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Nematode diversity and community structure associated with pomegranate and citrus from the district Jaipur (Rajasthan), India

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Abstract

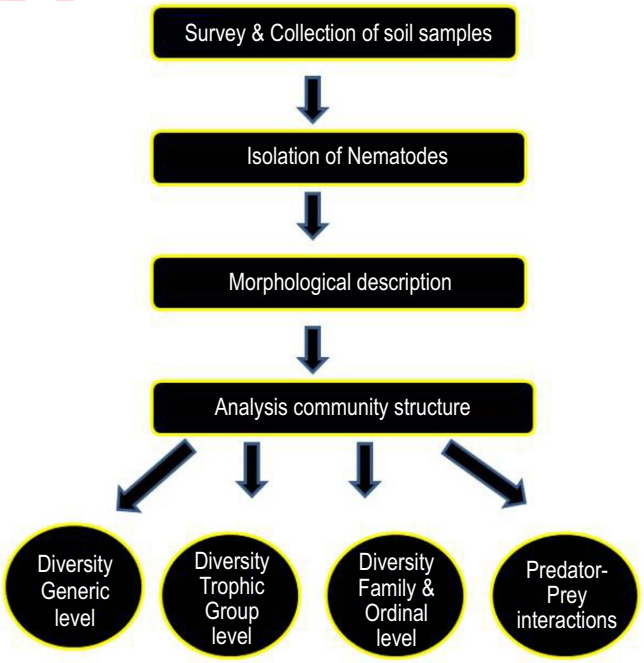
Aim: This study aimed to investigate the diversity, distribution, and community structure of plant and soil nematodes associated with pomegranate and citrus crops in Jaipur district, Rajasthan. A systematic survey was conducted across different locations and the rhizospheric soil samples were collected from pomegranate and citrus orchards to assess the present status of nematode fauna and analyse nematode community composition.

Methodology: Soil samples (n=59) were collected during a field survey from the pomegranate and citrus rhizosphere at different locations in the districts of Jaipur to determine the present status of soil and plant nematode fauna diversity and analyse nematode communities.

Results: The survey recorded a total of 14 nematode genera, comprising seven plant-parasitic, four microbivorous, and three predatory genera. Among the plant-parasitic nematodes, *Tylenchorhynchus mashhoodi* (AF = 36.0%; RF = 32.14%) and *Meloidogyne javanica* (AF=16.0%; RF=14.28%) were identified as the most prevalent species across the surveyed orchards. Community analysis further revealed that microbivorous and plant-parasitic nematodes showed the greatest frequency (39%) and density 37%). The findings indicate a diverse nematode community structure in pomegranate and citrus ecosystems of Jaipur, with significant prevalence of economically important plant-parasitic species.

Interpretation: The study highlights the need for sustainable management strategies to control *M. javanica* and *T. mashhoodi* in order to improve the crop health and productivity. These results provide a baseline information for understanding the nematode community dynamics and their potential impact on horticultural crops in the region.

Key words: Community analysis, Hot semi-arid, Nematode diversity, Orchard



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Introduction

Pomegranate and citrus are valuable commercial crops and the richest source of minerals and vitamins. It has a place in the daily diet of many people suffering from nutrient deficiency. In recent years, pomegranate and citrus production in Rajasthan has been in a steady decline due to climate shocks from erratic rainfall and prolonged heat; groundwater depletion; severe pest outbreaks and diseases; and nematodes, among which plant parasitic nematodes are a major constraint (Deshwal *et al.,* 2024; Bhati, 2020). The suitability of soil nematodes for long-term monitoring of biodiversity and community changes makes them considered bioindicators. Soil nematode communities exhibit considerable diversity particularly in high-temperature ecosystems, represent reliable bioindicators of ecosystem diversity and environmental change. However, their diversity, ecological roles, and distribution remain poorly understood (Yeates and Bongers, 1999; Yeates, 2003).

Extensive investigations have elucidated the diversity, distribution, and ecological occurrence of soil and plant parasitic nematodes across diverse agro-ecological regions of Rajasthan (Deshwal *et al.,* 2024; Meena *et al.,* 2024; Bhati, 2020; Baqri and Bohra, 2001). Among the plant parasitic nematodes, root-knot nematodes (*Meloidogyne* spp.) are regarded as one of the most economically important nematodes, owing to their extensive host range, widespread distribution, and capacity to induce severe yield reductions in numerous agriculturally important crops cultivated under varying agro-climatic conditions of the region (Manisha *et al.,* 2022; Bhati and Baheti, 2020; Singh *et al.,* 2019; Khan *et al.,* 2014). Consequently, comprehensive identification and characterization of nematode communities, integrating both taxonomic and ecological approaches, are fundamental for elucidating nematode biodiversity, assessing their distribution patterns, and formulating scientifically robust, sustainable, and integrated nematode management strategies.

A comprehensive understanding of nematode diversity in Rajasthan has progressively emerged through recent investigations; however, detailed information on the community structure, population dynamics, and ecological distribution of plant and soil nematodes in the Jaipur district remains inadequate. This deficiency constitutes a significant knowledge gap, particularly because Jaipur represents a major horticultural region characterized by the extensive cultivation of economically important fruit crops, including citrus and pomegranate (Meena *et al.,* 2018). Although these crops contribute substantially to the local agricultural economy, comprehensive studies on the diversity and ecological status of associated nematode communities are scarce. Furthermore, recent investigations have largely focused on the occurrence of major plant-parasitic nematodes, while comparatively little attention has been paid on analyzing community indices and ecological parameters that govern nematode assemblages in orchard ecosystems. Therefore, the present study was conducted with the aim of investigating the diversity and community structure of plant and soil nematodes associated with citrus and pomegranate plantations in Jaipur district, Rajasthan. The study further seeks to evaluate key ecological parameters, including frequency, density, prominence value, biomass, and importance value, to better understand nematode community dynamics in these cropping systems. It is hypothesized that citrus and pomegranate orchards in Jaipur harbor distinct nematode communities influenced by crop type and local soil conditions, with plant-parasitic nematodes constituting a dominant component of the nematode assemblage.

Materials and Methods

Collection sites: A random soil survey was conducted during 2024 and 59 rhizosphere soil samples were collected from pomegranate and citrus orchards located at SKN Agriculture University, Jobner (26.97587° N, 75.37609° E), Bhojpura Khurd (27.03926° N, 75.38004° E), Dola Ka Bas (27.17501° N, 75.54429° E), Agricultural Research Station (ARS), Durgapura (26.84268° N, 75.79028° E), and Dhindhol, Bassi (26.78990° N, 76.06880° E) in Jaipur district, Rajasthan, India. Each soil sample was a composite of 3–5 randomly selected subsamples collected from the rhizosphere. These samples were mixed to make a composite sample, and from this, 100 cc of soil was taken for further processing. The hand trowel was sterilized with 70% ethanol before leaving the sampling site. Samples were packed in polyethylene bags to minimize dehydration, tagged with a label providing all necessary information, and transported to the laboratory (Van Bezooijen, 2006).

Isolation of nematodes: The nematodes were isolated following Cobb's sieving and decanting method (Cobb, 1918), followed by modified Baermann's funnel technique (Schindler, 1961). Firstly, 200 cc of soil was mixed with water in a pan, allowed to settle, and then poured through a 20-mesh sieve into another pan. The roots and debris collected on the 20-mesh sieve were transferred into a beaker, and the debris was discarded. The contents of the second pan were then passed through a 150-mesh sieve into another pan. The contents of the third pan were then passed through a 325 mesh sieve, and the catch was collected in a 250 ml beaker. The whole suspension was poured onto a double-layered tissue paper placed on a wire-gauge support, which was then positioned above a Petri-dish containing water. The setup was covered to prevent evaporation and left for 48 hr, allowing nematodes to migrate through the tissue paper into the Petri dish. After 48 hr, the wire gauze was removed, and the Petri-dishes were examined under a stereoscopic microscope for the presence of nematodes.

Morphological description: Nematodes were extracted from the soil samples using a combination of the modified Baermann funnel technique and Cobb's sieving and decantation method (Baermann, 1917; Cobb, 1918). The extracted nematodes were heat-killed in water maintained at 60°C and subsequently fixed in triethanolamine formalin (TAF) solution. Fixed specimens were dehydrated with anhydrous glycerin using Seinhorst's rapid glycerin dehydration method (Seinhorst, 1959). Permanent

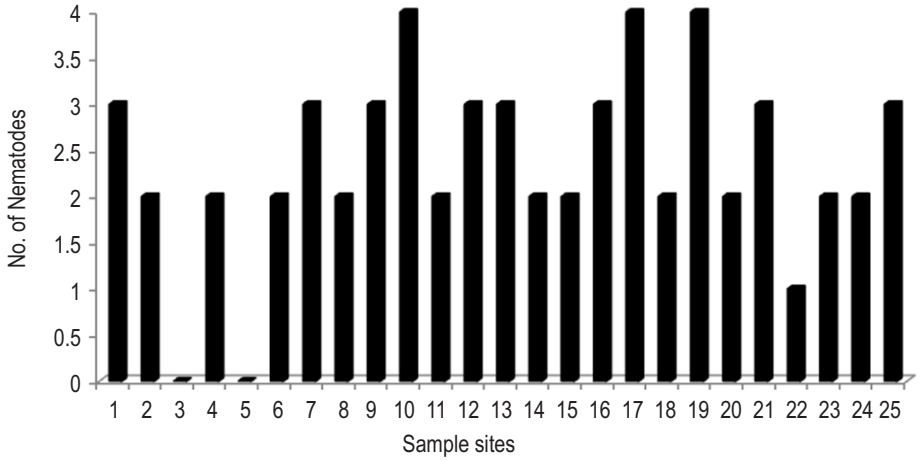


Fig. 1: Study site wise nematode population associated in Jaipur district.

microscope slides were prepared by mounting the nematodes in glycerin on glass slides supported with glass wool and sealed with a coverslip for detailed morphological examination. Nematodes were identified based on their morphological characteristics and morphometric traits. Morphological observations, including various diagnostic features, ratios and measurements, were examined using compound microscope. Identification up to the generic level was carried out using the taxonomic keys provided by Goodey (1963), Jairajpuri and Ahmad (1992), Ahmad (1996), Siddiqi (2000) and Ahmad and Jairajpuri (2010). In addition, the diagnostic key developed by the Nematology Laboratory, available online at http://nematode.unl.edu/knozlistbutt.htm, was used to identify plant-parasitic, microbivorous and predatory nematodes.

Counting of nematode population: The nematode population was determined by collecting and preserving nematodes in warm triethanolamine formalin. The population in each sample was counted five times using a Syracuse counting plate under a stereo-zoom microscope, and the mean value was calculated.

Community Structure Analysis: The nematode community structure was assessed by calculating the absolute frequency (AF), relative frequency (RF), absolute density (AD), relative density (RD), prominence value (PV), relative prominence value (RPV), relative biomass (RB), importance value (IV) and relative importance value (RIV), following the methods of Norton (1978) and Pervez *et al.* (2016). Nematodes were assigned to trophic groups based on their feeding habits according to the classification proposed by Yeates *et al.* (1993). Community analyses were performed at the trophic group, family and order levels using standard taxonomic classifications (Goodey, 1963; Jairajpuri and Ahmad, 1992; Ahmad, 1996; Siddiqi, 2000; Ahmad and Jairajpuri, 2010).

Predator–Prey relationship: Predator–prey relationships were evaluated by quantifying the abundance of predatory nematodes in relation to their potential prey, including plant-parasitic and microbivorous nematodes, across all sampling sites. Predator-prey ratios were calculated to examine the relationship between predator and prey populations and to assess the potential role of predatory nematodes in regulating nematode community dynamics.

Results and Discussion

Nematode generic diversity: A total of 14 genera of plant and soil nematodes were recorded during the present investigation. Of these, seven genera belonged to the plant-parasitic nematodes (PPNs), four to the microbivorous nematodes (MVNs), and three to the predatory nematodes (PRNs) (Table 1). Two nematode genera were encountered at the highest number of sampling sites (n = 11), indicating their wide distribution across the study area. Three genera were recorded from eight sampling sites, whereas one genus was restricted to a single sampling site, reflecting its limited occurrence (Fig. 1).

Community Structure Analysis

Frequency: The analysis of absolute and relative frequency revealed that *Tylenchorhynchus mashhoodi, Meloidogyne javanica* and *Cephalobus* sp. exhibited the highest frequency values within the plant-parasitic, predatory and microbivorous trophic groups, respectively. In contrast, *Trichodorus* sp., *Hemicriconemoides* sp., *Mylonchulus fortidens* and *Chiloplacus* sp. had the lowest absolute and relative frequencies within their respective groups (Table 2).

Density: The density analysis indicated that *Hoplolaimus indicus*, *Mononchus dentatus* and *Chiloplacus* sp. exhibited the highest absolute and relative densities within the plant-parasitic, predatory and microbivorous trophic groups, respectively. Whereas, *Trichodorus* sp., *M. fortidens* and *Acrobeles* sp. recorded the lowest density values within their respective trophic groups (Table 2).

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Table 1: Soil and plant nematodes associated in the district Jaipur.

Groups	Nematodes	Authority
Plant Parasitic Nematodes		
1.	*Tylenchorhynchus mashhoodi*	Siddiqi and Basir (1959)
2.	*Meloidogyne javanica*	Treub (1885)
3.	*Hoplolaimus indicus*	Sher (1963)
4.	*Helicotylenchus dihystera*	Cobb (1893); Sher (1961)
5.	*Pratylenchus thornei*	Sher and Allen (1953)
6.	*Trichodorus* sp.	Cobb (1913)
7.	*Hemicriconemoides* sp.	Chitwood and Birchfield (1957)
Predatory Nematodes		
8.	*Mesodorylaimus bastiani*	Butschli (1873); Andrassy (1959)
9.	*Mononchoides fortidens*	Schuuvmans Stekhoven (1951)
10.	*Mylonchulus dentatus*	Jairajpuri (1978)
Microbivorus Nematodes		
11.	*Cephalobus* sp.	Bastian (1865)
12.	*Panagrolaimus* sp.	Thorne (1937)
13.	*Acrobeles* sp.	Von Linstow (1877)
14.	*Chiloplacus* sp.	Thorne (1937)

Table 2: Community structure of soil and plant nematodes associated in the district Jaipur.

Groups	Nematodes	AF (%)	RF (%)	AD	RD (%)	PV	RPV (%)	RB (%)	IV	RIV (%)
Plant Parasitic Nematodes										
1.	*T. mashhoodi*	36.0	32.14	10.0	18.18	0.61	29.26	2.58	52.90	23.58
2.	*M. javanica*	16.0	14.28	9.2	16.36	0.36	17.56	10.41	41.04	18.98
3.	*H. indicus*	16.0	14.28	14.1	25.45	0.36	17.56	1.25	40.98	18.26
4.	*H. dihystera*	16.0	14.28	10.5	18.18	0.36	17.56	6.51	38.96	17.36
5.	*P. thornei*	12.0	10.71	7.5	12.72	0.24	11.71	1.74	25.17	11.22
6.	*Trichodorus* sp.	8.0	7.14	2.0	3.63	0.05	2.43	1.61	12.38	5.51
7.	*Hemicriconemoides* sp.	8.0	7.14	3.5	5.45	0.08	3.90	0.32	12.89	5.74
Predatory Nematodes										
1.	*M. bastiani*	12.0	37.5	5.5	29.41	0.17	30.33	5.45	72.36	34.39
2.	*M. dentatus*	12.0	37.5	10.2	58.82	0.34	60.71	1.96	98.28	46.72
3.	*M. fortidens*	8.0	25.0	2.0	11.76	0.05	8.92	2.96	39.71	18.87
Microbivorus Nematodes										
1.	*Cephalobus* sp.	32.0	47.05	6.5	18.75	0.33	26.61	0.27	66.07	32.25
2.	*Panagrolaimus* sp.	16.0	23.52	9.0	28.12	0.36	29.03	3.24	54.88	26.79
3.	*Chiloplacus* sp.	12.0	17.64	12.5	37.5	0.41	33.06	1.10	56.24	27.45
4.	*Acrobeles* sp.	8.0	11.76	5.3	15.62	0.14	11.29	0.28	27.66	13.52

Prominence value: The prominence value analysis demonstrated that *T. mashhoodi, M. dentatus* and *Chiloplacus* sp. had the highest prominence and relative prominence values within their respective trophic groups. *Trichodorus* sp., *M. fortidens* and *Acrobeles* sp. exhibited the lowest prominence values, indicating their comparatively minor contribution to the nematode community (Table 2).

Biomass: Among the trophic groups, *M. javanica, M. bastiani* and *Panagrolaimus* sp. exhibited the highest relative biomass values within their respective groups. In contrast, *Hemicriconemoides* sp., *M. dentatus* and *Cephalobus* sp. recorded the lowest relative biomass values (Table 2).

Importance value: The importance value analysis revealed that *M. dentatus, Cephalobus* sp. and *T. mashhoodi* were the most ecologically significant nematodes, exhibiting the highest importance and relative importance values within their respective trophic groups, whereas *Trichodorus* sp., *Acrobeles* sp. and *M. fortidens* had the lowest importance values, indicating that they contributed relatively less to the overall nematode community (Table 2).

Community analysis at the trophic group level: Based on their feeding habits, the nematode community was classified into three trophic groups: plant-parasitic, predatory and microbivorous nematodes. Community composition was subsequently analyzed

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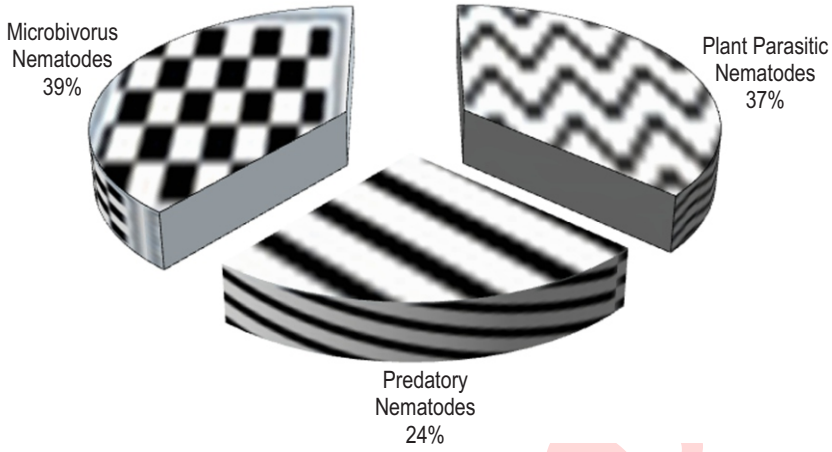


Fig. 2: Occurrence of nematode trophic groups in the district Jaipur.

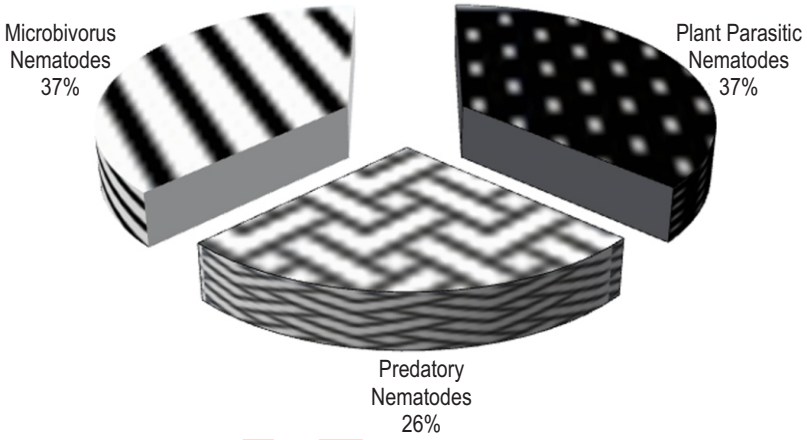


Fig. 3: Abundant of nematode trophic groups in the district Jaipur.

at the trophic-group level. The microbivorous nematodes constituted the largest proportion of the community, accounting for 39% of the total frequency, followed by the plant-parasitic group (37%). Predatory nematodes represented the smallest proportion, comprising 24% of the total community frequency (Fig. 2). A similar pattern was observed for absolute density. Predatory nematodes exhibited the lowest density, accounting 26% of the total nematode density, whereas both the plant-parasitic and microbivorous groups each contributed 37% of the total density (Fig. 3).

Community analysis at the family level: The nematode genera identified during the present study belonged to 11 families. Of these, six families were plant-parasitic (Trichodoridae, Pratylenchidae, Telotylenchidae, Hoplolaimidae, Criconematidae and Heteroderidae), three were predatory (Dorylaimidae, Diplogasteridae and Mylonchulidae), and two were microbivorous (Cephalobidae and Panagrolaimidae). Family-level analysis indicated that Cephalobidae was the most prevalent family, representing 75% of the nematode community. In contrast, Trichodoridae, Pratylenchidae, Telotylenchidae, Heteroderidae and Criconematidae were the least prevalent families, each accounting for 17% of the community (Fig. 4).

Community Analysis at the Order Level: Fourteen nematode genera were identified in the present study, and were classified into five taxonomic orders viz., Rhabditida, Tylenchida, Dorylaimida, Mononchida and Triplonchida. Among these, Tylenchida was the dominant order, accounting 43% of the total community, followed by Rhabditida (36%). The orders Dorylaimida, Mononchida and Triplonchida each represented 7% of the nematode community, indicating comparatively lower ordinal diversity (Fig. 5).

Predator–Prey relationship: The distribution of predator–prey nematodes varied among the sampling sites. A maximum of three

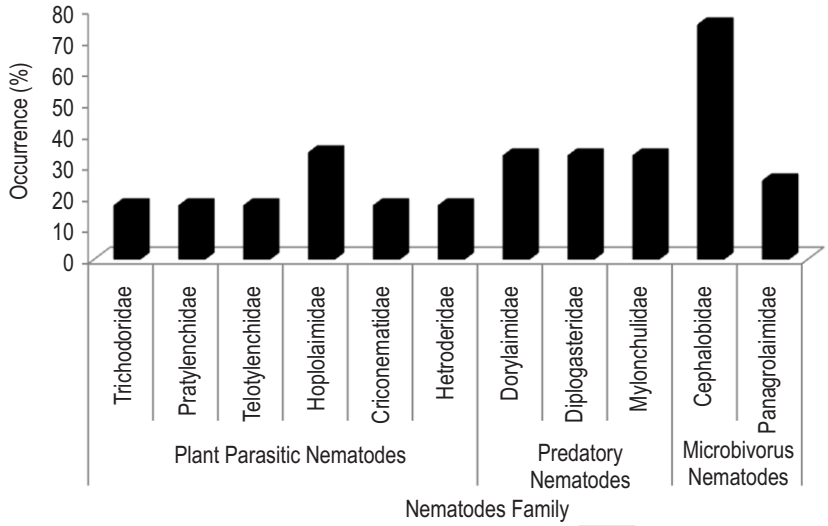


Fig. 4: Diversity of soil and plant nematodes at family level.

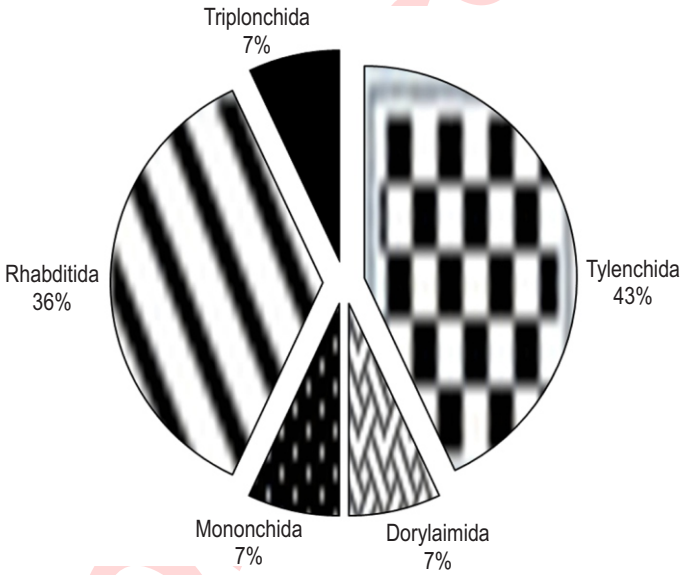


Fig. 5: Ordinal diversity of soil and plant nematodes.

predatory nematode genera was recorded at two sampling sites, whereas two predatory genera occurred at one site. A single predatory genera was recorded at five sampling sites. Among the prey nematodes, up to four genera were observed at two sampling sites, while four prey genera were recorded across five sampling sites. Furthermore, 13 sampling sites contained only prey nematode genera, while no predatory nematodes were encountered, suggesting a predominance of prey communities in the majority of surveyed locations (Fig. 6). Nematodes occupy an extensive range of terrestrial habitats, and their diversity, abundance and community composition are strongly regulated by ecological and edaphic factors. Owing to their well-resolved taxonomy, diverse trophic strategies and sensitivity to environmental disturbances, nematodes are widely recognized as reliable bioindicators of soil ecosystem structure and functioning (Tsiafouli *et al.,* 2017; Neher, 2021). Consequently, analyses of soil nematode assemblages have become an integral component of soil health assessment, providing valuable insights into nutrient cycling, decomposition processes, and the ecological consequences of agricultural management practices (Ferris *et al.,* 2022). The present investigation demonstrated that *M. javanica* and *T. mashhoodi* were the predominant plant-parasitic nematode species associated with pomegranate and citrus orchards across the surveyed regions of Jaipur district.

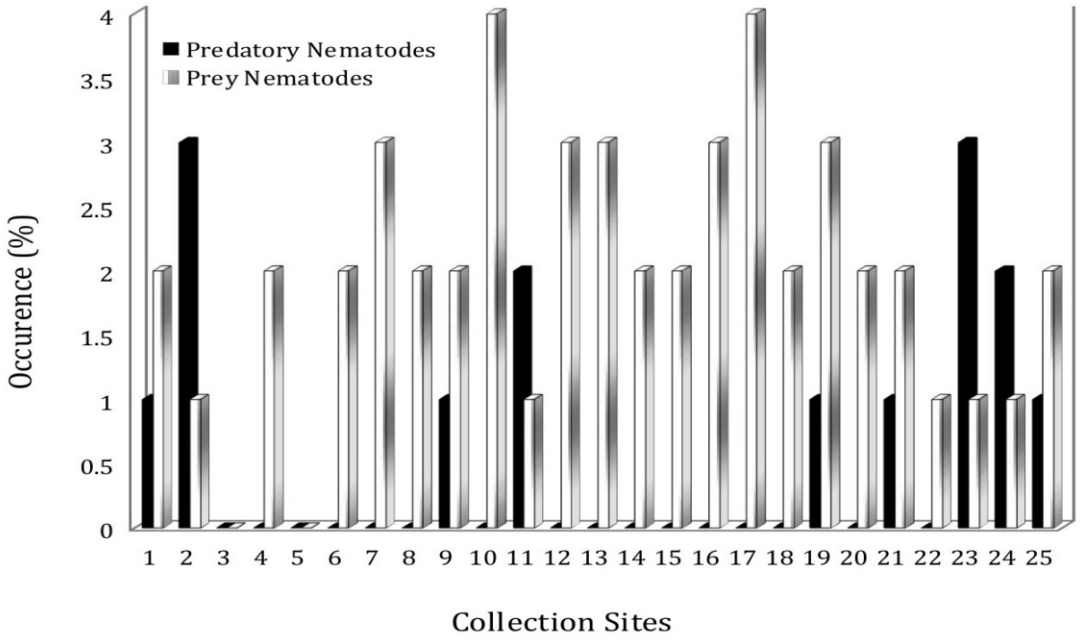


Fig. 6: Predator-prey ratio in study sites.

Their widespread occurrence indicates successful adaptation to the prevailing semi-arid agro-ecological conditions and suggests their ecological importance within perennial fruit production systems. These findings are consistent with those of Singh *et al.* (2019), who reported that severe infestations of root-knot nematodes, *M. incognita* and *M. javanica* were recorded in Rajasthan. Recent investigations have similarly documented the increasing prevalence of *Meloidogyne* spp. in fruit orchards, attributing their expansion to intensive cultivation practices, monoculture, and climate-induced alterations in soil environments (Khan *et al.,* 2022; Hallmann and Meressa, 2023). The differences in nematode diversity and community composition observed in the present study compared with those reported by Sivakumar (2002) are likely attributable to variations in geographical sampling locations.

Analysis of the trophic structure revealed that predatory nematodes, *M. bastiani, M. dentatus* and *M. fortidens* had the highest biomass because of their relatively large body size. These observations corroborate with previous reports where it was demonstrated that predatory nematodes constitute a major component of biomass (Vinciguerra and Giannetto, 1988; Pervez *et al.,* 2016). Predatory nematodes perform a critical ecological function by regulating prey populations, enhancing trophic connectivity, and maintaining the stability of soil food webs (Stirling and Blair, 2001; Neher, 2021; Zhang *et al.,* 2023). Predatory nematodes exert continuous top-down regulation of plant parasitic nematodes within the rhizosphere through active predation on a broad spectrum of soil nematodes. Their effectiveness is generally density dependent, with predation success largely determined by encounter frequency between predator and prey populations. Beyond direct suppression of plant parasitic nematodes, predatory nematodes indirectly promote plant growth by improving the soil ecological balance and contributing to the resilience of belowground food webs (Pervez and Bilgrami, 2000). Consequently, increasing emphasis has been laid on harnessing predatory nematodes and other biological antagonists as environmentally sustainable components of integrated nematode management strategies (Kanwar *et al.,* 2021; Bhat *et al.,* 2023).

Species prominence, which combines frequency of occurrence and population density, identified *M. javanica* and *T. mashhoodi* were most prevalent species across the surveyed orchards. In contrast, *M. dentatus* recorded the highest importance value, indicating its greater ecological dominance within the nematode community. The observed disparity between species prominence and importance value demonstrates that these indices capture different aspects of community organization. Therefore, the combined use of multiple ecological indices provide a more comprehensive assessment of nematode community structure than reliance on a single metric, which may underestimate the ecological contribution of individual taxa. Evaluation of nematode assemblages at higher taxonomic levels, including families and orders, provided a broader ecological perspective by reducing taxonomic complexity, while preserving functional information. Such an approach facilitates interpretation of trophic organization and ecological processes and is particularly considered suitable for large-scale ecological assessments and long-term monitoring of soil biodiversity under field conditions. Plant parasitic nematodes generally cause progressive reduction in crop growth and yield rather than acute

disease outbreaks. Continuous cultivation of perennial fruit crops such as pomegranate and citrus creates favourable conditions for multiplication, persistence, and spatial dissemination of nematode populations within orchard ecosystems. Recent studies have demonstrated that monoculture, prolonged orchard establishment, intensive management practices and changing climatic conditions significantly contribute to the build-up and distribution of plant-parasitic nematodes in fruit production systems (Dutta and Phani, 2023; Bozbuga *et al.,* 2023).

Periodic monitoring of nematode diversity, coupled with the conservation of beneficial trophic groups and implementation of integrated nematode management practices, will be essential for sustaining soil ecosystem functioning, improving productivity, and enhancing the long-term resilience of pomegranate and citrus production systems under semi-arid agro-ecosystems.

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References

Ahmad, W. and M.S. Jairajpuri: Mononchida- the predaceous soil nematodes. Nematology monographs and perspectives 7. E. J. Brill, Leiden, The Netherlands, 112 pages (2010).

Ahmad, W.: Plant parasitic nematodes of India - An identification manual. Department of Zoology AMU Aligarh Press, 345 pages (1996).

Baermann, G.: Eine einfache Methode zur Auffinfung von Ankylostomum (Nematoden) Larven in Erdporben. *Geneesk Tijdsch. Ned Indie,* **57**, 131-137 (1917).

Baqri, Q.H. and P. Bohra: Nematodes from Rajasthan, India. I. Six new species of Dorylaimida. *Nematology,* **3**, 113-127 (2001).

Bhat, A.A., A. Shakeel, S. Waqar, Z.A. Handoo and A.A. Khan: Microbes vs. Nematodes: Insights into biocontrol through antagonistic organisms to control root-knot nematodes. *Plants,* **12**, 451 pages (2023).

Bhati, S.S. and B. L. Baheti: Occurrence and population status of root-knot nematode, *Meloidogyne incognita* on cucumber under protected cultivation in Rajasthan. *J. Entomol. Zool. Stud.,* **8**, 1441-1444 (2020).

Bhati, S.S.: Nematodes: The unseen enemy of pomegranate in Western Rajasthan. *Agricul. Food E- Newsletter,* **2**, 187-188 (2020).

Bozbuga, R., S. Yildiz, E. Yuksel, G. Ozer, A.A. Dababat and M. Imren: Nematode–citrus plant interactions: host preference, damage rate and molecular characterization of Citrus root nematode *Tylenchulus semipenetrans*. *Plant Biol.,* **25**, 871–879 (2023).

Cobb, N. A.: Estimating the nematode population of soil. *Agric. Tech. Cire. Bur. Pl. Ind. U.S. Dep. Agric.,* **1**, 132 (1918).

Cobb, N.: Estimating the nema population of soil US Department of Agriculture, Bar. *Plant. Industry. Agr. Tech. Cir.,* **1**, 1- 48 (1918).

Deshwal, B., C. Gautam and K.V.V.S. Kranti: Morphological and molecular identification of root-knot nematode, *Meloidogyne incognita* infecting pomegranate (*Punica granatum* L.) in Jodhpur, Rajasthan, India. *Arch. Curr. Res. Int.,* **24**, 1-5 (2024).

Dutta, T.K. and V. Phani: The pervasive impact of global climate change on plant–nematode interaction continuum. *Front. Plant Sci.,* **14**, 1143889 (2023).

Ferris, H., S. Sánchez-Moreno and E.B. Brennan: Structure, functions and indicators of the soil food web in agricultural ecosystems. *Agricul. Ecosys. Environ.,* **330**, 107900 (2022).

Goodey, T.: Soil and Freshwater Nematodes (Revised by J. B. Goodey). Methuen, London, 544 pages (1963).

Hallmann, J. and B.H. Meressa: Root-knot nematodes in perennial fruit crops: distribution and management challenges. *Plants,* **12**, 1845 (2023).

Jairajpuri, M.S. and W. Ahmad: Dorylaimida: free-living, predaceous and plant-parasitic nematodes. (Ed.: E.J. Brill). The Netherlands and Oxford & IBH, New Delhi, 465 pages (1992).

Kanwar, R.S., J.A. Patil and S. Yadav: Prospects of using predatory nematodes in biological control for plant parasitic nematodes – A review. *Biological Control,* **160**, 104668 (2021).

Khan, M.R., R.K. Jain and R.V. Singh: Emerging importance of root-knot nematodes in horticultural crops under changing climate scenarios. *Indian J. Nematol.,* **52**, 85-96 (2022).

Khan, M.R., R.K. Jain, T. M. Ghule and S. Pal: Root knot nematodes in India-a comprehensive monograph. In: All India Coordinated Research Project on Plant Parasitic Nematodes with Integrated Approach for Their Control; Indian Agricultural Research Institute: New Delhi, India, 78 pages (2014).

Manisha, S.P. Bishnoi, M. Ravindra, A. Ramavath, P. Snehalatha and M. Manju: To study the distribution and occurrence of root knot nematode and other phyto-nematodes associated with okra in and around Jaipur district. *Pharma Innova. J.,* **11**, 1292-1296 (2022).

Meena, R., B.S. Chandrawat, Manisha and R.L. Midha: Occurrence and distribution of plant parasitic nematodes in mungbean in Jaipur District, Rajasthan, India. *Ann. Res. Revi. Biol.,* **39**, 32-39 (2024).

Meena, N.K., R. Asrey and M. Baghel: Pomegranate cultivation is promising in arid region of Rajasthan. *Indian Farm.,* **68**, 30-33 (2018).

Neher, D. A.: Role of nematodes in soil health and their use as indicators. *J. Nematol.,* **33**, 161-168 (2021).

Norton, D.C.: Ecology of Plant Parasitic Nematodes. John Willey and Sons, New York, pp. 31-58 (1978).

Online Copy

Pervez, R. and A.L. Bilgrami: Chemosensory responses of predatory nematodes, *Mesodorylaimus bastiani* and *Aquatides thornei* towards kairomones emitted by prey nematodes belonging to different trophic groups. *Nematologia Mediterranea,* **28**, 267-277(2000).

Pervez, R., A.L. Bilgrami, E. Kondo and T. Yoshiga: Attraction and aggregation behavior of *Mesodorylaimus bastiani* and *Aquatides thornei* (Nematoda: Dorylaimida). *Appl. Ento. Zool.,* **36**, 243-249 (2001).

Pervez, R., S.J. Eapen, T.K. Jacob, S. Hamza and V. Srinivasan: Diversity and community analysis of nematodes associated with *Piper nigrum* from Idukki District (Kerala), India. *Indian J. Nematol.,* **46**, 7-73 (2016).

Schindler, A.F.: A simple substitute for a Baermann funnel. *Plant Disease Report,* **45**, 747-748 (1961).

Seinhorst, J.W.: A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. *Nematologica,* **4**, 67-69 (1959).

Siddiqi, M.R.: Tylenchida-Parasites of Plants and Insects (2nd Edn.). CABI Publishing, London, UK, 852 pages (2000).

Singh, A., R.K. Kaul, P.S. Khapte, K.S. Jadon, Y. Rouphael, B. Basile and P. Kumar: Root knot nematode presence and its integrated management in pomegranate orchards located in Indian arid areas. *Horticulturae,* **8**, 160 (2022).

Singh, S., A. Khan and R. Sharma: Occurrence and distribution of root-knot nematodes in Rajasthan horticultural crops. *Indian J. Nematol.,* **49**, 45-52 (2019).

Singh, T., A, Prajapati, A.K. Maru, R. Chaudhary and D.J. Patel: Root-knot nematodes (*Meloidogyne* spp.) infecting pomegranate: A Review. *Agricul. Revi.,* **40**, 309-313 (2019).

Sivakumar, C.V.: Diversity of soil nematodes in cultivated ecosystems. *Indian J. Nematol.,* **32**, 56-61 (2002).

Sivakumar, M., K. Poornima, M.P.R. Mani and Umamaheshwari: Biodiversity of nematode fauna in Tamil Nadu range of Nilgiris biosphere. *Indian J. Nematol.,* **32**, 139-142 (2002).

Stirling, G.R. and B.L. Blair: Nematode diversity and community structure in agricultural soils. *Australasian Plant Pathol.,* **30**, 45-53 (2001).

Stirling, G.R. and A.B. Pattison: Beyond chemical dependency for managing plant-parasitic nematodes: examples from the banana, pineapple and vegetable industries of tropical and subtropical Australia. *Australasian Plant Pathol.,* **37**, 254-267 (2008).

Tsiafouli, M.A., E. Thébault and S.P. Sgardelis: Intensive agriculture reduces soil biodiversity across Europe. *Global Change Biol.,* **21**, 973- 985 (2017).

Tsiafouli, M.A., D.R. Bhusal and S.P. Sgardelis: Nematode community indices for microhabitat type and large scale landscape properties. *Ecol. Indica.,* **73**, 472- 479 (2017).

Van Bezooijen J.: Methods and Techniques for Nematology Manual. The Netherlands, 118 pages (2006).

Vinciguerra, M.T. and A. Giannetto: Biomass and trophic structure of nematode communities in cultivated soils. *Nematologia Mediterranea,* **16**, 151–157 (1988).

Vinciguerra, M.T. and L. Giannetto's: Faunistic and ecological analysis of the soil nematode community of a Holk Oak wood land on Etna. *Nematologia Mediterranea,* **16**, 117-127 (1988).

Wang, K.H. and C.R.R. Hooks: Plant-parasitic nematodes and their associated natural enemies within banana (*Musa* spp.) plantings in Hawaii. *Nematropica,* **39**, 57-73 (2009).

Yeates, G.W. and T. Bongers: Nematode diversity in agro ecosystems. Invertebrate biodiversity as bioindicators of sustainable landscapes, p. 113-135 (1999).

Yeates, G.W., T. Bongers, R.G.M. De goede, D.W. Freckman and S.S. Georgieva: Feeding habits in soil nematode families and genera – an outline for soil ecologists. *J. Nematol.,* **25**, 315-331 (1993).

Yeates, G.W.: Nematodes as soil indicators: functional and biodiversity aspects. *Biol. Fert. Soil,* **37**, 199-210 (2003).

Zhang, X., Y. Li and K. Wang: Agricultural intensification alters soil nematode community dynamics and ecosystem functioning. *Soil Biol. Bioche.,* **182**, 109021 (2023).

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