



Research Article

Occurrence and Distribution of Plant-Parasitic Nematodes in Okra Fields of Prayagraj District, Uttar Pradesh, India

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Abstract | A survey was conducted to investigate root-knot nematode presence and distribution of plant-parasitic nematode genera in okra fields across various sections of the Prayagraj district in Uttar Pradesh. Four blocks were selected for the study, which included Bahadurpur, Phulpur, Chaka, and Jasra, covering 20 different villages. The results showed that disease incidence throughout the various locations studied showed a wide range, which extended from 26.7 to 83.3 percent. Chaka showed the highest disease rate among all blocks whereas Phulpur showed the lowest rate of disease transmission. The research identified multiple nematode genera in the area, with *Meloidogyne* appearing as the most common and widely found species, while *Pratylenchus*, *Tylenchus*, *Rotylenchus* and *Helicotylenchus* followed behind, and *Heterodera* and *Xiphinema* showed presence at a much lower rate. The frequency analysis confirmed that *Meloidogyne* emerged as the most prevalent species throughout the surveyed locations. Nematode populations varied between blocks because Chaka block had the highest population and Jasra and Bahadurpur followed as the next highest blocks, whereas Phulpur had the lowest population. The study found that nematode populations showed a positive association with both disease incidence and gall index. The study shows that plant-parasitic nematodes exist throughout okra-growing areas of Prayagraj, which highlights the need for ongoing monitoring and effective management methods to prevent crop losses.

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Keywords | Okra, Plant-parasitic nematodes, Incidence, Distribution, Survey



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Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) belongs to the Malvaceae family and serves as one of the essential vegetable crops which people cultivate throughout tropical and subtropical areas. The product holds value because it provides essential nutrients through its protein and mineral and vitamin

content while also delivering industrial value through its fiber manufacturing applications. India ranks among the leading producers of okra globally and the crop contributes to vegetable production and export earnings through its significant agricultural output.

Plant-parasitic nematodes represent one of the main biotic stresses which pose economic challenges to

okra cultivation because they cause severe damage to crops. Root-knot nematodes (*Meloidogyne* spp.) rank as the most harmful nematode species because they can infect many different host organisms and they breed rapidly and survive in various environmental settings. Nematodes invade plants and create root-galls which block the normal physiological processes of plants and stop them from absorbing water and nutrients necessary for proper growth. Earlier reports have indicated substantial yield losses in okra due to root-knot nematodes which sometimes exceeded 20–40 percent under favorable conditions (Sasser, 1979; Baheti and Bhati, 2017).

The distribution and occurrence of plant-parasitic nematodes depends on various factors which include soil type and climatic conditions and cropping pattern and agricultural practices (Pant *et al.*, 2025). The vegetable-growing regions exhibit a presence of multiple genera which include *Meloidogyne*, *Pratylenchus*, *Rotylenchus* and *Helicotylenchus* that grow together in their shared rhizosphere (Pant *et al.*, 2006; Srivastava *et al.*, 2012). The recent studies established that environmental conditions and management practices control nematode population dynamics and community composition which results in their distribution across different locations (Jones *et al.*, 2013; Coyne *et al.*, 2018). Recent studies have also documented nematode diversity in mushroom-producing composts and the distribution of plant-parasitic nematodes in vegetable-growing areas (Jabbari, 2025; Kebede *et al.*, 2025).

Root-knot nematodes show widespread distribution in vegetable crops throughout eastern Uttar Pradesh. This study found multiple locations that had high infestation rates of root-knot nematodes in the Prayagraj region of eastern Uttar Pradesh (Pandey *et al.*, 2003). The presence of multiple nematode genera within the same field presents a challenge for effective management which requires detailed surveys to determine their distribution and relative importance. Recent investigations have also highlighted the increasing importance of nematode problems in intensively cultivated vegetable ecosystems, especially under changing climatic conditions (Coyne *et al.*, 2018; Sachan *et al.*, 2023).

Although several studies have been conducted on plant-parasitic nematodes in different regions, systematic information on their occurrence in okra-growing areas of Prayagraj district remains limited

(Pant *et al.*, 2006; Srivastava *et al.*, 2012). Therefore, the present investigation was undertaken to assess the incidence of root-knot nematodes and to study the distribution of different plant-parasitic nematode genera associated with okra in selected blocks of Prayagraj district.

Materials and Methods

Study area

The present investigation was conducted in different okra-growing areas of Prayagraj district, Uttar Pradesh, India. The region is characterized by a subtropical climate, which is favorable for the development and multiplication of plant-parasitic nematodes.

Survey and sampling

A systematic survey was carried out during the cropping season to assess the incidence of plant-parasitic nematodes in okra. Four blocks, namely Bahadurpur, Phulpur, Chaka and Jasra, were selected for the study (Table 1). From each block, five villages were surveyed, making a total of twenty villages. In each village, three fields were randomly selected, and ten plants were examined from each field, resulting in a total of thirty plants per village. Soil samples were collected at a depth of 15–20 cm from the rhizosphere zone. Samples of infected roots and around 500 g of soil were taken from each field and transported to the laboratory for nematode extraction and identification.

Assessment of disease incidence

The incidence of root-knot nematode was recorded based on the number of infected plants. Disease incidence was calculated using the formula:

$$\text{Disease incidence (\%)} = \left(\frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \right) \times 100$$

Estimation of gall index

Root galling was assessed using a standard 0–5 rating scale based on the severity of gall formation, and the mean gall index was calculated following the method described by Taylor and Sasser (1978).

Nematode extraction and identification

Soil and root samples were collected from the rhizosphere of selected plants and processed in the laboratory. Nematodes were extracted from soil samples using the modified Cobb's sieving and decanting method (Cobb, 1918), followed by the Baermann funnel technique for further recovery of active nematodes (Baermann, 1917). For microscopic

examination, the extracted nematodes were killed, fixed and mounted on permanent slides. Identification was carried out up to the genus level using standard taxonomic keys based on morphological characteristics (Mai and Mullin, 1996).

Statistical analysis

The collected survey data were evaluated using descriptive statistical analysis. To summarize the distribution of plant-parasitic nematodes in the surveyed areas, mean values, frequency of occurrence and standard error (SE) were calculated.

Results and Discussion

The survey conducted across different blocks of Prayagraj district revealed considerable variation in the incidence of root-knot nematode. The overall incidence ranged between 26.7 percent and 83.3 percent across the surveyed villages (Table 1). The block of Chaka showed the highest root-knot disease incidence through its 83.3 percent rate while Jasra and Bahadurpur followed behind and Phulpur block recorded the lowest rate. Chaka block displays higher nematode incidence because its soil and environmental conditions create ideal conditions for nematodes to reproduce and stay alive. The Prayagraj region showed similar results because more than 50

percent of fields were reported to be infested with root-knot nematodes which caused disease rates to reach 80 percent in specific areas (Pandey *et al.*, 2003). The previous studies have documented the root-knot nematode's extensive presence across various agro-climatic regions (Pant *et al.*, 2006).

The incidence of root-knot nematodes showed different levels of presence across various villages examined within the selected study areas. The highest incidence was recorded in villages such as Mahewa (83.3%), Chaka (80.0%) and Dandi (76.7%), where infection levels exceeded 70 per cent, whereas comparatively lower incidence was noted in villages like Tulsipatti (26.7%) and Rasulpur (30.0%). The village-level differences of this study can be explained through the different agricultural practices and irrigation methods and the environmental factors which affect nematode populations. The results demonstrate that nematode distribution patterns show different distribution patterns which exist between distinct locations within the same agro-climatic area. Previous research showed that different factors at the village level create variations in nematode populations. The research found that area-based soil and climate factors determine the presence and intensity of plant-parasitic nematodes as demonstrated by the studies conducted by (Srivastava *et al.*, 2012; Lavhe *et al.*, 2019).

Table 1: Village-wise incidence of root-knot nematode in okra.

Block	Village	Fields surveyed (No.)	Total observed plants (No.)	Total infected plants (No.)	Incidence (%)	Mean gall index	Nematode population
Bahadurpur	Badra	3	30	14	46.7	2.5	320
Bahadurpur	Bahadurpur	3	30	12	40.0	2.2	290
Bahadurpur	Chak	3	30	16	53.3	2.9	360
Bahadurpur	Jhunsi	3	30	15	50.0	2.7	340
Bahadurpur	Katta	3	30	13	43.3	2.4	310
Phulpur	Dayalpur	3	30	12	40.0	2.2	300
Phulpur	Rasulpur	3	30	9	30.0	1.8	230
Phulpur	Shahpur	3	30	11	36.7	2.0	280
Phulpur	Tulsipatti	3	30	8	26.7	1.6	210
Phulpur	Korapur	3	30	13	43.3	2.4	310
Chaka	Chaka	3	30	24	80.0	4.0	560
Chaka	Mahewa	3	30	25	83.3	4.3	600
Chaka	Dandi	3	30	23	76.7	3.9	540
Chaka	Dadari	3	30	18	60.0	3.2	410
Chaka	Naini	3	30	20	66.7	3.5	440
Jasra	Jari	3	30	22	73.3	3.8	500
Jasra	Jasra	3	30	17	56.7	3.0	390
Jasra	Kanti	3	30	21	70.0	3.6	480
Jasra	Ghoorpur	3	30	18	60.0	3.2	410
Jasra	Iradatgang	3	30	19	63.3	3.3	430

The different plant-parasitic nematode genera showed different distribution patterns in all the studied villages according to the data (Table 2). A total of several genera were identified, among which *Meloidogyne* was the most widely distributed genus, being present in almost all the villages surveyed. The study detected other genera which included *Rotylenchus*, *Pratylenchus*, *Helicotylenchus*, *Tylenchus*, *Heterodera* and *Xiphinema* at different levels of occurrence. The presence of multiple genera within the same village indicates a complex nematode community associated with the okra rhizosphere. The region demonstrates diverse plant-parasitic nematodes because environmental factors and cropping patterns and host plants create suitable conditions. Previous research has documented the presence of multiple nematode genera in vegetable-growing regions, where different genera existed together in the same agricultural field (Pant *et al.*, 2006; Lavhe *et al.*, 2019).

The occurrence of various plant-parasitic nematode genera in different locations is presented in Table 3. The surveyed area showed higher occurrences of *Meloidogyne* than any other recorded genus. *Pratylenchus* and *Tylenchus* spread throughout the blocks, while *Rotylenchus* and *Helicotylenchus* showed moderate occurrence. *Heterodera* and *Xiphinema* appeared less frequently, which showed they existed in the area as infrequent visitors. *Meloidogyne* dominates other genera because it can infect many host types and reproduce at high rates and thrive in various environmental situations. Previous research shows matching results because *Meloidogyne* has been found to be the most common economically significant plant-parasitic nematode in vegetable crops (Pant *et al.*, 2006; Pandey *et al.*, 2003). Recent studies show similar patterns, which show how root-knot nematodes exist in all different agro-ecological regions.

Table 2: Occurrence of plant-parasitic nematode genera in different villages of surveyed blocks.

Village	Meloidogyne	Rotylenchus	Helicotylenchus	Pratylenchus	Xiphinema	Heterodera	Tylenchus
Badra	+	-	+	+	+	-	+
Bahadurpur	+	-	+	-	+	-	+
Chak	+	+	-	+	-	-	+
Jhunsu	+	+	-	+	-	-	-
Katta	-	+	-	+	-	+	-
Dayalpur	+	-	+	+	-	-	+
Rasulpur	+	+	+	+	-	+	+
Shahpur	+	+	+	-	-	+	-
Tulsipatti	+	+	-	+	-	-	-
Korapur	+	+	+	+	-	+	-
Chaka	+	+	+	+	-	-	+
Mahewa	+	+	-	+	+	-	+
Dandi	+	-	-	+	-	+	+
Dadari	+	-	+	+	-	+	-
Naini	+	+	-	-	-	-	-
Jari	+	+	+	-	-	+	+
Jasra	+	+	+	+	-	+	-
Kanti	+	-	+	-	-	+	+
Ghoorpur	+	-	-	+	-	+	+
Iradatgang	+	-	+	+	-	-	-

+ = Present, - = Absent

The average nematode population together with its distribution pattern throughout the different blocks of the study is presented in Table 4 and Figure 1. The results of the study indicated noticeable variation in nematode populations among the surveyed blocks. The highest mean population was recorded in Chaka block, followed by Jasra and Bahadurpur, while the lowest population was observed in Phulpur block. The higher nematode populations observed in certain blocks may be related to local environmental and agronomic factors. The standard error values further

Table 3: Frequency and distribution of plant-parasitic nematode genera associated with okra in surveyed areas.

S. No.	Nematode genus	Frequency (%)	Distribution (Blocks)	Remarks
1.	<i>Meloidogyne</i> spp.	95	All blocks	Dominant
2.	<i>Rotylenchus</i> spp.	55	Bahadurpur, Phulpur, Chaka, Jasra	Moderately distributed
3.	<i>Helicotylenchus</i> spp.	50	Bahadurpur, Phulpur, Chaka, Jasra	Moderately distributed
4.	<i>Pratylenchus</i> spp.	70	All blocks	Widely distributed
5.	<i>Xiphinema</i> spp.	20	Chaka, Jasra	Low occurrence
6.	<i>Heterodera</i> spp.	30	Phulpur, Chaka, Jasra	Sporadic
7.	<i>Tylenchus</i> spp.	60	All blocks	Moderately distributed

indicated variability in nematode distribution within the blocks. The study found that nematode populations showed a positive association with both disease incidence and gall index. Similar trends of higher nematode populations in intensively cultivated vegetable-growing regions have been reported in earlier studies (Pant *et al.*, 2006), as well as in recent investigations highlighting the influence of environmental and agronomic factors on nematode proliferation (Pant *et al.*, 2025). These findings emphasize the need for effective nematode management strategies to minimize yield losses in okra cultivation.

Table 4: Mean nematode population and standard error (SE) across different blocks.

Block	Mean nematode population	SE ($\pm$)
Bahadurpur	324	12.1
Phulpur	266	19.6
Chaka	510	36.3
Jasra	442	20.8

Values are mean of five villages per block; SE= standard error.

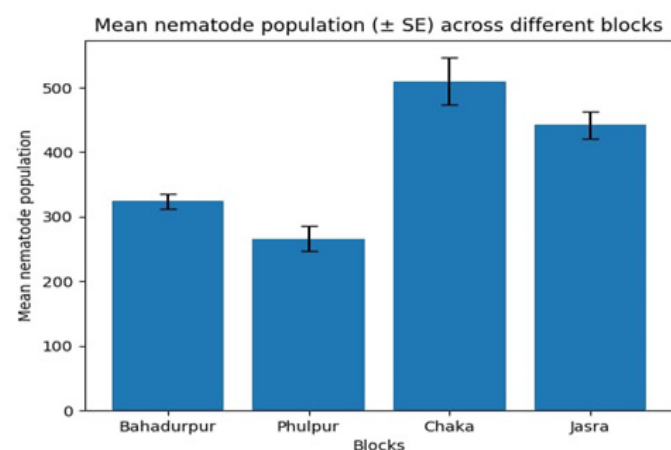


Figure 1: Mean nematode population ($\pm$ SE) across different blocks surveyed.

Conclusion

The present survey demonstrated a wide distribution of plant-parasitic nematodes in okra-growing regions of Prayagraj district, with noticeable variation in disease incidence and nematode population among different blocks and villages. Among the identified genera, *Meloidogyne* emerged as the most dominant and widely prevalent, followed by *Pratylenchus*, *Tylenchus*, *Rotylenchus* and *Helicotylenchus*, whereas *Heterodera* and *Xiphinema* were recorded with relatively lower frequency. Continuous cultivation of highly susceptible host crops and favourable environmental conditions

may contribute to the higher incidence observed in certain areas. The presence of multiple genera in one area shows that different types of nematodes live in the okra rhizosphere. The study results show that researchers need to conduct ongoing monitoring while using appropriate control measures to achieve successful nematode management. The research establishes a foundational resource for upcoming studies which will support the creation of site-specific strategies that help reduce agricultural damage.

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Novelty Statement

This study presents a field-based assessment of plant-parasitic nematodes associated with okra in four blocks and 20 villages of Prayagraj district, Uttar Pradesh, India. The study documents their occurrence, distribution and population levels at the village and block levels, providing useful information for future monitoring management of nematode problems in okra cultivation in the region.

Author's Contribution

Aditya Sharma: Field survey and sampling, laboratory work, data collection, data analysis, interpretation of results, and manuscript preparation and writing.

Hemlata Pant: Conceptualization, supervision, guidance, assistance with background and conceptual aspects, and critical review and correction of the manuscript.

Generative AI and AI assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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