Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(2): 3018-3021

Received: 16-01-2018
Accepted: 17-02-2018

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Predatory potential of predatory mites *Amblyseius indicus* and *Amblyseius tetranychivorus* (Acarina: Phytoseiidae) on different densities of *Tetranychus neocaledonicus* Andre population on brinjal

Pushpa Singh and RN Singh

Abstract
The present experiment was conducted to study the predatory potentiality of predatory mites *Amblyseius indicus* Narayanan & Kaur and *Amblyseius tetranychivorus* Gupta on the all stages of phytophagous mite *Tetranychus neocaledonicus* André on brinjal host plant. The trials were conducted in CRD with five treatments with the predator - prey ratio of 1:10, 1:15, 1:20, 1:25, and 1:30. Both the predators proved effective in curbing the phytophagous mite population with the rate of predation rising with the prey density. The most effective predator-prey ratio was 1:20 and 1:25 for both species of mite predators and linear increasing trend was noticed till 1:25 ratio after which the predation rate decreased at 1:30 ratio. The predators consumed more number of eggs of *T. neocaledonicus* followed by larvae and then adult stage.

Keywords: Predatory mite, phtophagous mite, predation, potentiality, *Amblyseius tetranychivorus*, *Amblyseius indicus*

Introduction
The vegetable mite *Tetranychus neocaledonicus* Andre´ is one of the important mite pests of vegetables and is distributed throughout the tropical and sub-tropical areas of world [1]. Besides vegetables it is found to attacks fruits, field crops, flowers and crops of economic importance. It sucks the sap from the plant cells there by producing white spots which with time coalesce gradually leading to premature falling of leaves [2]. *T. neocaledonicus* prefers lower surface of leaves and is found mainly along the midrib and veins of the leaves. They are also known to produce large amount of webbing [3].

The predaceous mites belonging to family Phytoseiidae plays a very important role in natural control of phytophagous mites and insects in nature. This family constitutes three sub family and nearly 2000 known species [4, 5] and is distributed all over the world. Mori *et al.* [6] reported in predator – prey interaction in Japan that *Amblyseius longispinosus* and *A. eharai* and *Phytoseiulus persimilis* were very able natural control agent of tetranychid mites. Cuellar *et al.* [7] reported successful control of many thrips species by *A. cucumeris*. *Amblyseius tetranychivorus* and *Amblyseius indicus* are well known predatory mites of India and are reported to effectively control phytophagous mites of fruits and vegetables. *A. tetranychivorous* preferred adult female of *T. ludeni* as food as compared to other life stages as reported by Puttaswamy and Channa Basavanna [8] and Puttaswamy [9].

Predator – prey interaction is the basis for success of any biological control programme, the relationship between the number of prey consumed per predator and prey density denotes the functional response of predator [10, 11] Functional and numerical responses helps in analysis of the effect of predation on prey population [12]. The impact on the number of prey killed by single predator per unit has been described as functional response by Solomon [10].

In brinjal cultivation large amount of pesticides are utilized for management of its pests. Indiscriminate use of pesticides has resulted in development of resistance in mites, which makes more important to look into importance of biological control through predatory mites. The study of feeding nature and potentiality of predators is very important component for implementing any type of biological control programme. It is in this context that the present investigation was undertaken to find out the predatory potential of *Amblyseius tetranychivorus* and *Amblyseius indicus* on egg, larva and adult stages of *Tetranychus neocaledonicus* on

brinjal host plant at different densities as well to compare both the predators in controlled laboratory condition.

Materials and Methods

The present experiment was conducted in the Acarology laboratory, Department of Entomology and Agricultural Zoology, B.H.U., Varanasi at 28-30 ^{0}C and 75 to 80% RH. The vegetable mite *T. neocaledonicus* was collected from the naturally infested brinjal plants in field of I.A.S., B.H.U. The mass culture was maintained on potted brinjal plants in poly house. The predators occurring naturally on brinjal plant were collected and brought to laboratory. Later these predators were studied and identification of mites were made with the help of keys and literature and then confirmed from specialists.. Several tests were conducted to confirm their predation on the vegetable mite.

The experiment was conducted during September 2013 and 2014 on brinjal leaf disc kept on petri disc (9 cm diameter) lined with moist cotton wool with four replications in Completely Randomized Design (CRD). Observations on number of prey consumed were recorded at interval of 12 hrs till 72 hrs. The different stages of prey *i.e.* egg, larvae and adult were studied to find the preference of predators on life stages of prey. The vegetable mite and the female of predatory mite were transferred with the help of fine soft brush on the leaves of brinjal at different predator-prey density of 1:10.1:15, 1:20, 1:25, and 1:30 with four replications. The number of prey consumed were recorded every 12, 24, 36, 48, 60.and 72 hrs. The prey-predator ratio was maintained by replacing the consumed prey by fresh supply.

Statistical analysis

The data obtained from the laboratory experiment were subjected to analysis of variance and the means were compared by't' test using SPSS V 16.0.

Results and Discussion

Amblyseius indicus after 12 hrs interval preyed upon 2.36±0.23 eggs, 1.44±0.18 larvae and 0.64±0.18 adult, after 24 hrs time interval 6.13±0.97 eggs, 2.57±0.28 larvae and 1.41±0.26 adults. The mean consumption of the predator was 5.78±0.95 eggs, 4.52±0.98 larvae, 1.76 ±0.10 adults after 36 hrs whereas; mean consumption after 48 hrs for egg stage was 9.33±1.34, 6.06±0.88 larvae, 2.69±0.31 adult stage. After passage of 60 hrs the predator preyed upon 11.33±1.01eggs, 7.30±0.88 larvae and 3.11±0.67 adults and at the end of observation period of 72 hrs the mean consumption of the prey was 15.55±2.04 eggs, 7.72±0.86 larvae and 3.39±0.53 adults. Total prey consumed at all the predator prey ratio was 252.43 eggs, 148.23 larvae and 65.23 adults during the whole observation period. Significant difference at 5% between treatments was observed only at egg stage after 24, 48, 60 and 72 hrs (Table 1).

The second predator under study *Amblyseius tetranychivorus* also preferred egg stage of *T. neocaledonicus* with predation of 2.50±0.20 eggs, 1.21±0.16 larvae and 0.64±0.18 adults after passage of 12 hrs. Predation after 24 hrs revealed the predator consuming upon 5.82±0.16 eggs, 2.24±0.21 larvae, 1.18±0.19 adults as compared to 6.05±1.03eggs, 4.13±0.94 larvae, 1.49±0.17 adults after period of 36 hrs. After 48 hrs the eggs consumed were 10.11±1.33 eggs, 5.53±1.08 larvae and 2.26±0.29 adults, 60 hrs intervals revealed the predator to consume upon 10.72±1.04 eggs 6.50±0.93larvae, 2.74±0.56 adults. The end of observation period of 72 hrs the observation was the eggs consumed 14.71±2.33, larvae 7.33±0.79 and 3.19±0.53 adults. The predator during the whole observation period consumed upon 249.63 eggs, 133.79 larvae and 65.23 adults of *T. neocaledonicus*. Significant difference between treatments was in consumption was observed at egg stage after 24, 36, 48, 60 and 72 hrs and at larvae stage after 48 hrs at 5% significance (Table 1).

The mean prey consumption by the predator *A. indicus* and *A. tetranychivorus* varied significantly across all the life stage egg, larva and adult of the prey *T. neocaledonicus*. The maximum consumption was that of egg stage followed by larvae and then adult. The egg stage was the most preferred stage for with total predation of 246.52 eggs, followed by 148.23 larvae and 65.23 adults in all of prey density over the observation period by *A. indicus*. Similarly the second predator *A. tetranychivorus* of *T. neocaledonicus* in all predators: prey density over the period of 72hrs preyed upon 244.63 eggs, 131.67 larvae and 57.67 adults. The preference for consumption of egg stage may be due to the fact that eggs being immobile and defenseless are easy victim and more number of are required by the predator to feel satiated as eggs have lower biomass as compared to larvae and adult stages. Pravin *et al*. [13] also reported that the predator *Phytoseiulus persimils* consumed more eggs and immature stage of two spotted mite than adults. Similar preference for predation of egg stage of prey *Oligonychus pratensis* by the predatory mite *Galendromus fluenis* was reported by Ganjisaffar and Perring [14] when choice was offered.

The experiment showed that there is significant difference in feeding potentiality of the predators at different predator prey density. For the predator *A. indicus* among the entire predator – prey ratio the prey density of 1:25 resulted in maximum consumption of 55.57 eggs 32.78 larvae and 12.41 adults which was at par with 1:20 ratio of predator prey resulting in the predation of 55.46 eggs, 30.01 larvae and 14.59 adults in the entire observation period of 72 hrs (Table 2). The second predator under study *A. tetranychivorus* recorded maximum predation at predator- prey ratio of 1:20 with predation of 55.91 eggs, 26.21 larvae and 13.36 adults which was again at par with prey density of 1:25 with predator consuming 54.84 eggs, 27.20 larvae and 11.75 adults (Table 3). Jeyarani *et al.* [15] reported maximum consumption of *T. urticae* by *A. longispinosus* at ratio of 5:50 and also found predator – prey ratio of 4:50 to be at par with 5:50.Similarly, Hamlen and Lindquist [16] had found 1:20 ratio of predator–prey very effective and reliable for *P. persimilis* and *T. urticae*, which was also validated by Opit *et al*. [17] and reported that 1:4 ratio must be maintained for *P. persimilis* and *T. urticae*. Jayasinghe [18] reported that the predator *Neoseiulus longispinosus* eliminated *T. urticae* population after 5 weeks of release at prey-predator ratio of 50:1 in polyhouse condition.

Both the predator's *A. indicus* and *A. tetranychivorus* showed a very positive functional response as the number of prey consumed increased with the increasing prey densities. All the stages eggs, larvae and adults were predated upon and as the densities increased so did the predation, similar trend of prey consumption was recorded by Hoque *et al.* [19] by the predator *P. persimilis* on *T. urticae*, Canlas *et al.* [20] also reported increase in consumption of *T. urticae* by *Neoseiulus californicus* (McGregor) with the increase in prey density and similar was the result reported on the prey *Panonychus ulmi* by predator *P. persimilis* [21] An increasing preying capacity of predator *A. swirskii* on *Polyphagotarsonemus latus* on brinjal was reported by Onzo *et al*. [22]. Increased predation rate of predatory mite *Neoseiulus longispinosus* was reported

with increased density of prey *Oligonychus coffeae* by Rahman *et al*. [23] and also that there was preference for larvae and nymphs as compared to adult stage of prey, whereas, a strong preference for egg stage of *T. urticae* by predator *N. longispinosus* was reported by Blackwood *et al*. [24].

The predators of *T. neocaledonicus* under study i.e., *A. indicus* and *A. tetranychivorus* proved to be very much predacious and effective in eliminating the prey population at different densities. Significant difference in predating capacity of the two predators was observed at larval stage after 24 hrs and at adult stage at 36 and 48 hrs, in rest of the time interval no statistical difference in feeding potentiality of both the species of mite predator was observed.

Table 1: Mean number of different stages of *Tetranychus neocaledonicus* Andre´ consumed by mite predators, *A. indicus* and *A. tetranychivorus*, (Pooled data 2013-2014)

Mite Predator	Time interval (hrs.)	Stages of Prey		
		Eggs Mean ± SD	Larvae Mean ±SD	Adult Mean ± SD
A. indicus	12 hrs	2.36 ± 0.23	1.44 ± 0.18	0.67 ± 0.17
A. tetranychivorous		2.50 ± 0.20	1.21 ± 0.16	0.64 ± 0.18
't' value		0.979	2.015	0.244
A. indicus	24 hrs	6.13 ± 0.97	2.57 ± 0.28	1.41 ± 0.26
A. tetranychivorous		5.82 ± 1.16	2.24 ± 0.19	1.18 ± 0.19
't' value		0.457	2.094*	1.545
A. indicus	36 hrs	5.78 ± 0.95	4.52 ± 0.98	1.76 ± 0.10
A. tetranychivorous		6.05 ± 1.03	4.13 ± 0.92	1.49 ± 0.17
't' value		- 0.420	0.642	2.922**
A. indicus	48 hrs	9.33 ± 1.34	6.06 ± 0.88	2.69 ± 0.31
A. tetranychivorous		10.11 ± 1.33	5.53 ± 1.08	2.26 ± 0.29
't' value		- 0.919	0.854	2.213*
A. indicus	60 hrs	11.33 ± 1.01	7.30 ± 0.88	3.11 ± 0.67
A. tetranychivorous		10.72 ± 1.04	6.50 ± 0.93	2.74 ± 0.56
't' value		0.932	1.397	0.925
A. indicus	72 hrs	15.55 ± 2.04	7.72 ± 0.86	3.39 ± 0.53
A. tetranychivorous		14.71 ± 2.33	7.33 ± 0.79	3.16 ± 0.13
't' value		0.604	0.739	0.575

** Significant at 0.01 level (2-tailed) *significant at 0.05 level(2-tailed)

Table 2: Total number of different stages of *T. neocaledonicus* predated upon by *Amblyseius indicus* during the observation period of 72 hrs.

Predator: prey ratio	Eggs	Larvae	Adults
1:10	39.03	26.36	12.26
1:15	50.60	32.31	15.06
1:20	55.46	30.01	14.59
1:25	55.57	32.78	12.41
1:30	45.86	26.77	10.91
Total	246.52	148.23	65.23

Table 3: Total number of different stages of *T. neocaledonicus* predated upon by *Amblyseius tetranychivorous* during the observation period of 72 hrs.

Predator: prey ratio	Eggs	Larvae	Adults
1:10	38.19	23.41	10.07
1:15	49.32	29.12	12.98
1:20	55.91	26.21	13.36
1:25	54.84	27.20	11.75
1:30	46.37	25.73	9.51
Total	244.63	131.67	57.67

Conclusion

The present experiment showed that both *Amblyseius indicus* and *Amblyseius tetranychivorus* were effective predators of *T. neocaledonicus*. In mite management strategy the preference of predators for egg stage of prey can be effectively utilized to reduce prey population at egg stage without reaching its damaging state. This type of study conducted in ideal laboratory condition may not represent the true picture as the natural field conditions has its own set of interwoven complexities like presence of webbing by prey which hampers the prey searching capability of predators. Therefore there is need to validate the result obtained in laboratory in field condition too. There is scope of utilizing these predators for control of Phytophagous mites on Brinjal with large scale mass production as well as studies in field condition for successful bio-control.

Acknowledgements

The authors are thankful to the Head, Department of Entomology and Agricultural Zoology, IAS, BHU Varanasi for providing facilities.

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