Türk. entomol. derg., 2020, 44 (3): 285-294
DOI: http://dx.doi.org/10.16970/entoted.651503

ISSN 1010-6960
E-ISSN 2536-491X

***Original article (Orijinal araştırma)***

# Detection and monitoring of *Thrips meridionalis* (Priesner, 1926) (Thysanoptera: Thripidae) with the colored sticky traps[1]

*Thrips meridionalis* (Priesner, 1926) (Thysanoptera: Thripidae)'in renkli tuzaklar ile tespiti ve izlenmesi

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## Abstract

This study was conducted to determine the capture rates of *Thrips meridionalis* (Priesner, 1926) (Thysanoptera: Thripidae) adults on different colored traps between 2017 and 2019 in Isparta Province of Turkey. Three locations were selected for investigation: (1) various orchards with apple trees, (2) various orchards with cherry trees, and (3) various orchards with walnut. The active period of the insect was determined to be between 15 March and 1 April over the three years. Ghost-white traps captured the most *T. meridionalis* and the differences between this color trap and other colored traps were found significantly differed according to a Tukey's HSD test in all orchards and in all years (P<0.001). It is suggested that an important technique in integrated pest management for monitoring and controlling of *T. meridionalis* adults could be to use ghost-white sticky traps.

**Keywords:** Apple, cherry, colored traps, peach thrips, walnut

## Öz

Bu çalışma *Thrips meridionalis* (Priesner, 1926) (Thysanoptera: Thripidae) erginlerinin farklı renk tuzakları ile yakalanma oranlarının belirlenmesi amacı ile 2017-2019 tarihleri arasında Isparta ilinde yapılmıştır. Denemeler 3 farklı lokasyonda yapılmıştır: (1) elma ağırlıklı meyve bahçesi, (2) kiraz ağırlıklı meyve bahçesi ve (3) ceviz ağırlıklı meyve bahçesi. Zararlının aktif uçuş zamanının üç yıllık çalışma verilerine dayanarak 15 Mart-01 Nisan tarihleri aralığında olduğu tespit edilmiştir. Çalışma sonunda en fazla *T. meridionalis* bireyi cezbeden renk, kirli beyaz olarak belirlenmiş ve Tukey HSD testi sonuçları sözü edilen rengin çekicilik oranının diğer tüm renklerin çekicilik oranına göre tüm meyve bahçelerinde ve tüm deneme boyunca farklı olduğunu göstermiştir (P<0.001). *Thrips meridionalis* erginlerinin izlenmesi ve kontrolü için kirli beyaz renk tuzaklarının entegre mücadelede kullanılabilirliğinin etkili bir yöntem olabileceği düşünülmektedir.

**Anahtar sözcükler:** Elma, kiraz, renkli tuzaklar, şeftali thripsi, ceviz

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[1] This study is presented orally and published as summary at the International Conferences on Science and Technology (26-30 August, 2019) in Kosovo. Part of this work was supported by Global Change Research Institute of the Czech Academy of Sciences.

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Received (Alınış): 27.11.2019 Accepted (Kabul ediliş): 18.03.2020 Published Online (Çevrimiçi Yayın Tarihi): 12.05.2020

## Introduction

Thrips (Thysanoptera), minute and slender insect, are widespread throughout the world in many temperate zones, with even a few species living in arctic regions. Their minute size makes them difficult to detect. Thrips have fringed wings and are blown by the wind which assists their natural ability to disperse widely (Grasselly et al., 1995). About 5,000 species have been described and only a few hundred are crop pests, however, these can cause serious direct damage or transmit pathogens to growing crops and harvestable produce (Grasselly et al., 1995). Therefore, thrips are a major economic threat to many plant industries (Sathe et al., 2015). Although colored sticky traps can accidentally capture of beneficial insects, controlling and monitoring of thrips has been commonly done with colored sticky traps (Martin et al., 2011; Atakan & Pehlivan, 2015).

*Thrips meridionalis* (Priesner, 1926) (Thysanoptera: Thripidae), peach thrips, is a species widely distributed in the warmer parts of Europe (Alford, 2007). Adult females and males look similar each other but males have a paler color. Their body color is brownish-black. Antenna of adults have eight segments, including two segmented styli (Alford, 2007). Peach thrips can be found in the flowers of almond, apple, apricot, cherry, grapevine, nectarine, pear, peach, plum and other species in the Rosaceae (Alford, 2007; Hazır et al., 2011; Uzun et al., 2015; Kaplan et al., 2016).

In southern Europe, *T. meridionalis* has three overlapping generations per year. Adults overwinter under dead leaves. They become active with the rise of temperature depending on the region, the earliest in mid-February through to late-May. They initially feed on early-flowering hosts, such as an almond. When the other host plants begin to flower, peach thrips then migrate to these hosts (Alford, 2007; Uzun et al., 2015; Kaplan et al., 2016).

During the ovulation period, eggs are deposited in the flowers over several weeks. Adults emerge over about one month. Females of the second generation deposit their eggs in leaves or fruit. The third-generation mates during autumn and fertilized females overwinter (Lacasa et al., 1991; Alford, 2007).

Thrips infestation of flowers can reduce fruit set owing to damage to the stamens and may cause development of necrotic patches on fruitlets due to damage to the ovaries. Sometimes very young fruitlets can be damaged and develop necrosis. These damaged areas enlarge while the fruitlets are growing. The damaged areas can split, allowing resin to exude from the cracks. Damaged fruits may wither and die without reaching maturity (Grasselly et al., 1995; Alford, 2007).

The capturing efficiency of colored sticky traps has been tested for many thrips species, especially *Frankliniella occidentalis* (Pergande, 1895) (Thysanoptera: Thripidae), and their predators, and *Orius niger* (Wolff, 1811) (Hemiptera: Anthocoridae). These traps are also used to determine the spatial distribution of both the pests and their natural enemies (Atakan & Canhilal, 2004; Atakan, 2010; Atakan & Bayram, 2011; Elekcioglu, 2013). However, such studies have not been conducted for *T. meridionalis* in Turkey.

Although *T. meridionalis* has been detected in low population densities in some areas of Turkey (Hazır et al., 2011), its population density is high in Atabey District, Isparta, due to presence of suitable hosts and climate. Therefore, the possibility of using colored sticky traps for *T. meridionalis* was investigated in this study.

## Materials and Methods

### Selection of study area

The study was conducted in three years, 2017, 2018 and 2019. Colored sticky traps were set up between 1 March and 15 April in each year. The active period of adults was determined to be 15 March to 27 March in 2017, 19-30 March in 2018 and 23 March to 1 April in 2019. The three locations were selected for investigation: (1) various orchards with apple trees (37°56’33.71" N, 30°37’31.96" E), (2) various orchards with cherry trees (37°56'24.06"N, 30°37’29.97"E), and (3) various orchards with walnut (37°56’36.51" N, 30°37’32.44" E) in Atabey District, Isparta Province.

**Sampling method**

Eleven different colors (RGB hexadecimal color codes given in parentheses) were tested for capture of *T. meridionalis*: ghost-white (F8F8FF), floral-white (FFFAF0), silver (C0C0C0), dodger-blue (1E90FF), deep-sky-blue (00BFFF), sky-blue (87CEEB), dark-red (8B0000), dark-olive-green (556B2F), coral (FF7F50), hot-pink (FF69B4) and yellow (FFFF00). Colored paper (21 x 30 cm), glued to a 0.6 mm thick cardboard backing and attached vertically to 2-m high posts in the three locations.

Three replicate blocks, each with a single trap of each color, were established in each orchard, giving 33 traps in each location. The colors were distributed randomly within each block. Traps were placed 1 m apart and blocks 50 m apart. Based on the findings of previous studies, the traps were placed 2 m above the soil surface in sunny places. The traps were checked each day during the study. Some of the traps were replaced with new ones at different times of the day when they were found with a high density of *T. meridionalis*. At the end of each year, all traps were collected and captured specimens counted under a binocular microscope in a laboratory. Selected specimens were placed in 70% ethanol for later identification.

**Thrips identification**

Adult females of *T. meridionalis*: body brownish black; 8-segmented antenna, third antenna segment light yellowish. Adult males: similar to female but paler in color. Adult females of *Thrips tabaci* Lindeman, 1889 (Thysanoptera: Thripidae): pale yellow to dark brown; antenna 7-segmented, segment I light yellow, yellowish gray; II darker grayish brown; bases of II-IV and V usually pale with apices brown. About 1.3% of the individuals were determined as *T. tabaci*.

**Climatic Data**

Climatic data devices (HOBO Data Logger, Onset Computer Corporation4, Bourne, MA, USA) were set up for measurement of ambient temperature at each of the three locations. The average climatic data across the three locations are shown in Figure 1.

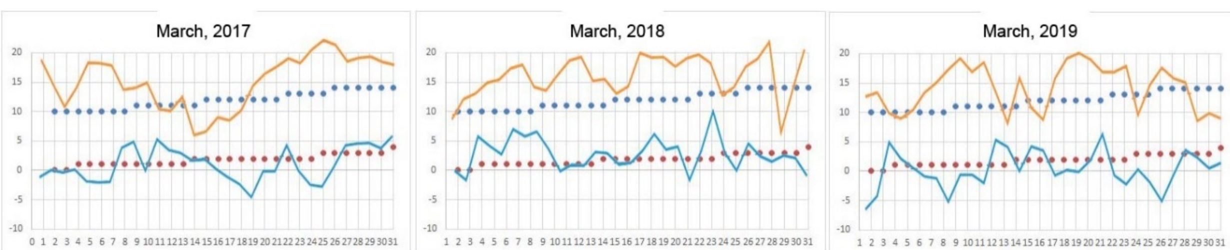


Figure 1. Average daily minimum (lower solid line) and maximum (upper solid lines) temperatures recorded in the three experimental locations. The dotted lines indicate the daily average of temperatures. X-axis: days; y-axis: temperature values.

**Data analysis**

Repeated measures analysis of variance (ANOVA) (SPSS version 10.1, IBM, Armonk, NY, USA) was performed to determine the effect of three factors (color, location and year) and their interactions on capture rates of *T. meridionalis.* The number of *T. meridionalis* capture with the different colors was the dependent variable. Data for each of the three years were treated as repeated measure and repeated measurements applied to the factor’s levels of the year and color. Tukey’s post hoc tests (multiple comparisons) were performed for evaluate the differences between the level averages of the factors ($P<0.05$). An ANOVA

(Tukey's honest significant difference test; HSD) was calculated to examine the differences of number of adults captured on the different colored sticky traps ($P<0.05$).

No *T. meridionalis* were captured on some colors (coral, dark-olive-green, dark-red, hot-pink and silver) during the study, so these colors were dropped from the analysis.

The numbers captured on the different colors were also examined by cluster analysis. Similarity analyses were calculated with the Multi-Variate Statistical Package (MVSP) 3.11c (Kovach, 1999). Similarity coefficients were compared by percent similarity. The average linkage between two groups is considered as the average distance between all pairs of cases and one number from each group. The percent similarity equation was:

$$PS_{A,B} = 100 \sum_{i=1}^{n} \min(P_{iA}, P_{iB})$$

where $P_{A,B}$ is the percent similarity of color trap A and color trap B, $P_{iA}$ is the proportion of individuals of color trap A in the $i^{th}$ (relating to total number of individuals of color trap A), $P_{iB}$ is the proportion of individuals of color trap B in the $i^{th}$, and n is the total number of color trap.

Dendrograms were produced according to the unweighted pair-group mean arithmetic method using MVSP software.

## Results

*Thrips meridionalis* was only captured on deep-sky-blue, dodger-blue, floral-white, ghost-white, sky-blue and yellow colored traps.

A total of 23,226 thrips were captured on the traps across the locations; 7,998, 8,111 and 7,117 in 2017, 2018 and 2019, respectively. The most (2,863) were captured at Location 3 in 2017, and the least (2225) at Location 1 in 2019. The was no correlation between temperature and capture rate.

The effect of year by location, year by color, location by color, and year by location by color interaction on population of *T. meridionalis* performed by repeated measures-ANOVA is shown Table 1.

Table 1. Repeated measures ANOVA for *Thrips meridionalis* captured on colored sticky traps

| Interaction | Df | Mean Square | F | P* |
|---|---|---|---|---|
| Year x Location | 4 | 1405 | 1.85 | 0.184 |
| Year x Color | 10 | 2475 | 3.76 | **0.001** |
| Location x Color | 10 | 1656 | 2.28 | **0.040** |
| Year x Location x Color | 20 | 876 | 1.33 | 0.196 |

* Significant effects are indicated in bold.

Repeated measures ANOVA showed statistically significant year by color ($F=3.76$, df=10; 60, $P=0.001$) and location by color ($F=2.28$, df=10; 30, $P=0.040$) interactions, but year by location and year by color by location interactions were not statistically significant (Tables 2 & 3).

The effect of year by color ($F=3.76$, df=10; 60, $P=0.001$) and location by color ($F=2.28$, df=10; 30, $P=0.040$) interactions may have resulted from different capture rates of traps in different years. However, the differences in capture rate with ghost-white compared to other colors was statistically significant for both year by color and location by color interactions (Tables 2 & 3).

Ghost-white traps had significantly higher numbers of captured *T. meridionalis* than the other colored traps and represented the majority of the capture over all locations and years (Figure 2). Floral-white traps the second highest captures (mean captured *T. meridionalis* is given in Table 4).

Table 2. Mean number of *Thrips meridionalis* caught by the different colored sticky traps during 2017-2019

| | 2017 | | | 2018 | | | 2019 | | |
|---|---|---|---|---|---|---|---|---|---|
| Color | T | M±SE | | T | M±SE | | T | M±SE | |
| Y | 50 | 5.6±0.51 | Da | 105 | 11.7±0.74 | Ca | 49 | 5.4±0.59 | Ca |
| DSB | 286 | 31.8±0.74 | Ca | 290 | 32.2±1.99 | Ca | 209 | 23.2±2.68 | Ca |
| DB | 165 | 18.3±1.00 | CDa | 124 | 13.8±0.48 | Ca | 58 | 6.4±0.68 | Ca |
| GW | 6673 | 741.4±24.20 | Aa | 6674 | 741.6±14.24 | Aa | 5999 | 666.6±23.95 | Aa |
| FW | 581 | 64.6±1.61 | Ba | 675 | 75.0±1.41 | Ba | 602 | 66.9±1.35 | Ba |
| SB | 243 | 27.0±1.65 | Ca | 243 | 27.0±1.51 | Ca | 200 | 22.2±0.58 | Ca |

Data were pooled over locations. T, total number; M, mean; SE, standard error of the mean; Y, yellow; DSB, deep-sky-blue; DB, dodger-blue; GW, ghost-white; FW, floral-white; SB, sky-blue; Means in the same column followed by the same letter are not statistically different, Tukey's post hoc test. Capital letters show the difference between within years, and lower letters between years.

Table 3. Results of repeated measures-ANOVA for *Thrips meridionalis*

| | Location I | | Location II | | Location III | |
|---|---|---|---|---|---|---|
| Color | M±SE | | M±SE | | M±SE | |
| Y | 9.3±0.72 | Da | 7.0±0.72 | Ca | 6.3±0.72 | Ca |
| DSB | 37.0±1.38 | Ca | 28.6±1.38 | Ca | 21.7±1.38 | Ca |
| DB | 15.2±0.46 | CDa | 11.7±0.46 | Ca | 11.7±0.46 | Ca |
| GW | 690.9±21.98 | Aa | 708.8±22.0 | Aa | 749.9±21.98 | Aa |
| FW | 68.0±0.56 | Ba | 70.9±0.56 | Ba | 67.6±0.56 | Ba |
| SB | 25.1±1.56 | CDa | 25.7±1.56 | Ca | 25.4±1.56 | Ca |

Data were pooled over sampling years. T, total number; M, mean; SE, standard error of the mean; Y, yellow; DSB, deep-sky-blue; DB, dodger-blue; GW, ghost-white; FW, floral-white; SB, sky-blue; Means in the same column followed by the same letter are not statistically different, Tukey's post hoc test. Capital letters show the difference between within location, and lower letters between locations.

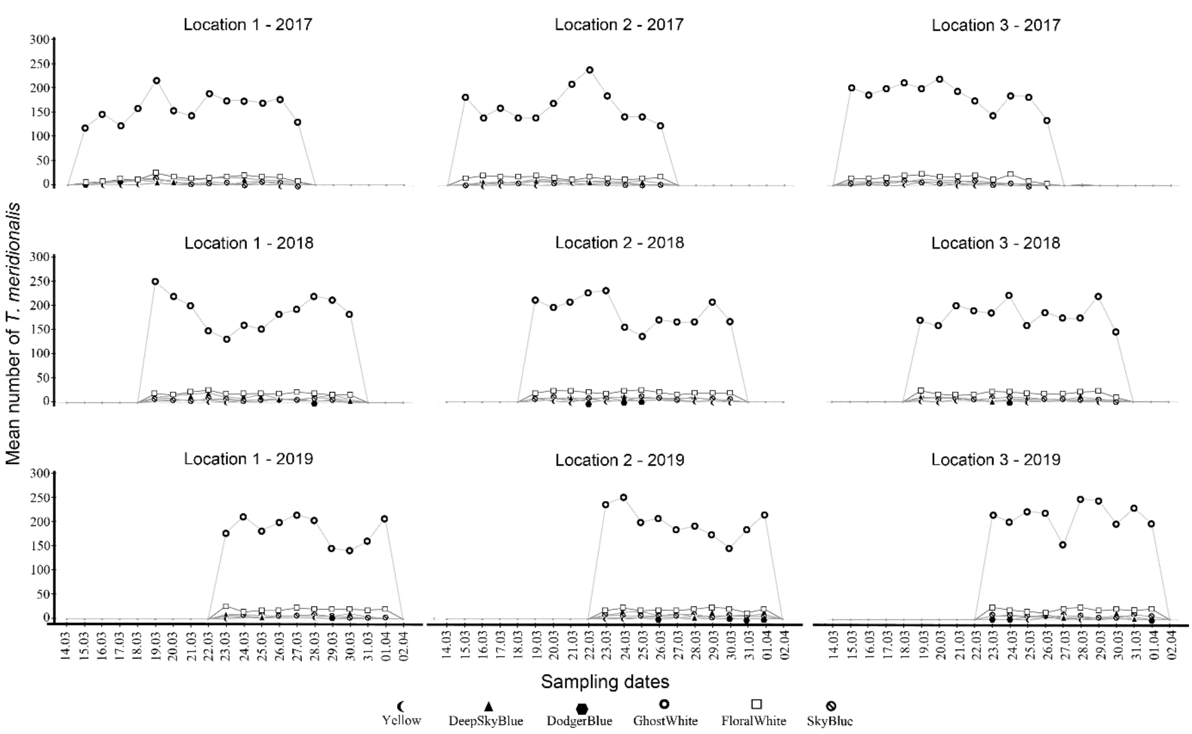


Figure 2. Daily capture of *T. meridionalis* in six colored sticky traps in three locations from 2017 to 2019.

Ghost-white traps captured most *T. meridionalis* and this was significantly different from all other colors according to a Tukey's HSD test in all locations and years. There were significant differences in the capture rates between most of the colors in each location and year, especially for ghost-white*s* (F=2950, df=5; 30, P<0.001).

In 2017, the most thrips were captured on ghost-white color at Location 3 (2438) between 15 and 27 March (Figure 2). This was followed by Locations 2 and 1 (2133 and 2102). Differences between capture rates with floral-white and deep-sky-blue were statistically different from yellow whereas individual capture rates of sky-blue and dodger-blue were not statistically different from yellow at Location 1. Also, significant differences were found between floral-white color yellow. However, differences in capture rates with yellow, deep-sky-blue, dodger-blue and sky-blue were not significant at both Locations 2 and 3 (Table 4).

Table 4. Mean number of adults of *Thrips meridionalis* caught by the different colored sticky traps at three locations from 2017 to 2019

| 2017 | Location I | | | Location II | | | Location III | | |
|---|---|---|---|---|---|---|---|---|---|
| Color | T | M±SE | | T | M±SE | | T | M±SE | |
| Y | 13 | 2.2±0.60 | c | 14 | 2.0±0.69 | c | 23 | 3.3±0.71 | c |
| DSB | 128 | 9.9±1.01 | b | 86 | 6.6±1.03 | bc | 72 | 6.6±1.17 | bc |
| DB | 65 | 5.4±1.09 | bc | 50 | 4.2±0.71 | bc | 50 | 4.2±0.71 | bc |
| GW | 2102 | 161.7±7.9 | a | 2133 | 164.1±9.29 | a | 2438 | 187.5±6.81 | a |
| FW | 184 | 14.2±1.60 | b | 202 | 15.5±0.85 | b | 195 | 15.0±1.76 | b |
| SB | 81 | 6.2±1.15 | bc | 77 | 6.4±0.78 | bc | 85 | 6.1±0.74 | bc |
| 2018 | Location I | | | Location II | | | Location III | | |
| Color | T | M±SE | | T | M±SE | | T | M±SE | |
| Y | 50 | 4.6±0.61 | c | 34 | 0.7±2.21 | c | 21 | 1.9±0.41 | c |
| DSB | 144 | 12.0±1.38 | b | 77 | 6.4±2.91 | bc | 69 | 6.3±1.20 | bc |
| DB | 51 | 4.6±0.68 | c | 36 | 3.6±2.12 | bc | 37 | 4.1±6.80 | bc |
| GW | 2260 | 188.3±10.13 | a | 2246 | 187.2±30.45 | a | 2168 | 180.7±0.92 | a |
| FW | 226 | 18.8±0.89 | b | 239 | 19.9±3.15 | b | 210 | 17.5±0.63 | b |
| SB | 81 | 6.8±0.74 | bc | 83 | 6.9±1.98 | bc | 79 | 6.6±0.41 | bc |
| 2019 | Location I | | | Location II | | | Location III | | |
| Color | T | M±SE | | T | M±SE | | T | M±SE | |
| Y | 21 | 2.1±0.41 | c | 15 | 2.5±0.81 | c | 13 | 2.2±0.54 | c |
| DSB | 61 | 6.1±0.91 | bc | 94 | 9.4±1.06 | bc | 54 | 6.0±0.78 | bc |
| DB | 21 | 2.3±0.55 | c | 19 | 2.7±0.64 | c | 18 | 4.5±0.96 | bc |
| GW | 1856 | 185.6±8.82 | a | 2000 | 200.0±9.72 | a | 2143 | 214.3±8.86 | a |
| FW | 202 | 20.2±1.02 | b | 197 | 19.7±1.09 | b | 203 | 20.3±1.16 | b |
| SB | 64 | 6.4±0.96 | bc | 71 | 7.1±0.59 | bc | 65 | 6.5±0.75 | bc |

T, total number; M, mean; SE, standard error of the mean; Y, yellow; DSB, deep-sky-blue; DB, dodger-blue; GW, ghost-white; FW, floral-white; SB, sky-blue; Means in the same column followed by the same letter are not statistically different by Tukey's HSD test (P<0.05).

In 2018, the most thrips were captured on ghost-white color at Location 1 (2260) between 19 and 30 March (Figure 2). This was followed by Locations 2 and 3 (2246 and 2168). Significant differences (P<0.05) were found between ghost-white and the other colors in all years. Whereas differences between deep-sky-blue, dodger-blue, floral-white and sky-blue were not significant but these were statistically different from yellow at Locations 1 and 2. Similar were found at Location 3 (Table 4).

In 2019, the most thrips were captured on ghost-white Location 3 (2143) between 23 March and 1 April (Figure 2). This was followed by Locations 2 and 1 (2000 and 1856). Ghost-white capture rate was statistically significant from the other colors at all locations. Yellow had the lowest capture rate and this was statistically different from all other colors at Location 1. Dodger-blue had the same capture rate as yellow at Locations 2 and 3. There was no significant difference between deep-sky-blue, dodger-blue, floral-white and sky-blue at any locations (Table 4).

The dendrogram (Figure 3) shows that ghost-white was the most dissimilar color and it differed significantly from all other colors in all years and at all localities.

Sky-blue and dodger-blue were found to be similar to each other (61%) and as the most similar at Location 1 in 2017. However, the most similar colors at Location 2 were dodger-blue and deep-sky-blue (59%) and at Location 3 it was sky-blue and deep-sky-blue w (63%) in 2017 (Figure 3).

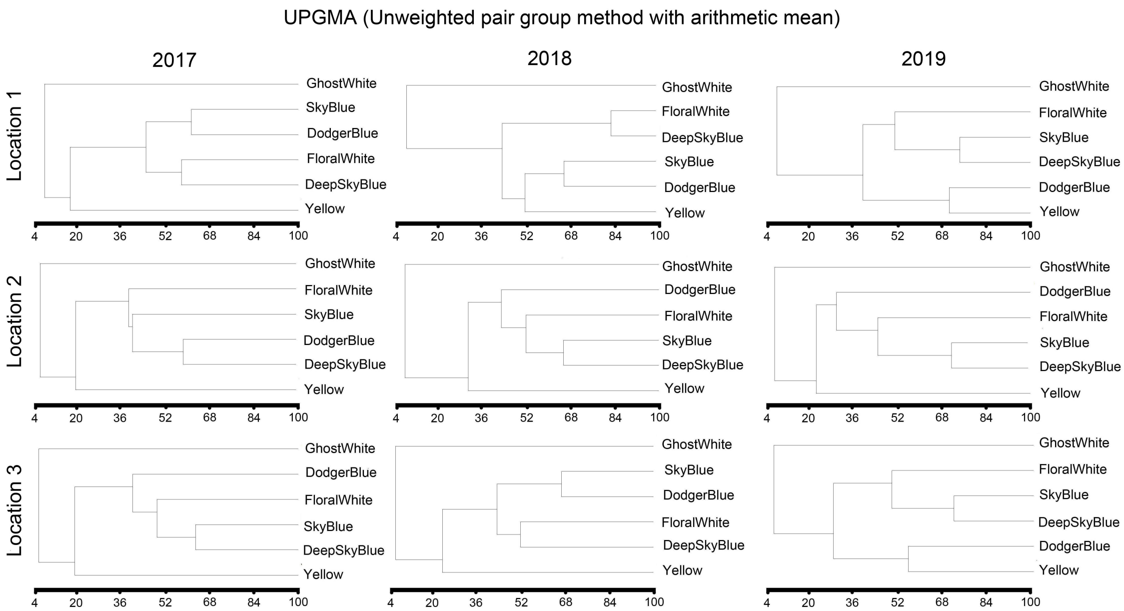


Figure 3. Dendrogram showing the capture similarities for *Thrips meridionalis* with different colored sticky traps based on the analysis of Euclidean data.

In 2018, floral-white and deep-sky-blue were the most similar (84%). Sky-blue and dodger-blue in were the second most similar (67%). Sky-blue and deep-sky-blue were the most similar (65%) at Location 2. Sky-blue and dodger-blue were similar (67%) and the second most similar (52%) were floral-white and deep-sky-blue at Location 3 (Figure 3).

In 2019, the most similar were sky-blue and deep-sky-blue (74%) and dodger-blue and yellow (71%) at Location 1. Sky-blue and deep-sky-blue were the most similar (71%) and floral-white color was similar to these (45%) at Location 2 (Figure 3).

Sky-blue and deep-sky-blue color were the most similar (71%) and dodger-blue and yellow were the second most similar (55%) at Location 3.

## Discussion

According to study of Uzun & Tezcan (2015), *T. meridionalis* was an abundant species (48%) in cherry orchards along the *T. tabaci* (48%), *Taeniothrips inconsequens* (Uzel, 1895) (48%), *Haplothrips reuteri* (Karny, 1907) (41%), *Aeolothrips intermedius* Bagnall, 1934 (14%) and *F. occidentalis* (14%) in Isparta Province. In contrast, Kaplan et al. (2016) reported that *T. meridionalis* was a rare species (0.8%) in Mardin Province, Turkey.

In our study, *T. meridionalis* was found at high population density although it appears to be active only for a short period each year. This might be attributed to host flowering and the other ecological factors. The hosts of *T. meridionalis* are recorded as almond, apple, apricot, cherry, grapevine, nectarine, pear, peach, plum and other species in the Rosaceae (Alford, 2007; Hazır et al., 2011; Uzun et al., 2015; Kaplan et al., 2016). Flowering periods of these hosts will be important for the feeding of *T. meridionalis*. Although the colored sticky traps were in position for about 1.5 months, the number of days in which thrips were captured was quite limited. The emergence of the insect at high population density for only a certain short period followed by a sudden decline is similar to many ecological events. Alford (2007) affirmed that the peach thrips has three overlapping generations annually in Southern Europe and adult individuals overwinter under the dead leaves. They become active with the rise in temperature, depending on the region, the earliest in mid-February through to late-May. They initially feed on early-flowering hosts, such as almond. Result of the present study confirmed those of Alford (2007). We think that the shortness of peach thrips activity period depends on the duration of the flowering period of almonds. In the present study, there were almond trees growing naturally around the selected locations where apples, cherries and walnuts were most cultivated. It was observed that the flowering period of almond and the flight of the thrips were almost the same. The cherry flowering period begins at the end of the almond flowering period. No *T. meridionalis* were captured on any colored sticky traps during that period. This might indicate that thrips might have migrated to cherry flower. This agrees with Alford (2007), Uzun et al. (2015), and Kaplan et al. (2016) who reported that when the other host plants reach the flowering stage, peach thrips migrate to other hosts from the early-flowering hosts. However, the reason for thrips not being caught in cherry orchards could also be in part due to other biotic or abiotic factors. One reason why the thrips were not captured after March might be due to the fact that cherry flowers were more attractive than the colored sticky traps.

Although there have been no studies on the color preferences of *T. meridionalis,* attractiveness of colors has been investigated for many other thrips species (Demirel & Yildirim, 2008; Elekcioglu, 2013; Atakan et al., 2014, 2016; Atakan & Pehlivan, 2015). Thrips have been shown to be most attracted to either white, yellow or blue sticky traps. Raymond (2009) reported that the main technique used to monitoring for western flower thrips, *F. occidentalis,* is to use either blue or yellow traps. In the study of Blumthal et al. (2005) four different colors were tested for *F. occidentalis* and a significantly higher number of *F. occidentalis* was found on yellow colored sticky traps matching *Gerbera jamesonii* Bolus ex Adlam (Asterales: Asteraceae) and *Chrysanthemum* L. (Asterales: Asteraceae). Similar results were found with yellow being the most attractive color for avocado thrips, *Scirtothrips perseae* Nakahara, 1997 (Thysanoptera: Thripidae) and white for predatory thrips, *Franklinothrips orizabensis* Johansen, 1974 (Thysanoptera: Thripidae) and *F. occidentalis* (Yee et al., 1999; Hoddle et al., 2002). Other studies also showed that yellow is the best color for monitoring and controlling *F. occidentalis* (Moreno et al., 1984; Samways, 1986; Blumthal et al., 2005). Some other studies showed that the most attractive color for *F. occidentalis* and *T. tabaci* was blue in lemon and orange orchards (Chen et al., 2004; Kaas, 2005; Elekcioglu, 2013) and blue with UV reflection appears to be an important component of trap efficacy (Ranamukhaarachchi & Wickhramarachchi, 2007). Elimem & Chermiti (2013) reported that the white-cream rose cv. Ociane was more attractive to *F. occidentalis* than the red cv. First-red in greenhouses; 29.5 and 39.9 thrips/flower on Ociane but only 12.4 and 29.6 thrips/flower on First-red, respectively. Rodriguez-Saona et al. (2010) showed that the white colored sticky traps were more attractive to *Scirtothrips ruthveni* Shull, 1909 (Thysanoptera: Thripidae) and *Frankliniella tritici* (Fitch, 1855) (Thysanoptera: Thripidae) compared to yellow or blue traps. However, Natwick et al. (2007) showed that blue traps consistently captured more adult thrips of both *F. occidentalis* and *T. tabaci* compared to yellow. There were no significant differences in numbers of adult *T. tabaci* caught on white and blue colors although blue traps caught significantly more onion thrips, *T. tabaci* than white traps (Liu & Chu, 2004). Walker (1974) reported that white was the most attractive to thrips. Given the better reflection of light compared to other colors, such as blue and yellow, the majority of thrips species, especially flower thrips, are attracted to white traps (Hoddle et al., 2002).

As there is still some disagreement about which color is the most attractive to thrips species, further studies are needed. In our study, capture rates obtained with ghost-white for *T. meridionalis* were significantly ($P<0.001$) greater than all other colors tested.

These variable results for different thrips species, even at the same species, suggest that in addition to the color as observed by the human eye, other ecological factors could be important. Also, the temperature and photoperiod may influence the responses of the thrips (Bournier, 1983). Therefore, other biotic and abiotic ecological factors should be investigated in relation to color attractiveness in order to identify ecological factors involved.

## Conclusions

According to the Tukey's HSD test ($P<0.01$) the largest number of *T. meridionalis* adults were captured on ghost-white sticky traps at all locations during this study. The cluster analysis Euclidean distance for all locations confirmed that ghost-white color traps were more attractive for *T. meridionalis* adults than any of the other colors tested. Therefore, it is concluded that ghost-white sticky traps are a particularly useful way to monitor and control *T. meridionalis* adults.

## Acknowledgements

Part of this work was supported by Global Change Research Institute of the Czech Academy of Sciences. We would like to thank Prof. Dr. Ekrem Atakan (Çukurova University, Agriculture Faculty, Plant Protection Department, Adana, Turkey) for identifying the thrips species. We would also like to thank Assoc. Prof. Dr. Özgür Koşkan (Isparta University of Applied Science, Agriculture Faculty, Isparta, Turkey) for helpful advice on the statistical analysis. This study was presented orally and published as summary at the International Conferences on Science and Technology in Kosovo, 2019.

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