

Original article (Original araştırma)

Thrips species associated with medicinal and aromatic plants in Adana (Turkey) with first record of *Bregmatothrips bournieri* Pelikan, 1988 (Thysanoptera: Thripidae)¹

Adana (Türkiye)'da tıbbi ve aromatik bitkilerdeki thrips türleri ile *Bregmatothrips bournieri* Pelikan, 1988 (Thysanoptera: Thripidae)'nin ilk kaydı

Naime Zülal ELEKÇİOĞLU^{2*}

Abstract

Medicinal and aromatic plants are used primarily in the medicine, food and cosmetic industries. Thrips are pests which feed on medicinal and aromatic plants, reducing the yield and commercial value of these crops. This study aimed to determine thrips species on medicinal and aromatic plants, and to contribute new species and hosts in Adana Province (Turkey). Thrips were collected by shaking of vegetative and generative plant parts on medicinal and aromatic plants. Samples were collected from 80 plant species belonging to 33 families in 2017 and 2018. A total of 32 thrips species belonging to four families; Thripidae (20 species), Aeolothripidae (5 species), Melanthripidae (2 species) and Phlaeothripidae (5 species) were identified. The most common and abundant species (with the number of samples and specimens found) were *Frankliniella occidentalis* (Pergande, 1895) (120 and 1379), *Thrips tabaci* Lindeman, 1889 (73 and 507) and *Thrips hawaiiensis* (Morgan, 1913) (42 and 503). Of the predatory thrips, *Aeolothrips collaris* Priesner, 1919 (48 and 144), was the most prevalent one. Most of the thrips species were obtained from plants of Lamiaceae (25 species) and Asteraceae families (15 species). *Bregmatothrips bournieri* Pelikan, 1988 collected on *Cymbopogon citratus* (DC.) Stapf (Poaceae) and *Lavandula angustifolia* Mill. (Lamiaceae) is a newly recorded species for fauna of Turkey.

Keywords: Aromatic plant, *Bregmatothrips bournieri*, *Frankliniella occidentalis*, Lamiaceae, medicinal plant

Öz

Tıbbi ve aromatik bitkiler öncelikle ilaç, gıda ve kozmetik endüstrisinde kullanılmaktadır. Thripsler beslenmeleriyle bu bitkilerin verimini ve ticari değerini düşüren zararlılardır. Bu çalışmada Adana İli'nde (Türkiye) tıbbi ve aromatik bitkilerdeki thrips türlerini belirlemek ve yeni thrips ve konukçu türlerine katkıda bulunmak amaçlanmıştır. Thripsler tıbbi ve aromatik bitkilerin vejetatif ve generatif bitki kısımlarının silkelmesi ile toplanmıştır. Örnekler 33 familyaya bağlı 80 bitki türünden 2017 ve 2018 yıllarında toplanmıştır. Dört familyaya bağlı toplam 32 thrips türü; Thripidae (20 tür), Aeolothripidae (5 tür), Melanthripidae (2 tür) ve Phlaeothripidae (5 tür) belirlenmiştir. En yaygın ve yoğun türler (örnekleme sayısı ve toplanan birey sayısı), *Frankliniella occidentalis* (Pergande, 1895) (120 ve 1379), *Thrips tabaci* Lindeman, 1889 (73 ve 507) ve *Thrips hawaiiensis* (Morgan, 1913) (42 ve 503) olmuştur. Avcı thripslerden *Aeolothrips collaris* Priesner, 1919 (48 ve 144), en yaygın tür olarak saptanmıştır. Thrips türlerinin çoğu Lamiaceae (25 tür) ve Asteraceae (15 tür) familyalarındaki bitkilerden elde edilmiştir. *Cymbopogon citratus* (DC.) Stapf (Poaceae) ve *Lavandula angustifolia* Mill. (Lamiaceae)'dan toplanan *Bregmatothrips bournieri* Pelikan, 1988 Türkiye faunası için yeni kaydedilen bir türdür.

Anahtar sözcükler: Aromatik bitki, *Bregmatothrips bournieri*, *Frankliniella occidentalis*, Lamiaceae, tıbbi bitki

¹ This study is a part of a project supported by Cukurova University (Project No: FBA-2017-8460) Turkey.

² Çukurova University, Vocational School of Karaisalı, 01170, Karaisalı, Adana, Turkey

* Corresponding author (Sorumlu yazar) e-mail: nelekcioglu@cu.edu.tr

Received (Alınış): 17.11.2019

Accepted (Kabul edilmiş): 14.01.2020

Published Online (Çevrimiçi Yayın Tarihi): 13.02.2020

Introduction

Thrips (Thysanoptera) are one of the most important insect groups which damage plants by sucking plant juices and scraping at fruits, flowers and leaves. Some are virus vectors and predators (Marullo & De Grazia, 2017). The order Thysanoptera currently consists of 6271 species in the world (ThripsWiki, 2019) of which about 200 species were recorded from Turkey (Tunç & Hastenpflug-Vesmanis, 2016).

Turkey, situated at the junction between Europe and Asia, is one of the richest countries for flora and fauna due to its diverse climatic and topographical conditions. Despite this richness and characteristic features, knowledge of thrips fauna of Turkey is still limited compared to neighboring countries located in the same zoogeographic region. For example, the thrips fauna of Bulgaria and Iran are known to consist of 155 and 270 species, respectively, despite these countries having lower floristic diversity than Turkey (Karadjova & Krumov, 2015; Mirab-Balou, 2018). Adana Province is located in the south part of Turkey, in the Mediterranean region. The region has a Mediterranean climate and known to have a high endemic floristic diversity. Of the nearly 12,000 plant taxa in Turkey, 1/3 of them are endemic (Arslan et al., 2015) and in Adana, 470 endemic species were recorded (Uygur et al., 2018). Turkey is one of the world's richest countries in terms of medicinal and aromatic plants; 30% of the plant species in the natural flora poses medicinal and aromatic properties (Bayram et al., 2010). These plants have been used as drugs to prevent disease, maintain health and wellness in traditional and modern medicine for many years (Demirci Kayıran & Kırıcı, 2019). Besides medicinal industry, medicinal and aromatic plants are used in the food, beverage, perfume and cosmetic industries (Yücer & Altıntaş, 2012). In order to evaluate sustainable production and market potential as competently in these plants, these products must be of the required quantity and quality. Studies on these plants in Turkey are mostly carried out on the cultivation of them. Pests are one of the major factors limiting the production (Simova-Tosia et al., 1997; Abro et al., 2016). They have adverse effects on the secondary metabolites in the plant parts used as drugs, as well as on the loss of productivity (Milek & Simala, 2010; Taşkın, 2015). Also, they cause direct damage such as shortening between nodes, color change in flower and other plant parts, decrease in number and diameter of flowers, leaf curling and leaf deformation. Thrips are one of the harmful pests feeding on the medicinal and aromatic plants (Popov, 1973; Czepiel, 2003; Pobożniak & Sobolewska, 2011).

This study aimed to determine thrips species on medicinal and aromatic plants in Adana Province, contribute new species and to understand their adaptations to different habitats. Such knowledge is of basic importance to explain the introduction and spread of species, particularly pest species. Also, to provide a detail of host plants, description of the new thrips records in order to support comprehensive and specific studies of thrips in Turkey.

Materials and Methods

Study sites

The studies were conducted in Karaisalı and Sarıçam districts located at Adana province, Turkey. Thrips species associated with medicinal and aromatic plants were collected from the experimental field of Çukurova University, Karaisalı Vocational School (37°15'12.96' N; 35°4'7.28' E) (Karaisalı) with a 1 ha sampling area and Ali Nihat Gökyiğit Botanical Garden (37°3'2.53' N; 35°21'15.49' E) (Sarıçam) with 0.85 ha sampling area. Thrips collections were carried out with non-periodical surveys during 2017 and April-July 2018.

Sampling and laboratory processing of specimens

Thrips were collected by shaking of vegetative (leaves and branches) and generative (flowers) plant parts. Five to ten plants from each medicinal and aromatic plant species (according to plant density) were randomly selected every sampling date. Five branches with/without flowers from each of the plants were tapped together into a white container (37 x 28 x 7 cm) for 15 s. The samples collected by fine brush were

then placed separately in plastic vials containing 60% ethanol (Atakan & Uygur, 2005). 178 medicinal and aromatic plant species from Sarıçam and 30 species from Karaisalı were checked. A total of 2795 thrips adults were collected from both districts during the two years. At the laboratory, specimens were extracted, labeled with information regarding their locations, host plants and date of collections. Specimens were identified by Prof. Dr. Ekrem Atakan (Plant Protection Department, Faculty of Agriculture, University of Çukurova, Adana, Turkey).

Results and Discussion

Thrips species

Totally 32 thrips species belonging to Thripidae (20 species), Aeolothripidae (5 species), Melanthripidae (2 species) and Phlaeothripidae (5 species) families were identified (Table 1). Of these, *Bregmatothrips bournieri* Pelikan, 1988 is a newly recorded species for the Thysanoptera fauna of Turkey.

Collection data are presented on a plant species basis. After each semicolon comes the collection date and after each date comes the number of collected specimens in brackets. Species are given in separate paragraphs by districts and years. Data on taxonomic information, world distribution and hosts are provided only for the new record species. Locality, collection date and host plants for the determined thrips species are given below.

Aeolothripidae

Aeolothrips albicinctus Haliday, 1836

Material examined. Sarıçam, 10.IV.2017 (7), *Glebionis coronaria* (L.) Tzvelev (Asteraceae).

Aeolothrips collaris Priesner, 1919

Material examined. Sarıçam, 05.IV.2017 (1), *Mentha arvensis* L. (Lamiaceae); 10.IV.2017 (1), *Euryops pectinatus* Cass. (Asteraceae); 17.IV.2017 (1), *Dianthus* sp. L. (Caryophyllaceae); 03.V.2017 (1), *Echinacea purpurea* (L.) Moench (Asteraceae); 08.V.2017 (2), *Lavandula stoechas* L. (Lamiaceae); (3), *G. coronaria*; (5), *Nigella sativa* L. (Ranunculaceae); 15.V.2017 (1), *Matricaria chamomilla* L. (Asteraceae); (5), *Perovskia atriplicifolia* Benth. (Lamiaceae); (6), *Achillea asplenifolia* Vent. (Asteraceae); (4), *Dracocephalum moldavica* L. (Lamiaceae); (5), *Melissa officinalis* L. (Lamiaceae); (1), *Thymus serpyllum* L. (Lamiaceae); 17.V.2017 (1), *Trigonella foenum-graecum* L. (Fabaceae); 22.V.2017 (3), *D. moldavica*; (4), *Carthamus tinctorius* L. (Asteraceae); (5), *Dianthus* sp.; (2), *Santolina chamaecyparissus* L. (Asteraceae); 26.V.2017 (2), *Thymbra spicata* L. (Lamiaceae); (1), *Ocimum basilicum* L. (Lamiaceae); 29.V.2017 (1), *P. atriplicifolia*; (3), *Senecio* sp. L. (Asteraceae); (1), *D. moldavica*; 05.VI.2017 (2), *Salvia fruticosa* Mill. (Lamiaceae); (8), *M. officinalis*; (1), *Phytolacca americana* L. (Phytolaccaceae); (1), *S. chamaecyparissus*; (1), *Lavandula angustifolia* Mill.; 12.VI.2017 (1), *Cistus salvifolius* L. (Cistaceae); (7), *Hypericum perforatum* L. (Hypericaceae); (2), *Senna floribunda* (Cav.) H.S. Irwin & Barneby (Fabaceae); 19.VI.2017 (1), *E. purpurea*; (2), *T. serpyllum*; (1), *D. moldavica*; 22.VI.2017 (2), *L. angustifolia*; (5), *Origanum vulgare* L. (Lamiaceae); 03.VII.2017 (1), *Salvia sclarea* L. (Lamiaceae); 06.VII.2017 (1), *H. perforatum*; (1), *Calendula officinalis* L. (Asteraceae); (3), *Cistus creticus* L. (Cistaceae).

Karaisalı, 16.III.2017 (2), *Rosmarinus officinalis* L. (Lamiaceae); 23.VI.2017 (3), *E. pectinatus*; 06.VII.2017 (28), *Mentha spicata* L. (Lamiaceae).

Sarıçam, 03.V.2018 (1), *D. moldavica*; 10.V.2018 (2), *A. asplenifolia*; (2), *L. stoechas*.

Karaisalı, 20.IV.2018 (1), *Pimpinella anisum* L. (Apiaceae); 17.V.2018 (6), *M. spicata*.

***Aeolothrips ericae* Bagnall, 1920**

Material examined. Sarıçam, 10.IV.2017 (2), *Teucrium chamaedrys* L. (Lamiaceae); 01.V.2017 (8), *Nigella damascena* L.; 08.V.2017 (1), *E. pectinatus*; 22.V.2017 (4), *Salvia officinalis*; (1), *D. moldavica*; 12.VI.2017 (2), *Sedum album* L. (Crassulaceae); 21.VI.2017 (1), *Erysimum cheiri* Crantz (Brassicaceae).

Karaisalı, 16.III.2017 (1), *R. officinalis*.

***Aeolothrips gloriosus* Bagnall, 1914**

Material examined. Karaisalı, 11.IV.2017 (1), *S. officinalis*.

***Aeolothrips intermedius* Bagnall, 1934**

Material examined. Sarıçam, 10.IV.2017 (1), *E. pectinatus*; 17.IV.2017 (2), *Dianthus* sp.; 21.IV.2017 (1), *Origanum majorana* L.; 24.IV.2017 (3), *Achillea millefolium* L.; 01.V.2017 (1), *Linum usitatissimum* L. (Linaceae); 08.V.2017 (1), *Ranunculus flammula* L. (Ranunculaceae); 22.V.2017 (1), *Artemisia dracunculus* L. (Asteraceae); 26.V.2017 (1), *O. basilicum*; 29.V.2017 (5), *E. purpurea*; (1), *D. moldavica*.

Karaisalı, 29.VI.2017 (1), *Tagetes erecta* L. (Asteraceae).

Melanthripidae

***Melanthrips fuscus* Sulzer, 1776**

Material examined. Sarıçam, 10.IV.2017 (2), *Brassica rapa* subsp. *nipposinica* (L. H. Bailey) Hanelt (Brassicaceae); 17.V.2017 (1), *T. foenum-graecum*.

***Melanthrips pallidor* Priesner, 1919**

Material examined. Sarıçam, 01.V.2017 (1), *L. usitatissimum*; 08.V.2017 (1), *Peganum harmala* L. (Nitrariaceae); 15.V.2017 (2), *M. chamomilla*; 10.VII.2017 (1), *Datura innoxia* Mill. (Solanaceae); 18.XII.2017 (1), *Hyssopus officinalis* L. (Lamiaceae).

Karaisalı, 08.V.2017 (2), *R. officinalis*; 05.VI.2017 (2), *S. fruticosa*.

Thripidae

***Bregmatothrips bournieri* Pelikan, 1988**

Material examined. Sarıçam, 21.VII.2017 (2♂♂), *Cymbopogon citratus* (DC.) Stapf (Poaceae).

Karaisalı, 03.VII.2017 (1♂), *L. angustifolia*.

The identification keys of the *Bregmatothrips* species in Turkey is recognized as follows (zur Strassen & van Harten, 2007; Elimem et al., 2012; Minaei, 2017):

– Body uniformly brown. Antennae seven segmented, segment I with two dorso-apical setae, III and IV each with forked sense cones. Forewing first vein with two setae on distal half, clavus with three or four veinal and one discal setae. Abdominal sternites with no pore plate.....*B. willcocksii* (Priesner, 1939)

– Body brown to dark brown. Antennae eight segmented, II and III more or less symmetric. Tergites II-VIII with a flange at the hind margin. Pronotum with two pairs of long postero-angular setae, and by the uniformly pale fore wings. Sense cones on antennal segments III and IV are simple not forked
.....*B. dimorphus* (Priesner, 1919)

– Body bicolored (Figures 1a, b). Antennae 8 segmented (Figure 1c), III and IV with simple sense cones *B. bournieri*

Description. Female large-winged (Figure 1a). Body bicolored, head, prothorax and abdominal tergites (II-X) brown (sometimes prothorax and abdominal tergites (II-VI) yellowish brown), antennal segments (I-II brown, III-V yellow, VI-VIII shaded, fore wings pale (Figure 1c). Head longer than wide with three pairs of ocellar setae present and projecting in front of compound eyes (Figure 1d); maxillary palps two-segmented. Antennae eight segmented (Figure 1c), segment I with two dorso-apical setae, III and IV each with simple sense cones. Pronotum trapezoidal with two pairs of well-developed posteroangular setae (Figure 1e). Mesonotum with weakly transverse sculpture, with no campaniform sensilla (Figure 1f). Metanotum reticulate (Figure 1f), median setae close to the anterior margin; campaniform sensilla absent. Prosternal ferna complete medially. Forewing first vein with three setae on distal half, clavus with 3 or 4 veinal and one discal setae. Abdominal tergite I weakly striate, I-VIII with campaniform sensilla close to posterior margin (Figure 1g), IX with two pairs of campaniform sensilla; X with dorsal split incomplete. Sternites without discal setae. Male microptera, similar in color and structure to female but smaller (Figure 1b). Tergite IX posterior without stout thornlike setae (Figure 1h). Abdominal sternites with no pore plate (Figure 1).

Distribution. Iran, Tajikistan and Turkmenistan.

Comments. The genus *Bregmatothrips* (Hood, 1912) is a common genus in tropical and subtropical areas (Mound & Marullo, 1996; Mound, 2011; ThripsWiki, 2019). Most of the species belonging to the genus are from Asia. In the genus, head protruding considerably in front of the eyes. This genus is closely related to *Sorghothrips* by having antennal segment I with paired median dorsoapical setae, and the abdominal tergites with posteromarginal craspeda and the median campaniform sensilla close to the posterior margin (Masumoto & Okajima, 2006). The damage belonging to the genus is characterized by white and silvery marks on the leaves caused by the cell contents being sucked out (Lewis, 1973). The genus, *Bregmatothrips* consists of 11 species worldwide. Of these only *B. willcocksii* and *B. dimorphus* have been recorded in Turkey (Tunç & Hastenpflug-Vesmanis, 2016). *Bregmatothrips bournieri* is newly defined. This species was originally described from Iran and its neighboring country, Turkmenistan from flowers of *Cynodon dactylon* (L.) Pers. (Pelikan, 1988). Some specimens occasionally also were collected on *Sorghum halepense* (L.) Pers. (Poaceae) (Minaei, 2017). In this study pest adults were collected from leaves of *C. citratus* and flowers of *L. angustifolia*. There is limited data about this species in literature. Further studies are needed to understand its distribution and host plants in Turkey.

***Chirothrips aculeatus* Bagnall, 1927**

Material examined. Sarıçam, 22.V.2017 (2), *Thymus vulgaris* L. (Lamiaceae); 10.VII.2017 (1), *C. officinalis*.

***Chirothrips manicatus* Haliday, 1836**

Material examined. Sarıçam, 12.VI.2017 (1), *C. salviifolius*.

***Frankliniella intonsa* (Trybom, 1895)**

Material examined: Sarıçam, 08.V.2017 (2), *N. sativa*; 22.V.2017 (4), *T. vulgaris*; 29.V.2017 (8), *E. purpurea*; (4), *D. moldavica*.

Karaisalı, 16.III.2017 (4), *M. spicata*; (2), *P. anisum*; (8), *Foeniculum vulgare* Mill. (Apiaceae); 04.V.2017 (2), *S. fruticosa*.

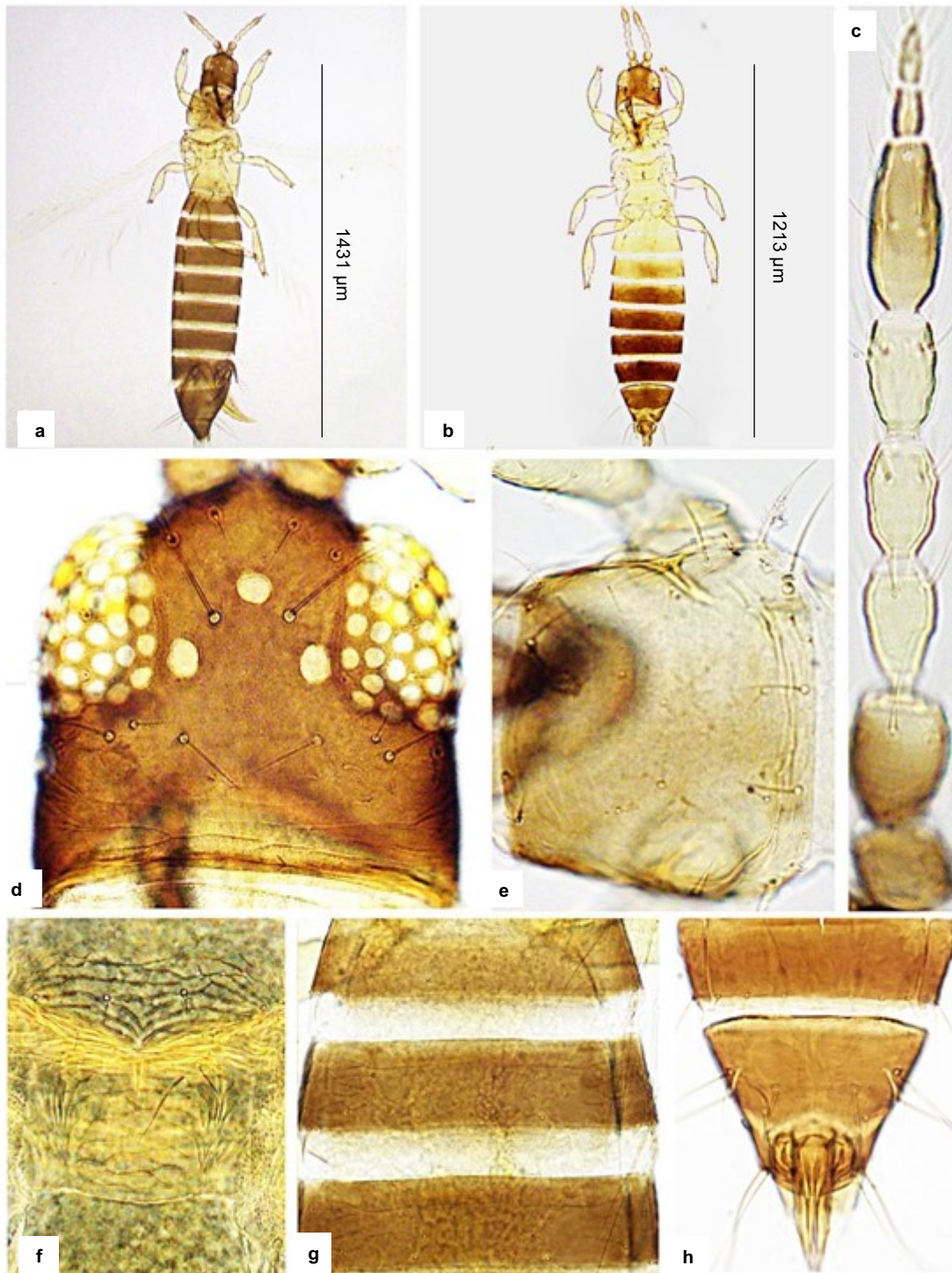


Figure 1. *Bregmatothrips bourneri*: a) female; b) male; c) antenna; d) head; e) pronotum; f) meso and metanotum; g) tergites II-IV; h) tergites VIII-X (male) (from Minaei, 2017).

Frankliniella occidentalis Pergande, 1895

Material examined. Sarıçam, 08.III.2017 (1), *O. basilicum*; 16.III.2017 (1), *N. sativa*; 17.IV.2017 (15), *Dianthus* sp.; 24.IV.2017 (8), *Cynara scolymus* L. (Asteraceae); 01.V.2017 (10), *N. damascena*; 03.V.2017 (7), *E. purpurea*; 08.V.2017 (15), *R. flammula*; (6), *L. stoechas*; (14), *P. harmala*; (12), *Nicotiana tabacum* L. (Solanaceae); (1), *O. vulgare*; (30), *Senecio* sp.; (1), *N. sativa*; 13.V.2017 (2), *L. usitatissimum*; 15.V.2017 (1), *M. chamomilla*; (22), *P. atriplicifolia*; (24), *A. asplenifolia*; (9), *D. moldavica*; 22.V.2017 (1), *T. vulgaris*; (1), *N. sativa*; (25), *C. tinctorius*; (43), *D. moldavica*; (5), *S. officinalis*; (34), *A. dracunculus*; (7), *Tulbaghia violacea* Harv. (Amaryllidaceae); (1), *Helichrysum italicum* (Roth) G. Don (Asteraceae); (10), *Alcea rosea* L. (Malvaceae); (17), *Dianthus* sp.; (31), *S. chamaecyparissus*; 26.V.2017 (2), *O. basilicum*; (3), *Passiflora edulis* Sims. (Passifloraceae); (7), *Myrtus communis* L. (Myrtaceae); 29.V.2017 (12), *Pelargonium crispum* (P. J. Bergius) L'Hér. (Geraniaceae); (5), *Ricinus communis* L. (Euphorbiaceae); (36), *A. millefolium*; (31), *E. purpurea*; (64), *P. atriplicifolia*; (13), *Ecballium elaterium*. A. Rich. (Cucurbitaceae); (4), *P. harmala*; (12), *Momordica charantia* L. (Cucurbitaceae); (7), *L. stoechas*; (20), *T. erecta*; (26), *D. moldavica*; (16), *Senecio* sp.; 05.VI.2017 (1), *C. tinctorius*; (27), *M. officinalis*; (4), *T. serpyllum*; (11), *T. erecta*; (6), *P. americana*; (6), *S. fruticosa*; (11), *Silybum marianum* (L.) Gaertn. (Asteraceae); (3), *S. chamaecyparissus*; (18), *L. angustifolia*; 10.VI.2017 (2), *A. rosea*; 12.VI.2017 (20), *N. damascena*; (14), *H. perforatum*; (38), *Hemerocallis* sp. L. (Asphodelaceae); (18), *S. floribunda*; (5), *T. violacea*; (13), *S. album*; 17.VI.2017 (2), *S. chamaecyparissus*; 19.VI.2017 (11), *M. officinalis*; (43), *P. atriplicifolia*; (15), *E. purpurea*; (5), *Salvia transsylvanica* Schur (Lamiaceae); (1), *T. serpyllum*; (11), *D. moldavica*; 21.VI.2017 (39), *S. marianum*; (4), *Capparis spinosa* L. (Capparaceae); 22.VI.2017 (12), *O. vulgare*; 03.VII.2017 (3), *Leonurus cardiaca* L. (Lamiaceae); (1), *L. angustifolia*; 06.VII.2017 (12), *H. perforatum*; (17), *S. album*; (1), *C. creticus*; (3), *M. officinalis*; (15), *Eschscholzia californica* Cham. (Papaveraceae); (1), *P. crispum*; (32), *Oenothera biennis* L. (Onagraceae); 10.VII.2017 (3), *T. violacea*; (2), *C. officinalis*; (3), *Koelreuteria paniculata* Laxm. (Sapindaceae); (1), *Hemerocallis* sp.; (3), *R. flammula*; (6), *S. transsylvanica*; (5), *D. innoxia*; 17.VII.2017 (9), *S. officinalis*; (1), *D. moldavica*; 21.VII.2017 (1), *C. citratus*; 24.VII.2017 (3), *H. perforatum*; 10.VIII.2017 (4), *O. biennis*.

Karaisalı, 22.II.2017 (1), *Coriandrum sativum* L. (Apiaceae); 28.II.2017 (1), *C. sativum*; 16.III.2017 (1), *M. spicata*; (2), *F. vulgare*; 18.IV.2017 (1), *Origanum onites* L.; 02.V.2017 (5), *C. spinosa*; 04.V.2017 (12), *S. fruticosa*; 14.VI.2017 (56), *C. spinosa*; 22.VI.2017 (12), *M. arvensis*; (21), *M. spicata*; 23.VI.2017 (32), *E. pectinatus*; 29.VI.2017 (13), *T. erecta*; 06.VII.2017 (37), *M. spicata*; 12.VII.2017 (2), *P. anisum*.

Sarıçam, 28.III.2018 (3), *N. sativa*; 19.IV.2018 (1), *M. chamomilla*; 18.V.2018 (9), *A. asplenifolia*; 25.V.2018 (7), *A. millefolium*; (3), *A. dracunculus*; 17.VIII.2018 (1), *H. officinalis*.

Karaisalı, 19.IV.2018 (5), *S. officinalis*; 20.IV.2018 (7), *S. fruticosa*; 04.V.2018 (3), *F. vulgare*; 17.V.2018 (12), *C. spinosa*; 18.V.2018 (5), *C. tinctorius*; 22.V.2018 (3), *M. charantia*; 08.VI.2018 (2), *C. officinalis*; 04.VII.2018 (4), *M. spicata*; 06.VII.2018 (39), *C. officinalis*.

Kakothrips pisivorus (Westwood, 1880)

Material examined. Karaisalı, 04.V.2017 (1), *S. fruticosa*.

Limothrips cerealium Haliday, 1836

Material examined. Karaisalı, 30.V.2017 (2), *O. vulgare*.

Limothrips denticornis (Haliday, 1836)

Material examined. Sarıçam, 29.V.2017 (1), *P. crispum*.

Karaisalı, 30.V.2017 (5), *O. vulgare*.

Scolothrips longicornis Priesner, 1926

Material examined. Sarıçam, 17.IV.2017 (1), *Pelargonium graveolens*; 24.IV.2017 (1), *O. onites*.

***Taeniothrips inconsequens* (Uzel, 1895)**

Material examined. Karaisalı, 11.IV.2017 (3), *S. officinalis*.

***Tenothrips discolor* (Karny, 1907)**

Material examined. Sarıçam, 17.VII.2017 (1), *M. spicata*.

***Thrips atratus* Haliday, 1836**

Material examined. Karaisalı, 05.VI.2017 (2), *S. fruticosa*.

***Thrips australis* (Bagnall, 1915)**

Material examined. Sarıçam, 02.VII.2017 (1), *Origanum vogelii* Greuter & Burdet (Lamiaceae).

***Thrips hawaiiensis* (Morgan, 1913)**

Material examined. Sarıçam, 10.IV.2017 (1), *E. pectinatus*; 24.IV.2017 (6), *C. scolymus*; 03.V.2017 (1), *E. purpurea*; 08.V.2017 (2), *N. tabacum*; (1), *R. flammula*; (1), *N. sativa*; 15.V.2017 (60), *P. anisum*; 22.V.2017 (6), *A. dracuncululus*; (1), *S. chamaecyparissus*; (1), *A. rosea*; (5), *D. moldavica*; 26.V.2017 (36), *M. communis*; (40), *P. edulis*; (2), *T. spicata*; (53), *R. communis*; 29.V.2017 (1), *E. elaterium*; (2), *A. millefolium*; (4), *P. harmala*; (29), *N. tabacum*; 05.VI.2017 (5), *M. officinalis*; (29), *P. americana*; (1), *S. chamaecyparissus*; (6), *T. erecta*; (1), *C. tinctorius*; 12.VI.2017 (8), *S. floribunda*; (20), *H. perforatum*; (1), *N. damascena*; 19.VI.2017 (6), *O. vulgare*; (38), *S. transsylvanica*; 21.VI.2017 (27), *C. spinosa*; 06.VII.2017 (7), *Plumeria alba* L. (Apocynaceae); 10.VII.2017 (1), *S. transsylvanica*; 10.VIII.2017 (12), *O. biennis*; 25.XII.2017 (62), *P. alba*.

Karaisalı, 02.V.2017 (1), *C. spinosa*; 08.V.2017 (13), *R. officinalis*; 14.VI.2017 (4), *C. spinosa*; 06.VII.2017 (1), *C. officinalis*.

Sarıçam, 18.V.2018 (2), *D. moldavica*; 01.VI.2018 (2), *T. erecta*; 08.VI.2018 (2), *M. officinalis*.

Karaisalı, 07.V.2018 (3), *O. basilicum*.

***Thrips major* Uzel, 1895**

Material examined. Sarıçam, 21.IV.2017 (2), *O. majorana*; 10.VII.2017 (1), *Portulaca oleracea* L. (Portulacaceae); 17.VIII.2017 (1), *H. officinalis*.

Karaisalı, 16.III.2017 (1), *R. officinalis*.

***Thrips meridionalis* (Priesner, 1926)**

Material examined. Karaisalı, 28.II.2017 (5), *R. officinalis*.

***Thrips minutissimus* Linnaeus, 1758**

Material examined. Karaisalı, 16.III.2017 (3), *R. officinalis*.

***Thrips physapus* Linnaeus, 1758**

Material examined. Sarıçam, 05.VI.2017 (4), *S. marianum*.

***Thrips tabaci* Lindeman, 1889**

Material examined. Sarıçam, 08.III.2017 (1), *O. basilicum*; 05.IV.2017 (1), *M. arvensis*; 10.IV.2017 (8), *E. pectinatus*; (16), *T. chamaedrys*; (3), *B. rapa* subsp. *nipposinica*; (7), *G. coronaria*; 17.IV.2017 (12), *Dianthus* sp.; (5), *P. graveolens*; (10), *A. asplenifolia*; 24.IV.2017 (6), *A. millefolium*; 01.V.2017 (19), *L. usitatissimum*; (4), *N. damascena*; 08.V.2017 (6), *O. vulgare*; (1), *G. coronaria*; 13.V.2017 (2), *L.*

usitatissimum; 15.V.2017 (10), *M. chamomilla*; 17.V.2017 (10), *T. foenum-graecum*; 22.V.2017 (2), *S. officinalis*; (6), *A. rosea*; (23), *T. violacea*; (2), *S. chamaecyparissus*; (2), *H. italicum*; 26.V.2017 (2), *O. basilicum*; 29.V.2017 (2), *Cardiospermum halicacabum* L. (Sapindaceae); (1), *N. sativa*; (18), *M. charantia*; (2), *E. elaterium*; 05.VI.2017 (6), *L. angustifolia*; (2), *T. erecta*; (4), *C. tinctorius*; (2), *M. officinalis*; (16), *S. chamaecyparissus*; 10.VI.2017 (2), *Althaea officinalis* L. (Malvaceae); 12.VI.2017 (6), *S. album*; (14), *T. violacea*; 17.VI.2017 (19), *S. chamaecyparissus*; 21.VI.2017 (8), *E. cheiri*; (3), *S. marianum*; 03.VII.2017 (1), *L. cardiaca*; 06.VII.2017 (9), *C. creticus*; (1), *E. californica*; 10.VII.2017 (3), *C. officinalis*; (2), *D. innoxia*; (17), *T. violacea*; (16), *P. anisum*; (1), *R. flammula*; 17.VII.2017 (2), *D. moldavica*; (1), *Mentha piperita* L. (Lamiaceae); 02.VIII.2017 (2), *P. anisum*; 10.VIII.2017 (1), *O. biennis*.

Karaisali, 02.II.2017 (7), *F. vulgare*; 22.II.2017 (17), *P. anisum*; (25), *C. sativum*; 28.II.2017 (24), *R. officinalis*; 16.III.2017 (8), *R. officinalis*; (10), *P. anisum*; 18.IV.2017 (2), *O. onites*; 02.V.2017 (3), *C. spinosa*; 30.V.2017 (4), *O. vulgare*; 22.VI.2017 (8), *C. tinctorius*; 12.VII.2017 (36), *P. anisum*.

Sarıçam, 20.IV.2018 (3), *T. erecta*; 10.V.2018 (3), *M. officinalis*; (4), *C. sativum*; 01.VI.2018 (2), *L. usitatissimum*; 08.VI.2018 (8), *S. chamaecyparissus*; 22.VI.2018 (6), *T. violacea*.

Karaisali, 01.III.2018 (2), *N. sativa*; 13.IV.2018 (5), *R. officinalis*; 19.IV.2018 (2), *C. officinalis*; 20.IV.2018 (7), *P. anisum*; 27.IV.2018 (2), *F. vulgare*.

***Thrips vulgatissimus* Haliday, 1836**

Material examined. Sarıçam, 21.VI.2017 (3), *S. marianum*.

Phlaeothripidae

***Haplothrips aculeatus* (Fabricius, 1803)**

Material examined. Sarıçam, 29.V.2017 (2), *Senecio* sp.; 06.VII.2017 (1), *C. creticus*.

Karaisali, 29.VI.2017 (1), *T. erecta*.

***Haplothrips distinguendus* Uzel, 1895**

Material examined. Sarıçam, 05.VI.2017 (1), *C. tinctorius*; 22.VI.2017 (1), *O. vulgare*.

***Haplothrips flavicinctus* (Karny, 1910)**

Material examined. Sarıçam, 05.IV.2017 (1), *M. arvensis*; 26.V.2017 (1), *P. edulis*; 19.VI.2017 (1), *D. moldavica*; 17.VII.2017 (3), *M. piperita*.

Karaisali, 30.V.2017 (3), *O. vulgare*.

***Haplothrips gowdeyi* (Franklin, 1908)**

Material examined. Sarıçam, 08.V.2017 (1), *N. tabacum*; 05.VI.2017 (15), *M. officinalis*; (14), *P. anisum*; (2), *P. americana*; 19.VI.2017 (3), *M. officinalis*; (1), *S. transsylvanica*; 10.VII.2017 (2), *K. paniculata*; 21.VII.2017 (1), *P. oleracea*.

***Haplothrips reuteri* (Karny, 1907)**

Material examined. Sarıçam, 10.IV.2017 (1), *G. coronaria*; (1), *T. chamaedrys*; 15.V.2017 (1), *A. asplenifolia*; 22.V.2017 (4), *C. tinctorius*; 26.V.2017 (5), *T. spicata*; 29.V.2017 (1), *E. purpurea*; 05.VI.2017 (1), *T. serpyllum*; (1), *M. officinalis*; (7), *S. marianum*; (1), *C. tinctorius*; 21.VI.2017 (24), *S. marianum*; 06.VII.2017 (1), *E. californica*.

Karaisali, 11.IV.2017 (1), *S. officinalis*; 17.IV.2017 (1), *Dianthus* sp.; 04.V.2017 (9), *S. fruticosa*; 26.V.2017 (6), *Chamaedrys polium* (L.) Raf. (Lamiaceae); 30.V.2017 (1), *O. vulgare*; 05.VI.2017 (2), *S. fruticosa*; 23.VI.2017 (1), *E. pectinatus*; 06.VII.2017 (1), *C. officinalis*.

The most common and abundant species (with the number of samples-specimens found) were *F. occidentalis* (120 and 1379), *T. tabaci* (73 and 507) and *T. hawaiiensis* (42 and 503). Of the predatory species, *A. collaris* (48 and 144), was the most common and abundant one (Table 1).

Table 1. Frequency and abundance of thrips species found in Adana Province of Turkey in 2017 and 2018

Thysanoptera species	f ¹	a ²	a (%)
Aelothripidae			
<i>Aelothrips albicinctus</i>	1	7	0.25
<i>Aelothrips collaris</i> *	48	144	5.15
<i>Aelothrips ericae</i>	8	20	0.71
<i>Aelothrips gloriosus</i>	1	1	0.04
<i>Aelothrips intermedius</i> *	11	18	0.64
Melanthripidae			
<i>Melanthrips fuscus</i> **	2	3	0.11
<i>Melanthrips pallidior</i> **	7	10	0.36
Thripidae			
<i>Bregmatothrips bournieri</i>	2	3	0.11
<i>Chirothrips aculeatus</i>	2	3	0.11
<i>Chirothrips manicatus</i>	1	1	0.04
<i>Frankliniella intonsa</i>	8	34	1.21
<i>Frankliniella occidentalis</i>	120	1379	49.34
<i>Kakothrips pisivorus</i>	1	1	0.04
<i>Limothrips cerealium</i>	1	2	0.07
<i>Limothrips denticornis</i>	2	6	0.21
<i>Scolothrips longicornis</i> *	2	2	0.07
<i>Taeniothrips inconsequens</i>	1	3	0.11
<i>Tenothrips discolor</i>	1	1	0.04
<i>Thrips atratus</i>	1	2	0.07
<i>Thrips australis</i>	1	1	0.04
<i>Thrips hawaiiensis</i>	42	503	18.00
<i>Thrips major</i>	4	5	0.18
<i>Thrips meridionalis</i>	1	5	0.18
<i>Thrips minutissimus</i>	1	3	0.11
<i>Thrips physapus</i>	1	4	0.14
<i>Thrips tabaci</i>	73	507	18.14
<i>Thrips vulgatissimus</i>	1	3	0.11
Phlaeothripidae			
<i>Haplothrips aculeatus</i>	3	4	0.14
<i>Haplothrips distinguendus</i>	2	2	0.07
<i>Haplothrips flavicinctus</i>	5	9	0.32
<i>Haplothrips gowdeyi</i>	8	39	1.39
<i>Haplothrips reuteri</i>	20	70	2.50
TOTAL		2795	100.00

¹ Frequency - number of samples in which the species was found;

² abundance - total number of individuals of the species collected; a (%): percentage of total individuals;

* predatory thrips species;

** pollen feeder species.

As shown in Table 1, nearly half of the total specimens (49%) were *F. occidentalis* individuals. *Frankliniella occidentalis* was collected from 61 medicinal and aromatic plants and the highest number was collected on *P. atriplicifolia* (129 individuals), *D. moldavica* (90 individuals) and *C. spinosa* (77 individuals). The second abundant species, *T. tabaci* (18%) was collected from 47 medicinal and aromatic plant species, which was frequently found on *P. anisum* (88 individuals), *T. violacea* (60 individuals) and *S. chamaecyparissus* (45 individuals). *Thrips hawaiiensis* was collected from 33 species of medicinal and aromatic plants and was 18% of the specimens. It was mostly collected from *P. alba* (69 individuals), *P. anisum* (60 individuals) and *R. communis* (53 individuals). *Aeolothrips collaris* was collected from 32 medicinal and aromatic plant species, visiting them to feed upon various arthropods. The highest number of specimens was collected on *M. spicata* (34 individuals) feeding on *F. occidentalis*.

The total numbers of four common thrips species on some medicinal and aromatic plants in Adana Province is shown in Table 2. A few thrips specimens were collected from Turkish oregano (*O. onites*) which is one of the most cultured and exported medicinal and aromatic plants in Turkey. Another one anise, (*P. anisum*) was mostly infected by *T. tabaci* followed by *T. hawaiiensis*. Rosemary (*R. officinalis*), which is mostly obtained from nature was infected mostly by *T. tabaci* and *F. occidentalis*. English lavender, *L. angustifolia*, which the Ministry of Agriculture encouraged farmers to produce, is mostly infected by *F. occidentalis*. *Plumeria alba* was only infected with *T. hawaiiensis*. Thrips damage on the leaves of *S. officinalis*, *S. fruticosa*, *O. basilicum*, *M. officinalis*, *M. spicata*, *P. anisum*, *L. usitatissimum* and *N. tabacum* were remarkable. Tiny pale spots or bronze scars were observed on the leaves. It is thought that essential oil as well as the photosynthetic capacity of the infected leaves were reduced. It is possible that thrips preferred the other plants for nectars and pollens more than for reproduction.

Frankliniella and *Thrips* species are the most harmful genera and present on all continents (Moritz, 2002; Mound, 2012; Pizzol et al., 2014). Western flower thrips, *F. occidentalis* is distributed worldwide and characterized as invasive, polyphagous and occurring on at least 250 plant species from more than 65 families, nearly every species of flowering plants (fruit, vegetable, ornamental, field crops and many weed species). Of the medicinal and aromatic plants *F. occidentalis* was collected on *Capsicum annuum* L. (Solanaceae), *Rosa* spp. (Rosaceae), *Salvia* spp., *O. majorana*, *M. piperita*, *Pelargonium* spp., *N. tabacum*, *C. tinctorius* (Anonymous, 2019). This species is mainly found in flowers but may occur elsewhere on plants. Blumth et al. (2005) determined that *F. occidentalis* is more common on yellow flowering and nectar-rich plants. Adults of the pest live and feed on flowers and they choose new leaves as food when flowers are absent. They also reproduce more when pollen is present (Hulshof et al., 2003). *Frankliniella occidentalis* became the most dominant and prevalent species within three years after its first introduction in Adana region in 1994 (Atakan et al., 1998). As Tunç & Hastenpflug-Vesmanis (2016) reported, *F. occidentalis* seems to have become the predominant thrips species on many crops and wild plants in Turkey. It is thought that one of the reasons of this population growth is the increasing resistance of the pest to the pesticides used for control (Dağlı, 2018). Onion thrips, *T. tabaci* is known to feed on many vegetable species and field crops as well as on a wide variety of weeds (Doederleini & Sites, 1993). It is a potential pest of cotton and some vegetables (onion, garlic and leek) in Turkey. It is also the vector of TSWV (Tomato spotted wilt virus) (Boonham et al., 2002). Hawaiian flower thrips, *T. hawaiiensis* is a polyphagous, flower-dwelling thrips which was introduced into Turkey in 2015 (Atakan et al., 2015). It was detected on lemon first but recorded also on some vegetables, ornamentals and field crop plants. This indicates that the invasive capacity and its population will increase in the upcoming years. Elekcioğlu (2018) determined 13 thrips species from 35 medicinal and aromatic plants during 2015-2016 at the same localities. *Frankliniella occidentalis*, *T. tabaci* and *T. hawaiiensis* were the prevalent species which the results are in conformity with data collected in this study. Atakan & Pehlivan (2018) determined 11 Thysanoptera species on 9 medicinal and aromatic plant species grown naturally in Balcalı Campus of

Çukurova University. *Thrips tabaci*, *T. major* and *F. occidentalis* were the most prevalent pest thrips species. They found only *A. collaris* as the predator thrips species and at very low numbers.

Table 2. Some plants associated with four common thrips species in Adana Province of Turkey during 2017-2018

Plant species	Lifespan	Individual numbers of thrips**				Total
		A, P*	Fo	Tt	Th	
Lamiaceae						
<i>Perovskia atriplicifolia</i> (Russian sage)	P	129	0	0	6	135
<i>Dracocephalum moldavica</i> (Moldavian balm)	P	90	2	7	10	109
<i>Mentha spicata</i> (Spearmint)	P	63	0	0	34	97
<i>Melissa officinalis</i> (Lemon balm)	P	41	5	7	13	66
<i>Lavandula angustifolia</i> (English lavender)	P	19	6	0	3	28
<i>Salvia officinalis</i> (Common sage)	P	19	2	0	0	21
<i>Salvia fruticose</i> (Anatolian sage)	P	25	0	0	2	27
<i>Salvia transsylvanica</i> (Transylvania sage)	P	11	0	39	0	50
<i>Ocimum basilicum</i> (Basil)	A	3	3	3	1	10
<i>Origanum onites</i> (Turkish oregano)	P	1	2	0	0	3
<i>Rosmarinus officinalis</i> (Rosemary)	P	0	37	13	2	52
Asteraceae						
<i>Echinacea purpurea</i> (Purple coneflower)	P	53	0	1	2	56
<i>Silybum marianum</i> (Milk thistle)	A	50	3	0	0	53
<i>Senecio</i> sp. (Ragwort)	P	46	0	0	3	49
<i>Achillea millefolium</i> (Common yarrow)	P	43	6	2	0	51
<i>Santolina chamaecyparissus</i> (Cotton lavender)	P	36	45	2	3	86
<i>Tagetes erecta</i> (French marigold)	A	24	5	8	0	37
Cappariaceae						
<i>Capparis spinosa</i> (Caper)	P	77	3	32	0	112
Cucurbitaceae						
<i>Calendula officinalis</i> (Pot marigold)	A	43	5	1	1	50
Apiaceae						
<i>Pimpinella anisum</i> (Anise)	A	2	88	60	2	152
<i>Foeniculum vulgare</i> (Fennel)	P	5	9	0	0	14
Passifloraceae						
<i>Passiflora edulis</i> (Purple passionflower)	P	3	0	40	0	43
Apocynaceae						
<i>Plumeria alba</i> (White frangipani)	P	0	0	69	0	69
Amaryllidaceae						
<i>Tulbaghia violacea</i> (Society garlic)	P	15	60	0	0	75
Euphorbiaceae						
<i>Ricinus communis</i> (Castor bean)	P	5	0	53	0	58
Linaceae						
<i>Linum usitatissimum</i> (Flax)	A	2	23	0	0	25
Solanaceae						
<i>Nicotiana tabacum</i> (Tobacco)	A	12	0	31	0	43
Ranunculaceae						
<i>Nigella sativa</i> (Black cumin)	A	6	3	1	5	15
Total		823	307	369	87	1586

* A, Annual; P, Perennial;

** Fo, *Frankliniella occidentalis*; Tt, *Thrips tabaci*; Th, *Thrips hawaiiensis*; Ac, *Aeolothrips collaris*.

In the present study thrips individuals were collected from 80 medicinal and aromatic plant species belonging to 33 families; which 25 of them from Lamiaceae, 15 species from Asteraceae, three species from Ranunculaceae and Apiaceae families each, two species from Solanaceae, Malvaceae, Fabaceae, Geraniaceae, Cucurbitaceae and one each from the other families. Many species found in the present study are known as pests of various crops in different parts of the world. The number of thrips species and total number of specimens collected from medicinal and aromatic plants from the Lamiaceae and Asteraceae families were higher, respectively. The same plant families were reported in a previous study dealing with host plant associations of Thysanoptera (Atakan, 2019). High host-specificities were recorded for *F. occidentalis* and *T. tabaci* more restricted on Asteraceae and Lamiaceae in that study. The author determined that the thrips fauna was dominated by *F. occidentalis*, contributing 81% of the specimens. According to Inoue & Sakurai (2007) some taxonomic groups are known to be preferred by thrips such as Asteraceae, Fabaceae, Rosaceae and Solanaceae in France. In a study in Croatia, thrips species from Aeolothripidae family were mostly found on plants from families Fabaceae, Asteraceae and Brassicaceae. Specimens from Thripidae family were the most abundant on Asteraceae and Fabaceae and family Phlaeothripidae was present, mainly on Poaceae, Asteraceae, and Fabaceae (Raspudić et al., 2009). The essential oils from species within the Lamiaceae family and their volatile constituents have been found to have a broad spectrum of biological activities against *F. occidentalis* and *T. tabaci* (Koschier et al., 2000; De Kogel & Koschier, 2002).

Secondary metabolites are known to work as important feeding stimulants in the selection of host plants by phytophagous insects (Jolivet, 1992). Plants secrete essential oils or protective chemical oils when they are attacked by pests (Rhoades, 1985). The nectar and pollens of flowers and their chemical contents and chemicals secreted by vegetative parts are attractive to pest species in turn of the natural enemies (Riudavets, 1995; Atakan & Pehlivan, 2018). It is thought that this is why flower-inhabiting thrips species are abundant between May and July. In this study, numbers of thrips peaked in May when numbers of flowering plant species were highest. From May, the total number of individuals decreases regularly until July and lowered when most of the annual medicinal and aromatic plant species started to senesce or harvest. However secondary plant metabolites of medicinal and aromatic plants have a wide spectrum of action on arthropod pests, including direct toxicity toward different stages of development, antifeedant, repellent, deterrent and attractive effects, and inhibition of development and oviposition (Chermenskaya et al., 2009; Costa et al., 2013; Zoubiri & Baaliouamer, 2014; Stepanycheva et al., 2018).

Data on thrips host plants in literature is generally lacking (Marullo, 2009). Determination of the host plant of a thrips can be difficult, with many host records being no more than transitory resting places of adults of these highly dispersive insects and a specific host association cannot be assumed just because large numbers of adult thrips are found on a plant (Mound, 2013). A particular plant may be used as a mating or feeding site, but not used for breeding, or a species may breed on various different plants under laboratory conditions, but be host-specific under field conditions (Garms et al., 2013). Comparison of data and that of previous studies revealed that most of the plant species in the present study are reported for the first time as the hosts or the plant associations of the thrips species in Turkey. Further studies are needed to understand the host plant diversity of the thrips species recorded in this study.

The present study shows that the regional faunal studies of thrips are important for reporting new records and to better understand their relationship with host plants. Medical and aromatic plants are becoming increasingly important in Turkey because of their potential to be used in alternative cropping systems, as raw material supply to the food industry and for use in complementary environment in alternative wards, therefore their production has become more widespread in recent years. Thrips are one of the important agents affecting yield and quality in cultivated medical and aromatic plants. Data obtained from this study show that local faunal studies should be conducted in different habitats and host plants to increase the knowledge of thrips species of Turkey. The large number of thrips and their host plants should be a useful guide to other researchers studying detailed taxonomic and faunal studies of thrips in different parts of Turkey.

Acknowledgments

The author thanks Prof. Dr. Ekrem Atakan (University of Çukurova, Faculty of Agriculture, Department of Plant Protection, Adana, Turkey) for identifying the thrips species.

References

- Abro, G. H., T. S. Syed, M. S. Khanzada, S. R. Khanzada, M. Salman, S. Anwar, M. Sarwar, S. H. Dayo, A. S. Perzada, S. Wang & A. H. Abro, 2016. Arthropods associated with some medicinal plants under field conditions in Sindh province of Pakistan. *Journal of Entomology and Zoology Studies*, 4 (1): 516-520.
- Anonymous, 2019. *Frankliniella occidentalis* (Western flower thrips). CABI, Invasive Species Compendium. (Web page: www.cabi.org) (Date accessed: October 2019).
- Arslan, N., H. Baydar, S. Kızıl, Ü. Karık, N. Şekeroğlu & A. Gümüşçü, 2015. "Tıbbi aromatik bitkiler üretiminde değişimler ve yeni arayışlar, 483-507". TMMOB Ziraat Mühendisleri Odası. Türkiye Ziraat Mühendisliği VIII. Teknik Kongresi Bildirileri Kitabı-1 (12-16 Ocak 2015, Çankaya Belediyesi Çağdaş Sanatlar Merkezi, Ankara, Türkiye), 709 s.
- Atakan, E., 2019. Predatory hemipteran bugs detected with thrips on ornamental plants in the Çukurova region of Turkey. *Turkish Journal of Biological Control*, 10 (1): 29-39.
- Atakan, E., A. F. Özgür & U. Kersting, 1998. "*Frankliniella occidentalis* (Pergande) (Thysanoptera, Thripidae) on cotton in Çukurova Region, 7-12". Proceedings of Sixth International Symposium on Thysanoptera (27 April-1 May 1998, Antalya, Turkey), 181 pp.
- Atakan, E., M. Ölçülü, S. Pehlivan & S. Satar, 2015. A new thrips species recorded in Turkey: *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae). *Turkish Bulletin of Entomology*, 5 (2): 77-84.
- Atakan, E. & S. Pehlivan, 2018. Predatory insect species associated with thrips (Thysanoptera) species on some medicinal and aromatic plants. *Derim*, 35 (1): 37-44.
- Atakan, E. & S. Uygur, 2005. Winter and spring abundance of *Frankliniella* spp. and *Thrips tabaci* Lindeman (Thysanoptera, Thripidae) on weed host plants in Turkey. *Journal of Applied Entomology*, 12: 17-26.
- Bayram, E., S. Kırıcı, S. Tansı, G. Yılmaz, O. Arabacı, S. Kızıl & İ. Telci, 2010. "Tıbbi ve aromatik bitkiler üretiminin artırılması olanakları, 437-457". Ziraat Mühendisliği VII. Teknik Kongresi, Bildirileri Kitabı-1 (11-15 Ocak 2010, Ankara, Türkiye), 577 s.
- Blumthart, M. R., A. R. Cloyd, L. Art Spomer & D. F. Warnock, 2005. Flower color preferences of Western flower thrips. *Horttechnology*, 15 (4): 846-853.
- Boonham, N., P. Smith, K. Walsh, J. Tamea, J. Morrisa, N. Spencer, J. Bennison & I. Barkera, 2002. The detection of Tomato spotted wilt virus (TSWV) in individual thrips using real time fluorescent RT-PCR (TaqMan). *Journal of Virological Methods*, 101: 37-48.
- Chermenskaya, T. D., M. O. Petrova & E. I. Savelieva, 2009. Laboratory and field evaluation of biological active substances of plant origin against greenhouse whitefly, *Trialeurodes vaporariorum* Westw. (Homoptera: Aleyrodidae). *Archives of Phytopathology and Plant Protection*, 42 (9): 864-873.
- Costa, A. V., P. F. Pinheiro, V. M. Rondelli, V. T de Queiroz, A. C. Tuler, K. B. Brito, P. Stinguel & D. Pratisoli, 2013. *Cymbopogon citratus* (Poaceae) essential oil on *Frankliniella schultzei* (Thysanoptera: Thripidae) and *Myzus persicae* (Homoptera: Aphididae). *Bioscience Journal*, 29 (6): 1840-1847.
- Czepiel, K., 2003. Thrips (Thysanoptera, Insecta) collected on *Thymus vulgaris* and *Melissa officinalis* in Fajslawice (The Lublin Region). *Acta Agrophysica*, 1 (1): 39-45.
- Dağlı, F., 2018. Spinosad resistance in a population of *Frankliniella occidentalis* (Pergande, 1895) from Antalya and its cross resistance to acrinathrin and formetanate. *Turkish Journal of Entomology*, 42 (4): 241-251.
- De Kogel, W. J. & E. H. Koschier, 2002. "Thrips responses to plant odours. Thrips and Tospoviruses, 189-190". Proceedings of the 7th International Symposium on Thysanoptera (2-7 July 2001, Reggio Calabria, Italy), Australian National Insect Collection Press, 390 pp.
- Demirci Kayıran, S. & S. Kırıcı, 2019. Herbal drugs for therapeutic purposes, which sold in herbalists in Adana, Turkey. *KSU Journal of Agriculture and Nature*, 22 (2): 183-192.

- Doederleini, T. A. & R. W. Sites, 1993. Host plant preferences of *Frankliniella occidentalis* and *Thrips tabaci* (Thysanoptera: Thripidae) for onions and associated weeds on the Southern high plains. *Journal of Economic Entomology*, 86 (6): 1706-1713.
- Elekcioglu, N. Z., 2018. Thrips species and their predators associated with medicinal and aromatic plants in Adana (Turkey) with a new record. *Fresenius Environmental Bulletin*, 27 (6): 4029-4036.
- Elimem, M., N. Navarro Campos & B. Chermiti, 2012. First record of *Bregmatothrips dimorphus* (Priesner, 1919) (Thysanoptera: Thripidae) in Tunisia. *Bulletin OEPP/EPPO Bulletin*, 42 (1): 158-160.
- Garms, B. J., L. A. Mound & N. A. Schellhorn, 2013. Polyphagy in the Australian population of South African citrus thrips (*Scirtothrip saurantii* Faure). *Australian Journal of Entomology*, 52: 282-289.
- Hulshof, J., E. Ketoja & L. Vanninen, 2003. Life history characteristics of *Frankliniella occidentalis* on cucumber leaves with and without supplemental food. *Entomologia Experimentalis et Applicata*, 108: 19-32.
- Inoue, T. & T. Sakurai, 2007. The phylogeny of thrips (Thysanoptera: Thripidae) based on partial sequences of cytochrome oxidase I, 28S ribosomal DNA and elongation factor-1 and the association with vector competence of topoviruses. *Applied Entomology and Zoology*, 42: 71-81.
- Jolivet, P., 1992. Insects and Plants Parallel Evolution and Adaptations. *Flora and Fauna Handbook No. 2*. Sandhill Crane Press, Inc. Gainesville, Florida, USA, 190 pp.
- Karadjova, O. & V. Krumov, 2015. Thysanoptera of Bulgaria. *ZooKeys*, 504: 93-131.
- Koschier, E. H., W. J. De Kogel & J. H. Visser, 2000. Assessing the attractiveness of volatile plant compounds to western flower thrips (*Frankliniella occidentalis* Pergande). *Journal of Chemical Ecology*, 26 (12): 2643-2655.
- Lewis, T., 1973. Thrips, Their Biology, Ecology and Practical Importance. Academic Press, London, United Kingdom, 267 pp.
- Marullo, R., 2009. Host-plant ranges and pest potential: habits of some thrips species in areas of southern Italy. *Bulletin of Insectology*, 62 (2): 253-255.
- Marullo, R. & A. De Grazia, 2017. *Thrips hawaiiensis* a pest thrips from Asia newly introduced into Italy. *Bulletin of Insectology*, 70 (1): 27-30.
- Masumoto, M. & S. Okajima, 2006. A revision of and key to the world species of Mycterothrips Trybom (Thysanoptera, Thripidae). *Zootaxa*, 1261: 1-90.
- Milek, T. M. & M. Simala, 2010. Rosemary beetle - *Chrysolina americana* L. (Coleoptera: Chrysomelidae) as a pest of aromatic plants, medicinal herbs and ornamentals. *Glasiło Biljne Zaštite*, 10 (5): 319-333.
- Minaei, K., 2017. Thrips, Minute Insects but Opportunist. Shiraz University Press, Shiraz, Iran, 254 pp.
- Mirab-Balou, M., 2018. An updated checklist of Iranian thrips (Insecta: Thysanoptera). *Far Eastern Entomologist*, 361: 12-36.
- Moritz, G., 2002. "The biology of thrips is not the biology of their adults: a development view, 259-267". Thrips and Tospoviruses: Proceedings of 7th International Symposium on Thysanoptera (2-7 July 2001, Italy), 390 pp.
- Mound, L. A. & R. Marullo, 1996. The thrips of Central and South America: an introduction (Insecta: Thysanoptera). *Memoirs on Entomology International*, 6: 1-487.
- Mound, L. A., 2011. Grass-dependent Thysanoptera of the family Thripidae from Australia. *Zootaxa*, 3064: 1-40.
- Mound, L. A., 2012. Thysanoptera (Thrips) of the World-a checklist. (Web page: www.ento.csiro.au/thysanoptera/worldthrips.html) (Date accessed: September 2019).
- Mound, L. A., 2013. Homologies and host-plant specificity: recurrent problems in the study of thrips. *Florida Entomologist*, 96 (2): 318-322.
- Pelikan, J., 1988. A new Irano-Turkmenian species of *Bregmatothrips* Hood, 1912 (Thysanoptera). *Acta Entomologica Bohemoslovaca*, 85: 464-468.
- Pizzol, J., D. Nammour, J. M. Rabasse, P. Parolin, N. Desneux, C. Poncet & P. Reynaud, 2014. Species and population dynamics of thrips occurring inside and outside greenhouses cultivated with roses in southern France. *International Journal of Agricultural Policy and Research*, 2 (4): 141-153.

- Pobożniak, M. & A. Sobolewska, 2011. Biodiversity of thrips species (Thysanoptera) on flowering herbs in Cracow, Poland. *Journal of Plant Protection Research*, 51 (4): 393-398.
- Popov, T., 1973. Thrips on medicinal plants in Bulgaria. *Rastitelna zashtita*, 9: 28-29.
- Raspudić, E., M. Ivezić, M. Brmež & S. Trdan, 2009. Distribution of Thysanoptera species and their host plants in Croatia. *Acta Agriculturae Slovenica*, 93 (3): 275-283.
- Rhoades, D. F., 1985. Offensive-defensive interactions between herbivores and plants. Their relevance in herbivore population dynamics and ecological theory. *The American Naturalist*, 125: 205-238.
- Riudavets, J., 1995. "Predators of *Frankliniella occidentalis* (Perg.) and *Thrips tabaci* Lind.: A Review, 49-87". In: *Biological Control of Thrips Pests* (Eds. A. J. M. Loomans, J. C. Van Lenteren, M. G. Tommasini, S. Maini & J. Riudavets). Wageningen Agricultural University Papers, Wageningen, Netherlands, 201 pp.
- Simova-Tosia, D., R. Spasia & O. Petrovia, 1997. "A study of the insect fauna on medicinal plants in Serbia, 531-540". *International Conference on Pests in Agriculture* (6-8 January 1997, Montpellier, France), 678 pp.
- Stepanycheva, E. A., M. O. Petrova, T. D. Chermenskaya & R. Pavela, 2018. Effects of volatiles of essential oils on behavior of the western flower thrips *Frankliniella occidentalis* Perg. (Thysanoptera, Thripidae). *Entomological Reviews*, 98 (7): 801-806.
- Taşkın, T., 2015. Plant protection problems in medicinal and aromatic plants. *TURKTOB*, 15 (4): 48-53.
- ThripsWiki, 2019. Thrips Wiki-providing information on the World's thrips. (Web page: thrips.info/wiki) (Date accessed: December 2019).
- Tunç, İ. & A. Hastenpflug-Vesmanis, 2016. Records and checklist of Thysanoptera in Turkey. *Turkish Journal of Zoology*, 40: 769-778.
- Uygur, H., G. Ünal, T. Hastürk, O. Gözüyeşil & S. Demirci, 2018. *Taurus Mountains and Their Precious Flowers*. Karahan Bookstore, Adana, 293 pp.
- Yücer, A. & G. Altıntaş, 2012. "Foreign trade of medicinal and aromatic plants of Turkey, 290-297". *Symposium on Medicinal and Aromatic Plants* (13-15 September, Tokat, Turkey), 526 pp.
- Zoubiri, S. & A. Baaliouamer, 2014. Potentiality of plants as source of insecticide principles. *Journal of Saudi Chemistry Society*, 18 (6): 925-938.
- zur Strassen, R. & A. van Harten, 2007. Order Thysanoptera. *Arthropod Fauna of the UAE*, 1: 133-152.