

Prevalence and densities of banana nematodes in Kondotty-local Government Area, Kerala State, India

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Abstract

To determine the types, frequency of occurrence and population densities of plant parasitic nematodes in soil samples associated with banana (*Musa paradisiaca*), a survey was conducted in the Kondotty Taluk of Malappuram district, Kerala, India. A total of 12 genera of nematodes including six commonly occurring nematodes in the banana rhizosphere, three new records from banana and one new unidentified genus were obtained during the survey. Two free-living nematodes were also frequently observed in the analyzed soil samples from banana rhizosphere including *Caenorhabditis elegans* and *Mononchus* sp. *C. elegans* is exclusively found associated with rhizosphere of Nendra and Nattupooan banana varieties.

Key words: Survey, banana, plant parasitic nematodes, occurrence.

Since the dawn of history plantain and banana (*Musa* spp.) have been exploited and cultivated for consumption by man (Akele, 1993, Tanimola *et al.*, 2013). Banana is grown in more than 130 countries with an annual total production of 80 million tons (MT) (UNCTAD, 2009) Banana contributes to 31.72% of the total global fruit production. India is the largest producer of banana, having an area of about 64.7 thousand ha with production of 23,205 thousand MT (Bennur *et al.*, 2015).

As a chief source of food, bananas provide a well-balanced diet, thus contributing to the food security of more than 400 million people in the developing world (Singh, 2002). After the black Sigatoka leaf streak disease caused by the fungus *Mycosphaerella fijiensis*, nematodes are the second-most important limiting biotic factor of banana production (Gowen *et al.*, 2005). These nematodes are taxonomically and tropically diverse in both terrestrial and aquatic habitats.

Banana is attacked by a complex of different species of parasitic nematodes (Bridge, 1993; Okafor *et al.*, 2015). *Radopholus similis*, *Pratylenchus goodeyi*, *P. coffeae*, *Helicotylenchus multicinctus* and *Meloidogyne* spp. are the most important nematodes of this crop, among the 150 different nematode species found associated with *Musa* spp. (Gowen *et al.*, 2005, Dhakshinamoorthy, 2011). Seventy-one species of different plant parasitic nematodes are known to be associated with banana in India (Koshy & Sosamma, 2001; Khan & Hasan, 2010). Nematodes cause a global estimated crop loss of banana of \$125 billion per year (Chitwood, 2003). Yield losses of 30-60% were reported by *R. similis* and *H. multicinctus* in India (Davide, 1995). Khan *et al.*, (2010) reported Rs 21,068.73 million, national loss due to plant parasitic nematodes associated with crops in India. The percentage of crop losses in banana due to *M. incognita* and *R. similis* is 7.9-34.6% and 12.02-21.8%, respectively.

Most of the farmers are unaware about the nematodes to relate their production problems and also, they fail to connect the problems such as toppling of banana and yield reductions to nematode infestations. Thus, growers cannot evaluate the crop damage caused by nematodes. Sampling soil and plant material from suspected sites and extracting nematodes for analysis is the only way to accurately diagnose nematode disease (Lambert & Bekal, 2002).

This preliminary study therefore focuses on gathering information about the occurrence, frequency and population density of major banana nematodes prevalent in the Kondotty Taluk of Malappuram district in order to inform the farmers and to suggest solutions to get rid of the nematodes attacking their cultivation.

Materials and Methods

The study was conducted in Kondotty, the seventh declared Taluk in Malappuram district which includes nine Panchayaths (villages): Vazhakkad, Vazhayur, Cherukavu, Pulikkal, Kondotty, Pallikal, Chelembra, Morayur and Nediyruppu. Two samples from each village containing soil and roots were collected randomly from banana farms in which the major varieties cultivated were Ethapazham (Nendra (6), Palayamkodan (Mysore) (9), Jnali Poovan (2), Poovan (2) and Venneerpoovan (1). Samples were collected during the month of August-October, 2016.

Collection of soil samples: For identification, soil samples of the randomly selected banana farm were collected from the rhizosphere with a hand trowel and then bulked in polythene bag and labeled. Soil samples from the rhizosphere were collected using a garden rake and trowel. Soil samples of about 200 g were obtained at maximum depth of 15 cm and collected 30-40 cm from the base of plant using the garden trowel.

Extraction of plant parasitic nematodes: Plant parasitic nematodes were extracted using the combination of Cobb's decanting and sieving

method (Ravichandra, 2015) which allows the recovery of most of the nematodes. 200 g of the soil samples were mixed up well with water in a plastic bucket and stirred with hand to break up the clumps of soil. The water and soil was stirred until a homogenous suspension was obtained.

The suspension was left for 15 seconds and passed from the plastic bucket through a set of sieves containing three different mesh sizes (600, 85 and 400). The residue present in the 600 and 85 mesh sieves was discarded after backwashing them. Backwashed material was retained on a 400- mesh sieve and poured into a 250 ml beaker.

Sample present in it was too dirty for direct viewing so it was poured after stirring to a 600-mesh sieve moistened with a tissue paper and the whole set up was placed in a large Petri plate. The filtrate was then collected for observation of nematodes after 24-36 hours.

Identification of nematodes: Nematodes were observed by a Stereo Microscope (Magnus MSZ-TR) and counted. Temporary slides were prepared for the observation under a research microscope (Olympus CX21i) using the objective 40x. Plant parasitic nematodes were identified up to the generic level using lucid key of Bell (2004).

Data analysis: Percentage frequencies of occurrence (FO) and population densities (PD) of the extracted nematodes were determined using the following equations (Imafidor & Mukoro, 2016):

$$\text{Percentage frequency of occurrence (FO)} = \frac{n}{N} \times 100$$

Where, n = Number of positive samples, N = total number of samples.

Population densities (PD) = number of nematodes/total number of samples

Results and Discussion

Nematodes associated with different host varieties are presented in Table 1. Mysore Poovan variety is seen to be a more susceptible host for banana nematodes with nine different types of nematodes, followed by Nendra (8 nematodes), Jnali poovan (6), Poovan and Venneerpoovan (both with 5 nematodes).

The distribution of different nematodes was assessed by analyzing soil samples and is presented in Table 2. Soil samples from Morayur Village represent favorable conditions as a good host for nematodes since it hosts about 11 genera among the total 12 reported nematodes. It is followed by Nediyruppu and Pallikal. The least distribution of nematodes was observed in Vazhakkad, the major banana producing Panchayat in Malappuram District.

Radopholus sp., was reported from all the Panchayaths followed by *Meloidogyne* sp. A new unidentified genus is also reported from the rhizosphere of Nendra and Mysore variety. *Caenorhabditis elegans* and *Mononchus* sp., were reported from Nendra and Poovan, and Venneerpoovan, Jnalipoovan and Nendra varieties, respectively.

Population density of different nematodes in various villages and the percentage frequency of occurrence of different nematodes are presented in Tables 3 and 4, respectively. Kondotty Village shows the highest population density (10.1) followed by Vazhayur (5.65), Vazhakkad (4.4), and Pulikkal (4.15). Least density of nematode population was observed in Morayur Village (1.93).

The frequently found plant-parasitic nematodes in the soils of Kondotty Taluk were *Radopholus* sp. and *Meloidogyne* sp. (65%). Meanwhile the least frequent ones were *Hemicycliophora* sp. and *Aphelenchoides* sp. (5%).

The survey of plant-parasitic nematodes of Kondotty in Malappuram district, Kerala revealed three important nematode genera prevalent in soils. In terms of frequency of occurrence, these plant-parasitic nematode genera are *Radopholus* sp., *Meloidogyne* sp. and *Helicotylenchus* (55%).

Other nematodes viz., *Hoplolaimus*, *Pratylenchus* and *Rotylenchulus* were less frequent. In Kondotty Taluk, *Radopholus* sp., and *Meloidogyne* sp., was of great importance. This observation was similar to that of Khan *et al.*, (2010) who reported *Radopholus similis* and *Meloidogyne incognita* as a major nematode problem of banana in Kerala. They did not report any other nematodes from Malappuram district in the Atlas showing distribution of plant parasitic nematodes infecting banana in Kerala.

Roy *et al.*, (2014) reported that *Radopholus similis*, *Helicotylenchus multicinctus* and *Pratylenchus coffeae* are more abundant migratory endoparasite nematodes of banana from Vellayani, Thiruvananthapuram and Kerala. But in Kondotty Taluk of Malappuram district *Pratylenchus* sp. is less frequent as compared to *Helicotylenchus* sp.

From the rhizosphere of banana, six different genera of plant parasitic nematodes have been reported from India (Khan *et al.*, 2010). *Helicotylenchus* sp., had not been reported as a key nematode pest of bananas when compared to *Radopholus* sp., *Hemicycliophora* sp., *Seinura* sp., and *Aphelenchoides* sp. were new reports from Kondotty Taluk, Malappuram, which were not reported from banana rhizosphere until now.

Apart from plant parasitic nematodes, predatory nematodes viz., *C. elegans* and *Mononchus* sp., were also observed as a prominent member among soil nematode communities of banana. Thus, banana is now acting as a host for these predatory nematodes. A new genus similar to *Radopholus* sp. with long filiform pointed tail has also been reported from banana rhizosphere.

Table 1. Nematodes observed in association with different host varieties.

Host varieties	Nematode species
Nendra	<i>Hoplolaimus</i> sp., <i>Radopholus</i> sp., <i>Seinura</i> sp., <i>Meloidogyne</i> sp., <i>Rotylenchulus</i> sp., <i>Caenorhabditis elegans</i> , <i>Mononchus</i> sp. new genus.
Mysorepoovan	<i>Helicotylenchus</i> sp., <i>Rotylenchulus</i> sp., <i>Pratylenchus</i> sp., <i>Radopholus</i> sp., <i>Hoplolaimus</i> sp., <i>Aphelenchoides</i> sp., new genus, <i>Mononchus</i> sp., <i>Hemicycliophora</i> sp.
Jnali Poovan	<i>Radopholus</i> sp., <i>Meloidogyne</i> sp., <i>Helicotylenchus</i> sp., <i>Hoplolaimus</i> sp., <i>Pratylenchus</i> sp., <i>Mononchus</i> sp.
Poovan	<i>Radopholus</i> sp., <i>Helicotylenchus</i> sp., <i>Hoplolaimus</i> sp., <i>C. elegans</i> , <i>Meloidogyne</i> sp.
Venneerpoovan	<i>Radopholus</i> sp., <i>Meloidogyne</i> sp., <i>Helicotylenchus</i> sp., <i>Mononchus</i> sp., <i>Seinura</i> sp.

Table 2. Distribution of nematodes associated with banana rhizosphere at Kondotty Taluk of Malappuram District.

Nematodes	Vazhakkad	Vazhayur	Cherukavu	Pulikkal	Kondotty	Pallikal	Chelembra	Nediyiruppu	Morayur
<i>Meloidogyne</i> sp.	+		+	+	+	+	+	+	+
<i>Radopholus</i> sp.	+	+	+	+	+	+	+	+	+
<i>Pratylenchus</i> sp.						+		+	+
<i>Rotylenchulus</i> sp.						+		+	
<i>Hoplolaimus</i> sp.			+			+	+		+
<i>Helicotylenchus</i> sp.	+	+	+	+	+	+		+	+
<u>New genus</u>		+					+	+	+
<i>Hemicycliophora</i> sp.					+				
<i>Aphelenchoides</i> sp.									+
<i>Seinura</i> sp.							+	+	+
<i>Mononchus</i> sp.				+		+	+		+
<i>C. elegans</i>	+	+		+				+	+

Table 3. Population density of nematodes in villages of Kondotty Taluk.

Villages in Kondotty Taluk	Number of samples	Mean number of nematodes	Population density
Vazhakkad	2	8.8	4.4
Vazhayur	2	11.3	5.65
Cherukavu	2	6.8	3.4
Pulikkal	2	8.3	4.15
Kondotty	2	20.2	10.1
Pallikal	3	6.2	2.06
Chelembra	2	7.2	3.6
Nediyiruppu	2	4.5	2.25
Morayur	3	5.8	1.93

Table 4. Percentage frequency of occurrence of different nematodes observed.

Nematode genera	No of positive samples	Frequency (%) of occurrence
<i>Meloidogyne</i> sp.	13	65
<i>Radopholus</i> sp.	13	65
<i>Pratylenchus</i> sp.	6	30
<i>Rotylenchulus</i> sp.	2	10
<i>Hoplolaimus</i> sp.	6	30
<i>Helicotylenchus</i> sp.	11	55
New record genus	5	25
<i>Hemicycliophora</i> sp.	1	5
<i>Aphelenchoides</i> sp.	1	5
<i>Seinura</i> sp.	4	20
<i>Caenorhabditis elegans</i>	5	25
<i>Mononchus</i> sp.	4	20

Conclusion

The results from the survey on the occurrence of plant parasitic nematodes in association with the rhizosphere of banana revealed the presence of six different genera of plant parasitic nematodes including *Radopholus* sp., *Meloidogyne* sp., *Helicotylenchus* sp., *Hoplolaimus* sp., *Pratylenchus* sp., and *Rotylenchulus* sp. Among them *Radopholus* sp., and *Meloidogyne* sp., were dominant in the rhizosphere of banana in accordance with the frequency of occurrence and it can be concluded that these are the major attacking nematodes of banana. Slight variation was found in the occurrence of banana nematodes in Kondotty Taluk, from one end to the other and it may be due to slight variations in environmental conditions, soil texture and agronomic practices.

During the survey, *C. elegans* and *Mononchus* sp. were found as new predatory nematodes from the rhizosphere of banana. A new unidentified genus showing similarities with *Radopholus* sp. but with long tail is also acting as a pest of banana. It's a new report from Kondotty; further studies are to be conducted to give a systematic position to it.

Hemicycliophora sp., *Seinura* sp. and *Aphelenchoides* sp. are new reports from banana rhizosphere. And thus, banana cultivation in the study area Kondotty Taluk is not free from plant parasitic nematodes and *Radopholus* sp. and *Meloidogyne* were the predominant ones. Therefore, priority will be given to study the pathogenicity and management of these nematodes in further studies.

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