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**Research Article**

# Diversity of mite (Acari) fauna associated with vegetables and ornamental plants in mid-hill conditions of Himachal Pradesh, India

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**ABSTRACT:** Survey was conducted in mid-hills of Himachal Pradesh during 2011-2012 to study the mite diversity in 16 different vegetables and ornamental crops. These ecosystems were surveyed to collect the prey and predatory mites at different locations. A total of 32 species in 15 genera and 7 families were observed during this study, out of which 6 species were of phytophagous mites belonging to 2 genera and 2 families, whereas 26 species were of the predatory mites belonging to 13 genera and 5 families. Among phytophagous mites, three species *viz. Tetranychus urticae* Koch, *T. ludeni* Zacher, *T. hypogeae* Gupta were most commonly found and recorded on different crops. Among predatory mites, 4 genera *viz. Amblyseius, Euseius, Neoseiulus* and *Amblydromella* were most common. Maximum numbers of predatory mite species were recorded on rose, cucumber and brinjal. Five genera of predatory mites *viz. Paraphytoseius*, *Pennaceius*, *Typhlodromips, Typhlodromalus* and *Lasioseius* were the new record in the state

**KEY WORD**: Acari-fauna, bio-control, phytophagous, predators, species diversity.

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## INTRODUCTION

Soil and climatic conditions in mid-hill region of Himachal Pradesh is suitable for growing a large number of ornamental and vegetable crops. Due to introduction of high yielding varieties, especially under poly-house conditions and with subsequent improvement in cultural practices the pest menace has aggravated in these crops. Mite pests are reported to be one of the important limiting factors in vegetable production in India (Channa Basavanna, 1971). These pests thrive and reproduce throughout the year on a wide range of crops and weeds especially under poly-house conditions. In India, spider mite is reported as serious pest of vegetables (Singh and Singh, 1996; Prasad, 2007). Average yield loss to vegetable crops was estimated to be 9.15-100% due to mite infestation, as reported by many authors in different agro-climatic conditions of the country (Gupta, 1991; Singh, 1995; Rai and Tripathi, 1999; Prasad and Singh, 2007; Prasad *et al.,* 2007; Patil and Nandihalki, 2009 and Vinothkumar *et al.*, 2009). World over insecticidal resistance is reported by mites on various crops (Craham and Helle, 1985; Goodwin *et al.*, 1991). In India, resistance was observed against dicofol (EC), dicofol (WP), abamectin, phosalone, phosphamidon, dimethoate, dicofol and wetable sulpher in different vegetables (Kumar *et al.,* 2001; Kumar *et al.,* 2002; Jhansi Rani and Sridhar, 2002; Sridhar and Jhansi Rani, 2003, 2007). Mite shows complicated behavioural pattern which enables them to reach the maximum advantage and also to cope with the vagaries of nature. Before applying the management tactics to control these destructive pests, primary requirement is to know their identity, host crops, distribution, seasonal fluctuation and their natural enemy complex. As the modern management practices are species specific, it is utmost important to know the diversity of various prey and predatory species so as to device effective management strategies on these crops.

Very meagre information is available on the mite and its predatory fauna on vegetable and ornamental crops under mid hill conditions of Himachal Pradesh. Earlier *Tetranychus ludeni* Zacher and *Euseius delhiensis* (Narayanan and Kaur) were reported on *Dahlia* sp. and rose (Sood and Kakar, 1990; Chauhan and Thakur 2007). No detail information is available on mite fauna on vegetable crops. Keeping this in view the present investigation was carried out to explore the diversity of phytophagous mites and their associated predatory mite complex on ornamentals and vegetables.

## MATERIALS AND METHODS

A regular survey was conducted during 2011 and 2012 on monthly basis from different ornamental and vegetable crops grown in different localities in mid-hill region of Himachal Pradesh. Leaf samples were examined with 10X hand lens, collected in polythene bags properly tied and brought to the laboratory. These samples were observed under the binocular microscope and mite specimens were picked with the help of fine needle and preserved in a mixture of 70% alcohol and glycerine (10:1). Clearing was done in 70% lactic acid for 4-6 hrs in cavity block at 40-60$^0$C. Tetranychid specimens were cleared in lactic acid and lignin pink in cavity block by placing cavity blocks on electric slide warmer (40-60$^o$C) for 1-2 hrs (Gutierrez, 1985). Lactic acid inflates the body and lignin pink makes the specimen translucid enabling it clearly visible under microscope. These specimens were picked with fine needle and mounted in drop of Hoyer's medium as per method given by Jeppson *et al.* (1975). Slides were dried in oven at 35-40$^o$C for 3-4 days. Identification of specimens was done under phase contrast microscope up to genera and species level by following the standard keys (Gupta and Gupta, 1994; Gupta, 2003). The diversity of predatory mites was calculated by using Shannon diversity index (1948).

$$\text{Shannon diversity index } (H^1) = \sum_{i=1}^{s} Pi\ (\ln Pi)$$

$H_{max} = \ln K$
where K is the number of species
Species evenness (J) = $H/H_{max}$
Species dominance = 1-J

## RESULTS AND DISCUSSION

During the present investigation rose, marigold, antirrhinum, carnation, weigella, english ivy, prime rose, cucumber, tomato, brinjal, cabbage, kale crop, red cabbage, capsicum, okra and bean were regularly surveyed. 32 mite species of 15 genera and 7 families were collected from these plants in mid-hill regions. Six species under two genera belonging to two phytophagous families *viz.* Tetranychidae and Eriophyidae and 26 species of 13 genera belonging to five predatory families *viz*. Anystidae, Ascidae, Phytoseiidae, Stigmaeidae, and Tydeidae were observed (Table.1).

On ornamentals, among phytophagous mites, most predominant species infesting these crops were *Tetranychus urticae* Koch observed on rose, marigold, antirrhinum and carnation. Earlier, *Tetranychus cinnabarinus* (Boisd.) and *Eutetranychus orientalis* (Klein) were reported as serious pests on ornamental crops from Punjab (Dhooria, 2009a; Dhooria, 2009b). In the present study, *Tetranychus ludeni* Zacher was observed on rose, antirrhinum and carnation. Earlier, this species was also reported on *Dahlia* by Sood and Kakar (1990) from Himachal Pradesh. In the present investigation, *Tetranycjus hypogeae* Gupta and *T. hydrangeae* Pritchard and Baker were recorded on primrose and weigella which were the first records in the state.

In vegetable crops, *Tetranychus urticae* was observed on cucumber, okra, tomato, bean and red cabbage. *Tetranychus ludeni* was observed on cucumber. Rai and Inderajeet (2011) reported *T. urticae*, *T. ludeni, Tetranychus neocaledonicus* Andre and *Tetranychus macfarlanei* Baker and Pritchard infesting many vegetables like okra, brinjal, cowpea, chilli, pumpkin, bitter gourd, cucumber, bottle gourd, sponge gourd, tomato, watermelon etc. in two district of eastern Uttar Pradesh. Eriophyidae mites were observed on brinjal and tomato in the month February to June in the present study. Rai and Inderajeet (2011) also reported Eriophyidae mite, *Aceria lycopersici* Wolff on tomato and brinjal from Uttar Pradesh.

The association of predatory mites with various species of prey mites and insect on different host plants observed in the present investigation are given in (Table 1). In this study, ten species of predatory mite *viz*. *Amblyseius largoensis* (Muma), *Neoseiulus longispinosus* (Evans), *Neoseiulus paspalivorus* (DeLeon), *Euseius finlandicus* (Oudemans), *Euseius alstoniae* Gupta, *Euseius prasadi* (Chant & McMurty), *Euseius* sp. and *Lasioseius* sp. were observed on rose (Table 2) associated with *T. urticae* and *T. ludeni*. *Lasioseius* genus was the first record on rose in the state. *Phytoseius roseus* Gupta and *Euseius delhiensis* (Narayanan and Kaur) were also observed on rose associated with pupae of whitefly. *Euseius delhiensis* was reported earlier by Chauhan and Thakur (2007) as predator of whitefly on rose in this area. *Neoseiulus paspalivorus* and *Neoseiulus* sp. (near to *paspalivorus*) were observed on primrose associated with *T. hypogeae*. *Neoseiulus longispinosus* was observed on english ivy. *Tydius* sp. was observed on bamboo. Both these habitats were new for these species in this region.

In vegetables, eight species of predatory mites were recorded on cucumber (Table 3). *Amblyseius largoensis* (Muma), *Amblyseius herbicolus* (Chant), *Amblyseius* sp. (close to *herbicolus*), *Amblyseius* sp., *Euseius finlandicus* (Oudemans), *Euseius prasadi* (Chant and Mcmurty), *Euseius neococcinae* Gupta and *Typhlodromips guajavae* Gupta.

These were associated with *T. urticae*, *T. ludeni* and whitefly. Earlier, *A. largoensis*, *A. herbicolus* and *E. finlandicus* were reported on pointed gourd and cowpea associated with *Polyphagotarsonemus latus* (Banks), *T. urticae* and *Panonychus citri* (McGregor) (Karmakar and Gupta, 2011). In the present investigation *E. neococcinae* and *T. guajavae* were new record in the state. *Agistimus* sp. observed on cucumber associated with *T. urticae* and *T. ludeni*. On capsicum only one species *Anystus baccarum* (Linn.) was observed. *Neoseiulus oahuensis* Prasad was observed on tomato for the first time which was associated with *T. urticae*, *Tetranychus* sp. and Eriophyid mites. Six species of predatory mites were observed on brinjal (Table 4) *viz*. *Paraphytoseius multidentatus* Swirski & Shechter, *Amblydromella himalayensis* Gupta, *Amblydromella mori* Gupta, *Phytoseius crinitus* Swirski & Shechter, *Pennaseius kapuri* Gupta, *Typhlodromalus chitradurgae* Gupta, associated with *Tetranychus* sp. and Eriophyidae mites. *P. multidentatus* was reported by Karmakar and Gupta, (2011) on brinjal associated with *Polyphagotarsonemus latus* (Banks).

**Table 1. Diversity of predatory mites in different habitats**

| Predatoty mites | Associated arthropods | Habitat |
|---|---|---|
| *Amblyseius largoensis* (Muma) | *Tetranychus urticae* Koch, *T. ludeni* Zacher and white fly | Rose (*Rosa indica* f. Rosaceae) and cucumber (*Cucumis sativa*, f. Cucurbitaceae) |
| *Amblyseius herbicolus* (Chant) | *Tetranychus urticae*, *T. ludeni* and white fly | Cucumber (*Cucumis sativa* f. Cucurbitaceae) |
| *Amblyseius.* sp. (close to herbicolus) | *Tetranychus urticae*, *T. ludeni* and white fly | Cucumber (*Cucumis sativa*, f. Cucurbitaceae), |
| *Amblyseius* sp. | *Tetranychus urticae*, *T. ludeni* and white fly | Cucumber (*Cucumis sativa*, f. Cucurbitaceae) |
| *Amblydromella mori* Gupta | *Tetranychus urticae* and Eriophyidae mites | Brinjal (*Solanum melongena* f. Solanaceae) |
| *Amblydromella himalayensis* Gupta | Eriophyidae mites | Brinjal (*Solanum melongena* f. Solanaceae) |
| *Anystus baccarum* (Linn.) | Unknown | Capsicum (*Capsicum* sp. f. Solanaceae) |
| *Agistimus* sp. | *Tetranychus urticae*, *T. ludeni* and white fly | Cucumber (*Cucumis sativa*, f. Cucurbitaceae) |
| *Euseius alstoniae* Gupta | *Tetranychus urticae* | Rose (*Rosa indica* f. Rosaceae) |
| *Euseius delhiensis* (Narayanan & Kaur) | *Tetranychus urticae* and pupae of whitefly | Rose (*Rosa indica* f. Rosaceae) |
| *Euseius finlandicus* (Oudemans) | *Tetranychus urticae*, *T. ludeni* and white fly | Rose (*Rosa indica* f. Rosaceae) and cucumber (*Cucumis sativai*, f. Cucurbitaceae) |
| *Euseius neococcineae* Gupta | *Tetranychus urticae*, *T. ludeni* and white fly | Cucumber (*Cucumis sativa*, f. Cucurbitaceae) |
| *Euseius prasadi* (Chant & McMurty) | *Tetranychus urticae*, *T. ludeni* and white fly | Rose (*Rosa indica* f. Rosaceae) and cucumber (*Cucumis sativa*, f. Cucurbitaceae) |
| *Euseius* sp. | *Tetranychus urticae* | Rose (*Rosa indica* f. Rosaceae) |
| *Lasioseius* sp. | *Tetranychus urticae* | Rose (*Rosa indica* f. Rosaceae) |
| *Neoseiulus longispinosus* (Evans) | Unknown | *English ivy (Hedera helix,* f. Araliaceae) |
| *Neoseiulus oahuensis* Prasad | Eriophyidae mites and *Tetranychus urticae* | Tomato (*Solanum lycopercicum, f.* Solanaceae) |
| *Neoseiulus paspalivorus* (DeLeon) | *Tetranychus urticae* | Rose (*Rosa indica* f. Rosaceae) and Primerose (*Primulla vulgaris,* f. Primulaceae) |
| *Neoseiulus* sp. (near to paspalivorus) | *Tetranycus hypogeae* Zacher | Primerose ( *Primulla vulgaris,* f. Primulaceae) |
| *Paraphytoseius multidentatus* (Swirski & Shechter) | Eriophyidae mites and *Tetrnychus* sp. | Brinjal (*Solanum melongena* f. Solanaceae) |
| *Pennaceius kapuri* Gupta | Eriophyidae mites and *Tetranychus* sp. | Brinjal (*Solanum melongena* f. Solanaceae) |
| *Phytoseius crinitus* Swirski & Shechter | Eriophyidae mites and *Tetranychus* sp. | Brinjal (*Solanum melongena* f. Solanaceae) |
| *Phytoseius roseus* Gupta | Pupae of whitefly | Rose (*Rosa indica* f. Rosaceae) |
| *Typhlodromips guajavae* Gupta | *Tetranychus urticae*, *T. ludeni* and white fly | Cucumber (*Cucumis sativa* f. Cucurbitaceae) |
| *Typhlodromalus chitradurgae* Gupta | Eriophyidae mites and *Tetranychus* sp. | Brinjal (*Solanum melongena* f. Solanaceae) |
| *Tydeus* sp. | Unknown | Bamboo (*Bambussa deltoids* f. Poaceae) |

**Table 2. Relative abundance and diversity index for predatory mites on Rose**

| Species | #Mean of species | Relative Abundance |
|---|---|---|
| *Euseius finlandicus* (Oudemans) | 5 | 16.67 |
| *Euseius prasadi* (Chant & McMurty) | 4 | 13.33 |
| *Euseius delhiensis* (Narayanan & Kaur) | 5 | 16.67 |
| *Euseius alstoniae* Gupta | 3 | 10.00 |
| *Euseius* sp. | 2 | 6.67 |
| *Lasioseius* sp. | 1 | 4.00 |
| *Neoseiulus paspalivorus* (DeLeon) | 3 | 10.00 |
| *Neoseiulus longispinosus* (Evans) | 6 | 20.00 |
| *Phytoseius roseus* Gupta | 1 | 3.33 |
| Total | 30 | |

#Population mean on 5 leaves

| | | |
|---|---|---|
| $H^1$ | = | 2.071 |
| Hmax | = | 2.197 |
| Species evenness (J) | = | 0.943 |
| Species dominance | = | 0.057 |

**Table 3. Relative abundance and diversity index for predatory mites on cucumber**

| Species | #Mean of species | Relative Abundance |
|---|---|---|
| *Agistimus* sp. | 1 | 3.03 |
| *Amblyseius herbicolus* (Chant) | 5 | 15.15 |
| *Amblyseius* sp. near *herbicolus*) | 4 | 12.12 |
| *Amblyseius largoensis* (Muma) | 8 | 24.24 |
| *Amblyseius* sp. | 2 | 6.06 |
| *Euseius finlandicus* (Oudemans) | 6 | 18.18 |
| *Euseius neococcinae* Gupta | 4 | 12.12 |
| *Typhlodromus guajavae* Gupta | 3 | 9.09 |
| Total | 33 | |

#Population mean on 5 leaves

| | | |
|---|---|---|
| $H^1$ | = | 1.945 |
| Hmax | = | 2.079 |
| Species evenness (J) | = | 0.935 |
| Species dominance | = | 0.065 |

**Table 4. Relative abundance and diversity index for predatory mites on brinjal**

| Species | #Mean of species | Relative Abundance |
|---|---|---|
| *Phytoseius crinitus* Swirski & Shechter | 2 | 18.18 |
| *Penaseius kapori* Gupta | 3 | 27.27 |
| *Amblydromella mori* Gupta | 1 | 9.09 |
| *Amblydromella himalayensis* Gupta | 1 | 9.09 |
| *Typhlodromalus chitradurgae* | 1 | 9.09 |
| *Paraphytoseius multidentatus* (Swirski & Shechter) | 3 | 27.27 |
| Total | 11 | |

#Population mean on 5 leaves

| | | |
|---|---|---|
| $H^1$ | = | 1.673 |
| Hmax | = | 1.792 |
| Species evenness (J) | = | 0.934 |
| Species dominance | = | 0.066 |

In the present study predatory mites *viz*. *P. multidentatus*, *P. kapuri*, *T. chitradurgae*, *T. guajavae*, *N. oahuensis*, *E. neococcinae, A. baccarum* and genus *Lasioseius* were new record on vegetable in the state and these were not reported earlier on any crop.

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