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Composition and distribution of Thysanoptera (Insecta) in the area of Balcalı, Adana Province, Türkiye

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ABSTRACT

This study was conducted to identify thrips (Insecta: Thysanoptera) species in the Balcalı area of Adana Province, Türkiye, known as a polyculture area having diverse topographic features. Thrips were extensively collected by the tapping method from awide range of agricultural crop plants during 2019-2020. A total of 1150 adult thrips individuals were collected, representing 24 identified species. Among them, the most prevalent and abundant species were the cotton thrips, *Thrips tabaci* Lindeman and the western flower thrips, *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae). These two species showed varying population dynamics based on the flowering patterns of the plants sampled. Thankfully, no thrips damage was observed on the sampled plants. Although invasive pest thrips species such as*Thrips hawaiiensis* (Morgan) and *Scirtothrips dorsalis* (Hood) (Thysanoptera: Thripidae) were found in low numbers, and both of them were collected mostly from flowers of sesame and green pepper plants. A low number of predatory thrips belonging to geniuses, *Aeolothrips* (Aeolothripidae) and *Scolothrips* (Thripidae) were detected on beans, potatoes and cotton after March.

1. Introduction

Thrips belonging to the order Thysanoptera are small and soft-bodied insects with a body size of 0.5-0.15 mm. Some of them are opportunistic and invasive pest species. There are approximately 6000 species defined in this order, and their feeding habits vary. Some species are phytophagous (plant-feeding), mycophagus (fungal-feeding) and predators (Morse and Hoodle 2006; Atakan et al. 2015). Thysanoptera species in Türkiye have mostly been studied in the Mediterranean, Aegean and some parts of Central Anatolia, and Türkiye Thysanoptera fauna has been published (Tunç and Hastenpflug-Vesmanıs 2016). Thysanoptera species have been detected in some temperate climate fruits (Atakan 2008), summer and winter vegetable species (Atakan 2007a, b) on stone and pome fruit trees in the Eastern Mediterranean Region, as well as ornamental plants grown both in greenhouses and outdoors(Atakan 2011). However, in recent years, due to climatic changes such as temperature increases, some tropical Thysanoptera species have spread over geographical areas due to global warming worldwide, and invasive pest insects including thrips have been causing serious damage to crop plants. For example, *Thrips hawaiiensis*, (Morgan) (Thysanoptera: Thripidae) known as Hawaiian flower thrips introduced to Spain (Goldaranzena 2011) and Türkiye (Atakan et al. 2021), seriously damaged, in particular,young lemon fruits. On the other hand, Chilli thrips, *Scirtothrips dorsalis* (Hood) (Thysanoptera: Thripidae) introduced into Türkiye in 2020, has caused serious damage on blueberries in Adana Province, Türkiye (Atakan and Pehlivan 2021).

Changes in crop plants diversity and climatic factors may affect the presence of Thysanoptera species and their distribution in species composition on arable crops (Lewis 1997). For example, the western flower thrips, *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), which causes economic damage in many crops in our country, was reported for the first time in Türkiye in 1994, but it was revealed in the last published study that this species actually existed in the province of Antalya in 1993 (Tunç and Hastenpflug-Vesmanis 2016). For this purpose, Thysanoptera species were investigated according to arable crop plants in Balcalı (Adana, Türkiye) in a certain agro-ecosystem with different crop patterns. This article can provide information about the composition of thrips species, their abundance in certain crop plants or trees, and thus, it can provide useful some data in controlling efforts for the pest thrips.

2. Material and Methods

2.1. Description of sampling sites

Thrips (Thysanoptera) species, their seasonal densities and distributions on some crop plants were investigated in the research area of Balcalı, University of Çukurova in Adana Province, Türkiye in 2019-2020. In this polyculture area, different plant species such as field crops (cotton, soybean, sesame and peanut), citrus, temperate climate fruits (apple, nectarine and loquat), cereals, and winter and summer vegetables are grown for both production and research activities. This ecological area has a typical Mediterranean climate.

2.2. Sampling of thrips

In the sampling units, 20 plants or trees were selected randomly from annual herbaceous cultivars (vegetables and field crops) and perennial woody cultivars (fruit trees). For the sampling, the flowering periods of the plants were considered, and the sampling was started with the beginning of the flowering period of the plants in different plant groups, as thrips are mostly found on flowers (Funderburk et al. 2000, 2018). Flowering or flowering shoots 20-30 cm long in four different directions of the trees were randomly selected for sampling. In herbaceous plants, the upper halves of the plants were considered in the sample. In the surveyed areas, plants representing each plant group or flowering shoots were shaken for 5-10 seconds onto the white container with 34 × 23 × 7 cm, and then thrips individuals (adults and larvae) were collected with the help of a suction tube and/or a fine brush, and were transferred to the Eppendorf plastic tubes (50 cc) filled with 60% ethyl alcohol. In addition, label information such as the place of sampling, date and plant species were recorded. For this purpose, 47 surveys were conducted at regular 15-day intervals and a total of 28 cultivated plants, including 4 field crops, 8 fruit trees and 16 vegetables, were sampled for this purpose. In total, 197, 156, 147 and 74 samples were taken from winter, summer vegetables, fruit trees and field crops, respectively. Samplings were carried out on the same day between 08:00 and 12:00 am.

2.3. Thrips diagnosis

Microscopic preparations were made for the identification of the collected Thysanoptera species. The samples, which were kept in tubes containing ethyl alcohol (60%), were put into the AGA solution including 9-parts ethyl alcohol 1-part glacial acetic acid and 1-part glycerin, for 2 days in order to soften the body tissues and partially empty the body contents. In temporary preparations, samples that are not very dark were kept in 10% sodium hydroxide (NAOH) medium on the hot plate at 60ºC for about 30 minutes, and dark samples for about one hour until slight color changes occurred. The body contents of the samples were completely discharged by rubbing their bodies from the ventral or dorsal side in 96% alcohol. Individuals were placed in Hoyer medium and microscopic slides were made. The identification of the thrips specimens was done with the help of key identification guides referencing Priesner 1951, Yakhontov 1964 and zur Strassen 2003.

2.4. Evaluation of data

The total number of identified Thysanoptera species and their distribution on crop plant species is shown in the Tables 1 and 2. The seasonal averages of the main pest thrips species, according to the crop groups, were not statistically compared because the cultivated plants sampled from different plant groups were grown in different ecological areas and also due to the differences in their growing periods. The total number of individuals according to the plant species of the identified species whose numbers vary from 1 to 9 are not shown in Table 2. Population densities (20 plants or trees) of the two common thrips species by plant groups for the period October 2019 to October 2020, are shown as relevant.

Table 1. Thysanoptera species and their total numbers during 2019-2020

Thysanoptera species	2019	2020	Total (2019+2020)
Aeolothripidae			
Aeolothrips collaris Priesner	0	16	16
Aeolothrips ericae Bagnall	0	4	4
Aeolothrips gloriosus Bagnall	0	5	5
Aeolothrips fasciatus (Lin.)	0	1	1
Aeolothrips intermedius Bagnall	0	11	11
Thripidae			
Anophothrips sudanensis Trybom	0	2	2
Chirothrips aculeatus Bagnall	0	2	2
Frankliniella intonsa (Trybom)	0	5	5
Frankliniella occidentalis (Pergande)	73	152	225
Limothrips denticornis (Haliday)	0	1	1
Mycterothrips tschirkunae (Yakhontov)	7	1	8
Rubiothrips vitis Priesner	0	1	1
Thrips hawaiiensis (Morgan)	5	61	66
Thrips major Uzel	4	25	29
Thrips meridionalis (Priesner)	0	1	1
Thrips minutissimus	0	9	9
Thrips tabaci Lindeman	278	407	685
Scirtothrips dorsalis Hood	36	8	44
Scolothrips longicornis Priesner	0	1	1
Phlaeothripidae			
Haplothrips aculeatus (Fabricious)	2	18	20
Haplothrips distinguendus (Uzel)	0	2	2
Haplothrips ganglbaueri Schmutz	2	2	4
Haplothrips kurdjumovi Karny	2	1	3
Haplothips reuteri (Karny)	0	8	8
Total	406	744	1150

3. Results

3.1. Thrips composition

A total of 1150 adult thrips individuals were recorded in this study, with very few thrips larvae collected. In total, 24 Thysanoptera species were recorded, including 5 from the family Aeolothripidae, 14 from the family Thripidae, and 5 from the family Phlaeothripidae. Species from the family Aeolothripidae were found only in 2020. Depending on the number of samples, thrips individuals were mainly collected in 2020. The most common and abundant species were *Thrips tabaci* Lindeman, *Frankliniella occidentalis* (Pergande), and *Thrips hawaiiensis* (Morgan), respectively. *Scirtothrips dorsalis* (Hood), which was detected for the first time in Türkiye in 2021 was actually found to exist in the Adana Province in 2019.

3.2. List of plant species with some thrips species

The list of plant species that host some thrips species and the number of thrips individuals are shown in Table 2. Predatory thrips have been recorded in very small numbers (1-6 individuals). *Aeolothrips collaris* Priesner have been found in potatoes, *Aeolothrips intermedius* Bagnall in beans (4 individuals), cotton (3 individuals), and sesame (4 individuals), where they were relatively more abundant. Species from the family Aeolothripidae were recorded in very low numbers in both seasonal vegetables and field crops. The main thrips species, *T. tabaci*, was widely sampled and found in large numbers on winter vegetables such as cauliflower (113 individuals), cabbage (106 individuals), and summer vegetable beans (103 individuals). This harmful species is also abundant in potato plants cultivated as early crops in the Çukurova region. It is prevalent in soft-fleshed fruit trees as well. The individuals of *F. occidentalis*,

Table 2. A list of crop plant species with numbers of commonly found thrips species during 2019-2020

Plant species/English name (scientific name)	A.co	A.in	H.ac	F.oc	T.ha	T. ma	T.ta	S.do	Total
Amaranthaceae									
Spanich (*Spinacia oleracea*)	0	0	0	2	0	0	0	0	2
Asteraceae									
Lettuce (*Lactuca sativa*)	0	0	0	5	0	0	3	0	8
Brassicaceae									
Cauliflower *(Brassica oleraceavar. Botrytis*)	0	0	0	1	0	0	113	0	114
Red cabbage (*Brassica oleraceavar. capitata f. Rubra*)	0	0	0	0	1	0	106	0	107
Cabbage (*Brassica oleracea*)	0	0	0	0	0	0	42	0	42
Rocket (*Eruca vesicaria*)	0	0	0	0	0	0	1	0	1
Peppergrass (*Lepidium sativum*)	0	0	0	0	0	0	0	0	0
Radish (*Raphanus sativus*)	0	0	0	3	0	0	5	0	8
Cucurbitaceae									
Cucumber (*Cucumis sativus*)	0	0	0	0	0	0	6	0	6
Pumpkin (*Cucurbita moschata*)	0	0	0	1	0	0	4	0	5
Fabaceae									
Broad bean (*Vicia faba*)	0	0	0	4	7	3	6	3	23
Bean (*Phaseolus vulgaris*)	2	4	2	35	3		103	0	149
Soybean (*Glycine max*)	2	0	2	31	1	0	14	4	54
Groundnut *(Arachis hypogaea*)	2	0	3	9	0	2	0	0	16
Lythraceae									
Pomegranade (*Punica granatum*)	0	0	0	0	2	0	1	0	3
Malvaceae	0	0							
Cotton (*Gossypium hirsitum*)	0	3	0	41	6	0	0	0	50
Pedeliaceae	0								
Sesame (*Sesamum indicum*)	0	4	3	25	27	1	1	3	64
Rutaceae									
Citrus (*Citrus* spp.)	1	0	0	15	0	12	31	0	59
Rosaceae									
Pear (*Pyrus communis*)	0	0	0	0	0	0	1	0	1
Almond (*Prunus dulcis*)	0	0	0	1	0	0	2	0	3
Apple (*Malus domestica*)	1	0	9	1	1	7	23	0	42
Plum (*Prunus Domestica*)	0	0	0	0	0	0	4	0	4
Apricot (*Prunus persica*)	0	0	0	1	0		1	0	2
Loquat *(Eriobotrya japonica*)	0	0	0	0	1	4	29	0	34
Solanaceae									
Pepper *(Capsicum annuum*)	1	0	1	14	7	0	12	33	68
Tomato (*Solanum lycopersicum*)	1	0	0	9	5	0	3	0	18
Potato (*Solanum tuberosum*)	6	0	0	8	0	0	152	0	166
Eggplant (*Solanum melongena*)	0	0	0	16	5	0	22	1	44

A.co: *Aeolothrips collaris*, A.in: *Aeolothrips intermedius*, F. oc: *Frankliniella occidentalis*, T.ha: *Thrips hawaiiensis*, T.ma: *Thrips major*, T.ta: *Thrips tabaci*, S.do: *Scirtothrips dorsalis*, H. ac: *Haplothrips aculeatus.*

also known as western flower thrips, were mostly collected in higher numbers from field crops such as cotton (41 individuals), soybean (31 individuals), and beans (35 individuals) (Table 2). *Thrips hawaiiensis*, which was observed in Türkiye for the first time on lemon trees grown in the Erdemli district of Mersin Province, Türkiye, caused significant damage to flowers and fruits. The highest number of this species (27 individuals) was collected from sesame plants, while individual counts on other cultivated plants ranged between 1 and 7. *Scirtothrips dorsalis* was predominantly collected from pepper plants (33 individuals). *Thrips major* Uzel was mainly recorded on citrus trees (total of 12 individuals).

3.3. Population fluctuations of two common thrips species

The population fluctuations of two common thrips species, *F. occidentalis* and *T. tabaci*, were observed over a specific period. Figure 1 displays the population counts based on sampling dates for 20 plants. As depicted in Figure 1, *T. tabaci* showed varying abundance in different cultivated plants, excluding field crops. In winter vegetables, the population density of *T. tabaci* remained relatively steady throughout the sampling dates, ranging between 6 and 8 individuals per 20 plants. Conversely, *F. occidentalis* was rarely found in the group of winter vegetables, with the highest count being 1 individual per 20 plants. Within the summer vegetable group, adult *T. tabaci* individuals were more prevalent from March to June, reaching the peak on May 7th with 31 individuals per 20 plants. After June, harmful *T. tabaci* individuals were not found on the plants. On the other hand, the highest population density of *F. occidentalis* in summer vegetables was observed on May 27th, with 4.5 individuals per 20 plants, coinciding with a significant decrease in the *T. tabaci* population. Regarding fruit trees (both soft and hard-tissue fruits), the highest number of *T. tabaci* individuals was recorded on February 5th, at the beginning of the flowering period. For *F. occidentalis*, they were rarely found on fruit trees in several sampling dates, with the highest count being 0.44 individuals per 20 plants on April 29th. In contrast to other cultivated plants, *F. occidentalis* individuals were more prominent in field crops such as cotton, soybean, and sesame. They were mainly collected from cotton flowers, with its highest population density being 6.5 individuals per 20 plants on August 24th. This information highlights the population fluctuations of the two thrips species over the specified period, providing valuable insights for further study and management strategies.

4. Discussion

Thrips tabaci and *F. occidentalis* species were the most commonly recorded in this study (Tables 1 and 2). It is evident that these two species were also common in previous studies conducted in Adana Province (Atakan 2007a, b). In other words, it was concluded that the introductions of 2 new invasive thrips species (*T. hawaiiensis* and *S. dorsalis*) into Adana Province did not cause any change in thrips composition in the sampling area, known as the polyculture area. Individuals of *T. tabaci* in winter vegetables and *F. occidentalis* individuals in summer vegetables appeared at relatively higher densities (Figure 1). This may be related to the bio-ecological demands of the species, their preferences for specific plant species (such as plant morphology and anatomy, and chemical content). Thrips were mainly recorded in the flowers of the sampled plants, and population

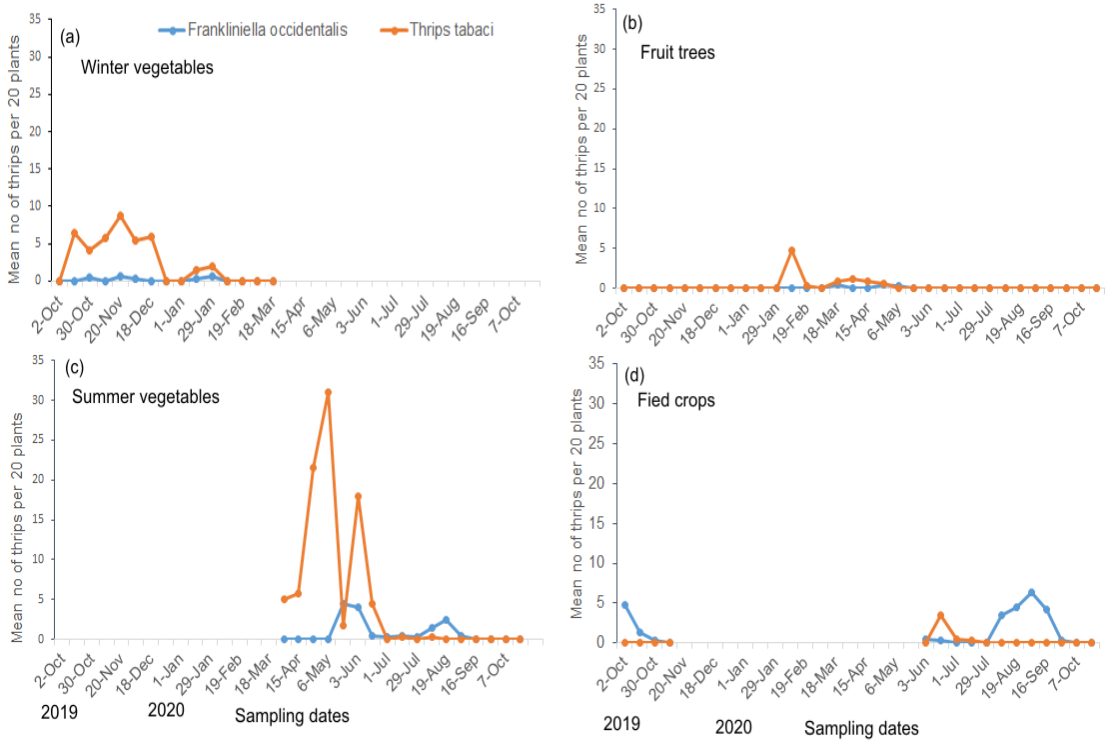

Figure 1. Population density patterns of two common Thysanoptera species on diverse crop plants during 2019-2020; winter vegetables (a), fruit trees (b), summer vegetables (c), field crops (d).

patterns in different plant groups changed according to the flowering status of the plants. In other words, their population densities depended on flower formations and flower densities in plants. Nectars, protein and carbohydrate nutrition in the flowers of plant species may have attracted thrips more in terms of their development and reproduction (Yudin 1986; Lewis 1997). The fact that *T. tabaci* was not found in many sampling dates after June may be related to its lower tolerance to summer temperatures compared to *F. occidentalis* (Lewis 1997).

When evaluating the numbers of thrips individuals from different plants, it is evident that the number of individuals, including common species, is low (Table 2). This situation, along with the diversity of plant and insect species, may indicate that maintaining a natural balance in agricultural ecosystems is possible with good habitat planning, allowing beneficial insects to easily suppress harmful species (Barbosa and Wratten 1998; Landis et al. 2000; Gurr et al. 2017). In this study, particularly, the predator *Orius* species (Hemiptera: Anthocoridae) were frequently collected alongside thrips, which may account for the absence of thrips larvae (Tatlıcıoğlu et al. 2022). The low mobility and soft body of thrips larvae make them vulnerable to such predatory insects (Funderburk et al. 2000; Osekre et al. 2008). Predatory thrips species were observed in the sampled crop plants after March, but only a low number of them were recorded, indicating their inactivity during the winter vegetation. The low individual numbers might be influenced by their habitat preferences, plant choices, and predation by larger general predators of the order Hemiptera (e.g., *Geocoris*, *Orius*, *Piocoris* and *Nabis* species) (Asghar et al. 2008). However, predatory Aeolothripidae species were recorded in large numbers on the flowers of the weeds in the same sampling area in previous works (Atakan and Uygur 2004, 2005). This may be related to the habitat and plant preferences of the predatory thrips of the genus *Aeolothrips*.

In conclusion, thrips were found to be more abundant on annual herbaceous plants compared to perennial arboreal plants. It was observed that thrips densities are closely linked to the flowering phenology of plants sampled. The richness of plant species diversity in a specific agro-ecosystem can promote healthier and more dynamic relationships between plants, harmful insects, and beneficial organisms i.e. predators and parasitoids (trophic relations). Moreover, investigating harmful or beneficial insect species in different targeted ecosystems, as demonstrated in this study, allows for early detection of invasive harmful species entering the ecosystem. This early detection of pest thrips on crop plants may contribute to planning of control tactics in preventing their spread over large agricultural areas. *Scirtothrips dorsalis*, which is often considered an important pest of pepper plants in the literature, was mostly collected from pepper flowers in the present study. Although *F. occidentalis* is known as a common pest insect in pepper production areas in Türkiye, it is thought to be beneficial to investigate this recently introduced thrips species in crop plants particularly in green peppers across a large region.

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