, nematode inoculum density and environmental conditions. The main objective of our experiment is to find out the inoculum density of the pathogen to reduce the inoculum density at below economic injury level. Keeping this in view an experiment was carried out on pathogenicity of *M. incognita* on tuberose (*Polianthes tuberosa* L.)

2. MATERIAL AND METHODS

The experiment was carried out in the net house of Department of Nematology during the summer season of 2019 to study the pathogenicity of *M. incognita* on tuberose. Soil from upland situation was collected and sieved to remove the stones and debris. Such soil was mixed homogeneously with finely dried cow dung and river sand in the ratio of 2:1:1. Then, the soil mixture was filled in a gunny bag and sterilized in an autoclave at 121°C at 15lb pressure per square inch for 30 minutes. A single egg mass of *Meloidogyne incognita* was collected from the tomato plants which were maintained as pure culture in the net house, Department of Nematology, AAU, Jorhat. After 24 hours, the hatched second stage juveniles of *M. incognita* were inoculated in the tomato seedlings grown in sterilized soil containing pot. These inoculated tomato plants were maintained as a source of inoculum for subsequent inoculation.

Required quantities of earthen pots were collected, cleaned and dried under the sun. Pots were filled with 1kg autoclaved soil, placing a few sterilized broken bricks at the bottom. Then these pots were labelled according to the allotted treatments and replications. Tuberose bulbs (Var. Vaibhav) were planted in 1kg capacity pot filled with sterilized soil. The pots were arranged in completely randomized design (CRD) with 5 replications for each treatment. Freshly hatched second stage juvenile of *M. incognita* were inoculated in a logarithmic series of 10, 100, 1000, 10,000 juveniles per pot. Two sets of checks including one for associated micro-organisms (where part of the original suspension was inoculated after complete removal of nematodes) were maintained.

The plants were watered regularly. Observations on different parameters were taken after 45 days of inoculation. Plant heights were recorded before uprooting the plants. The potted plants were uprooted very carefully with tap water so that there was no loss of roots and egg masses. Number of galls and egg masses per root system were recorded. Similarly, fresh shoot and root weights were taken. For recording dry weight the plants along with their root systems were packed in a paper bags labelled according to the treatments. The bags were kept in an oven at 60°C till constant weights of dried plant materials were obtained. The extraction of nematode from soil samples were done by modified Cobb's sieving and decanting technique (Christie and Perry, 1951) [7].

$$\text{Reproductive rate} = \frac{\text{Final nematode population}}{\text{Initial nematode population}}$$

Statistical analysis was performed by using SAS 1.0 software.

3. RESULTS AND DISCUSSION

The mean data on plant growth parameters viz., plant height, fresh and dry weight of shoot and root, number of galls, number of egg masses, final nematode population in soil and reproductive rate in different treatments are presented in Table 1 and 2 along with their CD values and plate 1 and 2.

In the present experiment it was observed that there was a progressive decrease in all plant growth parameters of tuberose with the increasing inoculum level of *Meloidogyne incognita* from 10 to 10,000 second stage juveniles per pot containing 1 kg sterilized soil. At the highest inoculum level, plants were very much stunted, chlorotic and with very few bulblets. It was observed that at the highest inoculum level, root systems were very much reduced with the galls which were bigger in size and mostly coalescent in the root. The treatments with no nematode (Check and associated check) were free from galls and egg masses.

Data revealed that plant height decreased progressively in the treatments with an initial inoculum level of 100 to 10,000 nematodes per pot. The highest reduction in plant height was observed in the treatment with 10,000 nematodes per pot. It was observed that there was no significant difference in plant height among the treatments with no nematode (Check and associated check) and the treatment with 10 nematodes per pot but all these treatments differed significantly from the treatments with 100, 1000 and 10,000 nematodes per pot. Further, it was observed that treatment with 100, 1000 and 10,000 nematodes per pot differed significantly from each other. There was no significant difference in fresh weight of shoot among the treatments with no nematode (Check and associated check) and the treatment with 10 nematodes per pot, but these treatments differed significantly from the treatments with 100, 1000 and 10,000 nematodes per pot. Further it was observed that treatments with 100, 1000 and 10,000 nematodes per pot differed significantly from each other. No significant difference in dry weight of shoot was observed among the treatments with check and associated check and the treatment with 10 nematodes per pot. But these treatments differed significantly from the treatments with 100, 1000 and 10,000 nematodes per pot. Further it was observed that treatments with 100, 1000 and 10,000 nematodes per pot differed significantly from each other. Data revealed that there was no significant difference in fresh weight of root among the treatments with no nematode (Check and associated check) and 10 nematodes per pot, but these treatments differed significantly from the treatments with 10, 100 and 10,000 nematodes per pot. Further it was observed that treatments with 100, 1000 and 10,000 nematodes per pot differed significantly from each other. No significant difference in dry weight of root was observed among the treatments with no nematode (Check and associated check) and the treatment with 10 nematodes per pot. But the treatments having 100, 1000 and 10,000 nematodes per pot differed significantly from each

other. The number of galls and egg masses per root system increased gradually with the increase in inoculum level from 10 to 1000 but it declined at 10,000 inoculum level per pot. The maximum number of galls and egg masses were recorded in the treatment with 1000 nematodes per pot. The minimum number of galls and egg masses were recorded in the treatment with 10,000 and 10 nematodes per pot respectively. However, no significant difference in galls and egg masses in between the treatments with 10 and 10,000 nematodes per pot but these treatments differed significantly from the treatments with 100 and 1000 nematodes per pot. There was a progressive increase in nematode population with the increase in level of inoculum from 10 to 10,000 nematodes per pot. Further, it was observed that there was no significant difference between the treatments having inoculum level of 1000 and 10,000 nematodes per pot. But these treatments differed significantly from 10 and 100 nematodes per pot. The reproductive rate of nematodes decreased significantly with increase in inoculum level from 10 to 10,000 nematodes per pot. The highest (30.56) and lowest (0.24) reproductive rates were observed in the inoculum level of 10 and 10,000 juveniles per pot respectively. Further, it was observed that there was no significant difference between the treatments having inoculum level of 1000 and 10,000 nematodes per pot. But these treatments differed significantly from 10 and 100 nematodes per pot.

The results obtained in the study of pathogenicity of *Meloidogyne incognita* on tuberose indicated that with the increase in inoculum level of *M. incognita* there was a corresponding decrease in plant height. This finding is in agreement with the findings obtained by Sundarababu and Vadivelu (1988) [8] on tuberose. Further it was observed that there was a significant reduction in plant height of tuberose plants at and above 100 nematodes per pot. Similar results were obtained by Mohanty and Das (1996) [9] on tuberose. Further, it was observed that at the highest inoculum level (10,000 J₂ per pot) the plants became completely stunted. Similar symptoms were also observed by Dutta (2011) [10] and Dungdung (2015) [11] on gladiolus.

There was a corresponding reduction in fresh and dry weight of the shoot and root of the plants with increase in level of inoculum from 10 to 10,000 nematodes per pot. Similar results were obtained by Johnson *et al.* (2002) [12] on gladiolus. Ravishankar and Singh (2008) [13] also recorded similar results on gladiolus. Further, it was observed that there was a significant reduction in shoot weight and root weight (fresh and dry) of the plants inoculated with 100 or above nematodes per pot. Similar findings had been reported by Duggal *et al.* (2016) [14] on gladiolus. Further, it was observed that at the highest inoculum level (10,000 J₂ per pot), the plants had very much reduced root system with less number of bulblets.

It was observed that number of galls and egg masses increased gradually with the increase in inoculum level from 10 to 1000 and declined at 10,000 inoculum level of *M. incognita* per pot. There was a progressive increase in nematode population in soil with increase in inoculum level from 10 to 1000 nematodes per pot. The maximum number of galls and egg masses were recorded in plants inoculated with 1000 nematodes per pot. Similar results were recorded by Manju and Subramanian (2015) [16] on gerbera.

The gradual increase in nematode population results in gradual decrease in reproductive rates. The maximum (30.56) and minimum (0.24) reproductive rate of *M. incognita* were recorded in the lowest inoculum level (10 J₂) and highest inoculum level (10,000 J₂) per pot respectively. The population growth rate was found to be inversely proportional with inoculum levels, being highest at 10 and lowest at 10,000 J₂ per pot. This might be due to competition of nematodes for host penetration, food and space. This finding is in conformity with Senthamarai *et al.* (2006) [17] on coleus and Kalaiarasan *et al.* (2006) [18] on groundnut.



Plate 1: Growth of tuberose plant under different inoculum levels of *Meloidogyne incognita*

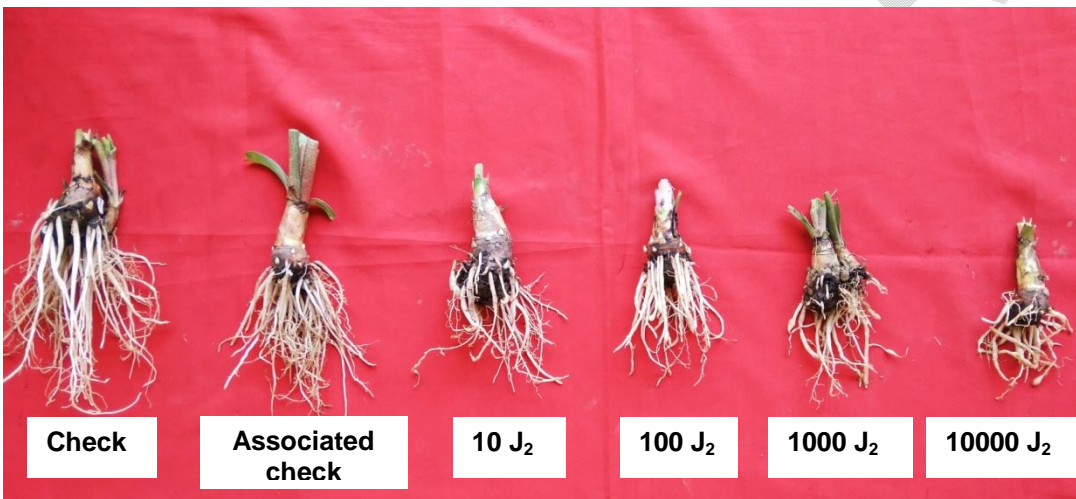


Plate 2: Effect of different inoculum levels on root growth

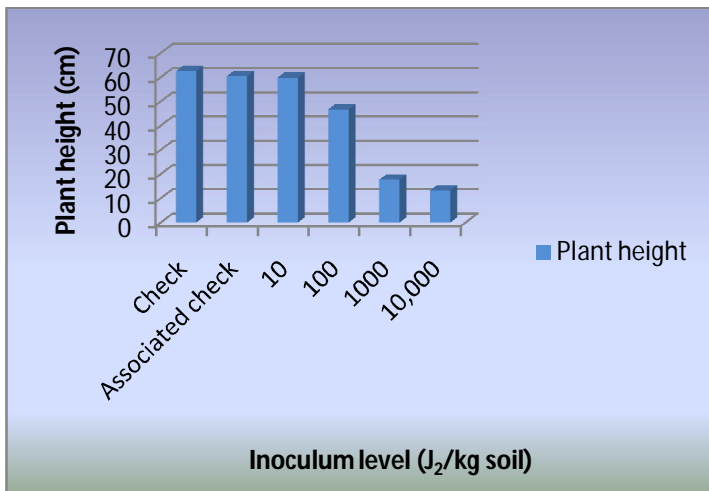


Fig. 1. Effect of different inoculum level on plant height of tuberose

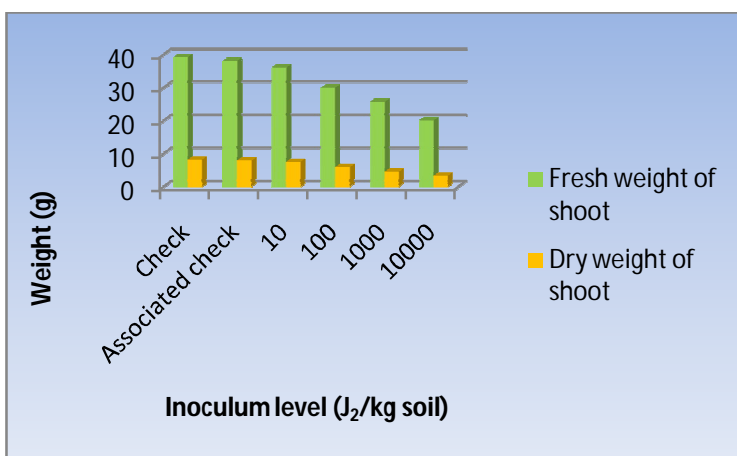


Fig.2. Effect of different inoculum level on fresh and dry weight of shoot of tuberose

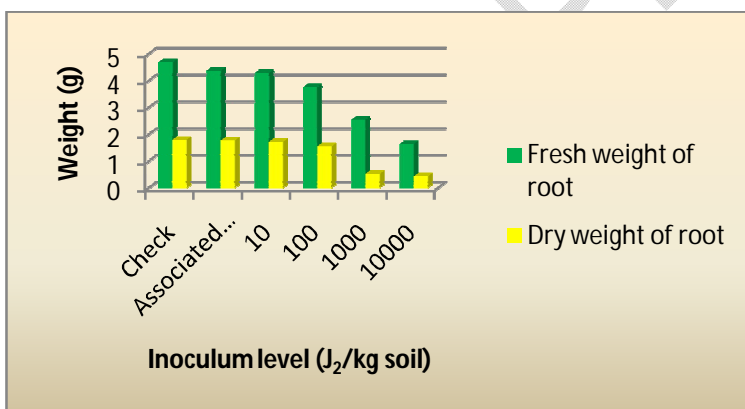


Fig.3. Effect of different inoculum level on fresh and dry weight of root of tuberose

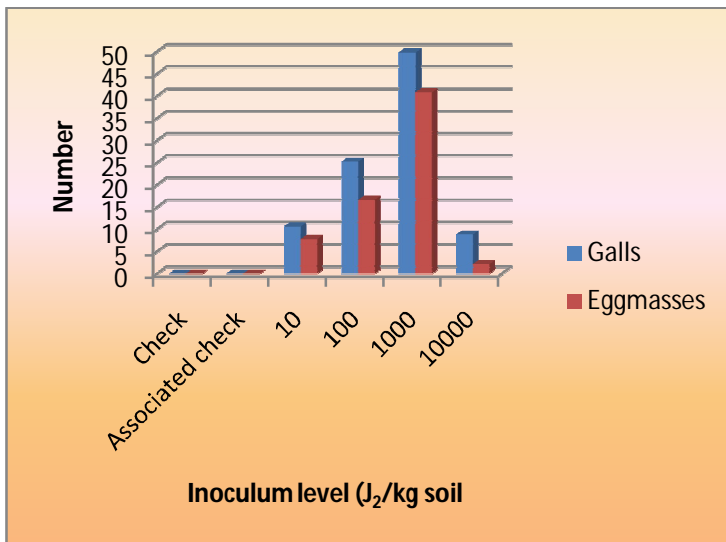


Fig. 4. Effect of different inoculum level on galls and eggmass formation per root system root of tuberose

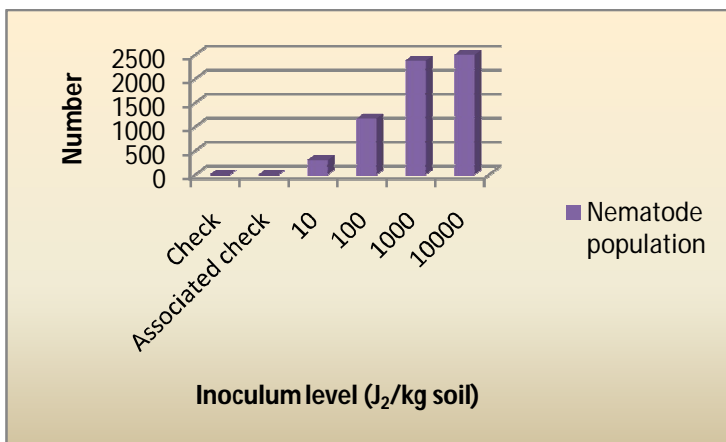


Fig. 5. Nematode population in soil

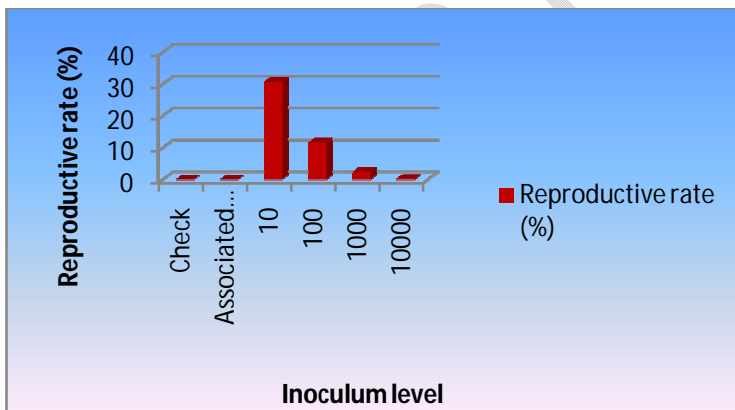


Fig. 6. Reproductive rate of nematode (%) in soil

4. CONCLUSION

In conclusion, this study reveals that an inoculum level of 100 second stage juvenile (J₂) of *M. incognita* per kg of soil is pathogenic to tuberose plants. The consistent decrease in plant growth parameters shows the intricate relationship between root-knot nematode inoculum level and plant responses. With this understanding farmers can make informed decisions regarding nematode management in tuberose, which will definitely help them in getting good price in the global flower market.

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Table 1. Effect of different inoculum levels of *Meloidogyne incognita* on plant growth parameters of tuberose (Mean of 5 replications)

Inoculum level (J ₂ /kg soil)	Plant height (cm)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
T ₁ : Check	62.54 ^a	39.30 ^a	8.27 ^a	4.69 ^a	1.80 ^a
T ₂ : Associated check	60.46 ^a	38.17 ^a	8.01 ^a	4.38 ^a	1.77 ^a
T ₃ : 10	59.84 ^a	36.18 ^a	7.58 ^a	4.30 ^a	1.72 ^a
T ₄ : 100	46.74 ^c	29.98 ^b	6.01 ^b	3.76 ^b	1.56 ^b
T ₅ : 1000	17.68 ^d	25.77 ^c	4.61 ^c	2.55 ^c	0.53 ^c
T ₆ : 10,000	13.22 ^e	20.15 ^d	3.42 ^d	1.64 ^d	0.44 ^d
S.Ed. (±)	1.54	1.58	0.34	0.25	0.04
CD _{0.05}	3.20	3.29	0.71	0.52	0.08

*MEAN FOLLOWED BY THE SAME LETTER IN THE SUPERScript(S) ARE STATISTICALLY AT PAR.

Table 2. Effect of different inoculum levels of *Meloidogyne incognita* on number of galls, egg masses and nematode population on tuberose (Mean of 5 replications)

Inoculum level (J ₂ /kg soil)	No. of galls/ root system		No. of eggmasses/ root system	Final nematode population (200 cc of soil)	Reproductive rate (%)
T ₁ : Check	0.00	0.00	0.00	0.00	0.00
T ₂ : Associated check	(0.70) ^d	(0.70) ^d	(0.70) ^d	0.00	0.00
T ₃ : 10	10.60	7.80	305.60	30.56	
T ₄ : 100	(3.29) ^c	(2.83) ^c	(17.47) ^c		
(5.05) ^b (4.10) ^b	25.20	16.60	1166.40	11.64	
T ₅ : 1000	49.80	40.80	2377.40	2.37	
(7.06) ^a (6.07) ^a		(48.75) ^a			

T ₆ : 10,000	8.80 (2.99) ^c	5.60 (2.14) ^c	2497.20 (49.94) ^a	0.24
S.Ed. (±)	0.31	0.31	1.03	
CD _{0.05}	0.65	0.64	2.14	

Values of number of galls, egg masses and final nematode population within in parentheses are square root ($\sqrt{x+0.5}$) transformed data.

Mean followed by the same letter in the superscript(s) are statistically *at par*.

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