



E-ISSN: 2320-7078  
P-ISSN: 2349-6800  
[www.entomoljournal.com](http://www.entomoljournal.com)  
JEZS 2020; 8(2): 1448-1453  
© 2020 JEZS  
Received: 17-03-2020  
Accepted: 19-04-2020

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## Population assessment and community analysis of plant parasitic nematodes associated with beetroot (*Beta vulgaris* L.) in different districts of Tamil Nadu

**R Brithevnan, K Poornima, N Swarnakumari and V Jegadeeswari**

### Abstract

This study was done to explore the existence of plant parasitic nematodes associated with beetroot growing areas of Tamil Nadu. A random survey was carried out in seven districts of Tamil Nadu viz., Coimbatore, Nilgiris, Erode, Dindigul, Krishnagiri, Theni, and Tirupur. Soil samples were collected at the depth of 10 - 15 cm and processed the samples. Community analysis plays a vital role in assessing the population of plant parasitic nematodes in a region and helps in identifying the major areas of nematode attack. In this survey six plant parasitic nematode species are observed *Meloidogyne incognita*, *Pratylenchus penetrans*, *Helicotylenchus dihystrera*, *Hoplolaimus indicus*, *Longidorus elongates*, *Tylenchorhynchus claytoni*. In this six plant parasitic nematodes *Meloidogyne incognita* had a highest number of populations and prominence value observed in Sathyamangalam block of Erode district, while the lowest populations observed in Palladam block of Tirupur district.

**Keywords:** Beetroot, survey, community analysis, plant parasitic nematodes, *Meloidogyne incognita*

### 1. Introduction

The beetroot (*Beta vulgaris* L.) is belonging to the family, Chenopodiaceae which includes silver beet, sugar beet and fodder beet. Beetroot is also known as 'garden beet' or 'table beet'. They are believed to have originated from Germany [1]. The beetroot is the second most important source of sugar (21.5% of the world sugar) and is grown in 57 countries [3]. Beetroot grown in hardy to low temperature and prefers cool climate for production and high yield. Deep well drained loam or sandy loams is the suitable for beetroot cultivation. In India beetroot is mainly cultivated in Haryana, Uttar Pradesh, Himachal Pradesh, West Bengal and Maharashtra. The area under beetroot cultivation in Tamil Nadu during the year 2012-2013 is 1,308 hectares with a production of 39, 383 tons [5] and average productivity is about 24-25t/ha. In Tamil Nadu beetroot growing major districts are Coimbatore, Nilgiris, Erode, Dindigul, Krishnagiri, Theni and Tiruppur. However, no work has yet been reported on the community structure of the phytonematodes associated with beetroot of Tamil Nadu. The objective of this study was to quantify and document of relative occurrence, distribution, density and prevalence of different nematode populations associated with beetroot cultivated in different districts of Tamil Nadu. A first reported of root knot nematode, *Meloidogyne* spp. Incidence in mango (*Mangifera indica*) and citrus (*Citrus aurantifolia*) in Tamil Nadu [9]. Incidence for guava root knot nematode, *Meloidogyne enterolobii* was found positive major guava growing districts of Tamil Nadu in India [2]. In Western Uttar Pradesh 12% of yield loss in beetroot due to plant parasitic nematodes [10]. Hence, this study shows on the community structure of the phytonematodes associated with beetroot in Tamil Nadu and it may be considered to the first documentation of Tamil Nadu, India.

### 2. Materials and Methods

#### 2.1. Collection of Soil Samples

During the month of August 2019 to March 2020 a random Survey was carried out to take the root and soil samples from crop fields of 7 districts of Tamil Nadu (Plate 1). 152 soil samples were collected from Kinathukadavu, Thondamuthur, Pollachi, Sultanpet, Sulur, Udhamandalam, Coonoor, Kothagiri, Koodalur, Sathyamangalam, Thalavadi, Kodaikanal, Odanchathram, Palani, Hosur, Thally, Chinnamanur, Cumpum, Udumalpet, Palladam blocks

randomly collected in a zigzag pattern to a depth of 10 -15 cm at the rate of 3 composite samples across each field. The soil samples were collected in polythene covers labelled properly and roots were separated from soil and carefully washed under tap water to remove adhering soil particles. Collected samples were stored under refrigerator (21 °C) for further studies.

## 2.2. Nematode Extraction

Nematodes were extracted from 200cc soil by using Cobb's sieving and decanting method [4] followed by modified Baermann's funnel technique [12]. Isolated nematodes were heat killed and fixed at 60-65 °C in 4% formalin and stored in viols. Prior to counting, viols were agitated thoroughly and take 3 ml suspension and add into a counting dish. Nematodes were counted using a stereo binocular microscope. After counting selected plant parasitic nematodes were transferred to Seinhorst' solutions and processed for dehydration by Seinhorst's rapid glycerin method and mounted on glass slides in anhydrous glycerin [13]. Mounted plant parasitic nematodes were identified under the basis of morphological characterization.

## 2.3. Community Analysis of Plant Parasitic Nematodes

The population densities of different nematode species in the samples were calculated using the formulae [8].

$$\text{Absolute frequency} = \frac{\text{Number of samples containing nematodes}}{\text{Total number of samples collected}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Absolute frequency of individual species}}{\text{Sum of frequencies of all species}} \times 100$$

$$\text{Absolute density} = \frac{\text{Number of individual nematodes in the samples}}{\text{Volume (or) unit of samples}} \times 100$$

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

$$\text{Prominence value} = \frac{\text{Absolute density} \times \sqrt{\text{Absolute frequency}}}{100}$$

## 3. Results

### 3.1. Nematode Distribution

Data presented in Table 1, indicated that a total of six species of plant parasitic nematodes viz., *Meloidogyne incognita* (Plate 2), *Pratylenchus penetrans*, *Helicotylenchus dihystra* (Plate 3a), *Hoplolaimus indicus*, *Longidorus elongates* and *Tylenchorhynchus claytoni* (Plate 3b) were found to be associated with beetroot soil samples collected from seven districts of Tamil Nadu. The result from this survey concluded that the incidence and population of *M. incognita*, highest in Erode district of Sathyamangalam (213.70), while the lowest population observed in Tirupur district of Palladam (77.30). The highest incidence of associated plant parasitic nematodes were *H. dihystra* in kotagiri (82.90), *P. penetrans* in Thalavadi (63.90), *H. indicus* in sultanpet (39.50), *T. claytoni* in Koodalur (26.3) and *L. elongates* in Thondamuthur (22.50) while, the lowest incidence observed were *H. dihystra* in Udhagamandalam (16.5), *P. penetrans* in Udhagamandalam (23.2), *H. indicus* in Thalavadi (4.1), *L. elongates* in Chinnamanur (4.0) and *T. claytoni* in Coonoor (3.4).



Field Survey



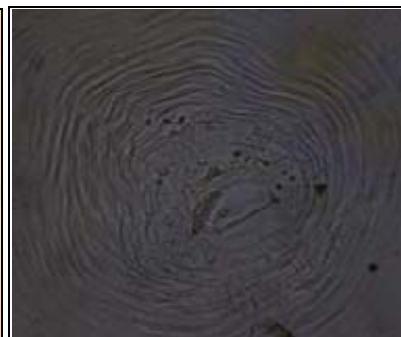
RKN infested beetroot



Plate 1: Survey of plant parasitic nematodes



Female



PCP



Male

Plate 2: Nematode identification - *Meloidogyne incognita*



**a. Helicotylenchus dihystrera**

**b. Tylenchorhynchus claytoni**

**c. Male T. claytoni**

**Plate 3: Nematode identification**

**Table 1: Distribution of plant parasitic nematodes associated with beetroot in different districts of Tamil Nadu.**

Blocks	Nematode populations in 200cc soil					
	<i>M. i</i>	<i>P. p</i>	<i>H. d</i>	<i>H. i</i>	<i>L. e</i>	<i>T. c</i>
<b>Coimbatore District</b>						
Kinathukadavu	156.30	30.20	40.70	28.90	12.60	20.40
Pollachi	123.50	46.30	52.30	25.60	5.60	-
Thondamuthur	208.40	60.70	32.40	18.20	22.50	10.10
Sultanpet	88.60	48.40	67.60	39.50	10.80	26.30
Sulur	93.50	39.90	68.70	14.60	12.10	8.30
<b>Nilgiris District</b>						
Coonoor	163.40	43.20	59.40	10.30	-	3.40
Koodalur	105.80	28.50	55.40	21.90	20.20	20.80
Kotagiri	128.90	34.70	82.90	29.20	7.20	-
Udhagamandalam	189.70	23.20	16.50	19.30	-	6.40
<b>Erode District</b>						
Sathyamangalam	213.70	93.20	48.10	5.30	9.20	-
Thalavadi	163.10	63.90	41.30	4.10	7.80	-
<b>Dindigul district</b>						
Kodaikanal	136.60	32.0	50.60	28.40	16.40	7.0
Odanchathram	120.30	45.10	37.50	32.10	10.30	11.10
Palani	87.90	23.90	39.60	24.90	-	10.40
<b>Krishnagiri district</b>						
Hosur	150.40	56.50	68.70	17.30	21.80	12.60
Thally	147.50	61.30	75.60	34.30	14.60	9.40
<b>Theni District</b>						
Chinnamanur	79.60	41.70	26.50	-	4.0	10.60
Cumpum	91.40	39.60	47.70	13.20	15.30	-
<b>Tirupur District</b>						
Palladam	77.30	41.40	67.10	-	8.70	-
Udumalpet	89.20	46.30	74.80	16.30	-	7.30

**Table 2: Community analysis of nematodes associated with beetroot in different districts of Tamil Nadu**

Blocks	Absolute Frequency (%)						Relative Frequency (%)					
	<i>M. i</i>	<i>P. p</i>	<i>H. d</i>	<i>H. i</i>	<i>L. e</i>	<i>T. c</i>	<i>M. i</i>	<i>P. p</i>	<i>H. d</i>	<i>H. i</i>	<i>L. e</i>	<i>T. c</i>
<b>Coimbatore District</b>												
Kinathukadavu	66.66	44.44	88.88	44.44	22.22	33.33	22.24	14.82	29.65	14.82	7.41	11.11
Pollachi	71.42	57.14	85.71	42.85	28.57	-	24.99	20.00	30.00	14.99	10.00	-
Thondamuthur	88.23	58.82	76.47	47.05	29.41	23.52	27.27	18.18	23.63	14.54	9.09	7.27
Sultanpet	57.14	42.85	71.42	42.85	14.28	28.57	22.22	16.66	27.77	16.66	5.55	11.11
Sulur	63.63	36.36	45.45	54.54	27.27	9.09	26.92	15.38	19.23	23.07	11.53	3.84
<b>Nilgiris District</b>												
Coonoor	87.50	50.00	61.54	37.50	-	25.00	33.46	19.12	23.53	14.34	-	9.56
Koodalur	92.31	53.85	61.54	38.46	30.77	23.08	30.77	17.95	20.51	12.82	10.26	7.69
Kotagiri	72.72	54.54	45.45	18.18	9.09	-	36.36	27.27	22.72	9.09	4.54	-
Udhagamandalam	81.25	68.75	56.25	43.75	-	18.75	30.23	25.58	20.93	16.27	-	6.97
<b>Erode District</b>												
Sathyamangalam	87.50	62.50	75.00	45.83	33.33	-	28.75	20.54	24.65	15.06	10.95	-
Thalavadi	82.35	64.70	88.23	47.05	29.41	-	26.41	20.75	28.30	15.09	9.43	-
<b>Dindigul district</b>												

Kodaikanal	73.33	46.67	53.33	26.67	20.00	6.67	32.35	20.59	23.53	11.76	8.82	2.94
Odanchathram	83.33	75.00	58.33	50.00	16.67	25.00	27.03	24.32	18.92	16.22	5.41	8.11
Palani	70.00	60.00	50.00	30.00	-	20.00	30.43	26.09	21.74	13.04	-	8.70
<b>Krishnagiri district</b>												
Hosur	100.0	62.50	75.00	25.00	37.50	50.00	29.63	18.52	22.22	7.41	10.71	14.29
Thally	77.78	44.44	55.56	33.33	22.22	44.44	28.00	16.00	20.00	12.00	8.00	16.00
<b>Theni district</b>												
Chinnamanur	66.67	50.00	33.33	-	16.67	33.33	33.33	25.00	16.67	-	8.33	16.67
Cumpum	75.00	62.50	75.00	25.00	37.50	-	28.57	19.05	28.57	9.52	14.29	-
<b>Tirupur District</b>												
Palladam	66.66	58.33	75.00	-	33.33	-	28.57	25.00	32.14	-	14.28	-
Udumalpet	53.84	69.23	84.61	46.15	-	23.07	19.44	25.00	30.55	16.66	-	8.33

**Table 3:** Community analysis of nematodes associated with beetroot in different districts of Tamil Nadu

Blocks	Absolute Density (%)						Relative Density (%)					
	<i>M. i</i>	<i>P. p</i>	<i>H. d</i>	<i>H. i</i>	<i>L. e</i>	<i>T. c</i>	<i>M. i</i>	<i>P. p</i>	<i>H. d</i>	<i>H. i</i>	<i>L. e</i>	<i>T. c</i>
<b>Coimbatore District</b>												
Kinathukadavu	62.52	12.08	16.28	11.56	5.04	8.16	54.06	10.44	14.07	9.99	4.35	7.05
Pollachi	49.40	18.52	20.92	10.24	2.24	-	48.75	18.28	20.65	10.10	2.21	-
Thondamuthur	83.36	24.28	12.96	7.28	9.00	4.04	59.15	17.23	9.19	5.16	6.38	2.86
Sultanpet	35.44	19.36	27.04	15.80	4.32	10.52	31.51	17.21	24.04	14.04	3.84	9.35
Sulur	37.40	15.96	27.48	5.84	4.84	3.32	39.43	16.83	28.97	6.16	5.10	3.50
<b>Nilgiris District</b>												
Coonoor	65.36	17.28	23.76	4.12	-	1.36	58.41	15.44	21.23	3.68	-	1.21
Koodalur	52.90	14.25	27.70	10.95	10.10	10.40	41.88	11.28	21.93	8.67	8.00	8.23
Kotagiri	51.56	13.88	33.16	11.68	2.88	-	45.56	12.26	29.30	10.32	2.54	-
Udhagamandalam	75.88	9.28	6.60	7.72	-	2.56	74.36	9.09	6.46	7.56	-	2.50
<b>Erode District</b>												
Sathyamangalam	85.48	37.28	19.24	2.12	3.68	-	57.82	25.21	13.01	1.43	2.48	-
Thalavadi	65.24	25.56	16.52	1.64	3.12	-	58.20	22.80	14.73	1.46	2.78	-
<b>Dindigul district</b>												
Kodaikanal	68.30	16.00	25.30	14.20	8.20	3.50	50.41	11.81	18.67	10.48	6.05	2.58
Odanchathram	60.15	22.55	18.75	16.05	5.15	5.55	46.92	17.59	14.63	12.52	4.02	4.33
Palani	43.95	11.95	19.80	12.45	-	5.20	47.08	12.80	21.21	13.34	-	5.57
<b>Krishnagiri district</b>												
Hosur	75.20	28.25	34.35	8.65	10.90	6.30	45.95	17.26	20.99	5.29	6.66	3.85
Thally	73.75	30.65	37.8	17.15	7.30	4.70	43.04	17.89	22.06	10.01	4.26	2.74
<b>Theni District</b>												
Chinnamanur	39.80	20.85	13.25	-	4.50	5.30	47.55	24.91	15.83	-	5.38	6.33
Cumpum	45.70	19.80	23.85	6.60	7.65	-	44.11	19.11	23.02	6.37	7.38	-
<b>Tirupur District</b>												
Palladam	30.92	16.56	26.84	-	3.48	-	39.74	21.28	34.50	-	4.47	-
Udumalpet	35.68	18.52	29.92	6.52	-	2.92	38.13	19.79	31.98	6.97	-	3.12

**Table 4:** Prominence value of nematodes associated with beetroot in different districts of Tamil Nadu

Blocks	Prominence value					
	<i>M. i</i>	<i>P. p</i>	<i>H. d</i>	<i>H. i</i>	<i>L. e</i>	<i>T. c</i>
<b>Coimbatore District</b>						
Kinathukadavu	5.10	0.80	1.53	0.77	0.23	0.47
Pollachi	4.17	1.40	1.94	0.67	0.12	-
Thondamuthur	7.83	1.86	1.13	0.50	0.49	0.19
Sultanpet	2.67	1.26	2.28	1.03	0.16	0.56
Sulur	2.98	0.96	1.85	1.70	0.60	0.11
<b>Nilgiris District</b>						
Coonoor	6.11	1.22	2.37	0.25	-	0.06
Koodalur	5.08	1.05	2.17	0.68	0.56	0.58
Kotagiri	4.39	1.02	2.23	0.49	0.08	-
Udhagamandalam	6.84	0.76	0.49	0.51	-	0.11
<b>Erode District</b>						
Sathyamangalam	7.99	2.94	1.66	0.14	0.21	-
Thalavadi	5.92	2.05	1.55	0.11	0.17	-
<b>Dindigul district</b>						
Kodaikanal	5.85	1.09	1.85	0.73	0.37	0.09
Odanchathram	5.49	1.95	1.43	1.13	0.21	0.28
Palani	3.68	0.93	1.40	0.68	-	0.23
<b>Krishnagiri district</b>						



Hosur	7.52	2.23	2.97	0.43	0.67	0.39
Thally	6.50	2.04	2.82	0.99	0.34	0.31
<b>Theni District</b>						
Chinnamanur	3.25	1.47	0.76	-	0.08	0.31
Cumpum	3.96	1.40	2.07	0.33	0.47	-
<b>Tirupur District</b>						
Palladam	2.52	1.26	2.32	-	0.20	-
Udumalpet	2.62	1.54	2.75	0.44	-	0.14

### 3.2. Community Structure of Nematodes Associated with Beetroot

An analysis of nematode communities (Table 2 and Table 3) revealed the presence of six genera of plant parasitic nematodes associated with beetroot. *M. incognita* was more frequently occurring nematode than other nematodes having an absolute frequency (92.31%). These were followed by *H. dihystra* (88.88%), *P. penetrans* (75.00%), *H. indicus* (54.54%), *T. claytoni* (50.00%) and *L. elongates* (37.50%). *M. incognita* (85.48%) had the highest absolute densities, followed by *H. dihystra* (37.8%), *P. penetrans* (37.28%), *H. indicus* (17.15%), *L. elongates* (10.9%), *T. claytoni* (10.52%). While the highest relative frequency observed for *M. incognita* (36.46%), followed by *H. dihystra* (32.14%), *P. penetrans* (27.27%), *H. indicus* (23.07%), *T. claytoni* (16.67%), *L. elongates* (14.29%). Relative densities were *M. incognita* (74.36%), followed by *H. dihystra* (34.5%), *P. penetrans* (25.21%), *H. indicus* (14.04%), *T. claytoni* (9.35%), *L. elongates* (8.0%). The most important plant parasitic nematode *M. incognita* were detected in this survey and it had a highest prominence value in Erode district of Sathyamangalam (7.99) (Table 4) followed by Thondamuthur (7.83), Hosur (7.52), Udhamandalam (6.84), Thally (6.50), Coonoor (6.11), Thalavadi (5.92), Kodaikanal (5.85), Odanchathram (5.49), Kinathukadavu (5.10), Koodalur (5.08), Kotagiri (4.39), Pollachi (4.17), Cumpum (3.96), Palani (3.68), Chinnamanur (3.25), Sultanpet (2.67), Udumalpet (2.62) and the lowest value detected in Palladam block of Tirupur district (2.52) (Table 4).

## 4. Discussion

### 4.1. Nematode Distribution

Root knot nematodes are the most important pest of horticultural crops and widespread, polyphagous in nature. Internationally, the major root-knot (*Meloidogyne* species) nematodes associated with beetroot (*Beta vulgaris*) include *M. arenaria*, *M. incognita*, *M. chitwoodi*, *M. hapla* and *M. enterolobii* with limited information on *M. javanica* [15]. Tamil Nadu highest population of *M. enterolobii* associated with guava, both in 200g soil (414) and 5g roots (588) was found in Theni district [1]. In Tamil Nadu three *Meloidogyne* species viz., *Meloidogyne arenaria*, *M. incognita* and *M. javanica* were recorded on vegetable crops grown in plain areas [14]. In beetroot, *M. incognita* is the important nematode that cause major yield loss in beetroot growing areas of Tamil Nadu. In this investigation showed that both ecto and endo parasitic nematodes were associated with beetroot and infestation level highly observed in temperate region than plains. Interrelations between exotic beetroot cultivars 'Detroit Red Dark' and 'Crimson Globe' with *Meloidogyne* species in the predominant beetroot producing regions of South Africa and the results showed 'Detroit Red Dark' was tolerant to *M. incognita*, whereas 'Crimson Globe' was resistant to *M. javanica* [7]. Based on the study conducted it is concluded that plant parasitic nematodes both endo and ectoparasites are distributed in the beetroot major growing districts of Tamil

Nadu. Apart from root knot nematodes migratory endoparasites *P. Penetrans* can also cause damage to the crop.

### 4.2. Community Structure of Nematodes Associated with Beetroot

Community analysis results indicated that *M. incognita* was present in major beetroot growing districts of Tamil Nadu. A total of six nematodes recorded among these *M. incognita* was the more frequently occurring nematode than other nematodes. Root knot nematodes are adapted to parasitize on large number of plants and it had a host range over 3000 wild and cultivated plant species are reported to be affected. Prominence value results showed that Erode district highly infested with *M. incognita* than other districts, at the same time Tirupur district had a lowest value. Population assessment and community analysis of plant parasitic nematodes associated with beetroot in different districts of Tamil Nadu showed variation in their frequency, density and diversity which may be due to ecological and edaphic factors [6]. Though root knot nematodes, *M. incognita* and spiral nematodes, *H. dihystra* are the major plant parasites predominantly associated with beetroot. While the Stunt nematode, *T. claytoni* and needle nematode, *L. elongates* had a least frequently rate.

Thus, the present study clearly indicated that the association of plant parasitic nematodes especially the most economically important nematode species like *M. incognita* would cause severe yield loss to beetroot major growing districts of Tamil Nadu. Increasing nematode problems enforcing to use of eco-friendly management strategy of biocontrol agents to manage nematode population below the economic threshold level.

## 5. Conclusion

In summarising up of the findings on the survey concluded that six genera of plant parasitic nematodes associated with beetroot viz., *Meloidogyne incognita*, *Pratylenchus penetrans*, *Helicotylenchus dihystra*, *Hoplolaimus indicus*, *Longidorus elongates*, *Tylenchorhynchus claytoni* in their six species *M. incognita* had a highest population densities and most predominantly occurring nematodes than associated nematodes.

## 6. Acknowledgements

Authors acknowledge my deep sense of gratitude and sincere thanks to my chairperson Dr. K. Poornima, Professor and Head, Department of Nematology and members Dr. N. Swarnakumari, Assistant Professor (Department of Nematology) and Dr. V. Jegadeeswari, Assistant Professor (Department of spices and plantation crops) who has been instrumental in the successful completion of this work.

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