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Phytophagous mites and their natural enemies in cucumber (*Cucumis sativus* L.) from Himachal Pradesh

Vijay Singh and Usha Chauhan

Abstract
Infestation of *Tetranychus macfarlanei* Baker and Pritchard was recorded in the present study. Among the natural enemies seven species of predatory mites, one saprophagous mite of family Acaridae and one spider species of family Araneidae was recorded associated with *T. macfarlanei*. Majority of predatory mite species were from family Phytoseiidae. Mite species were *viz. Amblyseius herbicolus* (Chant), *Amblyseius largoensis* (Muma), *Amblyseius guajavae* Gupta, *Euseius finlandicus* (Oudemans), *Euseius prasadi* (Chant & McMurtry), *Euseius neococcinae* Gupta, *Agistemus fleschneri* Summers and *Acarus gracilis* Margaret whereas recorded spider species was *Neoscona* sp. Maximum population of phytophagous mites and associated natural enemies were recorded during summer season.

Keywords: Phytophagous, biological control, natural enemies, predator

Introduction
Cucumber is an important vegetable mainly valued as salad and rarely cooked vegetable throughout the world. Due to medicinal, cosmetic and tonic properties it is used in various products. Its high demand around the year attracts the attention of farmers in the state like Himachal Pradesh where economy of peoples mainly depends upon the horticultural crops. Cucumber is among them and grown throughout year in playhouses as well as in open field. Various pests are reported to attack this crop and cause reduction in quality and yield. Spider mites are one of them and reported as serious pests which affect the production both in field as well as in protected condition [1, 2]. Due to their short life cycle they multiply in an enormous number. Their feeding directly damages the chloroplast. Which initially result into chlorosis and later cause browning of the plants. On severe damage the crop this can be easily observed from a distance. On heavy infestation estimated crop loss can be 100% [3, 4, 5, 6]. For their management different acaricides are used around the world but due to short life cycle mites are reported resistant towards these chemicals [7, 8]. Therefore, biological control is an alternative to chemical control as it is ecofriendly, durable and safe for human health and other organisms [9]. Due to increasing demand of organic products, farmers are now aware about integrated pest management tactics. Different natural enemies were reported in association with phytophagous mites on a variety of crops from various parts of the country [10, 11, 12, 13, 14, 15]. Among the natural enemies, primarily Phytoseiidae mites are important biocontrol agents of pests mites throughout the world [16, 17]. But there was little information regarding the phytophagous mites and associated natural enemies on cucumber from the state. Before applying biological control of phytophagous mites by using leaf-inhabiting natural enemies it is important to study their seasonal occurrence and finding generalist predator that can successfully control phytophagous mite. So, the present study was planned to know the status of natural enemies and their seasonal abundance associated with spider mites in cucumber.

Materials and Methods
Present investigation was conducted during 2013 & 2014 at experimental farm, Department of Entomology, UHF, Nauni, Solan on cucumber (var. Kheera 90). Data were recorded from May to August at fifteen days interval both the years. Five plants were selected randomly. Five leaves from each plant were taken and placed in well labelled polythene bags. In the laboratory, leaf samples were kept in refrigerator at 5 ^{0}C overnight to immobilize the mites. Next day the number of mites and natural enemies were counted and categorized.

Spiders were collected in the field from collected leaves with the help of moistened camel hair brush and placed in well labelled glass vial containing 70% alcohol and glycerine. Samples were observed under stereo zoom microscope (Olympus SZX 9) and only motile stages were counted carefully.

Identification

Mite specimens were mounted on microscopic slides in a drop of Hoyer's medium [18, 19]. Slides were dried in hot air oven at 35-40oC for 4-5 days. Specimens were observed under phase contrast microscope (Olympus SZX 41) and identification was done by following standard keys [20, 21, 22].

Population of spider mites and associated natural enemies were correlated with abiotic factors (*i.e.* average temperature and relative humidity) by calculating the correlation coefficient.

Results

During the study infestation of phytophagous mite of family Tetranychidae *viz. Tetranychus macfarlanei* Baker & Pritchard was recorded. Seven predatory mites of two families *viz.* Phytoseiidae & Stigmaeidae, one saprophagous mite of family Acaridae and one spider of family Araneidae was reccorded in association with *T. macfarlanei*. Phytoseiidae species were *Amblyseius herbicolus* (Chant), *A. largoensis* (Muma), *A. guajavae* Gupta, *Euseius finlandicus* (Oudemans), *E. Prasadi* (Chant & McMurtry), *E. Neococcinae* Gupta, and Stigmaeidae was *Agistemus fleschneri* Summers. One saprophagous mite of family Acaridae was *Acarus gracilis* Margaret and one spider species i.e. *Neoscona* sp. was recorded in association with *T. macfarlanei*.

Seasonal population of *T. macfarlanei* and associated natural enemies during 2013:

Seeds of cucumber (var. Kheera 90) were sown in the field during second week of April. Infestation of *T. macfarlanei* was recorded in May with average popultaion of 0.6±0.4 mite/leaf. Increase in population was recorded during June (4.4±1.16 mites/leaf). Population of *T. macfarlanei* declined in July month i.e. 2.20±0.66 mites/leaf. But during August increase was observed in mite population *i.e.* 2.6±0.51 mites/leaf (Table 1). Among associated natural enemies, *A. largoensis* was recorded dominant. Population of this predatory mite was recorded from May to August. Average population in the month of May was 0.8±0.37 mites/leaf (Table 2). During June and July months simmilar population of *A. largoensis* was recorded (0.4±0.24 mites/leaf). Population in the month of August was 0.2±0.20 mites/leaf. Population of *E. prasadi* was recorded from May to July. Population during these months was 0.6±0.4 (May), 0.2±0.20 (June) and & 0.4±0.20 (July) mites/leaf). *E. finlandicus* was observed from May to July.

Similar population trend was recorded in these i.e. 0.2±0.20 mites/leaf repectively. *A. herbicolus* was recorded from May and June with a population of 0.6±0.4 mites/leaf respectively (Table 2).

Similar population of *A. fleschneri* was recorded during May and June i.e. 0.2±0.20 mites/leaf. *A. guajavae* and *Acarus gracilis* were observed in the month of June and August. Average population was 0.6±0.24 in the month of June and 0.4±0.24 mites/leaf during August respectively (Table 2). Population of *Neoscona* sp. was recorded from May to July. Population was 0.4±0.24 & 0.2±0.20 per leaf, respectively (Table 3).

Seasonal variation in population of *T. macfarlanei*and their natural enemies on cucumber in 2014

During 2014, population of *T. macfarlanei* was recorded in the month of May i.e. 2.8±0.37 mites/leaf. Increase in population was observed in the month of June with 3.6±0.81 mites/leaf. Population declined was recorded from July to August with 2.4±0.40 & 0.8±0.49 mites/leaf, respectively (Table 1).

A. largoensis was dominant among predatory mite species during 2014. This species was recorded from May to August. Population was 0.4±0.20 mites/per leaf during May and June and 0.2±0.2 mites/leaf during July and August (Table 4). Population of *E. prasadi* was 0.4±0.24 & 0.6±0.4 mites/leaf during May and June while population of *E. finlandicus* was 0.2±0.20 mites/leaf during these months. During this season population of *A. herbicolus* was 0.6±0.4 &0.2±0.20 mite/leaf in the month of May and June. *A. guajavae* was observed in the month of June with population of 0.6±0.24 mites/leaf. *A. fleschneri* was observed during June and *Acarus gracilis* in the month of August with similar population of 0.2±0.20 mite/leaf respectively (Table 4). *Neoscona* sp. was recorded in the month of May to July. Average population was 0.4±0.24 per leaf in May and 0.2±0.20 per leaf during June & July, respectively (Table 3). Correlation study of *T. macfarlanei* population and associated natural enemies with abiotic factors (average temperature and relative humidity) revealed that the population of *T. macfarlanei* was positively correlated with temperature however population was negatively correlated with relative relative humidity. All species of natural enemies were positively correlated with temperature and negatively correated with relative humidity. Whereas, *Acarus gracilis* showed negative correlation with temperature and possitive correlation with relative humidity (Table 5).

Table 1: Seasonal incidence of *T. macfarlanei* during 2013 & 2014

Month	Mite Population*	
	2013	2014
May	0.6±0.40	2.8±0.37
June	4.4±1.16	3.6±0.81
July	2.2±0.66	2.4±0.40
August	2.6±0.51	0.8±0.49

*(Average population of five leaves± Standard error of mean)

Table 2: Seasonal abundance of predatory mites during 2013

Species/Month	Mite Population*			
	May	June	July	August
A. herbicolus	0.6±0.24	0.6±0.24	0.0	0.0
A. largoensis	0.8±0.37	0.4±0.24	0.4±0.24	0.2±0.20
A. guajavae	0.0	0.6±0.24	0.0	0.0
E. finlandicus	0.2±0.20	0.2±0.20	0.2±0.20	0.0
E. prasadi	0.6±0.40	0.2±0.20	0.4±0.24	0.0
E. neococcinae	0.0	0.4±0.24	0.0	0.0
A. fleschneri	0.2±0.20	0.2±0.20	0.0	0.0
A.gracilis	0.0	0.0	0.0	0.4±0.24

*(Average population of five leaves ± Standard error of mean)

Table 3: Seasonal abundance of *Neoscona* sp. during 2013 & 2014

Month	Spider Population*	
	2013	2014
May	0.4±0.24	0.4±0.24
June	0.4±0.24	0.2±0.20
July	0.2±0.24	0.2±0.20
August	0.0	0.0

*(Average population of five leaves ± Standard error of mean)

Table 4: Seasonal abundance of predatory mites during 2014

Mite species	Mite Population*			
	May	June	July	August
A. herbicolus	0.6±0.40	0.2±0.20	0.0	0.0
A. largoensis	0.4±0.24	0.4±0.24	0.2±0.20	0.2±0.20
A. guajavae	0.0	0.6±0.24	0.0	0.0
E. finlandicus	0.2±0.20	0.2±0.20	0.0	0.0
E. prasadi	0.4±0.24	0.6±0.40	0.0	0.0
E. neococcinae	0.4±0.24	0.0	0.0	0.0
A. fleschneri	0.0	0.2±0.20	0.0	0.0
A. gracilis	0.0	0.0	0.0	0.2±0.20

*(Average population of five leaves ± Standard error of mean)

Table 5: Correlation of *T. macfarlanei* and associated natural enemies population with climatic factors during 2013 and 2014

Species	Climatic factors			
	Temperature (ºC)		Relative Humidity (%)	
	2013	2014	2013	2014
T.macfarlanei	0.481	0.818	0.267	-0.821
A. herbicolus	0.845	0.985	-0.921	-0.883
A. largoensis	0.349	0.548	-0.901	-0.968
A. guajavae	0.878	0.951	-0.308	-0.429
E. finlandicus	0.683	0.548	-0.756	-0.968
E. prasadi	0.226	0.739	-0.759	-0.888
E. neococcinae	0.878	-0.316	-0.308	-0.689
A. fleschneri	0.845	0.951	-0.921	-0.429
A.gracilis	-0.683	-0.571	0.756	0.715
Neoscona sp.	0.866	0.155	-0.951	-0.861

Discussion

In the present investigation infestation of *T. macfarlanei* was recorded for the first time on cucumber from Himachal Pradesh. Seven species of predatory mites, one saprophagous mite and one species of spider were found associated with *T. macfarlanei*. Infestation of *T. macfarlanei* was reported on brinjal Kaur *et al.* [1] reported *T. urticae* as predominant pest of cucumber. Earlier, Six species of phytophagous mites and twenty six species predatory mites were recorded on vegetable and ornamental crops from Himachal Pradesh [12]. Infestation of spider mites on different crops were recorded from different parts of the country [24, 12, 15]. Eleven species of predatory mites were reported in association with spider mites on rose [23]. Thrips and phytoseiid were reported in association with spider mite on carnation and tomato from Himachal Pradesh [14, 15]. Two species of predatory mites and one predatory beetle were reported to be associated with spider mites on okra [10].

In the present study, maximum population of *T. macfarlanei* and natural enemies associated with it were recorded in June month which were supported by the study of Pokle and Shukla [24]. They reported the maximum population of spider mite on tomato in June month which is similar to the results of present study. Seasonal population fluctuation on brinjal was reported by Patil and Nandihalli [5]. Results of their study were in conformity with the present study. In the present study, most species of natural enemies were reported during May and June which is supported by the study Singh and Chauhan [25]. During their study they reported maximum species of predatory mites during summer months. During present investigation *Neoscona* sp. was associated with *T. macfarlanei* and the maximum population was recorded during May and June both the growing seasons. These results were supported by Singh and Chauhan [14] as they reported predatory thrips in association with spider mites and reported maximum population in June month. Similar observations were recorded by Rachana *et al.* [10]. They reported the population of *Stethorus pauperculus* during summer months on okra. The results of correlation study were supported by the study of Singh & Chauhan [15]; Pokle and Shukla [24] as they reported positve correlation between temperature and mite population while the mite population were negatively correlated with relative humidity.

Conclusion

Mite are serious pests of horticultural crops mainly in the protected conditions and cause a severe loss the crop. The present study potential predators and applying the IPM practices during their emergence period so that they can be controlled before reaching the economic injury level.

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