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Research Article
(Araştırma Makalesi)

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Composition, frequency and abundance of thrips (Thysanoptera) species on outdoor ornamental plants in Balcalı, Adana (Türkiye)

Balcalı, Adana'da dış mekan süs bitkilerinde thrips (Thysanoptera) kompozisyonu, bulunma sıklıkları ve yoğunlukları

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ABSTRACT

Objective: Phytophagous thrips are among the important pests of ornamental plants. Unlike other studies, in this study, thrips species mostly in perennial arboreal and shrub plants were investigated in the Balcalı location of Adana province, Türkiye in 2019-2020.

Materials and Methods: Thrips were collected from ornamental plants by shaking method, and the collected individuals were stored in 60% ethyl alcohol.

Results and Conclusion: Eleven harmful and two beneficial thrips species were determined from 788 adult thrips individuals collected. The most common and abundant in dense numbers, respectively, Hot pepper thrips, *Thrips hawaiiensis* (Morgan, 1913), Western flower thrips, *Frankliniella occidentalis* (Pergande, 1895) that they are important pests, and Gold-tipped tubular thrips, *Haplothrips gowdeyi* (Franklin, 1908) were determined and constituted 58.6%, 27.5% and 4.0% of the total individuals, respectively.

ÖZ

Amaç: Fitofag thripsler süs bitkilerinin de önemli zararlıları arasındadır. Diğer çalışmalardan farklı olarak bu çalışmada, çoğunlukla çok yıllık ağacımsı ve çalımsı bitkilerde thrips türleri 2019-2020 yıllarında Adana İli Balcalı yöresinde araştırılmıştır.

Materyal ve Metot: Thripsler süs bitkilerinden silkme yöntemiyle toplanmış olup, topanan bireyler %60 etil alkol içersinde saklanmıştır.

Bulgular ve Sonuç: Toplanan 788 ergin thrips bireyinden, 11 zararlı ve 2 yararlı thrips türü saptanmıştır. En yaygın ve bol sayılarda önemli bitki zararlılardan sırasıyla, Acı biber thripsi, *Thrips hawaiiensis* (Morgan, 1913), Batı çiçek thripsi, *Franklinella occidentalis* (Pergande), ve Altın uçlu tübüler thrips, *Haplothrips gowdeyi* (Franklin, 1908) saptanmış olup, toplam bireylerin sırasıyla, %58.6 ve % 27.5 ve % 4.0'ünü oluşturmuşlardır.

INTRODUCTION

Türkiye's total exports of ornamental plants, including seeds, increased by 60.6% in the last ten years to $80.6 million in 2019 (Anonymous, 2021). On the other hand, Imports of orrnamental plants such as seeds, seedings increased by 32% to $48.3 million in the same period. Most of the imports forms large outdoor plants with its production material (seeds, seedlings, saplings, etc.). Ornamental plants sector In Türkiye ranks 20th in world exports. Outdoor ornamental plants (trees, shrubs, ground cover plants and seasonal flowers) are grown in general, in parks, gardens, highway, urban afforestation, recreation and residential settlements. Türkiye is very suitable for the cultivation of ornamental plants in terms of climate and soil characteristics, and it is the gene source of many ornamental plants (Anonymous, 2021).

In addition to sectoral problems in productions of ornamental plants, phytophagous thrips species belonging to the order Thysanoptera, have an important place among the factors that cause damage (Lewis, 1997; Karsavuran & Gücük, 2007). Thrips are small-bodied insects with adult body size varying between 0.5-15 mm and, they have high mobility. Their feeding habits differ, and there are phytophagous (plant-feeding), mycophagus (fungal-feeding) and predatory thrips species. Thrips are small, and they are cylindrical-bodied insects with 3 needles. They have a rasping-sucking mouth structure. Thrips including Terebrantia and Tubulifera divided into two subgroups. Most harmful thrips belongs to the Terebrentia suborder. Some of thrips species are responsible for transportations of the important plant virus diseases (such as tomato spot wilt virus) to some herbaceous ornamentals (Chatzivassiliou et al., 2000; Atakan et al., 2013).

Since the visual effect is at the forefront in ornamental plants, the tolerance to the damage caused by harmful factors is very low. One of the harmful organism groups in ornamental plants is Thysanoptera (thrips) species, and they significantly reduce the commercial value of agricultural products (Lewis, 1997). Insects of this order are small and soft-bodied, mostly feeding on different organs of plants, causing typical nutritional damage (scar tissue and silvering). *Frankliniella occidentalis* (Pergande, 1895) (Thysanoptera: Thripidae), known as western flower thrips, is an important vector of two plant virus diseases that cause serious damage to ornamental plants. This thrips species causes economic loss in many agricultural products, especially ornamental plants. Exotic thrips species have started to be recorded in Türkiye due to the gradual increase in international trade, inadequacies in quarantine measures and also global warming. One of these is *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae), known as Chilli thrips or Tea thrips and originating from Asia. This harmful species, which feeds on many plant species, is an important problem especially in lemon orchards (Hazır et al., 2022). Thysanoptera species were investigated in seasonal ornamental plants in Adana province, Türkiye (Atakan, 2011, 2019a, b). However, the composition of thrips in agricultural crops may change with the introduction of new species in crops. It is thought that researching possible alternative host plants of harmful species (ornamental plants) and knowing their reproductive potential in open areas during periods when agricultural activities are relatively low (autumn-early spring) can guide efforts to control thrips in agricultural products in the protected areas. For this purpose, this study was carried out on perennial woody and shrubby plants in Çukurova University Balcalı Campus, which is defined as a natural ecosystem, where no pesticide is applied.

MATERIALS and METHODS

Description of sampling area

Çukurova University Campus was established on an area of 1500 decares. Çukurova University Campus, which is the subject of the research, is very rich in terms of biological diversity due to its location on the shore of Seyhan Dam Lake in the north of Adana city, having variable topographic characteristics within the borders of the Wildlife Development Area, and most importantly being protected from the pressure of urbanization (Yücel, 2005; Yücel et al., 2019). In order to interpret the results, the thrips samplings were performed in an area of approximately 0.5 ha, where different plant species were found together.

Collection of thrips

Collection of thrips species inhabiting outdoor ornamentals at the Çukurova University Campus located at Adana Province, Türkiye. In this area, mostly perennial tree-like and shrub ornamental plants were sampled. Surveys were carried out in fall (October and November) winter (December, January and February) and early spring (March and April) periods to determine which thrips species are active, and whether they have reproductive abilities in this period. From October 2019 until April 2020, sampling was carried out every 15 days in winter months and weekly in March and April. Thrips individuals collected from all five plants of each plant species were taken into a tube. Each tube represented one sample. Thus, a total of 90 samples were taken during the study period.

Thrips were collected from perennial plants by tapping method from 4 different directions of plants, and from herbaceous plants by shaking the upper part of a plant into a white container (37 × 28 × 7 cm) for 10 seconds. Thrips individuals that fell into the container were collected with the help of a fine-tipped sable brush or suction tube and taken into plastic tubes (1.8 cc) containing 60% ethyl alcohol.

Plants and thrips identifications

Identification of the sampled plant species was made using the key identifications of Türkmen (1987) and Göçük (1996).

The thrips samples brought to the laboratory were first kept in AGA liquid (9 parts of 60% ethyl alcohol, one part of glacial acetic acid and one part of glycerine) for 2 days, allowing the bodies of thrips individuals to soften and partly to evacuate the body contents. Thrips samples washed in alcohol (60%) were left on the hot plate for at least 45 minutes in glass cells containing 10% sodium hydroxide. A slight color change and opening of the wings were achieved in adult individuals. Samples were washed in 96% alcohol and prepared in hoyer medium. Thrips preparations were kept at 45^{o}C for about 7 days. The samples were identified under a light microscope. Identification keys published by Nakahara (1994), zur Strassen (2003), and Minaei & Mound (2008) were used.

Evaluation of data

The frequency and total number of the identified species in the samples, as well as their ratio in the total adult individuals are given in a table by using Karman (1971). The overall frequency was found by dividing the number of samples containing a thrips species by the total number of samples.The number of individuals at plant species and family levels, as well as index values of common species are shown in the relevant tables. Since the individual numbers of thrips species such as *Microcephalothrips abdominalis*, *Thrips angusticeps*, *Thrips meridionalis* and *Thrips pillichi* were very low, they were not shown in the table representing the host list. The general index value was given at the family level and was calculated by dividing the total number of individuals by the total number of samples (Tekşam & Tunç, 2009). Family level index values of two very common important thrips species were calculated. The index value was found by dividing the total number of individuals in a plant family by the total number of samples for each species.

RESULTS and DISCUSSION

Thrips composition, frequency of occurrence, number of individuals and rates of occurrence

Thrips species, frequency of occurrence and relative abundance in the sampled ornamental plants are shown in Table 1. A total of 13 Thysanoptera species were identified, 2 from the Aeolothripidae family, 8 from the Thripidae family, and 3 from the Phlaeothripidae family. Twenty-three species were recorded in seasonal ornamental plants grown in parks and gardens in Adana (Atakan, 2019 a, b). The difference in the number of species may be related to the width of the sampling area, the large number of plants sampled, and the seasonal ornamental plants rich in flowers, nectars and pollens. Species from the family Aeolothripidae feed on different preys, including thrips. *Thrips hawaiiensis* (Morgan, 1913),

Frankliniella occidentalis (Pergande, 1895) and *Haplothrips gowdeyi* (Franklin, 1908) were more common and abundant species in terms of frequency and number of individuals in the samples, respectively. This study revealed that *T. hawaiiensis*, which introduced to Türkiye in 2015 and caused significant damage especially to lemon fruits in the herbaceous group, was the main thrips species of the ornamental plants sampled. In previous studies, *F. occidentalis*, the main thrips species in ornamental plants, was replaced by *T. hawaiiensis*. *Thrips hawaiiensis* is a species of Asian origin, it feeds on many plant species, and its reproductive capacity is higher than *F. occidentalis* (Murai, 2001; Cao et al., 2018). It has also been reported to be high in adaptation to different ecological conditions in those previous works. In this study, a few larvae of common thrips species were detected, mostly adult females were recorded. This issue shows that common and abundant species cannot reproduce in the fall-early spring period, at least in ornamental plants. Orientation of thrips to plants may be related to flower densities, richness in nectars and pollen, as well as the chemical contents of the plants (Yudin et al., 1986; Lewis, 1997).

Table 1. List of identified thrips species with their overall frequency and overall abundance on ornamental plantsin Balcalı during 2019-2020 (*: Predatory thrips species)

Çizelge 1. *Balcalı'da 2019-2020 yıllarında dış mekan süs bitkilerinde thrips türleri, bulunma sıklıkları ve yoğunlukları (* Avcı thrips türleri)*

Thysanoptera Family/species	Overall frequency		Overall abundance	
	Number of samples found	%	Total no found in individuals	%
Aeolothripidae				
Aeolothrips collaris Priesner, 1919	13	13	23	2.9
Aeolothrips gloriosus Bagnall, 1914	4	4	7	0.9
Thripidae				
Frankliniella occidentalis (Pergande, 1895)	67	64	216	27.5
Microcephalothrips abdominalis (Crawford, 1910)	2	2	2	0.2
Thrips angusticeps Uzel, 1895	1	1	1	0.1
Thrips hawaiiensis (Morgan, 1913)	68	65	461	58.6
Thrips major Uzel, 1895	3	3	20	2.6
Thrips meridionalis (Priesner, 1926)	1	1	1	0.1
Thrips tabaci Lindeman, 1889	2	2	2	0.2
Thrips pillichi Priesner, 1924	1	1	1	0.1
Phlaeothripidae				
*Haplothrips aculeatus (*Fabricius, 1803)	7	7	19	2.4
Haplothrips gowdeyi (Franklin, 1908)	7	7	32	4.0
Haplothrips reuteri (Karny, 1907)	3	3	3	0.4

Plant species in which thrips species were detected

The distribution of thrips in the sampled ornamental plant species and the total number of individuals are shown in Tables 2 and 3. Relatively high densities of *T. hawaiiensis* were detected on *Europs pectinatus* and *Lantana camara*, while *F. occidentalis* individuals were mostly caught on *L. camara*. *Haplothrips gowdeyi* was also found mostly on *Plumbago capensis*. *Haplothrips gowdeyi* reproduces by feeding on the flowers of plants from the Asteraceae and Poaceae families, and it is not known exactly whether this species is always a phytophagous or sometimes being a predator (Mound & Wells, 2015; Tunç & Hastenpflug-Vesmanis, 2016). The common features of the plants, in which thrips were collected in relatively higher numbers, are that they remain flowering during the sampling and their flowers are yellow. Yudin et al. (1986) reported that yellow flowers are much more attractive especially for thrips, and nectar and pollen in flowers play an important role in the reproduction of adult females. Although some ornamental plants having yellow-colored and plenty flowers were more attracted to adults of two common species, these plants had no effect on reproduction of the thrips during the sampling period. The first adults of predatory thrips species were caught in March. Therefore, this issue may indicate that the species of the genus *Aeolothrips* are not active in vegetation and thus, they are overwintering. In the previous study conducted in the same sampling area (Atakan & Uygur, 2004), individuals of *Aeolothrips* were recorded on the weeds in the early spring time (March). *Aeolothrips collaris* was collected from the *Medicago minima*, a

relatively large number (10 specimens) of herbaceous plant species. In some plant species (especially shrubs and arboreal plants) where the numbers of thrips were relatively abundant, they were often not found or recorded in very low numbers. This may be due to the habitat preferences of predatory aeolothripids and the richness of pollens in the plants sampled. Typical thrips damage (silvering or scar tissue formation) was not observed in any of the plant species sampled during the sampling period.

Table 2. Host plant list and total numbers of the identified thrips species in Balcalı during 2019-2020

Çizelge 2. *Balcalı'da 2019-2020 yıllarında teşhis edilen thrips türlerinin konukçu bitki listesi*

Host plant family	Scientific name	A.co	A.gl	F.o	T.ha	T.ta	T.ma	H.ac	H.go
Asteraceae	*Euryops pectinotus*	0	0	43	73	0	0	2	0
Caprifoliaceae	*Viburnum tinus*	2	0	23	13	0	0	0	0
	Viburnum opulus	0	0	7	7	1	0	0	0
Fabaceae	*Medicago minima*	10	0	6	4	0	0	0	0
Leguminosae	*Parkinsonia aculeata*	0	0	4	41	0	0	0	3
Lythraceae	*Lagerstroemia indica*	0	0	23	0	0	0	0	0
Oleaceae	*Jasminum fruticans*	1	0	7	5	0	0	0	2
Plumbaginaceae	*Plumbago capensis*	0	0	7	6	0	0	0	24
Polygalaceae	*Polygola myrtifolia*	0	7	11	5	0	2	0	0
Rosaceae	*Rosa* spp.	3	0	35	200	0	18	4	0
Scrophulariaceae	*Phygelius aegualis*	0	0	0	0	0	0	0	0
	Russelia eguistiformis	0	0	0	1	0	0	0	3
Verbanaceae	*Lantana camara*	6	0	57	100	1	0	12	0
	Lantana montevidensis	0	0	4	6	0	0	0	0

A.co: *Aeolothrips collaris*, A.gl: *Aeolothrips gloriosus*, F.o: *Frankliniella occidentalis*, T.ha: *Thrips hawaiiensis*, T.ta: *Thrips tabaci*, T.ma: *Thrips major*, H.ac: *Haplothrips aculeatus*, H.go: *Haplothrips gowdeyi*

Table 3. Total numbers of the *Franklinella occidentalis* and *Thrips hawaiiensis* according to ornamental plant families in Balcalı during 2019-2020

Çizelge 3. *Balcalı'da 2019-2020 yıllarında süs bitkileri familyalarına göre Franklinella occidentalis and Thrips hawaiiensis'in toplam* sayıları

Host plant family	*Frankliniella occidentalis*	*Thrips hawaiiensis*	Total
Asteraceae	43	73	116
Caprifoliaceae	30	20	50
Fabaceae	6	4	10
Leguminosae	4	41	45
Lythraceae	23	0	23
Oleaceae	7	5	12
Plumbaginaceae	7	6	13
Polygalaceae	11	5	16
Rosaceae	35	200	235
Scrophulariaceae	0	1	1
Verbanaceae	61	106	167
Total	227	461	688

Seasonal distributions of two thrips species

Total numbers of both *T. hawaiiensis* and *F. occidentalis*, which were more common and abundant, according to ornamental plant families two sampling periods i.e. autumn-winter and early spring periods are given in Table 4. *Thrips hawaiiensis* was mostly collected in the autumn-winter period. During this period, 157 individuals of this thrips species were collected from the Rosaceae family. On the contrary, *F.*

occidentalis was sampled relatively more in spring (March and April). The greater abundance of *T. hawaiiensis* during the winter months may be related to its higher adaptation to cold conditions (Murai, 2001; Zhang et al. 2014). The lower population densities of this species in the spring may be related to its migration to more suitable host plants for reproduction. This species is especially damaging lemons in lemon varieties that bloom and produce fruits throughout the year, causes serious damage (Atakan et al., 2021; Hazır et al., 2022). The lower numbers of *F. occidentalis* in the fall-winter period, including the plant families, in which *T. hawaiiensis* were common, may be related to plant preference, low tolerance to cold weather conditions, or lower competitiveness than the previous thrips species. However, studies are needed on this subject in order to make sound comments.

Table 4. Total numbers of *Franklinella occidentalis* and *Thrips hawaiiensis* according to host plant and season-in Balcalı during 2019-2020

Çizelge 4. *Balcalı'da 2019-2020 yıllarında süs bitkileri familyalarına ve farklı mevsimlere göre Franklinella occidentalis ve Thrips hawaiiensis'in toplam sayıları*

	Thrips species					
	Thrips hawaiiensis			*Frankliniella occidentalis*		
Host plant family	Autumn-winter (October- February)	Spring (March and April)	Total	Autumn-winter (October- February)	Spring (March and April)	Total
Asteraceae	58	15	73	15	28	43
Caprifoliaceae	7	23	30	0	23	23
Fabaceae	0	4	4	0	6	6
Leguminosae	41	0	41	0	4	4
Lythraceae	0	0	0	0	23	23
Oleaceae	2	3	5	1	6	7
Plumbaginaceae	5	1	6	0	7	7
Polygalaceae	0	5	5	0	11	11
Rosaceae	157	43	200	11	24	35
Scrophulariaceae	0	1	1	0	0	0
Verbanaceae	61	45	106	29	28	61
Total	331	140	471	56	162	220

Distribution indices

The general distribution index was high in Rosaceae (*Rosa* spp.) and Verbanaceae families, with values of 19.6 and 12.5, respectively. In other words, thrips were collected in plants from these two plant families. As a matter of fact, it is seen that the distribution index of *T. hawaiiensis* were high on plants from these two families (16.1, 8.79, respectively). It is seen that the distribution index value of *F. occidentalis* in Verbanaceae plants was higher (4.8) than the indexs found in other plant families.

Table 5. General and specific distribution indexs for *Franklinella occidentalis* and *Thrips hawaiiensis* according to ornamental plant families in Balcalı during 2019-2020

Çizelge 5. Balcalı'da 2019-2020 yıllarında süs bitkileri familyalarında *Franklinella occidentalis* ve *Thrips hawaiiensis*'in genel ve özel dağılım indeksleri

Host plant family	Total no of samples	Total no of thrips	General Index	*Frankliniella occidentalis*		*Thrips hawaiiensis*	
				Total no of individual	Index	Total no of individual	Index
Asteraceae	13	116	8.9	43	3.3	73	5.6
Caprifoliaceae	6	43	7.1	23	3.8	20	3.3
Fabaceae	6	10	0.1	6	1.0	4	-
Leguminosae	7	45	6.4	4	-	41	5.8
Lythraceae	6	23	3.8	23	3.8	0	-
Oleaceae	8	12	1.5	7	-	5	-
Plumbaginaceae	6	13	2.1	7	1.7	6	1.0
Polygalaceae	7	16	2.2	11	1.8	5	-
Rosaceae	12	235	19.6	35	2.9	200	16.7
Scrophulariaceae	6	1	-	0	-	1	-
Verbanaceae	13	163	12.5	57	4.8	106	8.1

CONCLUSIONS

In this study, it was found that *T. hawaiiensis* and *F. occidentalis*, which are harmful in agriculture, were common in some ornamental plants in the fall-early spring period, but they could not reproduce in this period. These two thrips species were frequently collected from shrubby perennial ornamental plants such as, *E. pectinatus*, *Rosa* spp and *L. camara*. In general, chemical control of pest thrips is difficult, and usage of pesticides has well-known various negative effects to human, animals, wild life as well as environment. *Thrips hawaiiensis*, which was introduced to Türkiye in 2015, was a main thrips species at least in certain plant species sampled in the current study. With proper habitat management (Dent, 1991; Gurr & Wratten, 1999), cultivation of *E. pectinatus* and *L. camara* plants in agroecosystems may have a contrubition to pest mangement of thrips by way of being trap plants for harmful thrips and banker plants for predatory insects such as priate bugs, (Hemiptera: Anthocoridae) which are primary natural enemies of the thrips (Atakan, 2019b).

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