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RESEARCH NOTE

Weeds as potential reservoirs and hosts for root-knot nematodes in tomato cultivation

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ABSTRACT

Tomato, the most widely cultivated vegetables globally, is significantly threatened by biotic factors, particularly root-knot nematodes (RKNs) like *Meloidogyne* species, which are polyphagous parasites with a broad host range. Weeds play a crucial role as alternative hosts for RKNs, enabling their persistence in fields and serving as reservoirs of infection for subsequent crops. This study focuses on the Kolar district of Karnataka, India, a major tomato-producing region, where prominent weed hosts of RKNs are identified which include *Mesosphaerum suaveolens*, *Crassocephalum crepidioides, Spermacoce ocymoides, Portulaca oleracea*, *Solanum nigrum, Alternanthera sessilis, Ageratum conyzoides* and *Emilia sonchifolia* showing symptoms of nematode infection, such as gall formation. Morphological identification of nematode species revealed the presence of *Meloidogyne incognita*, *M. javanica*, and *M. enterolobii*. The findings underscore the importance of managing weed populations to control nematode infestations and mitigate their impact on tomato cultivation.

Keywords: *Meloidogyne* spp., Tomato, Root-knot nematodes, Reservoirs, Weed hosts

Tomato is the most widely grown vegetable in the world and global tomato production reached 41.52 million tonnes by 2020 and is projected to rise to approximately 51.93 million tonnes by 2026, as per the prevailing worldwide forecast (Chandrasekaran *et al*. 2021). Karnataka is one among the primary tomato-producing states in India which along with other states contribute to approximately 90% of the country's total tomato production (NHB 2019). Among the array of biotic constraints affecting tomato production, root-knot nematodes (RKNs) are among the important ones and cannot be overlooked.

While often perceived as nuisances due to their competitive nature and ability to reduce crop yields, weeds also serve as crucial collateral hosts for various plant pathogens, including nematodes (Lopez *et al*. 2021). RKNs have the ability to persist on weeds regardless of whether there is a main host present in the field, thereby serving as a reservoir of infection for subsequent crops and heightening the risk of disease (Rich *et al*. 2008). Even after the primary crop is harvested, these weeds retain nematodes, maintaining their presence in the soil and perpetuating a continual threat to future crops.

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Root-knot nematodes, in particular, exhibit a polyphagous nature with a broad host range that enables them to infect numerous plant species. These undesirable plants provide breeding ground for nematodes, particularly root-knot nematodes, which are obligate parasites relying on living plant hosts for survival and reproduction. The presence of weeds complicates nematode management efforts, as eradication becomes more challenging once nematodes establish populations in weed reservoirs (Schwarz *et al*. 2024). It is believed that weeds result in more significant crop losses compared to pathogens or insects individually (Fried *et al*. 2017). When coupled with nematodes in the field, their combined effect could pose a more significant threat to crop production (Dentika *et al*. 2021). Kolar, located in Karnataka, India, is renowned for its significant contribution to tomato production. RKNs that infect tomato plants may find alternative hosts in weed plants that proliferate in the inter-cropping phase, potentially serving as reservoirs until the next crop is planted. It is therefore important to identify the weed hosts of nematode to mitigate their impact on tomato crops.

A survey and sampling were conducted from February to March (2023) in tomato fields located in five different areas within Kolar district, Karnataka, to identify weeds serving as hosts for RKNs. This study was carried out during the period between the removal of the previous tomato crop and the planting of a new vegetable crop. The primary objective was to identify and assess common weed hosts of RKN present in the fields during this intermediate period. Initially, common weed species growing in the tomato fields were catalogued. While looking for weed hosts of nematodes, the focus was particularly on those weed plants that were found growing in the planting holes of black plastic mulch, previously used for tomato cultivation, as these sites were more likely to harbour root-knot nematodes inoculum. Uprooted weeds were examined for symptoms of nematode infection, such as gall formation.

The collected weed samples were carefully labelled and transported to the AICRP-Nematodes laboratory at University of Agricultural Sciences, Bangalore, for further analysis. In the laboratory, the shoot portions of the weeds were separated from the roots. The roots were thoroughly washed with tap water to remove any adhering soil and debris. Clean roots were cut into 5-6 cm segments for further processing. Root segments were stained with acid fuchsin to enhance the visibility of nematodes (Bybd *et al.* 1983). After staining, the roots were preserved in a lactophenol solution to prevent decay and facilitate further examination. Female nematodes were carefully excised from the stained root samples.

Figure 1. Prominent weed hosts of root-knot nematodes. (a) *Solanum nigrum* (black nightshade) (b) *Crassocephalum crepidioides* (Cressleaf groundsel) (c) *Portulaca oleracea* (Purslane) (d) *Mesosphaerum suaveolens* (Pignut) (e) *Alternanthera sessilis* (Sessile joyweed) (f) *Ageratum conyzoides* (Billygoat weed) (g) *Emilia sonchifolia* (Purple snow thistle) (h) *Spermacoce ocymoides* (Button weed)

Their perineal patterns were observed under a compound microscope to identify and classify the different species of RKNs present.

In the tomato fields of Kolar, Karnataka, prominent identified weeds were: *Bidens pilosa* (Beggar's tick), *Euphorbia hirta* (Asthma weed), *Emilia sonchifolia* (Purple snow thistle), *Amaranthus viridis* (Green Amaranth), *Portulaca oleracea* (Purslane), *Cleome viscosa* (Tickweed), *Solanum nigrum* (Black nightshade), *Ageratum conyzoides* (Billygoat weed), *Chenopodium album* (Lamb's quarters), *Crassocephalum crepidioides* (Cressleaf groundsel), *Cyperus rotundus* (Nutgrass), *Mesosphaerum suaveolens* (Pignut), *Commelina benghalensis* (Benghal dayflower), *Spermacoce ocymoides* (Button weed), *Convolvulus arvensis* (Field bindweed), *Sporobolus indicus* (Smutgrass), *Digitaria sanguinalis* (Crabgrass), *Alternanthera sessilis* (Sessile joyweed), *Mimosa pudica* (Sensitive plant). Among these common weeds, we observed gall formation as shown in the **Figure 1**, which is a typical symptom of RKNs on eight weeds (**Table 1**). Among which three weeds belonged to *Asteraceae* family, one belonged to the family *Solanaceae* and others belonged to *Lamiaceae*, *Rubiaceae*, *Portulacaceae* and *Amaranthaceae* family. Tomato plants that were found growing as volunteer crops from the seeds of the previous season crop were also found infected with RKNs.

The nematode count per 5g of root samples varied across the identified weed hosts. Among the prominent weeds, *Solanum nigrum* recorded the highest nematode density with 490 ± 14 (Mean ± SE) individuals, followed by *Mesosphaerum suaveolens* with 380 ± 15 and *Crassocephalum crepidioides* with 325 ± 12. *Ageratum conyzoides* had a similar infestation level, showing 330 ± 13 nematodes per 5g of roots. *Portulaca oleracea* exhibited 285 ± 18,

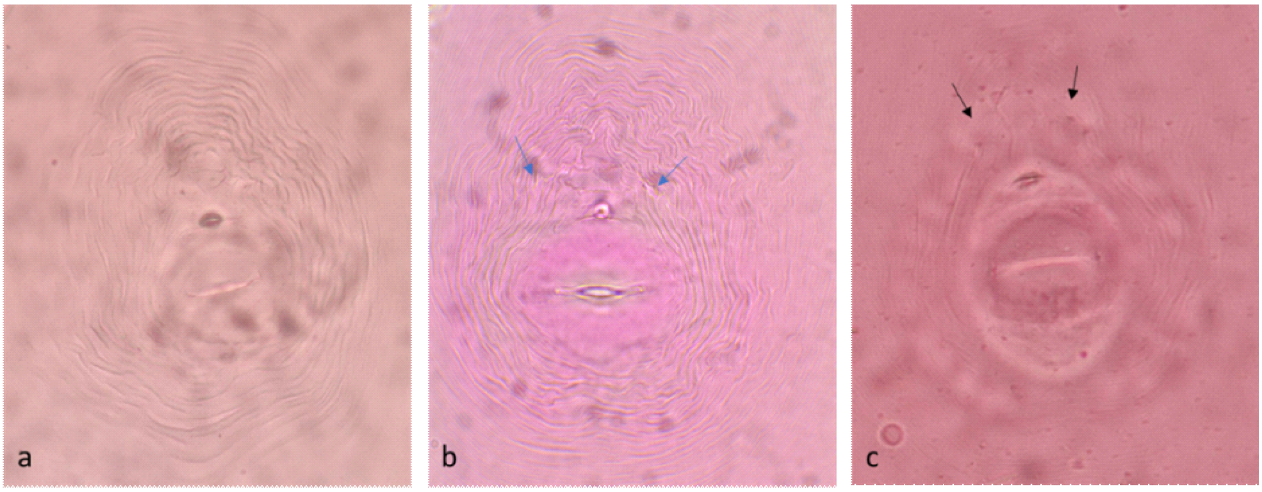

Figure 2. Perineal pattern of RKN species (a) *Meloidogyne incognita*, (b) *M. javanica* and (c) *M. enterolobii*. (Blue arrows indicate lateral lines and black arrows indicate phasmids)

Table 1. The prominent weeds that were identified as hosts of RKN at five different locations

Prominent weeds as reservoirs of RKN	Family	Location				
		A1	A2	A3	A4	A5
Mesosphaerum suaveolens	*Lamiaceae*	+	+	+	+	+
Crassocephalum crepidioides	*Asteraceae*	+	+	-	+	+
Spermacoce ocymoides	*Rubiaceae*	+	-	+	+	+
Portulaca oleracea	*Portulacaceae*	+	+	+	+	+
Solanum nigrum	*Solanaceae*	+		+	+	+
Alternanthera sessilis	*Amaranthaceae*	+	-	+	-	+
Ageratum conyzoides	*Asteraceae*	+	+	+	+	+
Emilia sonchifolia	*Asteraceae*	+	+	+	-	+
RKN species		*M. i, M. e, M. j*	*M. i*	*M. i, M. e*	*M. i*	*M. i, M. e*

A1- Talagavara, A2- Mathikunte, A3- Kumbiganahalli, A4- Kuduvanahlli, A5- Kolar
M. i- *Meloidogyne incognita*, M. e- *Meloidogyne enterolobii*, M. j- *Meloidogyne javanica*

while *Emilia sonchifolia* had 275 ± 10. Lower nematode counts were observed in *Spermacoce ocymoides* (210 ± 10) and *Alternanthera sessilis* (195 ± 11), indicating potential differences in susceptibility or nematode preference across weed species. These findings emphasize the role of diverse weed species in sustaining root-knot nematode populations, potentially contributing to their persistence in tomato fields.

Novel weed hosts

Among the eight weeds which were identified as prominent reservoirs of root-knot nematode, *Alternanthera sessilis, Crassocephalum crepidioides, Mesosphaerum suaveolen* and *Spermacoce ocymoides* stand out as particularly noteworthy. To the best of our knowledge, these weed species have not yet been reported as hosts for root-knot nematodes. This discovery highlights the potential role these weeds may play in the epidemiology of root-knot nematode infestations, underscoring the importance of further research to understand their impact on tomato cultivation.

Morphological identification of RKN species

Morphological identification of RKN species through morphological/external pattern identified three different species of RKN such as *M. incognita*, *M. javanica* and *M. enterolobii* (**Figure 2**). *M. incognita* typically showed a high, smooth and rounded dorsal arch with coarse, wavy striations. Whereas, *M. javanica* had a lower, flatter dorsal arch with finer, more parallel striations and distinct lateral lines. Perineal pattern of *M. enterolobii* resembled *M. incognita* with a high dorsal arch but featured more irregular and coarse striations, particularly in the dorsal region with prominent phasmids

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