

Diversity of spider mites (Acari: Tetranychidae) infesting fruit crops in Kerala, India

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Abstract

The study was undertaken at the College of Agriculture, Vellayani, Department of Entomology, to investigate the faunal diversity of spider mites in Kerala's fruit crop ecosystem. In this study, collection and identification of spider mites that affect fruit crops was done through field surveys at different locations throughout Kerala. A total of 15 tetranychid species from five genera were collected from 12 different fruit crops, with the genus *Tetranychus* Dufour being the most abundant and the host plant banana recording the highest number of spider mites. Significant findings include the identification of new host plants for certain mite species, such as *Tetranychus fijiensis* Hirst, *Tetranychus macfarlanei* Baker and Pritchard and *Eutetranychus orientalis* Klein on jackfruit, *Tetranychus truncatus* Ehara on passion fruit, *Tetranychus udaipurensis* Gupta and Gupta on banana and papaya. A taxonomic key to spider mite species identified during the study has been given in the work adding insights into host specificity, contributing valuable information on spider mite infestation in Kerala's fruit science sector.

Keywords: Spider mites, Tetranychidae, *Tetranychus*, *Oligonychus*, abundance, fruit crops

Introduction

Kerala, often referred to as God's Own Country, is home to 118 fruit plants, including 96 tropical and 22 subtropical species (Thomas, 2022). Fruits are a vital part of the human diet providing energy along with essential vitamins, minerals, and fibers. Mango, banana, jackfruit, guava, sapota and pineapple are some of the major fruit crops being grown in the state. Just as any other crops, fruit plants are also attacked by numerous pests, among which mites are also a huge concern.

In recent years, reports of spider mites' infestation on various crops have increased. Binisha *et al.* (2016) reported a total of 19 species of phytophagous and predatory mites belonging to 8 families from vegetable ecosystem in Thrissur, Kerala. The phytophagous mite families recorded were Tetranychidae, Tenuipalpidae, and Tarsonemidae represented by the genera *Tetranychus* Dufour, *Eutetranychus* Banks, *Brevipalpus* Donnadieu, and *Polyphagotarsonemus* Banks. Surveys conducted by Prakash *et al.* (2022) to study the diversity of spider mites on ornamentals revealed the presence of eight species *viz.*, *Eutetranychus orientalis* Klein, *Oligonychus biharensis* Hirst, *Tetranychus fijiensis* Hirst, *Tetranychus marianae* McGregor, *Tetranychus neocaledonicus* Andre, *T. okinawanus* Ehara, *Tetranychus truncatus* Ehara, and *Tetranychus urticae* Koch.

While there have been efforts to document mite fauna in vegetables, ornamentals, and medicinal crops, research on the diversity of mites in fruit crops remains limited in Kerala. In the present scenario, understanding the native spider mite fauna in the fruit crop ecosystem is crucial for assessing the diversity of phytophagous and predatory mites. Hence a study is conducted to explore the faunal diversity of spider mites associated with

the major fruit crops cultivated in Kerala. The present study was undertaken at the Department of Entomology, College of Agriculture, Vellayani, during 2022 - 2024 to explore the diversity of phytophagous mites in the fruit crops ecosystem in Kerala.

Material and methods

Survey and sample collection: Field surveys were conducted across Kerala to collect samples from fruit crops infested with spider mites. A total of 12 fruit crops were sampled *viz.*, banana (*Musa paradisiaca* Linn.), mango (*Mangifera indica* L.), jackfruit (*Artocarpus heterophyllus* Lam.), acid lime (*Citrus aurantiifolia* (Christm.) Swingle), seedless lemon (*Citrus* sp.), avocado (*Persea americana* Mill.), guava (*Psidium guajava* L.) sitaphal (*Annona squamosa* Linn.), papaya (*Carica papaya* Linn.), pomelo (*Citrus maxima* (Burm.) Merrill), passion fruit (*Passiflora edulis* Sims.) and lychee (*Litchi chinensis* Sonn.). From each survey location, leaf samples were collected based on observation of symptoms associated with mite infestation. Mite infested leaf samples were placed in zip lock polythene bags, labelled and carried to the laboratory for further observation. In the laboratory, the individual leaf was thoroughly examined under a stereo-zoom microscope (Carlzeiss Stemi 508) for the recovery of mites. Mite specimens from each sample were slide mounted for taxonomic studies, while a fraction of the sampled mites was preserved in 70% ethyl alcohol for further studies. State map of Kerala indicating locations surveyed for sample collection was constructed using QGIS 3.38.1 software (Fig. 1).

Preparation of permanent slides: Permanent slides of the collected mite specimens were prepared by mounting them on glass slides using Hoyer's media. Single specimen representing both male and female mites of the same species was mounted

separately on different slides. The male tetranychid mites were mounted in the lateral position to ensure better orientation of the aedeagus, which is a key character for species level identification. The slide-mounted specimens were kept in an oven at 40°C for seven to ten days to get cleared. The slides were then labelled with details of host, locality, date of collection, collector's name and accession number. The edges of the cover slip were sealed with nail polish to avoid any damage to the specimen due to excessive moisture.

Identification of mites: The permanent slides prepared were observed under a phase contrast microscope (Radical RXLr 4) with attached image analyzer software to study the taxonomic characters. The morphological features like the number and nature of setae on the dorsal and ventral sides of idiosoma, leg chaetotaxy and male genitalia were studied. Identification of the slide-mounted mite specimens was made using keys provided by Krantz (1978), Nassar and Ghai (1981), Gupta (1985), Gupta and Gupta (1994), and Srinivasa *et al.* (2021) and on confirmation with mite taxonomists. A taxonomic key for the identification of mite fauna associated with fruit crops in Kerala obtained in the survey was prepared.

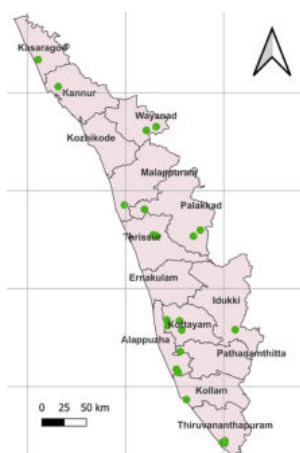


Fig. 1. Survey map of Kerala state

Results and discussion

The study identified 15 species of spider mites across five genera: *Eotetranychus* (Oudemans), *Eutetranychus* (Banks), *Oligonychus* (Berlese), *Schizotetranychus* (Tragardh), and *Tetranychus* (Dufour), on twelve different fruit crops. The genus *Tetranychus* showed the highest diversity, with seven species followed by *Oligonychus* – five species, *Schizotetranychus*, *Eotetranychus* and *Eutetranychus* - one species each respectively. Details of spider mite species infesting different fruit crops in Kerala is given below (Table 1).

Table 1. Spider mites collected during the survey along with their host plants and location

	Scientific name of mite	Host plants	Location	Latitude (°N)	Longitude (°E)	
1	<i>Eotetranychus</i> sp.	Pomelo	Pallichal, Thiruvananthapuram	8.447	77.011	
2	<i>Eutetranychus orientalis</i>	Jackfruit	Kalliyoor, Thiruvananthapuram	8.420	77.010	
		Papaya	Kayamkulam, Alappuzha	9.177	76.517	
3	<i>Oligonychus biharensis</i>	Jackfruit	Vellayani, Thiruvananthapuram	8.429	76.985	
			Kalliyoor, Thiruvananthapuram	8.420	77.010	
			Kanhangad, Kasargod	12.339	75.108	
			Vellanikkara, Thrissur	10.550	76.282	
			Kayamkulam, Alappuzha	9.177	76.517	
4	<i>O. grypus</i>	Lychee	Vellanikkara, Thrissur	10.550	76.282	
		Mango	Krishnapuram, Alappuzha	9.145	76.537	
		Banana	Kayamkulam, Alappuzha	9.177	76.517	
			Krishnapuram, Alappuzha	9.145	76.537	
5	<i>O. punicea</i>	Mango	Kanhangad, Kasargod	12.339	75.108	
6	<i>O. tylus</i>	Banana	Onapparamba, Kannur	12.064	75.313	
			Kannara, Thrissur	10.537	76.320	
			Ettumannur, Kottayam	9.672	76.550	
7	<i>Oligonychus</i> sp.	Banana	Kanhangad, Kasargod	12.339	75.108	
		Guava	Thavanur, Malappuram	10.854	75.988	
			Muthalamada, Palakkad	10.599	76.761	
8	<i>Schizotetranychus baltazari</i>	Acid lime	Vellayani, Thiruvananthapuram	8.429	76.985	
			Kalliyoor, Thiruvananthapuram	8.420	77.010	
			Vellanikkara, Thrissur	10.550	76.282	
			Muthalamada, Palakkad	10.599	76.761	
			Pallichal, Thiruvananthapuram	8.447	77.011	
9	<i>Tetranychus fijiensis</i>	Lemon	Vellanikkara, Thrissur	10.550	76.282	
		Acid lime	Vellanikkara, Thrissur	10.550	76.282	
		Banana	Kumarakom, Kottayam	9.622	76.429	
		Jackfruit	Vellanikkara, Thrissur	10.550	76.282	
			Vechoor, Kottayam	9.681	76.420	
		Mango	Kalliyoor, Thiruvananthapuram	8.420	77.010	
			Krishnapuram, Alappuzha	9.145	76.537	
10	<i>T. ludeni</i>	Papaya	Vellayani, Thiruvananthapuram	8.429	76.985	
11	<i>T. macfarlanei</i>	Passion fruit	Nelliampathy, Palakkad	10.536	76.691	
		Papaya	Manganam, Kottayam	9.578	76.572	
12	<i>T. truncatus</i>	Banana	Ettumannur, Kottayam	9.672	76.550	
		Jackfruit	Kalliyoor, Thiruvananthapuram	8.420	77.010	
13	<i>T. udaipurensis</i>	Banana	Tiruvalla, Pathanamthitta	9.357	76.558	
		Guava	Vandiperiyar, Idukki	9.582	77.117	
			Thavanur, Malappuram	10.854	75.988	
		Papaya	Muthalamada, Palakkad	10.599	76.761	
			Pallichal, Thiruvananthapuram	8.447	77.011	
			Passion fruit	Mathamangalam, Wayanad	11.655	76.311
				Vandiperiyar, Idukki	9.582	77.117
14	<i>T. truncatus</i>	Banana	Krishnapuram, Alappuzha	9.145	76.537	
		Papaya	Eravipuram, Kollam	8.867	76.619	
15	<i>Tetranychus</i> sp.1		Ettumannur, Kottayam	9.672	76.550	
		Sitaphal	Vandiperiyar, Idukki	9.582	77.117	
		Guava	Ambalavayal, Wayanad	11.617	76.212	
15	<i>Tetranychus</i> sp.2	Passion fruit	Pattambi, Palakkad	10.811	76.192	
		Avocado	Pallichal, Thiruvananthapuram	8.447	77.011	
		Jackfruit	Kanhangad, Kasargod	12.339	75.108	
		Mango	Ambalavayal, Wayanad	11.617	76.212	
	Papaya	Vellanikkara, Thrissur	10.550	76.282		

All the spider mite species recorded in the study belong to subfamily Tetranychinae Berlese with the characters of empodium without tenant hairs and true claws - claw like, female with one or two pairs of anal setae and male with three to four pairs of genital setae. Shape of aedeagi of spider mite species recorded in the study is depicted in Fig 2. Taxonomic key to different species of Tetranychinae associated with fruit crops collected in the present study is given below:

1. Tarsus I without duplex setae; empodium rudimentary
Eutetranychus orientalis Klein
Tarsus I with two sets of duplex setae; empodium not rudimentary
Tetranychini Reck.....2
2. True empodium claw split distally with 3 pairs of proximoventral hairs
Tetranychus Dufour.....3
True empodium claw not split distally with proximoventral hairs 7
3. Females with proximal pair of duplex setae in line with proximal tactile setae4
Females with proximal pair of duplex setae not in line with proximal tactile setae.....6
4. Aedeagus with distinct knob; empodia split into distal hairs.....5
Aedeagus very long, slender, tapering distally like a sword; empodia with a strong mediodorsal spur
Tetranychus fijiensis Hirst
5. Aedeagal knob small with both anterior and posterior projections.....*Tetranychus macfarlanei* Baker and Pritchard (1960)
Aedeagal knob small with only anterior acute projection
Tetranychus ludeni Zacher
Upper surface of the knob convex, berry-like with anterior

and posterior projection, short aedeagal shaft, gradually bending dorsal.....*Tetranychus udaipurensis* Gupta and Gupta

Aedeagal knob is minute, without much anterior and posterior projection and bent at right angle to the shaft
Tetranychus truncatus Ehara

6. Empodium with unicate claw....*Oligonychus* Berlese ... 8
Empodium not with unicated claw.....11
7. Aedeagus bent ventral.....*Oligonychus punicae* (Hirst)
Aedeagus bent dorsal.....9
8. Male aedeagus without distinct knob, dorsally directed, obtusely angulate near middle forming sigmoid shape and again bent posteriorly with narrow, tapered, dorso-caudad directed tip.....*Oligonychus grypus* Baker and Pritchard
Male aedeagus with distinct knob.....10
9. Very prominent aedeagal knob with long, slender, tapered posterior projection and dorsal margin flat, distally curved down.....*Oligonychus biharensis* (Hirst)
Small knob looks like a laterally dilated spear with broad base, roughly triangular.....*Oligonychus tylus* Baker and Pritchard
10. Empodium with bifurcated claw.....*Schizotetranychus baltazari* Rimando
Empodium not bifid, split distally into three pairs of hairs without spur
Eotetranychus Oudemans

Among the host plants, banana showed the highest diversity of spider mites, with seven species: *Oligonychus grypus*, *O. tylus*, *Tetranychus macfarlanei*, *T. fijiensis*, *T. truncatus*, *T. udaipurensis* and *Oligonychus* sp. Six tetranychid species recorded on papaya include *T. fijiensis*, *T. ludeni*, *T. udaipurensis*, *E. orientalis*, *T. truncatus*, and *Tetranychus* sp.2. Jackfruit recorded five species

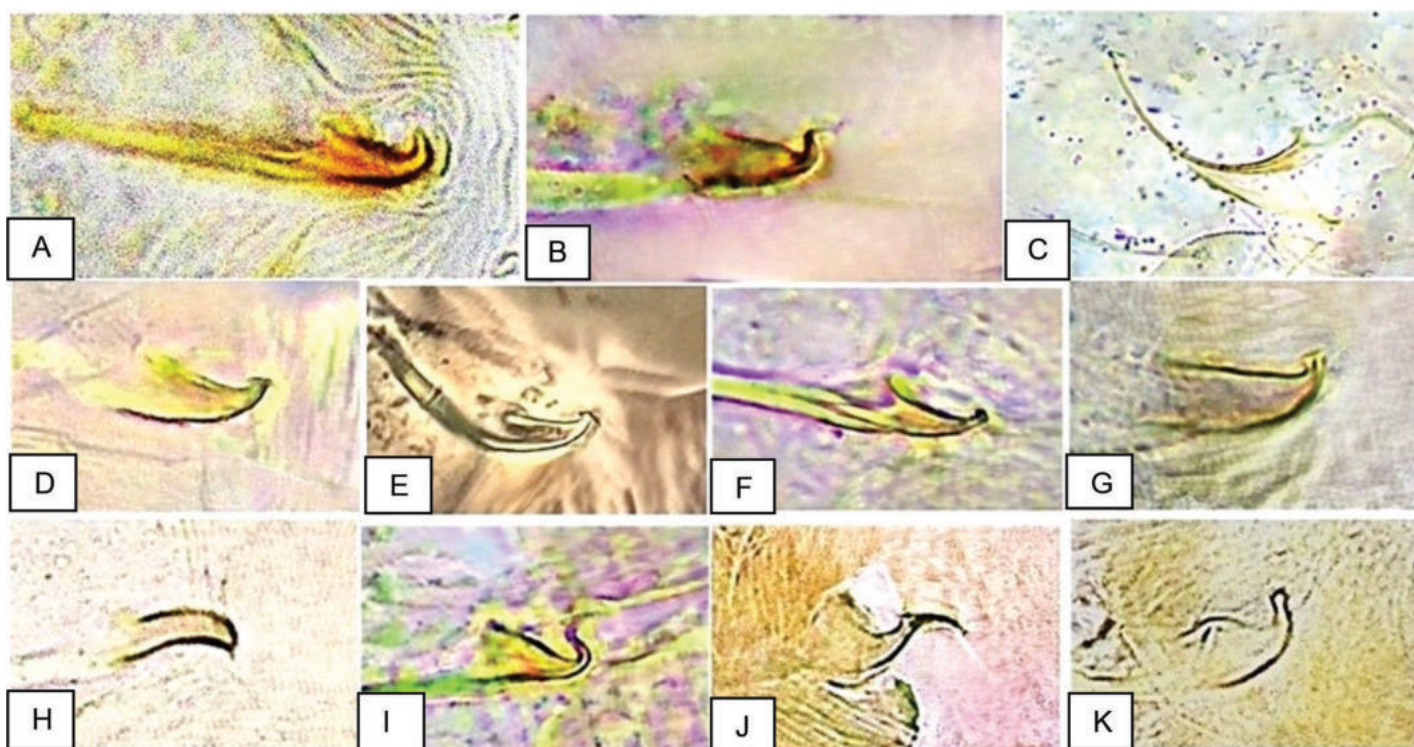


Fig. 2. Aedeagii of spider mite species A. *Eutetranychus orientalis*; B. *Schizotetranychus baltazari*; C. *Tetranychus fijiensis*; D. *Tetranychus macfarlanei*; E. *Tetranychus ludeni*; F. *Tetranychus udaipurensis*; G. *Tetranychus truncatus*; H. *Oligonychus punicae*; I. *Oligonychus grypus*; J. *Oligonychus biharensis*; K. *Oligonychus tylus*

viz., *E. orientalis*, *O. biharensis*, *T. macfarlanei*, *T. fijiensis*, and *Tetranychus* sp.2. Four species of spider mites were collected from mango: *O. punicae*, *O. biharensis*, *T. fijiensis* and *Tetranychus* sp.2. Three species were collected from guava (*T. truncatus*, *Oligonychus* sp., and *Tetranychus* sp.1) and passion fruit (*T. fijiensis*, *T. truncatus*, and *Tetranychus* sp.1). Acid lime was found to host two species viz., *Schizotetranychus baltazari* and *Tetranychus fijiensis*. However, lychee, seedless lemon, pomelo, sitaphal and avocado each recorded only one species of spider mites viz., *O. biharensis*, *S. baltazari*, *Eotetranychus* sp., *Tetranychus* sp.1, and *Tetranychus* sp.2, respectively. The percentage abundance of spider mite species collected in the study is calculated (Fig. 3).

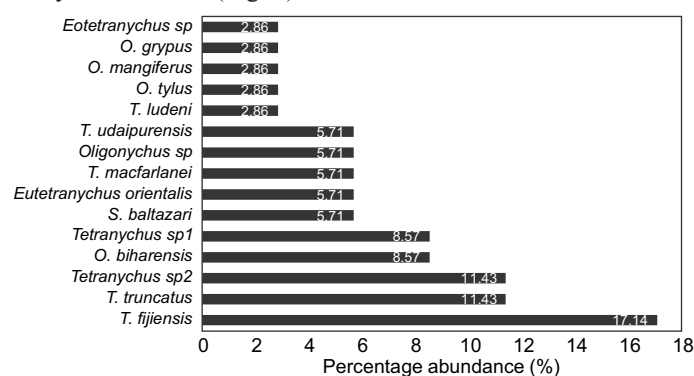


Fig. 3. Percentage abundance of different spider mite species

The study recorded *Tetranychus fijiensis* as the predominant (17.16%) (Fig. 3) mite species on fruit plants. It recorded a wider host range (six host plants) and the associated host plants include acid lime, banana, jackfruit, mango, papaya and passion fruit. This study recorded jackfruit (*Artocarpus heterophyllus*) as the new host for *T. fijiensis* in Kerala.

In the present study, *Tetranychus truncatus* was recorded on four host plants, including banana, guava, papaya, and passion fruit with abundance of 11.43% from different localities of Kerala. In Kerala, *T. truncatus* was first reported by Bennur *et al.* (2015) on vegetable crops. Later, the species was reported by Arunima (2017) on banana, cowpea, pumpkin, tapioca and dahlia. Bhaskar and Lenin (2018) reported *T. truncatus* as a serious pest of banana (Nendran) in Kerala. Recently, *T. truncatus* was reported on some ornamentals by Prakash *et al.* (2022). This study recorded passion fruit (*Passiflora edulis*) as the new host for *T. truncatus*.

In the study, *Oligonychus biharensis* was found associated with three host plants viz., jackfruit, lychee and mango with abundance 8.57%. Recently, Prakash *et al.* (2022) reported *Oligonychus biharensis* on rose, bauhinia and pinto peanut from Kerala. The mite species *Eutetranychus orientalis* was collected from jackfruit and papaya with abundance 5.71%. Safeer and Ramani, (2017) reported *E. orientalis* on papaya from Calicut, Kerala. However, jackfruit (*Artocarpus heterophyllus*) is reported as the new host for *E. orientalis*.

The study recorded the mite species *Schizotetranychus baltazari* on two plants belonging to citrus family viz., acid lime and seedless lemon with abundance 5.71%. Recently, Poojar *et al.* (2022) reported *Schizotetranychus baltazari* on acid lime from Tamil Nadu. The mite species *Tetranychus macfarlanei* was found associated with two host plants jackfruit and banana with abundance 5.71%. This study recorded banana (*Musa*

paradisiaca) and jackfruit (*Artocarpus heterophyllus*) as new hosts for the mite species.

Recently, Poojar *et al.* (2022) reported *Tetranychus udaipurensis* on three new hosts lablab bean, castor and drumstick from Coimbatore region of Tamil Nadu. Niveditha, 2023 reported *T. udaipurensis* as a new pest of drumstick from Kerala. The present study recorded banana (*Musa paradisiaca*) and papaya (*Carica papaya*) as new host plants for *T. udaipurensis* with abundance 5.71%. The study recorded *Oligonychus grypus* on banana with abundance of 2.86%. This species was previously reported on banana by Migeon (2015). In India, *O. grypus* was reported on rice by Sivakumar and Ramaraju, (2016) and Poojar *et al.* (2022).

The major research highlights of this study are the diversity and abundance of spider mites infesting different fruit plants across Kerala. Fifteen species belonging to five genera were identified in the study, with the genus *Tetranychus* exhibiting the highest diversity. The identification of spider mite species on new host plants like *Tetranychus truncatus* on passionfruit, *T. fijiensis* on jackfruit, *T. udaipurensis* on banana and papaya provides valuable details on their host range and specificity. This study highlights the importance of identifying and understanding mite biodiversity to formulate pest management strategies in Kerala's fruit crop ecosystems and support the long-term protection of these perennial fruit crops.

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