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Orijinal araştırma (Original article)

Predatory hemipteran bugs detected with thrips on ornamental plants in the Çukurova region of Turkey

Ekrem ATAKAN[1]*

Çukurova Bölgesi'nde süs bitkilerinde thripslerle birlikte saptanan avcı hemipter böcekler

Öz: Bu çalışmada 18 bitki familyasına bağlı 30 bitki türü, thripsler ve avcı böcekler yönünden örneklenmiştir. Parklarda ev bahçelerinde ve seralarda yetiştirilen süs bitkilerinde thrips (Thysanoptera) ve avcı böcek toplamaları 2013 ve 2014 yıllarında Çukurova Bölgesi'nde (esas olarak Adana ilinde) yürütülmüştür. Toplam 20 Thysanoptera türü kaydedilmiştir. Örneklerin en az %10'nunda bulunan thrips türleri *Frankliniella occidentalis* (Pergande) ve *Thrips tabaci* Lind'dir. *F. occidentalis* toplam örneklerin %51'inde ve toplam bireylerin %81'inde bulunarak dominant thrips olmuştur. Predator Anthocoridae türü olan *Orius niger* (Wollf) yüksek sayılarda toplanmış olup (250 adet birey), toplam bireylerin %43'ünü oluşturmuştur. Thripsler ve faydalı böcekler (esas olarak *O. niger*), Asteracea, Lamiaceae ve Verbanaceae familyalarına bağlı bitkilerde yaygın olarak görülmüşlerdir. Birçok bitki türünde avcı başına düşen thrips sayısı 5 adetten daha az olmuştur. Bu durum, thrips türlerinin, özellikle açık alanda yetiştirilen mevsimlik süs bitkilerinde avcı böcekler tarafından etkili bir şekilde baskı altına alınabileceğini gösterebilir.

Anahtar kelimeler: Avcı, Hemiptera, thrips, süs bitkileri

Abstract: In this study, 30 plant species belonging to 18 plant families were sampled for thrips (Thysanoptera) and predatory insects. Collections of thrips and predatory bugs were carried out on ornamental plants in parks, home gardens and greenhouses in the Çukurova region of Turkey, mainly Adana Province. Thrips were sampled from ornamental plants at irregular intervals during 2013-2014. A total of 20 Thysanoptera species were recorded. The most notable species present (at least 10% of samples) were, in descending order of abundance, *Frankliniella occidentalis* (Pergande) and *Thrips tabaci* Lind. The thrips fauna was dominated by *F. occidentalis* which was found on 51% of the samples and contributed 81% of all specimens. A total of 5 predatory hemipteran species were recorded. *Orius niger* (Wollf) (Anthocoridae) was collected in the highest number (250 specimens), accounting for 43% of all individuals. Thrips and beneficial insects (mainly *O. niger*) were most common on the plant species belonging to the families Asteraceae Lamiaceae and Verbanaceae. On many plant species, the prey/predator ratio was less than 5 thrips per predator, which may indicate that species of thrips are being effectively suppressed by the predatory bugs detected, particularly on ornamental plants grown in open areas.

Keywords: Predator, Hemiptera, thrips, ornamentals

[1] Çukurova Üniversitesi Ziraat Fakültesi Bitki Koruma Bölümü-01330 Adana
*Sorumlu yazar (Corresponding author) e-mail: eatakan@mail.cu.edu.tr
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Introduction

Insect and mite species can be harmful to ornamental plants. The damage of both disease agents and harmful arthropod species to ornamental plants are more noticeable, since such plants are used more for their visual appeal. Thysanoptera (thrips) species have an important status as pests on ornamental plants. The thysanopteran species of western flowers thrips, *Frankliniella occidentalis* (Pergande) and onion thrips *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), are of economic importance in many crops, including ornamental plants (Lewis, 1997). These harmful thrips transmit viral diseases such as Tomato spotted wilt virus (TSWV) and Impatiens necrotic spot virus (INSV) diseases (Daughtrey et al, 1997; Ullmann et al, 1997) to ornamental plants.

Pesticides have been widely used worldwide for pests and mites in agricultural crops grown in both open fields and greenhouses. However, the negative effects of pesticide use on human and environmental health are well known. In addition, the resistance of insects and mites to insecticides is also one of the common problems. Thrips, especially *F. occidentalis*, have developed resistance to a large number of pesticides (Jensen, 2000; Gao et al, 2012). Insecticide resistance in this pest thrips has been well documented for several insecticide groups, including spinosad (Bielza et al, 2007; Bielza, 2008; Zang et al, 2008; Dong-gang, 2016; Dağlı, 2018). Therefore, alternative methods of control should be considered. One alternative is biological control. Many beneficial predatory insect species, e.g., the predatory bugs, *Orius*, feed on thrips and some *Orius* species, such as *Orius laevigatus* (Fieber), are commercially used against pest thrips in greenhouses in Turkey.

Although there have been a large number of studies published on various subjects related to *F. occidentalis* worldwide, the beneficial insect species and their importance to thrips control on ornamental plants are not well known.

Therefore, this study investigated (1) the importance of two species of thrips on ornamental plants, (2) predatory insects feeding on them and (3) some relationships between them. The objective was that the obtained data could be used in the integrated control of harmful Thysanoptera species on ornamental plants.

Materials and Methods

Thrips collections were carried out on ornamental plants in parks, home gardens and greenhouses in the Çukurova region of Turkey (mainly Adana province) at irregular intervals during 2013-2014. The numbers of samples taken from representative plant species varied from 1 to 10, depending on plant densities in the sampled areas. The shaking method was used to sample insects. For that purpose, the ornamental plants were shaken into a white container (37 × 28 × 7 cm) for 10 seconds. The predatory bugs and thrips were collected by means of a fine brush or a suction tube. The collected thrips samples and the small predators were placed in plastic tubes (2 ml) with 60% ethyl alcohol. The samples of thrips brought to the

laboratory were kept in AGA (10 parts of 60% ethyl alcohol, 1 part glacial acetic acid and 1 part glycerin) for one day and then again rinsed in ethyl alcohol (60%). The thrips were then kept in lactophenol until a slight color change occurred. Microscope slides of the thrips were made with Hoyer's medium. Thrips identifications and counting were carried out under a stereomicroscope at 45x magnification.

Slide-mounted thrips (adults) were identified by using the keys of Zur Strassen (2003) and Balou et al (2012). *Orius* spp. were identified with the keys of Önder (1982) and Tommasini (2004). For identification of Lygaeidae and Geocorine species, the identification keys prepared by Çakır & Önder (1990) were used. Other predators and pestiferous insect species were identified by reference to material stored in the Entomology Laboratory of the Plant Protection Department, Faculty of Agriculture, University of Çukurova, Adana, Turkey. No identification keys are available for nymphs of *Orius*. Therefore, these were treated as a single entity.

Statistical analysis

Only hemipteran predators were identified throughout the study. Data associated with thrips and predatory bugs identified were pooled over sampling years because, in general, thrips numbers were low and their population trends in numbers were similar. Monthly numbers of *F. occidentalis* and *Orius* spp. were evaluated in only Balcalı, Adana Province, in 2014. Data were pooled over plant species and sampling date because the population trends of thrips on sampled ornamentals were similar and their numbers were generally low. The lists of host plants of both thrips and predators are given in Table 1. *Orius* spp. numbers were regressed with thrips numbers by using the linear relationship at $P < 0.05$ significance level. Analysis was done by using the Statistical Package Program (Version 15.0) (SPSS, 2006). Relationships between populations of the thrips and other predator groups were not quantified because individuals of the predatory bugs, *Geocoris* or *Piocoris* were rarely found through the sampling periods.

Results and Discussion

Thrips composition

In this study, 30 plant species belonging to 18 plant families were sampled for thrips and predatory insects (Table 1). A total of 20 thysanopteran species were recorded. These thrips were *Aeolothrips collaris, Aeolothrips ericae, Aeolothrips gloriosus, Aeolothrips propongius, Scolothrips longicornis* (Aeolothripidae); *Frankliniella occidentalis, Frankliniella intonsa, Isoneurothrips australis, Microcephalothrips abdominalis, Neohydatothrips samayunkur, Pezothrips kellyanus, Thrips major, Thrips meridionalis, Thrips tabaci, Thrips minutissimus, Thrips vulgatissimus* (Thripidae); and *Haplothrips aculeatus, Haplothrips gowdeyi, Haplothrips reuteri* and *Haplothrips tamaricinus* (Phlaeothripidae). Species belonging to Aeolothripidae and Phlaeothripidae were the less common.

Table 1. Host list and total numbers of two thrips species and their predators in the Çukurova region of Turkey during 2013-2014

Plant species	Total number of thrips species		Total number of predatory insects					
	Fo	Tt	On	Ol	O nymph	Dp	Ga	Pe
Asteraeceae								
Ageratum maritimum	14	0	1	4	0	0	21	0
Chrysantemum indicum	248	45	57	5	6	8	21	2
Chrysanthemum coronatum	21	10	11	1	9	1	0	0
Coreopsis grandiflora	0	0	2	2	0	1	5	0
Centaurea sp.	8	0	2	1	2	3	1	0
Dimorphotheca sinuata	45	44	17	16	12	4	3	0
Matricaria sp.	8	1	6	0	0	0	0	0
Tagetes erecta	30	2	17	12	1	0	33	0
Tagetes patula	16	8	5	5	2	2	12	1
Zinnia elegans	3	6	3	0	0	0	0	2
Amaranthaceae								
Celosia sp.	25	0	3	1	3	0	32	0
Gomphrena globosa	2	0	1	0	0	0	3	0
Apocynaceae								
Vinca rosea	1	0	3	0	0	0	0	0
Brassicaceae								
Alyssum maritimum	59	40	5	5	10	5	0	3
Caryophyllaceae								
Dianthus chinensis	53	84	3	2	1	0	1	1
Caprifoliaceae								
Abelia grandiflora	22	2	5	2	0	0	0	0
Gereniaceae								
Pelargonium hortorum	46	27	3	2	0	0	0	0
Hydrangeaceae								
Hydrangea sp.	37	1	0	0	0	0	0	1
Lamiaceae								
Salvia splendens	107	6	12	5	10	4	1	0
Tradescantia pallida	6	0	0	0	0	0	0	0
Lythraceae								
Cuphea hyssopifolia	63	9	2	1	3	0	15	0
Nyctaginaceae								
Bougainvillea glabra	2	1	0	0	0	0	0	0
Portulacaceae								
Portulaca grandiflora	19	3	1	0	0	0	22	0
Plumbaginaceae								

Table 1 (continued)

Plant species	Total number of thrips species		Total number of predatory insects					
	Fo	Tt	On	Ol	O nymph	Dp	Ga	Pe
Plumbago capensis	0	0	0	0	0	0	0	0
Scrophulariaceae								
Antirrhinum sp.	22	9	1	0	2	0	0	0
Solanaceae								
Petunia hybrida	2	0	2	0	0	1	0	0
Ranunculaceae								
Ranunculus sp.	0	1	0	0	0	0	0	0
Rosaceae								
Rosa sp.	13	1	3	1	0	0	0	0
Verbenaceae								
Verbena laciniata	54	6	9	0	1	6	11	1
Lantana sp.	92	18	20	19	3	1	15	3

Fo: *Frankliniella occidentalis*; Tt: *Thrips tabaci*; On: *Orius niger*; Ol: *Orius laevigatus*; Dp: *Deraeocoris pallens*; Ga: *Geocoris arenarius*; Pe: *Piocoris erythrocephalus*

The most notable species present (at least 10% of samples), were in descending order *F. occidentalis* and *T. tabaci.* The thrips fauna was dominated by *F. occidentalis*, being found in 51.35% of the samples and contributing 81.47% of the specimens. *Thrips tabaci* was detected on 22.52% of the samples and comprised 2.44% of the specimens. The second major species *Neohydatothrips samayunkur* was detected on 27.66% of the samples and accounted for 7.72% of the specimens. However, this pest thrips was not common on the ornamentals sampled and high numbers of it were detected on only *Tagetes* spp. (marigold) in Balcalı, Adana Province.

Frankliniella occidentalis was detected for the first time in Antalya Province in Turkey in 1993 (Tunç & Göçmen, 1994). One year later, it was recorded in cotton fields in Adana Province (Atakan, 1998). This harmful thrips dominated the thrips fauna in the Çukurova region within three years. *Frankliniella occidentalis* is the main thrips species on many plants, including summer and winter vegetables, cotton, fruit trees and ornamentals in Turkey. The dominance of *F. occidentalis* is likely due to its high reproduction rate and high level of insecticide resistance (Jensen, 2000; Gao et al, 2012). *Frankliniella occidentalis* is native to western North America. International agricultural trade flows have increased very rapidly and *F. occidentalis* has been introduced to and established in many countries and has become a cosmopolitan pest. It has been reported that this thrips has established in more than 60 countries (Kirk & Terry, 2003).

The total numbers of two common thrips species on ornamental plants in the Çukurova region of Turkey is shown in Table 1. *Frankliniella occidentalis* was

detected on 27 of 30 plant species. Most of the specimens were found on *Chrysantemum indicum* (Indian chrysantemum) (248 specimens), *Salvia splendens* (Scarlet sage) (107 specimens) and *Lantana* spp. (Lantanas) (92 specimens). *Thrips tabaci* was found on 21 of the 30 plant species, with the largest numbers being recorded on *Dianthus chinensis* (China pink) (84 specimens), *C. indicum* (45 specimens) and *Dimorphotheca sinuata* (Glandular cape marigold) (44 specimens).

Beneficial insect community

The beneficial insect community is shown in Table 2. A total of 5 predatory hemipterans were recorded. *Orius niger* was collected in the highest number (250 specimens), accounting for 43% of all adult individuals, followed by *Geocoris arenarius* (Jakovkev) (196 specimens), which was 34% of all adult individuals. In addition, *Deraeocoris pallens* Reuter and *Piocoris erythrocephalus* (Le Peletier & Serville) contributed 6% and 2% of all individuals, respectively. *Orius niger* was the main *Orius* species on ornamental plants. It appeared to be the most active predator in the hard winter months in the region. This may be a consequence of the year round availability of its thrips prey (Atakan & Uygur, 2004). *Orius niger* is the most commonly found anthocorid species in Italy, while *O. laevigatus* is the most abundant species in the warmest locations in Italy (Tommasini, 2004).

Table 2. Total numbers and proportions of predatory hemipteran bugs collected in Çukurova region of Turkey during 2013-2014

Family	Total number of individuals	Percent of all adults (%)
Anthocoridae		
Orius niger (Wollf)	250	43
Orius laevigatus (Fieber)	84	15
Lygaeidae, Geocorinae		
Geocoris arenarius (Jakovkev)	196	34
Piocoris erythrocephalus (P.-S.)	14	2
Miridae		
Deraeocoris pallens Reuter	36	6
Total	**580**	**100**

Orius niger was found on 25 of 30 plant species and the numbers of thrips on these ornamental plants were high. *Orius laevigatus* was detected on 13 of the 30 plant species and recorded at the highest number on *D. sinuata*, on which the number of both thrips species were found to be relatively greater. Relatively high numbers of *O. niger* were recorded on *D. sinuata*, *Alyssum maritimum* (Sweet alyssum) and *S. splendens*. *Orius niger* and *O. laevigatus* produced nymphs on these ornamentals. Low numbers of *D. pallens* were found on 10 of the 30 plant species sampled in the current study. Relatively higher numbers of *G. arenarius* were recorded on *Tagetes erecta* (Aztec marigold) (33 specimens) and *Celosia* sp. (32 specimens). Low and similar numbers of *P. erythrocephalus* were detected.

Monthly abundance of *Frankliniella occidentalis* and *Orius* spp.

The monthly total numbers of *Frankliniella* thrips and *Orius* in Balcalı are provided in Figure 1. In the period January-April, *F. occidentalis* and *Orius* spp. were not captured. This situation may be related to the lack of flowering plants during this period.

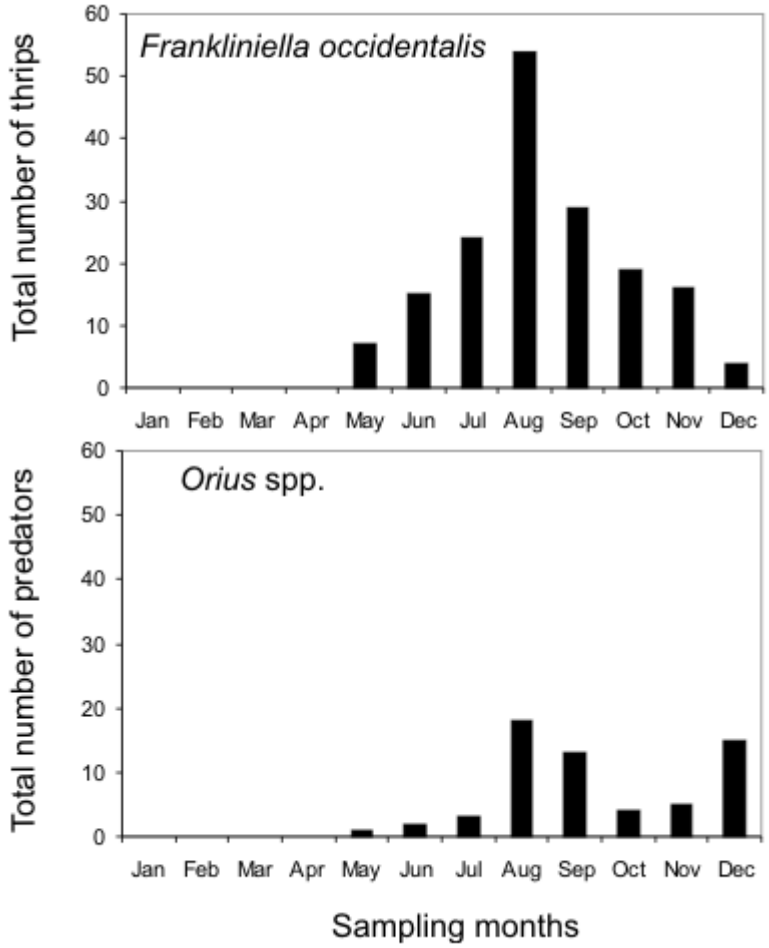

Figure 1. Total numbers of *Frankliniella occidentalis* and predatory *Orius* spp. on ornamentals in 2014.

Frankliniella occidentalis is more common on yellow, multi-flowering and nectar-rich plants; yellow-flowered plant species are particularly attractive to *F. occidentalis* (Yudin et al, 1986). *Orius* species feed on nectar and pollen when its prey are lacking (Dick & Jarvis, 1962; Salas-Aguilar & Ehler, 1977; Kiman & Yeargan, 1985). Therefore, the flowers of ornamental plants may be important as

pollen and nectar sources for the survival of *Orius* species, as well as other predators and parasitoids, during the unavailability or scarcity of arthropod prey.

The first *F. occidentalis* adults were recorded in May on ornamental plants and the highest number was in August (54 specimens). From August, the total number of individuals decreased regularly, with only 4 individuals found in December. The population trend for *Orius* spp. was similar to the thrips species but they were recorded in lower numbers. As for the thrips density, the highest number of *Orius* spp. was in August (18 specimens). However, the decreasing population trend reversed, that is increased, in December (15 specimens). Regarding the predator-prey relationship, there was a significant, positive relationship between the numbers of thrips and numbers of *Orius* spp. ($F = 10.119$, $df = 1,10$, $P = 0.010$, $R^2 = 0.50$; Figure 2)

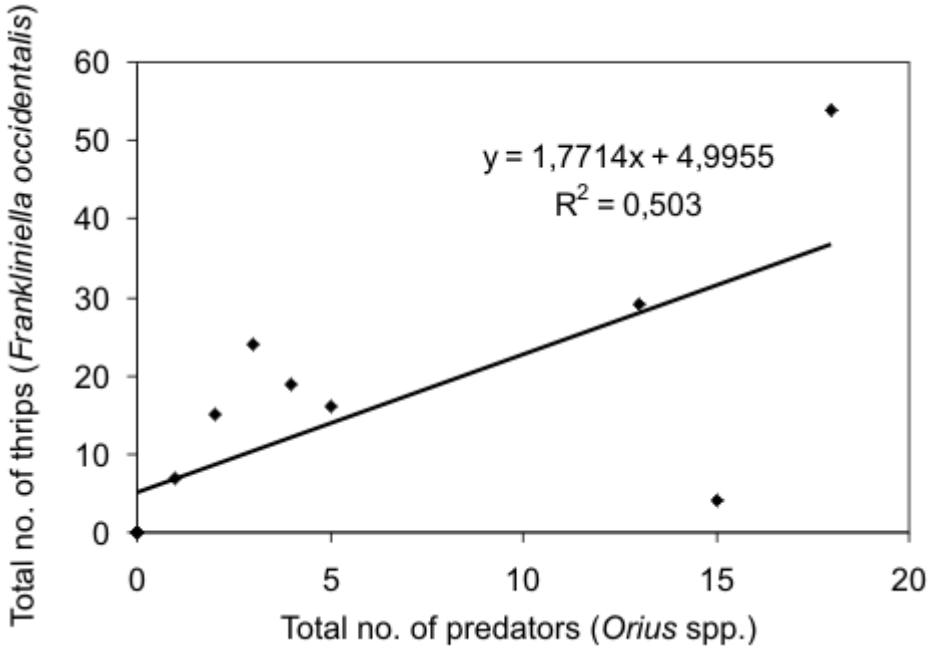

Figure 2. Regression analysis between total numbers of *Orius* spp. and *Frankliniella occidentalis* in 2014.

Thrips / predator ratios at plant family level

Ratios of thrips/predatory insects at the plant family level are given in Table 3. The highest thrips/*Orius* spp. ratio was recorded for the Caryophyllaceae family (22.83 thrips per *Orius* specimen). The lowest thrips/*Orius* ratio was for the Apocynaceae family. This issue may be due to lower numbers of thrips and *Orius* when compared to those of other plant families (Table 1). For the Asteraceae, Amaranthaceae, Brassicaceae, Caprifoliaceae, Lamiaceae, Rosaceae and

Solanaceae families, the number of thrips per *Orius* was less than 5 individuals. This may indicate that thrips are at major risk of predation. While the thrips/*Orius* ratio was very low for the Lamiaceae family (0.81 thrips per *Orius*), the thrips / *Geocoris* ratio was high (119 thrips per *Geocoris*) whereas the Portulacaceae family had the lowest thrips/*Geocoris* ratio (0.95 thrips per *Geocoris*). When all predator species were considered together and the families Caryophyllaceae, Geraniaceae, and Scrophulariaceae were excluded, the number of thrips per predatory insect (including all predators) was below 5 individuals.

Table 3. Ratios of thrips/predatory insects at the plant family level in the Çukurova region of Turkey during 2013-2014

Family	Thrips/*Orius* spp.	Thrips /*Geocoris*	Thrips/all predators
Asteraeceae	2.54	5.30	1.59
Amaranthaceae	1.5	0.77	0.50
Apocynaceae	0.33	-	0.33
Brassicaceae	4.95	-	3.53
Caryophyllaceae	22.83	-	17.12
Caprifoliaceae	3.42	-	3.42
Geraniaceae	14.6	-	14.6
Hydrangeaceae	-	-	38
Lamiaceae	0.81	119	0.80
Lythraceae	14.4	4.8	3.6
Nyctaginaceae	-	-	-
Portulacaceae	21	0.95	0.91
Plumbaginaceae	-	-	-
Ranunculaceae	-	-	-
Rosaceae	3.5	-	3.5
Scrophulariaceae	10.33	-	10.33
Solanaceae	1	-	0.66
Verbenaceae	4.04	11.33	2.78

(-) No predatory insects were found.

Prey-predator ratios on most sampling dates were very low (less than 5 thrips per *Orius*). This is much lower than the ratio of 217 thrips per *Orius* which was reported to be the critical ratio for *Orius insidiosus* to sufficiently suppress population of *F. occidentalis* in greenhouses (Sabelis & Van Rijn, 1997). The effective suppression of thrips by a predator depends upon several factors including initial population densities of the prey and predator, their fecundity and structure of the host plant (Osekre et al, 2008). This may indicate that in the current study the populations of thrips on ornamental plants were being suppressed effectively by the predators identified. In contrast, no beneficial insects were encountered on the ornamental plants grown in greenhouses in the region. It is likely that heavy pesticide applications applied against pests or diseases had eliminated them. Hence, heavy thrips damage to *Dianthus* spp. was observed in a greenhouse.

Conclusion

A total of 20 thrips species and 5 beneficial insect species were identified. Thrips and beneficial insects (mainly *Orius*) were more common on the plant species belonging to the families Asteraceae, Lamiaceae and Verbanaceae. This may be related to the fact that the plants belonging to these families are rich in nectars and pollens. While thrips damage was not observed in seasonal ornamentals grown in open areas (i.e. parks and home gardens), thrips damage due to *F. occidentalis* attacks was detected on the ornamental plants grown in greenhouses (for example on *Dianthus* spp.). It is not necessary to manage the thrips found on the ornamental plants in parks and gardens with insecticide applications because (i) there was a significant and positive relationship between thrips and predatory insects, (ii) and on many plant species, the prey/predator ratios were less than 5 thrips per predator. The results of this study suggest that thrips species are being effectively suppressed by the predatory bugs detected, particularly on ornamental plants grown in open areas. Separately, chemical control of insects, including thrips, on ornamental plants grown in greenhouses should not be the only option. Integrated Pest Management (IPM) programs should be implemented, including the release of beneficial insects against pest thrips in greenhouses.

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