

Community analysis of nematodes associated with *Philodendron burle-marxii* with a new record of *Meloidogyne incognita* in Thiruvananthapuram, Kerala, India

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ABSTRACT: Survey conducted on *Philodendron burle-marxii*, an ornamental plant, in 13 panchayats of Thiruvananthapuram district, Kerala, revealed the occurrence of plant parasitic nematodes like *Meloidogyne incognita*, *Rotylenchulus reniformis* and *Helicotylenchus dihystera*; and predatory nematodes such as *Iotonchus indicus* and *Mylonchulus minor*. Rhabditids and other free-living nematodes were also encountered. The highest population of *M. incognita* was recorded from Vallakadavu area of Thiruvananthapuram Corporation (199 J₂ 200 cm³ soil⁻¹) followed by Veniyoor area of Venganoor panchayat. The highest population of *R. reniformis* was recorded from Pallichal area of Kalliyoor panchayat (99 nematodes 200 cm³ soil⁻¹). The highest population of *I. indicus* was from Ponnudi area of Peringamala panchayat (3.5 nematodes 200 cm³ soil⁻¹) and that of *M. minor* was from Peppara area of Vithura panchayat (6 nematodes 200 cm³ soil⁻¹). The bacterial feeding nematodes belonging to order Rhabditida was recorded from all the areas sampled. *M. incognita* recorded the highest prominence value to a tune of 1827.0 and 2959.0 for both Nemom and Vamanapuram respectively. This is the first report of *M. incognita* infecting *P. burle-marxii* in India evidenced by the morphology of female and second stage juveniles. The infected plants exhibited stunting, chlorosis of the lower leaves, abnormal leaf glossiness, and crinkling, curling, and a reduction in leaf size ranging from 30 to 80 per cent.

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KEY WORDS: Phytoparasites, first report, stunting, chlorosis, predatory nematodes, Rhabditida

INTRODUCTION

The genus *Philodendron*, belonging to the family Araceae, comprises numerous species valued in horticulture for their attractive foliage and adaptability to indoor environments. Among them, *Philodendron burle-marxii*, commonly known as 'Burle Marx,' has gained popularity for its visual

appeal and ease of maintenance. Native to the tropical rainforests of Brazil, *P. burle-marxii* thrive under conditions of high humidity, consistent warmth, and indirect light. These ecological conditions make it particularly well-suited for indoor cultivation. It prefers well-drained, organic-rich soil and benefits from regular misting to simulate its native habitat. The species is characterized by deep

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green leaves with prominent venation and a distinctive wavy or rippled margin, contributing to its ornamental value.

Root-knot nematodes (*Meloidogyne* spp.) are considered the most economically destructive plant-parasitic nematodes because of their global distribution and exceptionally wide host range, which includes more than 3,000 plant species (Abad *et al.*, 2003). With over 100 described species, *Meloidogyne* spp., infest nearly all agricultural crops as well as a wide range of weed hosts (Hussey and Janssen, 2002; Elling, 2013). Root-knot nematodes are known to suppress plant growth in *Philodendron* cv. Red Princess, even when gall formation is minimal and egg masses are small and often inconspicuous (Lehman and Stokes, 1979). *P. burle-marxii* is generally hardy and exhibits resistance to most common pests and diseases. However, sucking pests such as mealybugs and spider mites have occasionally been observed feeding on the plant. However, there is hardly any report of nematodes attacking this plant. Preliminary observations on the potted plants of *P. burle-marxii* in many locations across Thiruvananthapuram district, Kerala revealed symptoms including stunted growth, rosetting and narrowing of leaves. Affected plants exhibited severely galled roots indicative of nematode activity. Nematodes are important phytopathogens reported to cause an economic loss of \$173 billion to agriculture sector worldwide (Elling, 2013). There are reports of nematodes attacking other members of family Araceae. Kumar (1991) reported the incidence of root knot nematode *Meloidogyne* sp., on *Colocasia* sp., from all twenty-five panchayats selected for the study. A survey was undertaken to ascertain the occurrence of nematodes infecting *Philodendron burle-marxii* in and around Thiruvananthapuram district of Kerala.

MATERIALS AND METHODS

A survey was under taken to ascertain the nematodes associated with *P. burle marxii* in 13 panchayats of Thiruvananthapuram district and Thiruvananthapuram Corporation (Table 1), following purposive sampling technique. Fifty-two soil samples were collected from the following

panchyats viz., Parassala, Chenkal, Amaravila, Athiyannur, Venganoor, Vizhinjam, Kalliyoor, Vithura, Nanniyode, Peringamala, Attingal, Kizhuvilam, and Chemaruthi. Soils were collected from the rhizosphere of *P. burle-marxii* at a depth of 15-30cm with a soil auger. Soil samples were drawn both from potted plants and those raised in the gardens in the ground and also from wild growing plants. These samples were thoroughly mixed, bulked and nematodes were extracted from 200 cm³ composite sample by Cobb's sieving and decanting technique and fine-tuned by modified Baermann's funnel technique.

Community analysis of nematodes was computed from 12 localities of Nemom and Vamanapuram blocks of Thiruvananthapuram district (Table 2). Absolute frequency (AF%), Relative frequency (RF%), Absolute Density (AD%), Relative density (RD%), and Prominence value (PV) were used to describe the nematode community structure (Norton, 1978). (1) AF % = Number of samples containing a species /total number of samples examined × 100, (2) RF % = Frequency of the species /sum of frequencies of all species × 100, (3) AD % = No. of individuals of a species in a sample / volume of sample x 100, (4) RD % = No. of individuals of in a sample /total of all individuals in a soil × 100, (5) Prominence value = Density × Frequency.

Females of root knot nematodes were extracted from the galled roots under a stereomicroscope Zeiss Stemi 508. Female nematode was kept in a drop of 45 per cent lactic acid and the posterior region having the perineal pattern was cut carefully and cleaned. Perineal pattern was cutout based on the procedure provided by (Hartman and Sasser, 1985). Morphological characters of the nematodes were recorded; microphotographs of the specimen mounted on permanent slides were taken using a light microscope mounted with a digital camera.

RESULTS AND DISCUSSION

The survey showed that *M. incognita* was the major plant parasitic nematode infecting *P. burle-marxii* grown in most of the localities (Table 1). The highest population of *M. incognita* was found

Table 1. Distribution of nematodes in the rhizosphere of *Philodendron burle-marxii* in and around Thiruvananthapuram district

Location	Block	Panchayat	samples	<i>M. incognita</i>	<i>R. reniformis</i>	<i>H. dihystra</i>	<i>I. indicus</i>	<i>M. minor</i>	Rhabditida	free living
Karikkakom	TVPM	Corporation	3	177.7	49.3	54.3	3.0	0.0	215.0	124.3
Vallakadavu			2	199.0	73.0	35.0	2.5	4.0	207.0	129.0
Kulathoor	Parassala	Parassala	2	140.0	50.5	10.0	0.0	2.0	217.5	123.0
Arayur		Chenkai	3	54.0	55.0	31.0	2.7	3.3	235.3	136.7
Kannakuzhy	Perumkadavila	Amaravila	2	63.5	20.0	77.0	2.0	4.0	158.0	132.0
Avanakuzhy	Athiyannur	Athiyannur	2	145.0	52.0	0.0	2.0	2.0	250.0	153.0
Veniyoor		Venganoor	2	189.5	67.0	22.0	0.0	4.0	213.0	135.5
Vizhinjam		Vizhinjam	1	23.0	45.0	34.0	3.0	2.0	178.0	230.0
Pappanchani	Nemom	Kalliyoor	3	116.0	75.0	59.0	2.7	4.7	231.0	170.7
Vellayani			4	57.25	0.00	8.0	3.0	4.5	183.0	129.8
Shasthamkovil			2	34.5	45.0	20.0	2.5	0.0	158.0	85.0
Balaramapuram			2	52.0	50.0	30.5	2.5	4.0	206.0	120.0
Pallichal			2	58.0	91.0	53.0	0.0	2.0	219.5	134.5
Peppara		Vithura	2	47.5	76.0	50.5	2.0	6.0	228.5	108.5
Vattapankade	Vamanapuram	Nanniyode	2	107.5	77.5	66.0	2.5	4.0	204.5	146.0
Anakulam			2	135.5	62.0	0.0	2.0	4.5	216.5	120.5
Alammoodu			2	112.0	63.5	50.0	0.0	4.0	116.5	122.0
Thennoor		Peringamala	2	147.5	0.00	22.0	2.5	1.0	31.0	88.0
Njaraneeli			3	44.0	56.3	73.3	3.0	0.0	49.0	
Ponmudi			3	45.3	67.3	62.7	3.5	4.3	206.7	137.7
kadakom	Chiryankeezhu	Attingal	2	86.5	46.0	28.5	0.0	2.0	75.5	104.5
Anchuthengu		Kizhuvilam	2	34.5	51.5	48.5	2.0	0.0	204.5	103.0
Narikkallumukku	Varkala	Chemaruthi	2	95.5	61.5	0.00	2.5	2.0	200.0	150.0

from Vallakadavu area of Thiruvananthapuram Corporation (199 J₂ 200 cm³ soil⁻¹.) followed by Veniyoor area of Venganoor panchayat. The next important phytoparasitic nematode was *Rotylenchulus reniformis* followed by *Helicotylenchus dihystra*. The population of *R. reniformis* was maximum in Pallichal area of Kalliyoor panchayat (99 nematodes 200 cm³ soil⁻¹). *Iotonchus indicus* and *Mylonchulus minor* were the major predatory nematodes recorded from the rhizosphere of *P. burle-marxii*. The population of *I. indicus* was highest in Ponmudi area of Peringamala panchayat (3.5 nematodes 200 cm³ soil⁻¹). Whereas *M. minor* was recorded maximum

in Peppara area of Vithura panchayat (6 nematodes 200 cm³ soil⁻¹) followed by Pappanchani of Kalliyoor panchayat (4.7 nematodes 200 cm³ soil⁻¹). The bacterial feeding nematodes belonging to order Rhabditida was recorded from all the areas sampled. Other free-living nematodes belonging to different orders were also recorded from the rhizosphere of *P. burle-marxii*. Mc Sorley (1980) reported that *M. javanica* and *M. incognita* were the major nematodes infecting *Colocasia esculenta* and *Xanthosoma* spp. *Meloidogyne* sp., was the major nematode infecting yams cultivated in Kalliyoor panchayat (11.02) of Thiruvananthapuram district followed by Kulakada panchayat of Kollam

Table 2. Community analysis of nematodes (200 cm³ soil) associated with rhizosphere of *Philodendron burle-marxii* in Thiruvananthapuram district

Nematode Species	AF	RF	AD	RD	PV
Block/ Nemom -15					
<i>Meloidogyne incognita</i>	100	14.7	182.7	12.5	1827.0
<i>Rotylenchulus reniformis</i>	93.3	13.7	168.5	11.5	1627.6
<i>Helicotylenchus dihystra</i>	100	14.7	110.5	7.5	1105.0
<i>Iotonchus indicus</i>	93.3	13.7	6.4	0.4	19.5
<i>Mylonchulus minor</i>	93.3	13.7	10.6	0.7	102.4
Rhabditida	100	14.7	613.0	41.8	6130.0
Other free-living nematodes	100	14.7	374.3	25.5	3743.0
Block/ Vamanapuram - 14					
<i>Meloidogyne incognita</i>	100	14.9	295.9	22.2	2959.0
<i>Rotylenchulus reniformis</i>	92.9	13.8	163.3	12.3	1567.7
<i>Helicotylenchus dihystra</i>	92.9	13.8	137.0	10.3	1315.2
<i>Iotonchus indicus</i>	92.9	13.8	6.8	0.5	65.3
<i>Mylonchulus minor</i>	92.9	13.8	8.9	0.7	85.4
Rhabditida	100	14.9	412.1	31.0	4121.0
Other free-living nematodes	100	14.9	307.1	23.1	3071.0

district. Whereas in *Colocasia* sp., root knot nematode was abundant in Mangalapuram of Thiruvananthapuram district (12.14) and Mayyanad of Kollam district (12.09). Other nematodes reported from these tuber crops were *R. reniformis*, *Helicotylenchus* sp., *Radopholous similis* and *Hoplolaimus* sp., (Kumar, 1991). *Meloidogyne* sp was reported to be important nematode infecting *Colocasia* sp., in India (Srivastava *et al.*, 1969). Nadakal and Thomas (1964) reported root knot nematode infecting *Colocasia* sp., from Kerala. *M. incognita*, *Paratylenchus minutus*, *Pratylenchus coffeae*, and *H. dihystra* were the phytonematodes reported to be associated with anthuriums and other tropical ornamentals (Bala and Hosein, 1996). Gu *et al.* (2022) reported the association of *Meloidogyne* sp., with caladium tubers. Esser (1973) extracted *Meloidogyne* spp. from 52.8 per cent of soil samples and 27.9 per cent of caladium tuber samples. Kokalis – Burelle *et al.* (2017) reported that 56 of the 75 varieties tested were found to be susceptible to *Meloidogyne* spp.

Perusal of the data on community analysis of nematodes from 12 localities of Nemom and Vamanapuram blocks (Table 2) revealed that nematodes belonging to order Rhabditida were the most prominent nematode fauna in both blocks surveyed (6130.0 and 4121.0 for Nemom and Vamanapuram respectively). They also recorded the highest absolute frequency and density. Among the phytonematodes *M. incognita* was the most frequent nematode with a relative frequency of 14.7 and 14.9 for both the blocks surveyed. *M. incognita* recorded the highest prominence value to a tune of 1827.0 and 2959.0 for both Nemom and Vamanapuram respectively. *R. reniformis* was the next prominent nematode in both the blocks (1627.6 and 1567.7 for Nemom and Vamanapuram respectively). However, they have frequency value of 93.3 and 92.9 respectively compared to *H. dihystra* which was more frequently occurring with a relative frequency of 14.7 per cent in the Nemom block. In Vamanapuram block both *R. reniformis* and *H. dihystra* recorded the same



Fig. 1 *Meloidogyne incognita* infected *Philodendron burle-marxii*: a. Healthy & Infected plant; b. Plant with galls on roots

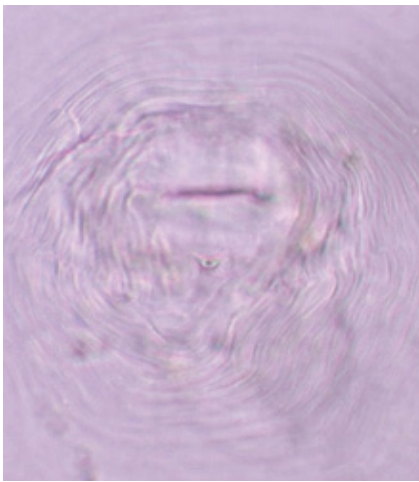


Fig. 2 Perineal pattern of *Meloidogyne incognita* female

relative frequency (13.8). The high population of rhabditids indicates the soil is rich in organic matter and suitable for cultivation of ornamentals. However, the high population of root knot nematode is a concern since these ornamental plants are being propagated by rooted cuttings. There are more chances for fast spread of the nematodes to new areas and related ornamental crops. Hence, treatment of rooted cutting with nematicides or biocontrol agents is a necessity. Sigariova and Karplyk (2015) reported that *M. incognita*, *Rotylenchus robustus*, *Pratylenchus penetrans*, *Tylenchorynchus claytoni*, *Helicotylenchus dihystrera* and *Paratylenchus nanus* was associated with the rhizosphere of *Dahlia variabilis* grown in Kyiv, Ukraine. Community analysis of nematodes extracted from the soil around the roots of ornamental plants showed that *H. dihystrera* was the most frequent (AF 51.90 per cent) and prominent plant parasitic nematode (PV

401.99) cultivated in Jorhat, Assam (Deuri, *et al.* 2015). Our studies also showed similar results in which *H. dihystrera* exhibited high Absolute frequency of occurrence in the Nemom block. In contrary, *M. incognita* was the most prominent nematode in both the blocks.

Based on the characters of the perineal pattern the nematode has been identified as *M. incognita* (Kofoid and White, 1919) (Chitwood, 1949). The nematode was identified by the morphological features of ten adult females including and ten second stage juveniles (J_2). Measurements of females: body length (L) = 565.32-773.31 μm ; body width = 387.87-661.32 μm ; a = 1.17-1.46 μm ; stylet length = 12.52-16.82 μm ; neck length = 148.47-210.61 μm ; LMB = 29.46-41.89 μm ; WMB = 25.53-43.03 μm . The perineal pattern of female nematodes (Netscher and Taylor, 1974) have a high, dorsal, and trapezoidal arch, characterized by thickened transverse striations akin to the original description of the *M. incognita*., LVS = 19.79-26.89 μm ; AVS = 16.93-21.32 μm ; ATT = 13.89-20.94 μm ; IPD = 22.83-29.68 μm (Fig. 4). Second stage juveniles (J_2): body length (L) = 395.42-415.42 μm ; stylet length = 12.92-16.76 μm ; H-MB = 46.78-57.92 μm ; ABW = 8.97-11.98 μm ; tail length = 46.98-54.95 μm ; c = 6.92-12.00 μm ; c' = 4.15-5.62 μm .

M. incognita infected plants exhibited pronounced stunting, chlorosis of the lower leaves, abnormal leaf glossiness, and significant morphological alterations including crinkling, curling, and a reduction in leaf size ranging from 30 to 80 per cent (Figs. 1, 2). Additional symptoms included leaf rosetting and stem twisting. These aboveground manifestations were visibly distinguishable from a considerable distance. Below ground, the primary symptom was root galling (Fig. 3), with root tip galls being particularly prominent. Symptom severity was notably higher in potted plants compared to those cultivated in open soil. The infected plants displayed a prostrate growth habit, deviating markedly from the symmetrical architecture typical of healthy plants, thereby significantly diminishing their aesthetic value. This is the first report of *M. incognita* infecting *P. burle-marxii* from India. Nematode infestation severely affects both

the quantity and quality of ornamental crop production by reducing flower size, total flower number, and the productive life span of plants. Among the nematodes associated with ornamental crops, root-knot nematodes (*Meloidogyne* species) are the most destructive and economically significant, causing extensive root galling and growth suppression. Other important nematode groups include foliar nematodes (*Aphelenchoides* spp.), stem and bulb nematodes (*Ditylenchus* spp.), and root-lesion nematodes (*Pratylenchus* spp.), which also contribute to yield and quality losses (Khan *et al.*, 2024)

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