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Short Communication

Exploring *Solanum* species for resistance to root-knot nematode (*Meloidogyne incognita*)

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ABSTRACT

Sixty-six accessions including 11 *Solanum* species and eight accessions intermediate between *S. melongena* and *S. insanum* were screened against root-knot nematode, *Meloidogyne incognita,* for identification of sources of resistance. Accession of *S. insanum* (IC316278) and the intermediate between *S. melongena* and *S. insanum* accession (IC253952) were found to be moderately resistant (RKI: 3, 11-30 galls per root system) in initial screening, and were found susceptible when these were exposed to *M. incoginta* for a period of 90 days. However, accession of *S. torvum* was found to be resistant, as it consistently recorded less number of galls and egg masses after 45 days (7.0 galls and 4.6 egg masses per root system) and 90 days (8.4 galls and 6.6 egg masses per root system) post-inoculation of *M. incognita*. Thus, it can be concluded that *S. torvum* accession, IC618029, is a valuable source of resistance to *M. incognita* which can be used in nematode resistance breeding programme and as a rootstock particularly in brinjal and tomato to lessen nematode damage.

Keywords: *Meloidogyne incognita*, resistance, *Solanum*, susceptible

INTRODUCTION

Root-knot nematode, *Meloidogyne incognita* (Kofoid & White, 1919), is a major endo-parasite that causes significant economic loss in several solanaceous crops. In India, plant-parasitic nematodes (PPN) alone are responsible for an average annual crop loss of 21.3% or Rs.102,039.79 million (1.58 billion USD). Among PPN, *Meloidogyne* spp. causes severe losses in vegetables crops including tomato (23% yield loss, Rs.6035.2 million monitory loss), brinjal (21% yield loss, Rs.3499.12 million monitory loss) and okra (19.5% yield loss, Rs.2480.86 million monitory loss) (Kumar et al., 2020). The *Meloidogyne* spp. is also found to be economically important pathogen under protected cultivation. The cultivars that are resistant to nematode can significantly reduce yield loss and also lower the need of nematicides. Root-knot nematode (RKN) resistance sources were identified in several wild brinjal species, *viz*., *Solanum torvum, S. aethiopicum, S. macrocarpon* (Okorley et al., 2018; Sargin & Devran, 2021). The identified resistant wild species were also utilised as root-stock due to their tolerance or resistance to biotic and abiotic factors (Ocal et al., 2018). Therefore in present study, indigenous wild species of *Solanum* were assessed for their resistance reaction to *M. incognita* that can be used as a nematode-resistant rootstock, for susceptible cultivars of other solanaceous crops that are grown in protected structures.

Sixty-six accessions including 11 *Solanum* species *viz*., *S. aethiopicum* (3), *S. incanum* (3), *S. insanum* (25), *S. macrocarpon* (1), *S. melongena* (11), *S. nigrum* (1), *S. sisymbriifolium* (1), *S. torvum* (1), *S. viarum* (7), *S. violaceum* (3), *S. virginianum* (2) and eight accessions intermediate between *S. melongena* and *S. insanum* were obtained from the ICAR-National Bureau of Plant Genetic Resources, Regional Station, Thrissur, Kerala and were evaluated against the root-knot nematode, *M. incognita,* under artificially inoculated pot conditions under glasshouse conditions during 2020-22.

Preliminary screening was carried out in a 5-inch diameter pot containing 1000 cc sterilized soil. Single seedlings of each accession were transplanted in each pot. One week after transplanting, freshly hatched juveniles (J2) of *M. incognita* @ 2 J2 per cc soil were inoculated by making holes around the plants. Each accession was replicated five times and maintained under greenhouse condition. Observations on number of galls and/or egg masses per root system were taken 45 days after nematode inoculation. The average number of galls or egg masses along with standard error of mean is presented.

The experiment was repeated for the accessions belonging to *S. insanum* (1), *S. torvum* (1) and IC253952 that have shown resistant/moderately resistant reaction in preliminary screening along with susceptible cultivated check, Pusa Purple Long. The experiment was conducted in 6-inch diameter pot containing 1400 cc sterililized soil. Two sets, each set containing five plants were maintained. One set was uprooted at 45 days and second set was uprooted at 90 days after nematode inoculation. The roots were washed with tap water to remove adhering soil particles and blotted dry. The number of galls/ egg masses per root system was counted under magnifying glass. The degree of resistant reaction in each genotype was recorded based on the root-knot index on 1-5 scale and categorised as per the method suggested by Gaur et al. (2001) (Table 1).

Table 1 : Root-knot index (RKI) scale for assessment of reaction of *Solanum* germplasm accessions

RKI	No. of galls/ egg masses	Reaction
1	0	Highly resistant (HR)
2	1-10	Resistant (R)
3	11-30	Moderately resistant (MR)
4	31-100	Susceptible (S)
5	>100	Highly susceptible (HS)

Preliminary screening of 66 accessions revealed that accession belonging to *S. torvum* (IC618029) was found resistant (RKI: 2, < 10 galls per root system) to the root-knot nematode, *M. incognita*. Whereas accessions belonging to *S. insanum* (IC316278) and IC253952 (intermediate between *S. melongena* and *S. insanum*) were found to be moderately resistant (RKI: 3, 11-30 galls per root system) based on root-knot gall index. The remaining accessions of *S. aethiopicum* (3), *S. insanum* (24), *S. macrocarpon* (1), *S. melongena* (11), *S. nigrum* (1), *S. sisymbriifolium* (1), *S. viarum* (7), *S. violaceum* (3), *S. virginianum* (2) and seven accessions intermediate between *S. melongena* and *S. insanum*, were found susceptible (RKI: 4, 31-100 galls per root system). Three accessions of *S. incanum* (IC439282, IC531765, IC531763) and cultivated check Pusa Purple Long (control) were found to be highly susceptible (RKI:5, > 100 galls per root system) to *M. incognita* (Table 2). The number and size of root-knot galls produced by *M. incognita* differed between species as well as between accessions within the same species. However, irrespective of gall size, accessions were categorized as per the root-knot index based on the number of galls per root system.

Accessions belonging to resistant and moderately resistant lines were further tested for 45 days in 6-inch diameter pot containing 1400 cc sterililized soil to confirm the nematode resistance. All accessions have been found to fall into their respective resistance categories. The second set was uprooted at 90 days after nematode inoculation in order to find durable resistance. In this case, it was found that *S. torvum*, IC618029 proved to be resistant as it recorded 8.4 galls and 6.6 egg masses per root system (Table 3, Fig. 1). In contrast, observation on root galls and egg masses after 90 days of inoculation on moderately resistant germplasm, *S. insanum* (IC316278) and IC253952 accession resulted in an increased number of galls and egg masses per root system (Table 3). Although the plant age influences the gall index and nematode reproduction, moderately resistant germplasm may have a significant role in lowering the density of nematodes. Increase in the number of galls and/or egg masses were not observed in *S. torvum* (IC618029) after 90 days of nematode inoculation. In addition, although few, minute galls were noticed on S. torvum at 45 days of nematode inoculation, they appeared to be suppressed or not easily noticeable after 90 days of inoculation, which gives an indication of the innate resistance available in S. torvum to M. incognita.

Table 2 : Reaction of accessions belonging to *Solanum* species against root-knot nematode, *Meloidogyne incognita*, during preliminary screening

Accession	Galls/ root system	Resistance response	Accession	Galls/ root system	Resistance response
S. aethiopicum			*S. sisymbriifolium*		
IC618025	59.8 ± 2.4	S	IC636940	38.8 ± 0.9	S
IC618026	50.2 ± 1.8	S	*S. torvum*		
IC618030	46.4 ± 2.4	S	IC618029	7.6 ± 1.2	R
S. incanum			*S. viarum*		
IC439282	104.8 ± 1.8	HS	IC135913	48.8 ± 1.1	S
IC531763	108.2 ± 1.8	HS	IC241673	47.6 ± 1.2	S
IC531765	117.8 ± 2.4	HS	IC260033	60.8 ± 1.5	S
S. insanum			IC405347	56.0 ± 2.7	S
IC316278	23.0 ± 1.2	MR	IC541409	65.8 ± 1.7	S
IC203584	60.2 ± 2.5	S	IC567383	42.0 ± 1.1	S
IC203593	43.1 ± 2.7	S	IC618028	50.8 ± 1.9	S
IC203609	36.6 ± 1.9	S	*S. violaceum*		
IC241678	48.6 ± 1.3	S	IC618020	65.6 ± 2.9	S
IC253967	50.2 ± 1.9	S	IC618021	45.8 ± 1.2	S
IC265586	60.2 ± 1.7	S	IC618023	62.4 ± 1.8	S
IC324870	49.8 ± 2.2	S	*S. virginianum*		
IC333582	49.0 ± 1.0	S	IC618042	57.0 ± 1.8	S
IC373370	64.2 ± 1.3	S	IC260080	51.0 ± 3.1	S
IC422760	74.6 ± 2.9	S	*S. melongena*		
IC531744	60.2 ± 1.8	S	IC113028	69.8 ± 2.1	S
IC531749	45.6 ± 1.5	S	IC203587	68.6 ± 1.4	S
IC531750	53.8 ± 1.8	S	IC203588	51.4 ± 2.4	S
IC531751	82.4 ± 1.2	S	IC203604	74.4 ± 2.6	S
IC531755	57.6 ± 1.9	S	IC212564	70.2 ± 1.7	S
IC531756	62.0 ± 1.5	S	IC241666	57.8 ± 2.3	S
IC531758	72.8 ± 3.4	S	IC256161	60.8 ± 1.7	S
IC531760	77.8 ± 2.5	S	IC421593	52.0 ± 1.0	S
IC531761	57.8 ± 1.8	S	IC618016	61.8 ± 2.0	S
IC531762	44.0 ± 1.6	S	IC618035	49.2 ± 1.2	S
IC531771	57.2 ± 1.5	S	IC626119	58.6 ± 2.4	S
IC531772	43.4 ± 1.3	S	Accessions intermediate between *S. melongena* and *S. insanum*, the progenitor		
IC531773	86.2 ± 1.4	S	IC203595	53.4 ± 1.2	S
IC545903	77.0 ± 3.0	S	IC253952	19.4 ± 1.0	MR
S. macrocarpon			IC253963	66.4 ± 2.4	S
IC421450	45.8 ± 1.6	S	IC253957	46.2 ± 1.5	S
S. nigram			IC260115	48.4 ± 1.3	S
IC213934	49.2 ± 1.4	S	IC265589	83.6 ± 2.0	S
S. melongena			IC324556	39.4 ± 1.2	S
(susceptible check)					
Pusa Purple Long	135.0 ± 3.7	HS	IC531767	60.2 ± 1.7	S

values (±SE) are means of five replicates; R=resistant, MR=moderately resistant, S=susceptible, HS = highly susceptible

Table 3 : Status of resistance of *Solanum* species in terms of root-galling and egg mass production by *Meloidogyne incognita*

Species/Accession	Confirmatory evaluation#				Resistance response at 90 DAI
	45 days DAI		90 days DAI		
	Galls/root system	Egg masses/ root system	Galls/root system	Egg masses/ root system	
S. torvum (IC618029)	7.0 ± 1.4	4.6 ± 1.1	8.4 ± 0.5	6.6 ± 1.3	Resistant
IC253952*	26.2 ± 2.4	20.8 ± 1.5	47.6 ± 3.4	45.0 ± 6.4	Susceptible
S. insanum (IC316278)	24.2 ± 2.5	17.6 ± 1.9	43.8 ± 4.0	34.8 ± 3.8	Susceptible
S. melongena (Pusa Purple Long)	139.2 ± 7.6	138.75 ± 7.1	225.5 ± 11.8	169.8 ± 6.1	Highly susceptible

values (±SE) are means of five replicates; * accession intermediate between *S. melongena* and *S. insanum*, the progenitor; DAI: days after inoculation

Fig. 1 : Comparison of the root galling due to *Meloidogyne incognita* in *Solanum* species at 90 days after inoculation A. Resistant *Solanum torvum*, IC618029 and B. highly susceptible *Solanum melongena* var. Pusa Purple Long

It has been reported in several studies that *S. torvum* provides broad-spectrum resistance against root-knot nematodes (Ocal et al., 2018; Sargýn & Devran, 2021) and other soil pathogens (Ramesh et al., 2016). The present results with *S. torvum* accession, IC618029, resistant to *M. incognita* are in agreement with these studies. In *S. torvum*, compounds such as sesquiterpenoids, chitinases, and NLR genes appear to be involved in resistance reactions, influencing the nematode's viability at different stages of the resistance reaction (Bagnaresi et al., 2013; Zhang et al., 2023). On the contrary, it was also reported in host suitability studies that some cultivars of *S. torvum* showed resistance to susceptible reactions against *M. javanica* (Garcia-Mendivil et al., 2019) and susceptible reactions to Japanese *M. hapla* populations (Murata & Uesugi, 2021). Therefore, it is important to choose well-documented resistant accession in resistance breeding programmes and for reducing the soil populations of *M. incognita* below threshold level. In future, *S. torvum*, IC618029 accession can be utilized as a resistant rootstock for managing root-knot nematodes in commercial crops like tomato and brinjal.

REFERENCES

Bagnaresi, P., Sala, T., Irdani, T., Scotto, C., Lamontanara, A., Beretta, M., Rotino, G. L., Sestili, S., Cattivelli, L., & Sabatini, E. (2013). *Solanum torvum* responses to the root-knot nematode *Meloidogyne incognita*. *BMC Genomics*, *14*, 540. https://doi.org/10.1186/1471-2164-14-540

Garcia-Mendivil, H. A., Escudero, N., & Sorribas, F. J. (2019). Host suitability of *Solanum torvum* cultivars to *Meloidogyne incognita* and *M. javanica* and population dynamics. *Plant Pathology*, *68*, 1215-1224. https://doi.org/10.1111/ppa.13036

Gaur, H. S., Singh, R. V., Kumar, S., Kumar, V., & Singh, J. V. (2001) Search for nematode resistance in crops. AICRP on Nematodes, Division of Nematology, IARI, New Delhi, pp. 4

Kumar, V., Khan, M. R., & Walia, R. K. (2020). Crop loss estimations due to plant-parasitic nematodes in major crops in India. *National Academy Science Letters, 43*(5), 409–412. https://doi.org/10.1007/s40009-020-00895-2.

Murata, G., & Uesugi, K. (2021). Parasitism of *Solanum torvum* by *Meloidogyne hapla* populations from Japan. *Journal of Phytopathology*, *169*, 122–128. https://doi.org/10.1111/jph.12966

Ocal, S., Ozalp, T., & Devran, Z. (2018). Reaction of wild eggplant *Solanum torvum* to different species of root-knot nematodes from Turkey. *Journal of Plant Diseases and Protection, 125*, 577–580. https://doi.org/10.1007/s41348-018-0167-3

Okorley, B. A., Agyeman, C., Amissah, N., & Nyaku, S. T. (2018). Screening selected *Solanum* plants as potential rootstocks for the management of root-knot nematodes (*Meloidogyne incognita*). *International Journal of Agronomy*, https://doi.org/10.1155/2018/6715909

Ramesh, R., Achari, G., Asolkar, T., Dsouza M., & Singh, N. P. (2016). Management of bacterial wilt of brinjal using wild brinjal (*Solanum torvum*) as root stock. *Indian Phytopathology*, *69*, 260-265.

Sargin, S., & Devran, Z. (2021). Degree of resistance of *Solanum torvum* cultivars to Mi-1.2-virulent and avirulent isolates of *Meloidogyne incognita*, *Meloidogyne javanica*, and *Meloidogyne luci*. *Journal of Nematology, 53*, e2021-68. doi: 10.21307/jofnem-2021-068.

Zhang, H., Chen. H., Tan, J., Huang, S., Chen, X., Dong, H., Zhang, R., Wang, Y., Wang, B., Xiao, X., Hong, Z., Zhang, J., Hu, J., & Zhang, M. (2023). The chromosome-scale reference genome and transcriptome analysis of *Solanum torvum* provides insights into resistance to root-knot nematodes. *Frontiers in Plant Science, 14*, 1210513. doi:10.3389/fpls.2023.1210513.

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