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Orijinal araştırma (Original article)

Biological control of Western flower thrips, *Frankliniella occidentalis* with *Orius* species in eggplant greenhouses in Turkey[1]

Türkiye'de *Orius* türleri ile örtüaltı patlıcan yetiştiriciliğinde zararlı Batı Çiçek Thripsi, *Frankliniella occidentalis* ile biyolojik mücadele

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Summary

The Western flower thrips, *Frankliniella occidentalis* (Pergande), is a major pest, causing serious damage on eggplant in greenhouses. The present study was conducted to determine the efficacy and optimum release rate of the predators *Orius niger* Wolff and *O. laevigatus* Fieber in terms of their performance post-release in Antalya (Turkey) during 2003-2005. The predators were released (1, 2, 4 and 6 adults of each *Orius* per m^2) only one time at the beginning of growing season in the first year. However, suppression of the thrips by *Orius* was not sufficient, particularly at the beginning of spring. Therefore, a second release was performed in the spring period in the second year trials. The findings showed *O. laevigatus* to be a more efficient predator in controlling *F. occidentalis* than *O. niger* in greenhouses. *O. laevigatus* displayed more rapid colonization than *O. niger* and efficiently controlled *F. occidentalis* on eggplant after two releases of 6 adults per m^2 in October and March, whereas *O. niger* exhibited slower colonization of the plants compared to *O. laevigatus*, and its predatory effect on the pest thrips took longer.

Key words: *Orius niger, Orius laevigatus, Frankliniella occidentalis,* protected cultivation, biological control

Özet

Batı çiçek thripsi, *Frankliniella occidentalis* (Pergande) örtüaltı patlıcan yetiştiriciliğinde önemli zararlılardan birisidir. Antalya İlinde 2003-2005 yıllarında yürütülen bu çalışmada *Orius niger* Wolff ve *O. laevigatus* Fieber salımları yapılarak, uygun avcı ve salım yoğunluğu belirlenmesi amaçlanmıştır. İlk yıl çalışmasında yetiştirme periyodunun başlarında sadece bir kez *F. occidentalis*'e karşı 1, 2, 4 ve 6 ergin/m^2 yoğunlukta avcı salımları yapılmıştır. Bu yapılan salım, özellikle bahar dönemi için thrips popülasyonunu baskı altına almada yeterli olmamıştır. Bu nedenle ikinci yıl çalışmasında bahar döneminde ikinci salımlar yapılmıştır. Sonuçlar, örtüaltı patlıcan yetiştiriciliğinde *F. occidentalis* mücadelesinde O. *laevigatus*'un O. *niger*'e göre daha etkili bir avcı olduğunu göstermektedir. O. *laevigatus*'un O. *niger*'e göre daha hızlı kolonize olduğu, Ekim ve Mart aylarında 6 ergin/m^2 yoğunluğunda yapılan iki salım ile zararlıyı kontrol ettiği görülmüştür. *O. niger*, *O. laevigatus*'a göre daha yavaş kolonize olmasına rağmen, uzun dönemde zararlı üzerinde etkili olduğu görülmüştür.

Anahtar sözcükler: *Orius niger, Orius laevigatus, Frankliniella occidentalis,* örtüaltı sebze yetiştiriciliği, biyolojik mücadele

[1] This study is a part of the first author's Ph. D. Thesis.

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Introduction

Western flower thrips (WFT), *Frankliniella occidentalis* Pergande (Thysanoptera: Thripidae) is an important pest distributed, over North America, Europe, Australia and South America, that primarily feeds on ornamental and vegetable crops in greenhouses and fields (Tavella et al., 1991; Tommasini and Maini, 1995; Kirk and Terry, 2003). It is a very widely-spread and a serious pest of vegetables and ornamental plants in greenhouses and cotton in the fields in Turkey (Tunc and Gocmen, 1994; Yaşarakıncı and Hıncal, 1997; Atakan et al., 1998; Kececi, 2007). The insect causes discoloration of leaves and fruits, necrosis and deformation by feeding and ovipositing damage due to inserting their eggs into plant tissues (Tommasini and Maini, 1995). Furthermore, it transmits the tomato spotted wilt virus (TSWV) and the impatiens necrotic spot (INSV) that are most epidemic on a wide range of the agricultural crops (Jones, 2005; Rotenberg *et al*., 2009).

Synthetic insecticides are widely used for WFT control; however, chemical control of the pest in the field creates serious problems since the adults and larval stages feed within the flowers and buds, providing a shelter for them against pesticides. It is remarkably difficulty to control the pest because the female lays eggs into plant tissues, thereby avoiding contact with chemicals applied. Another problem is that it is resistant to some commercial pesticides used widely (Immaraju et al., 1992; Brodsgaard, 1994; Dagli ve Tunc, 2006).

For those reasons, it is of importance to develop alternative control strategies against this pestiferous thrips. Biological control possibilities of WFT using *Orius* species on major vegetables such as pepper, eggplant, cucumber, tomato and strawberry, which are important in protected cultivation. This concept has been investigated by the researchers since 90's years (Van de Veire and Degheele, 1992, 1997; Chamber et al., 1993; Dissevelt et al. 1995; Sanchez et al., 2000; Tommasini and Maini, 2001; Tavella et al., 2003), eggplant (Tommasini et al., 1997; Chiappini, 1993), cucumber (Dissevelt et al. 1995), tomatoes (Shipp and Wang, 2003) and strawberry (Dissevelt et al. 1995).

The aim of the study was (i) to compare *O. laevigatus* and *O. niger* as biological control agents of WFT and (ii) to determine the most convenientt release rate and frequency under the protected crop conditions during the growing season in Turkey.

Materials and Method

Insect Rearing

Frankliniella occidentalis was maintained on seedlings of French beans, *Phaseolus vulgaris* (L.) in meshed cages (32*50*50 cm) (Dagli ve Tunc, 2006). *O. niger* adults were previously collected from cotton fields and *O. laevigatus* adults were provided from the Koppert Co. (Antalya, Turkey). These two species were mass-reared in insectariums for further experiments. Rearing of the *Orius* species was carried out in a plastic jar (10X6X6cm) with a hole on the side of the jar for ventilation. A bean pod was served as an oviposition site and water source for the adults and replaced by a fresh one daily. *Ephestia kuehniella* Zell. eggs were provided as food for both adults and nymphs of *Orius* (Blümel, 1996; Bakker et al. 2000).

Both thrips and *Orius* cultures were kept in climate controlled rooms at 26±1°C temperature, 70%±10 relative humidity and long day conditions (16L:8D).

Plot experiments in different growing seasons

Greenhouse trials were conducted for assessment of *O. niger* and *O. laevigatus* efficiency and their optimum release rate. Assays were performed in eggplant greenhouses of the Bati Akdeniz Agricultural Research Institute (Batı Akdeniz Tarımsal Araştırma Enstitüsü). Experiments were completely randomized block with 3 replications. Each plot was 10 m^2 with 14 plants. Plants were initially infested with WFT females (twenty-five individuals reared under the laboratory conditions per plot) at 7-10 days after planting. This treatment was repeated in all plots for each year. Each plot was separated from others with insect net (80 mesh) to prevent thrips and *Orius* movement among the plots. Then, 1-3 day old *O. niger* and *O. laevigatus* adults were released separately in plot assays against WFT.

Four different release rates (1, 2, 4 and 6 individuals per m^2) were applied for both *O. laevigatus* and *O. niger.*

The experiments were done in two different growing seasons (2003-2004 and 2004–2005). In the first year of the experimental period, the plants were transplanted into the glasshouses on the 2nd of October, 2003. Predators were released to colonize the plants at the rates described above between 4 and 6th of November 2003.

In the second year experiments were conducted in plots after transplanting seedlings into the glasshouses on the 17th of September, 2004, and predators were released twice. The first predators were released at same rates on 23 October 2004. A second predator release at the same rates was done at the beginning of spring (12 March 2005), due to the occurrence of low predatory efficiency based upon the previous year results.

Insect Sampling

Thrips (larvae and adult) and *Orius* (nymph and adult) populations were counted once a week from nine randomly selected leaves and flowers of three plants.

Data Analysis

The number of thrips for each pot was subjected to analysis of variance (ANOVA) (SAS). The significance of the differences among the number of thrips was tested with Duncan's multiple range test at the $P \leq 0.05$ significance level.

Results

The thrips were successfully colonized on plants. At the beginning of the growing season, there was no statistically significant difference for both years in the plots, at which time Orius species were released (Table 1, 2).

First year experiment

The highest population rate of WFT within the flowers was 5.76 adults plus larvae in control plots during autumn in the first year (Fig. 1). The WFT population in control and experimental plots with *Orius* did not show significant differences on flowers until 10th of December. In that time, the thrips population in the six *O. laevigatus* released plots was under the economical threshold level (2.15 individuals per flower) and the number of thrips in plots in which *Orius* was released showed a significant difference compared to control plots ($p<0.05$) (Table 1). Due to the lack of economic threshold data for WFT in eggplant flowers, the threshold for pepper was used to evaluate eggplant (Shipp, 1995). The maximum predator population was 0.81 individual per flower in *O. laevigatus* plots in which 6 individual per m^2 were released on 24th of December. The highest *O. niger* population was 0.40 individuals per flower in the plots in which 6 individuals per m^2 were released on the same date (Fig. 1).

While the highest thrips density was 14.74 individuals per leaf in control plots on 30th of December, the highest *Orius* population was 0.66 individuals per leaf in the plots with 6 individuals of *O. laevigatus* per m^2 in autumn (Fig. 1).

The thrips populations showed a relative increase by March. Mean numbers of thrips exceeded the threshold level in the plots with *Orius* individuals after 24 March. The highest thrips population density was 9.26 individuals per flower in the control plots on May 5 and 59.15 individuals per leaf in the control plots on the 28th of April (Table 1).

Although the thrips number per leaf in 6 *O. laevigatus*-released plots was statistically different from the other plots after 7th of April, it was above the economical threshold ($p<0.05$) (Table 1). The number of *O. laevigatus* per leaf was between 0.22 and 0.40 individuals in the same period and the same plots. Both *Orius* species were not able to suppress the thrips populations in the spring time.

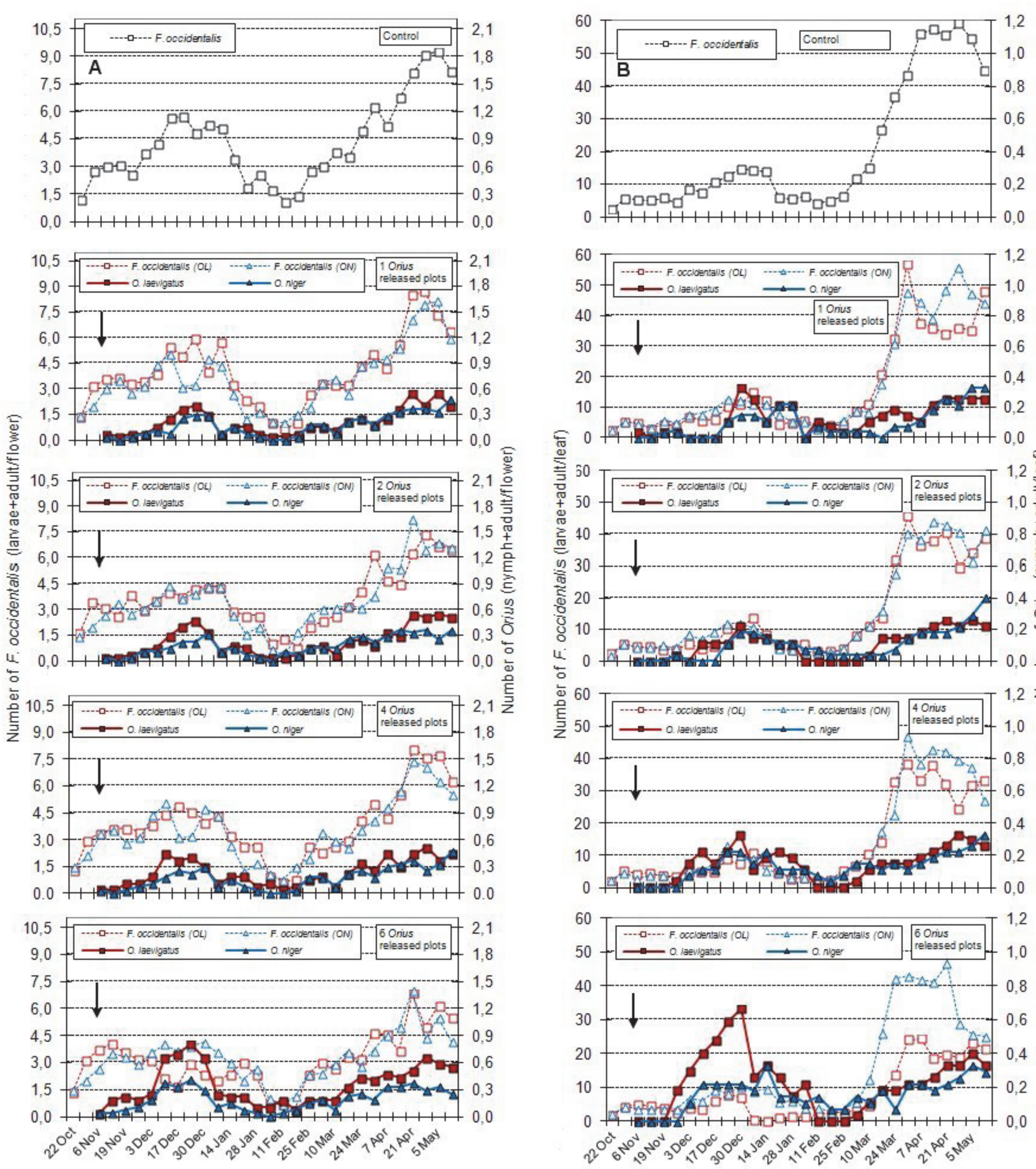

Figure 1. *Frankliniella occidentalis,Orius laevigatus and Orius niger* population changes in a protected eggplant production facility in the first year (2003-2004) of the experiments (A: Flower, B: Leaf; *F. occidentalis* (OL): *F. occidentalis* in *O. laevigatus* released plots, *F. occidentalis* (ON): *F. occidentalis* in *O. niger* released plots, ↓: *Orius* release date).

Table 1. *Frankliniella occidentalis* population densities in the flowers or leaves from the control or *Orius*-released plots in the first year (larvae and adulst per flower or leaf)

	Control		OL1*		OL2		OL3		OL4		ON1		ON2		ON3		ON4	
Flower																		
22 Oct	1.22	a**	1.33	a	1.67	a	1.33	a	1.33	a	1.44	a	1.44	a	1.44	a	1.44	a
31 Oct	2.76	a	3.18	a	3.48	a	3.00	a	3.14	a	2.00	a	2.00	a	2.11	a	2.00	a
3 Dec	4.26	a	3.85	a	3.55	a	3.85	a	3.11	a	4.40	a	3.52	a	4.40	a	3.55	a
10 Dec	5.66	a	5.44	ab	4.00	ab	4.44	ab	2.15	b	5.03	ab	4.44	ab	5.03	ab	4.00	ab
17 Dec	5.76	a	4.89	ab	3.78	ab	4.89	ab	1.70	b	3.11	ab	3.66	ab	3.11	ab	3.62	ab
24 Dec	4.83	a	5.92	a	4.26	a	4.59	a	2.92	a	3.22	a	3.92	a	3.22	a	3.92	a
30 Dec	5.28	a	4.00	a	4.33	a	4.00	a	2.33	a	4.74	a	4.33	a	4.74	a	4.11	a
3 March	3.00	a	3.33	a	2.33	a	2.33	a	3.00	a	3.40	a	3.06	a	3.40	a	2.40	a
10 March	3.80	a	3.22	a	2.67	a	2.67	a	2.67	a	3.55	a	3.11	a	2.92	a	2.89	a
17 March	3.52	a	3.22	a	3.22	a	3.00	a	3.33	a	2.66	a	3.22	a	2.55	a	3.59	a
28 April	9.09	a	8.70	a	7.40	a	7.59	a	5.00	a	8.00	a	6.48	a	7.03	a	4.33	a
5 May	9.26	a	7.33	a	6.70	a	7.77	a	6.14	a	8.14	a	6.88	a	6.25	a	5.47	a
12 May	8.22	a	6.33	a	6.48	a	6.29	a	5.51	a	5.92	a	6.59	a	5.52	a	4.18	a
Leaf																		
22 Oct	2.33	a**	2.33	a	2.33	a	2.00	a	2.00	a	2.67	a	1.67	a	2.33	a	2.18	a
31 Oct	5.56	a	5.33	a	5.44	a	5.29	a	4.33	a	5.44	a	5.11	a	4.74	a	4.44	a
3 Dec	8.39	a	6.78	a	5.29	a	4.67	a	4.00	a	7.59	a	8.48	a	5.81	a	6.92	a
10 Dec	7.42	a	5.48	a	4.07	a	4.74	a	3.63	a	7.89	a	6.63	a	5.52	a	6.18	a
17 Dec	10.44	a	6.03	a	4.55	a	4.70	a	5.96	a	9.44	a	9.18	a	7.55	a	9.25	a
24 Dec	12.39	a	10.33	a	10.33	a	8.81	a	7.89	a	12.77	a	11.77	a	13.03	a	8.14	a
30 Dec	14.74	a	11.26	ab	10.44	ab	7.33	b	7.22	b	12.33	ab	11.89	ab	10.33	ab	10.37	ab
3 March	11.63	a	8.66	ab	8.18	ab	6.66	ab	3.29	b	8.81	ab	7.96	ab	7.11	ab	5.85	ab
10 March	15.03	a	10.92	ab	11.14	ab	10.33	ab	4.59	b	8.29	ab	10.96	ab	7.14	ab	12.59	ab
17 March	26.63	a	20.85	ab	13.74	ab	14.00	ab	9.18	b	17.67	ab	15.92	ab	17.52	ab	26.15	a
24 March	36.72	a	32.33	a	32.00	a	32.66	a	13.63	a	31.03	a	27.66	a	22.81	a	42.18	a
31 March	43.28	a	56.85	a	45.59	a	38.48	a	24.15	a	47.85	a	40.15	a	47.15	a	42.89	a
07 April	56.02	a	37.70	ab	36.37	ab	33.11	ab	24.48	b	44.67	ab	38.24	ab	38.33	ab	42.00	ab
14 April	57.44	a	35.92	ab	37.78	ab	37.81	ab	18.55	b	39.26	ab	43.59	ab	42.74	ab	41.18	ab
21 April	55.55	a	33.92	ab	40.52	ab	31.92	ab	19.77	b	48.48	ab	42.70	ab	42.00	ab	46.66	ab
28 April	59.15	a	35.85	abc	29.67	abc	24.18	bc	18.88	c	55.81	ab	40.40	ab	39.59	abc	28.96	ab
5 May	54.55	a	35.14	ab	34.22	ab	31.78	ab	23.33	b	47.26	ab	31.44	ab	37.48	ab	25.67	ab
12 May	44.85	a	48.00	a	38.52	a	33.18	a	21.63	a	44.33	a	41.03	a	27.00	a	25.15	a

*Released individuals: OL1, *O. laevigatus* 1 adult/m^2 releasing; OL2, *O. laevigatus* 2 adult/m^2 ; OL3, *O. laevigatus* 4 adult/m^2 ; OL4, *O. laevigatus* 6 adult/m^2 ; ON1, *O. niger* 1 adult/m^2 ; ON2, *O. niger* 2 adult/m^2 ; ON3, *O. niger* 4 adult/m^2 ; ON4, *O. niger* 6 adult/m^2 ; **Within a row, means followed by different letters are significantly different (P<0.05) according to the Duncan multiple-range test.

Second year experiment

In the second year experiment, the thrips population in all plots did not show a significant difference until November 24 ($p<0.05$) (Table 2). At that sampling date, the highest population density of WFT in the flowers was 7.91 adults plus larvae in the control plots. Although the thrips population in flowers decreased due to *Orius* sp. attacks in all *Orius*-released plots, remarkable efficacy from the *Orius* predation was observed in plots with 6 individuals of *O. laevigatus* per m^2. The mean numbers of thrips declined to 2.96 individuals per flower on the 24^{th} of November. In this period, the highest *Orius* population was 0.81 individuals per flower in the plots in which 6 individuals per m^2 *O. laevigatus* had been released (Fig. 2).

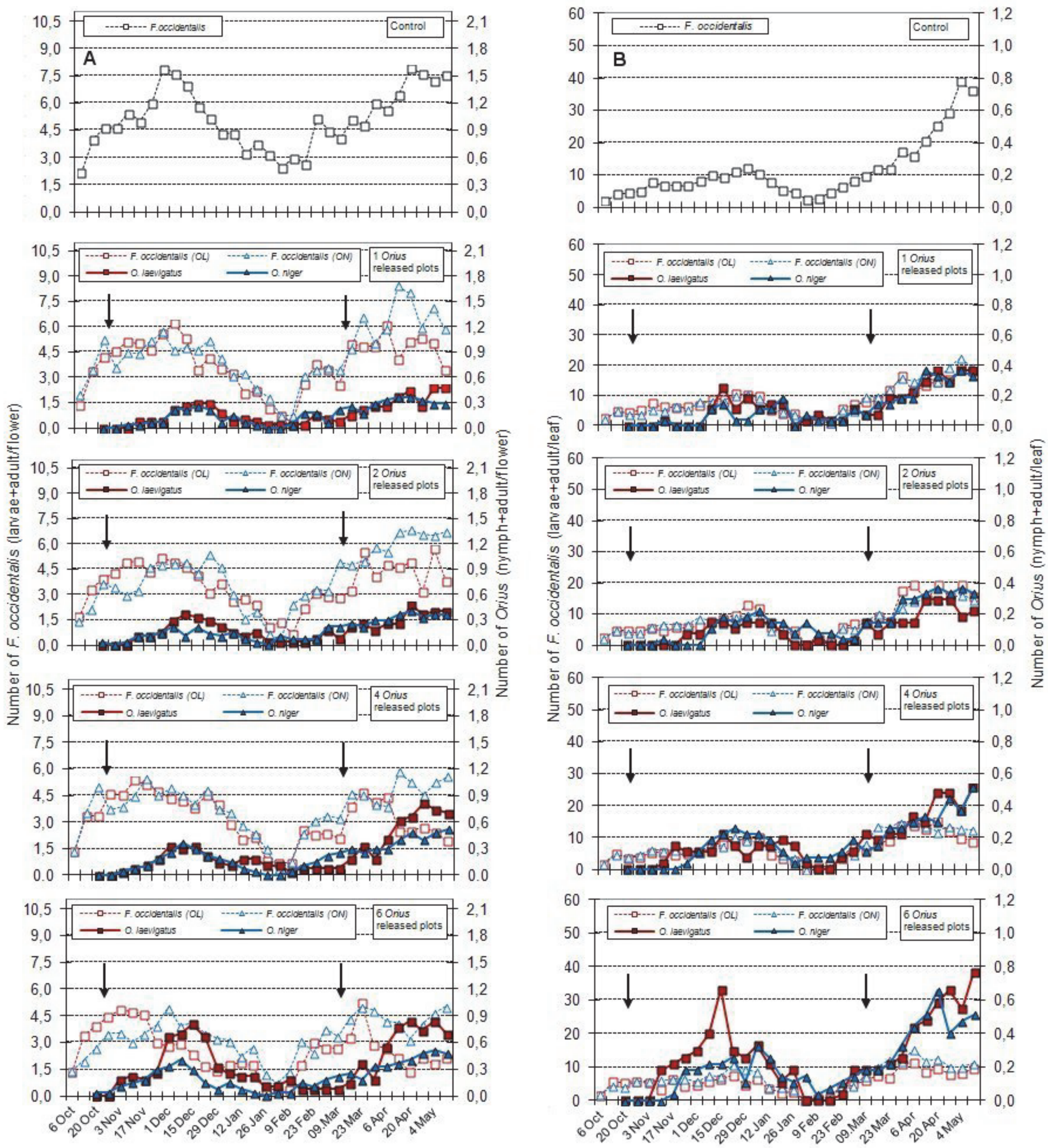

Figure 2. *Frankliniella occidentalis*, *Orius laevigatus* and*Orius niger* population changes in a protected eggplant production facility in the second year (2004-2005) of the experiment (A: Flower, B: Leaf; *F. occidentalis* (OL): *F. occidentalis* in *O. laevigatus* released plots, *F. occidentalis* (ON): *F. occidentalis* in *O. niger* released plots, ↓: *Orius* release date).

Table 2. *Frankliniella occidentalis* population densities in the flowers or leaves of the control and*Orius*-released plots in the second year (2004-2005)(larvae and adults per flower or leaf)

Tarih	Control		OL1*		OL2		OL3		OL4		ON1		ON2		ON3		ON4	
									F l o w e r									
6 Oct	2.17	a**	1.33	a	1.67	a	1.33	a	1.33	a	2.00	a	1.44	a	1.33	a	1.44	a
13 Oct	4.03	a	3.36	a	3.29	a	3.33	a	3.37	a	3.40	a	2.11	a	3.51	a	2.00	a
24 Nov	7.91	a	5.59	ab	5.18	ab	4.74	ab	2.96	b	5.70	ab	4.74	b	4.55	ab	3.96	b
1 Dec	7.65	a	6.18	ab	4.92	ab	4.33	ab	2.77	b	4.59	ab	4.81	b	4.89	ab	4.96	ab
8 Dec	6.96	a	5.33	ab	4.59	ab	4.22	ab	2.92	b	4.74	ab	4.89	ab	4.55	ab	3.92	b
15 Dec	5.81	a	3.44	ab	4.11	ab	3.81	ab	2.33	b	4.63	ab	4.29	ab	4.00	ab	4.11	ab
16 March	5.11	a	5.00	a	3.22	a	3.89	a	3.22	a	4.70	a	4.74	a	4.59	a	4.37	a
23 March	4.76	a	4.85	a	5.55	a	4.66	a	5.26	a	6.55	a	5.00	a	4.52	a	5.00	a
30 March	6.02	a	4.81	ab	4.04	ab	4.11	ab	2.85	b	5.04	ab	5.78	ab	4.00	ab	4.81	ab
6 April	5.62	a	6.11	a	4.73	a	4.40	a	2.66	a	5.89	a	5.55	a	3.85	a	4.18	a
13 April	6.48	ab	4.03	ab	4.63	ab	2.48	b	2.11	b	8.41	a	6.74	ab	5.81	ab	4.11	ab
20 April	7.92	a	5.11	abc	4.89	ab	2.51	bc	1.33	c	8.00	a	6.81	ab	5.22	ab	3.18	bc
27 April	7.63	a	5.33	ab	3.15	b	2.70	b	2.11	b	5.92	ab	6.55	ab	4.51	ab	4.03	ab
4 May	7.25	a	5.00	abc	5.70	ab	2.40	bc	1.81	c	7.11	a	6.51	ab	5.23	ab	4.66	ab
11 May	7.53	a	3.40	bc	3.77	bc	1.92	c	2.15	c	5.85	abc	6.74	ab	5.55	ab	5.04	ab
									L e a f									
6 Oct	2.00	a**	2.33	a**	2.33	a	2.00	a	1.67	a	2.33	a	2.00	a	1.67	a	2.00	a
13 Oct	3.85	a	4.89	a	4.70	a	4.96	a	5.55	a	4.78	a	4.70	a	4.63	a	4.40	a
24 Nov	6.42	a	6.26	a	5.52	a	5.04	a	4.18	a	5.15	a	6.59	a	6.18	a	6.59	a
1 Dec	8.18	a	6.77	a	5.88	a	5.51	a	4.85	a	7.89	a	8.74	a	5.25	a	5.59	a
8 Dec	9.74	a	8.81	a	7.66	a	7.52	a	5.77	a	8.18	a	7.70	a	6.99	a	7.51	a
15 Dec	9.07	a	8.59	a	8.33	a	8.26	a	6.32	a	8.14	a	7.03	a	7.44	a	7.03	a
22 Dec	10.77	a	10.48	a	9.59	a	8.92	a	7.44	a	9.96	a	9.03	a	10.29	a	10.77	a
29 Dec	11.96	a	10.41	ab	12.67	a	9.48	ab	4.78	b	10.41	ab	9.77	ab	8.96	ab	9.37	ab
16 March	11.78	a	8.37	a	8.92	a	7.59	a	7.40	a	9.40	a	10.00	a	13.59	a	9.96	a
23 March	11.83	a	11.66	a	7.66	a	9.29	a	6.66	a	11.85	a	8.26	a	13.11	a	11.96	a
30 March	17.05	a	16.44	a	17.48	a	14.11	a	11.1	a	15.81	a	12.03	a	14.77	a	11.59	a
6 April	15.59	a	11.22	a	19.44	a	13.85	a	11.5	a	14.74	a	14.29	a	14.81	a	15.41	a
13 April	20.40	a	13.48	ab	14.67	ab	12.78	ab	8.63	b	16.04	ab	14.59	ab	13.59	ab	11.81	ab
20 April	25.20	a	14.59	ab	19.33	ab	15.26	ab	9.63	b	14.70	ab	14.77	ab	11.81	ab	12.55	ab
27 April	29.00	a	15.26	ab	15.40	ab	12.00	b	7.92	b	19.11	ab	15.00	ab	13.37	ab	10.14	b
4 May	38.76	a	18.59	b	19.37	b	9.85	b	8.33	b	22.22	ab	16.33	b	12.81	b	10.07	b
11 May	36.06	a	18.00	b	15.48	b	8.85	b	9.59	b	19.15	b	14.67	b	12.37	b	11.07	b

*Releasing Doses: OL1, *O. laevigatus* 1 adult/m^2 releasing; OL2, *O. laevigatus* 2 adult/m^2 ; OL3, *O. laevigatus* 4 adult/m^2 ; OL4, *O. laevigatus* 6 adult/m^2 ; ON1, *O. niger* 1 adult/m^2 ; ON2, *O. niger* 2 adult/m^2 ; ON3, *O. niger* 4 adult/m^2 ; ON4, *O. niger* 6 adult/m^2 ; **Within a row, means followed by different letters are significantly different (P<0.05), according to the Duncan multiple-range test.

The highest mean density of thrips was 11.96 individuals per leaf in control plots on the 29th of December. The WFT population in the control and *Orius*-released plots showed no significant difference on the leaves until this date ($p<0.05$) (Table 2). On the same date, the minimum thrips number was 4.78 individuals per leaf in the plots with 6 *O. laevigatus* per m^2, while the highest *Orius* density was 0.66 individuals per leaf in the same plot on the 15th of December (Fig. 2).

In spring time, the thrips population started to increase on the 23th of February, likely due to an increase in the mean temperature. Additionally, a second predators release was done due to lack of predator effectiveness on 12th of March. Thrips density dramatically declined to 2.85 thrips per flower on 30th of March and to 2.48 thrips per flower on 13th of April in the plots where 6 and 4 individual per m^2 *O. laevigatus* were released, respectively. The highest *O. laevigatus* density was 0.85 individual per flower in the plots where 6 individuals were released per m^2 on the 20th of April and 4th of May.

The highest mean thrips density (adults plus larvae) was 38.76 individuals per leaf on 4th of May in the control plots. The thrips density was 8.63 thrips per leaf in the plots with 6 *O. laevigatus* per m^2 on 13th of April; the thrips numbers in other plots were statistically different ($p<0.05$) (Table 2). Two weeks afterthis record, there was no significant difference between the mean number of thrips in plots with 6 individuals per m^2 of *O. laevigatus* and *O. niger* ($p<0.05$) (Table 2). These results showed that *O. laevigatus* rapidly colonized the plants in plots with 6 predator individuals per m^2 in spring time.

Findings both in the autumn period of first year and autumn and spring period of the second year showed 0.5 *O. laevigatus* per flower, with a thrips number on flowers under the threshold level.

Discussion

Field experiments showed that *O. laevigatus* is more effective than *O. niger* in controlling WFT on eggplant in Antalya province. However, one release per growing season did not provide adequate WFT control, thus, an additional release of *O. laevigatus* and *O. niger* was done at the beginning of spring. *O. laevigatus* displayed more rapid colonization than *O. niger* and efficiently controlled WFT on eggplant after the two releases of 6 adults per m^2 in October and March. This double application approach per year (one in autumn and one in spring) was determined necessary for overall effective control.

The eggplant growing season starts by mid-September and ends by June in Antalya province. Pest and predator populations fluctuate greatly during this period, most notably due to significantly lower temperatures during the winter months. Previous studies reported no development of *O. laevigatus* below 11.3ºC (Sanchez and Lacasa, 2002) and 9.4 ºC for WFT (Gaum *et al.*, 1994). The mean temperatures were 11.89 and 12.71ºC in greenhouses where trial plots were established in January- February in 2004 and 2005. These values are advantageous to WFT at the beginning of the spring season and WFT increases its population much more quickly than *Orius*. Nevertheless, the heating system in most greenhouses has only been used for preventing the plants from cold stress in our region, resulting in an inappropriate climatic condition for the predator durability. The findings indicated a necessity for a second predator release to efficiently control WFT. In this manner, the findings in our study can be adapted to IPM strategies in regions with similar climatic conditions.

Comparative trials using all releases in October and March for both *O. laevigatus* and *O. niger* resulted in a more rapid colonization and higher efficiency of *O. laevigatus*. In a trial of eggplant grown in greenhouses in Northern Italy, a release of only 1-2 *O. laevigatus* per m^2 was needed to effectively control thrips (Tommasini *et al.,* 1997). This may be related to the difference in growing periods which started in April and ended in September. Several studies carried out in Italy also reported that effective control of WFT is possible with a release of 1-3 indiviuals per m^2 of *O. laevigatus* on pepper in tunnel houses in the northern part of the country (Tommasini and Maini, 2001; Tavella *et al.,* 2003). Additionally *O. laevigatus* can more effectively control WFT if placed on the plants early (Tommasini and Maini, 2001). Sanchez *et al*. (2000) also reported that *Orius* population was higher than thrips population at the end of the growing season.

Our results indicate the necessity of a higher release rate for controlling of WFT than that of previously reported recommendations for pepper. This difference can be associated with the effect of host plant on survival, adult longevity and fertility of *Orius* individuals.

Our findings indicated that *O. niger* could reach the same population level as *O. laevigatus* after 2-4 weeks. Other studies have reported that *O. niger* and *O. insidiosus* populations showed an initial equal increase; however, *O. niger* individuals exceeded *O. insidiosus* by the end of the growing season (Van de Veire and Degheele, 1992). Interestingly, *O. niger* can be considered to be efficient at controlling thrips once it has reached maximum growth capacity, even with only one release.

In conclusion, our findings demonstrate that *O. laevigatus* can suppress thrips more efficiently than *O. niger.* While no studies to date have examined the effects of *O. niger* on WFT on eggplant, we have demonstrated that *O. niger* might be able to playa role in the suppression of the WFT populations.

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