JOURNAL OF AGRICULTURE AND PLANT SCIENCES, JAPS, Vol 20, No. 2, 2022

Manuscript received: 01.12.2022
Accepted: 14.12.2022

In print: ISSN 2545-4447
On line: ISSN 2545-4455
doi: ----------------------
Original scientific paper

USE OF *Orius laevigatus* TO CONTROL *Frankliniella occidentalis* (THYSANOPTERA: THRIPIDAE) POPULATION IN GREENHOUSE PEPPER

Biljana Atanasova[1*], Dusan Spasov[1], Dragica Spasova[1], Mite Ilievski[1]
[1]*Faculty of Agriculture, Goce Delcev University – Stip, Krste Misirkov 10-A, 2000 Stip, Republic of North Macedonia*
**Corresponding author: biljana.atanasova@ugd.edu.mk*

Abstract

Although chemical pesticides play a vital role in controlling the number of harmful insects, they also contribute to accelerate pollution of soil, air and water. Due to the frequent use, insects become resistant to active ingredients very quickly; they destroy the natural enemies of the pests and have a harmful effect on humans. Accordingly, the application of biological protection, that is, the use of living organisms (predators and parasites) in plant protection programmes in protected areas, takes on a larger scale worldwide rather than the use of chemical pesticides.

The aim of our research was determining the effectiveness of pirate bug *Orius laevigatus* (Hemiptera: Anthocoridae) on reducing the population of Western flower thrips (*Frankliniella occidentalis*). The experiment was set in commercial greenhouses (3 unheated plastic tunnels, ca. 125 m^2, each), located in the area of Dabilje, Republic of Macedonia, during 2019 and 2020.

The results obtained correspond to our expectation in controlling the population of the trips. Predator proved to be effective in reducing the number of thrips population.

Key words: *predators, biological control, western flower thrips, pirate bug*

INTRODUCTION

Western flower thrips, *Frankliniella occidentalis* Pergande (Thysanoptera: Thripidae) is an important pest of pepper, and a broad range of vegetable and ornamental crops in greenhouses and fields (Tavella et al., 1991; Tommasini and Maini, 1995; Kirk and Terry, 2003). That very small insect, commonly hides in flowers, buds and leaf axils, and often go unnoticed until damage appears. Both larval and adult thrips have rasping mouthparts that they use to puncture the plant surface. They feed on the sap that is exuded from the resulting wound. Plants are also injured when female thrips lay their eggs in the plant tissue. Western flower thrips is of special importance because it transmits the tomato spotted wilt virus (TSWV) and impatiens necrotic spot virus (INSV), that are most epidemic on a wide range of the agricultural crops (Jones, 2005; Rotenberg et al., 2009).

Controlling greenhouse pests by chemical pesticides results with many problems, such as development of resistance in pests and rising environmental and health concerns (Arnaouty et al., 2020). Indeed, greenhouse crops are harvested frequently, at short intervals, and thus intensive use of chemicals becomes questionable because of the possible contamination of products with chemical residues. Furthermore, greenhouse vegetables are consumed fresh, which is another motivation for farmers to reduce intensive chemical control and to meet the consumers demands for offering products of high quality.

The possibility to apply biological control programmes against greenhouse pests is highly needed. It can overcome the abovementioned problems, and at the same time can provide an adequate pest control. They will not completely eliminate pest problems but can reduce pest population, and damage to an acceptable level (under the economical threshold). Biological control generally requires more time than pesticides to bring a pest population under an acceptable control level (Arnaouty et al., 2020).

The aim of the present study was to determine the effectiveness of the pirate bug *O. laevigatus* (Hemiptera: Anthocoridae) on reducing the population of Western flower thrips (*Frankliniella occidentalis*) at peppers, grown for commercial production in plastic, unheated tunnels, during 2019 and 2020.

MATERIAL AND METHODS

The study was conducted in commercial greenhouses (3 unheated plastic tunnels, ca. 125 m^2, each), located in the area of Dabilje, Republic of North Macedonia, during 2019 and 2020. One of the tunnels was used for biological control, one for chemical control and one was untreated tunnel (control). Each tunnel included 9 rows of 75 pepper plants (675 plants/tunnel) of Kurtovska kapija type. The transplanting of pepper started at the beginning of May, and the growing season extended to the end of September, 2019 and 2020, respectively.

Population density of *F. occidentalis* was estimated in intervals od 15 days throughout the growing season of pepper, counting nymphs and adults. Fifty randomized plants from each tunnel were chosen and the thrips were sampled from 50 plant flowers. The number of thrips was directly inspected on the plant using a special magnifying hand lens (x 10).

In the tunnel used for biological control, a blend of nymphs and adults of *O. laevigatus* were released at rate of 1 predator per m^2, when thrips appeared on the plants. Three following releases were carried out in the both 2019 and 2020 years of research (Table 1). *O. laevigatus* applied, came from Bioline Agrosciences Ltd., United Kingdom.

Table 1. Releasing rates and dates of tested *O.laevigatus* against *F. occidentalis* on pepper plants during 2019 and 2020.

		2019			2020		
	Rate of application	Date of first releasing	Date of second releasing	Date of third releasing	Date of first releasing	Date of second releasing	Date of third releasing
Oriuslaevigatus	1 individual/ m^2	18.V	8.VI	1.VIII	17.V	7.VI	5.VII

In the chemical treated tunnel, 3 pesticides were applied against *F. occidentalis* and the timing and rate of applications of different pesticides were determined by the grower, based on his assessment of pest populations (Table 2).

Table 2. A list of pesticides applied to control *F.occidentalis* on sweet pepper pests in the chemical treated tunnel during 2019 and 2020.

Application time	Active ingridient	Application rate/100 L
	2019	
18.V	Acrinathrin 22,5 g/L +abamectn 12,6 g/L	100 ml
27.V	Abamectin 18 g/L	100 ml
5.VI	Pyrethrin 50 g/L	100 ml
14.VI	Acrinathrin 22,5 g/L +abamectn 12,6 g/L	100 ml
23.VI	Abamectin 18 g/L	100 ml
2.VII	Pyrethrin 50 g/L	100 ml
11.VII	Acrinathrin 22,5 g/L +abamectn 12,6 g/L	100 ml
20.VII	Abamectin 18 g/L	100 ml
30.VII	Pyrethrin 50 g/L	100 ml
8.VIII	Acrinathrin 22,5 g/L +abamectn 12,6 g/L	100 ml
17.VIII	Abamectin 18 g/L	100 ml
27.VIII	Pyrethrin 50 g/L	100 ml

	2020	
17.V	Acrinathrin 22,5 g/L +abamectn 12,6 g/L	100 ml
26.V	Abamectin 18 g/L	100 ml
4.VI	Pyrethrin 50 g/L	100 ml
13.VI	Acrinathrin 22,5 g/L +abamectn 12,6 g/L	100 ml
22.VI	Abamectin 18 g/L	100 ml
1.VII	Pyrethrin 50 g/L	100 ml
10.VII	Acrinathrin 22,5 g/L +abamectn 12,6 g/L	100 ml
19.VII	Abamectin 18 g/L	100 ml
29.VII	Pyrethrin 50 g/L	100 ml
7.VIII	Acrinathrin 22,5 g/L +abamectn 12,6 g/L	100 ml
16.VIII	Abamectin 18 g/L	100 ml
26.VIII	Pyrethrin 50 g/L	100 ml

The number of thrips for each treatment was subjected to analysis of variance (ANOVA) (SPSS). The significance of differences among the number of thrips in different treatments was tested with LSD test at $P \leq 0.05$ significance level.

RESULTS AND DISCUSSION

The first thrips were found on the plants during second half of May, in both 2019 and 2020. Most of the thrips were found on pepper flowers and occasionally on the leaves. Berlinger et al. (1997) found that *F. occidentalis* is mainly attracted by the flowers than leaves. Higgins (1992) found that, in British Columbia (Canada), more than 85% of *F. occidentalis* larvae were found on leaves, and the majority (84-95%) of adults in flowers was females.

The mean number of thrips/flowers is presented in Table 3. The numbers of thrips/flowers in the biological controlled tunnel and in chemical treated tunnel were lower than in the untreated greenhouse (control). Thrips infestation started in May, in both years of research 2019 and 2020, when the number of thrips/flowers was similar in the three experimental greenhouses. In the control, the population density of the thrips increased and continued to grow until the end of the season to reach the highest number of thrips/flower (31.34 in 2019 and 32.16 in 2020) at the last week of the growing season (Table 3).

Table 3. Number of thrips/50 flowers in the sweet pepper tunnels during 2019/2020.

Days of inspection	Control	Biologically controlled tunnel	Chemically controlled tunnel
	2019		
17.V	9.04	8.66	8.48
31.V	13.16	7.72	6.50
7.VI	16.90	4.12	5.50
21.VI	19.56	6.10	4.26
5.VII	22.18	5.16	3.68
19.VII	24.12	3.88	3.16
2.VIII	27.56	4.56	2.26
16.VIII	28.64	3.08	1.94
30.VIII	31.34	2.16	1.48
	2020		
16.V	12.98	12.58	12.68
30.V	14.68	9.94	10.26
6.VI	18.70	8.08	9.38
20.VI	22.86	11.36	7.50

4.VII	25.30	8.34	5.26
18.VII	26.46	6.50	4.46
1.VIII	28.36	7.74	3.56
15.VIII	30.62	4.20	2.04
29.VIII	32.16	2.50	1.70

O. laevigatus proved to be an efficient predator in maintaining the number of thrips under the economic threshold. According to Ramchandra and Chang (2013) the number of thrips under the economic threshold is 4.9 individuals/flower. In our research, the lowest number of thrips/flowers, recorded in the biologically controlled tunnel was 2.16 thrips/flower in 2019 and 2.50 thrips/flower in 2020. In the chemically controlled tunnel, the lowest number of thrips/flowers was 1.48 thrips/flower and 1.70 thrips/flower in 2020, what was expected after the application of the insecticides.

In the biologically controlled tunnel, the number of thrips/flower reduced to the economic threshold in the third week after the first release of *O.laevigatus*, at the rate of 1 adult/m^2 in 2019. After the second and the third release of *O.laevigatus*, the number of thrips/flower continued declines. (Graph. 1). In 2020 the number of thrips/flower reached 4.20, which is below the economic threshold according to Ramchandra and Chang (2013), after the third release of 1 adult/m^2 of *O.laevigatus* (Graph.2). Similar results were obtained by Keçeci and Gürkan, in 2013 Arnó etal. (2008) reported that *Orius* species could serve as an important biological control agent for use in sweet pepper.

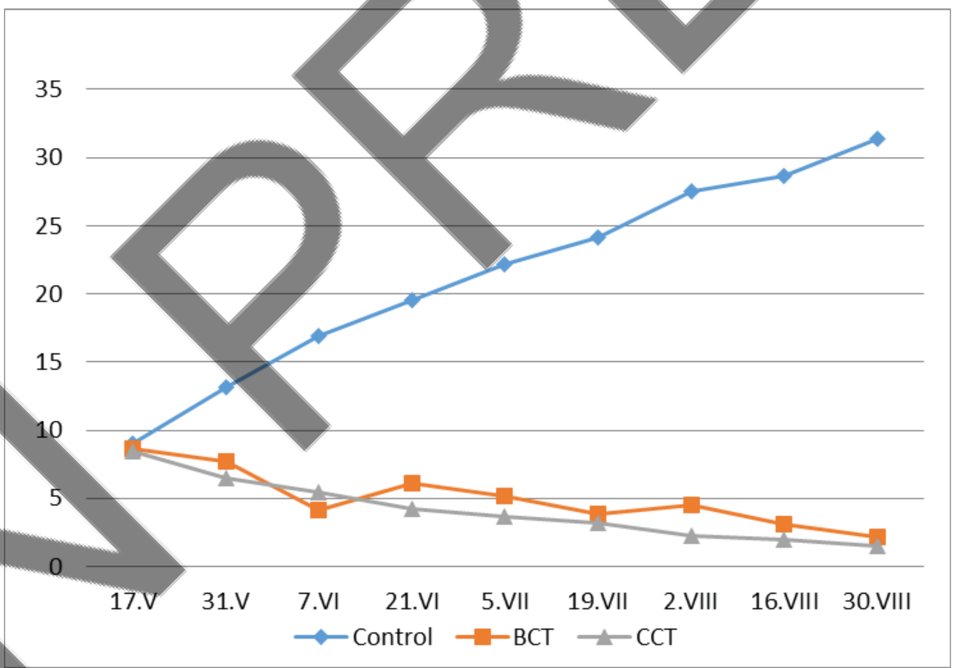

Figure 1. Mean number of thrips/50 flowers for different treatments in 2019

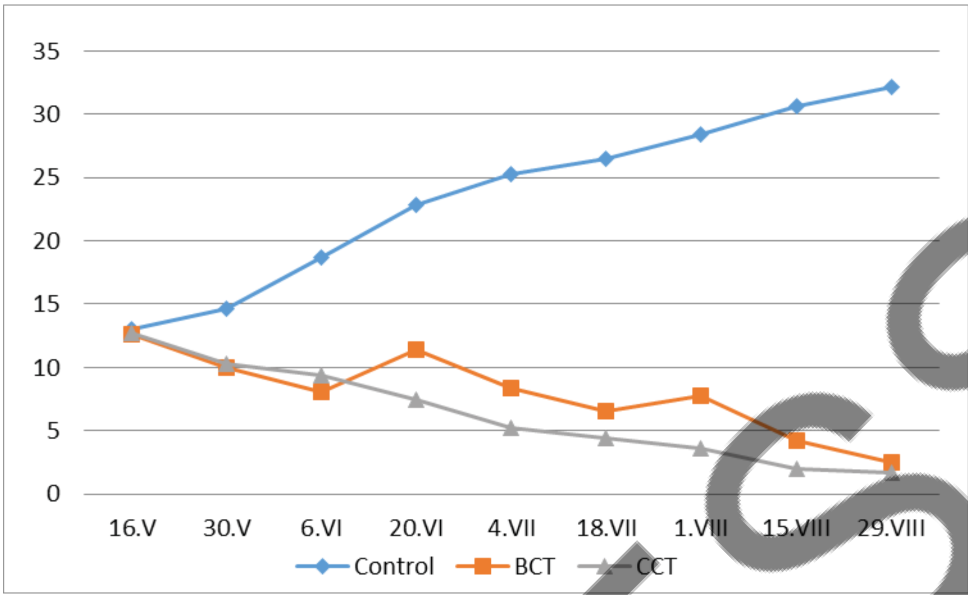

Figure 2. Mean number of thrips/50 flowers for different treatments in 2020

Statistically, insignificant differences were found between the biologically and chemically controlled tunnels in both years of research. There was significant difference between the control and the chemically controlled tunnel and between control and biologically controlled tunnel in years of research, 2019 and 2020 (Table 4).

Table 4. Analysis of variance (SPSS) and multiple comparisons between the treatments and the number of thrips/50 flowers in 2019 and 2020.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Number of thrips/50 flowers for different treatments in 2019	Between Groups	1696.150	2	848.075	39.108	<.001
	Within Groups	520.449	24	21.685		
	Total	2216.598	26			
Number of thrips/50 flowers for different treatments in 2020	Between Groups	2039.879	2	1019.940	38.172	<.001
	Within Groups	641.264	24	26.719		
	Total	2681.143	26			

MULTIPLE COMPARISONS

LSD

Dependent Variable	(I) Treatments	(J) Treatments	Mean Difference (I-J)	Std. Error	Sig.
Number of thrips/50 flowers for different treatments in 2019	Control	BCT	16.34056*	2.19521	<.001
		CCT	17.24944*	2.19521	<.001
	BCT	Control	-16.34056*	2.19521	<.001
		CCT	.90889	2.19521	.683
	CCT	Control	-17.24944*	2.19521	<.001
		BCT	-.90889	2.19521	.683
Number of thrips/50 flowers for different treatments in 2020	Control	BCT	18.77333*	2.43672	<.001
		CCT	18.08444*	2.43672	<.001
	BCT	Control	-18.77333*	2.43672	<.001
		CCT	-.68889	2.43672	.780
	CCT	Control	-18.08444*	2.43672	<.001
		BCT	.68889	2.43672	.780

*The mean difference is significant at the 0.05 level

CONCLUDING REMARKS

In the present study releasing *O. laevigatus* showed to be effective and safe compared to the chemical control program under the same circumstances. The pirate bug reduced *F. occidentalis* individuals below the economic threshold and can be used effectively to decrease or even to completely replace the chemical treatments in pepper production in plastic tunnels.

The results showed that there are statistically significant differences between the population of *F. occidentalis* in the tunnel with performed biological control using *O. leavigatus* and the control, as well as between the population of *F. occidentalis* in the tunnel with performed chemical treatments and the control. No statistically significant differences were observed between the population of *F. occidentalis* in tunnels with biological and chemical control.

So, we can recommend *O. laevigatus* for controlling *F. occidentalis* on pepper plantations in the greenhouses.

REFERENCES

Arnaouty, S. A. El., El-Heneidy, A. H., Afifi, A. I., Heikal, I. H, Kortam, M. N. (2020). Comparative study between biological and chemical control programs of certain sweet pepper pests in greenhouses. Egyptian Journal of Biological Pest Control 30: 28-34.

Arnó, J., Roig, J., Riudavets,J.(2008). Evaluation of *Oriusmajusculus* and *O. laevigatus* as predators of *Bemisatabaci* and estimation of their prey preference. Biological Control 44(1):1-6

Beringer, M. J., Lebiush-Mordechi, S., Fridja, D., Khasdan, V., Siti, E., Rodman, R. (1997). Western flower thrips phenology in Israel IOBC/ WPRS Bull. 20: 153-155.

Higgins, C.J. (1992). Western Flower Thrips (Thysanoptera: Thripidae) in Greenhouses: Population Dynamics, Distribution on Plants, and Associations with Predators. Journal of Economic Entomology, 85 (5): 1891–1903.

Jones, D.R. (2005). Plant Viruses Transmitted by Thrips. Eur J Plant Pathol. 113: 119–157

Kirk, W. D. J.,Terry,L. I.(2003).The spread of the western flower thrips *Frankliniella occidentalis* (Pergande).Agricultural and Forest Entomology 5 (4): 301-310.

Keçeci, M., & Gürkan, M.O. (2013). Biological control of Western flower thrips, Frankliniella occidentalis with Orius species in eggplant greenhouses in Turkey. *Turkish journal of entomology,* 37 (4): 467-476.

Ramchandra, Y., Chang, N.(2013). Economic thresholds of *Thrips palmi* (Thysanoptera: Thripidae) for eggplants in a greenhouse. Applied Entomology and Zoology 48(2): 195-204.

Rotenberg, D., Krishna Kumar, N. K., Ullman, D. E., Montero-Astúa, M., Willis, D. K., German, T. L., Whitfield A. E. (2009). Variation in Tomato spotted wilt virus titer in *Frankliniella occidentalis* and its association with frequency of transmission. Phytopathology 99(4):404-10.

Tavella, L., Arzone, A., Alma, A. (1991). Researches on *Oriuslaevigatus* (Fieb.), a predator of *Frankliniella occidentalis* (Perg.) in greenhouse. A preliminary note. OILB/WPRS Bull. 14 (5): 65-72

Tommasini, M.G., Maini, S. (1995). *Frankliniella occidentalis* and other thrips harmful to vegetable and ornamental crops in Europe. Wageningen Agric. Univ. Papers 95 (1): 1-42.

УПОТРЕБА НА *Orius laevigatus* ЗА КОНТРОЛА НА ПОПУЛАЦИЈАТА НА *Frankliniella occidentalis* (THYSANOPTERA: THRIPIDAE) КАЈ ПИПЕРКА ВО ЗАШТИТЕН ПРОСТОР

Билјана Атанасова[1*], Душан Спасов[1], Драгица Спасова[1], Мите Илиевски[1]
[1]Земјоделски факултет, Универзитет „Гоце Делчев" – Штип, ул. „Крсте Мисирков" 10-А, 2000 Штип, Република Северна Македонија
**Контакт-автор: biljana.atanasova@ugd.edu.mk*

Резиме

Иако хемиските пестициди играат витална улога во контролирањето на бројот на штетни инсекти, тие исто така придонесуваат за забрзување на загадувањето на почвата, воздухот и водата. Поради честата употреба инсектите многу брзо стануваат отпорни на активни материи, ги уништуваат природните непријатели на штетниците, а штетно влијаат и врз луѓето. Соодветно на тоа, примената на биолошката заштита, односно употребата на живи организми (предатори и паразити) во програмите за заштита на растенијата во заштитените подрачја, зазема поголем обем во светски рамки отколку употребата на хемиски пестициди.

Целта на нашето истражување беше да се утврди ефикасноста на предаторот*Orius laevigatus* (Hemiptera: Anthocoridae) за намалување на популацијата на западниот цветен трипс (*Frankliniella occidentalis*). Експериментот беше поставен во комерцијални оранжерии (три тунели без греење, околу 125 m^2, секој), лоцирани во областа Дабиље, Република Македонија, во текот на 2019 и 2020 година.

Добиените резултати одговараат на нашите очекувања во контролирањето на популацијата на патувањата. Предаторот се покажа како ефикасен во намалувањето на бројот на популацијата на трипсот.

Клучни зборови: *предатори, биолошка контрола, западен цветен трипс, пиратска бубачка*