Survey and identification of plant parasitic nematodes associated with tea gardens in Dibrugarh district of Assam

ABSTRACT

The present investigation was carried out to determine~~know~~ the occurrence and distribution of plant parasitic nematodes associated with tea plants ~~of~~ in different tea gardens in Dibrugarh district. ~~Soil samples were collected from different tea gardens of seven blocks from Dibrugarh district~~. A survey~~Survey~~ of plant parasitic nematodes revealed that eight genera of plant parasitic nematodes were found to be associated with tea plants in the Dibrugarh ~~of Dibrugarh~~ district. The genera of plant parasitic nematodes recorded were *viz*., *Helicotylenchus, Hoplolaimus, Tylenchorhynchus, Paratylenchus, Meloidogyne Xiphinema*, ~~*Xiphinema*~~ and also nematode~~s~~ genera found under Tylenchus~~Tylenchs~~ and Criconematids. Community analysis of plant parasitic nematodes revealed that the genus *Helicotylenchus* ranked first in relative frequency, absolute frequency, absolute density, relative density, and prominence value. The genus *Hoplolaimus* ranked second in relative frequency, absolute frequency, absolute density, relative density, and prominence value. ~~The genus~~ *Paratylenchus* ranked third in relative frequency, absolute frequency, absolute density, relative density, and prominence value.

INTRODUCTION

Tea (*Camellia sinensis* L.) belongs to the family Theaceae is one of the important plantation crop grown in India and other parts of the world including China, Kenya, Sri Lanka, Turkey & Vietnam. The tea industry is one of the oldest organized industry in India with a large network of tea producers, retailers, distributors, auctioneers, exporters and packers. In India, tea is mainly cultivated in Assam, West Bengal, Kerala, Tamil Nadu and Karnataka. In Assam, tea is mainly cultivated in the valley of the Brahmaputra on the North and of the Barak on the South. Assam alone occupies about 3.37 lakh ha with a production of 691.91 million kg in 2018 (Anon., 2020). Hence, it is considered that tea industry occupies a very prominent place in the economy of Assam in terms of production of quality tea and contributing in generation of highest number of employment generation.

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The tea crop suffers from number of pest and diseases like fungi, bacteria, virus and nematodes. Among various constraints in tea production, plant parasitic nematodes are considered to be one of the important pest which can cause considerable loss in tea production (Srivastava and Singh, 1967 and Whitehead, 1969). The first report of root-knot nematode in young tea was made from South India where large number of tea seedlings were found to be infected by this nematode (Barber, 1901). Among different species of root-knot nematode ,the species like *Meloidogyne incognita, M. javanica, M. hapla* and *M. thamesi* are some of the economically important species causing severe damage to the nursery seedling of lesser than one year old except *M. bravicauda* (Rao, 1970 and Sivapalan, 1972). However, *M. incognita and M. javanica* were found to be most harmful nematode species on nursery tea while *M. bravicauda* on mature tea (Whitehead, 1969). Neog (1997) found that one juvenile of *M. incognita* per gram of soil was pathogenic in tea seedling in Assam. Large scale failure of nursery seedlings raised from both seeds and vegetatively propagated clones due to severe damage caused by root-knot nematode also reported by many workers (Banerjee, 1967; Basu, 1967, 1968; Basu and Roy, 1976, 1979) from the north-eastern region of India showed that generally both young tea and mature tea are highly susceptible to *M. javanica* and *Pratylenchus coffeae* (Visser and Vythilingam, 1959).

Very little work has so far been done on tea. Therefore, a detailed study on this nematode is felt highly essential for better understanding of problem so that efforts can be made for management of the pest more efficiently. Therefore, the present studies have been carried out with the survey and identification of plant parasitic nematodes associated with tea gardens in Dibrugarh district of Assam

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MATERIALS AND METHODS

A ~~Roving~~ roving survey was carried out during 2014-2016. Soil and plant samples were collected from seven ~~Blocks~~ blocks of Dibrugarh district, *viz*., Barbaruah, Lahowal, Panitola, Khowang, Tengakhat, Tingkhong, and Jaipur, to have a clear picture ~~about~~ of the occurrence and distribution of plant parasitic nematodes in tea plants. A total of 162 samples were collected from the rhizosphere of tea plants from different blocks of the Dibrugarh district of Assam. Each bulk sample was constituted of several sub-samples. Samples were collected randomly, and all relevant information~~s~~ was~~were~~ recorded at the time of collection of samples. The samples were transferred to the laboratory and stored in the refrigerator at 4°C till the extraction of nematodes was made. Extraction of nematodes from soil samples was~~were~~ done by modifyin~~modified~~ Cobb's sieving and decanting technique (Christie and Perry, 1951). Killing and fixing of nematodes were done in 8 per cent hot formalin.

Community analysis of plant parasitic nematode

Community analysis of plant parasitic nematode was done by using the methods given by Norton (1978).

Absolute frequency is expressed as a percentage

$$\text{Absolute frequency} = \frac{\text{Number of samples containing a species}}{\text{Number of samples collected}} \times 100$$

Relative frequency is calculated as

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Sum of frequency of all species}} \times 100$$

Relative density is expressed in percentage and was calculated as

$$\text{Relative density} = \frac{\text{Number of individuals of a species in a sample}}{\text{Total of all individuals in a sample}} \times 100$$

Absolute density is calculated as

$$\text{Absolute density} = \frac{\text{Total number of individual of a species}}{\text{Total number of samples collected}} \times 100$$

Prominence value (P.V) of Beals (1960) was calculated as

$$PV = \text{density} \times \sqrt{\text{frequency}}$$

RESULTS AND DISCUSSION

Survey and identification of plant parasitic nematodes associated with tea

Eight ~~of~~ plant parasitic nematode species recorded from the seven blocks of the Dibrugarh district were *Helicotylenchus* sp., *Hoplolaimus* sp., *Tylenchorhynchus* sp., *Paratylenchus* sp., *Meloidogyne* sp., *Xiphinema* sp., Criconematids, and Tylenchs.

The nematodes found to be associated with 14 corporate sector gardens are *viz*., *Helicotylenchus* sp., *Hoplolaimus* sp., *Tylenchorhynchus* sp., *Paratylenchus* sp., *Xiphinema* sp., Criconematids, and Tylenchs.

The maximum population of spiral nematode, *Helicotylenchus* sp. (44.28), was recorded from the Tengakhat block, whereas the~~whereas,~~ minimum population (15) was recorded from the Lahowal block. Similarly, the lance nematode, *Hoplolaimus* sp. with a maximum population of 21.66 was recorded from the Lahowal block, and the minimum population (4) was recorded from the Jaipur block. Further, the nematode *Paratylenchus* sp., with a maximum population of ~~(~~22~~)~~ was recorded from the Tingkhong block. The maximum population of *Tylenchorhynchus* sp. (24), was recorded from the Khowang block. The nematode, *Xiphinema* sp., was found with a population of 18 only from block Jaipur.

The highest frequency of occurrence (100%) for *Helicotylenchus* sp. was~~were~~ recorded from two gardens of Barbaruah, Jaipur, Panitola, Tengakhat, and Khowang blocks, and ~~from~~ one garden of Tingkhong, and Lahowal block and the lowest frequency of occurrence (66.66%) was~~were~~ recorded from one garden of the Lahowal block. The lance nematode, *Hoplolaimus* sp., with a frequency of occurrence of 100%, was~~(100%) were~~ recorded from one garden~~-~~ of Barbaruah, Jaipur, Lahowal, Panitola, Tingkhong, and Khowang block, and the lowest frequency of occurrence (40%) was recorded from one garden of Jaipur ~~-~~block. The nematode *Paratylenchus* sp., with a frequency of occurrence of 100%, was~~(100%) were~~ recorded from two gardens in~~ of~~ Barbaruah, one garden in~~of~~ Jaipur, Panitola, Tingkhong, and Khowang block, whereas~~,~~ the lowest frequency of occurrence (40%) was recorded from Panitola block. Further, the nematode *Tylenchorhynchus* sp., with the highest frequency of occurrence (100%), was~~were~~ recorded from two gardens of Barbaruah, one garden of Panitola, and Khowang block, whereas~~,~~ the lowest frequency of occurrence (50%) was recorded from Lahowal block. Similarly, ~~The~~ the

nematode, *Xiphinema* sp., with a frequency of occurrence (80%), was recorded highest from the Jaipur block. The h~~H~~ighest frequency of occurrence (20%) for Criconematids was recorded from the Barbaruah block. The nematodes found under Tylenchus were ~~Tylenchs was~~ recorded only from block Tingkhong with a frequency of occurrence of 40% (Table 1).

The nematodes found to be associated with 14 ~~-~~small tea grower gardens are *viz*., *Helicotylenchus* sp., *Hoplolaimus* sp., *Tylenchorhynchus* sp., *Paratylenchus* sp., *Xiphinema* sp., *Meloidogyne* sp., and Criconematids.

The maximum population of spiral nematode, *Helicotylenchus* sp. (36), was recorded from the Barbaruah block, whereas the~~,~~ minimum population (13.75) was recorded from the Tingkhong block. Similarly, the lance nematode, *Hoplolaimus* sp., with a maximum population of 18.33, was recorded from the Jaipur block and the minimum population (6.66) was recorded from the Tengakhat block. Further, the nematode *Paratylenchus* sp., with a maximum population of ~~(~~22,~~)~~ was recorded from the Barbaruah block. The maximum population of *Tylenchorhynchus* sp. (21) was recorded from the Jaipur block. The nematode, *Xiphinema* sp., was found with a population of ~~(~~11.66~~)~~ from the Tingkhong block.

The highest frequency of occurrence (100%) for *Helicotylenchus* sp. was~~were~~ recorded from two gardens of Barbaruah, Jaipur, Lahowal, Panitola, Tengakhat, Tingkhong, and Khowang block. The lance nematode, *Hoplolaimus* sp., with a frequency of occurrence of~~(~~100%,~~)~~ was~~were~~ recorded from two gardens in~~of~~ Khowang, Lahowal, Barbaruah, and Jaipur, and ~~from~~ one garden in ~~of~~ Panitola, and Tingkhong and the lowest frequency of occurrence (50%) was recorded from one garden in the ~~of~~ Tengakhat block. The nematode *Paratylenchus* sp., with a frequency of occurrence of 100%, was ~~(100%) were~~ recorded from two gardens of Lahowal, one garden of Barbaruah, Jaipur, Panitola, Tengakhat, Tingkhong, and Khowang block, whereas the ~~,~~ lowest frequency of occurrence (50%) was recorded from Jaipur block. Further, the nematode *Tylenchorhynchus* sp., with the highest frequency of occurrence (100%), was~~were~~ recorded from two gardens in~~of~~ Jaipur, one garden in~~of~~ Panitola, and Khowang, block whereas~~,~~ the lowest frequency of occurrence (66.66%) was recorded from Khowang block. Similarly, the nematode, *Xiphinema* sp., with a frequency of occurrence (83.33%), was recorded highest from the Tingkhong block. The highest frequency of occurrence (50%) for Criconematids was recorded from the Panitola block. The root-knot nematode, *Meloidogyne* sp., was recorded highest from blocks Tingkhong and Tengakhat with a frequency of occurrence of 50% (Table 2).

Of the eight genera of plant parasitic nematodes recorded from the Dibrugarh district from the rhizosphere of tea plants, the maximum population of *Helicotylenchus* sp. (152.50) was recorded from Barbaruah block, and the minimum population (95.83) was recorded from Lahowal block. In the Lahowal block, the maximum population recorded for *Hoplolaimus* sp. was ~~(~~90.00,~~)~~ and the minimum population (55.00) was recorded from the Khowang block. The ~~M~~maximum population of *Paratylenchus* sp. (75.00) was recorded from the Barbaruah block, and the minimum population (45.00) was recorded from the Lahowal block. Similarly, the maximum

population of *Tylenchorhynchus* sp. (80.00) was recorded from the Khowang block, and a minimum population (32.00) was recorded from the Tingkhong block. In the Tengakhat block the population of *Meloidogyne* sp., was recorded to be a maximum (3.00) and the minimum population (2.00) was recorded from the Tingkhong block. Maximum population of *Xiphinema* sp. (40.00) was recorded from the Tingkhong block, and minimum population (32.50) was recorded from the Jaipur block. Criconematids with the ~~a~~ highest population (20.00) were~~was~~ recorded from the Barbaruah block and minimum population (1.20) were~~was~~ recorded from the Tengakhat block. The nematode under Tylenchus with a population of (5.00) was recorded only from ~~–~~the Tingkhong block. The spiral nematode, *Helicotylenchus* sp., was found to be present in all the samples, with the highest frequency of occurrence, 100 per~~–~~cent in soil~~ was~~ recorded from Barbaruah, Jaipur, Khowang, Tengakhat, and Panitola. The ~~Highest~~ highest frequency of occurrence for *Hoplolaimus* sp. was recorded from the Lahowal block (91.66%), and the lowest frequency of occurrence (66.66%) was recorded from the Tengakhat block. The highest~~Highest~~ frequency of occurrence for *Paratylenchus* sp. (90%) was recorded from the Barbaruah block, and the lowest frequency of occurrence (56%) was recorded from the Tingkhong block. The highest ~~Highest~~ frequency of occurrence (82.60%) for stunt nematode, *Tylenchorhynchus*~~–~~ sp., was recorded from the Khowang block, whereas the~~,~~ lowest frequency of occurrence (28%) was recorded from the Tingkhong block. The highest~~Highest~~ frequency of occurrence (16.66%) for root-knot nematode, *Meloidogyne* sp., was recorded from the Tengakhat block, and the lowest frequency (8.69%) was recorded from the Khowang block. In Jaipur block, the highest frequency of occurrence of *Xiphinema* sp. was recorded to be 40.90%, which was found to be highest among all the blocks ~~where as~~whereas the lowest frequency of occurrence (40%) was recorded from the Tingkhong block. The highest~~Highest~~ frequency of occurrence (12.50%) for criconematids was recorded from the Lahowal block whereas, lowest frequency of occurrence (4.10%) was recorded from the Tengakhat block. The nematodes under ~~tylenchs~~ Tylenchus were recorded only from the Tingkhong block with a frequency of occurrence of 8% (Table 3).

Among the nematodes from the seven blocks, *Helicotylenchus* sp., *Hoplolaimus* sp., and *Paratylenchus* sp. were found to be associated with all the blocks, *viz*., Barbaruah, Lahowal, Panitola, Khowang, Tengakhat, Tingkhong, and Jaipur.~~,~~ *Tylenchorhynchus* sp. was found to be associated with all the blocks except Tengakhat,~~,~~ *Meloidogyne* sp. was found to be associated with blocks Khowang, Tengakhat and Tingkhong.~~,~~ *Xiphinema* sp. was found to be associated with blocks Jaipur, and Tingkhong. Criconematids were~~was~~ found to be associated with all the blocks except Jaipur and Khowang. Tylenchus was found only in block Tingkhong.

Among the eight genera of nematodes from the seven blocks, the spiral nematode, *Helicotylenchus* sp., was recorded from all the 28 tea gardens, the lance nematode, *Hoplolaimus* sp. was recorded from 27 gardens, the pin nematode, *Paratylenchus* sp. was recorded from 23 gardens, the stunt nematode, *Tylenchorhynchus* sp., was recorded from 16 gardens, Criconematids was recorded from 7 gardens, *Xiphinema* sp. was recorded from 4 gardens, the nematodes under Tylenchus were recorded from one garden, and the root-knot nematode *Meloidogyne* sp., was recorded from 4 gardens.

A total of eight genera of plant parasitic nematodes *viz.*, *Helicotylenchus, Tylenchorhynchus, Paratylenchus, Hoplolaimus, Xiphinema, Meloidogyne*, criconematids, and tylenchus were recorded from the rhizosphere of tea plants of Dibrugarh district (Table 4).

Basu and Banerjee (1967) recorded the species of *Hoplolaimus, Rotylenchus, Helicotylenchus, Tylenchorhynchus, Tylenchus, Paratylenchus,* and *Aphelenchoides* from the soil collected around the rhizosphere of tea plants from tea nurseries in Jorhat. Some of the important species, like *Scutellonema brachyurum, Pratylenchus brachyurus, Paratylenchus curvitalus, Aphelenchoides compositicola, Tylenchus agricola, Meloidodera fleridensis, Tylenchorhynchus mashhoodi, Hoplolaimus columbus,* and *Aphelenchus agricola* associated with tea crops, were reported from Tocklai Experimental Station, Jorhat (Anon., 1968). Singh (1989) recorded *Tylenchorhynchus, Helicotylenchus, Hoplolaimus* and *Paratylenchus* from soil and roots of plantation crops, namely tea, coffee, betel vine, black pepper, coconut, and arecanut from the Jorhat district. Further, the nematodes *Helicotylenchus, Hoplolaimus, Tylenchorhynchus, Meloidogyne, Xiphinema* have already been reported from Assam in different crops (Phukan and Sanwal, 1980; Choudhury, 1985; Das, 1993). Campos *et al.* (1990) also reported several species of plant parasitic nematodes associated with tea plantations in different countries of the world.

3.1 Community analysis of plant parasitic nematodes associated with tea in Dibrugarh district

In the present investigation, out of eight genera recorded from Dibrugarh district from the rhizosphere of tea plants, *Helicotylenchus* sp. is the most frequently occurring ~~occurred~~ species with an absolute density of ~~(~~24.44%~~)~~, a relative density (43.08%), an absolute frequency of ~~(~~98.14%~~)~~, a relative frequency of ~~(~~30.50%~~)~~ and aprominence value of 241.95. In earlier studies also, *H. dihystera* was reported with a high frequency of occurrence from Assam. Choudhury *et al*. (2004) reported~~,~~ *Helicotylenchus* sp. with a high prominence value from Assam. The lance nematode, *Hoplolaimus* sp., ranked second in absolute density (12.09%), relative density (21.31%), absolute frequency (81.48%), relative frequency (25.32%), and prominence value of 109.05. The pin nematode, *Paratylenchus* sp., ranked third in absolute density (10.49%), relative

density (18.49%), absolute frequency of (66.04%), relative frequency (20.52%), and prominence value of 85.17. The stunt nematode, *Tylenchorhynchus* sp. ranked fourth in absolute density (7.25%), relative density (12.77%), absolute frequency ~~of~~ (50.61%), relative frequency (15.73%) and prominence value ~~of~~ 51.54. The nematode, *Xiphinema* sp., ranked fifth in absolute density (1.79%), relative density (3.15%), absolute frequency ~~of~~ (11.25%), relative frequency (3.49%), and prominence value (5.99). The root-knot nematode, *Meloidogyne* sp., ranked seventh in absolute density (0.20%), relative density (0.35%), absolute frequency ~~of~~ (4.93%), relative frequency (1.53%), and prominence value (0.44). The nematode, criconematids, ranked sixth in absolute density (0.35%), relative density (0.61%), absolute frequency ~~of~~ (8.02%), relative frequency (2.49%), and prominence value (0.99). The nematodes under tylenchus ranked ~~eight~~ eighth in absolute density (0.12%), relative density (0.21%), absolute frequency ~~of~~ (1.23%), relative frequency (0.38%), and prominence value ~~of~~ (0.13).

Das and Rahman (1996) and Murad *et al.* (2020) presented a comprehensive account of the community structure of twenty plant parasitic nematodes in and around the field and horticultural crops. Out of twenty species of plant parasitic nematodes, *Helicotylenchus dihystera*, *Tylenchorhynchus annulatus*, *Hirschmanniella oryzae*, and *Meloidogyne incognita* were the most predominant species. Out of these, *H. dihystera* ranked first in relative frequency, absolute density, relative density, and prominence value. Nandwana *et al.* (2005) also reported *Helicotylenchus* with the highest prominence value from Rajasthan in the sugarcane ecosystem. Absolute density and prominence value are the most important parameters for estimating the dominance of a particular species. Patel *et al.* (2007) reported the frequency of a few plant parasitic nematodes, *viz.*, *Rotylenchulus reniformis*, *Helicotylenchus* sp., *Tylenchorhynchus* sp., *Meloidogyne* sp., and *Pratylenchus* sp., in certain medicinal plants from Gujarat, and they recorded the highest frequency of occurrence of *Helicotylenchus* sp. (40.9%) followed by *Tylenchorhynchus* sp. (36.3%).

CONCLUSION

The plant parasitic nematode genera recorded were *viz.*, *Helicotylenchus* sp., *Hoplolaimus* sp., *Tylenchorhynchus* sp., *Paratylenchus* sp., *Meloidogyne* sp., *Xiphinema* sp., and a few genera under criconematids, and tylenchs. *Helicotylenchus* was recorded from all ~~the~~ 28 tea gardens with 100 per cent frequency of occurrence.

Helicotylenchus ranked first in relative frequency, absolute frequency, absolute density, relative density, and prominence value. The genus *Hoplolaimus* ranked second in relative frequency, absolute frequency, absolute density, relative density, and prominence value. ~~The genus~~

Paratylenchus ranked third in relative frequency, absolute frequency, absolute density, relative density, and prominence value.

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Table 1. Plant parasitic nematodes associated with tea in different corporate sector tea gardens in Dibrugarh district

Sl. No	Block	Total no of sample collected	Type of tea gardens	Nematode	Population range in 250 cc soil	Frequency (%)	Average population
1	Barbaruah	5	Corporate sector(a)	*Helicotylenchus* sp.	20-40	100	28
				Hoplolaimus sp.	10-20	100	16
				Paratylenchus sp.	10-20	100	14
				Tylenchorhynchus sp.	10-20	100	16
		5	Corporate sector (b)	*Helicotylenchus* sp.	20-30	100	26
				criconematids	0-5	20	1
				Hoplolaimus sp.	0-10	60	6
				Paratylenchus sp.	10-30	100	18
				Tylenchorhynchus sp.	10-20	100	16
2	Jaipur	5	Corporate sector(a)	*Helicotylenchus* sp.	30-40	100	34
				Hoplolaimus sp.	10-20	100	14
				Xiphinema sp.	10-30	80	16
		5	Corporate sector(b)	*Helicotylenchus* sp.	10-30	100	18
				Hoplolaimus sp.	0-10	40	4
				Paratylenchus sp.	10-30	100	18
3	Lahowal	6	Corporate sector (a)	*Helicotylenchus* sp.	10-30	66.66	15
				Hoplolaimus sp.	10-20	83.33	13.33
				Tylenchorhynchus sp.	0-10	50	5
		6	Corporate sector (b)	*Helicotylenchus* sp.	20-30	100	21.66
				Hoplolaimus sp.	20-30	100	21.66
				Paratylenchus sp.	0-10	50	5
4	Panitola	7	Corporate sector(a)	*Helicotylenchus* sp.	20-30	100	22.85
				Hoplolaimus sp.	0-10	71.42	7.14
				Paratylenchus sp.	10-20	100	12.85
				Tylenchorhynchus sp.	0-10	71.42	7.14
		5	Corporate	*Helicotylenchus* sp.	20-30	100	18

			sector(b)	*Hoplolaimus* sp.	10-20	100	16
				Paratylenchus sp.	0-10	40	4
				Tylenchorhynchus sp.	10-20	100	14
5	Tengakhat	7	Corporate sector (a)	*Helicotylenchus* sp.	30-70	100	44.28
				Hoplolaimus sp.	20-30	71.42	15.71
		6	Corporate sector(b)	*Helicotylenchus* sp.	20-50	100	30
				Hoplolaimus sp.	10-20	50	8.33
				Paratylenchus sp.	10-30	83.33	15
6	Tingkhong	6	Corporate sector (a)	*Helicotylenchus* sp.	20-40	83.33	21.66
				Hoplolaimus sp.	10-20	66.66	10
				Paratylenchus sp.	0-10	50	5
		5	Corporate sector (b)	*Helicotylenchus* sp.	10-40	100	22
				Hoplolaimus sp.	10-20	100	14
				Paratylenchus sp.	10-30	100	22
				tylenchs	0-10	40	4
7	Khowang	7	Corporate sector(a)	*Helicotylenchus* sp.	20-40	100	24.28
				Paratylenchus sp.	10-20	85.71	11.42
				Tylenchorhynchus sp.	10-30	71.42	11.42
		5	Corporate sector(b)	*Helicotylenchus* sp.	20-30	100	26
				Hoplolaimus sp.	10-20	100	14
				Paratylenchus sp.	10-20	100	14
				Tylenchorhynchus sp.	20-30	100	24

Table 2. Plant parasitic nematodes associated with the gardens of small tea grower's in Dibrugarh district

Sl. No	Block	Total no of sample collected	Type of tea gardens	Nematode	Population range in 250 cc soil	Frequency (%)	Average population
1	Barbaruah	5	Small tea growers (STG) (a)	*Helicotylenchus* sp.	30-40	100	36
				criconematids	10	40	2
				Hoplolaimus sp.	10-20	100	16
				Paratylenchus sp.	10-30	100	22
				Tylenchorhynchus sp.	0-10	80	8
		5	STG(b)	*Helicotylenchus* sp.	20-40	100	32
				Hoplolaimus sp.	10-20	100	14
				Paratylenchus sp.	0-10	60	6
2	Jaipur	6	STG(a)	*Helicotylenchus* sp.	20-30	100	21.66
				Hoplolaimus sp.	10-20	100	13.33
				Paratylenchus sp.	10-30	100	15
				Tylenchorhynchus sp.	10-20	100	21
		6	STG(b)	*Helicotylenchus* sp.	10-40	100	21.66
				Hoplolaimus sp.	10-30	100	18.33
				Paratylenchus sp.	0-20	50	10
				Tylenchorhynchus sp.	10-30	100	15
				Xiphinema sp.	10-20	66.66	8.33
3	Lahowal	5	STG(a)	*Helicotylenchus* sp.	20-40	100	34
				criconematids	4	20	0.8
				Hoplolaimus sp.	10-20	100	16
				Paratylenchus sp.	10-20	100	16
				Tylenchorhynchus sp.	0-10	80	8
		6	STG(b)	*Helicotylenchus* sp.	10-30	100	16.66
				criconematids	12	33.33	2
				Hoplolaimus sp.	10-20	100	11.66
				Paratylenchus sp.	10-20	100	11.66
				Tylenchorhynchus sp.	10-20	100	13.33

Sl. No	Block	Total no of sample collected	Type of tea gardens	Nematode	Population range in 250 cc soil	Frequency (%)	Average population
4	Panitola	6	STG(a)	*Helicotylenchus* sp.	20-40	100	23.33
				criconematids	0-12	50	2
				Hoplolaimus sp.	10-20	100	11.66
				Paratylenchus sp.	10-20	100	13.33
		7	STG(b)	*Helicotylenchus* sp.	30-40	100	31.42
				Hoplolaimus sp.	0-10	85.71	8.57
				Paratylenchus sp.	10-20	71.42	11.42
				Tylenchorhynchus sp.	10-20	100	12.85
5	Tengakhat	5	STG(a)	*Helicotylenchus* sp.	20-40	100	26
				criconematids	0-2	20	0.4
				Hoplolaimus sp.	10-20	60	10
				Meloidogyne sp.	0-4	20	0.8
				Paratylenchus sp.	10-20	80	12
		6	STG(b)	*Helicotylenchus* sp.	20-50	100	25
				Hoplolaimus sp.	10-20	50	6.66
				Meloidogyne sp.	8	50	1.33
				Paratylenchus sp.	10-30	100	16.66
6	Tingkhong	6	STG(a)	*Helicotylenchus* sp.	20-30	100	21.66
				Hoplolaimus sp.	10-20	100	13.33
				Paratylenchus sp.	10-20	100	15
				Xiphinema sp.	10-20	83.33	11.66
				Meloidogyne sp.	12	50	2
		8	STG(b)	*Helicotylenchus* sp.	10-30	100	13.75
				criconematids	9	37.5	1.62
				Hoplolaimus sp.	10-30	75	15
				Xiphinema sp.	10-20	62.5	11.25
				Tylenchorhynchus sp.	10-20	87.5	10
7	Khowang	5	STG(a)	*Helicotylenchus* sp.	10-20	100	16
				Hoplolaimus sp.	10-20	100	16
				Paratylenchus sp.	10-20	100	16
				Tylenchorhynchus sp.	10-20	100	14
		6	STG(b)	*Helicotylenchus* sp.	10-30	100	16.66
				Hoplolaimus sp.	10-20	100	11.66
				Tylenchorhynchus sp.	0-10	66.66	8.33
				Meloidogyne sp.	9	33.33	1.5

Table 3. Average Population (per 200 ml of soil) and Frequency of plant parasitic nematodes associated with different tea gardens in Dibrugarh district

Block	Total no. of samples	*Helicotylenchus* sp.	*Hoplolaimus* sp.	*Paratylenchus* sp.	*Tylenchorhynchus* sp.	*Meloidogyne* sp.	*Xiphinema* sp.	criconematids	tylenchs
Barbaruah	20	152.50 (100)	65 (90)	75 (90)	50 (70)	-		20 (10)	-
Jaipur	22	130 (100)	70 (85)	60 (63.63)	40 (54.54)	-	32.50 (40.90)	-	-
Khowang	23	120 (100)	55 (69.56)	57.50 (69.56)	80 (82.60)	2.25 (8.69)		-	-
Lahowal	23	122.50 (95.83)	90 (91.66)	45 (58.33)	37.50 (54.16)	-		4 (12.5)	-
Tengakhat	24	192.50 (100)	62.50 (66.66)	62.50 (62.5)	-	3 (16.66)		1.20 (4.10)	-
Panitola	25	140 (100)	62.5 (88)	65 (80)	52.50 (68)	-		3 (12)	-
Tingkhong	25	120 (96)	82.50 (84)	57.50 (56)	32 (28)	2 (12)	40 (40)	3.25 (12)	5 (8)

Figure in the parentheses are frequency of occurrence

Table 4. Community analysis of different plant parasitic nematodes associated with tea in Dibrugarh district

Nematodes species	Absolute density	Relative density (%)	Absolute frequency (%)	Relative frequency (%)	Prominence value
Helicotylenchus sp.	24.44	43.08	98.14	30.50	241.95
Hoplolaimus sp.	12.09	21.31	81.48	25.32	109.05
Paratylenchus sp.	10.49	18.49	66.04	20.52	85.17
Tylenchorhynchus sp.	7.25	12.77	50.61	15.73	51.54
Xiphinema sp.	1.79	3.15	11.25	3.49	5.99
Meloidogyne sp.	0.20	0.35	4.93	1.53	0.44
criconematids	0.35	0.61	8.02	2.49	0.99
tylenchs	0.12	0.21	1.23	0.38	0.13
Total	56.73		321.70		