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A Harmful Thrips Species on Lemon in The Eastern Mediterranean Region of Turkey: Thrips hawaiiensis (Morgan) (Thysanoptera: Thripidae)

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ABSTRACT

Some thrips species (Thysanoptera) are known as major pests because of causing the damage, especially to young citrus lemon fruits. Therefore, thrips surveys were carried out in from flowering period until the fruit reached a size of 4-5 cm in diameter in Adana and Mersin provinces, Turkey. In each orchard, 100 fruits were randomly collected and checked individually to determine thrips damage on young fruits. A total of 13 thysanopteran species were determined. *Frankliniella occidentalis* (Pergande) was the most common thrips species on different citrus varieties in Adana province, but *Thrips hawaiiensis* (Morgan) dominated thrips fauna in the citrus lemon groves in Mersin province. No thrips damage was recorded in the groves where *F. occidentalis* was commonly present. *Thrips hawaiiensis* appeared to be harmful on lemon flowers and fruits. Thrips caused silvery or bronzed stains on flowers and fruits. Thrips damage was observed in the mid-May when the flower density was low i.e. third or fourth weeks following petal fall. The staining rates on fruits due to *T. hawaiiensis* in the sampled lemon orchards ranged from 20 to 34%.

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Türkiye'nin Doğu Akdeniz Bölgesi'nde Limonlarda Zararlı Bir Thrips Türü: Thrips hawaiiensis (Morgan) (Thysanoptera: Thripidae)

ÖZET

Bazı thrips türlerinin özellikle genç turunçgil meyvelerinde zararlı oldukları bilinmektedir. Bu amaçla, thrips sürveyleri, Adana ve Mersin illerinde, çiçeklenme döneminden başlayarak limon meyveleri 4-5 cm çapına gelinceye kadar dönemde yürütülmüştür. Her bahçede tesadüfü olarak 100 meyve thrips zararı yönünden incelenmiştir. Toplam 13 Thysanoptera türü bulunmuştur. Adana ilinde farklı turunçgil çeşitlerinde *Frankliniella occidentalis* (Pergande) çok yaygın olarak bulunurken, Mersin ilinde limonlarda *Thrips hawaiiensis* (Morgan) ana thrips türü olmuştur. *F. occidentalis*'in yaygın olduğu yerlerde thrips zararı görülmemiştir. *T. hawaiiensis* limon çiçeklerinde meyvelerinde zararlı bir tür olarak ortaya çıkmıştır. Thrips çiçeklerde ve meyvelerde gümüşü veya bronzlaşmış lekelere neden olmuştur. Thrips zararı çiçek petal yapraklarının dökümünden sonraki 3. veya 4. haftalarda, mayıs ayı ortalarında gözlenmiştir. *T. hawaiiensis* nedeniyle örneklenen limon meyvelerinde lekelenme oranı %20 ile %34 arasında değişmiştir.

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INTRODUCTION

Around 135 million tons of citrus was annually produced in the world. This production was leaded by the US, China, Mexico, Spain, and India. The world orange production was approximately 52% which consisted of 23% tangerine, 11% lemon, 5% is grapefruit and the rest is other citrus varieties (FAO, 2014). Turkey has been generated approximately 1.354.66 million acres citrus areas with 4.293.007 tons

of citrus production that was 43% of oranges, 31% of mandarins, 20% of lemons and 5% of grapefruits (TUIK, 2016). Adana and Mersin provinces in Çukurova Region are the largest producer areas in our country with 1.142.686 tons and 1.052.992 tons, respectively, which is about 57% of Turkey production (Anonymous, 2015).

A study conducted in citrus orchards in Turkey indicated that there were 89 pests, 16 nematodes and 155 weed species, 34 disease agents were detected in the area (Uygun et al., 2010). Among these species, there was also thrips belonging to order Thysanoptera that are the important polyphagous crop pests causing economical damage in the different agricultural products (Lewis, 1973). The thrips, which contains approximately 5500 species, have a body size less than 1 mm with some of opportunistic and invasive species. Although feeding habits of thrips species are quite different, phytophagous (plant-feeders), mycophagous (fungus feeders) and predatory thrips are general feeding types of thrips (Morse and Hoodle, 2006; Atakan et al., 2015). The thrips species belonging to the genus *Frankliniella*, *Scirtothrips* and *Thrips hawaiiensis* (Morgan) are known to be the most economically damaging species (Mound and Teulon, 1995; Morse and Hoodle, 2006; Marullo and De Grazia, 2017). Thysanoptera fauna has been studied in various parts of Turkey including Antalya (Tunç, 1990; Tunç, 1991; Tunç, 1992), Manisa and Mardin province (Özsemerci et al., 2006; Kaplan et al., 2016). Moreover, in the Eastern Mediterranean Region, thrips species were studied in citrus (Nas et al., 2007; Ölçülü, 2014), vegetables (Atakan, 2007a; Atakan, 2010), fruits (Atakan, 2007b) and ornamentals (Atakan, 2011).

According to results of the thrips survey performed in the Çukurova region of Turkey, *F. occidentalis* dominated the thrips fauna. *Thrips hawaiiensis* (Morgan) was the second more common insects with a ratio of 18% in the total number of adults on vegetables (Pehlivan and Atakan, 2017). This pest detected was the first time in Turkey on lemons and spread quickly all over the Çukurova region of Turkey within one year (Atakan et al., 2015; Pehlivan and Atakan, 2017). Thysanoptera fauna of citrus in the Eastern Mediterranean Region of Turkey studied thoroughly. It was found that common species such as *F. occidentalis* and *Thrips major* Uzel were not pest of citrus. In Antalya province, 36 thrips species were found in citrus orchards where *T. major* was the most common (Tekşam and Tunç, 2009).

In a previous study (Atakan et al., 2015), diagnosis, biology distribution, host plants, and damage degree of *T. hawaiiensis* was given. In the current study, the recent status of *T. hawaiiensis* on citrus over past four years has been presented. Besides, information on the spread, general population phenology and damage of *T. hawaiiensis*, which is considered a new species for citrus, has been given. It is believed that this study could provide useful knowledge in thrips management in citrus in the region.

MATERIALS and METHODS

Thrips species (*Pezothrips kellyanus* and *Thrips hawaiiensis*) are known causing damage especially to young citrus fruits (mainly lemon fruits). For this purpose, surveys were conducted from the flowering time until the citrus fruits reached a size of 4 cm in diameter depending on the variety of citrus in the eastern Mediterranean region of Turkey in 2017-2018. Thrips were regularly sampled in the Balcalı (Adana province) and Erdemli (Mersin province) regions. Citrus flowers in each orchard were sampled to determine thrips during the flowering period. For this purpose, fruiting branches from four cardinal directions (one inflorescence per cardinal direction) in the grove were shaken separately onto the plastic white tray. The fallen thrips were transferred to Eppendorf tubes (2 cc) containing 60% ethyl alcohol via suction tube or fine brush. Samples were brought to the laboratory and examined under a stereoscopic microscope and placed in AGA (9 parts of 60% ethyl alcohol, 1 part of glacial acetic acid, 1 part of glycerin) for further diagnosis. Following in the solution for one or two days, thrips samples were transferred into small plastic tubes containing 60% ethyl alcohol (Atakan, 1998) and labeled. Thysanoptera species were identified by the senior author.

Since *T. hawaiiensis* is mainly causing damage in lemons, weed hosts of this species growing in lemon groves were also sampled in Balcalı and Erdemli in irregular intervals. For this propose, weeds were tapped onto the white tray for 5 s., and extracted thrips were placed in the plastic tubes (2 cc in volume) including ethyl alcohol with 60%. Thrips were exposed to the same procedure explained before.

Thrips preparation

In order to facilitate the preparation, thrips samples were kept in AGA fluid for 2 days and then taken into alcohol (60% ethyl alcohol). Then, they were kept in the 5% NaOH liquid until a slight discoloration was occurred and the body content was cleared by entering the liquid the body. Specimens were kept in 96% ethyl alcohol for 5 minutes and assembled into Hoyer media. Prepared thrips specimen slides were left for dry in the oven at 47 °C for approximately 3 weeks.

Fruit samplings for thrips damage

In each citrus orchard, 100 fruits representing each citrus group were randomly collected and checked individually. The fruits showing the damage of the irregular holy spots with-silvery or bronzed on fruit surfaces were accepted as damaged. Fruits that did not

show such symptoms were considered healthy. Thus, the damage ratio in 100 fruits in each orchard was determined. Sampling for the ratio of infestation and consequently the damage were done in May when *T. hawaiiensis* appeared. Since *T. hawaiiensis* is causing damage only in lemons (Goldaranzena, 2011; Atakan et al., 2015), surveys on the thrips damage were mostly performed in the Erdemli location, where lemons are widely cultivated, at weekly intervals during its fruiting stage (fruits with a diameter of 0.5-4 cm).

RESULTS

Diagnosis of Adult Thrips hawaiiensis Morgan

The adult females are approximately 1.3 mm in size and the abdomen is brownish, thorax and head are orange or brownish-yellowish brown (Figure 1a). The antennas possess 7 or 8 segments. Antennas are 7-segmented in the samples examined. The third antenna segment, the end of the 2 antenna segments, the base of the 4th and 5th antenna segments are yellow. Males are smaller and also lighter in color than females (Figure 1b).

Thysanoptera composition and phenology

In the study, a total of 13 thysanopteran species were determined in surveyed citrus groves of the region. Thrips species were: *Aeolothrips gloriosus* Bagnall, *Melanthrips fuscus* (Sulzer), *Frankliniella occidentalis* (Pergande), *Limothrips cerealium* (Haliday), *Thrips hawaiiensis* (Morgan), *Thrips major* Uzel, *Thrips tabaci* Lindeman, *Thrips meridionalis* (Priesner), *Thrips vulgatissimus* Haliday, *Rhipidothrips gratiosus* Uzel, *Rubiothrips vitis* (Priesner), *Haplothrips aculeatus* Fabricius and *Haplothrips reuteri* Uzel. The most common thrips in Balcalı, which is a polyculture area, was *F. occidentalis* which was followed by *T. hawaiiensis* that was an invasive and pestiferous species causing an important damage in lemon areas. *Aeolothrips gloriosus* Bagnall was a predator species feeding upon pest thrips. The *Melanthrips* species is known to be pollen feeder. Most of the species belonging to the Thripidae family are recognized as pests of different crops.

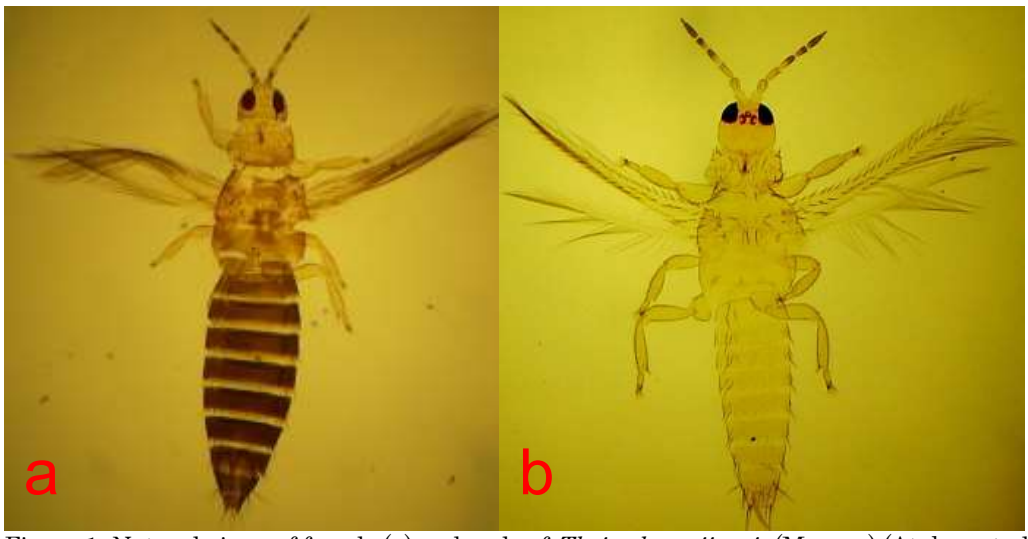

Figure 1. Natural views of female (a) and male of *Thrips hawaiiensis* (Morgan) (Atakan et al., 2015).
Şeki1 1. Thrips hawaiiensis (Morgan)'in dişi (a) ve erkek (b) bireylerinin doğal görünümleri (Atakan ve ark., 2015).

Thysanoptera species were also identified in Erdemli (Mersin province) where lemons are commonly cultivated. The main thrips species in this location was *T. hawaiiensis* which was followed by a lower number of *F. occidentalis* and also a few number of *T. tabaci* (only 8 specimens). Most of the Thysanoptera species were found during the flowering period of citrus in April. A few adults and larvae of *T. hawaiiensis* were found on the fruits. The most common thrips inhabiting the flowers in May and June was *T. hawaiiensis*. Also, fewer numbers *F. occidentalis* or *T. major* was recorded during these months. The population of *T. hawaiiensis* occurred high during the young fruit period of Lamas-Kütdiken lemon varieties which are flowering throughout the year. Relatively greater numbers of *T hawaiiensis* on flowers were present in mid-May and mid- June period. Trees were bearing few numbers of flowers at this period. Thrips individuals of mostly *T. hawaiiensis* were migrating from surrounding areas to flowers.

Distribution and host status of Thrips hawaiiensis (Morgan)

The distribution of *T. hawaiiensis*, which was the first time detected on lemons in Turkey in 2015, was investigated in the Eastern Mediterranean Region (Figure 2). Following the first report, citrus production areas and other cultivated plants were observed to determine the distribution range of this thrips in the region. The survey results indicated that this species is widespread throughout the eastern Mediterranean region of Turkey.

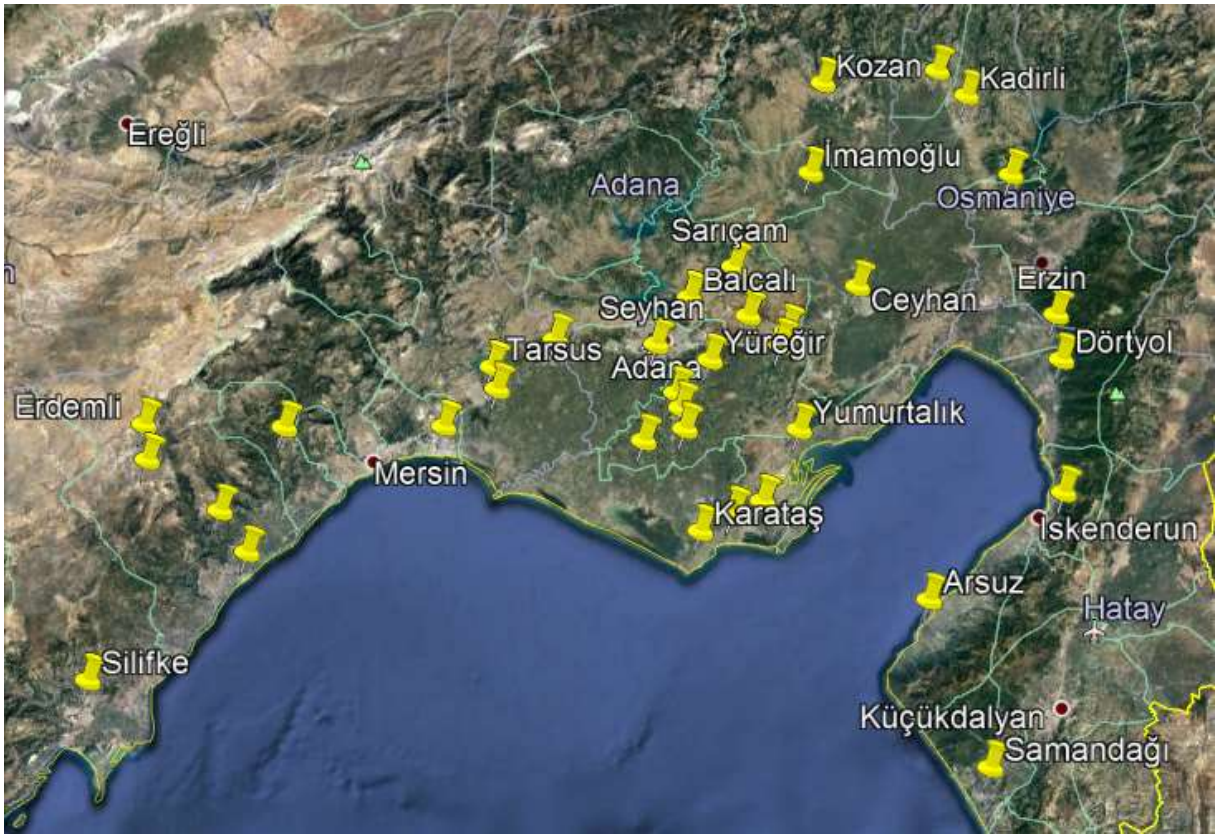

Figure 2. Distribution map of *Thrips hawaiiensis* (Morgan) in citrus grown areas in the eastern Mediterranean region of Turkey.

Şekil 2. Thrips hawaiiensis (Morgan)'ın Doğu Akdeniz Bölgesi'nde turunçgil yetiştirilen alanlarda dağılımını gösteren harita.

In current study, female and male individuals of this pest were found on citrus varieties including nectarine, pepper, bean, cucumber, eggplant, pumpkin, radish, tomato, sunflower, ornamental plants, violets, geranium, cultured blackberry, pomegranate, grape, cotton, soybean, sesame, corn, and sunflower. If the sampling areas and frequency were expanded, it was estimated that the distribution areas and the number of host plant species would increase. Some weeds are known to be the important alternative host as a source of pollens and also are considered as the ecological niches for many thrips species. The weed hosts were investigated in the lemon orchards where *T. hawaiiensis* was problematic. *Thrips hawaiiensis* was recorded on 8 weed species (*Amaranthus retroflexus*, *Daucus carota*, *Calendula arvensis*, *Crepis* sp., *Epilobium parviflorum, Medicago polymorpha*, *Ochtodium aegyptiacum* and *Sinapis arvensis*). Of which, *Daucus carota* (Apiaceae, wild carrots) was determined one of the most attracted weeds for this pest. This thrips were recorded on the flowers of this weed in almost every sampling date. Only adult male and female individuals (no larvae) were collected from weed flowers. These weeds could be a source of nectars and pollens for the adults.

Damage to lemons by Thrips hawaiiensis (Morgan)

There was no damage on fruits of mandarins, oranges, and grapefruits due to thrips attacks (mainly *T. hawaiiensis*) in surveyed citrus areas in the region. The thrips damage was recorded only on lemons (Lamas-Kütdiken varieties) in Erdemli location. When *T. hawaiiensis* feeds with flowers (mostly adults), silvered scars were appeared on petal leaves of flowers (Figure 3). During the peak of the flowering period, the thrips damage was not determined, however this damage was mainly observed in the mid- or late- May when a few flowers were present in the lemon groves. At this period, the thrips densities were greater than 50 individuals in some flowers. In these particular flowers, the staminal filament (male organ) was damaged by turning to brown and flowers were shed. The phytophagous thrips species cause not only scars in the shape of smooth circular but also large silvery stains on young fruits. These silvered scars on young fruits are more common, especially where the fruits are touched to each other; these places are shelters to hide places for thrips and thus, thrips are concentrated in these areas. The first stained lemon fruits in the town of Erdemli were encountered in the first week of May. The rate of stained fruit increased towards the end of May. The staining rates in the sampled lemon orchards

ranged from 20 to 34%. When *T. hawaiiensis* was detected for the first time in 2015, fruit damage ratios in lemon groves were over 50%, but then, in following years, due to heavy insecticides applications, these ratios fell below 50%.

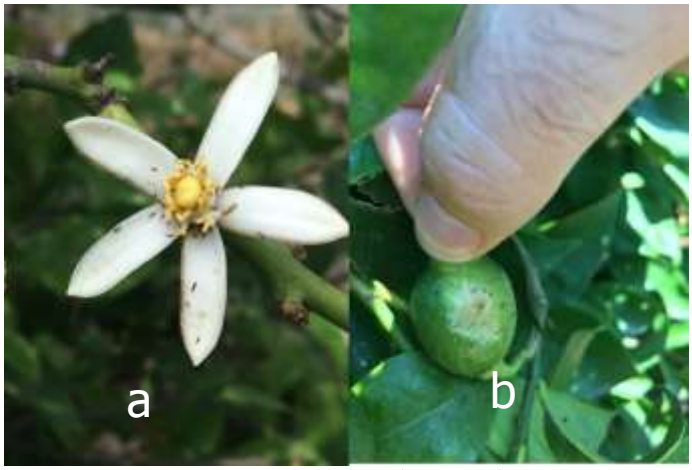

Figure 3. *Thrips hawaiiensis* (Morgan) adults on a flower (a) and its damage on young lemon fruit (b).

Şekil 3. Çiçekte Thrips hawaiiensis (Morgan) erginleri (a) ve genç limon meyvesindeki zararı (b).

Thrips control in lemons

Thrips hawaiiensis mostly caused the scar tissues on young fruits (2-3 cm in diameter). Our results suggest that the pesticide applications could be done weekly in May (week 3 and week 4 after petal falls). Additionally, this study also suggests that insecticide applications in April at peak flowering time are not necessary. In late June, a few flowers are found on lemon trees in the orchards. Therefore, the pesticide applications in this month are economically not logical. In this period, the majority of fruits have harder textures with a larger spike, which are not preferred for feeding. Insecticides from different groups with different mode actions in the region are widely used during the flowering and fruit formation period of trees. However, it was observed that spinosyn group insecticide such as spinetoram with summer oil exhibited good result against this pest in the Erdemli, Mersin.

DISCUSSION and CONCLUSION

In this study, while 13 Thysanoptera species were found in polyculture area (Balcalı location, Adana province) and 5 species were found in lemon cultivated areas (Erdemli location, Mersin province). The rich plant biodiversity in Balcalı location may have positively affected the thrips biodiversity on citrus. *Frankliniella occidentalis* was found to be more common and detected with the highest individual numbers in all citrus varieties, but *T. hawaiiensis* dominated thrips fauna detected in lemon groves in Mersin province. Tekşam and Tunç (2009) found 36 thrips species in citrus orchards of Antalya province. Eight Thysanoptera species were recorded in the study conducted in the citrus orchards of the eastern Mediterranean Region (Nas et al. 2007). *Thrips major* were main thrips species inhabiting citrus grown areas in Antalya province (the western Mediterranean region of Turkey) while *F. occidentalis* was predominant species in citrus orchards in the eastern Mediterranean region (Ölçülü, 2014).

One of the main reasons of *F. occidentalis* becoming predominant thrips species on citrus in polyculture area may be related to the mass migration of this thrips from nearby cultivated crop plants. Besides, *F. occidentalis* feeds upon many weedy plants species and reproduces on them in the region (Atakan and Uygur, 2005). *F. occidentalis* is also dominant thrips species infesting various arable plants (winter and summer cultivated plants) (Atakan 2007a, b). Contrarily, *T. hawaiiensis* prefers lemons more and recently this species is often considered as a pest on fruiting organs of lemons, i.e. buds, flowers and young fruits (Atakan et al., 2015). Whereas, only *F. occidentalis* was detected on flowers of lemons (Meyer variety) in Tarsus (Mersin province) in 2014 and 2015, but no thrips damage was detected on the lemon fruits. *Thrips hawaiiensis* replaced by *F. occidentalis* only within one year in Mersin. While *F. occidentalis* is the more common species during the peak flowering, *T. hawaiiensis* appears to cause damage in a later period of lemons i.e. young fruit formation stage in Mersin. *Thrips hawaiiensis* sustain high reproductive rate by reproducing nearly 20 generations per year (Murai, 2001). Favorable climatic conditions in the region (Mersin province) and its preference to young lemon fruits could be among the reason for thrips becoming more common and damaging on the lemons.

The thrips damage is usually seen as large circular silvered or bronzed scars on the young fruits of lemons. Golderanza (2011) has identified *T. hawaiiensis* for the first time in Spain in 2011, and he described similar findings of the damage. Wounds on the fruit are superficial and do not work on fruit tissues. However, the commercial value of the fruits, in which wounds and stains occur in the form of silvering, decreases their market values. The petals of the flowers become brown when the thrips feed on it and also flowers are shed after intense thrips colonization. In the present study, the number of individuals in some flowers ranged from 50 to 80. The intense damage occurred in the middle of May when the fruits are young and the fruit diameters vary between 2-3 cm. Signs of damage in young fruits (2 or 3 cm in diameter) occurred at 3 or 4 weeks after the petal leaves falling of lemon flowers.

Studies carried out in Spain reported that second stage larva of Kelly's citrus thrips, *P. kellyanus* was harmful on citrus fruits (mainly lemons), and first four weeks after petals falling were found to be critical in the

formation of fruit damage (Baker et al., 2002; Navarro-Campus et al., 2012 and 2013). During the first 3-6 weeks after petal fall, due to the larval activity of *S. citri* which is an important polyphagous thrips in citrus was caused similar damage with *P. kellyanus* (Rhodes and Morse, 1989).

Individuals of *T. hawaiiensis* (mainly females and males) were densely recorded on the wild carrots (*Daucus carota*) naturally grown in the sampled lemon groves. The coverage of this weed was below 10%. This weed species is likely the source of nectars and pollens for adult thrips. It was observed that thrips staining rates in lemon groves with the weeds (Barbaros district, Mersin province) were relatively low. It is believed that the weeds (mainly *D. carota*) might play a role in attracting thrips. In this study, the thrips density of citrus (lemon) flowers in weedy and non-weedy citrus (lemon) groves were not compared. However, in the study in Balcalı (Adana), the average number of thrips on the mandarin flowers in the weedy plot was significantly lower than those of non-weedy plots (unpublished data). Further research is needed on this subject.

This pest thrips did not yet develop resistance to insecticides (Murai, 2001), but in the region, insecticides belonging to different groups and action modes have been intensively used against the thrips species, since its first report in 2015, in the region. Therefore, further research on this issue also is needed.

As consequently, *T. hawaiiensis* damage was recorded only in local area and on lemon varieties of Kütdiken and Lamas, which are flowering year-round. No thrips damage was recorded in widely cultivated Meyer lemons in Adana. In the Erdemli, where the thrips damage on lemons was important, growers are applying insecticides to lemon trees intensively during the peak flowering period. During the flowering period, insecticides applications is harmful to honey bees and other beneficial insects present in the groves (Brittain et al., 2010). Insecticide applications for thrips control in citrus groves during flowering periods are not suggested. Because average thrips numbers were less than 10 thrips per flower and *F. occidentalis*, which is not regarded as a pest in citrus, was found to be common in the peak flowering period. The critical time for the formation of thrips damage to lemons in the region is 3 or 4 weeks after the petal fall; this is corresponding to mid- or late- May. Weekly spraying in lemon orchards may be useful until the fruit size become 4 cm in diameters from mid-May to mid-June. Because of very few numbers of present flowers and fruits already ripened on the lemon trees, pesticide applications against thrips in late June seem to be not meaningful and not suggested.

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Statement of Conflict of Interest

Authors have declared no conflict of interest.

Author's Contributions

The contribution of the authors is equal.

REFERENCES

Anonymous 2015. Türkiye'de Turunçgil Üretimi, Dış Ticareti ve Sorunları. (http://www.zmo.org.tr/genel/bizden_detay.php?kod=23137&tipi=17&sube=0) Erişim tarihi: 20.08.2017.

Atakan E 2007a. Thrips (Thysanoptera) Species Occurring on Fruit Orchards in Çukurova Region of Turkey. Book of Abstracts of Second Symposium on Palaeartic Thysanoptera, 18-20 September 2007, Strunjan, Slovenia.

Atakan E 2007b. Thrips (Thysanoptera) Species Occurring on Winter Vegetable Crops in Çukurova Region of Turkey. Book of Abstracts of Second Symposium on Palaeartic Thysanoptera, 18-20 September 2007, Strunjan, Slovenia.

Atakan E 2010. Çukurova Bölgesi'nde Yazlık Sebzelerde Thysanoptera (Thrips) Türleri ve Avcı Böcekler Üzerinde Araştırmalar. VIII. Sebze Tarımı Sempozyumu Bildirileri, 23-26 Haziran 2010, Van.

Atakan E 2011. Adana İlinde Merkez Parklarında Bazı Süs Bitkilerinde Bulunan Thysanoptera (Thrips) Türleri. Türkiye IV Bitki Koruma Kongresi Bildirileri 28-30 Haziran 2011, Kahramanmaraş.

Atakan E, Ölçülü M, Pehlivan S, Satar S 2015. Türkiye'de Yeni Zararlı Bir Thrips Türü: *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae). Türkiye Entomoloji Bülteni, 5: 77-84.

Atakan E, Uygur S 2005. Winter and Spring Abundance of *Frankliniella* spp. and *Thrips tabaci* Lindeman (Thysan., Thripidae) on Weed Host Plants in Turkey. Journal of Applied Entomology, 129: 17-26.

Baker GJ, Jackman DJ, Keller M, MacGregor A, Purvis S 2002. Development Of An Integrated Pest Management System for Thrips in Citrus. HAL Final Report CT97007.http://www.sardi.sa.gov.au/pestsdiseases/horticulture/horticultural_pests/kelly_citrus_thrips/research_report_1997-2000. Accessed on 08 January 2019.

Brittain C, Bommarco R, Vighi M, Barmaz S, Settele J, Potts SG 2010. The Impact of An Insecticide on Insect Flower Visitation and Pollination in Agricultural Landscape. Agricultural and Forest Entomology, 12: 259-266.

Goldaranzena A 2011. First Record of *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae), an Asian Pest Thrips in Spain. Bulletin OEPP/EPPO, 41: 170-173.

Kaplan M, Bayhan E, Atakan E 2016. Mardin İli Bağ Alanlarındaki Thysanoptera Türleri, Mevsimsel Yoğunlukları ve Yayılış Alanlarının Belirlenmesi. Türkiye Entomoloji Bülteni, 6 (2): 161-168.

Lewis T 1973. Thrips: Their Biology, Ecology and Economic Importance. London: Academic. 349 pp.

Marullo R, De Grazia A 2017. *Thrips hawaiiensis* A Pest Thrips From Asia Newly Introduced into Italy. Bulletin of Insectology, 70: 27-30.

Morse JG, Hoddle MS 2006. Invasion Biology of Thrips. Annual Review of Entomology, 51: 67–89.

Mound LA, Teulon DAJ 1995. Thysanoptera As Phytophagous Opportunists, 130, pp. 3–19.

Murai T 2001. Development and Reproductive Capacity of *Thrips hawaiiensis* (Thysanoptera: Thripidae) and its Potential As a Major Pest. Bulletin of Entomological Research, 91: 193-198.

Nas S, Atakan E, Elekçioğlu N 2007. Doğu Akdeniz Bölgesi Turunçgil Alanlarında Bulunan Thysanoptera Türleri. Türkiye Entomoloji Dergisi, 31: 307-316.

Navarro-Campos C, Aguilar A, Garcia-Mari F 2012. Aggregation Pattern, Sampling Plan, and Intervention Threshold for *Pezothrips kellyanus* in Citrus Groves. Entomology Experimentalis et Applicata, 142: 130–139.

Navarro-Campos. C, Pekas A, Aguilar A, Garcia-Mari F 2013. Factors Influencing Citrus Fruit Scarring Caused by *Pezothrips kellyanus*. Journal of Pest Science, 86: 459-469.

Ölçülü M 2014. Doğu Akdeniz Bölgesi Turunçgil Bahçelerinde Thysanoptera Türleri ve Doğal Düşmanlarının Popülasyon Değişimleri ile *Pezothrips kellyanus* (Bagnall) (Thysanoptera: Thripidae)'un Bazı Biyolojik Özelliklerinin Araştırılması. Cukurova University, Institute of Natural and Applied Science, Adana, Turkey.

Özsemerci F, Akşit T, Tunç İ 2006. Manisa İli Bağ Alanlarında Saptanan Thrips Türleri ve Önemli Türlerin İlçelere Göre Dağılımları. Türkiye Bitki Koruma Bülteni, 46: 51-63.

Pehlivan S, Atakan E 2017. Thysanoptera (Thrips) Species on Cultivated Plants in Çukurova Region of Turkey. 5th Symposium on Palaearctic Thysanoptera. 26th-29th September 2017, Cracow, Poland.

Rhodes AA, Morse JG 1989. *Scirtothrips citri* Sampling and Damage Prediction on California Navel Oranges. Agriculture, Ecosystem and Environment, 26: 117–129.

Tekşam İ, Tunç İ 2009. An Analysis of Thysanoptera Associated with Citrus Flowers in Antalya, Turkey: Composition, Distribution, Abundance and Pest Status of Species. Applied Entomology and Zoology, 44: 455-469.

Tunç İ 1990. Antalya'da Bulunan Avcı Thysanoptera Türleri ve Habitatları. Türkiye II. Biyolojik Mücadele Kongresi Bildirileri, 26-29 Eylül 1990, Ankara.

Tunç İ 1991. Studies on the Thysanoptera of Antalya IV. Thripidae Stephens-3. Akdeniz Üniversitesi Ziraat Fakültesi Dergisi, 4: 11-26.

Tunç İ 1992. Studies on the Thysanoptera of Antalya II. Thripidae Stephens- Part 1. Türkiye Entomoloji Dergisi, 16: 33-46.

TÜIK 2016. Türkiye İstatistik Kurumu, Tarımsal Üretim İstatistikleri. https://biruni.tuik.gov.tr/ medas/ ?kn=92&locale=tr. (Erişim tarihi: 23.04.2017).

Uygun N, Ulusoy MR, Karaca İ, Satar S 2010. Meyve ve Bağ Zararlıları. Özyurt Matbaacılık, Adana.