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PLANT PARASITIC NEMATODE DIVERSITY IN SATHGUDI SWEET ORANGE ORCHARDS OF TELANGANA STATE, INDIA

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ABSTRACT

A study was conducted in 2024 to assess the diversity and community structure of plant-parasitic nematodes (PPN) in the rhizosphere soil of Sathgudi sweet orange orchards across Nalgonda District, Telangana, India in 2024. Soil samples collected from various orchards revealed the presence of six predominant PPN genera: *Rotylenchulus*, *Pratylenchus*, *Tylenchorhynchus*, *Hoplolaimus*, *Tylenchulus semipenetrans*, and *Meloidogyne*. The nematode community was analyzed using key ecological indices, including frequency, density, and prominence value. Among the identified genera, *Rotylenchulus* was the most prevalent (76.92%), followed by *Pratylenchus* (69.23%) and *Tylenchorhynchus* (61.53%), whereas *Meloidogyne* was the least abundant in the surveyed locations. This comprehensive identification and analysis of PPN communities associated with Sathgudi orange orchards provided baseline data for developing effective nematode management strategies to reduce yield losses, improving the sustainability and productivity of Sathgudi orange cultivation in Telangana.
Keywords **:** plant parasitic nematode, sweet orange, diversity, prominence

Introduction

Sweet orange (*Citrus sinensis*) is among the most important citrus fruits cultivated in India, highly valued for its refreshing taste, nutrient-rich profile, and versatility in fresh and processed products. In India, sweet oranges cover 19.8% of the total citrus area and contribute to 28% of total citrus production (DoA & FW, 2021). The main sweet orange-producing states include Andhra Pradesh, Telangana, Maharashtra, Karnataka, Madhya Pradesh, and Punjab. Telangana is one of the leading producers, with 23,646 ha under cultivation, yielding around 0.615 million tonnes. Within Telangana, Nalgonda district is the top producing region, with 17,674 ha under cultivation and a production of 0.454 million tonnes (Department of Horticulture, Telangana State, 2023). Among sweet orange varieties, Sathgudi (in Andhra Pradesh and Telangana), Mosambi (in Maharashtra), Malta and Jaffa (in Punjab) are traditionally grown in India. However, the productivity of Sathgudi sweet orange in Telangana is hindered by various biotic factors, including pathogens (such as *Fusarium* spp., *Candidatus Liberibacter asiaticus*, citrus tristeza virus, citrus mosaic virus, and phytoplasma), insect pests (such as the citrus mite, *Phyllocoptruta oleivora*; fruit fly, *Bactrocera* spp.; leaf miner, *Phyllocnistis citrella*; psylla, *Diaphorina citri*; and fruit-sucking moth, *Eudocima* spp.), and plant-parasitic nematodes.

Plant parasitic nematodes (PPN) are a major biotic constraint in citrus producing regions, contributing to significant yield losses. Among them, Citrus nematode, *Tylenchulus semipenetrans* is a major threat across all citrus-growing areas (Duncan, 2009; Kumar and Arthurs, 2021). Global yield losses caused by this nematode are estimated between 10% and 30% (Kumar and Arthurs, 2021; Baniya *et al.,* 2025), with losses in India have been reported as 27% (Kumar *et al.,* 2020). It causes a gradual decline and induces citrus dieback,

in association with other pathogens, in the country. Additionally, various ectoparasitic (*Helicotylenchus* spp., *Hoplolaimus* spp., *Hemicycliophora* spp.), migratory endoparasitic (*Pratylenchus*, *Radopholus* spp.), and sedentary endoparasitic (*Meloidogyne* spp.) and semi-endoparasitic (*Rotylenchulus* spp.) nematodes have also been reported pathogenic to citrus (Patel and Patel, 2013; Kumar and Arthurs, 2021).

Despite the importance of PPN, their relative abundance and distribution in sweet orange orchards in Telangana remain underexplored. Considering that nematode populations are affected by climatic factors, soil type and cultivation practices, there is a need to assess their abundance and spatial distribution in Sathgudi orange orchards. This information is vital for developing a targeted, location-specific integrated pest management (IPM) strategy. Hence, a comprehensive survey was conducted to evaluate the diversity and community analysis of PPN in the soil rhizosphere of thirteen Sathgudi orange orchards in Nalgonda district of Telangana. Acquiring knowledge on nematode population dynamics and distribution patterns can aid in assessing ecological disturbances, predicting potential disease outbreaks, and implementing effective nematode management strategies in Sathgudi orange.

Materials and Methods

Survey and sample collection

A comprehensive survey was conducted in thirteen Sathgudi sweet orange orchards across five mandals *viz*., Thipparthy, Nidamanoor, Gurrampode, Devarakonda and Chandampet of Nalgonda district to study the diversity and community structure of PPN. Composite soil samples were collected from thirteen different geographical locations within this district (Table 1). Samples were collected from depths of 15-30 cm near the feeder roots of Sathgudi sweet orange trees. After labelling, all soil samples were transported to the laboratory for nematode extraction and identification.

Table 1 : Field surveyed localities in Nalgonda District, Telangana, India

Study site No.	Location		GPS Coordinates	
	Village	Mandal	Latitude	Longitude
1	Jonnagaddala Gudem	Thipparthy	17° 0' 48.852" N	79° 21' 22.464" E
2	Thippalammaguda	Thipparthy	16° 56' 18.528" N	79° 23' 48.156" E
3	Yerrabelly	Nidamanoor	16° 55' 30.504" N	79° 20' 11.472" E
4	Yerrabelly	Nidamanoor	16° 55' 6.888" N	79° 20' 35.556" E
5	Yerrabelly	Nidamanoor	16° 55' 6.888" N	79° 20' 35.556" E
6	Yerrabelly	Nidamanoor	16° 54' 15.984" N	79° 21' 30.06" E
7	Yerrabelly	Nidamanoor	16° 53' 7.224" N	79° 19' 13.188" E
8	Guntipally	Nidamanoor	16° 52' 49.224" N	79° 23' 5.064" E
9	Yerrabelly	Nidamanoor	16° 54' 31.284" N	79° 24' 42.588" E
10	Pittalagudem	Gurrampode	16° 53' 19.716" N	79° 8' 17.16" E
11	Pittalagudem	Gurrampode	16° 53' 35.124" N	79° 8' 36.204" E
12	Konda Mallepally	Devarakonda	16° 43' 0.516" N	78° 58' 33.852" E
13	Pole Palli	Chandampet	16° 38' 4.488" N	78° 54' 16.56" E

Nematode Processing and identification

Cobb's sieving and decanting technique, followed by the Baermann funnel technique (Southey, 1986) was used for the isolation of PPN from soil samples. After 48 hours of incubation, the resulting nematode suspensions were placed in beakers and immersed in hot water at 60°C for 2 minutes. Once cooled, the suspensions were concentrated and different PPN genera groups were counted under a stereo microscope. Temporary mounts were prepared for identification using a compound microscope. PPN in each sample were identified to genus level based on morphological characteristics, including body shape, stylet length and type, lip region, pharyngeal overlap, tail type, and vulva position using dichotomous keys (Mai and Lyon, 1975; Mai and Mullin, 1996).

Community analysis

Community structure of the identified was analysed by using different formulae (Norton, 1978) *viz*., Absolute frequency (AF), Relative frequency (RF), Absolute density (AD), Relative density (RD), Prominence value (PV) and Relative prominence value (RPV).

Results

Microscopic identification of PPN genera

The survey of PPN conducted across thirteen locations in Nalgonda district, Telangana revealed the presence of six PPN genera, *viz*., *Rotylenchulus* sp.,

Pratylenchus sp., *Tylenchorhynchus* sp., *Tylenchulus semipenetrans*, *Meloidogyne* sp. and *Hoplolaimus* sp. (Fig. 1). Among these, *Rotylenchulus* was the most abundant nematode genus followed by *Pratylenchus* sp. and *Tylenchorhynchus* sp. While, *Meloidogyne* sp. was least abundant in the surveyed areas (Fig. 2 and 3).

Morphological identification of the nematodes was based on distinct features: *Rotylenchulus* sp. was identified by a high and conoid-rounded lip region, 'C' shape when heat killed and the dorsal oesophageal gland orifice (DEGO) positioned more than one half the stylet length and posterior to the base of the knobs. *Pratylenchus* sp. was confirmed by its low, flattened small body, sclerotized head frame, and distinct tail region. *Tylenchorhynchus* sp. was identified by its rounded lip region, offset by a slight constriction, and conoid tail. *T. semipenetrans* was distinguished by its long, pointed tail and excretory pore located at 50-60% of the body length, while, *Meloidogyne* was identified by a well-developed stylet with rounded to ovoid basal knobs and a rounded tail tip. Finally, *Hoplolaimus* was characterized by its tulip-shaped basal stylet knobs and a bluntly rounded tail.

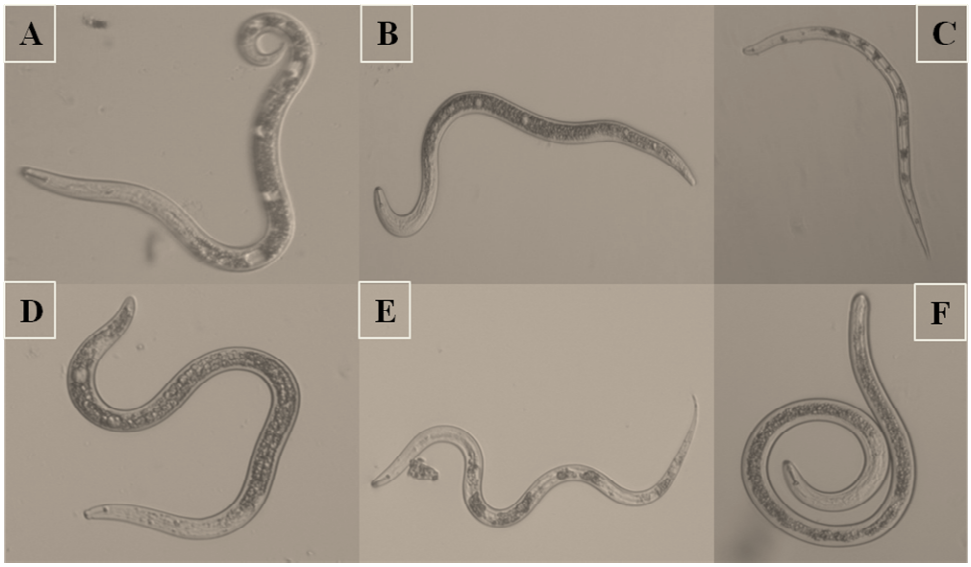

Fig. 1: Microscopic illustrations of plant-parasitic nematodes identified in Sathgudi sweet orange. (A) *Rotylenchulus* sp. (B) *Pratylenchus* sp. (C) *Meloidogyne* sp. (D) *Tylenchorhynchus* sp. (E) *Tylenchulus semipenetrans* (F) *Hoplolaimus* sp. Images were captured at 40x magnification (Olympus BX41, Model BX41TF, Tokyo, Japan)

Fig. 2: Distribution map of plant-parasitic nematodes in Sathgudi sweet orange growing areas of Nalgonda District, Telangana

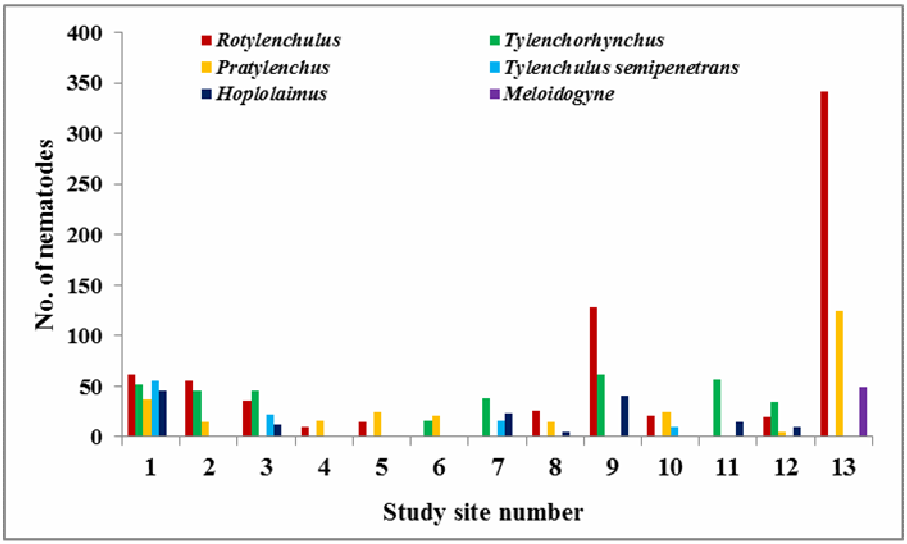

Fig. 3: Plant parasitic nematode genera (Avg. No. per 200 cc soil) associated with Sathgudi sweet orange in Nalgonda District, Telangana

Community analysis of PPN genera

Frequency

The data showed that *Rotylenchulus* sp. was the most frequently occurring nematode (AF=76.92% and RF=25.64%) followed by *Pratylenchus* sp. (AF= 69.23% and RF=23.07%), *Tylenchorhynchus* (AF= 61.53% and RF=20.51%) and *Hoplolaimus* sp. (AF= 53.84% and RF=17.94%). While, *T. semipenetrans* (AF= 30.76% and RF=10.25%) and *Meloidogyne* sp. (AF=7.69% and RF=2.56%) were least abundant (Table 2).

Density

The data showed that *Rotylenchulus* sp. had the highest absolute and relative density (AD=27.5% and RD=32.68%) followed by *Tylenchorhynchus* sp. (AD=13.5% and RD=26.74%). Whereas, *Pratylenchus* sp. (AD=10.84% and RD=24.30%), *Hoplolaimus* sp. (AD=5.80% and RD=9.37%), *T. semipenetrans* (AD=4% and RD=6.14%) and *Meloidogyne* sp. (AD=1.88% and RD=0.73%) were having the lowest density and relative density (Table 2).

Prominence Value

The prominence value of PPN genera ranged from 5.21 to 241.1. Based on the nematode population and frequency of occurrence, *Rotylenchulus* sp. was the most prominent nematode (PV=241.1 and RPV= 47.55%) in Sathgudi sweet orange followed by *Tylenchorhynchus* sp. (PV=105.8 and RPV=20.86%) and *Pratylenchus* sp. (PV=90.19 and RPV=17.78%). The least prominent nematodes in the community were *Hoplolaimus* sp. (PV=42.55 and RPV=8.39%), *T. semipenetrans* (PV=22.18 and RPV=4.37%) and *Meloidogyne* sp. (PV=5.21 and RPV=1.02%) (Table 2).

Table 2. Community analysis of PPN (200cc soil) infecting Sathgudi sweet orange in Nalgonda District, Telangana, India

Parameter	*Rotylenchulus* sp.	*Tylenchorhynchus* sp.	*Pratylenchus* sp.	*Tylenchulus semipenetrans*	*Hoplolaimus* sp.	*Meloidogyne* sp.
AF	76.92	61.53	69.23	30.76	53.84	7.69
RF	25.64	20.51	23.07	10.25	17.94	2.56
AD	27.5	13.5	10.84	4.00	5.80	1.88
RD	32.68	26.74	24.30	6.14	9.37	0.73
PV	241.1	105.8	90.19	22.18	42.55	5.21
RPV	47.55	20.86	17.78	4.37	8.39	1.02

(AF-Absolute frequency; RF-Relative frequency; AD-Absolute density; RD-Relative density; PV-Prominence value) AF of sp. = No. of samples containing species/ No. of samples collected ×100; RF of sp. = Frequency of species/ Sum of frequencies of all species present in samples × 100; AD of sp. = No. of individuals of a sp. in a sample/Volume or mass or unit of a sample × 100; RD of sp. = No. of individuals of a sp. in a sample/Total no. of individuals of all species in a sample × 100; PV of sp. = Absolute density √Absolute frequency; RPV of sp. = PV of a sp./sum of PV of all sp.) × 100

Discussion

This study investigates the PPN associated with Sathgudi sweet orange in Nalgonda, Telangana with *Rotylenchulus* sp. identified as the most abundant species in surveyed orchards. Several studies reported that this nematode was found associated with citrus species in other citrus growing regions of the world (Inserra *et al.,* 1996; Abd-Elgawad, 2020; Yahaya *et al.,* 2024). This species has been reported as a threat to agricultural production in tropical and subtropical regions. In India, *Rotylenchulus* sp. has been reported as a threat to vegetables, fruit trees and oil seed crops (Khan, 2023). The widespread distribution of *Rotylenchulus* sp. can be attributed to several factors including the soil, irrigation practices, machinery and other means. *Pratylenchus* sp. was the second most prevalent nematode in the surveyed with similar findings reported in other citrus-growing regions globally (Divsalar *et al.,* 2012; Eisvand *et al.,* 2019; Abu Habib *et al.,* 2020; Zoubi *et al.,* 2022). Other nematode genera such as *Tylenchorhynchus*, *Hoplolaimus*, *Tylenchulus* and *Meloidogyne* were identified in a few surveyed locations.

Few studies have reported the presence of these nematode genera in citrus orchards in India. For instance, *T. semipenetrans*, *Pratylenchus*, and *Helicotylenchus* sp., *Hoplolaimus* sp. were found to be prevalent in citrus orchards in Rajasthan (Nandwana *et al.,* 2005) and Assam (Mahanta *et al.,* 2018; Kumar and Das, 2019; Borthakur *et al.,* 2024). Recently, Kumar *et al.* (2025) identified the prevalence of *T. semipenetrans* and *Helicotylenchus* sp. followed by *Hoplolaimus* sp., *Tylenchorhynchus* sp. and *Pratylenchus* sp. in Assam lemon orchards. Similarly, Yangchan *et al.* (2025) reported a higher abundance of *T. semipenetrans* followed by *Meloidogyne* spp., *Helicotylenchus* spp. and *Pratylenchus* spp. in citrus orchards of Himachal Pradesh. Our results, thereafter confirm these earlier reports, whereas, *Xiphinema* was the dominant nematode species followed by *Pratylenchus*, *Tylenchulus* and *Helicotylenchus* in citrus orchards in Maharashtra (Deshmukh *et al.,* 2016). Despite the significance of PPN, its pathogenic impact on citrus species in India remains underexplored. These distribution patterns suggest that environmental factors may influence the populations of nematodes in different regions. The current study provides valuable insights into the severity of nematode infestation in Sathgudi sweet orange orchards in Nalgonda District, Telangana, paving the way for future research initiatives focused on nematode management in these commercial areas.

Conclusion

Among the six PPN genera identified in Sathgudi sweet orange orchards, *Rotylenchulus* sp. emerged as the most prevalent across five mandals in Nalgonda district of Telangana. However, a comprehensive investigation is needed in other Sathgudi orange growing regions of Telangana to better understand the yield losses attributed to PPNs and to develop effective strategies to mitigate these losses.

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Declarations

Conflict of interest

No potential conflict of interest was reported by the authors.

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