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SCREENING AND EVALUATION OF *SOLANUM* SPECIES TO OBSERVE POTENTIAL ROOTSTOCKS FOR THE MANAGEMENT OF *MELOIDOGYNE INCOGNITA* IN TOMATO

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ABSTRACT

The study was carried out to evaluate the responses of different *Solanum* species to *Meloidogyne incognita* under pot conditions and to identify resistant rootstock(s) for the management of *M. incognita* in tomato by employing grafting technique. Twelve *Solanum* species were screened against *M. incognita* at the net house of Department of Nematology, Assam Agricultural University, Jorhat Assam. The observation on number of galls and egg masses in roots and nematode population per pot were recorded after 45 days of inoculation of *M. incognita*. These data were further used to calculate the root knot index (RKI), responses of various *Solanum* spp. and nematode reproduction rate. All the *Solanum* species showed varying degree of responses to *M. incognita*. Among these, *S. torvum* and *S. lycopersicum* cv. Hisar Lalit were found to be resistant against *M. incognita* whereas *S. viarum* was found to be susceptible against *M. incognita* and the remaining species were highly susceptible to *M. incognita*. *S. torvum* and *S. lycopersicum* cv. Hisar Lalit showed the lowest number of galls per root system, egg massesper root system and final nematode population in soil per pot. On the other hand, *S. lycopersicum* cv. S-22 showed the highest number of galls per root system, egg masses per root system and final nematode population in soil per pot. Utilizing resistant cultivars is an economically efficient method for managing plant parasitic nematodes and these resistant rootstocks can be used in tomato grafting technology for the management of *M. incognita*.

Key words : Screening, *Solanum* spp., *Meloidogyne incognita*, Resistance, Tomato.

Introduction

Tomato, scientifically known as *Solanum lycopersicum* L., is a widely cultivated crop and a member of the Solanaceae family which encompasses more than 4000 species exhibiting significant morphological variations (Singh *et al*., 2017). Tomato is globally considered as the second most important fruit as well as vegetable crop after potato (Costa and Heuvelink, 2018). Tomatoes are recognized as vegetables for nutritional purposes and are highly valued for their abundant lycopene and vitamin C content (Wu *et al*., 2022).

Numerous pests attack tomatoes, wreaking havoc on their leaves, stems, fruits and roots (Khulbeand Batra, 2024). One of the most devastating pests is the root-knot nematode, which has been considered to be the cause of significant yield reductions around the globe (Ghule *et al*., 2014; Onkendi *et al*., 2014; Tapia-Vázquez *et al*., 2022). Root-knot nematode poses a significant threat to solanaceouscrops, as it inflicts harm by feeding on them and prompting the formation of large galls or “knots” throughout the root system of infested plants (Seid *et al*., 2015). This interference can disrupt the plants’ ability to uptake water and nutrients, leading to a substantial impact on the translocation of photosynthates (Anwar *et al*., 2010).

To mitigate nematode infestations and minimize production setbacks, chemical nematicides have been widely employed as a common strategy. However, these substances continue to have a deleterious influence on flora and fauna contributing to health hazards and environmental contamination (Kumar *et al.*, 2023). The adoption of resistant cultivars is one of the most efficient and environmentally benign way to control root knot nematode among non-chemical methods (Mukhtar *et al.*, 2014; Forghani and Hajihassani, 2020). However, there are meagre resistant varieties available that can be effectively grown to combat this destructive pest on a global scale (Saucet *et al.*, 2016).

In light of these considerations, the present investigation was proposed to identify the rootstocks that are resistant to *Meloidogyne incognita*by screening of a few *Solanum* species against *M. incognita* for further studies.

Materials and Methods

Experimental Procedure

During the year, 2022, a pot culture experiment was conducted at the net house of Department of Nematology, Assam Agricultural University, Jorhat, to evaluate the responses of twelve *Solanum* species against *M. incognita*. Four wild *Solanum* species *viz.*, *Solanum torvum*, *S. violaceum*, *S. pimpinellifolium* and *S. viarum* and eight *S. lycopersicum* cultivars *viz.*, Hisar Lalit, Miku (TO-2184), Arka Samrat, Dona-55, S-22, Pusa Ruby, S-3410 and BSS-422 were used for screening against *M. incognita*. The seeds of *Solanum* species *viz.*, *S. torvum*, *S. violaceum*, *S. pimpinellifolium*, *S. viarum* were obtained from the Department of Horticulture, Assam Agricultural University, Jorhat. The *S. lycopersicum* cv., Hisar Lalit was collected from Chaudhary Charan Singh Haryana Agricultural University, Hisar and the other tomato cultivars were procured from local markets of Jorhat. To promote optimal and early germination, the seeds were soaked in GA_3 solution @ 100 ppm for 24 hours prior to sowing in plastic pro-trays containing mixture of coco-peat and vermicompost in a ratio of 1:1. After 21 days of germination, the seedlings were transplanted into earthen pots with a soil capacity of 1000 cc and containing mixture of sterilized soil, dried cow dung and river sand in the ratio of 2:1:1 under net house conditions.

Nematode Inoculation

The tomato seedlings grown in sterilized soil-filled pots were inoculated with a precise number of freshly hatched second stage juveniles (J_2) of *M. incognita* obtained from a pure culture on three days of transplanting. The nematode inoculum (J_2) was inoculated at a depth of 1 cm near rhizosphere (root zone) and again covered with sterile soil after inoculation. The rate of inoculation was maintained at 1 J_2 per cubic centimetre (cc) of soil.

Treatment details

The experiment was laid in completely randomized design (CRD) with 12 treatments and 5 replications (Table 1).

Screening and evaluation of *Solanum* spp. against *Meloidogyne incognita*

Plants were uprooted carefully after 45 days of inoculation and the roots were washed gently to make them free from any soil particle. The records of observations such as number of galls per root system, egg masses per root system and final nematode population in soil were kept. Root knot index (0-5 scale) was calculated for each plant based on the number of galls per root system as provided by Sasser *et al.* (1984) (Table 2). The resistance/susceptibility of the plants *to M. incognita* was recorded based on the root knot index.

Table 1 : Different treatments.

Treatment	Treatment Details
T_1	*Solaumtorvum*
T_2	*S. violaceum*
T_3	*S. pimpinellifolium*
T_4	Hisar Lalit
T_5	*S. viarum*
T_6	Miku (TO-2184)
T_7	Dona-55
T_8	S-22
T_9	S-3410
T_{10}	Arka Samrat
T_{11}	BSS-422
T_{12}	Pusa Ruby

The *S. lycopersicum cv.* Pusa Ruby was used as susceptible check (SC).

Table 2 : Root knot index scale (Sasser *et al.*, 1984).

Gall index	No. of galls/root system	Resistance reaction
1	No galls	Highly resistant
2	1-10 galls	Resistant
3	11-30 galls	Moderately resistant
4	31-100 galls	Susceptible
5	>100 galls	Highly susceptible

Results and Discussion

The *Solanum* species exhibited varied responses to *M. incognita* encompassing both resistance and

Table 3 : Responses of different *Solanum* spp. against *Meloidogyne incognita.*

S. no.	*Solanum* spp.	Number of galls per root system	Number of egg masses per root system	RKI	Reaction
1.	*S. torvum*	7.00	5.20	2.00	R
2.	*S. violaceum*	109.40	25.80	5.00	HS
3.	*S. pimpinellifolium*	94.40	37.60	4.50	HS
4.	Hisar Lalit	7.20	5.80	2.00	R
5.	*S. viarum*	59.80	12.40	4.00	S
6.	Miku (TO-2184)	94.60	36.40	4.50	HS
7.	Dona-55	170.80	48.40	5.00	HS
8.	S-22	190.20	69.60	5.00	HS
9.	S-3410	150.40	40.20	5.00	HS
10.	Arka Samrat	149.80	40.80	5.00	HS
11.	BSS-422	174.20	41.60	5.00	HS
12.	Pusa Ruby	127.40	58.40	5.00	HS
	S.Ed (±)	0.08	0.09	-	-
	$CD_{0.05}$	0.16	0.17	-	-

susceptibility. Among the species screened against *M. incognita*, *S. torvum* (7.00, 5.20) and *S. lycopersicum cv.* Hisar Lalit (7.20, 5.80) showed the lowest number of galls and egg masses. Conversely, *S. lycopersicum cv.* S-22 exhibited the highest number of galls (190.20) and egg masses (69.60) (Table 3). Collonier *et al.* (2001), Kashyap *et al.* (2003), Tzortzakakis *et al.* (2006), Sherly (2010) Sargin and Devran (2021) and Polimera *et al.* (2022) also reported resistance reaction of *S. torvum* against *M. incognita*. Kalaiarasan (2009) conducted an experiment taking forty-two tomato genotypes/varieties to determine their resistance against *M. incognita*. Notably, Hisar Lalit exhibited a remarkable resistance response showing the lowest number of galls per plant (<10 galls/plant). Additionally, the study revealed that *S. lycopersicum cv.* Hisar Lalit contained a higher phenol activity (516.4) as compared to the other genotypes that were inoculated with *M. incognita.* Brow *et al.* (1997); Ehlers *et al.* (2002); Jacquet *et al.* (2005) and Kamran *et al.* (2012) screened *Solanum* species against *M. incognita* and found that the nematode was capable of inducing root galling on all the *Solanum* species, albeit at different rates. These variations in gall formation could be attributed to dissimilarities in the genetic makeup of the *Solanum* species.

Among the twelve *Solanum* spp., *S. torvum* and *S. lycopersicum cv*. Hisar Lalit showed resistant response (RKI 2), while *S. viarum* showed susceptible reaction (RKI 4) to *M. incognita*. The remaining varieties were recorded as highly susceptible (RKI 5) (Table 3). Dhivya *et al.* (2016) examined various *Solanum* species for their responses to *M. incognita* and confirmed that *S. torvum* and *S. sisymbriifolium* exhibited resistant reactions to *M. incognita*, while *S. viarum* showed susceptible reaction and *S. violaceum* showed highly susceptible reaction against *M. incognita*. These findings align with and further corroborate the results obtained in the current investigation. Furthermore, it was concluded that wild *Solanum* species exhibit higher levels of disease-resistant enzymes such as peroxidase, polyphenol oxidase, phenylalanine ammonia lyase and acid phosphatase activity, which contribute to their resistance against *M. incognita* (Dhivya *et al.*, 2016).

Table 4 : Final nematode population and rate of reproduction of *Meloidogyne incognita* in different species of *Solanum.*

S. no.	*Solanum* spp.	Final nematode population in soil per pot	Rate of reproduction
1.	*S. torvum*	425.80	0.43
2.	*S. violaceum*	1483.20	1.48
3.	*S. pimpinellifolium*	1557.40	1.56
4.	Hisar Lalit	466.80	0.47
5.	*S. viarum*	1024.80	1.02
6.	Miku (TO-2184)	2137.60	2.14
7.	Dona-55	2201.20	2.20
8.	S-22	2292.80	2.29
9.	S-3410	2156.20	2.16
10.	Arka Samrat	1827.60	1.83
11.	BSS-422	1874.20	1.87
12.	Pusa Ruby	2147.60	2.15
	S.Ed (±)	0.02	-
	$CD_{0.05}$	0.04	-

The findings indicate that S-22 showed the highest number of final nematode population per pot (2292.80) and reproduction rate (2.29). On the other hand, *S. torvum* (425.80, 0.43) and Hisar Lalit (466.80, 0.47) showed lowest number of final nematode population and reproduction rate (Table 4). Oostenbrink (1966) and Seinhorst (1967) reported that plants with higher reproduction rates serve as favourable hosts for nematodes, while those with lower reproduction rates are less conducive hosts. In a separate study by Sujatha *et al.* (2017), forty tomato genotypes were screened against *M. incognita* to study their host responses where Hisar Lalit, HN 2, PNR 7, IIHR 2614, and IIHR 2868 were reported to be resistant to *M. incognita*.

Conclusion

With the changing pest management approaches, there is a progressive shift away from chemical towards non-chemical methods, driven by apprehensions regarding chemical toxicity and environmental hazards. To address this, the study focused on identifying *Solanum* rootstocks that exhibit resistance to *M. incognita* as potential means of managing the root knot disease on tomatoes. This study indicated that the evaluation of *Solanum* rootstocks showed a significant variation in response to *M. incognita.* To effectively manage root-knot nematodes, resistant germplasms or cultivars of *Solanum* spp. can be used as rootstocks and grafted with scions of suitable and widely approved tomato varieties.This could prove to be useful crop management tool in mitigating the harmful effects of root knot nematodes on tomato.

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