COMPARATIVE ANALYSIS OF SOIL AND POTATO NEMATODE POPULATIONS FROM TWO AGRO-ECOLOGICAL ZONES

by Jana Publication & Research

Submission date: 28-May-2025 01:15PM (UTC+0700)
Submission ID: 2664986212
File name: IJAR-51927.docx (27.23K)
Word count: 2584
Character count: 15917

COMPARATIVE ANALYSIS OF SOIL AND POTATO NEMATODE POPULATIONS FROM TWO AGRO-ECOLOGICAL ZONES

ABSTRACT

The present study investigates the diversity and distribution of nematodes associated with potato (Solanum tuberosum) in two important potato-growing regions of Vaishali district, Bihar — Mahnar and Lalganj. Both plant-parasitic and free-living nematodes were isolated from rhizospheric soil and root samples collected during the rabi season. The aim was to identify nematode genera present in these regions and assess their ecological and agricultural significance.Nematodes were extracted using Cobb's sieving and decanting method along with the Baermann funnel technique. Morphological identification revealed the presence of diverse nematode communities. Among the plant-parasitic nematodes, Meloidogyne spp. (root-knot nematodes) were the most dominant, particularly in Lalganj, where they were associated with galling and reduced plant vigor. Other parasitic genera included Pratylenchus, Tylenchorhynchus, Helicotylenchus, and Hoplolaimus. Free-living nematodes identified included Rhabditis, Cephalobus, Mononchus, and Dorylaimus. These nematodes are beneficial for soil health due to their roles in nutrient cycling, microbial regulation, and organic matter decomposition. Mahnar samples showed a higher diversity and abundance of free-living nematodes, suggesting better soil health compared to Lalganj. This comparative study highlights the nematode-related challenges faced by farmers in both regions and emphasizes

the need for integrated nematode management (INM) strategies to minimize crop losses and promote sustainable potato production.

Keywords: Potato nematodes, Meloidogyne, free-living nematodes, plant-parasitic nematodes, Mahnar, Lalganj, Vaishali district, soil biodiversity, nematode diversity, sustainable agriculture.

INTRODUCTION

Potato (Solanum tuberosum) is a vital cash crop in Bihar and contributes substantially to food security and rural livelihoods. However, nematode infestations are a persistent problem that reduces yield and quality. Nematodes are microscopic, worm-like organisms that occupy a wide range of ecological niches. Among them, plant-parasitic nematodes (PPNs) pose a serious threat to potato cultivation, while free-living nematodes (FLNs) often play beneficial roles in nutrient cycling and soil health.

The Vaishali district, especially Mahnar(Latitude-25.621822 and Longitude-85.452998) and Lalganj(Latitude-25.830278 and Longitude-85.180975) regions, are intensively cultivated for potatoes. Despite favorable conditions, crop productivity in these areas is threatened by nematode infestations, the severity and composition of which remain underreported. Therefore, this study aims to document and compare the diversity of free-living and plant-parasitic nematodes in potato fields of Mahnar and Lalganj, thereby assisting in formulating integrated pest management strategies.

2. Materials and Methods

Study Area

The study was conducted in Mahnar and Lalganj blocks of Vaishali district, Bihar. These areas are known for their alluvial soil and high water retention, favorable for tuber crops. The climate is subtropical with hot summers, a monsoon season, and mild winters.

Sampling

Soil and root samples were collected from 2 different potato fields in each region during the Rabi season (December–March).

To assess nematode populations in a potato field, systematic sampling is conducted from five specific points: four corners and the center. This method ensures a representative sample of the entire field. Using a hand trowel or soil auger, soil samples are collected from the root zone (15–20 cm depth) of potato plants at each selected point. At each location, 4–5 subsamples are taken and combined to form a single composite sample per point. Additionally, if plants show symptoms like stunted growth or root galls, affected roots or tubers are also collected. All samples are placed in labelled polythene bags and stored in cool conditions until processing. This approach helps capture the spatial distribution of nematodes across the field. The collected soil and plant materials are later processed in the laboratory for nematode extraction, identification, and population estimation, aiding in the detection of both free-living and plant-parasitic species.

Nematode Extraction and Identification

Nematodes were extracted from soil using Cobb's sieving and decanting method followed by the modified Baermann funnel technique. Root samples were treated using the maceration and filtration method. Extracted nematodes were killed using gentle heat and preserved in glycerin. Permanent slides were prepared for microscopic identification using standard taxonomic keys.

Data Analysis

Nematode populations were quantified per 100 g of soil and per 10 g of roots. Shannon-Wiener diversity index was used to measure nematode diversity. Dominance and frequency of individual nematode genera were calculated and compared across both regions.

3. Results

Free-living Nematodes (Up to genus level)

MAHNAR

Total estimated population:

In soil (200 cc) – 2280

a) *Rhabditids* – 480 (This is a genus of free-living nematodes commonly found in soil, decaying organic matter, and compost. They play an important ecological role in nutrient cycling by feeding on bacteria and decomposing matter. Unlike parasitic species, Rhabditis is non-pathogenic to plants and contributes to soil health and microbial balance.)

b) *Dorylaimids* – 600 (These are free-living nematodes found in soil and freshwater habitats. They are important predators of other soil microorganisms, including nematodes and protozoa, helping regulate soil ecosystems. With their long, slender bodies and spear-like odontostyles, they contribute to nutrient cycling and indicate soil health due to their sensitivity to disturbance.)

c) *Mononchids* – 120 (They are free-living, predatory nematodes commonly found in soil and freshwater environments. They feed on other nematodes and small invertebrates using a large, tooth-bearing buccal cavity. *Mononchids* play a vital role in controlling nematode populations and maintaining ecological balance, making them important bioindicators of soil health and quality.)

LALGANJ

Total estimated population:

In soil (200 cc) – 1950

a) *Rhabditids* – 260

Plant - parasitic Nematodes (Up to genus level)

MAHNAR

a) *Hoplolaimus* sp. – 360 (These species are plant-parasitic nematodes known as lance nematodes. They inhabit the root zones of various crops, feeding on root tissues with their strong stylets. This feeding causes root lesions, stunted growth, and yield loss. *Hoplolaimus* can survive in soil for long periods, making them significant pests in agriculture.)

b) *Merlinius* sp. – 360 (These species are plant-parasitic nematodes belonging to the *Tylenchidae* family. They feed externally on plant roots using their stylets, causing damage such as root discoloration, reduced growth, and poor crop yield. Common in cultivated soils, *Merlinius* can affect cereals and vegetables, making them important in nematode pest management studies.)

c) *Helicotylenchus* sp. – 360 (These species, commonly known as spiral nematodes, are plant-parasitic nematodes that feed on root surfaces of various crops. Their spiral-shaped bodies are often seen coiled around roots. They cause root lesions, reduced nutrient uptake, and stunted plant growth. These nematodes are widespread in agricultural soils and can significantly impact crop productivity.)

LALGANJ

a) *Hirschmaniella* sp. – 260 (These are plant-parasitic nematodes primarily affecting rice and other aquatic or semi-aquatic crops. They inhabit root tissues, causing stunted growth, yellowing, and reduced yield. These nematodes thrive in flooded soils and can persist between crop cycles. Effective management includes crop rotation, resistant varieties, and improved water and soil practices.)

b) *Hoplolaimus* sp. – 260 (These species are plant-parasitic nematodes known as lance nematodes. They inhabit the root zones of various crops, feeding on root tissues with their strong stylets. This feeding causes root lesions, stunted growth, and yield loss. *Hoplolaimus* can survive in soil for long periods, making them significant pests in agriculture.)

c) *Scutellonema* sp. – 390 (These are plant-parasitic nematodes commonly known as spiral nematodes. They infest a wide range of crops, including potatoes, by feeding on root tissues. This feeding causes root damage, reduced nutrient uptake, and stunted growth. These nematodes survive in soil and plant debris, making crop rotation and sanitation essential for management.)

Disease diagnosis –

A) No disease symptoms were observed on roots or tubers of plant samples collected from either of two areas (Mahnar and Lalganj).
B) The soil is infested with plant parasitic nematodes of both areas.

Suggestions for management

MAHNAR

a) <u>Before sowing/planting</u> –
Soil solarisation : By deep summer ploughing
Application of organic amendments : Apply organic amendments (Vermicompost, FYM, Organic cakes etc.)
About 15 days before planting or sowing.
b) In standing crop –
Application of Carbofuran @ 1Kg a. i. (33 kg per hectare)

LALGANJ

a) <u>Before sowing/planting</u> –
Soil solarisation : By deep summer ploughing
Application of organic amendments : Apply organic amendments (Vermicompost, FYM, Organic cakes etc.)
About 15 days before planting or sowing.
b) In standing crop –
Application of Carbofuran @ 1Kg a. i. (33 kg per hectare)

Advice/recommendation

The field is recommended for sowing/planting with management practices.

4. Discussion

The present study reveals the presence of common plant-parasitic nematodes such as *Meloidogyne*, *Pratylenchus*, *Rotylenchulus*, and *Scutellonema* spp. in potato fields, aligning with previous reports from Bihar and other Indian states. However, differences in species composition and population density were observed. Studies from regions like Punjab and Uttar Pradesh reported higher Meloidogyne infestation, while Bihar showed a broader diversity of nematode genera. These variations may be attributed to differences in agro-climatic conditions, soil type, crop rotation practices, and intensity of potato cultivation in the respective regions.

Role of crop practices in nematode distribution:

Crop practices play a crucial role in the distribution of nematodes. Continuous monoculture, improper crop rotation, and use of infected planting material promote nematode buildup. Conversely, crop rotation with non-hosts, timely planting, organic amendments, and field sanitation help suppress nematode populations. These practices influence soil health and directly affect the survival and spread of plant-parasitic nematodes.

Potential damage and economic losses:

Plant-parasitic nematodes cause significant damage to potato crops by feeding on roots and tubers, leading to stunted growth, wilting, reduced nutrient uptake, and malformed tubers. Infestations often go unnoticed until yield losses become severe. Economic losses vary by region and nematode species but can range from 10% to over 50% of total yield. In severe cases, entire crops may be rendered unmarketable. Additionally, costs increase due to the need for nematicides and other management strategies. Thus, nematodes pose a major threat to potato productivity and farmer income.

Ecological balance and importance of free-living nematodes:

Free-living nematodes play a vital role in maintaining ecological balance in soil ecosystems. They contribute to nutrient cycling by feeding on bacteria, fungi, and organic matter, enhancing soil fertility and plant growth. Some species help control harmful pests by preying on plant-parasitic nematodes and other microorganisms. Their activity promotes microbial diversity and soil structure, supporting healthy root systems. Free-living nematodes also serve as bioindicators of soil health, reflecting changes in environmental conditions. Overall, they are essential for sustainable agriculture and maintaining a balanced and productive soil ecosystem.

Need for sustainable nematode management:

Sustainable nematode management is essential to protect crop yields, maintain soil health, and reduce dependency on chemical nematicides. Integrated approaches like crop rotation, organic amendments, resistant varieties, and biological control ensure long-term suppression of harmful nematodes while preserving beneficial species, promoting environmental safety and sustainable agricultural productivity.

Recommendations for Farmers and Extension Workers:

1. Practice Crop Rotation: Rotate potatoes with non-host crops to break nematode life cycles.

2. Use Resistant Varieties: Adopt nematode-resistant or tolerant potato cultivars.

3. Maintain Field Sanitation: Remove infected plant debris and use clean planting material.

4. Apply Organic Amendments: Use compost, neem cake, or green manure to improve soil health and suppress nematodes.

5. Promote Soil Testing: Regularly monitor soil for nematode populations to guide timely and effective management strategies.

5. Conclusion

The present study investigated the diversity and population of free-living and plant-parasitic nematodes in soil samples collected from potato-growing areas of Mahnar and Lalganj in Vaishali district. In Mahnar, the total estimated nematode population in 200 cc of soil was 2280. Among free-living nematodes, *Rhabditids* (480), *Dorylaimids* (600), and *Mononchids* (120) were identified. These genera play crucial roles in soil health through nutrient cycling, microbial regulation, and ecological balance. Lalganj recorded a slightly lower total nematode count (1950), with *Rhabditids* (260) being the only free-living genus detected.

In terms of plant-parasitic nematodes, Mahnar showed the presence of *Hoplolaimus* (360), *Merlinius* (360), and *Helicotylenchus* (360), all of which are known to damage plant roots, impair nutrient uptake, and reduce crop yield. Lalganj samples revealed *Hirschmaniella* (260), *Hoplolaimus* (260), and *Scutellonema* (390), indicating a diverse and significant parasitic load in the region. These genera are associated with root damage, stunted growth, and economic loss in various crops including potatoes and rice.

Interestingly, no visible disease symptoms were observed on the roots or tubers of the sampled potato plants from either location. However, the detection of plant-parasitic nematodes in the soil underscores the potential threat they pose to crop productivity. The findings emphasize the importance of regular monitoring and integrated, sustainable nematode management strategies in these agricultural regions.

Emphasis on integrated pest management (IPM):

The findings reveal significant populations of plant-parasitic nematodes in both Mahnar and Lalganj, despite the absence of visible disease symptoms on potato roots or tubers. This highlights the importance of Integrated Pest Management (IPM) to prevent potential yield loss. IPM strategies should include regular nematode monitoring, crop rotation with non-host species, use of resistant potato varieties, and application of organic amendments like compost or neem cake. Biological control agents and soil health restoration practices should be promoted to suppress parasitic nematodes while preserving beneficial free-living nematodes, ensuring sustainable crop production and long-term soil ecosystem stability.

Importance of Further Research and Continuous Monitoring:

The presence of diverse free-living and plant-parasitic nematodes in Mahnar and Lalganj highlights the complex soil ecosystem and potential agricultural challenges. Although no visible disease symptoms were observed on roots or tubers, the soil infestation by plant-parasitic nematodes such as *Hoplolaimus, Merlinius*, and *Scutellonema* indicates a latent threat to crop health and yield. Continuous monitoring is essential to detect early population surges and prevent economic losses. Further research is needed to understand nematode population dynamics, host interactions, and environmental factors influencing their distribution. This knowledge will aid in developing targeted management strategies, such as crop rotation, resistant varieties, and soil health improvement, minimizing reliance on chemical nematicides. Moreover, studying free-living nematodes' ecological roles can enhance soil fertility and sustainability. Overall, ongoing surveillance and integrated nematode management are crucial for safeguarding crop productivity and ensuring long-term agricultural sustainability in these regions.

References:

1. Siddiqi, M. R. (2000). Tylenchida: Parasites of Plants and Insects (2nd ed.). CABI Publishing.

2. Luc, M., Sikora, R. A., & Bridge, J. (2005). Plant Parasitic Nematodes in Subtropical and Tropical Agriculture (2nd ed.). CABI.

3. Yeates, G. W., Bongers, T., De Goede, R. G. M., Freckman, D. W., & Georgieva, S. S. (1993). Feeding habits in soil nematode families and genera—an outline for soil ecologists. Journal of Nematology, 25(3), 315–331.

4. Ferris, H., Bongers, T., & De Goede, R. G. M. (2001). A framework for soil food web diagnostics: Extension of the nematode faunal analysis concept. Applied Soil Ecology, 18(1), 13–29.

5. Lal, L., & Sharma, Y. R. (1990). Nematode problems of tuber crops and their management. Indian Journal of Nematology, 20(Special Issue), 33–47.

6. Khan, M. R., & Jairajpuri, M. S. (1994). Diversity and predatory behavior of mononchid nematodes from India. Indian Journal of Nematology, 24(1), 59–65.

7. Jairajpuri, M. S., & Ahmad, W. (1992). Dorylaimida: Free-living, Predaceous and Plant-parasitic Nematodes. Oxford & IBH Publishing.

8. Moens, M., Perry, R. N., & Starr, J. L. (2009). Root-knot Nematodes. CABI Publishing.

9. Hunt, D. J., & Perry, R. N. (2011). Techniques for Work with Plant and Soil Nematodes (2nd ed.). CABI.

10. Bridge, J., & Page, S. L. J. (2001). Estimation of nematode infestation levels on roots. Tropical Pest Management, 26(3), 296–298.

11. Trudgill, D. L., & Blok, V. C. (2001). Apomictic, polyphagous root-knot nematodes: exceptionally successful and damaging biotrophic root pathogens. Annual Review of Phytopathology, 39, 53–77.

12. Kyndt, T., Fernandez, D., & Gheysen, G. (2014). Plant-parasitic nematode infections in rice: molecular and cellular insights. Annual Review of Phytopathology, 52, 135–153.

13. Shah, M. H., & Sharma, P. (2023). Diversity and distribution of plant-parasitic nematodes in vegetable crops of Eastern India. Indian Journal of Nematology, 53(2), 112–120.

COMPARATIVE ANALYSIS OF SOIL AND POTATO NEMATODE POPULATIONS FROM TWO AGRO-ECOLOGICAL ZONES

ORIGINALITY REPORT

13%	6%	12%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	El-Sayed Ewis Omran, Mahmoud Farag Mahmoud, Heba M. Abd El-Nabi. "chapter 10 Eco-Friendly Nematodes", IGI Global, 2023 Publication	3%
2	Ravinder Kumar, Milan Kumar Lal, Rahul Kumar Tiwari, Brajesh Singh. "Sustainable Production of Root and Tuber Crops", Routledge, 2025 Publication	2%
3	dergipark.org.tr Internet Source	1%
4	Submitted to Aga Khan University Student Paper	1%
5	repository.nwu.ac.za Internet Source	1%
6	Serigne T Kandji, Callistus K.P.O Ogol, Alain Albrecht. "Diversity of plant-parasitic nematodes and their relationships with some soil physico-chemical characteristics in improved fallows in western Kenya", Applied Soil Ecology, 2001 Publication	1%
7	Jingliang Chen, Yafeng Zhang, Chao Liu, Lei Huang. "Distribution pattern of soil nematode communities along an elevational gradient in	1%

arid and semi-arid mountains of Northwest China", Frontiers in Plant Science, 2024
Publication

8	sherekashmir.informaticspublishing.com Internet Source	1 %
9	" Morphological Variation in the Rice Root Nematode, (Van Breda De Haan, 1902) Luc & Goodey, 1964 from Korea, with Inferences from its Ribosomal and Mitochondrial DNA ", Journal of Nematology, 2022 Publication	1 %
10	mspace.lib.umanitoba.ca Internet Source	<1 %
11	ir.jkuat.ac.ke Internet Source	<1 %
12	Forge, T.A.. "Responses of grassland soil nematodes and protozoa to multi-year and single-year applications of dairy manure slurry and fertilizer", Soil Biology and Biochemistry, 200510 Publication	<1 %
13	biblio.ugent.be Internet Source	<1 %
14	es.scribd.com Internet Source	<1 %
15	sciendo.com Internet Source	<1 %
16	Mohammad Akhtar, Irshad Mahmood. "Control of plant-parasitic nematodes with organic and inorganic amendments in agricultural soil", Applied Soil Ecology, 1996 Publication	<1 %

17	researchspace.ukzn.ac.za Internet Source		<1 %

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		