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Occurrence and distribution of cyst nematodes (*Heterodera* spp.) in India

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ABSTRACT

Analysis of 67 soil and root samples from 14 Indian states across diverse agroecological zones of India and crops (cereals, millets, pulses, oilseeds, fruits, vegetables, cash crops, and one weed) revealed the occurrence of four *Heterodera* species: *H. avenae*, *H. zaeae*, *H. cajani*, and *H. mothi*. Species were identified by cyst, vulval-cone, and second-stage juvenile morphology. *Heterodera* cysts occurred in 15 samples (22.4%), mainly from Delhi, Uttar Pradesh, and Rajasthan. *H. avenae* was the most widespread, primarily on wheat, followed by *H. zaeae*, *H. cajani*, and *H. mothi* (associated with *Cyperus rotundus* L.). Co-occurrence of more than one species was common (60% of positive samples). This study provides the first record of *H. cajani* on soybean in Assam. The findings of this study indicate that cyst nematodes can survive in fields even without host crops present. Therefore, monitoring cyst nematode populations can help implement appropriate management strategies by adjusting the crop rotation.

Keywords: Morphology, survey, *H. avenae*, *H. zaeae*, *H. cajani*, *H. mothi*

Introduction

Cyst nematodes (*Heterodera*; *Globodera*) are the most economically important pests of crops, second only to root-knot nematodes (Jones *et al.*, 2013) [9]. The cyst nematode, upon infecting host plants, induces characteristic histological changes termed the syncytium. Further, the nematode is well adapted to transform the body cuticle into a persistent tanned structure after the death of the female body (termed a cyst) to protect its eggs. Earlier, the genus *Heterodera* included 12 species (Sharma, 1998) [24], but currently the number of described species stands at 87 nominal species (Yang *et al.*, 2024; Wen *et al.*, 2024) [28, 27]. They are distributed in eight genera: *Heterodera* (87 species), *Globodera* (14 species), *Cactodera* (14 species), *Dolichodera* (1 species), *Paradolichodera* (1 species), *Betulodera* (1 species), *Punctodera* (4 species), and *Vittatidera* (1 species), totalling 121 valid species (Handoo *et al.*, 2018; Perry *et al.*, 2018) [6, 18]. The most economically important one is the cereal cyst nematode (*Heterodera avenae*), which severely impacts cereal crops, particularly wheat. Infected fields can suffer yield losses ranging from 30% to 100%, with a reported loss of up to 28.5% in India (Kumar *et al.*, 2020) [16]. Since 1958, 22 species of *Heterodera* have been identified in India based on the structures of the vulval cone top (Kaushal *et al.*, 2007; Kaushal, 2013) [10, 11]. Among these, *H. avenae* causes 'molya' disease in wheat and barley, especially in northern regions, leading to potential losses of up to 97.28 million rupees in wheat (Jain *et al.*, 2007) [8]. Another significant species is the pigeon pea cyst nematode (*Heterodera cajani*), which was first reported in Delhi (Koshy, 1967) [14]. Other economically important *Heterodera* species infecting maize, sorghum, rice, and banana are *H. zaeae*, *H. sorghi*, and *H. oryzicola*, respectively. Over the past several years, there has been no systematic survey conducted on the occurrence and distribution of cyst nematodes in India. Therefore, this study aims to identify *Heterodera* species based on morphological observations and to understand their presence and distribution across different states in India.

Materials and Methods

Soil sampling and nematode extraction

Soil samples were collected from the fields of various crops grown in 14 states of India. Altogether 67 samples were collected across India. Nematode extraction from soil samples was performed using Cobb's decanting and sieving method (Cobb, 1918) [3] followed by the modified Baermann funnel technique (Schindler, 1961) [21]. The collected nematode suspension was then observed under a stereoscopic binocular microscope to identify the presence of juveniles and males. Cysts were isolated from residue retained on the 60-mesh sieve and further examined using OLYMPUS, Japan, stereo-zoom microscopes (SZ-PT and SZ-9). Cysts were carefully picked using forceps and segregated into different Petri plates based on their types (shape, size and colour) for identification. Second-stage juveniles (*J*_{2s}) that hatched from these cysts were subsequently used for detailed morphological studies.

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Morphological observations of *Heterodera* spp

For species identification, vulval cone tops were prepared from 10 cysts from each population following the methods described by Cooper (1955)^[4] and Perry *et al.* (2021)^[17]. The prepared vulval cones were mounted in modified Kaiser's glycerine jelly (Dioni, 2003)^[5]. Identification was done based on the cyst's size, colour, shape, vulval cone structures, and J_{2s} (Handoo *et al.*, 2018)^[6]. J_{2s} collected from the sample were heat-killed and preserved in TAF solution (7 ml of 40% formaldehyde, 2 ml of triethanolamine, and 91 ml of distilled water), and were subsequently placed in glycerol (Seinhorst, 1959)^[22]. Permanent and semi-permanent slides were prepared (Handoo, 2002)^[7], and photomicrography was taken under stereoscopic (Leica, Germany) and compound microscopes (Leica DMLB, Germany) using an image-analysing camera.

Results and Discussion

A total of 67 soil and root samples were collected from 14 states across various agroecological zones in India. The sampling included a diverse range of crops, such as cereals, millets, pulses, oilseeds, fruits, vegetables, cash crops, and one weed (*Cyperus rotundus*). Table 1 and 2 provides details on crops, locations, and states and the identified *Heterodera* species, as well as crops and locations where no cyst nematodes were recorded. The data represent presence or absence records only; cyst counts and population densities are not included due to the variability in sampling times throughout the year. The analysis of soil samples revealed the presence of four species of *Heterodera*: *Heterodera avenae*, *H. zaeae*, *H. cajani*, and *H. mothi* (as detailed in Tables 1 and 2; Figure 1).

Table 1. Survey for the occurrence of the cyst nematodes (*Heterodera* spp.) in different states of India

States	Samples	Positive	Frequency (%)	Species identified
Delhi (IARI)	11	6	54.5	<i>H. avenae</i> , <i>H. zaeae</i> , <i>H. cajani</i> , <i>H. mothi</i>
Uttar Pradesh (Bijnor, Meerut, Lucknow)	4	4	100	<i>H. avenae</i> , <i>H. zaeae</i> , <i>H. cajani</i>
Rajasthan (Udaipur, Jaipur, Alwar)	4	4	100	<i>H. avenae</i> , <i>H. cajani</i>
Assam (Jorhat)	4	1	25	<i>H. cajani</i>
Telangana (Hyderabad)	13	0	0	—
Chhattisgarh (Fundahar, Purenna)	6	0	0	—
Punjab (Ludhiana)	5	0	0	—
Bihar (Samastipur)	4	0	0	—
Jharkhand (Ranchi)	4	0	0	—
Arunachal Pradesh (Lower Subansiri)	3	0	0	—
Meghalaya (Umiam)	3	0	0	—
West Bengal (<i>Nadia</i>)	3	0	0	—
Tamil Nadu (Kanyakumari)	2	0	0	—
Odisha (Bhubaneswar)	1	0	0	—

Table 2. Survey for the occurrence of the cyst nematodes (*Heterodera* spp.) in different crops in India

Crop	Samples	Positive	Frequency (%)	Species identified
Wheat	11	5	45.5	<i>H. avenae</i> , <i>H. cajani</i> , <i>H. zaeae</i>
Maize	14	2	14.3	<i>H. zaeae</i> , <i>H. avenae</i>
Soybean	6	3	50.0	<i>H. avenae</i> , <i>H. zaeae</i> , <i>H. cajani</i>
Pigeonpea / arhar	8	3	37.5	<i>H. avenae</i> , <i>H. cajani</i> , <i>H. zaeae</i>
Motha / <i>Cyperus rotundus</i>	2	2	100	<i>H. mothi</i>
Other crops	26	0	0	None

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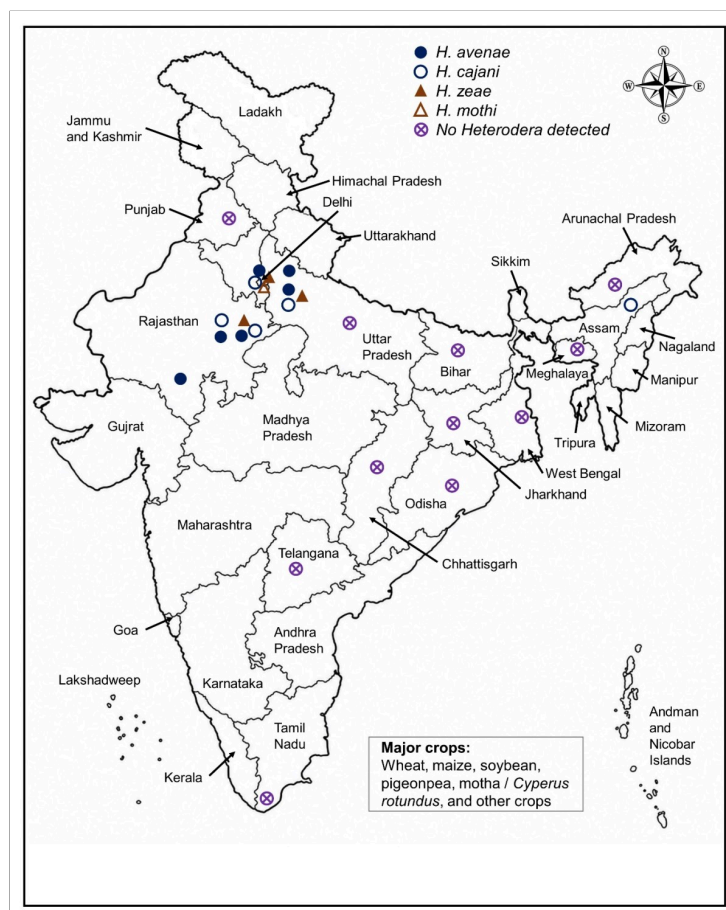


Figure 1. Distribution of cyst nematodes (*Heterodera* spp.) in surveyed states of India.

Populations were identified morphologically based on diagnostic features including cyst shape, size, colours, vulval cone structures and J_2 s head and tail shapes, etc. Among the 67 samples collected from different agroecological zones, *H. avenae*, commonly known as the cereal cyst nematode, was found in Delhi, Uttar Pradesh, and Rajasthan. *H. cajani*, the pigeonpea cyst nematode, was identified in Delhi, Uttar Pradesh, Rajasthan and Assam. *H. zeae* was found in Delhi and Uttar Pradesh, while *H. moths*, known as the Nutgrass cyst nematode, was identified only in Delhi.

The presence of *Heterodera* was found in 15 out of 67 samples (22.4%). Fifty-two samples (77.6%) were negative. The identified species included *H. avenae* in 12 samples, *H. zeae* in eight, *H. cajani* in five, and *H. moths* in two. *H. avenae* was the most widespread species, found in wheat (5 records), pigeonpea (Cobb, 1918) [3], maize (Bhatti *et al.*, 1981) [2], and soybean (Bhatti *et al.*, 1981) [2] across Rajasthan, Uttar Pradesh, and Delhi. *H. zeae* was recorded in Uttar Pradesh and Delhi, affecting wheat, maize, soybean, and pigeonpea (with 2 records each). *H. cajani* exhibited the broadest geographic distribution, occurring in Uttar Pradesh, Delhi, Assam, and Rajasthan, specifically on wheat, pigeonpea, and soybean. This study first recorded the occurrence of *H. cajani* from Assam in a soybean sample. *H. moths* was found associated with motha (*C. rotundus* L.), a common weed, with two samples collected at IARI in Delhi. Among the crop field samples, the occurrence of cysts was found in soybean (3 of 6 samples positive), wheat (5 of 11), pigeonpea (3 of 8), maize (2 of 14), and motha (2 of 2). No cyst nematodes were found in chickpea, mungbean, rice, sorghum, finger millet, pearl millet, cowpea, other beans, vegetables, litchi, mango, taro, sugarcane, or cotton. Samples with cysts were primarily found in four regions. Delhi (IARI) had the highest prevalence, with 6 positives out of 11 samples, showing the presence of all four species. All four samples from Uttar Pradesh and all four samples from Rajasthan were positive. In Assam, one out of four samples were positive. All samples from the other ten states- Telangana (13 samples), Chhattisgarh (Handoo *et al.*, 2018) [6], Punjab (Dioni, 2003) [5], Bihar (Cooper, 1955) [4], Jharkhand

(Cooper, 1955) [4], Arunachal Pradesh (Cobb, 1918) [3], Meghalaya (Cobb, 1918) [3], West Bengal (Cobb, 1918) [3], Tamil Nadu (Bhatti *et al.*, 1981) [2], and Odisha (Ali *et al.*, 2005) [1]- had no cyst nematodes detected in the samples. More than one species of cyst nematodes was common. Nine out of the 15 samples (60%) contained two or three species, while six samples had a single species. *H. avenae* was present in all nine mixed samples, most often alongside *H. zeae*. Three-species mixtures occurred in wheat from Bijnor, UP and in pigeonpea from IARI, Delhi and Meerut, UP. The presence of multiple species in the crop field may be attributed to the residual populations from previous crops in the rotation or to weed hosts that support these populations. The cysts of *H. avenae*, which complete only one generation during the wheat-growing season, were observed in maize fields. In contrast, *H. cajani*, a multivoltine species with a host range limited to leguminous crops, was commonly found in both maize and wheat fields.

Two species of *Heterodera* viz., *Heterodera avenae* infecting graminaceous hosts and *H. cajani* infecting leguminous crops, are considered India's most frequently encountered and economically important species. Cereal cyst nematode (*H. avenae* and *H. filipjevi*) has a very limited host range, mostly infecting wheat, barley, and oat, all belonging to the graminaceae family.

H. avenae was identified by its cyst shape, which is predominantly lemon-shaped, varying in colour from light brown to black. The individual cyst sizes were variable (Figure 2A). The cone-top structure was ambifenestrate, with a short vulval slit (9-10 μ m) in the fenestral bridge and pronounced bullae in the vulval cone structure (Figure 3A). Its first occurrence was reported from Sikhar district in Rajasthan by Vasudeva (1958) [26]. Currently, it is widespread in the northern wheat-growing regions of India and causes the characteristic 'molya' disease in wheat and barley. Among cyst nematodes reported in India, *H. avenae* is the most economically significant species and a considerable concern for wheat cultivation in northern India. In India, wheat is a major crop affected by *H. avenae*, causing yield losses of 49% (Bhatti *et al.*, 1981) [2].

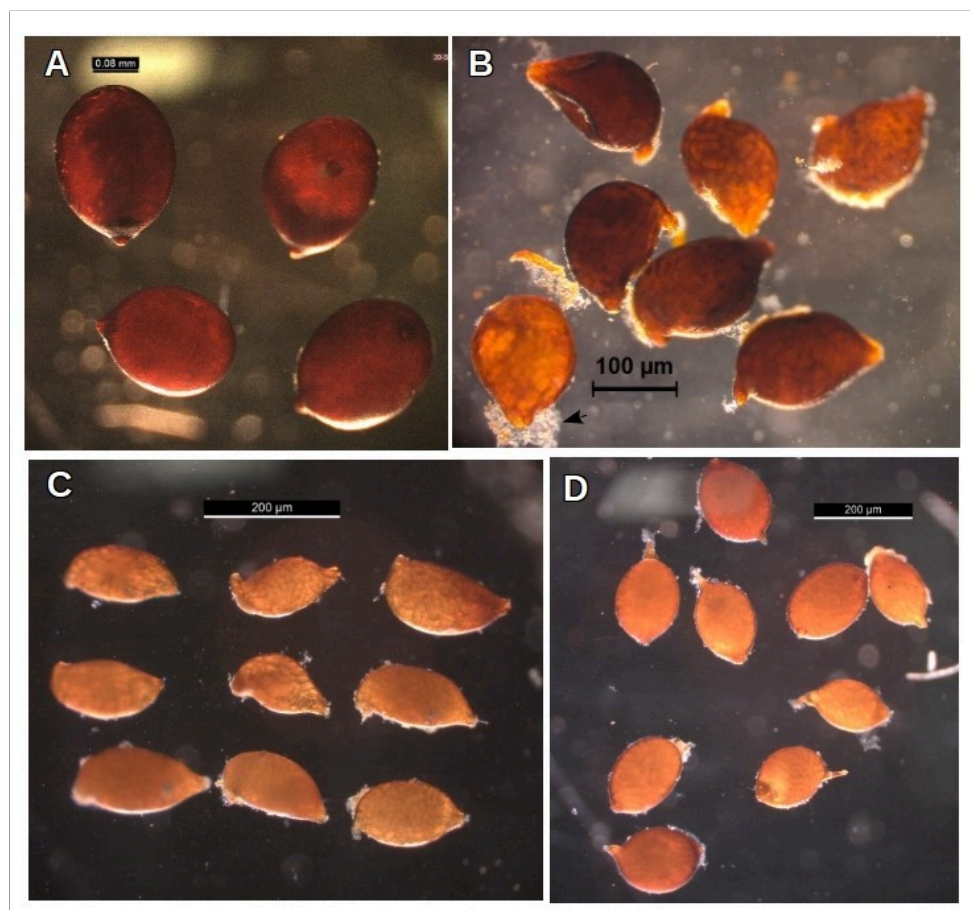


Figure 2. Variations in *Heterodera* cysts: A: *Heterodera avenae*; B: *H. cajani*; C: *H. moths* and D: *H. zeae* from India.

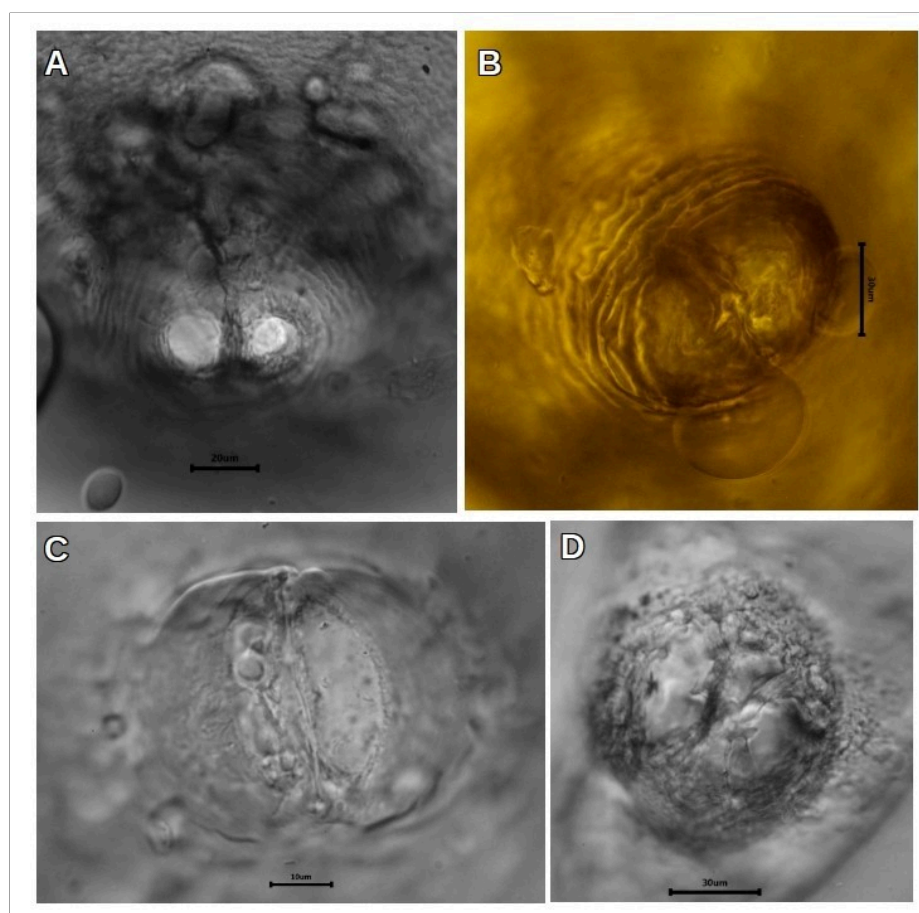


Figure 3. Vulval cone structure of *Heterodera*: A: *Heterodera avenae*; B: *H. cajani*; C: *H. moths* and D: *H. zeae* from India

H. cajani was identified by the presence of a large egg mass attached to the posterior end of fresh cysts. The cysts are also lemon-shaped,

dark brown to black, with a narrow posterior end and a short protuberance (Figure 2B). Its cone-top structure is ambifenestrated, featur

ing finger-like bullae, a long vulval slit, and a thick but short under-bridge (Figure 3B). This species is the second most important cyst nematode affecting leguminous crops such as pigeonpea and cowpea; however, its small cysts and lack of above-ground symptoms make detection challenging. *H. cajani* females are very different from females of other species. A large egg sac, almost twice as big as the cyst itself, is a distinguishing feature of the nematode (Ali *et al.*, 2005)^[1]. *H. cajani* has been found primarily in sandy-loam and black cotton soils in India (Reddy *et al.*, 1993; Varaprasad *et al.*, 1997)^[20, 25]. The 'pearly root' of pigeonpeas (Sharma, 1991)^[23] is a confirmatory symptom of *H. cajani* infection. The occurrence of *H. cajani* has been reported earlier in Delhi (Rao *et al.*, 2011; Kumar *et al.*, 2022)^[19, 15]. *H. zae* was identified by having a light brown, thin-walled cyst that is lemon-shaped, with a prominent vulval cone (Figure 2D). The vulval cone has an ambifenestrate structure and features finger-like cross-bullae located beneath the underbridge, often leading to confusion with *H. cajani*. It also possesses a long vulval slit and a short

vulval bridge, with an indistinct anus (Figure 3B). *H. zae* was first identified in Chapli, Udaipur district, Rajasthan, India by Koshy *et al.* (1970)^[13]. Subsequently, it was found in numerous maize-growing regions across northern, western, central, and southern India (Kaushal *et al.*, 2007)^[10].

H. mothi cysts are light to dark brown, lemon-shaped, and transparent, allowing the eggs to be visible from outside. They also feature a protruding vulval cone (Figure 2C). The cone top is ambifenestrate with prominent bullae, and the lengths of the vulval bridge and slit are equal (Figure 3C). The anus is distinct. A notable characteristic of the J_2 s is its long tail with an acute terminus and an elongated hyaline part, with the phasmid located far from the anus (Figure 4C). The J_2 is distinct from the other three species of *Heterodera* (Figure 4). This nematode species was first described in Uttar Pradesh, India by Khan and Husain (1965)^[12] in nut grass (*Cyperus rotundus*). Although it has since been found in northwestern India, its economic significance to crops remains unclear.

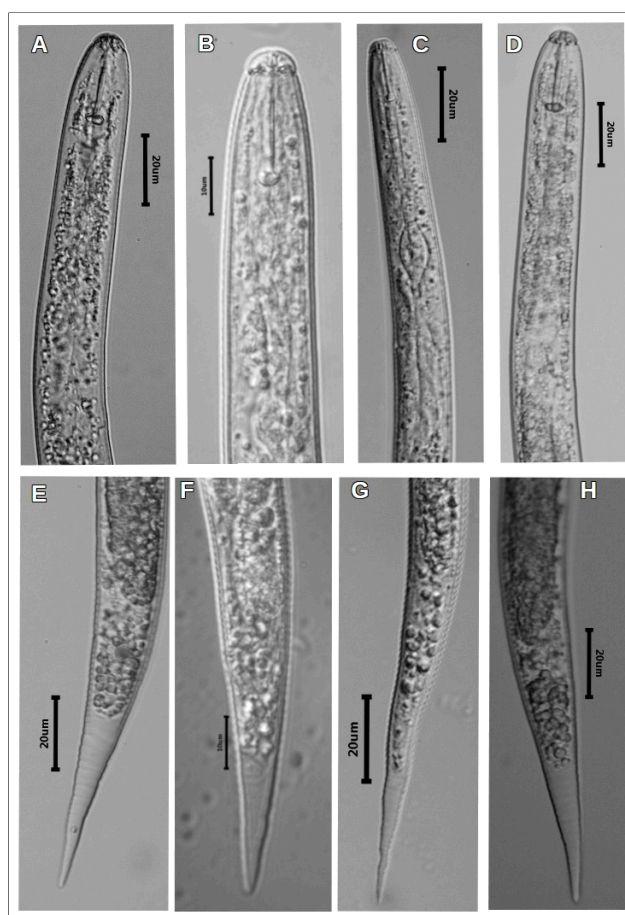


Figure 4. Second-stage juveniles (J_2) of *Heterodera*: A: *Heterodera avenae*; B: *H. cajani*; C: *H. mothi* and D: *H. zae*; E: *H. avenae*; F: *H. cajani*; G: *H. mothi* and H: *H. zae* from India

Conclusion

Cyst nematodes (*Heterodera* spp.) were detected in approximately one in five samples, primarily in wheat, maize, soybean, and arhar in Delhi, Uttar Pradesh, and Rajasthan. Four species of *Heterodera*: *H. avenae*, *H. cajani*, *H. zae* and *H. mothi* were identified based on cyst, vulval cone and second-stage juvenile morphology. *H. avenae* was identified as the dominant species, and mixed-species infestations were common. Motha (*Cyperus rotundus*) was found to harbour *H. mothi*. Samples collected from southern, eastern, and northeastern states were uniformly negative; however, the limited sampling in these regions indicates a need for more extensive studies with population counts to confirm and get the distribution pattern in India. The study confirms the occurrence of *H. cajani* in soybean from Assam. It is believed to be the first report in Assam, India.

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References

1. Ali SS, Singh B. Nematodes of pigeon pea and their management. In: Ali M, Kumar SDK, editors. *Advances in Pigeonpea Research*. New Delhi: Agencies Pvt Limited; 2005:284-314.
2. Bhatti DS, Dalal MR, Malhan I. Estimation of loss in wheat yield due to the cereal cyst nematode *Heterodera avenae*. *Tropical Pest Management*. 1981;27(3):375-378.

3. Cobb NA. Estimating the nema population of soil, with special references to the sugarbeet and root-gall nemas, *Heterodera schachtii* Schmidt and *Heterodera radicola* (Greef) Muller, and with a description of *Tylencholaimus aequalis* n. sp. Agricultural Technology Circular. 1918;1:48.
4. Cooper BA. A preliminary key to British *Heterodera* for use in soil examination in Soil Zoology: Proceedings of the University of Nottingham Second Easter School in Agricultural Science, 1955. In: McE Kevan DK, editor. London: Butterworths; 1955:269-580.
5. Dioni W. Safe microscopic techniques for amateurs. Part 1 - mounting microscopic subjects. Part 4 - the glycerin jellies. Micscape 94. 2003.
6. Handoo ZA, Subbotin SA. Taxonomy, Identification and Principal Species. In: Perry RN, Moens M, Jones JT, editors. Cyst Nematodes. UK: CAB International; 2018:365-397.
7. Handoo ZA. A key and compendium to species of the *Heterodera avenae* group (Nematode: Heteroderidae). Journal of Nematology. 2002;34:250-262.
8. Jain RK, Mathur KN, Singh RV. Estimation of losses due to plant parasitic nematodes on different crops in India. Indian Journal of Nematology. 2007;37:219-221.
9. Jones JT, Haegeman A, Danchin EG, Gaur HS, Helder J, Jones MG, *et al.* Top 10 plant-parasitic nematodes in molecular plant pathology. Molecular Plant Pathology. 2013;14(9):946-961.
10. Kaushal KK, Srivastava AN, Pankaj, Chawla G, Singh K. Cyst-forming nematodes in India - a review. Indian Journal of Nematology. 2007;37:1-7.
11. Kaushal KK. Plant Nematology: Cyst and Root knot nematodes. New Delhi, India: Biotech Books; 2013:169-170.
12. Khan AM, Husain SI. *Heterodera mothi* n. sp. (Tylenchida: Heteroderidae) parasitising *Cyperus rotundus* L. at Aligarh, U.P., India. Nematologica. 1965;11:167-172.
13. Koshy PK, Swarup G, Sethi CL. *Heterodera zae* n. sp. (Nematoda: Heteroderidae), a cyst-forming nematode on *Zea mays*. Nematologica. 1970;16:511-516.
14. Koshy PK. A new species of *Heterodera* from India. Indian Phytopathology. 1967;20:272-274.
15. Kumar K, Sutar V, Davies K, Mohan S. Molecular characterization of the pigeon pea cyst nematode, *Heterodera cajani* Koshy, 1967 from India. Journal of Eco-friendly Agriculture. 2022;17:174-176.
16. Kumar V, Khan MR, Walia RK. Crop loss estimations due to plant-parasitic nematodes in major crops in India. National Academy of Science Letters. 2020;43:409-412.
17. Perry RN, Hunt DJ, Subbotin SA. Techniques for work with plant and soil nematodes. Wallingford, UK: CABI; 2021. 290.
18. Perry RN, Moens M, Jones JT. Cyst nematodes. CAB International, UK; 2018. 464.
19. Rao SB, Rath A, Gonthalwal R, Atkinson H, Rao U. A comparison of the variation in Indian populations of pigeonpea cyst nematode, *Heterodera cajani* revealed by morphometric and AFLP analysis. ZooKeys. 2011;135:1-19.
20. Reddy MV, Raju TN, Sharma SB, Nene YL, McDonald D. Handbook of pigeonpea diseases. Information bulletin no. 42. Patancheru, AP, 502324, India: International Crops Research Institute for the Semi-Arid Tropics; 1993. 64.
21. Schindler AR. A simple substitute for a Baermann funnel. Plant Disease Reporter. 1961;45:747-748.
22. Seinhorst JW. A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. Nematologica. 1959;4(1):67-69.
23. Sharma SB. Pearly root of pigeonpeas caused by *Heterodera cajani*. Indian Journal of Nematology. 1991;21(2):169.
24. Sharma SB. The cyst nematodes. Springer Science & Business Media; 1998. 452.
25. Varaprasad KS, Sharma SB, Loknathan TR. Nematode constraints to pigeonpea and chickpea in Vidarbha region of Maharashtra in India. International Journal of Nematology. 1997;7:152-157.
26. Vasudeva RS. Report of the Division of Mycology and Plant Pathology. Scientific Report of the Agricultural Research Institute, New Delhi; 1958.
27. Wen Y, Liu F, Zhen H, Ye WM, Ni C, Xu C, *et al.* A new cyst nematode, *Heterodera luodingensis* n. sp. (Nematoda: Heteroderinae) from rice in China. Plant Disease. 2024;109.
28. Yang Z, Zhang H, Jiang Z, Yan W, Mingrui L. Morphological and molecular characterization of *Heterodera ripae*, a new record cyst nematode in the rhizosphere soil of *Fagopyrum esculentum*. Scientific Reports. 2024;4:9958.

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