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Study on diversity and community structure of mite fauna associated with vegetable crops in West Bengal, India

S.C. Bala[1] and K. Karmakar[2]*

[1]All India Network Project on Agricultural Acarology, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741 235, India

[2]Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741 252, India

***Corresponding Author Email :** kkbckv64@gmail.com

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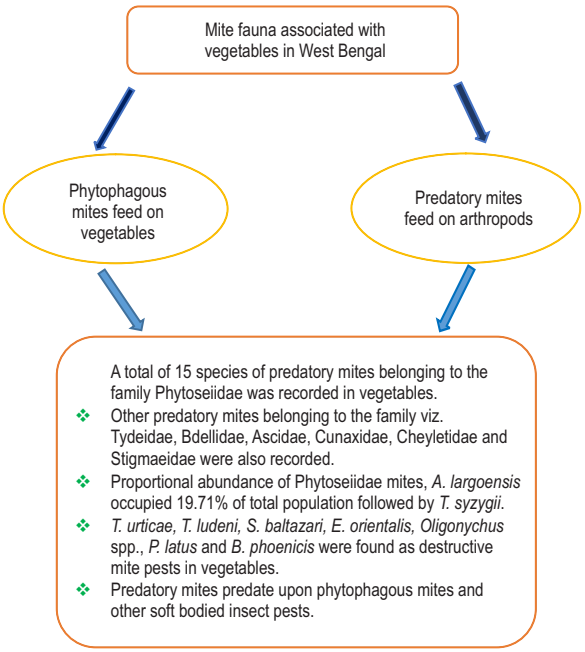
Abstract

Aim: A study was carried out to understand the diversity and community structures of phytoseiid and phytophagous mite fauna associated with vegetable crops in West Bengal aiming for the development of better and ecologically sound mite pest management strategy.

Methodology: Mite samples were collected from different agro-climatic zones of West Bengal and the specimens were brought to the AINP on Agricultural Acarology laboratory, BCKV, Kalyani for mounting on glass slides using modified Berlese's medium. The slides were then kept on slide wormer at 35-40°C for 5-7 days to process for observation under a phase contrast microscope.

Results: A total of fifteen species of phytoseiid mites were recorded belonging to the genera *Amblyseius, Euseius, Paraphytoseius, Typhlodromips, Scapulaseius, Neoseiulus, Phytoseius, Typhlodromus* (*Anthoseius*) and *Indoseiulus*. *Amblyseius largoensis* was observed as predominant mite species followed by *Typhlodromips syzygii* occupied 19.71 and 15.05 % of total predatory mite population, respectively. The other predatory mites belonging to the family Tydeidae, Bdellidae, Ascidae, Cunaxidae, Cheyletidae and Stigmaeidae were also recorded during the period of investigation. Predatory mites were observed to predate upon different stages of phytophagous mites, mealy bugs and pupae of whitefly. Concerning the phytophagous mites, *Tetranychus urticae, Tetranychus ludeni, Schizotetranychus baltazari, Eutetranychus orientalis, Oligonychus andropogoni, Polyphagotarsonemus latus* and *Brevipalpus phoenicis* were found as destructive mite pests in vegetables.

Interpretation: Phytophagous mite is a serious concern for successful vegetables cultivation in West Bengal. Predatory mites were found effective against phytophagous mites and other soft bodied insect and they could be utilized for biological control programme to minimize the use of chemical pesticides.



Key words: Diversity, Phytophagous mites, Predatory mites, Vegetable crops, West Bengal

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Introduction

West Bengal is the largest producer of horticultural crops accounting for 9.6% of total horticultural production in the country. The major horticulture produce, comprises vegetables (86.4%). The state produces 23.04 m. MT of vegetables from an area of 1.38 m. ha. with the productivity of 16.7 t ha^{-1}. Although, there are many constraints but severe infestation of pests and diseases limits the successful vegetable cultivation to obtain better crop yield and ensuring food security. In most cases, farmers rely on pesticides to manage insect pests and diseases in vegetable production that invoke resistance against pests and becoming a severe problem to mitigate insect pests attack to harvest good crop yields (Jallow *et al.,* 2017). Over use of pesticides is also leading to health problems and affecting on the environment when not handled properly. Moreover, due to introduction of high yielding varieties, expansion of irrigation facilities and adoption of modern cultural practices, mite pest problem has been increasing tremendously affecting vegetables production. Therefore, mite pests appears as one of the major limiting factors for vegetable cultivation in diverse agro-ecosystem in India.

Among them, spider mite menace is a serious concern for the cultivating solanaceae and cucurbitaceae vegetables. The average yield loss of 9.15-100% in vegetable crops due to severe infestation of spider mite has been reported (Prasad and Singh, 2007; Patil and Nandihalli, 2009; Prasad *et al.,* 2008, Vinoth Kumar *et al.,* 2009) in different agro-climate regions. Predatory mites belonging to the family Phytoseiidae constitute a significant beneficial group of mites having an important role for maintaining the harmful phytophagous mites and soft bodied insect pests. Farmers have now realized the tremendous potential of predatory mites as one of the most effective natural enemies to control the pest mites and small sucking insect species worldwide (Bjorson, 2008). Predatory mites have received global attention since 1950 owing to their significance as natural predators of phytophagous mites. Therefore, they can be adopted in the biological and integrated pest management strategies against different pest in vegetables (Swirski and Amitai, 1997), however, prior it is absolutely important to determine the diversity of phytoseiid mite species that can be employed in pest management strategies. Identification of beneficial mite fauna associated with vegetable is more important that might be exploited in biological pest control.

Till date, predatory mites of family Phytoseiidae consists more than 2,400 nominal species worldwide (Demite *et al.,* 2019) and every year new species are being supplemented to this list. The knowledge of Indian Phytoseiidae is based on several major contributions by Gupta (2003). Recent studies have raised the total number to 243 species belonging to 21 genera in three subfamilies of Phytoseiidae from India (Karmakar and Gupta, 2014; Pramanik and Karmakar, 2016; Karmakar *et al.,* 2017; Karmakar and Bhowmik, 2018; Kar and Karmakar, 2021; Molla *et al.,* 2021; Bhowmik and Karmakar, 2021). So far, there is no consolidated report of predatory mites from vegetable crops (Lahiri *et al.,* 2004; Karmakar and Gupta, 2011) and Haneef and Sadanandan, 2013). Due to inadequate information regarding mite fauna associated with vegetables in West Bengal, the present investigation was under taken to explore the diversity of phytophagous mites as well as their related predatory mites.

Materials and Methods

Study area: Mite samples were collected from different agro-climatic zones of West Bengal which covered Nadia, Murshidabad, Malda, North 24 Parganas, South 24 Parganas, Bankura, Burdwan, Hooghly, Jalpaiguri and Cooch Behar districts.

Collection and preservation of specimens: Phytoseiid mite fauna harbouring different species of vegetable crops were examined by making extensive survey covering different locations of West Bengal during 2018-2020. Phytoseiid mites were collected directly from the plant with a fine camel hair brush (size 000) and then preserved in 70% alcohol until permanent slides were prepared. Besides, a direct beating method was adopted, simply beating the plant parts over a black cardboard and the dislodged mites were collected with a single hair brush. The mite specimens were preserved in a separate small plastic vial containing 70% alcohol mentioning the name of the host and collection data.

Identification of specimens: The specimens were brought to the Acarology Laboratory (All India Network Project on Agricultural Acarology), Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, West Bengal. The collected mite specimens were transferred in a cavity block and mounted on glass slides using modified Berlese's medium for identification. The slides were dried keeping on hot plate at 35-40^{0}C for 5-7 days. The mites were examined with a phase contrast microscope (BX 53, Olympus, Japan) and the species were identified following the keys provided by Chant and McMurty (2007).

Statistical analysis: To understand the diversity and community structure of different phytoseiid and phytophagus mites in different locations, the number of specimens for each species was enumerated reflecting the species richness (S) and the following diversity and evenness indices were calculated based on the formulae provided by Shannon-Weiner (1963) Pielou (1975) and Simpson (1949).

Results and Discussion

The present investigation focused on different winter and summer vegetable crops for collection of mite species. Altogether, 800 mite specimens were collected associated with vegetable crops from diverse agro-climatic zone of West Bengal. A total of fifteen species of phytoseiid mites belonging to nine genera *viz., Amblyseius, Euseius, Paraphytoseius, Typhlodromips, Scapulaseius, Neoseiulus, Phytoseius, Anthoseius* and *Indoseiulus* were recorded under the family Phytoseiidae (Table1). Furthermore, under the genus *Amblyseius* three species like *Amblyseius largoensis,*

Table 1: Phytoseiid mite fauna associated with different vegetable crops in West Bengal

Predatory mite order Mesostigmata, Family: Phytoseiidae	Host habitat	Distribution in West Bengal	Associated arthropods
Amblyseius largoensis (Muma)	Chilli, Brinjal, Papaya, Amaranthus, Garlic, Broad bean, Dolichos bean, Moong, Bitter gourd, Ridge gourd, Cucumber, Ladies finger, Pointed gourd	Nadia, Bankura Burdwan, Hooghly, Maldha, Murshidabad, 24 Parganas (N) 24 Parganas (S) New Jalpaiguri and Cooch Behar	*T. macfarlanei* *P. latus* *O. mangiferus* *T. urticae* *Brevipalpus* sp.
Amblyseius herbicolus (Chant)	Brinjal, Chilli, Bean, Tomato, Potato	New Jalpaiguri, Cooch Behar	*T. urticae* *P. latus* Eriophyidae mite
Amblyseius fraterculus (Berlese)	Pointed gourd	24 Parganas (N) 24 Parganas (S)	*T. urticae, P. latus,* *Brevipalpus* sp. mealy bug
Euseius alstoniae (Gupta, 1975)	Papaya, Okra,	Burdwan, Bankura, Hooghly	*P. latus* *Brevipalpus* sp.
Euseius ovalis (Evans, 1953):	Chilli, Papaya, Garlic, Dolichos bean, pointed gourd, Bean, Brinjal, Broad bean	Nadia, Burdwan, Hooghly, New Jalpaiguri	*S. spinki, T. urticae* *P. latus*, mealy bug
Euseius finlandicus (Oudemans)	Garlic	Nadia, Murshidabad Malda	*T. urticae, P. latus* Eriophyidae
Paraphytoseius multidentatus (Swirski and Shechter)	Brinjal, Tomato, Vendi, Dolichos bean, chilli	Nadia, Cooch Behar, New Jalpaiguri, Murshidabad 24 Parganas (N)	*T. urticae, P. latus* Pupa of whitefly Eriophyidae mites
Typhlodromips syzygii (Gupta, 1975)	Okra, Potato, chilli, Ash gourd, Ladies finger, Ridge gourd, Bottle gourd, Bitter gourd	Nadia, Burdwan, Hooghly, Maldha, Murshidabad	*T. urticae, P. latus* *B. phoenicis*
Scapulaseius asiaticus (Evans)	Pointed gourd, Okra, Ridge gourd, Bitter gourd	Nadia, Burdwan, Hooghly, 24 Parganas (N), 24 Parganas (S)	*P. latus*, *Tetranychus urticae*
Neoseiulus longispinosus (Evans)	Pointed gourd, Amaranthus, Brinjal, Ladies finger	Nadia, Burdwan, Hooghly, Maldha Murshidabad	*T. urticae, P. latus* Eriophyidae
Neoseiulus paspalivorus (De Leon, 1957)	Pointed gourd	Nadia, Murshidabad, 24 Parganas (N)	*Tetranychus urticae* *P. latus* Eriophyidae mites
Neoseiulus pranadae Karmakar and Gupta, 2014	Pointed gourd, chilli, Ladies finger	Nadia, Burdwan, Hooghly, Murshidabad	*T. urticae,* *P. latus*
Phytoseius jujuba (Gupta,1977)	Ladies finger, Bean	South 24 Parganas	*T. urticae, P. latus*
Anthoseius spp.	Chilli, Mung bean, Garlic	Nadia, Murshidabad, Malda, Bankura, Hooghly,	*T. urticae, P. latus,* *Brevipalpus* sp. mealy bug
Indoseiulus ricini	Garlic, papaya	Nadia	*T. urticae, P. latus*

Amblyseius herbicolus and *Amblyseius fraterculus*, under the genus *Euseius*, three species *viz., Euseius ovalis, Euseius alstoniae* and *Euseius finlandicus* were recorded. Similarly, under the genus *Paraphytoseius* one species *Paraphytoseius multidentatus*, under the genus *Typhlodromips*, one species *Typhlodromips sygygii*, under the genus *Scapulaseius*, one species *Scapulaseius asiaticus*, under the genus *Neoseiulus*, three species like *Neoseiulus longispinosus*, *Neoseiulus paspalivorus* and *Neoseiulus pranadae*, each of one species under the genus, *Phytoseius jujuba*, *Typhlodromus* (*Anthoseius*) sp. and *Indoseiulus ricini* were recorded. Concerning the proportional abundance of Phytoseiidae mite, *Amblyseius largoensis* occupied 19.71 per cent of total population followed by *Typhlodromips syzygii, Euseius ovalis, Paraphytoseius multidentatus, Neoseiulus longispinosus, Neoseiulus pranadae, Euseius alstoniae, Scapulaseius asiaticus, Typhlodromus (Anthoseius)* sp. *Phytoseius jujuba, Amblyseius herbicolus, Neoseiulus paspalivorus, Amblyseius fraterculus, Euseius finlandicus* and *Indoseiulus ricini* was enumerated 15.05, 10.21, 9.67, 9.31, 6.81, 5.73, 4.48, 4.65, 4.30, 3.94, 3.58, 0.71 and 0.53 per cent of phytoseiid mite population in surveyed areas, respectively.

The study revealed the highest diversity of phytoseiid mite in terms of H^1 = 2.35 with good number of species evenness 1.1, effective number of species 11 and the highest dominance

Table 2: Predatory mite fauna (order: Prostigmata) associated with different vegetables in West Bengal

Predatory mite order: Prostigmata	Host habitat	Distribution in West Bengal	Associated arthropods
Family: Tydeidae Genus: *Tydeus sp.*	Ash gourd, Cucumber, tomato, chilli	Nadia, Burdwan Hooghly, Malda	*P.latus, Tetranychus* sp.
Family: Bdellidae Genus: *Bdelloides* sp.	Chilli, Ladies finger, potato, chilli, pumpkin,	Nadia, Burdwan, Bankura, Malda	*P. latus, Tetranychus* sp. Mealy bug
Family:Ascidae *Lasioseius parberlesei*	Brinjal, Ladies finger, Cucumber,	Nadia, Murshidabad, Malda	*P. latus, Tetranychus* sp. *Brevipalpus* sp.
Family: Stigmaeidae *Agistemus industani*	Pointed gourd, Ladies finger, pumpkin	Burdwan, Nadia, 24 Parganas (N), 24 Parganas (S),	P. latus, *Tetranychus* sp.
Family: Cunaxidae *Cunaxa* sp.	Chilli, Ladies finger, bitter gourd, pumpkin,snake gourd	Nadia, Burdwan, Bankura, Hooghly	*P. latus, Tetranychus* sp. whitefly
Family:Cheyletidae *Cheyletogenes* sp.	Ladies finger, ridge gourd, bitter gourd, snake gourd	Burdwan, Nadia, 24 Parganas (N), Hooghly	*T. urticae, P. latus*

was 0.91, which revealed that vegetable ecosystems was highly congenial for the survival of phytoseiid mite species. However, *Amblyseius largoensis* was found as most predominant species followed by *Typhlodromips syzygii*. Predatory mites belonging to the family viz., *Tydeidae, Bdellidae, Ascidae, Cunaxidae, Stigmaeidae*, and Cheyletidae belonging to the order prostigmata were also recorded in vegetables with lowest species diversity in terms of H1=1.15, where effective number of species was 3, species evenness was 0.55 and dominance was 0.43.

The genus, *Tydeus* was predominant followed by Cunaxa recorded 28.82 and 23.42 per cent of prostigmatid mite population. So far, as phytophagous mite infesting on vegetables are concerned, the most dominant species were *Tetranychus urticae, T. ludeni, Polyphagotarsonemus latus* and *Eutetranychus orientalis* having diverse host range fed on brinjal, pointed gourd, papaya, tomato, okra, potato, snake gourd, cucumber, broad bean, chilli, ash gourd, ladies finger, ridge gourd, bottle gourd, bitter gourd, green gram, pumpkin, broad bean, amaranthes, cowpea, squash and radish. The mite species, *Eutetranychus orientalis* fed on chilli, snake gourd, curry leaf, *Schizotetranychus baltazari* fed on chilli, curry leaf, *Oligonychus andropogoni* fed on sugarcane and *Polyphagotarsonemus latus* (Bank) on chilli, tomato, garlic, capsicum, cabbage, potato, cauliflower and *Brevipalpus phoenicis* fed on pointed gourd, bitter gourd, brinjal etc. The present findings are in agreement with the findings of Rai and Inderajeet (2011), Maheswary *et al.* (2015), Singh and Chauhan (2014) and Roy and Gupta (2016). They reported *Tetranychus urticae, Tetranychus ludeni, Tetranychus macfarlanei, Panonychus citri* infesting on vegetables like okra, brinjal, cowpea, chilli, pumpkin, bitter gourd, cucumber, bottle gourd, sponge gourd, tomato, watermelon, causing enormous damage.

Predatory mites prey on different species of arthropods was investigated and presented in Table1 and 2. In this context, *Amblyseius largoensis, Euseius ovalis, Euseius alstoniae, Typhlodromips syzygii, Paraphytoseius multidentatus, Neoseiulus longispinosus, Neoseiulus paspalivorus, Neoseiulus pranadae, Scapulaseius asiaticus, Amblyseius herbicolus, Phytoseius jujuba, Amblyseius fraterculus, Euseius finlandicus, Indoseiulus ricini, Anthoseius* sp., *Tydeus* sp., *Bdelloides* sp. *Lasioseius parberlesei, Agistemus industani* and *Cunaxa* sp. were preyed on *Tetranychus urticae, Tetranychus macfarlanei, Oligonychus mangiferus, Brevipalpus phoenicis, Polyphagotarsonemus latus*, eriophyoid mites, mealy bug and pupae of whitefly. The present findings are in line with the findings of Karmakar and Gupta (2011), Karmakar and Gupta (2010) and Bala *et al.* (2019) who found that *Amblyseius largoensis, Amblyseius herbicolus, Typhlodromips syzygii, Paraphytoseius multidentatus, Euseius finlandicus, Cheyletogenes* sp., *Cunaxoides* sp. *Agistemus* sp. were accompanying with chilli, pointed gourd, cowpea, brinjal, tomato and predated upon *Polyphagotarsonemus latus, Tetranychus urticae, Panonychus citri, Tetranychus ludeni, Brevipalpus* sp., *Oligonychus* sp. and mealy bug etc. The findings of this study are also similar to the observations of Escudero and Ferragut (2005); Naher *et al.* (2005); Onzo *et al.* (2012), Sharma and Chauhan (2013) Binisha and Bhaskar, (2013), Singh and Chauhan (2014), Bala *et al.* (2018) and Maheswary *et al.* (2015).

A comprehensive report of Indian phytoseiid mites have been provided by Gupta, 2003, later Karmakar and Gupta, 2014; Pramanik and Karmakar, 2016; Karmakar *et al*., 2017 discovered and reported numbers of new species of phytoseiid mites associated with agri-horticultural crops. They stated that phytoseiid mites were most common predators associated with phytophagous mites in the vegetables and are effective biological control agent against *T. urticae, T. macfarlanei, P. latus, B. phoenicis* and *E. orientalis*. Phytoseiid mites were found effective against phytophagous mites and other soft bodied insect pests. The database generated on mite fauna will be helpful in developing management strategies, therefore, predatory mites should be conserved for natural suppression of mite pests in order to minimise the use of chemical pesticides.

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