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Evaluation of *Orius laevigatus* Fiber (Heteroptera: Anthocoridae) for Biological Control of *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) on Greenhouse Cucumber in South of Iran

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ABSTRACT

Thrips tabaci Lind. is a major pest of greenhouse cucumber, *Cucumis sativus* L. in Khuzestan province, Iran. Greenhouse evaluations were conducted to determine effectiveness of *Orius laevigatis* Fieber inundation at different release rate to control of *T. tabaci* in greenhouse cucumber. Population densities of *T. tabaci* and *O. laevigatus* were weekly monitored and cucumber fruits were weekly harvested and graded in the different experimental treatments. Twice releases of *O. laevigatus* with two weeks interval at inundative rate of one and three predatory bugs per plant could not significantly suppress the thrips population and decrease percentage of unmarketable fruit yield (P_{um}) during whole of trial period. Periodical inundation of three predatory bugs per plant every two weeks could effectively control *T. tabaci* population and significantly reduce P_{um} in comparison to control treatment. Results showed that *O. laevigatus* could not establish on greenhouse cucumber in south of Iran. As a conclusion, this predatory bug can not provide a sustainable control of *T. tabaci* on greenhouse cucumber in south of Iran. Use of other *Orius* species should be evaluated to biological control of *T. tabaci* on greenhouse cucumber.

Key words: Predatory bug, onion thrips, population suppression, inundation, release rate

INTRODUCTION

Onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) is one of the most destructive pest of greenhouse cucumber, *Cucumis sativus* L., in Iran (Yarahmadi, 2009). Feeding by thrips can cause direct and indirect damage. Indirect damage arises from feeding on parenchyma of leaves and subsequent reduction in photosynthetic ability of the plant and eventually can result in significant yield loss, while direct damage causing the fruit to curl and rendering it unmarketable (Boone, 1999). Disease transmission is another form of thrips indirect damage (Lewis, 1997). Use of biological control in greenhouses is likely to increase markedly over time as more managers seek to reduce the effects of pesticide resistance and change the impediments to pest control (Pilkington *et al.*, 2010). Among biological control agents, predatory arthropods probably play a prominent role in determining the number of plant feeding thrips on plants under greenhouse condition (Sabelis and van Rijn, 1997). *Orius* predatory bugs (Heteroptera: Anthocoridae) are important natural enemies of greenhouse pests such as thrips, aphids and spider mites that are now marketed as biocontrol agents against thrips that attack crops in greenhouses (Ito, 2007).

Acceptance of biological control as a serious control strategy depends on good public relations and education. Beliefs that use of natural enemies creates new pests and biological control agents are unreliable arose mainly as a result of strong pressure to market natural enemies before they were fully tested. Several greenhouse studies were conducted to evaluate efficacy of these predators to control of thrips on various host plants, such as cucumber (Kim *et al.*, 2004), tomato (Shipp and Wang, 2003), sweet pepper (Bosco *et al.*, 2008), eggplant (Hemerik and Yano, 2010), rose (Chow *et al.*, 2010), chrysanthemum (Silveria *et al.*, 2009) and other ornamental crops (Cloyd, 2009).

Among these predators *Orius laevigatus* Fieber are common in several greenhouse crops including cucumber, melon, pepper and strawberry and are well known biocontrol agents for thrips (Arno *et al.,* 2007). However, quantitative data are not available to evaluate this hypothesis about *T. tabaci* on greenhouse cucumber.

This study was conducted to evaluate the effectiveness of biological control of *T. tabaci* by inundative release of *O. laevigatus* on greenhouse cucumber. To assess the effectiveness of *O. laevigatus,* data were collected on the changes in population densities of *T. tabaci* and *O. laevigatus* and associated fruit damage in the different release rates of this predatory bug.

MATERIALS AND METHODS

Experimental design: The experiments were carried out during 2010 to 2011 at Shahid Chamran University research greenhouse (10 by 12 m), Ahwaz, Khuzestan, Iran. The greenhouse was divided in to two blocks of eight compartments. The compartments were covered by 100 mesh gauze and each compartment had two rows of 10-12 cucumber plants. Commercial cucumber variety Negeen was used. Cucumber seedlings were transplanted at 11 September 2010. Temperature and humidity for the greenhouse was kept at 25±5°C and 70±10%. The plants were maintained according to commercial practices. The plants were automatically irrigated and fertilized according to standard commercial recommendations (Soleimani *et al.*, 2009).

Confidor (Imidacloprid, 0.35 SC) (2 g L^{-1}) was applied to keep the no infestation treatment (control) free of thrips. Some target specific pesticides were used to control other pests and disease if it is necessary. Omite (Propargite, 57% EC) was applied at the rate of 2 g L^{-1} for control of spider mites. Dithane M-45 (Mancozeb, 80% WP) (2 g L^{-1}) and Ridomil (Methalaxil, 5% G) (2 g L^{-1}) were used for control of powdery mildew *Shaerotheca fuliginea* Sclechtend and downy mildew *Pseudoperonospora cubensis* Berk. and M.A. Curtis, respectively. Benlat (Benomyl, 20% WP) (1.5 g L^{-1}) was applied against *Phytophthora drechsleri* Tucker and other soil borne fungal pathogens. Greenhouse isolation conditions and pre plant soil sterilization caused minimal undesirable pest and disease infestations.

Introduction of the thrips populations: *T. tabaci* were collected from an experimental colony that maintained on onion plant *Allium cepa* L. pots under laboratory condition at 26±1°C, 60 RH and 16 L: 8 D photoperiod.

Thrips population was introduced in to each experimental compartment by using five adult thrips per plant when cucumber plants were tree leaf stage. To favor establishment, adult thrips was contained in a round 2 cm diameter clip cage fastened on the leaf and was allowed to lay eggs for 72 h.

Inundation of the predatory bug: *Orius laevigatus* was reared on eggs of *Ephestia kuehniella* Zeller in insectarium at 26±1°C, 60 RH and 16 L: 8 D photoperiod. The predatory bugs were released three weeks after initial thrips introductions. The treatments were designed according to different release rates of *O. laevigatus* as: (A) no predatory bug release (control), (B) twice releases of one predatory bug per plant with two weeks interval, (C) twice releases of three predatory bugs per plant with two weeks interval and (D) periodical releases of three predatory bugs every two weeks. The predatory bugs were released onto the middle leaves of every plant each introduction. Four replicates were set up for each treatment in a randomized complete design.

The thrips and predatory bug population monitoring: The population densities of *T. tabaci* were monitored weekly using commercial yellow sticky traps (13 by 8 cm) and leaf counts. To monitor thrips density, one yellow sticky trap was placed just above the crop canopy for a 24 h period and then collected for counting adult thrips on both sides of it. Yellow sticky trap positions were randomized within each compartment in each sampling date. Each week, starting at the same time, three plants were also randomly selected from each compartment for leaf counts. Three leaves from different height levels (top, middle and bottom) of the canopy of each selected plant were randomly chosen. The adult and immature thrips were counted in situ by a 20X LED lighted loupe magnifier. Thrips abundance was expressed as Cumulative Thrips Day (CTD) per sticky trap or per three leaves of plant. The cumulative insect (thrips) day parameter for each sampling method was calculated according to Ruppel (1983) formula as:

$$CTD_i = \sum (T_i + T_{i+1}) / 2) \times D$$

where, T_i and T_{i+1} are number of thrips in two consecutive samplings and D is time distance between two samplings.

Several authors have used cumulative insect days as a density measure to calculate economic decision making levels in various pests (Sanches *et al.*, 2007; Reuda *et al.*, 2007; Shipp *et al.*, 1998).

Using leaf and counts sampling methods did population monitoring of *O. laevigatus*. In leaf and flower counts three leaves and flowers by the same method mentioned above were chosen and number of nymphs and adults of *Orius* bugs were recorded, respectively.

Fruit harvest and grading: Cucumbers were weekly harvested from 30 October 2010 to 8 January 2011. The fruits harvested when their diameter was between 2.5 and 3.5 cm. Each compartment was harvested separately and labeled accordingly. Total fruit weights and numbers recorded for each compartment. All fruits graded individually to marketable, including quality class A (without any thrips damage) and quality class B (with slight thrips silvery feeding scars but without malformation) and unmarketable or quality class C (with sever thrips silvery feeding scars and malformation).

Data analyses: Efficacies of *O. laevigatus* inundative releases were evaluated by comparing thrips densities and percentage of unmarketable fruit yield (P_{um}) over the trial period for different treatments.

Comparisons for total and marketable fruit weights among the treatments and the thrips population densities as monitored by the sampling methods in the compartments were done using repeated-measure analysis of variance (ANOVA) and Student-Newman-Keuls (SNK) Post Hoc tests. Comparison between the treatment and control was performed by Dunnett test.

All analyses were carried out using the SPSS software version 16 (SPSS Inc., Chicago, USA).

RESULTS

***Thrips tabaci* population dynamics:** Population dynamics of *T. tabaci* as monitored by yellow sticky traps and leaf counts in the different treatments were shown in Fig. 1a-d. Population trends as measured using yellow sticky trap and plant leaf count were similar.

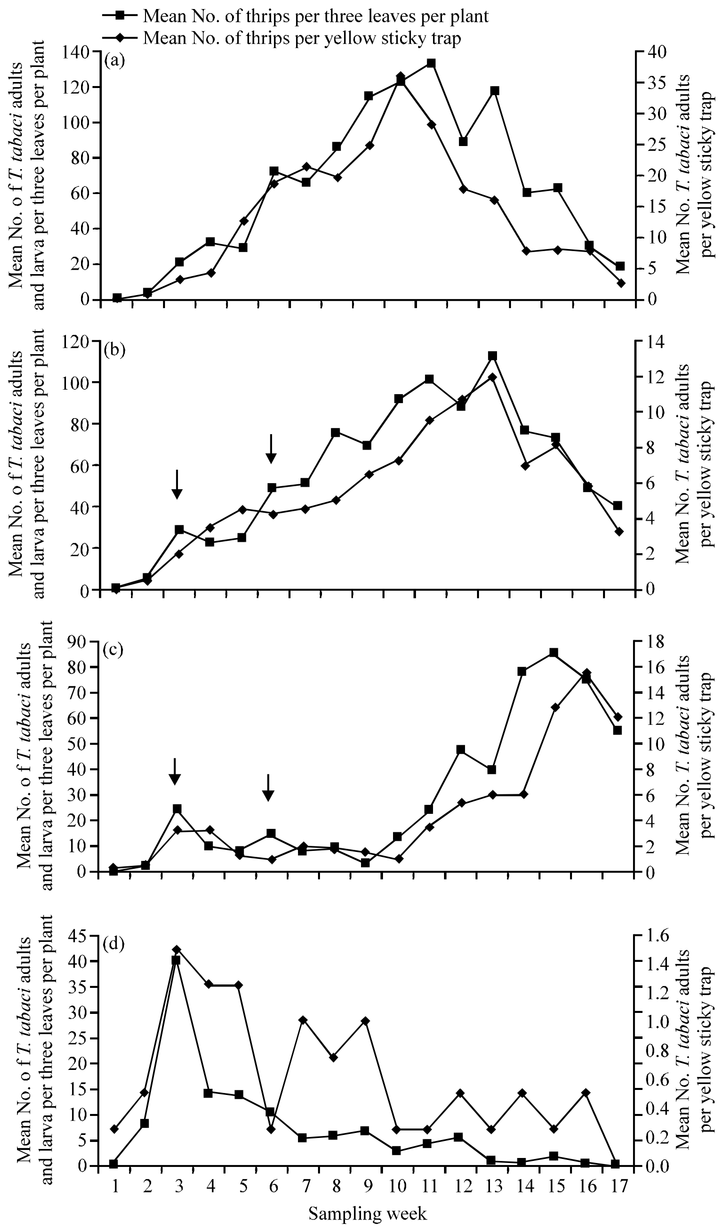

Fig. 1: Population dynamics of *T. tabaci* as monitored by yellow sticky trap and leaf counts sampling methods in the different experimental treatments: (a) No release (Control), (b) twice releases of one predatory bug per plant with two weeks interval, (c) twice releases of three predatory bugs per plant with two weeks interval and (d) periodical releases of three predatory bugs every two weeks. Arrows indicates predator introductions

In the a and b treatments, population densities of *T. tabaci* increased rapidly from 0.15 and 0.3 to 132.35 and 101.65 adults and larvae per three leaves per plant and 0.25 and 0 to 28 and 9.5 adults per yellow sticky trap in leaf counts and yellow sticky trap sampling methods, respectively. The population densities of these treatments as monitored by leaf counts and yellow sticky trap sampling methods, decreased slowly after 11th sampling week as reached 18.5 and 40.05 thrips per three leaves per plant and 2.5 and 3.25 thrips per sticky trap at 17th sampling week, respectively. This result showed that *O. laevigatus* could not suppress *T. tabaci* by twice releases of one predatory bug per plant (Fig.1a, b).

The thrips densities in the c treatment were subjected to decreased (under 14 thrips per three leaves and 3.5 thrips per yellow sticky trap for leaf counts and yellow sticky trap sampling methods, respectively) during six weeks after first and second predator releases from 4th to 9th sampling weeks. After this period, thrips population densities rapidly built up from 3.05 to 85 adult and larvae per three leaves per plant from 10th to 15th sampling weeks (Fig.1c). This result indicated that *O. laevigatus* at release rate of three predatory bugs per plant could not suppress *T. tabaci* populations more than four weeks after the inundation.

In the d treatment, *O. laevigatus* could continuously suppress *T. tabaci* to lesser than 14 thrips per three leaves per plant and 1.5 thrips per yellow sticky trap in the leaf counts and yellow sticky trap sampling methods, respectively (Fig. 1d).

Analysis of variance (ANOVA) of the weekly thrips population densities in the experimental treatments showed that the thrips densities in the B treatment could not significantly suppressed by *O. laevigatus* in comparison to the control treatment (df = 1, 38; F = 3.58; p = 0.644 and df = 1, 6; F=1; p=0.356 for leaf counts and yellow sticky trap sampling methods, respectively). Not significant difference among CTD_s of the B and control treatments (df = 1, 32; F = 0.011; p = 0.894 and df = 1, 32; F = 1.412 and p = 0.129 for leaf counts and yellow sticky trap sampling methods, respectively), revealed that the release rate could not effectively control *T. tacabi* infestation (Table 1, 2).

ANOVA and mean testing of thrips density data for each sampling date indicated that a significant differences on population densities of *T. tabaci* between the C and control treatments occurred during 8 weeks after first inundation of *O. laevigatus* (df = 3, 76; F = 0.217; p = 0.000 and df = 3, 12; F = 71.90; p = 0.000 for leaf counts and yellow sticky trap sampling methods, respectively). The thrips densities were not significantly suppressed by *O. laevigatus* for the rest weeks of the trial (Table 1, 2). Significant difference in CTD_s was not found between the C and control treatments by repeated measure ANOVA that showed *O.laevigatus* could not suppress the thrips population at this release rate (df = 1, 32; F = 1.669; p = 0.096 and df = 1, 32; F = 0.378 and p= 0.43 for leaf counts and yellow sticky trap sampling methods, respectively) (Table 1, 2).

Comparisons between the CTDs in the different treatments were showed in Table 1 and 2. The results revealed that periodical inundation with three predatory bugs every two weeks caused a significant reduction in population density of *T. tabaci* on greenhouse cucumber (df=3, 64; F=5.467; p = 0.01 and df = 3, 64; F = 6.6657; p = 0.001) for leaf counts and yellow sticky trap sampling methods, respectively. As a result, the thrips population densities were continuously suppressed at a significantly lower level in this treatment.

***Orius laevigatus* population dynamics:** Population dynamics of *O. laevgatus* as monitored by leaf and flower counts in the different treatments were shown in Fig. 2a-c. Population trends

Table 1: Means of thrips adults and larvae±SE and cumulative insect days as sampled weekly by leaf counts in the different experimental treatments

	Number of thrips per three leaves per plant and cumulative thrips days (CTDs) in the different experimental treatments			
Weeks after first inundation- CTD_s	A	B	C	D
0	20.70±3.01[a]	29.45±7.97[a]	24.20±1.23[a]	10.35±4.27[a]
1	31.80±6.55[a]	13.84±6.53[b]	9.75±2.37[b]	22.50±4.99[a]
2	28.55±6.84[a]	13.65±3.87[b]	8.25±2.36[b]	25.10±5.5[a]
3	71.80±10.69[a]	10.35±4.12[b]	14.75±4.13[b]	48.70±7.55[a]
4	65.75±11.57[a]	5.15±2.05[b]	8.05±2.42[b]	51.55±8.93[a]
5	95.35±11.3[a]	5.70±2.37[b]	9.30±2.99[b]	75.60±12.96[a]
6	113.05±13.5[a]	10.41±4.76[b]	7.33±4.44[b]	70.95±9.64[a]
7	120.90±10.38[a]	7.57±4.89[c]	17.76±5.72[b]	92.38±14.92[a]
8	116.57±15.55[a]	6.09±5.40[c]	43.09±9.11[b]	112.71±15.47[a]
9	89.76±10.68[a]	11.00±6.06[b]	51.14±8.48[a]	90.14±14.6[a]
10	117.52±15.56[a]	7.04±6.35[c]	44.04±9.52[b]	113.67±15.5[a]
11	63.90±10.31[a]	7.28±6.83[b]	80.76±16.22[a]	79.51±16.85[a]
12	35.57±7.75[a]	7.52±7.32[b]	78.61±13.33[a]	53.95±10.74[a]
13	36.04±8.11[a]	8.00±7.80[b]	79.09±13.47[a]	54.42±10.97[a]
14	25.33±8.44[a]	8.38±8.28[b]	60.19±1350[a]	46.33±11.42[a]
CTD_s	11024.25±1037.4[a]	1244.95±89.95[b]	5207.85±407.59[a]	9827.40±887.83[a]

Means within rows followed by the same letter are not significantly different ($p<0.05$). A: No predatory bug release (control), B: Twice release of one predatory bug per plant with two weeks interval, C: Twice release of three predatory bugs per plant with two weeks interval and D: Periodical release of three predatory bugs every two weeks

Table 2: Means of thrips adults±SE and cumulative insect days as sampled weekly by yellow sticky trap in the different experimental treatments

	Number of thrips per three leaves per plant and cumulative thrips days (CTDs) in the different experimental treatments			
Weeks after first inundation- CTD_s	A	B	C	D
0	3.20±0.25[a]	1.50±0.65[a]	3.20±1.03[a]	2.00±0.40[a]
1	4.20±0.75[a]	1.25±0.47[b]	3.20±0.62[a]	3.50±095[a]
2	12.50±3.27[a]	1.25±0.25[c]	1.25±0.47[c]	4.50±0.64[b]
3	18.50±5.33[a]	0.25±0.25[c]	1.00±0.00[b]	4.25±0.85[a]
4	21.25±5.92[a]	1.00±0.40[d]	2.00±0.40[c]	4.50±0.28[ab]
5	19.50±1.32[a]	0.75±0.25[d]	1.75±0.25[c]	5.00±0.40[b]
6	24.75±2.49[a]	1.00±0.57[c]	1.50±0.28[b]	6.50±0.86[a]
7	35.75±2.83[a]	0.25±0.25[c]	1.00±0.40[b]	7.25±1.65[a]
8	28.00±5.11[a]	0.25±0.25[d]	3.50±0.64[c]	9.50±0.86[b]
9	17.75±3.94[a]	0.50±0.50[c]	5.25±1.10[bc]	10.75±2.01[b]
10	16.00±5.25[a]	0.25±0.25[c]	6.00±0.70[bc]	12.00±1.08[b]
11	7.75±4.17[a]	5.00±0.28[b]	6.00±0.91[a]	7.00±0.70[a]
12	8.00±4.45[a]	0.25±0.25[b]	12.75±1.43[a]	8.25±1.03[a]
13	7.75±2.59[a]	0.50±0.28[c]	15.50±2.95[ba]	5.75±1.65[a]
14	2.50±1.04[a]	0.00±0.00[c]	12.00±3.48[bc]	3.25±0.94[b]
CTD_s	2398.37±228.33[a]	106.75±8.04[b]	1454.25±130.52[a]	992.25±86.89[a]

Means within rows followed by the same letter are not significantly different ($p<0.05$). A: No predatory bug release (control), B: Twice release of one predatory bug per plant with two weeks interval, C: Twice release of three predatory bugs per plant with two weeks interval and D: Periodical release of three predatory bugs every two weeks of *O. laevigatus* as monitored by leaf counts were similar to flower counts. In the a, b and c treatments, the population densities of *O. laevgatus* reached peaks of 0.15, 0.55 and 0.75 adults and nymphs per three leaves per plant at 1, 1 and 2 weeks after first inundation, respectively. The population densities of *O. laevgatus* dropped when the releases stopped in 6th sampling week and then disappeared since 15th and 11th sampling weeks in the a and b treatments (Fig. 2a, b). In the c treatment, the density of *O. laevigatus* established from first inundation to end of trial (Fig. 2c). The increase in *O. laevigatus* densities matches a decrease in the thrips population in the same treatment.

Fruit damage: Total fruit yields of the biological control treatments were not significantly different as compared to control (df = 3, 64; F = 1.78; p = 0.16) (Table 3). Significant differences in marketable fruit yields were not found between the b and c treatments in comparison to control

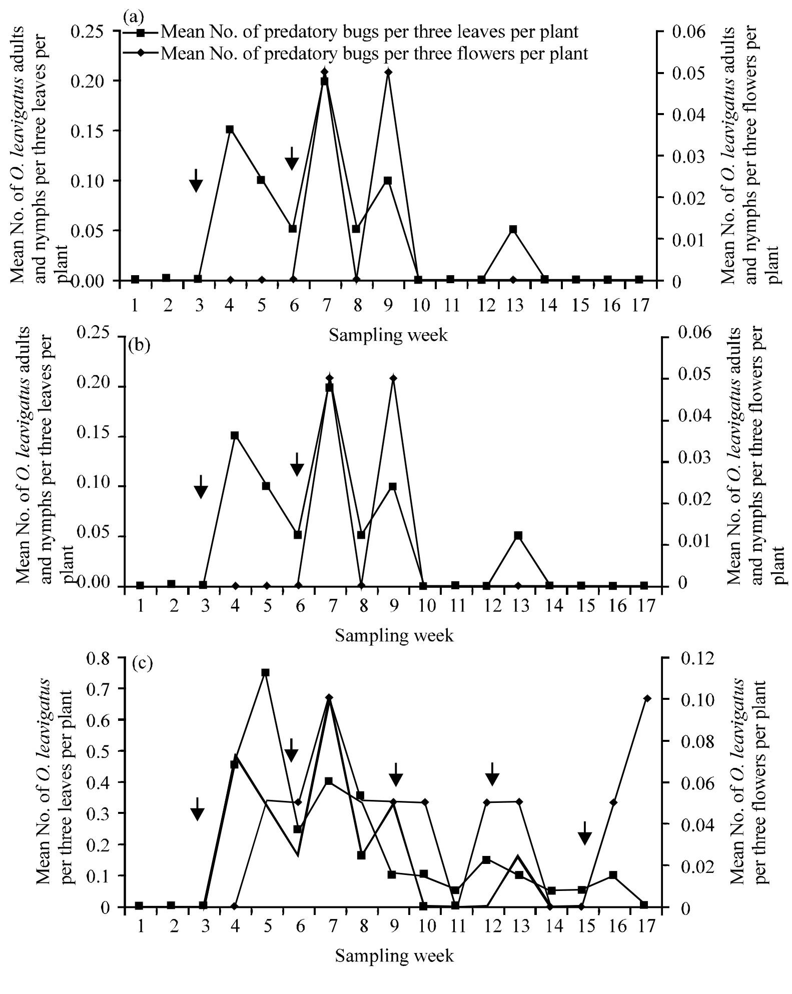

Fig. 2: Population dynamics of *O. laevigatus* as monitored by flower and leaf counts sampling methods in the different experimental treatments: (a) twice releases of one predatory bug per plant with two weeks interval, (b) twice releases of three predatory bugs per plant with two weeks interval and (c) periodical releases of three predatory bugs every two weeks. Arrows indicates predator introductions

Table 3: Means±SE of total and marketable fruit yield and cumulative thrips days (CTD_s) in the different experimental treatments

	The experimental treatments			
Results	A	B	C	D
Mean of total fruit yield	0.787±0.497[a]	0.706±0.426[a]	1.6060±0.963[a]	2.532±1.299[a]
Mean of marketable fruit yield	0.600±0.397[a]	0.621±0.373[a]	1.4930±0.973[ab]	2.519±1.292[b]
CTD_s	0.219±0.063[a]	0.185±0.0558[a]	0.1137±0.535[a]	0.032±0.016[b]

*Means within rows followed by the same letter are not significantly different (p<0.05). A: No predatory bug release (control), B: Twice releases of one predatory bug per plant with two weeks interval , C: Twice releasea of three predatory bugs per plant with two weeks interval and D: Periodical releases of three predatory bugs every two weeks

but periodical inundations of *O. laevigatus* every two weeks could significantly increase marketable fruit yield as compared to control (df = 3, 64; F = 2.624; p = 0.058) (Table 3). Comparison between PF3 in the different treatments indicated that twice releases of one and three predatory bugs with two weeks interval could not significantly decrease PF3 in comparison to control but significantly lower PF3 was harvested in periodical release of three *O. laevigatus* as compared to control (df = 3, 64; F = 3.06; p = 0.034) (Table 3).

DISCUSSION

Monitoring of population densities for both *O. laevigatus* and *T. tabaci* indicated that this predatory bug failed to establish on greenhouse cucumber. The high population densities of *T. tabaci* and low population densities of *O. laevigatus* in the B treatment over the trial period indicated that this release rate was not enough for thrips suppression in greenhouse cucumber and higher release rate required to desirable thrips control. Twice inundative releases of three predatory bugs per plant with two weeks intervals could control thrips population for short period and then the thrips population rapidly increases that result of a low reproductive potential or a low ability to establish reproducing populations on greenhouse cucumber.

Many factors contribute to variation in efficacy of *Orius* bugs such as the availability of pollen and the tendency of a given species or population of these predatory bugs to enter reproductive or feeding diapause (Van den Meiracker, 1994). Greenhouse cucumbers are generally parthenocarpic that produce only female flower. Lack of pollen resource in these cucumbers may one of the main factors causing unsuccessful establishment of *O. laevigatus* on greenhouse cucumber. Companion planting of parthenocarpic greenhouse cucumber with other plants that their flowers making pollen can enhance effectiveness and establishment of *O. laevigatius*.

Effect of photoperiods on reproductive diapause of *O. laevigatus* appears to be another important factor of establishment failure in autumn culture of greenhouse cucumber in south of Iran. Reproductive diapause was affected by photoperiod in *O. laevigatus* (Tommasini and van Lentern, 2003). Kim *et al.* (2004) reported that low temperature and short photoperiod in autumn culture of plastic house cucumber cause *O. strigicollis* undergoes reproductive diapauses. Similarly, *O. insidiosus* undergoes reproductive diapause when the photoperiod is short and temperature is low (Ruberson *et al.*, 1991). Chambers *et al.* (1993) explained that early season supplementary lighting using tungsten bulbs to extend the photoperiod ensured good control of thrips on peppers in February and March by preventing diapause and thus promoting breeding by *O. laevigatus* on sweet pepper. In short photoperiod, applying blue light resource could prevent facultative diapauses of *O. insidiosus* (Stack and Drummond, 1997). *O. albidipennis* Reuter has little tendency to enter diapause (fewer than 25%) at most day lengths, down to 8 hours and may be a suitable candidate for biological control of *T. tabaci* during autumn and winter culture of greenhouse crops (Van den Meiracker, 1994).

Plants with a defense cover of hairs as a direct defense against herbivores unavoidably interfere with the effectiveness and establishment of natural enemies of herbivores. This kind of plant defense may have some negative effects on the third trophic level. On the other hand it may decrease the availability of herbivorous arthropods to predators, hinder predator foraging and even cause mortality among the predators (Sabelis and van Rijn, 1997). Defense cover of hairs may decrease ovipositon site of *O. laevigatus* females and due to the population can not establish.

Shipp and Whitfield (1991) found that *Amblyseius cucumeris* Oudemans had higher predation rate and could establish on glabrous sweet pepper leaves than on hairy cucumber leaves. Coll and Ridgway (1995) found that *O. insidiusus* showed poor functional and numerical response to thips, aphids, leafhoppers and whiteflies on tomato that bean and corn. They suggested that glandular hairs on leaves and stems of tomato hindered the searching behavior of this predator. Investigation on *Macrolophus pygmaeus* Rambur and *O. niger* Wolff showed that trichome intensities in various cultivar of tomato affected time allocation of activities these predatory bugs (Leonidas *et al*., 2006). Ferguson and Schmidt (1996) showed that same rates of egg laying and hatch by *O. insidiosus* on pepper in comparison to tomato that has glandular hairs.

Among the various release rates of *O. laevigatus*, only periodical release of three predatory bugs every two weeks could significantly suppress the thrips population densities and decrease PF3 over whole trial period. Shipp and Wang (2003) reported that innundative introductions of *O. insidiosus* at rate of 10 adults per plant biweekly failed to reduce *F. occidentalis* population densities to economically acceptable levels with mean fruit damage levels exceeding 8% 100 weeks after the first introduction of *O. insidiosus*. Kim *et al.* (2004) showed that *O. strigicollis* Poppius at inundative rate of four bugs per plant could control moderate densities of *T. palmi* Karny on cucumber under plastic house condition but could not suppress high and low densities of the thrips. One release of *O. laevigatus* at rate of 1-2 bugs per m^2 could establish on sweet pepper and eggplant tunnels and effectively suppress *F. occidentalis* and *T. tabaci* on these plants (Tommasini, 2003). Present results about *Orius* bug establishment and biological control success agree with those presented by Kim *et al.* (2004) and conflicts with those observed by Tommasini (2003). Different characters of the host plants about availability of pollen and defense cover of hairs may be due to the conflict result.

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