



DIVERSITY OF SPIDER MITES (TETRANYCHIDAE) ON ORNAMENTAL PLANTS IN CENTRAL KERALA

JAYALAKSHMI PRAKASH*, HASEENA BHASKAR¹, DEEPU MATHEW, VIDYA C V¹,
CHINNAMADE GOWDA² AND SHYLAJA M R

Centre for Plant Biotechnology and Molecular Biology; ¹Department of Agricultural Entomology, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur 680656, Kerala, India
²Department of Agricultural Entomology, College of Agriculture, University of Agricultural Sciences, GKVK, Bengaluru 560065, Karnataka, India

*Email: jayalakshmi prakashkg@gmail.com (corresponding author)

ABSTRACT

Purposive sampling surveys were conducted in homestead gardens and ornamental nurseries at different localities of Thrissur and Ernakulam districts during 2017-19 to study the diversity of spider mites associated with ornamental plants. Mite samples collected from rose, adenium, gerbera, marigold, chrysanthemum, balsam, cock's comb, orchid, cassia, cairo morning glory, zinnia, bauhinia, crape jasmine and pinto peanut were maintained as isoline cultures in the laboratory. Male and female specimens from isolines were slide mounted for morphological characterisation and identification. The results revealed eight species belonging to three genera viz., *Tetranychus truncatus* Ehara, *T. okinawanus* Ehara, *T. urticae* Koch, *T. fijiensis* Hirst, *T. neocaledonicus* Andre, *T. marianae* McGregor, *Eutetranychus orientalis* Klein and *Oligonychus biharensis* Hirst. The study recorded new hosts for the alien species, *T. okinawanus* and *T. truncatus* which suggests the potential of these species to turn invasive in Kerala's ecosystems. The spider mite fauna on rose was more diverse, indicating the need for imposing strict quarantine regulations. The study observed *T. marianae* as a new record from Kerala.

Key words: Spider mites, diversity, key to species, morphology, ornamental plants, host range, central Kerala, *Tetranychus truncatus*, *T. okinawanus*, *T. marianae*, new record

Spider mites belonging to the family, Tetranychidae comprises of several agricultural and horticultural pests of high economic importance. Spider mites are highly polyphagous in nature and due to its short life cycle, high fecundity and small size, its control is often cumbersome. They are the most diverse group of arthropods encountered in quarantines. Many spider mite species intercepted at the port of entry belonged to the genus *Tetranychus* viz., *T. evansi* Baker & Pritchard *T. fijiensis* Hirst and *T. kanzawai* Kishida, because of the inter-continental movement of fruits, flowers and ornamental plants (Dhooira, 2016). Trade of commercial ornamentals has been recognized worldwide as an important invasion pathway for non-native pests. In Kerala, Thrissur district is considered as the centre of floriculture nursery business. Majority of nurseries in the area do not maintain their own sources of mother plants. They either purchase plants from other states or import planting materials from other countries which often serve as the potential pathway for pest invasion. Recently, a spider mite species, *Tetranychus okinawanus* Ehara was reported on an ornamental plant, *Adenium obesum* for the first time in India from commercial nurseries in

Thrissur district, Kerala (Zeity et al., 2016) which would probably have gained entry into India through imported planting materials. Though spider mite infestation is a serious problem on ornamental plants, no studies have been conducted to document the diversity of mite fauna on ornamental plants in Kerala.

MATERIALS AND METHODS

Purposive sampling surveys were carried out in commercial ornamental nurseries and homestead gardens of Thrissur and Ernakulam districts during November, 2017 to May 2019. During the survey, mite infested leaf samples from the ornamental plants viz., rose, marigold, chrysanthemum, balsam, cock's comb, gerbera, adenium, bauhinia, cairo morning glory, orchid (*Vanda* sp.), zinnia, cassia, crape jasmine and pinto peanut were collected, labelled with locality details and brought to Acarology laboratory. In the laboratory, the leaves were observed under stereomicroscope and single gravid female mite from each sample was collected using camel hair brush and placed on mulberry leaf kept on wet sponge in plastic trays to establish isoline cultures. For morphological characterisation of mites,

permanent slides of male and female specimens from each established isolate culture were prepared separately, using Hoyer's medium. Female specimens were mounted in dorsal orientation, while male specimens were mounted in both dorsal and lateral orientation. The slides were observed under phase contrast microscope (Leica DM 500 phase contrast microscope), which has image analyzer software, to study the taxonomic characters. Characters such as chaetotaxy of hysterosoma and legs and structure of empodium of legs of female were used for genus level identification, while the shape of male genitalia, aedeagus was used for species level identification. Slide mounted specimens were identified based on the available species description and taxonomic keys provided by Gupta (1985), Gupta and Gupta (1994), Ehara (1995), Srinivasa et al. (2012) and Zeity et al. (2016).

RESULTS AND DISCUSSION

The study recorded eight species of spider mites belonging to three genera viz., *Tetranychus* Dufour, *Oligonychus* Berlese and *Eutetranychus* Banks in association with 14 ornamental plants. The genus

Tetranychus was diverse with six species viz., *Tetranychus truncatus* Ehara, *T. okinawanus* Ehara, *T. urticae* Koch, *T. fijiensis* Hirst, *T. neocaledonicus* Andre and *T. marianae* McGregor. One species each were recorded from the genera, *Oligonychus* and *Eutetranychus* viz., *Oligonychus biharensis* Hirst and *Eutetranychus orientalis* Klein, respectively (Table 1).

Spider mite fauna on rose was found to be more diverse with five species viz., *T. truncatus*, *T. urticae*, *T. okinawanus*, *T. marianae* and *O. biharensis*. Both gerbera and chrysanthemum recorded two mite species viz., *T. okinawanus* and *T. urticae*, while marigold recorded *T. okinawanus* and *T. truncatus*. Adenium and balsam recorded only *T. okinawanus*, while bauhinia and pinto peanut recorded only *O. biharensis*. The ornamental plants zinnia, cock's comb, cassia, cairo morning glory and crape jasmine recorded one species each of spider mite viz., *T. neocaledonicus*, *T. truncatus*, *T. fijiensis*, *T. okinawanus* and *Eutetranychus orientalis* respectively.

Taxonomic key to the identification of spider mites

Table 1. Spider mites associated with ornamental plants of Kerala

S. No.	Plant	Location	GPS coordinates		Species
			Latitude (°N)	Longitude (°E)	
1.	Rose	Vellanikkara	10.33	76.17	<i>Tetranychus okinawanus</i> Ehara
		Vellanikkara	10.32	76.16	<i>Tetranychus urticae</i> Koch
		Madakkathara	10.33	76.15	<i>Tetranychus urticae</i> Koch
		Vellanikkara	10.55	76.28	<i>Tetranychus marianae</i> McGregor
		Elanadu	10.62	76.39	<i>Tetranychus truncatus</i> Ehara
2.	Adenium	Aryampadam	10.55	76.28	<i>Oligonychus biharensis</i> Hirst
		Manaloor	10.49	76.10	<i>Tetranychus okinawanus</i> Ehara
3.	Gerbera	Vellanikkara	10.55	76.28	
		Paravattani	10.52	76.24	<i>Tetranychus Okinawanus</i> Ehara
4.	Zinnia	Vellanikkara	10.32	76.16	<i>Tetranychus urticae</i> Koch
		Vellanikkara	10.32	76.16	<i>Tetranychus neocaledonicus</i> Andre
5.	Cairo morning glory	Vyttila	9.98	76.32	<i>Tetranychus okinawanus</i> Ehara
		Vellanikkara	10.33	76.17	<i>Tetranychus truncatus</i> Ehara
6.	Marigold	Odakkali,	10.05	76.33	
		Vellanikkara	10.55	76.28	<i>Tetranychus okinawanus</i> Ehara
7.	Chrysanthemum	Madakkathara	10.33	76.15	<i>Tetranychus urticae</i> Koch
		Vellanikkara	10.32	76.16	<i>Tetranychus truncatus</i> Ehara
8.	Cock's comb	Vellanikkara	10.32	76.16	
		Vellanikkara	10.32	76.16	<i>Oligonychus biharensis</i> Hirst
9.	Pinto peanut	Vellanikkara	10.32	76.16	
		Odakkali	10.04	76.37	
10.	Balsam	Vellanikkara	10.54	76.27	<i>Tetranychus okinawanus</i> Ehara
		Wadakkanchery	10.63	76.22	
11.	Orchid	Vellanikkara	10.54	76.28	<i>Tetranychus okinawanus</i> Ehara
12.	Bauhinia	Vellanikkara	10.32	76.16	<i>Oligonychus biharensis</i> Hirst
13.	Cassia	Vellanikkara	10.32	76.16	<i>Tetranychus fijiensis</i> Hirst
14.	Crape jasmine	Vellanikkara	10.32	76.16	<i>Eutetranychus orientalis</i> Klein

associated with ornamental plants collected during the study is furnished below.

1a. Tarsus I without duplex setae (Fig. 1B); empodium absent (Fig. 1B); with 2 pairs of anal setae (Fig. 1A).....**Genus *Eutetranychus* Banks**

.....aedeagus hook-like with distal bent longer than dorsal margin of shaft, slightly concave (Fig. 4A)***Eutetranychus orientalis* Klein**

1b. Tarsus I with two sets of duplex setae; empodium well developed: with one pair of anal setae.....2

2a. Tarsus I with two sets of duplex setae distal and adjacent (Fig. 2A); empodium of legs claw like with proximoventral hairs (Fig. 2B).....

.....**Genus *Oligonychus* Berlese**

.....aedeagus long and slender with axis of the knob parallel to the shaft; posterior projection of aedeagal knob acute with tip bending downward; dorsal surface of the knob nearly straight (Fig. 4B).....

.....***Oligonychus biharensis* Hirst**

2b. Tarsus I with two sets of duplex setae well separated (Fig. 3A), dividing segment into three more or less equal parts; empodium of legs split distally into three pairs (Fig. 3B).....**Genus *Tetranychus* Dufour**.....3

3a. Aedeagus very long, slender bend upward, tapers distally (Fig. 4C)***Tetranychus fijiensis* Hirst**

3b. Aedeagus not very long, with a knob distally.....4

4a. Aedeagal knob with anterior projection rounded.....5

4b. Aedeagal knob with anterior projection not rounded.....6

5a. Anterior projection of knob broadly rounded; posterior projection of knob very narrow, acute resembling bird's beak (Fig. 4D).....***Tetranychus okinawanus* Ehara**

5b. Anterior and posterior projection of knob rounded and berry like; anterior projection better developed than posterior projection (Fig. 4E).....

.....***Tetranychus neocaledonicus* Andre**

6a. Dorsum of aedeagal knob convex; anterior and posterior projections of knob acute and similar (Fig. 4F).....***Tetranychus urticae* Koch**

6b. Dorsal surface of aedeagal knob not convex; anterior projection of knob not acute, anterior and posterior projections not similar.....7

7a. The dorsal margin of aedeagal knob with a medial indentation near the posterior half (Fig. 4G).....***Tetranychus truncatus* Ehara**

7b. Aedeagal knob with an acute/angulate posterior projection (Fig. 4H)...***Tetranychus marianae* McGregor**

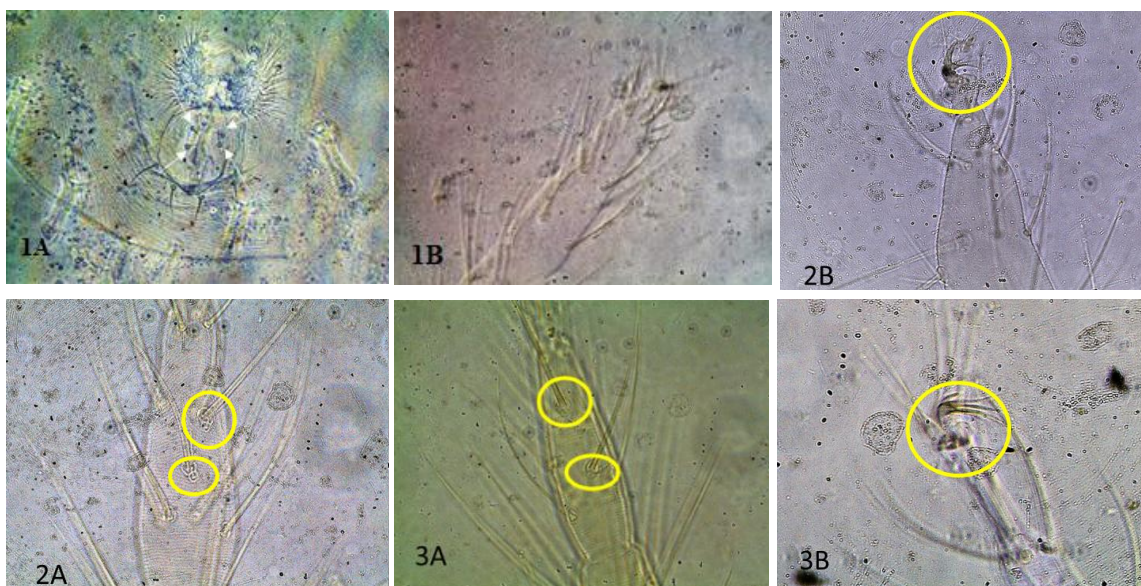


Fig. 1. Key characters of the genus *Eutetranychus* (100x); 1A. Anal setae; 1B. Tarsus I without empodium

Fig. 2. Key characters of the genus *Oligonychus* (100x); 2A. Duplex setae; 2B. Empodium

Fig. 3. Key characters of the genus *Tetranychus* (100x); 3A. Duplex setae; 3B. Empodium



Fig. 4. Aedeagus of species of spider mites (100 x); 4A. *Euteranychus orientalis* 4B. *Oligonychus biharensis* 4C. *Tetranychus fjiensis*; 4D. *T. okinawanus* 4E. *T. neocaledonicus* 4F. *T. urticae* 4G. *T. truncates* 4H. *T. marianae*

The spider mites collected on different host plants from different localities during the study were identified by examining morphological features of specimens. The three genera *Tetranychus*, *Oligonychus* and *Euteranychus* could be distinguished based on the structure of empodium (Fig. 1B, 2B, 3B) and position of duplex setae on tarsus I (Fig. 2A, 3A) (Gupta, 1985). The species of *Tetranychus* were identified based on the morphology of aedeagus, particularly the structure of aedeagal knob (Fig. 4 C - H) (Gupta, 1985; Gupta and Gupta, 1994; Ehara, 1995; Srinivasa et al., 2012; Zeity et al., 2016).

The study recorded *T. okinawanus* as the predominant mite species on ornamental plants. It recorded wider host range (8 host plants) and the associated host plants include rose, gerbera, adenium, balsam, marigold, chrysanthemum, orchid and cairo morning glory. All host plants recorded in this study, except adenium are new host record for *T. okinawanus* from India. This species was reported for the first time from India on the ornamental plant, *Adenium obesum* from a nursery in Thrissur district in Kerala (Zeity et al., 2016). Later it was reported on cucumber (Bennur et al., 2015; Lenin et al., 2015 and Lenin and Bhaskar, 2016), papaya, ashgourd, brinjal and cowpea (Arunima et al., 2017) from different localities of Kerala.

In the study, *T. truncatus* was recorded on marigold, cock's comb, and rose from different localities of Thrissur district. In India, *Tetranychus truncatus* was first reported from Northwestern Himalayan regions of Jammu and Kashmir and Himachal Pradesh (Rather, 1983). However, Gupta and Gupta (1994), stated that the record of *T. truncatus* on *Dahlia* sp. from Jammu and Kashmir could be *T. urticae*, which was known to infest *Dahlia*. Long years later, Srinivasa et al. (2012)

reported *T. truncatus* from Karnataka on mulberry. In Kerala, *T. truncatus* was first reported by Bennur et al. (2015) who recorded the mite species on some vegetable crops. The mite also infests cucumber and amaranthus grown in polyhouses in Kerala (Lenin and Bhaskar, 2016). Later, Arunima (2017) reported *T. truncatus* on cowpea, pumpkin, tapioca, banana and *Dahlia* from different regions of Kerala. The mite has recently emerged as a serious pest of banana (Nendran) in Kerala (Bhaskar and Lenin, 2018). This study records three new host plants for *T. truncatus* from India viz., marigold, cock's comb, and rose.

The present study recorded *T. urticae* Koch on rose, chrysanthemum and gerbera from different localities of Thrissur district. The two spotted spider mite, *T. urticae* was first described by Koch in 1836 (Pritchard and Baker, 1955), and later found to be distributed throughout the tropical and sub-tropical parts of the world (Jeppson et al., 1975). Out breaks of *T. urticae* infestation on lady's finger and beans in Bangladesh has been reported by Gapud (1981). Biswas et al. (2004) reported that the mite infests vegetable crops and ornamental plants in Bangladesh. Tehri (2014) documented pest status of *T. urticae* on green house vegetables, ornamental and horticultural crops worldwide and reported its polyphagous nature. The spider mite, *T. urticae* is a serious pest on rose grown in polyhouse and open condition in Navsari, Gujrat (Desai et al., 2017). In Kerala, the two spotted spider mite, *Tetranychus urticae* was reported as a predominant species on vegetable crops viz., brinjal, bhindi, amaranthus and cowpea (Sudharma and Nair, 1999; Binisha and Bhaskar, 2013). Lekha and Kinathi (2019) reported *T. urticae* on brinjal, moringa and winged bean from Northern districts of Kerala. However, recent studies conducted by All India

Network Project on Agricultural Acarology to document spider mite diversity on crops of Kerala during 2013-2018 did not record *T. urticae* on vegetable crops. But in this study, *T. urticae* was found infesting rose grown both under polyhouse and open condition as well as on gerbera and chrysanthemum.

The mite species, *Tetranychus neocaledonicus* was recorded on ornamental plant zinnia from Vellanikkara, Thrissur. It is a cosmopolitan species in tropical and subtropical areas, infesting a wide variety of agricultural plants (Pritchard and Baker, 1955; Bolland et al., 1998). It was reported in India by Khot and Patel (1956), later by Manson (1963), Nassar and Ghai (1981) Gupta (1992); Gupta and Gupta (1994); Gupta, 1995; Gupta and Chatterjee, 1997; and Migeon (2015). Recently Lekha and Kinathi (2019) also reported *T. neocaledonicus* on brinjal, tomato and okra from Kerala. The reported host range of *T. neocaledonicus* include *Chrysanthemum* sp., *Dahlia* sp., *Gerbera* sp., *Helianthus annuus*, *Tagetes erecta*, *Gladiolus* sp., *Bauhinia* sp., *Bougainvillea* sp., *Jasminum* sp. and *Arachis pintoi* (Spider Mite Web, 2019).

The study recorded the mite species, *T. marianae* on rose from Vellanikkara. This is the first record of the species from Kerala. *Tetranychus marianae* was first described by McGregor in 1950 from USA. Later it was reported from 71 different host plants from different countries (Bolland et al., 1998). In India it was first reported from Karnataka, recently by Zeity et al. (2016) on *Centrocema pubescence*, and later only during this study.

In the study, *Oligonychus biharensis* was recorded on rose, bauhinia and pinto peanut. The mite is a native of India and described by Hirst in 1924. It was later reported by Nassar and Ghai (1981); Gupta (1992); Gupta and Gupta (1994). Its host range among ornamental plants include rose, bauhinia and hibiscus (Spider Mite Web, 2019).

The spider mite species, *E. orientalis* was recorded only on crape jasmine, while *T. fijiensis* was recorded only on cassia. *Eutetranychus orientalis* is a polyphagous mite reported on a wide range of crops (Spider Mite Web, 2019). In India *Tetranychus fijiensis* has been reported by Hirst (1924); Manson (1963); Daniel (1977); Gupta (1992); Gupta & Gupta (1994). Later it was recorded by Zeity et al. (2016) on *Arachis hypogea*, *Ficus racemosa*, *Mangifera indica*, *Ricinus communis* and *Zea mays*. *Cassia* sp. is a new host record for *T. fijiensis*.

The study on diversity of spider mites revealed that *T. okinawanus* is the predominant species infesting ornamental plants in Kerala. The study reports *T. marianae* for the first time in Kerala. The study has also shown that the ornamental plant, rose harbours many species of spider mites, indicating the need for imposing strict quarantine regulations for movement of planting materials of rose to avoid entry and invasion of mites into new areas. The study reports many new hosts for *T. okinawanus* and *T. truncatus*, indicating the potential of the mite species which were only recorded recently from Kerala, to turn invasive in Kerala's ecosystems is also brought out in the study.

REFERENCES

- Spider mites web. 2019. <http://www.montpellier.inra.fr/CBGP/spmweb> (Accessed on 10.03.2019).
- Arunima V. 2017. DNA barcoding of spider mites (Prostigmata: Tetranychidae) on major crop plants of Kerala. MSc (Ag) thesis. KAU, Thrissur. 59 pp.
- Bennur S, Abida P S, Valsala P A, Mathew D, Bhaskar H. 2015. DNA barcoding of spider mites (Prostigmata: Tetranychidae) in vegetables using *COI* and *ITS2* markers. *Genome* 58(5): 195.
- Bhaskar H, Lenin N. 2018. Management of banana leaf mite, *Tetranychus truncatus* (Prostigmata: Tetranychidae), a new pest of banana. Book of abstracts, National seminar on frontiers in biological research. March 12-14, 2018. Department of Zoology, University of Calicut, Kerala, 9 p.
- Biswas G C, Islam W, Haque M M, Saha R K, Hoque K M P, Islam M S, Haque M E. 2004. Some biological aspects of carmine mite, *Tetranychus cinnabarinus* Boisd. (Acari: Tetranychidae) infesting egg-plant from Rajshahi. *Journal of Biosciences* 4(5): 588-591.
- Bolland H R, Gutierrez J, Flechtmann C H W. 1998. A world catalogue of the spider mite family (Acari: Tetranychidae). Brill Academic Publishers, Netherlands. 392 pp.
- Desai S R, Patel K G, Shukla A. 2017. Seasonal incidence of spider mite (*Tetranychus urticae* Koch) (Acari: Tetranychidae) infesting rose under poly house condition. *International Journal of Current Microbiology and Applied Sciences* 6(9): 2661-2669.
- Dhooria M S. 2016. Fundamentals of applied acarology. Springer, New York. 470 pp.
- Ehara S. 1995. A New Species of *Tetranychus* (Acari, Tetranychidae) from the Ryukyu Islands. *Japan Journal of Entomology* 63 (1): 229-233.
- Gapud V P. 1981. Insect and mite pest of plant crops in Bangladesh and their natural enemies. In: A Compendium for biological control in IPM. United States agency for International development agriculture research council/Chechi and company consulting Inc. 265 pp.
- Gupta S K. 1985. Handbook. Plant mites of India. Zoological Survey of India, Calcutta. 520 pp.
- Gupta S K. 1992. Arachnida: Plant mites (Acari). In: Ghosh, A. K. (ed.), Fauna of West Bengal (3rd Ed.). Zoological Survey of India, Calcutta. 61-211 pp.
- Gupta S K. 1995. Plant mites (Acari). In: Alfred, J. R. B. (ed.), Fauna of Meghalaya (2nd Ed.). Zoological Survey of India, Calcutta. 17-50 pp.
- Gupta S K, Chatterjee K. 1997. Acari: plant mites. Fauna of Delhi (6th Ed.). Zoological Survey of India, Calcutta. 485-532 pp.
- Gupta S K, Gupta Y N. 1994. A taxonomic review of Indian Tetranychidae

- (Acari: Prostigmata) with description of new species, re-descriptions of known species and keys to genera and species. Memoirs Zoological Survey of India 18: 1-196.
- Gupta S K, Gupta Y N. 1994. A taxonomic review of Indian Tetranychidae (Acari: Prostigmata) with description of new species, re-descriptions of known species and keys to genera and species. Memoirs of Zoological Survey of India. 18: 1-196.
- Jeppson L R, Keifer H H, Baker E W. 1975. Mites injurious to economic plants. University of California Press. 614 pp.
- Khot K N, Patil G P. 1956. Life history of the gladiolus mite, *Tetranychus equatorius* McGregor. Indian Journal of Science 18(2): 149-164.
- Lekha C, Kinathi S. 2019. Phytophagous mites infesting vegetable crops of Kerala, India. Persian Journal of Acarology 8: 69-72.
- Lenin N, Bhaskar H. 2016. Mite pests of vegetable crops under protected cultivation in Kerala. Entomon 41 (3): 305-308.
- Lenin N, Bhaskar H, Abida P S, Mathew P M. 2015. Molecular approach in species determination of *Tetranychus* complex in polyhouse cucumber. Genome 58(5): 244.
- Manson D C M. 1963. Mites of the families Tetranychidae and Tenuipalpidae associated with citrus in South East Asia. Acarologia 5: 351-364.
- Migeon A. 2015. The Jean Gutierrez spider mite collection. Zookeys 489: 15-24.
- Nassar O A, Ghai S. 1981. Taxonomic studies on tetranychoid mites infesting vegetable and fruit crops in Delhi and surrounding areas. Oriental Insects 15: 333-396.
- Pritchard A E, Baker E W. 1955. A revision of the spider mite family Tetranychidae. Memoirs of Pacific Coast Entomological Society. 472 pp.
- Rather A Q. 1983. New records of five genera and eighteen species of phytophagous mites (Acarina) from India with notes on their host range, distribution and economic importance. In: Abstracts of 2nd All India Symposium on Acarology, Pune, 1983, 25-26 pp.
- Srinivasa N, Gowda C C, Mallik B, Raghavendra P. 2012. New record of *Tetranychus truncatus* (Ehara) as a potential pest from Karnataka. Indian Journal of Entomology 74(4): 379-383.
- Sudharma K, Nair G M. 1999. Occurrence of phytophagous mites and natural enemies on vegetables in Kerala. Insect Environment 5: 15-16.
- Tehri K. 2014. A review on reproductive strategies in two spotted spider mite, *Tetranychus urticae* Koch 1836 (Acari: Tetranychidae). Journal of Entomology and Zoology Studies 2(5): 35-19.
- Zeity M, Srinivasa N, Gowda C C. 2016. New records of spider mites and description of male of *Stylophoronychus baghensis* Prasad (Acari: Tetranychidae) from India. Oriental Insects 50(3): 119-128.
- Zeity M, Srinivasa N, Gowda C C. 2016. New species, new records and re-description of spider mites (Acari: Tetranychidae) from India. Zootaxa 4085 (3): 416-430.

(Manuscript Received: November, 2020; Revised: January, 2021;
Accepted: January, 2021; Online Published: May, 2021)
Online published (Preview) in www.entosocindia.org Ref. No. e20277