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PREDATORY EFFICACY OF *PHYTOSEIULUS PERSIMILIS* ATHIAS-HENRIOT (ACARI: PHYTOSEIIDAE) ON THE TWO SPOTTED SPIDER MITE *TETRANYCHUS URTICAE* KOCH (ACARI: TETRANYCHIDAE)

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Abstract

The relative abundance *Tetranychus urticae* and *Phytoseiulus persimilis* as well as voracity of the predator were conducted on potted eggplants. After six weeks of release of ten female *T. urticae* in control plants, the highest mite population reached at 184.21 / leaf, against 67.92 and 107.48 / leaf in plants which received two predators after 1st and 3rd week respectively. After nine weeks the number of mite / leaf reduced to 13.21 and 23.97 / leaf after 1st and 3rd week of introduction of the predator, the control population was 81.32. Adult *P. persimilis* as single predator fed 8.2, 15.4 and 20.6 *T. urticae* eggs after 24, 48 and 72 h respectively. Again a single predator when tested separately fed 5.4, 10.8 and 14.6 *T. urticae* larvae after 24, 48 and 72 h respectively. A single adult predator fed on 3.6, 7.0 and 12.0 adult *T. urticae* after the same durations. When varying number (10, 20, 30, 40 and 50) of prey (larvae or adults) were provided to a single predator it fed 5.0, 6.6, 6.8, 9.0 and 9.4 larvae against 3.2, 3.2, 3.4, 3.6 and 3.6 adults respectively.

Key words: Predation, spider mite, eggplant, voracity, release.

Introduction

Tetranychus urticae Koch (Acari: Tetranychidae) is the major mite pest species on agricultural crops worldwide (Takafuji *et al.* 2000, Sim *et al.* 2003, Alatawi *et al*. 2005). This tiny spider, popularly known as two spotted spider mite (TSSM), feed by sucking the contents of plant cells and damage includes webbing, fine stippling, leaf yellowing, leaf drop, and even plant death (Helle and Sabelis 1985). It is common in greenhouses where it is an important pest of vegetables (beans, capsicum, cucumbers, egg plant, and tomato etc.), fruit (melon, grapes and strawberries), cut flowers and ornamental plants (carnations, roses, chrysanthemums, cymbidium orchids, ficus, palms etc.). In outdoors it causes damage to sweet corn, beans, peas, hops, grapes, deciduous fruit trees (apples, nashi, peaches and nectarines), strawberries and many other fruit, vegetables, flowers and ornamental plants (Bostanian *et al.* 2003).

Unfortunately, chemical control of this pest has limitations because of development of resistance (Tsagkarakou *et al*. 2002). As a result, a more integrated approach including biological control with predatory insects and/or mites is increasingly being recommended (Grafton-Cardwell *et al.* 1997, Pratt and Croft 2000, Skirvin and Fenlon 2001). Biological control of spider mites has centered on the use of predatory mites in the family Phytoseiidae (Schausberger and Croft 2000, Schausberger and Walzer 2001, Çakmak *et al.* 2005).

One species of phytoseiid mite that is widely used and is commercially available is *Phytoseiulus persimilis* Athias–Henriot, which was accidentally introduced into Germany from Chili in 1958 (Dosse 1958). It was subsequently shipped to other parts of the world (McMurty *et al.* 1978). Releases of *P. persimilis* to suppress

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mite populations have performed with varying degrees of success (Berntein 1985, Bancroft and Margolies 1999). Little information is available on the performance of *P. persimilis* against *T. urticae* in Bangladesh. This led to the present study on the relative abundance of prey and predator population as well as voracity of the predator was studied.

Materials and Methods

Eighteen eggplant (*Solanum melongena* L.) plants were grown on separate earthen pots. Six pots with eggplants were arranged in each of three Plots as A, B and C in the experimental field of the University of Rajshahi. The pots were covered by separate nets.

Infestation of Mite

The potted eggplants were infested by *T. urticae* on 19th November 2004 when the plants were seven weeks old. The TSSM used for infestation were collected from lab cultures maintained on potted eggplants for more than one year. Each plant was infested with 10 adult female mites. That was done by placing the mite containing host plant parts on eggplant leaves on the potted plants so that the mites moved on to the test plants to grow mite population.

Release of Predator

P. persimilis were collected from grower's fields of Rajshahi area. They were cultured on *T. urticae* on potted eggplants in the laboratory for more than three months. The predators were release on the eggplants of Plot B on 26th November 2004 (1 week after TSSM release) and on the eggplants of Plot C on 9th December 2004 (3 weeks after TSSM release). On each plant two adult females (*P. persimilis*) were released on the 10 leaves. Plot A was maintained as control where predators were not released.

Counting Method

The number of mites were counted every week on all plants of Plot A (control), B and C starting from 1st week to 9th week after infestation. During count 10 leaves were selected randomly from each of the eggplants throughout the plots. The counting was performed on both surfaces of the leaves.

Voracity tests

In the first experiment, predation was conducted individually on an excised leaf disc (2 cm^2). Fifty preys (eggs, larvae or adults separately) were transferred on each leaf disc. Thus ten discs were prepared for each of the test for egg, larvae and adults. One adult predator was released on each disc and was kept on water soaked cotton bed in a petri dish to maintain freshness. The discs were checked after 24, 48 and 72 hours and the number of prey consumed by an individual predator was recorded.

In the second experiment, separate tests with one individual of predator (either adult or larva) having 5 replications were conducted in a day. A prey density (only adults) of 10, 20, 30, 40 and 50 were used. The total number of prey consumed was recorded after 24 hours.

Results

The average number of *T. urticae* / leaf of six eggplant of Plot A after release of prey and predator are presented in Table 1. The number of mites differ significantly ($P<0.01$) among different weeks. The highest number of mite / leaf (184.21 ± 10.13) was prevailed on sixth week of infestation. In the Plot B the number of mites / leaf differ significantly among also different weeks ($P<0.01$); in this plot highest number of mite / leaf (87.50 ± 9.05) was found on fourth week of infestation. The predator population became higher after fourth week of mite infestation but very lower after sixth week. The number of mites per leaf on six plants of Plot C, where predators were released after third week of mite infestation remained higher up to fifth week (114.25 ± 6.36). Then the mite population declined slowly.

Table 1. Mean number of mites (*Tetranychus urticae)* and predators (*Phytoseiulus persimilis*) in experimental plots by releasing the predator after 1 and 3 weeks.

[Week	Plot A	Plot B		Plot C	
	Mite	Mite	Predator	Mite	Predator
1^{st}	$^{*}10.00^{a}$	10.00^{a}	-	10.00^{a}	-
2^{nd}	73.57^{b} ± 7.88	46.36^{bc} ± 4.36	2.00^{ab}	41.12^{bcd}± 2.87	-
3^{rd}	137.84^{cd} ± 14.92	80.66^{d} ± 8.86	3.15^{a} ± 0.29	67.53^{ef} ± 5.68	-
4^{th}	160.48^{cde} ± 14.30	87.50^{d} ± 9.05	4.99^{cd} ± 0.27	90.09^{fg} ± 4.96	2.00^{a}
5^{th}	175.18^{d} ± 11.70	82.26^{d} ± 10.57	5.73^{d} ± 0.44	114.25^{g} ± 6.36	4.24^{ab} ± 0.59
6^{th}	184.21^{e} ± 10.13	67.92^{cd} ± 8.66	3.54^{bc} ± 0.28	107.48^{g} ± 13.38	6.61^{b} ± 1.10
7^{th}	166.41^{de} ± 8.65	64.28^{cd} ± 9.98	3.84^{bcd} ±1.17	63.84^{de} ± 6.58	6.27^{b} ± 0.84
8^{th}	121.98^{c} ± 13.47	33.76^{ab} ± 6.50	2.08^{a} ± 0.32	34.48^{abc} ± 3.51	3.64^{a} ± 0.36
9^{th}	81.32^{b} ± 5.50	13.21^{a} ± 1.95	1.37^{a} ± 0.34	23.97^{ab} ± 6.60	1.71^{a} ± 0.33
F	29.83^{**}	15.38^{**}	9.12^{**}	32.13^{**}	10.20^{**}
LSD (1%)	40.41	28.69	1.91	24.84	2.52

*Means having same digit are statistically insignificant; **P<0.01

A single predator fed 8.2 ± 0.86, 15.4 ± 0.51 and 20.6 ± 0.51 eggs after 24, 48 and 72 hours respectively (Table 2). Again a single predator when tested separately fed 5.4 ± 0.53, 10.8 ± 0.58 and 14.6 ± 0.51 TSSM larvae after the same durations respectively. A single adult predator fed on 3.6 ± 0.68, 7.0 ± 0.32 and 12 ± 0.45 adults after the above mentioned durations respectively. *P. persimilis* did not demonstrate a prey stage feeding preference consistently throughout the duration of the experiment. A significantly (P<0.01) higher proportion of eggs of *T. urticae* were consumed by predator that was exposed to prey monocultures.

A single predator fed higher number of prey both larvae (9.4 ± 1.17) and adults (3.6 ± 0.40) at higher densities (Table 3). So with the increase in prey the voracity was also increased. It can also be seen that predator always preyed more larvae than adults (P<0.01).

Table 2. Mean number of eggs, larvae and adults prey consumed by adult predator, *Phytoseiulus persimilis* at different time intervals.

Types of prey against single predator	Voracity after		
	24h	48h	72h
50 (eggs)	$^{*}8.2^{b}$ ± 0.86	15.4^{c} ± 0.51	20.6^{c} ± 0.51
50 (larvae)	5.4^{ab} ± 0.51	10.8^{b} ± 0.58	14.6^{b} ± 0.51
50 (adults)	3.2^{a} ± 0.37	7.0^{a} ± 0.32	12.0^{a} ± 0.45
F	16.52^{**}	75.83^{**}	81.05^{**}
LSD (1%)	2.67	2.09	2.12

*Means having same digit are statistically insignificant; **P<0.01

Table 3. Consumption of TSSM adults at different densities by *Phytoseiulus persimilis* larvae and adults during 24 hours

Stage of Prey	Prey density against single predator				
	10	20	30	40	50
Larva	5.0 ± 0.45	6.6 ± 0.68	6.8 ± 0.86	9.0 ±1.61	9.4 ± 1.17
Adult	3.2 ± 0.37	3.2 ± 0.58	3.4 ± 0.24	3.6 ± 0.68	3.6 ± 0.40
t (8df)	3.09*	3.80**	3.80**	3.09*	4.70**

*P<0.05, **P<0.01

Discussion

Waite (1998) reported that *P. persimilis* gave effective control of the pest when it was released onto strawberry with low levels of TSSM infestation in southeast Queensland, Australia. Similarly Kim (2001) investigated the effectiveness of *P. persimilis* as a predator against TSSM on strawberry in five commercial greenhouses and got an excellent result by releasing the predator at a rate of 3/m^2 in Korea. Trials conducted in Florida utilizing *P. persimilis* to control *T. urticae* on Crotons and Areca palms reduced the number of acaricide applications by 87–92% in Crotons, and 100% in Areca palms (Cashion *et al*. 1994). Bonomo *et al*. (1991) also reported that releases of *P. persimilis* gave effective control of TSSM at lower density of TSSM. Spicciarelli *et al*. (1992) recommended that phytoseiid mites give good control of TSSM, if one mite is released per plant when the infestation of TSSM has reached two individuals per leaf, and about 30% of the leaves are infested.

All developmental stages of TSSM are eaten by the adult female *P. persimilis*. During initial observations, it was found that *P. persimilis* adults aggressively attacking *T. urticae* adults. Previous research illustrates that protonymph *P. persimilis* prefer larval *T. urticae* over deutonymphs, while adult *P. persimlis* prefer deutonymphs over larvae (Fernando and Hassel 1980). Studies conducted by Takafuji and Chant (1976) demonstrated that adult *P. persimilis* attack larvae and protonymphs of *T. pacificus*, but preferred eggs even when the availability of mobile prey stages were abundant. Alternatively, Chant (1961) observed that *P. persimilis* feeding on *T. telarius* dispersed from prey patches once active prey forms were consumed, leaving the eggs uneaten. *P. persimlis* may have a preference for prey adults in low-density populations of *T. urticae*, and switch to eggs as prey density increases (Mori and Chant 1965). The number of each stage eaten depends on the density of prey and predator, temperature, humidity, stage of predator feeding and which prey stages are available for it to feed upon.

It would appear that *P. persimilis* can give good control of two-spotted spider mite, particularly if the predator is introduced early in the cropping season when numbers of TSSM are still fairly small.

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