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RESEARCH

Loquat, a non-native plant in Türkiye, is a key seasonal host in the life cycle of *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae)

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Abstract The Hawaiian flower thrips, *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae) is an important pest of several fruit crops in Türkiye's Mediterranean region, one of the world's major citrus-growing regions. In this study, the population fluctuation of *T. hawaiiensis* and other thrips species was investigated in citrus orchards, weeds, and nearby loquat trees. Results showed significant differences in populations of *T. hawaiiensis* among citrus varieties. The highest population density and damage ratio of *T. hawaiiensis* among citrus species were recorded in lemon variety (Kütdiken). *Thrips hawaiiensis* was detected on *Daucus carota* L. and *Amaranthus albus* L. among weeds as well as on flowers of loquat in the sampling area. The life cycle of *T. hawaiiensis* switched seasonally among citrus, weed, and loquat host plants. In addition, *Melanthrips pallidior* (Priesner, 1919) was the predominant species on weeds in the sampling area. These data suggest that *T. hawaiiensis* populations may be affected by climatic variations and hosts in and around the citrus orchard. The results are important in optimizing thrips monitoring and management strategies in citrus.

Keywords Thripidae · Citrus · Crop damage · *Eriobotrya japonica* · Weed

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Introduction

Thrips (Thysanoptera) are small insects typically 1–2 mm long and yellow or brown in color (Morse & Hoddle, 2006). The life cycle includes the following stages: egg, two larval instars, non-feeding stages called prepupa and pupa, and adult (De Breuil et al., 2021). Thrips have rasping-sucking mouthparts and are significant pests of many crops. There are approximately 6000 thrips species described (Mound & Morris, 2007), although less than 1% of them are considered serious pests of agriculture. Some species are beneficial as pollinators, and others are predators of other insects or mites. Crop damage by thrips occurs by direct feeding on plants, by oviposition wounds, or by serving as a vector and spreading plant pathogenic viruses (Kritzman et al., 2001; Iglesias et al., 2021). Flower thrips have many hosts, including weeds that are not generally targeted for pesticide application and, hence, serve as refugia for thrips populations (Katayama, 2006). Therefore, weeds represent a critical niche for pest thrips in

proximal distance to or within agricultural fields (Ghosheh & Al-Shannag, 2000). Knowledge of the thrips species and population of weeds is critical to understanding the seasonal life history and dispersal in relation to cultivated crops.

The Hawaiian flower thrips, *Thrips hawaiiensis* (Morgan, 1913) (Thysanoptera: Thripidae) is a flower-inhabiting thrips species widely distributed in Asia (Murai, 2001; Aliakbarpour & Salmah, 2011), Europe (Reynaud et al., 2008; Atakan et al., 2015), and North America (Goldarazena, 2011). In Türkiye, *T. hawaiiensis* is a significant thrips species with notable abundance (Atakan et al., 2021). Additionally, it has a wide host range feeding on flowers of herbaceous plants (Miyazaki & Kudo, 1988). This pest leads to damage to plants through oviposition by adults and feeding by larvae on tender leaves, flowers, and fruits, inducing spot lesions, scarring, bud malformations, and reduced fruit yield (Murai, 2001; Wu et al., 2014; Fu et al., 2016, 2018). However, *T. hawaiiensis* is not known to vector any economically significant plant viruses (Murai, 2001).

Monitoring and predicting pest population occurrence are significant in establishing environmentally friendly pest management strategies and understanding the 'host plant–insect pest' interaction, although little is known about the seasonal host switching of *T. hawaiiensis* among different hosts. Several studies were carried out on the seasonal abundance and distributions of *T. hawaiiensis* in Spain (Goldarazena, 2011), China (Cao et al., 2018) and Türkiye (Atakan et al., 2021). However, most of these studies were focused on a few plant species.

Our study aimed to improve our understanding of (i) the population density and damage rate of *T hawaiiensis* in various citrus varieties, (ii) the species of thrips on the flowers of weedy plants and loquats (*Eriobotrya japonica* Lindl.) in the vicinity of citrus orchards, and (iii) the seasonal host switching of *T. hawaiiensis* among citrus, weeds, and loquat. These data will help developing improved management strategies for thrips populations on different citrus varieties.

Materials and methods

Study location

This study was conducted from 2016 until 2018 at the Cukurova University Subtropical Fruits Research and Application Center to determine the population density of *T. hawaiiensis* in different citrus varieties. The study was carried out in a 0.3-ha orchard located in the southeast Mediterranean region of Türkiye (coordinates: 37°03′08″N-35°21′14″E in the north-west; 37°03′03″N-35°21′05″E in the north-east; 37°03′03″N-35°21′14″E in the south-west; 37°02′55″N-35°21′07″E in the southeast) with a total of 16 varieties of citrus fruits. The citrus trees were spaced by 5 × 7 m, drip irrigated, and their age varied between 10 and 15 years old. This study was conducted in mandarin trees (Clementine, Owari) and lemon trees (Kütdiken, Meyer) in 2016–2017, while in 2017–2018 mandarin trees (Clementine, Owari, Dobashi Beni, Nova, Okitsu, Robinson, W. Murcott), orange trees (Moro blood, Cara cara, Valencia, Fukumoto), lemon trees (Kütdiken, Meyer), grapefruit (Star Ruby, Marsh seedless), and Palestine sweet lime were sampled. In the sampling location, loquat trees are grown on the edge of the citrus grove. The Mediterranean climate is typical of the southeast Mediterranean region of Türkiye which is characterized by citrus orchards, stone-pome orchards, greenhouses, and forests.

Sampling of *Thrips hawaiiensis*

The population fluctuations of *T. hawaiiensis* adults were studied in the citrus plots of the research center on flower buds, flowers, and fruits throughout two consecutive seasons from 31 March 2016 to 5 February 2018. Four trees from each cultivar were selected randomly and sampled to count the number of *Thrips* spp. along four different directions (east, west, south, and north). The population of adults was monitored once a week from the flowering onset to developing fruits (≈2 cm in diameter) and biweekly afterwards. For each flower panicle, 3–5 flowers were inspected at the flowering periods. The flowers of each cultivar were placed separately in plastic containers and vigorously tapped. The collected thrips were placed individually into Eppendorf tubes with 70% ethanol using a fine brush (number 000) and stored for later identification and counting. Thrips were also checked in three loquat trees placed in the vicinity of citrus varieties both years following the same method of citrus trees. In the second year of study, natural flowers of various weed species grown around the citrus trees were

sampled weekly. Each sampling unit consisted of five randomly-chosen plants for each weed species, and each week new plants were sampled. Samples of adults and larval stages taken from citrus trees, weeds, and loquats were identified in the laboratory using a stereo microscope (Leica) at a magnification of 50x.

Thrips preparation

Thrips samples were processed for identification using a specific treatment known as AGA, which consists of a mixture of 9 parts of 60% ethyl alcohol, 1 part of glacial acetic acid, and 1 part of glycerin. After the treatment, the thrips samples were transferred to 1-ml Eppendorf tubes containing 5% NaOH for several minutes. Subsequently, the thrips were transferred to 96% ethanol for 5 min. The next step involved placing the thrips on a microscope slide in Hoyer mounting medium. To complete the process, the prepared slides were dried in an oven at approximately 47 °C for approximately three weeks (Nakahara, 1994; Mound & Marullo, 1996; Atakan et al., 2021). The examination of the prepared slides was conducted using a stereo microscope (Leica) at a magnification of 50x. Thrips species were identified by referring to identification keys provided by Nakahara (1994), Mound and Marullo (1996), zur Strassen (2003), and Atakan et al. (2021).

The ratio of *Thrips hawaiiensis* damage

Forty fruits per tree were randomly selected from the four quadrants of the tree during the citrus harvest period, meaning that 160 fruits for each of the four replicates per variety were individually checked. Fruit blemish and shape were noted. Irregular or halo-shaped and silvery-bronze fruits, especially around the fruit stalk, were considered to be damaged by *T. hawaiiensis* (Atakan et al., 2021).

Meteorological data

Daily weather data were taken from a weather station located on the experimental farm. The maximum and minimum average monthly temperature (Celsius) and rainfall (millimeters) were recorded.

Statistical analyses

The study was conducted in a randomized block design with four replications. The total number of adult thrips found in each citrus cultivar was statistically compared separately for both years of studies. Before analyses, data from *T. hawaiiensis* sampling were log-transformed in order to meet the assumption of normality, as measured by the Shapiro–Wilk test, and homogeneity, as measured by the Bartlett test. An analysis of variance (ANOVA) using citrus varieties as a fixed factor and the number of *T. hawaiiensis* as a random factor was used to compare the mean values, with a significance level of $P = 0.05$. To assess significant differences between means, Tukey's test was used (Tiring & Satar, 2021; Tiring et al., 2023).

The study assessed the impact of sampling dates on the population growth of *T. hawaiiensis*, considering different citrus varieties, and evaluated the population of *T. hawaiiensis* in both years using General Linear Model analysis (Univariate; $P < 0.05$). The study treated the number of thrips as a random factor, while sampling dates and citrus varieties were treated as independent fixed factors (Atakan et al., 2021).

The percentage of damage caused by *T. hawaiiensis* was computed as the ratio between the number of *T. hawaiiensis* damaged fruits (NDT) and the total number of randomly inspected fruits (TNF) for each replicate using the formula: (NDT / TNF) x 100. A one-way ANOVA was performed to determine differences in the percentage of fruit damage among citrus varieties using citrus varieties as a fixed factor and the percentage of fruit damage as a random factor. Means were compared using Tukey test ($P < 0.05$) (Koschier et al., 2002). All statistical analyses were performed using SPSS, version IBM SPSS Statistic 23 software.

Results

A total of 2433 *T. hawaiiensis* were counted during the two-year study on citrus trees. The respective numbers of *T. hawaiiensis* in the first and second year of the study were 2098 (86%) and 335 (14%), respectively. *Thrips hawaiiensis* showed differences in abundance according to citrus varieties in both 2016–2017 ($F = 19.665$; $df = 3, 15$; $P < 0.001$) and 2017–2018 ($F = 26.247$; $df = 15, 63$; $P < 0.001$). Regarding other thrips species, a total of 41 individuals were counted

Table 1 Identified thrips species and their total numbers on different citrus varieties and loquat fruits in 2016–2017

Citrus variety	Thrips species	Total number of thrips
Meyer	*Thrips hawaiiensis*	573
	Haplothrips distinguendus	1
	Aeolothrips collaris	1
	Frankliniella occidentalis	1
	Melanthrips pallidior	4
Kütdiken	*Thrips hawaiiensis*	1508
Palestine sweet lime	*Thrips hawaiiensis*	13
Owari	*Thrips tabaci*	5
	Aeolothrips collaris	1
	Limothrips cerealium	1
	Aeolothrips ericae	1
	Thrips hawaiiensis	17
	Haplothrips reuteri	1
Clementine	*Melanthrips fuscus*	2
	Thrips hawaiiensis	22
Dobashi Beni	*Melanthrips pallidior*	4
	Thrips hawaiiensis	2
Nova	*Melanthrips fuscus*	3
	Thrips hawaiiensis	13
	Thrips major	1
W. Murcott	*Thrips hawaiiensis*	15
Robinson	*Thrips hawaiiensis*	28
Okitsu	*Thrips hawaiiensis*	13
Valencia	*Melanthrips fuscus*	5
	Thrips hawaiiensis	15
Fukumoto	*Melanthrips fuscus*	4
	Thrips hawaiiensis	7
	Thrips tabaci	1
Moro blood	*Thrips hawaiiensis*	8
Cara cara	*Thrips hawaiiensis*	11
Marsh seedless	*Melanthrips pallidior*	2
	Thrips hawaiiensis	10
Star Ruby	*Thrips hawaiiensis*	12
Loquat	*Frankliniella occidentalis*	9
	Thrips hawaiiensis	581
	Thrips tabaci	7

on citrus trees throughout the study (Table 1). Among them, *Melanthrips fuscus* (Sulzer, 1776) accounted for 14 individuals, while the amount of *Melanthrips pallidior* (Presnier, 1919) was of 12 individuals. The remaining species were detected in lower numbers.

Table 2 Generalized Linear Model (GLM) analysis of the number of *Thrips hawaiiensis* in different fruit varieties

Year	Factors	df	Ms	F	P
First year	Fixed factors				
	Variety	3	16026.042	5.279	0.002
	Random factors				
	Sampling date	23	2759	0.909	0.587
	Error	69	3035.933		
Second year	Fixed factors				
	Variety	15	52.575	6.166	< 0.001
	Random factors				
	Sampling date	11	53.706	6.299	< 0.001
	Error	187	8.526		

Table 2 shows the influence of sampling date and citrus varieties on the observed population of *T. hawaiiensis*. The citrus varieties significantly affected the abundance of this insect in both years ($P < 0.01$), whereas sampling dates were significant only in the second year. The number of *T. hawaiiensis* was significantly more abundant in lemon flowers of variety Kütdiken than in other citrus varieties (Figs. 1 and 2), although the highest weekly pest number during the study was detected in the lemon variety Meyer on 19 April 2016 (Fig. 3). After that date, the population density was higher in Kütdiken than in Meyer variety (Fig. 3). In 2016–2017, the lowest population was observed in the Clementine variety, while the lowest density in 2017–2018 was reported in the Dobashi Beni variety (Figs. 1 and 2). Among the mandarin varieties, the highest population was detected in Owari in 2016–2017 and in Robinson in 2017–2018 (Figs. 2 and 4). The highest population among the oranges was observed in Valencia, whereas the lowest was in Fukumoto (Fig. 2). Among the grapefruit varieties, the population density was higher in Star Ruby than in Marsh seedless (Fig. 2). The population differences in abundance among citrus varieties decreased as the season progressed. *Thrips hawaiiensis* was also detected in the loquat placed in the vicinity of the sampling area, with the blooming being observed between November and January (Fig. 5). The number of *T. hawaiiensis* in loquat panicles was higher in 2016–2017 than in 2017–2018 (Fig. 3).

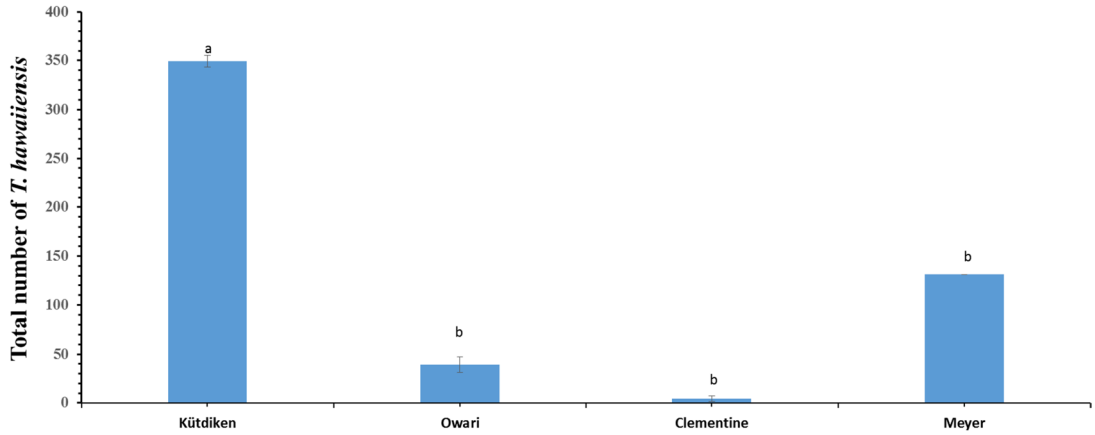


Fig. 1 The total mean numbers of *Thrips hawaiiensis* with standard errors of means in the different varieties of citrus in 2016–2017. Different letters over the bars indicate statistically significant differences according to Tukey test ($P < 0.05$)

The citrus flowering period started in the third week of March in the first year of study and in the first week of April in the second year. The density of *T. hawaiiensis* began increasing after the onset of flowering. In the first year, the number of *T. hawaiiensis* in Meyer variety panicles peaked 1 week after the beginning of flowering, while, in Kütdiken panicles, *T. hawaiiensis* peaked 4 weeks after the onset of flowering (Fig. 3). The population of *T. hawaiiensis* in Clementine and Owari panicles was low. In the second year of study, the number of *T. hawaiiensis* in flowers of Meyer panicles peaked 1 week after the onset of flowering, while in Kütdiken panicles the peak occurred 3 weeks after the beginning of flowering (Fig. 4). The population density of *T. hawaiiensis* in the panicles of orange, mandarin, Palestine sweet lime, and grapefruit varieties was overall very low during the study. The pest population in these varieties generally peaked 2–4 weeks after the onset of flowering. However, its density increased in Owari and Dobashi Beni 6 weeks after the onset of flowering.

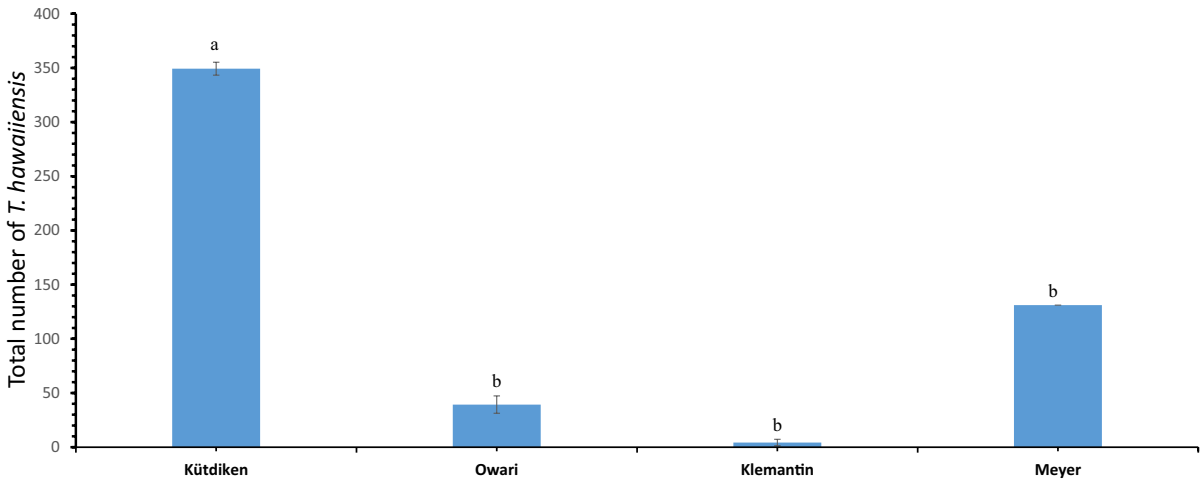


Fig. 2 The total mean numbers of *Thrips hawaiiensis* with standard errors of means in the different citrus varieties in 2017–2018. Different letters indicate statistically significant differences according to Tukey test ($P < 0.05$)

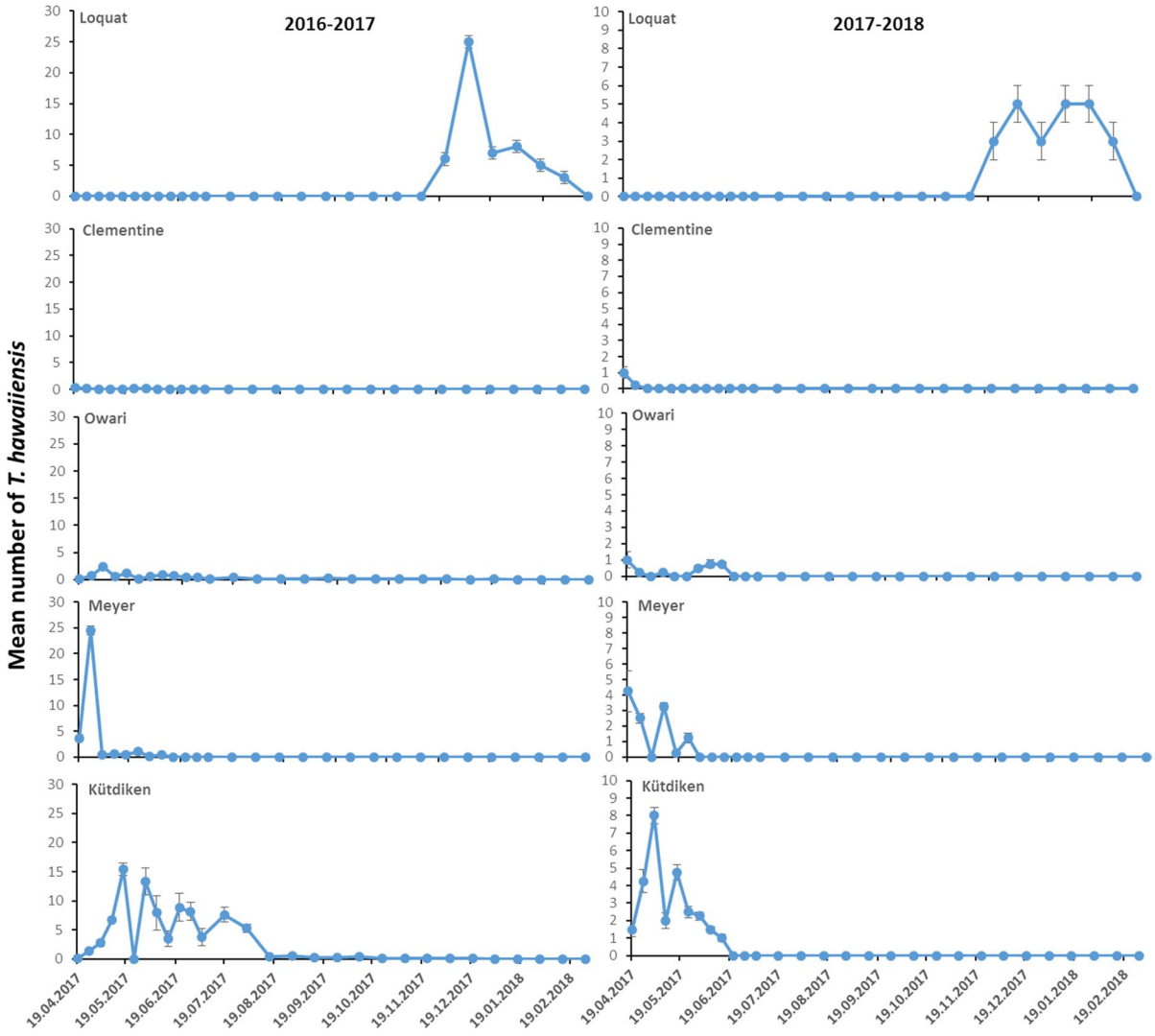


Fig. 3 Mean (±SE) number of *Thrips hawaiiensis* adults on loquat, Clementine, Meyer, Kütdiken, and Owari throughout the study

Differences in the percentage of damage caused by *T. hawaiiensis* were observed among citrus varieties in both the 2016–2017 ($F = 592.282$; $df = 3, 15$; $P < 0.001$) and 2017–2018 ($F = 35.388$; $df = 15, 63$; $P < 0.001$) periods. In the first year of the study, the percent damage of *T. hawaiiensis* among citrus varieties was detected as 52.5%, 46.3%, 4.4%, and 0.0% in Meyer, Kütdiken, Owari, and Clementine varieties, respectively (Table 3). In the second year, the highest damage ratio of *T. hawaiiensis* was observed in the lemon variety Meyer (Table 3).

In our study, the maximum temperature ranged between 20 and 41 °C between March and July 2016 and between 17 and 39 °C in 2017 (Fig. 5). The minimum temperature in 2016 varied between 2 and 24 °C and between 3 and 20 °C in 2017. Also, the rainfall was higher in 2017 than in 2016.

A total of 8 weed species (*Mercurialis annua, Silene gallica, Sinapis alba, Chenopodium album, Scolymus maculatus, Senecio vulgaris, Daucus carota*, and *Amaranthus albus*) were identified in this study, and all of them were in the flowering stage when the sampling started. *Melanthrips pallidior* was observed on *M. annua, S. gallica, S. alba, C. album, S. maculatus*, and *S. vulgaris*, while *T. hawaiiensis* was detected on *A. albus* and *D.*

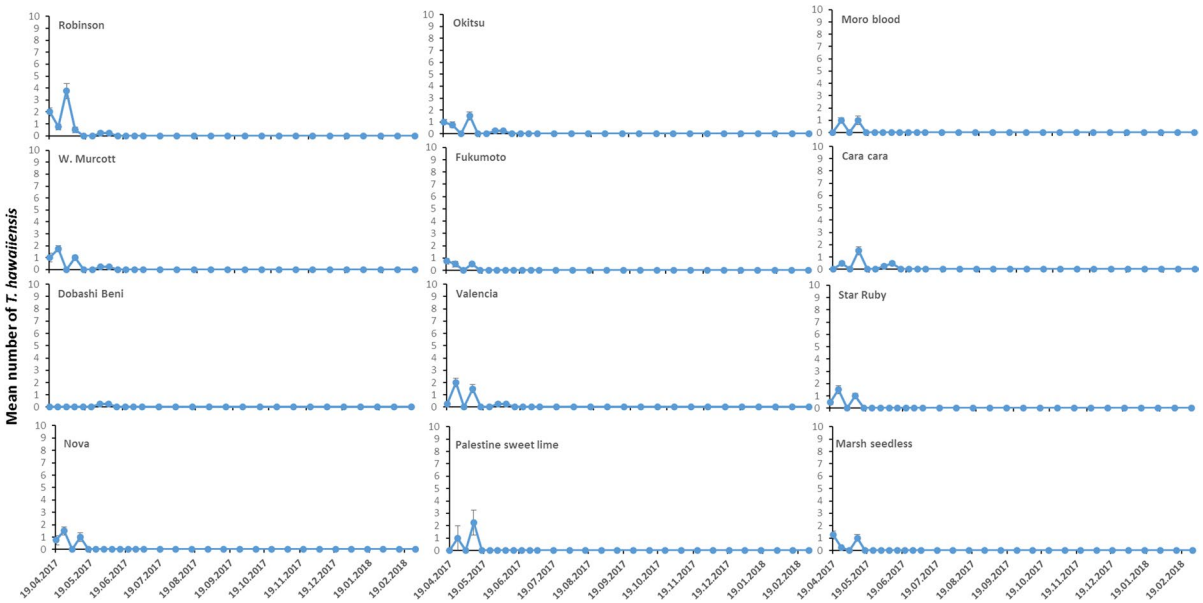


Fig. 4 Mean (±SE) number of *Thrips hawaiiensis* adults on the various citrus varieties in 2017–2018

carota, in which the highest number was recorded (Table 4). The abundance of *M. pallidior* changed throughout each season on weeds and the highest population was detected in *S. alba* in March.

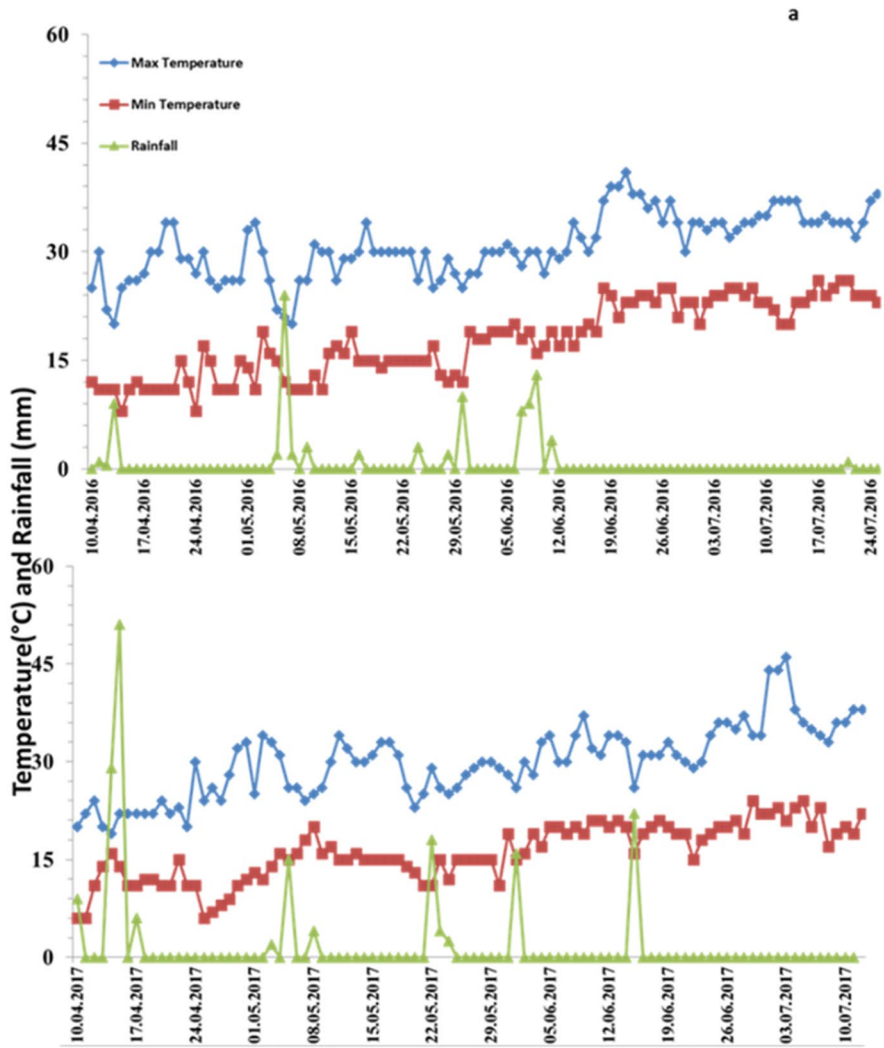
Discussion

Two significant findings arose from the present study. First, field observations showed that the population of *T. hawaiiensis* was higher in Kütdiken than in other citrus varieties. Second, loquat and weeds had an important impact as alternative hosts for seasonal migration of the pest. The blooming was recorded between March and May in citrus and between November and January in loquat trees. After developing in citrus fruits, *T. hawaiiensis* moved to weeds and then overwintered in the loquat trees that blooms in winter.

The density of insect population on various host plants is usually associated with differences in host plant selection. Host preference in phytophagous insects comprises behavioral responses to stimuli including, but not limited to, visual and phagostimulatory characteristics related to host and non-host plants (Visser, 1986). Color and odor are thought to be significant attractants for flower-visiting insects (Faegri & Van der Pijl, 1979). Each flower has a separate model of hue and reflectance, and thrips are attracted by some colors such as bright pink (Wang et al., 2013). The color of the lemon flower is purple-white, while white is the predominant color of other citrus varieties in our study. Here, the population density of *T. hawaiiensis* was higher in lemon flowers than in the other citrus species, and this could be associated with flower color.

Thrips hawaiiensis has become the predominant thrips species in the flowers of many plants, including mango and weeds in Malaysia (Aliakbarpour & Salmah, 2011) and citrus in Florida (Childers & Nakahara, 2006). In many provinces of China, particularly Hainan Province, *T. hawaiiensis* is a dominant insect pest on bananas and mango, causing increasing amounts of serious damage to these fruit crops (Fu et al., 2016, 2018). In addition, *T. hawaiiensis* can also damage pepper, eggplant, and other vegetables (Yuan et al., 2008). The Hawaiian flower thrips has quickly acclimated to citrus and nectarine fruits in Türkiye, primarily due to its invasive characteristics, including high fecundity and short life cycle. (Atakan et al., 2015). The present study observed that *T. hawaiiensis* adapted to both loquat and weeds as well.

Abiotic factors such as rain may affect the population density of insects (Kao, 1984). In fact, thrips



b

Host	J	F	M	A	M	J	J	A	S	O	N	D
Mercurialis annua												
Silene gallica												
Sinapis alba												
Chenopodium album												
Scolymus maculatus												
Senecio vulgaris												
Daucus carota												
Amarantus albus												
Eriobtyra japonica												
Citrus lemon												
Citrus reticulata												
Citrus paradisi												
Citrus sinensis												

Fig. 5 Meteorological data (**a**) and blooming time of thrips host species (**b**) observed during the study. Red cells indicate a high flower rate, yellow cells indicate a low flower rate, and white cells indicate no flower

Table 3 Percentage scars around calix by *Thrips hawaiiensis* on different citrus fruit varieties in 2016–2017 and 2017–2018

Variety	Damage (%)	
	2016–2017	2017–2018
Kütdiken	46.3 ± 1.61b	1.9 ± 0.63 cd
Meyer	52.5 ± 1.44a	15.6 ± 1.2a
Palestine sweet lime	-	0.0 ± 0.00d
Nova	-	1.9 ± 0,63 cd
Okitsu	-	0.0 ± 0.00d
Owari	4.4 ± 0.63c	1.9 ± 0.63 cd
Dobashi Beni		4.4 ± 0.63c
Clementine	0.0 ± 0.00c	1.3 ± 0.72 cd
Robinson	-	1.3 ± 0.72 cd
W. Murcott	-	1.9 ± 0.63 cd
Moro blood		10.6 ± 1.20b
Cara cara	-	9.4 ± 0.63b
Fukumoto	-	5.0 ± 1.02c
Valencia	-	1.9 ± 0.62 cd
Marsh seedless		3.1 ± 0.63 cd
Star Ruby		1.3 ± 1.44 cd

Means and their standard errors are listed. Different letters indicate statistically significant difference according to Tukey's test ($P < 0.05$)

are exposed to raindrops when frequent rainfalls occur (Kirk, 1997), and rainy days are likely to increase the expenditure of energy as thrips attempt to escape drops, thereby reducing the thrips feeding rate (Aliakbarpour et al., 2010). Hence, frequent rain throughout the rainy season can diminish population densities of this insect (Aliakbarpour et al., 2010). In our study, the total number of *T. hawaiiensis* was lower in 2017–2018 than in 2016–2017. This situation could be related to temperature and rainfall. Belaam-Kort et al. (2021) indicated that *Thrips* spp. were generally active in spring and early summer during the flowering period of citrus and when the average temperature ranged from 20 to 25 °C. Also, after this period and when the temperature exceeded 30 °C, thrips populations gradually decreased until disappearance because of the absence of flowers and young fruits. In our study, a similar result was observed, as the population of *T. hawaiiensis* was low between August and November.

Table 4 The population density of thrips species in flowers on weed

Variety	Species	Total
Daucus carota	*Thrips hawaiiensis*	19
	Melanthrips pallidior	1
Mercurialis annua	*Melanthrips pallidior*	14
Silene gallica	*Melanthrips fuscus*	36
Senecio vulgaris	*Melanthrips pallidior*	24
Amaranthus albus	*Thrips hawaiiensis*	9
	Melanthrips pallidior	2
Chenopodium album	*Melanthrips pallidior*	17
Sinapis alba	*Melanthrips pallidior*	92
Scolymus maculatus	*Melanthrips pallidior*	1

The significant population density differences among citrus varieties may be due to host-based effects. Our findings indicate that *T. hawaiiensis* is an important pest of lemon. The presence of *T. hawaiiensis* in citrus varieties was observed until after bloom (after June), after which *T. hawaiiensis* adults were detected on *D. carota* and *A. albus* between July and August, during the weed blooming time. Our findings are in agreement with those of Atakan et al. (2021), who did not find thrips larvae on weeds, suggesting that weeds may be alternative hosts for seasonal migration. In Türkiye, the blooming time of loquat was between November and February, and in that period adults and larvae were detected on loquat flowers. In these months, few plant species produce flowers in Türkiye Therefore, loquats represent a significant host and refuge in or around citrus orchards and are very important for overwintering of *T. hawaiiensis*. Loquats are mainly propagated through seed, so they may grow naturally and are abundant in orchards and parks.

Murai (2001) estimated the lowest threshold temperature for *T. hawaiiensis* as 10.4 °C. In November-January, the blooming period of loquat in the investigated region, the mean temperature in the last 29 years was 15.8 °C in November, 11.1 °C in December, 9.5 °C in January (5.6 °C min − 15 °C max), and 10.7 °C in February. Therefore, the pest can continue its development on loquat in winter and move to citrus at blooming, which occurs between March and April. Both the blooming time of the loquat and the low development threshold temperature of *T. hawaiiensis* caused loquat to become the key overwintering host plant.

Both loquat and *T. hawaiiensis* are native to East Asia. Among thrips, *T. hawaiiensis* is the dominant

species in loquat trees in China and Türkiye (Cao et al., 2018, 2020, 2021; Atakan et al., 2021), whereas it is not as prevalent in regions like Italy, Spain, and Florida (Childers & Achor, 1991; Vono et al., 2022). This situation can be related to climate, but the host plants may also have a significant role in pest population dynamics. This research showed that loquat plays a critical role in the annual life cycle of *T. hawaiiensis*, and the pest population might be lower in the absence of loquat in or around citrus orchards. Therefore, a better knowledge of pest refuges and overwintering hosts is critical to understanding the population fluctuation of *T. hawaiiensis* and planning successful management strategies.

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Author contributions SS, GT, EAS and İY conceived the ideas and designed the methodology; SS, EAS and İY conducted the experiments; SS and GT conducted the acquisition of data, analysis and interpretation of data; SS and GT wrote the manuscript and revised critically. EAT made the all identification of the thrips. All authors contributed critically to the drafts and gave final approval for publication.

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Data availability All data generated or analyzed in this study are available in this published manuscript.

Declarations

Ethics approval This article does not contain any studies with human participants or animals performed by any of the authors.

Consent to participate Not applicable.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

Conflict of interest There is no conflict of interest.

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