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Determination of thrips (Thysanoptera) fauna on stone and pome fruit trees in Balıkesir province, Türkiye

Balıkesir ilinde taş ve yumuşak çekirdekli meyve ağaçlarındaki thrips (Thysanoptera) türlerinin saptanması

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ABSTRACT

This study was carried out to identify species belonging to Thysanoptera in stone and pome fruit orchards in the districts (Balya, Bandırma, Bigadiç, Burhaniye, Dursunbey, Erdek, Gönen, Havran, Kepsut and Manyas) of Balıkesir Province, Turkey in 2018 and 2019. The survey revealed 32 Thysanoptera (thrips) species. Thrips were examined in 9900 flowers, leaves, and fruits from 198 orchards during the research. The most widespread (total number of samples) and abundant (total number of individuals) species were: *Taeniothrips inconsequens* (Uzel) (Thripidae: Thysanoptera) (158 specimens- 2922 individuals), *Haplothrips reuteri* (Karny) (Phlaeothripidae: Thysanoptera) (76- 529), *Thrips meridionalis* (Priesner) (55- 359) and *Thrips minutissimus* Linnaeus (21- 209) (Thripidae: Thysanoptera). The highest number of thrips specimens were detected from cherry (*Prunus avium* L.), followed by apple (*Malus domestica* L.), peach (*Prunus persica* Batsch), and plum (*Prunus domestica* L.) trees. Ta. *inconsequens* predominated the thrips fauna on peach and cherry. *H. reuteri* was the most abundant species on pear. Thrips were found in 41.94% of flowers, while they were detected in 1.83% and 1.16% of fruit and leaves. This study was designed to fill the gaps in the data such as diversity in plant species associated, spatial distribution on plant parts, and temporal distribution in relation to phenological periods.

INTRODUCTION

Turkey is ranking as the first country in the world in the production of cherry and sour cherry. Turkey produces 19.2% of the world's total production of cherries, 13% of sour cherries, 8% of apricots, 3% of apples and peaches, and 2% of pears and plums. Turkey's production most of which are stone and pome fruit production (tons) are apple (4.300.486), apricot (833.398), peach (729.804), cherry (724.944), pear (545.569), plum (329.056), and sour cherry (189.184) (TUIK 2020).

Many studies have been conducted on the pests and beneficial species of stone and pome fruit trees in Turkey (Atakan 2008a, 2008b, 2008c, Bolu et al. 2007, Çınar et al. 2004, Ertop and Özpınar 2011, Hazır et al. 2011, Güven 2013, Kaplan and Tezcan 2011, Özder 1998, Öztürk and

Atakan 2008, Tezcan 1995, Tezcan and Önder 1999, Ulusoy et al. 1999,2009).

Approximately 6.288 species of thrips are known in the world (Thrips Wiki 2018). From Turkey, 194 species belonging to the order of Thysanoptera are registered (Başar and Yaşar 2018, Tunç and Hastenpflug-Vesmanis 2016) and Thysanoptera species constitute 0.57% of the species in the Turkish insect fauna (Tezcan 2020).

Bagnall (1934) provided the first faunistic report on the Thysanoptera fauna of Turkey. Lodos (1993) was the first to compile a list of species belonging to the order Thysanoptera in Turkey (Lodos 1993). Tunç and Hastenpflug-Vesmanis (2016) provided the species list of Turkey's Thysanoptera fauna, which contains new records for Turkey. Other researchers have contributed significantly to this issue (Atakan 2008a, 2008b, 2008c, 2009, Barış et al. 2019, Hazır et al. 2011, Kaplan et al. 2016, Maya and Tezcan 2018, Ölçülü and Atakan 2013, Özsemerci et al. 2006, Öztürk and Atakan 2008, Şahin and Tezcan 2014, Uzun et al. 2015).

Although some published studies related to insect species found in stone and pome fruit orchards in Balıkesir have been reported (Erözmen and Yaşar 2017, Giray 1969), there was no record of species belonging to the Thysanoptera order in these studies.

Gargani (1996) stated that *Thrips tabaci* Lindeman, 1889, *Th. major* Uzel, 1895, *Th. angusticeps* Uzel, 1895 and *Th. minutissimus* Linnaeus, 1758 (Thripidae: Thysanoptera) were commonly seen in nectarine, peach, and plum in Tuscany (Italy). He reported that other thrips species, except *Th. major*, were harmful during the development and ripening stages of fruits, and this damage reached 40-60% in nectarines. Thrips cause different types of damage depending on where they are found. In California and New Zealand, the damage is caused both by larval feeding on immature fruit at fruit petal fall, which results in severe reddish-brown of the fruit surface, as well as by silvering injury (Bournier 1970). It has been reported that *Th. major* causes severe spots and deformities in citrus fruits in several North African countries, with adults and larvae feeding on blooms and fruits (Bournier 1963).

Atakan (2008a), in the study on apple, plum, and nectarine trees in Adana, determined that *Frankliniella occidentalis* (Pergande, 1895) is an economically important thrips species. In a previous study to determine Thysanoptera species in nectarines and their fruit damage, it was discovered that thrips (primarily larvae) feeding on the ovary causes brown scar tissue formation in the fruit, as well as discoloration called silvering on the fruit surface during the pre-harvest period (Hazır et al. 2011). The major species in nectarine blossoms was *F. occidentalis*, according to a study conducted in Balcalı (Adana), and this species caused spotting in fruits at rates ranging from 5-30 percent (Atakan 2008a). The percentage of fruits with thrips injury was highest on nectarines, 29, followed by plums, 17, according to a study conducted in orchards in the Çukurova Region (Atakan 2008d).

In this study, we aimed to determine the species of Thysanoptera, their local distribution, frequency, and abundance; to ascertain species composition, spatial distribution on plant parts, and temporal distribution in relation to phenological periods on stone and pome fruit orchards in the districts of Balıkesir province (which is an important production area of stone and pome fruits in the western part of Turkey).

The data collected contribute to the knowledge of Thysanoptera fauna of one of the least touched parts of Turkey in this regard. The gaps in the data such as diversity in plant species associated, spatial distribution on plant parts, and temporal distribution in relation to phenological periods are filled.

MATERIALS AND METHODS

The material collected from ten districts in Balya, Bandırma, Bigadiç, Burhaniye, Dursunbey, Erdek, Gönen, Havran, Kepsut, and Manyas districts of Balıkesir Province from March to August in 2018 and 2019. The field surveys were conducted in 198 orchards in the districts studied, and included apple (*Malus domestica* L.), cherry (*Prunus avium* L.), peach (*Prunus persica* B.), pear (*Pyrus communis* L.), plum (*Prunus domestica* L.), and sour cherry (*Prunus cerasus* L.) trees. The pesticide was not used to control thrips in the orchards sampled for this study.

The number of orchards sampled was determined by taking into account the actual fruit production potential of the districts. The number of orchards investigated in each district were Balya (8), Bandırma (25), Bigadiç (22), Burhaniye (15), Dursunbey (26), Erdek (9), Gönen (33), Havran (35), Kepsut (15), Manyas (10).

A total of 50 flowers and 50 leaf samples were taken from 13 randomly selected trees in each grove, by walking diagonally. The collected samples were placed in paper bags, after that, the samples were placed in a plastic bag with the district, date, and garden number written on them and brought to the laboratory in an icebox. For fruit sampling, the beating method was applied for a total of 50 fruits, from four sides of 13 trees. Thrips on fruits were collected by beating them on a 19 × 31 cm white cloth stretched over a frame in the field. And, this was repeated three times for the early, mid-season, and late-maturing varieties. Thus, 9.900 flowers, 9.900

leaves, and 9.900 fruits were sampled. Flowers were sampled in March and April, while leaves and fruits were sampled in March, April, May, June, July, and August, depending on the fruit variety. The flower and leave samples brought to the laboratory were brushed separately into white dishes using sable brushes. Each sample was individually shaken into a white tray with a sable brush, and the thrips that fell into the tray were collected using the brush. The flower petals and sepals were dissected and examined for the separation of the remaining thrips if any. The specimens were placed into Eppendorf tubes containing preservation fluid, AGA, (9 parts 60% ethyl alcohol, 1-part glycerine, and 1 part acetic acid). After a preliminary inspection and identification with a stereo microscope, the collected thrips were preserved in 60% ethyl alcohol. Samples whose diagnosis has been completed are labeled and kept in the collection of Balıkesir University, Faculty of Arts and Sciences, Department of Biology, Zoology Museum.

The pre-diagnosis process of thrips was made by comparing with previously identified specimens and using Zur Strassen (2003). Pre-diagnosed specimens were identified/confirmed by Prof. Dr. Ekrem ATAKAN.

Data analysis and evaluation

A simple district or host index was used to analyze the distribution of a certain thrips species in the districts or on different plants. The following formulas were used to determine the district and host indices: the total number of individuals of a given thrips species in the district divided by the total number of samples in the district gives the district index.

The total number of individuals of a certain thrips species on the plant species divided by the total number of samples from the host species is the host index.

RESULTS AND DISCUSSION

A total of 32 species belonging to four families of Thysanoptera were identified as a result of this research, as shown in Table 1. The species found are listed with their frequency (number of samples in which the species was found) and abundance (total number of individuals of the species collected).

Most of the common species were from Thripidae; representatives of Phlaeothripidae, Aeolothripidae, and Melanthripidae were relatively less common.

The most common and abundant species, with the number of samples-specimens they were represented by, were *Taeniothrips inconsequens* (Uzel, 1895) (158 specimens-2922 individuals), *Haplothrips reuteri* (Karny, 1907) (76-529), *Thrips meridionalis* (Priesner, 1926) (55- 359) and *Th. minutissimus* Linnaeus, 1758 (21- 209).

The number of the specimens found was 2481 and 1967 in 2018 and 2019, respectively. The abundance of the thrips species was highest in April in both years regarding the seasonal distribution of the species by months. Plums and peaches were at the pink bud stage in March 2019, daily minimum temperatures (°C) dropped below zero, causing frost damage to fruit trees in the winter and late spring. While the number of thrips collected in March 2018 was 644, the number of thrips collected in March 2019 was 143. Lower temperatures in 2019 resulted in a fall in the number of thrips collected, according to research. In the previous study carried out in fruit orchards in Antalya, it was stated that *Th. meridionalis*, which was the most common species, could not be observed in June-October, but continued to exist in winter and spring (Tunç 1989b). Consistent with the results obtained from this study conducted in Antalya, it was observed in this study that *Th. meridionalis* could not be sampled in the summer months (from June to October), but could be sampled in the spring months.

The species reported from Balıkesir for the first time; *Haplothrips andresi* Priesner, *H. arenarius* Priesner, *H. distinguendus* (Uzel), *H. globiceps* (Bagnall) and *H. minutus* (Uzel) (Phlaeothripidae), *Th. angusticeps* Uzel, *Th. australis* (Bagnall), *Th. euphorbiae* Knechtel, *Th. dubius* Priesner, *Th. mareoticus* (Priesner), *Th. pillichi* Priesner and *Th. simplex* (Morison) (Thripidae); *Aeolothrips ericae* Bagnall, *A. fasciatus* (Linnaeus), *A. gloriosus* Bagnall, *A. priesneri* Knechtel, *A. versicolor* Knechtel and *Orothrips priesneri* (Titschack) (Aeolothrpidae); *Melanthrips pallidior* Priesner and *M. rivnayi* Priesner, (Melanthripidae).

Aeolothrips collaris, *A. gloriosus*, *A. intermedius*, *M. fuscus*, *M. pallidor*, *Or. priesneri*, *F. occidentalis*, *Ox. ajugae*, *T. inconsequens*, *T. frici*, *T. angusticeps*, *T. major*, *T. meridionalis*, *T. minutissimus*, *T. tabaci*, *Haplothrips aculeatus*, *H. globiceps*, *H. reuteri* have been recorded previously in the fruit production areas in different regions of Turkey (Maya and Tezcan 2018, Şahin and Tezcan 2014, Tunç 1989a, 1989b, Uzun et al. 2015).

Distribution of thrips species in districts

Out of 32 species 22 (68.75%) were found in Havran, 20 (62.50%) in Dursunbey, 16 (50.00%) in Bigadiç, 13 (40.62%) in Kepsut, 10 (32.25%) in Gönen, 9 (28.12%) in Burhaniye and Bandırma, 8 (25.00%) in Manyas, 6 (18.00%) in Balya, and 2 (2%) in Erdek.

Ta. inconsequens was found in all areas, but *H. reuteri*, Th. *meridionalis* and *Th. minutissimus* were less common and tended to be confined locally (Table 2). The majority (44.07%) of the specimens were collected in Bigadiç. The

Table 1. List of identified thrips species with their overall frequency and overall abundance on stone and pome fruit trees in Balıkesir region of Turkey during 2018-2019

Family/ Species	Yearly frequency		Yearly abundance		Overall frequency	%	Overall abundance	%
	2018	2019	2018	2019				
Aeolothripidae								
Aeolothrips ericae	2	0	3	0	2	0.40	3	0.07
Aeolothrips fasciatus	3	2	4	6	5	1.01	10	0.22
Aeolothrips gloriosus	5	2	6	6	7	1.41	12	0.27
Aeolothrips intermedius	10	0	11	0	10	2.02	11	0.25
Aeolothrips priesneri	1	2	1	2	3	0.61	3	0.07
Aeolothrips versicolor	1	0	1	0	1	0.20	1	0.02
Orothrips priesneri	2	0	2	0	2	0.40	2	0.04
Melanthripidae								
Melanthrips fuscus	0	1	0	1	1	0.20	1	0.02
Melanthrips pallidior	3	0	3	0	3	0.61	3	0.07
Melanthrips rivnayi	1	0	1	0	1	0.20	1	0.02
Thripidae								
Frankliniella occidentalis	16	9	37	34	25	5.05	71	1.60
Oxythrips ajugae	2	10	3	35	12	2.42	38	0.85
Taeniothrips inconsequens	99	59	1558	1364	158	31.92	2922	65.69
Tenothrips frici	0	1	0	1	1	0.20	1	0.02
Thrips angusticeps	16	10	48	30	26	5.25	78	1.75
Thrips australis	2	3	14	7	5	1.01	21	0.47
Thrips dubius	4	0	9	0	4	0.81	9	0.20
Thrips euphorbia	1	0	1	0	1	0.20	1	0.02
Thrips major	7	5	18	10	12	2.42	28	0.63
Thrips mareoticus	1	0	6	0	1	0.20	6	0.13
Thrips meridionalis	39	16	225	134	55	11.11	359	8.07
Thrips minutissimus	12	9	146	63	21	4.24	209	4.70
Thrips pillichi	9	3	20	9	12	2.42	29	0.65
Thrips simplex	2	0	2	0	2	0.40	2	0.04
Thrips tabaci	12	9	15	41	21	4.24	56	1.26
Phlaeothripidae								
Haplothrips aculeatus	1	1	1	1	2	0.40	2	0.04
Haplothrips andresi	15	0	24	0	15	3.03	24	0.54
Haplothrips arenarius	0	1	0	1	1	0.20	1	0.02
Haplothrips distinguendus	1	0	1	0	1	0.20	1	0.02
Haplothrips globiceps	0	1	0	1	1	0.20	1	0.02
Haplothrips minutus	3	5	3	10	8	1.62	13	0.29
Haplothrips reuteri	55	21	318	211	76	15.35	529	11.89
Total			495		4.448			

district index for Bigadiç was 13.85. Based on the district index and the percentage of specimens in a total number of specimens collected in a given district *Ta. inconsequens* was the dominant species in Bigadiç and Kepsut districts.

Distribution of thrips in fruit orchards

As a result of the field studies carried out in 2018-2019, the highest number of thrips specimens were collected from cherry which is 2.168, followed by apple with 1.227 and peach with 733, 205 pieces of plum, 101 pears, and 14 sour cherries.

Ta. inconsequens was present on all stone and pome fruit species. But the other major thrips species, *H. reuteri*, *Th. meridionalis* and *Th. minutissimus* were not found in some fruit species and found very low numbers on other fruit species (Table 3).

Based on the percentage of specimens in a total number of specimens collected on all fruit species and values of the host index, *Ta. inconsequens* predominated thrips fauna on peach and cherry whereas *H. reuteri* was the most abundant species on pear.

Table 2. List of identified thrips species with their overall frequency and overall abundance on stone and pome fruit trees in Balıkesir region of Turkey during 2018-2019

District	Number of individuals and district index[a] of the species										
	Total number of			*Taeniothrips inconsequens*		*Haplothrips reuteri*		*Thrips meridionalis*		*Thrips minutissimus*	
	Individuals	Samples	General index	No.	Index	No.	Index	No.	Index	No.	Index
Balya	16	8	2.0	2	0.3	1	0.1	0	0	2	0.3
Bandırma	129	24	5.4	70	2.9	12	0.5	37	1.5	1	0
Bigadiç	1422	93	15.3	1288	13.8	42	0.5	0	0	10	0.1
Burhaniye	67	15	4.5	9	0.6	22	1.5	15	1.0	0	0
Dursunbey	942	120	7.9	486	4.1	209	1.7	133	1.1	18	0.2
Erdek	32	5	6.4	24	4.8	0	0	0	0	0	0
Gönen	616	77	8.0	304	3.9	170	2.2	77	1.0	0	0
Havran	611	89	6.9	265	3.0	40	0.4	36	0.4	173	1.9
Kepsut	501	36	13.9	428	11.9	9	0.3	45	1.3	3	0.1
Manyas	112	28	4.0	46	1.6	24	0.9	16	0.6	2	0.1
Total	4.448	495		2.922		529		359		225	

[a] The total number of individuals of a given thrips species in the district divided by the total number of samples in the district yields the district index.

Th. australis, popularly known as eucalyptus thrips (Mound 2010), was initially recorded in plum and cherry flowers at three separate places (Burhaniye, Dursunbey, and Havran) in Balıkesir.

Ta. inconsequens, *H. reuteri, Th. meridionalis* and *Th. minutissimus* are noteworthy by being phytophagous. Additionally, the presence of species like *M. fuscus*, *M. pallidior*, and *M. rivnayi* which feed on pollen, and species like *A. collaris*, *A. fasciatus*, *A. intermedius*, *A. versicolor*, and *Or. priesneri* which are known as predators of small arthropods in orchards are important in terms of biological diversity and natural balance (Tunç et al. 2012a, 2012b, Zur Strassen 2003).

Distribution of plant parts

Thrips were detected in a total of 9.900 flowers, leaves, and fruits from 198 orchards during the research. Thrips were found in 41.94% of flowers, while they were detected in 1.83% and 1.16% of fruit and leaves.

When the distribution of Thysanoptera species was analyzed based on the plant parts it was determined that the thrips density was higher in flowers than in other plant sections. *A. ericae*, *A. fasciatus*, *A. gloriosus*, *A. intermedius*, *A. priesneri*, *A. versicolor*, *H. distinguendus*, *H. globiceps*, *H. arenarius*, *M. pallidor*, *M. rivnayi*, *M. fuscus*, *Or. priesneri*, *Te. frici*, *Th. australis*, *T. euphorbiae*, *T. major*, *T. mareoticus*, *T. simplex*, and *T. tabaci* were found in only flowers. *Ox. ajugae*, *Ta. inconsequens*, *Th. meridionalis*, *H. reuteri* were found in leaves. Ta. inconsequens, Th. meridionalis, Th. angusticeps, Th. minutissimus, Th. pillichi, H. aculeatus, H. andresi, H. minutus, and H. reuteri were found in fruits.

Thrips were found in high numbers during the blooming stage of fruit trees, but there were no or only a few thrips

Table 3. Distribution of major thrips species on stone and pome fruits species in Balıkesir in 2018-2019

Fruit species	Number of individuals and plant index[a] of the species										
	Total number of			Taeniothrips inconsequens		*Haplothrips reuteri*		*Thrips meridionalis*		*Thrips minutissimus*	
	Individuals	Samples	General index	No.	Index	No.	Index	No.	Index	No.	Index
Apple	1.227	199	6.17	559	2.81	287	1.44	173	0.87	36	0.18
Cherry	2.168	187	11.59	1.572	8.41	164	0.88	97	0.52	154	0.82
Peach	733	56	13.09	612	10.93	33	0.59	55	0.98	3	0.05
Pear	101	16	6.31	43	2.69	42	2.63	0	0	0	0
Plum	205	28	7.32	130	4.64	3	0.11	31	1.11	16	0.57
Sour cherry	14	9	1.56	6	0.67	0	0	3	0.33	0	0
Total	4.448	495		2.922		529		259		209	

[a] The total number of individuals of a certain thrips species on the plant species divided by the total number of samples taken from the plant species yields the host index

in the fruits after flowering, according to earlier research (Maya and Tezcan 2018, Ölçülü and Atakan 2013, Şahin and Tezcan 2014, Uzun et al. 2015).

Different kinds of fruits and vegetables are produced in Balıkesir Province because of favorable climate conditions. While peach cultivation is focused on in Kepsut district, apple cultivation is prominent in Dursunbey. Barley, safflower, wheat, rye, corn, chickpea, sunflower, forage crops are grown in Dursunbey district. In recent years, walnut orchards have increased considerably throughout the province. Dursunbey district is a mountainous region due to its high altitude (672 m) and is closed to sea breezes, and 65% of the total area of the district consists of forests. 51.61% of the species found at the end of the study were collected from this region. Especially Edremit gulf region (Havran, Burhaniye) is located in the coastal zone in terms of climate, this region has allowed the formation of fruit gardens consisting of different fruit species. Olive, mandarin, plum, and fig cultivation is carried out intensively in Havran district and covers large areas. Twenty-two (70.97%) of the species found as a result of this study carried out in the fruit production areas of Balıkesir Province were found in Havran. The reason for the high diversity of species is due to the cultivation of different cultural plants in the district. The presence of forest areas around the area where *Th. minutissimus*, which is known to be typically found in the flowers of species belonging to the genus Quercus, was sampled in Havran is thought to be the reason for the high number of this species.

Systematic sampling, investigations, experiments, and other work that would yield data required to define the fruit orchard ecosystems with an emphasis on their thrips associates should be carried out in different locations in a limited number of orchards throughout the year and multiple years rather than surveying orchards in different parts of the country for a limited period during the season. Such surveys should be capable to identify ecosystem variables on which the integrated pest management would be implemented.

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ÖZET

Taş ve yumuşak çekirdekli meyve bahçelerinde bulunan Thysanoptera takımına bağlı türleri saptamak amacıyla yürütülen bu çalışma, 2018 ve 2019 yıllarında Balıkesir ilinin Balya, Bandırma, Bigadiç, Burhaniye, Dursunbey, Erdek, Gönen, Havran, Kepsut ve Manyas ilçelerinde gerçekleştirilmiştir. Çalışma süresince, 198 bahçedeki taş ve yumuşak çekirdekli meyve ağaçlarından alınan toplam 9900 çiçek, meyve ve yaprakta bulunan thripsler sayılmıştır. Çalışma sonunda 32 thrips (Thysanoptera) türü saptanmıştır. En yaygın ve en yüksek sayıda bireyle temsil edilen türler, bulunduğu örnek sayısı-birey sayısı ile birlikte *Taeniothrips inconsequens* (Uzel) (Thripidae: Thysanoptera) (158 örnek- 2922 birey), *Haplothrips reuteri* (Karny) (Phlaeothripidae: Thysanoptera) (76-529), *Thrips meridionalis* (Priesner) (55- 359) ve *Thrips minutissimus* Linnaeus (21- 209)'dur. En fazla sayıda thrips bireyi kiraz (*Prunus avium* L.) bahçelerinden toplanırken, bunu elma (*Malus domestica* L.), şeftali (*Prunus persica* Batsch) ve erik (*Prunus domestica* L.) izlemektedir. Şeftali ve kiraz bahçelerinde baskın tür, *Ta. inconsequens* olarak saptanmıştır. *H. reuteri* armut bahçelerinde en yaygın bulunan türdür. Buna göre, Balıkesir'de çiçeklerde thrips oranı %41.94 iken, meyvelerde %1.83 ve yapraklarda %1.16 olarak bulunmuştur. Bu çalışmada bulunan thripsler farklı bitki türleri, bitki kısımları ve farklı fenolojik dönemler hakkında bilgi eksikliğini giderecek nitelikte olup, daha önceki yıllarda yapılan çalışmalarla bütünleşecek şekilde tamamlanmıştır.

Anahtar kelimeler: kiraz, elma, şeftali, *Taeniothrips inconsequens*, *Haplothrips reuteri*, çiçek

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