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Bayramiç (Çanakkale) İlçesinde Akdeniz Meyve Sineği, Ceratitis capitata (Wiedemann, 1824)'nın Bazı Meyve Bahçelerinde Popülasyon Gelişmesinin Belirlenmesi

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Özet

Bu çalışma, 2021-2022 yıllarında Çanakkale İli'nin Bayramiç İlçesi'nde ayva, Bayramiç beyazı (Nektarin), elma, incir, kiraz, şeftali ve Trabzon hurması bahçelerinde Akdeniz meyve sineğinin [Ceratitis capitata (Wiedemann, 1824)] popülasyon gelişmesinin belirlenmesi amacıyla yürütülmüştür. Çalışmanın yapıldığı bahçelere birer adet McPhail ve delta tipi feromon tuzakları asılmıştır. Ayrıca, bahçelerde zarar oranını belirlemek için rastgele 100 meyve kontrol edilmiştir. İlk ergin uçuşları, 2021 yılında etkili sıcaklıklar toplamının 1255 gün-derece olduğu 2 Ağustos tarihinde şeftali bahçesinde tespit edilmiştir. Ertesi yıl ise etkili sıcaklıklar toplamının 1146 gün-derece olduğu 29 Temmuz tarihinde incir bahçesinde tespit edilmiştir. Tuzaklarda en fazla ergin birey, 2021 yılında 8 Kasım tarihinde 486 (adet/2 tuzak) olarak Trabzon hurması bahçesinde tespit edilmiştir. Ayrıca, Bayramiç beyazı nektarini, zararlının yeni konukçusu olarak tespit edilmiştir. Çalışma sonucunda, C. capitata'nın zararının tespit edildiği bahçelerdeki zarar oranları Trabzon hurması bahçesinde %15,6, şeftali bahçesinde %14,0, Bayramiç beyazı bahçesinde %8,6 ve ayva bahçesinde %6,1 olarak belirlenmiştir.

Anahtar Kelimeler: C. capitata, Popülasyon Gelişmesi, Feromon Tuzak, Delta Tuzak, McPhail Tuzak

Determining the Population Fluctuation of the Mediterranean Fruit Fly, Ceratitis capitata (Wiedemann, 1824), in Some Fruit Orchards in Bayramiç (Çanakkale)

Abstract

This study was conducted in 2021-2022 in the Bayramiç district of Çanakkale province to determine the population development of the Mediterranean fruit fly [Ceratitis capitata (Wiedemann, 1824)] in quince, Bayramiç beyazı (nectarine), apple, fig, cherry, peach, and persimmon orchards. In the selected orchards, one McPhail and one delta-type pheromone trap were installed. Additionally, 100 fruits were randomly inspected in the orchards to determine the damage rate. The first adult flights were detected in a peach orchard on August 2, 2021, when the total effective temperature was 1255 degree-days. The following year, on July 29, the first adult flights were observed in the fig orchard, with a total effective temperature of 1146 degrees-day. The highest number of adult individuals in the traps was recorded on November 8, 2021, with 486 individuals (adult/2traps) in a persimmon orchard. Additionally, Bayramiç beyazı was identified as a new host for the pest. At the end of the study it was found that the damage rates in the orchards where C. capitata was detected, were 15.6% in the persimmon orchard, 14,0% in the peach orchard, 8.6% in the Bayramiç white orchard, and 6.1% in the quince orchard.

Key words: Pest, Population Development, Pheromone Trap, Delta Trap, McPhail Trap

Introduction

The province of Çanakkale possesses suitable ecological and climatic conditions for fruit cultivation. However, many pest species cause significant losses in fruit production. In addition to damaging plants during different phenological stages, insects act as vectors for diseases, thereby reducing both the quality and yield of crops. Particularly, the high population density of polyphagous pests, which can find food and hosts under any condition, poses major challenges for fruit production (Avcı, 2022).

In Turkey, a total of 24.9 million tons of fruit was produced in 2021 on an area of 35,913,447 decares. The annual production consisted of 38% pome fruits (9.6 million tons), 21% citrus fruits (5.3 million tons), 14% grapes (3.6 million tons), and 11% stone fruits (2.9 million tons) (TÜİK, 2021). The province of Çanakkale, located in the Marmara Region, holds significant potential for fruit production, with a total production of 635,725 tons across 602,131 decares. This includes 36% stone fruits, 23% olives, 20% pome fruits, 10% berries, 7% grapes, and 4% nuts (TÜİK, 2022).

In the Bayramiç district, which accounts for 23.7% of the province's total fruit production, notable outputs include geographically indicated apple production (72,580 tons), covering 69.6% of the province's apple output, and cherry production (12,969 tons), comprising 40.9% of the province's total production. The most important fruit of Bayramiç is Bayramiç beyazı, a nectarine variety that received geographical indication in 2013 and became Turkey's 7th registered product in Europe in 2021. Produced across 7,200 decares with an output of 13,741 tons, almost all of this variety is cultivated in Bayramiç and sold domestically and internationally (TÜİK, 2022).

One of the significant fruit pests in Çanakkale province is the Mediterranean fruit fly (Ceratitis capitata, Wiedemann, 1824) (Diptera: Tephritidae). It is known to infest over 300 hosts, primarily citrus fruits, as well as pome and stone fruits (Christenson and Foote, 1960; Liquido et al., 1991; Vera et al., 2002; Ricalde et al., 2012). Among the 118 fruit fly species present in Turkey, C. capitata has been reported as one of the most significant pests (Kütük et al., 2013).

Effective trapping methods include delta traps containing 9% Nulure + 3% Borax salt + Trimedlure capsule + 88% water, as reported by Zümreoğlu (1990). The shortest development period of C. capitata among its hosts was found in persimmons (22.7 days), and the longest in apples (33.1 days) (Özkan, 1993). Ricalde et al. (2012) reported that the optimal temperature for C. capitata development in Brazil was 30°C. Under favorable conditions, the pest can remain active year-round (Elekçioğlu, 2009).

Previous studies have shown that C. capitata can produce 4-5 generations per year in Aydın, 2-4 in Konya, and up to 7-8 in the Mediterranean region of Turkey (Başpınar et al., 2009; Satar et al., 2016; Satar and Tiring, 2017; Üçpınar, 2019). Other research, such as by Elitaş (2022), recorded significant pest captures in Bursa in 2021, including 660 individuals in peach orchards, 678 in pear orchards, and 1,402 in persimmon orchards.

Ceratitis capitata is a serious issue for the export of many fruits from Turkey, emphasizing the importance of keeping its population below economic damage thresholds through effective management programs (Elekçioğlu, 2009).

This study was conducted in Bayramiç district, an important center in terms of fruit production areas and diversity, to identify the basic criteria for pest management in high-export potential fruits such as Bayramiç Beyazı (nectarine), apple, and cherry.

Material and Methods

This study was conducted in 2021–2022 in the Bayramiç district of Çanakkale province to monitor the population development of the C. capitata in various fruit orchards, including Bayramiç Beyazı (nectarine), peach, cherry, fig, apple, quince, and persimmon. Basic information for pest control will be obtained through the monitoring of population development. In each orchard, McPhail (Decis trap) traps and delta-type pheromone traps were installed to determine pest population development.

The traps used consisted of McPhail (Decis trap: 0.015 g Deltamethrin + 0.5 g Chlorohydrate trimethylamine + 0.03 g 1.5-Diaminopentane + 7.8 g Ammonium acetate) and delta-type traps containing Trimedlure capsules (Figure 1).

Figure 1. McPhail (Decis trap) and delta trap

The study was conducted in two different apple, cherry, Bayramiç beyazı and one peach, quince, persimmon, and fig orchards determined by considering the production density in different villages and neighborhoods of Bayramiç district. The coordinates and characteristics of the orchards are given in Table 1.

Table 1. Study areas and parcel data

Fruit	Location	Variety	Area	Altitude	Coordinate
Apple	Tepecik	Golden/ Red Chief	23,0	112 m	39.8153-26.6483
Apple	Evciler	Pick lady	16,1	301 m	39.7541-26.7900
Cherry	Tepecik	Ziraat 900	12,9	102 m	39.8146-26.6373
Cherry	Evciler	Ziraat 900	8,4	204 m	39.7868-26.7416
Bayramiç	Saçaklı	Bayramiç Beyazı	10,7	84 m	39.8213-26.5536
Bayramiç	Evciler	Bayramiç Beyazı	10,0	276 m	39.7615-26.7776
Peach	Ağaçköy	Sweetlady/ Caldesi85	24,7	98 m	39.8135-26.5700
Quince	Camikebir	Eşme	4,5	91 m	39.8173-26.6031
Persimm	Camikebir	Fuyu	10,0	107 m	39.8225-26.6180
Fig	Bıyıklı (First year)	Bursa Siyahı	122,6	324 m	39.8570-26.7149
Fig	Üzümlü (Second year)	Bursa Siyahı	8,3	164 m	39.7900-26.6854

To assess the population dynamics of Ceratitis capitata in fruit orchards, a McPhail trap (Decis trap) and a delta trap were hung in each orchard. The traps were placed in the orchards, taking into account the species, variety characteristics and crown structures of the trees, 1-1.5 m above the ground and in line with the crown projection in the south-southeast part of the tree. The hung traps were checked regularly twice a week from May to the end of December. In addition, 100 fruits were checked during the weekly checks and their dent status was determined and recorded. The following formula was used for this rate.

$$\text{Ratio of fruit with damage \%} = \frac{\text{Number of fruit with damage}}{\text{Total number of fruits}} X100 \qquad \ldots\ldots\ldots\ldots\ldots(1)$$

The climate data specified during the research were taken from the early warning stations of the Çanakkale Provincial Directorate of Agriculture and Forestry located in the villages of Saçaklı and Evciler in the Bayramiç district.

Results and Discussion

3.1. Determination of the First Adult Flights

To identify the first flight dates of the Mediterranean fruit fly, pheromone traps were placed in the selected orchards on May 24, 2021, and June 14, 2022. In 2021, the first adult captures were observed on August 2 in peach orchard traps, 69 days after trap installation and at an accumulated effective temperature of 1,255 degree-days. In 2022, the first captures were recorded on July 29 in the fig orchard traps, 45 days after installation and at an accumulated effective temperature of 1,146 degree-days. The first adult flights in Bayramiç were observed in late July to early August.

Comparable studies have reported the first flights in early May in peach orchards in Adana (Tiring and Satar, 2017), on August 23 in Bursa (Elitaş, 2022), and on July 30-August 28 in Şanlıurfa (Güler, 2022).

3.2. Population Development of Ceratitis capitata

In the Tepecik apple orchard, the first pest capture was recorded on September 20, 2021, under an average temperature of 27°C and a relative humidity of 60.62%. The population peaked twice: on October 14 (26 adults/trap) and on November 1 (38.5 adults/trap). The last adult was captured on December 7, 2021. However, no pest activity was observed in the Evciler apple orchard during the same season or in the subsequent years (Figure 2).

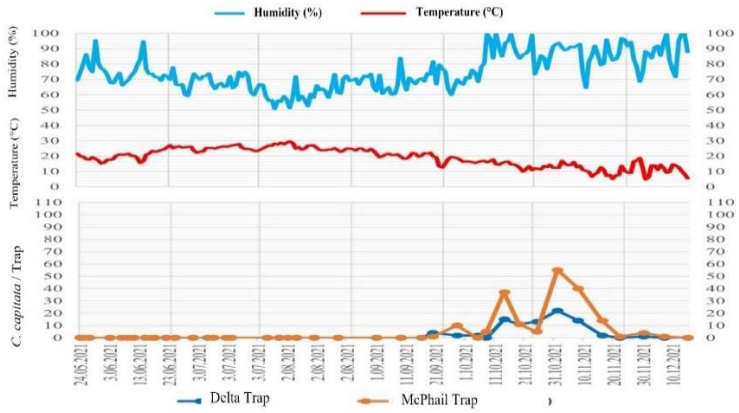


Figure 2. Population development and climate data of *C. capitata* in Tepecik apple orchard in 2021

During the first year of the study, population development was observed in the selected apple orchard in the Tepecik neighborhood; however, no infested fruits were detected. Başpınar et al. (2009) reported in their study that only a small number of adult individuals were caught in traps placed in apple orchards and that no infested fruits were observed.

In the first year of the study, traps placed in a cherry orchard in the Tepecik neighborhood recorded the first occurrence of the pest on August 19, 2021, when the mean temperature was 25.1°C, and the mean humidity was 73.48%. At that time, 0.5 (adult/trap) were caught (Figure 3). In this region, the Mediterranean fruit fly reached its first peak population in the cherry orchard on October 14, 2021, with 13.5 (adult/trap). The highest population density of the Mediterranean fruit fly was recorded on November 8, 2021, with 15 adults per trap. This date also marked the pest's second peak. Following this peak, the pest's presence gradually declined, and the final observation was recorded on November 22, 2021, with 3 adults (adult/trap).

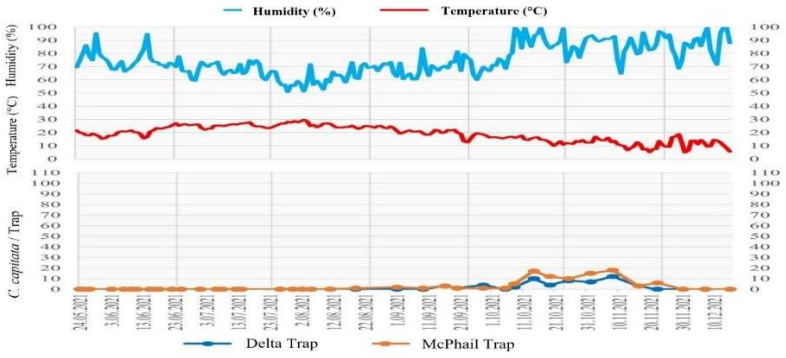


Figure 3. Population development and climate data of *C. capitata* in the Tepecik cherry orchard in 2021

In the first year of the research, no adult individuals were found in the traps placed throughout the production season in the trial area designated as a cherry orchard in the Evciler village, throughout the production season. Similarly, in the second year of the study, traps were placed again in the same orchards, but no pests were recorded in either of the two traps.

In the first year of the research, no adult individuals were found in the traps placed throughout the production season in the trial area selected as a cherry orchard in the Evciler village. Similarly, in the second year of the study, traps were placed in the same orchards, but no pests were found in either trap.

The low pest density in cherry orchards in the Bayramiç region is thought to be due to the completion of the cherry harvest by mid-June, preventing the pest from causing any damage to cherry trees. Buğday and Keçeci (2020) reported in their study conducted in cherry orchards in the Elazığ and Malatya provinces that although cherry is among the hosts of Ceratitis capitata, pest population development in the region begins in July or later, significantly reducing the likelihood of damage to cherries.

In 2021, the first pest occurrence in the Bayramiç Beyazı orchard in Saçaklı village was recorded on August 19, 2021, at the mean temperature was 25.1°C and the mean humidity was 73.48%. On this date, an average of 0.5 adults per trap was captured (Figure 4). The pest reached its first population peak in this orchard on September 16, 2021, at 6 adults per trap. The highest population density of the C. capitata was recorded on October 25, 2021, at an average of 31.5 adults per trap, marking the second population peak. Following this second peak, the population density began to decline, and the final observation was recorded on November 22, 2021, with an average of 0.5 adults per trap.

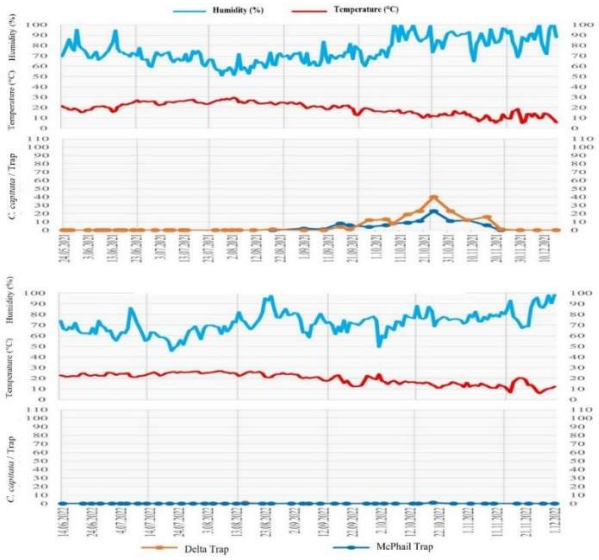


Figure 4. Population development and climate data of *C. capitata* in Bayramiç Beyazı in 2021 and 2022

In the second year of the study, two different traps were placed in the Bayramiç Beyazı orchard in Evciler village and Şaçaklı neighbourhood, but no pest was captured in the traps

Tiring (2015) reported in a study conducted in 2014 in nectarine orchards in Adana that the first flights of C. capitata coincided with the harvest period. He also noted that, fruits on the trees showed increased signs of damage after the end of harvest season with the cessation of pesticide applications, because of the suppressing of the pest with pesticides before the harvest. Similarly, Tamer (2022) reported in a study conducted in Bayraktutan (Iğdır) nectarine orchards that a total of 1,306 individuals were caught in delta and McPhail-type traps, with a damage rate of 17.6% observed in the orchard.

In 2021, the first pest occurrence in the peach orchard in Ağaçköy village was recorded on August 2, when the mean temperature was 27.8°C and the mean humidity was 50.12%. On this date, an average of 0.5 adults per trap were captured (Figure 5). Ceratitis capitata reached its highest population density in the orchard on October 5, 2021, at 196.5 adults per trap, marking the first peak. The pest formed its second population peak on October 19, 2021, with 135.5 adults per trap, and its third peak on November 8, 2021, at 80.5 adults per trap. Following the third peak, the population density gradually declined, with the final observation recorded on November 30, 2021, when 4 adults per trap were captured.

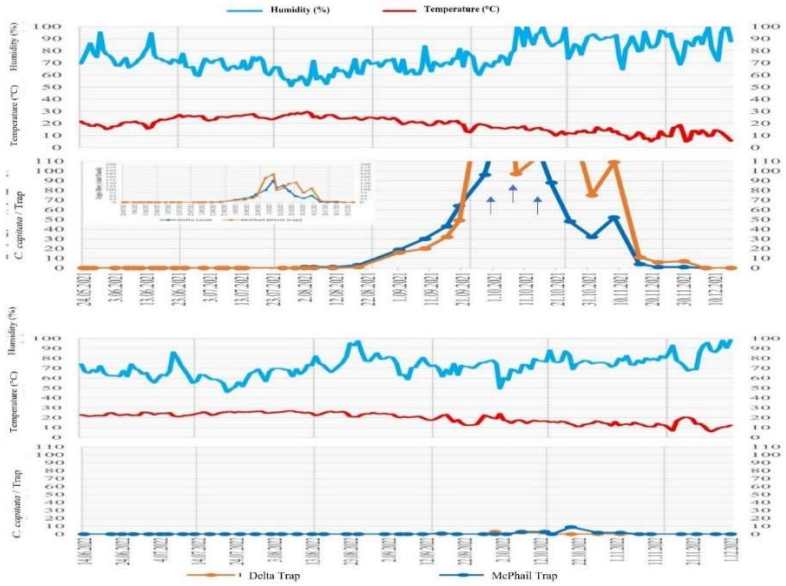


Figure 5. Population development and climate data of *C. capitata* in the peach orchard in 2021 and 2022

In 2022, the first pest occurrence in the peach orchard in Ağaçköy village was recorded on September 20, when the mean temperature was 15.5°C and the mean humidity was 74.75%. On this date, an average of 0.5 adults per trap was captured (Figure 5). The pest population in the peach orchard reached its highest density on October 27, 2022, at 4.5 adults per trap. The last observation of the pest was made on October 15, 2022, with 1 adult per trap. No infested fruits were detected in the peach orchard during 2022. In a study conducted in Brazil in 2002-2003, it was reported that the C. capitata was active in peach orchards between June and December, and that the most intense period of the pest was in early October (41 adult /trap) (Souza-Filho et al., 2007). Büyükbaş (2019) reported that the damage rate of C. capitata in peach orchards in Kayseri province was between 12-15% in 2018 and 1-2% in 2019.

In the Quince orchard located in the Camikebir neighborhood, the first pest occurrence during the first year of the study was observed on September 16, 2021, when the mean temperature was 19.7°C and the mean humidity was 69.78%. On this date, 6 adults per trap were captured (Figure 6). Ceratitis capitata population in this orchard reached its highest density on October 5, 2021, with 98 adults per trap, marking the first population peak. The second population peak occurred on October 19, 2021, with

89.5 adults per trap. An insecticide treatment (cypermethrin + acetamiprid) was applied on October 25, 2021, which resulted in a decline in the pest population. The last observation in this orchard was made on December 7, 2021, with 5.5 adults per trap captured.

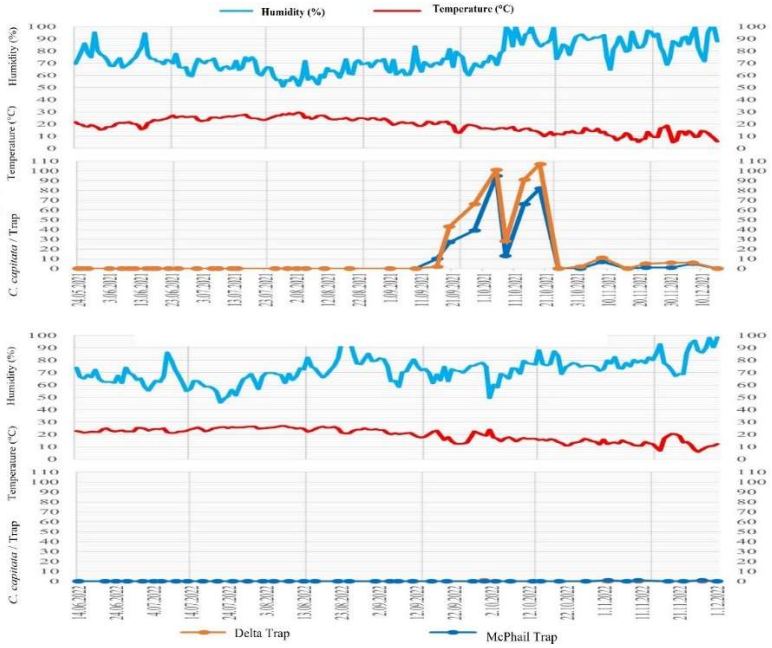


Figure 6. Population development and climate data of *C. capitata* in the quince orchard in 2021 and 2022

In the second year of the study, the first pest occurrence in the quince orchard was recorded on October 3, 2022, when the mean temperature was 17.4°C and the mean humidity was 60.35%. On this date, an average of 0.5 adults per trap were captured (Figure 6). The last observation of the pest in the quince orchard was made on December 1, 2022, with 0.5 adults per trap. No infested fruits were detected in the quince orchard during the second year of the study. However, in the first year, infested fruits were observed, with the damage rate in quince fruit calculated at 6.1%. Mustafa and Abdel-Jabbar (1996) reported that the C. capitata caused 26.7% damage to quince in Jordan and the average number of larvae per fruit was 20.4.

In the persimmon orchard located in the Camikebir neighborhood, the first pest occurrence during the first year of the study was recorded on September 20, 2021, when the mean temperature was 22.2°C and the mean humidity was 73.14%. On this date, an average of 0.5 adults per trap were captured (Figure 7). Ceratitis capitata population in the persimmon orchard reached its first peak on October 14, 2021, with 25 adults per trap. The second peak was recorded on October 25, 2021, with 104 adults per trap, while the highest population density was observed on November 8, 2021, with 243 adults per trap. Following this peak, the pest population began to decline, and the final observation was made on December 7, 2021, with 1.5 adults per trap captured.

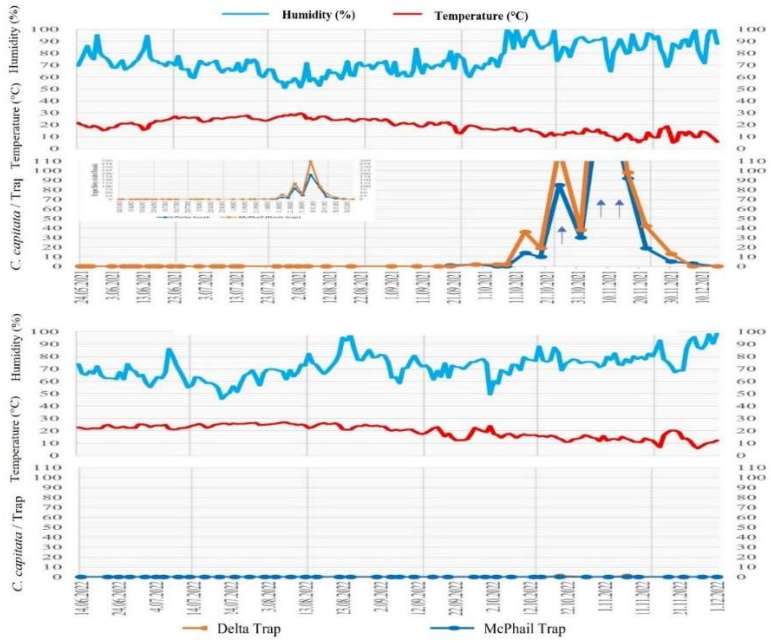


Figure 7. Population development and climate data of *C. capitata* in persimmon orchard in 2021 and 2022

In the second year of the study, the first pest occurrence in the persimmon orchard in the Camikebir neighborhood was observed on October 27, 2022, when the mean temperature was 16.5°C and the mean humidity was 75.6%. On this date, an average of 0.5 adults per trap were captured (Figure 8). The last observation in this orchard was made on November 10, 2022, with 0.5 adults per trap captured. No infested fruits were detected in the persimmon orchard during 2022. Tiring (2015) reported that the persimmon orchard in Ballıca (Adana) had the highest damage rate in 2014 and the rate of damaged fruit reached 65%. Kılıç and Demirel (2018) reported that the damage rates in persimmon orchards were between 3.35% and 100% in 2013 and between 2.44% and 95% in 2014. In another study conducted in persimmon orchards in southern Syria in 2016, it was reported that the infection rate was 21.5% (Mansour and Mohamad, 2016).

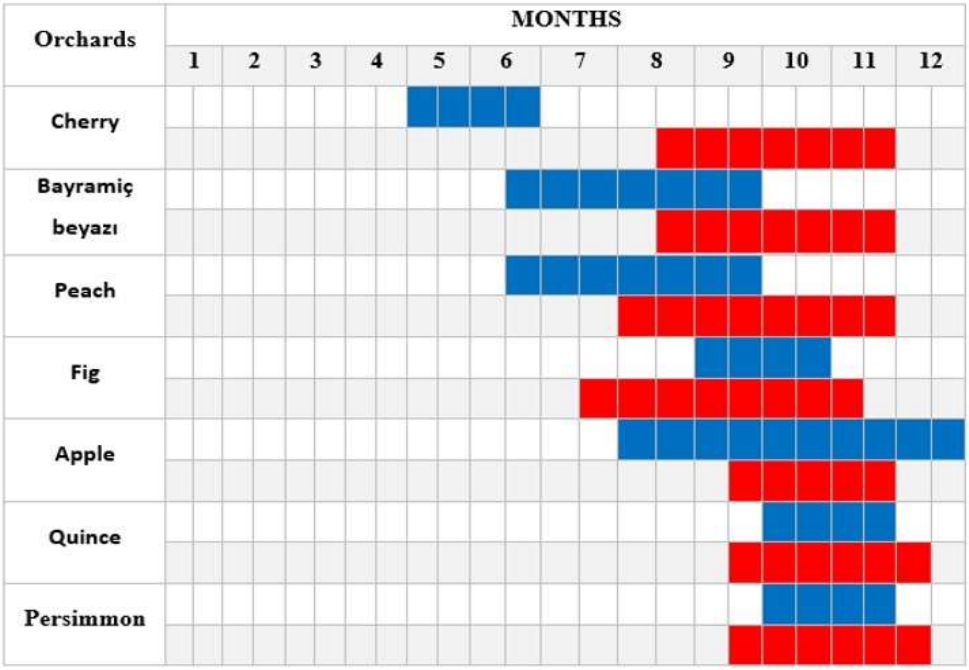
In the first year of the study, no pest was detected in the traps hung in the fig orchard. In the first year, it was evaluated that the adults were not caught because the area where the traps were hung in the fig orchard was windy during the production season and the traps were hung in a different fig orchard the following year. In 2022, the first pest was caught as 1 (adult/trap) adult on 29 July when the average temperature was 25.8ºC and the relative humidity was 64.5%. The last pest was caught in the trap as 1 (adult /trap) adult on 10 November. In the study conducted in the fig orchard in 2022, no struck fruit was found. Saleh et al. (2004) reported the damage rate of Mediterranean fruit fly as 35.1% in a fig orchard in Gaza (Palestine). Tiring (2015), in his study examining the population development of C. capitata in fig orchard, reported that some struck fruits did not fall and remained on the branches, so the fruits containing larvae were damaged by birds.

3.3. Final Flight of *Ceratitis capitata* Adults

To monitor the population dynamics of the C. capitata, pheromone traps were placed on May 24, 2021, in the first year of the study, and on June 14, 2022, in the second year. During the first year, the final adult flights were recorded on December 7, 2021, in apple, quince, and persimmon orchards when the thermal constant had reached 2226 degree-days. The respective capture rates in the pheromone traps were 0.5, 5.5, and 1.5 adults per trap. In 2022, the final adult flights were observed on December 1, 2022, in the Quince orchard, with 0.5 adults per trap captured, at a total effective temperature of 2216 degree-days.

In Bayramiç district, the final adult flights of the Mediterranean fruit fly were determined to occur in early December (Table 3).

Table 3. Population development of *C. capitata* (red) and fruit harvest times (blue) in Bayramiç district.



A study conducted in Adana reported that the final flights of the Mediterranean fruit fly extended until February 5, 2014, and January 19, 2015 (Tiring, 2015). Another study in Bursa indicated that the final flights in 2021 occurred on December 29 (Elitaş, 2022). Similarly, a study conducted in Şanlıurfa reported that the C. capitata's final flights ended on November 27, 2020, and December 17, 2021 (Güler, 2022).

In the first year of the study, the C. capitata population density was high, whereas in the second year, the pest population in the traps was negligible. This significant decline in the second year is thought to be due to climatic factors (Figure 8). The very low population development in the second year of the study is believed to be due to several factors, including the lower average winter temperatures compared to the first year.

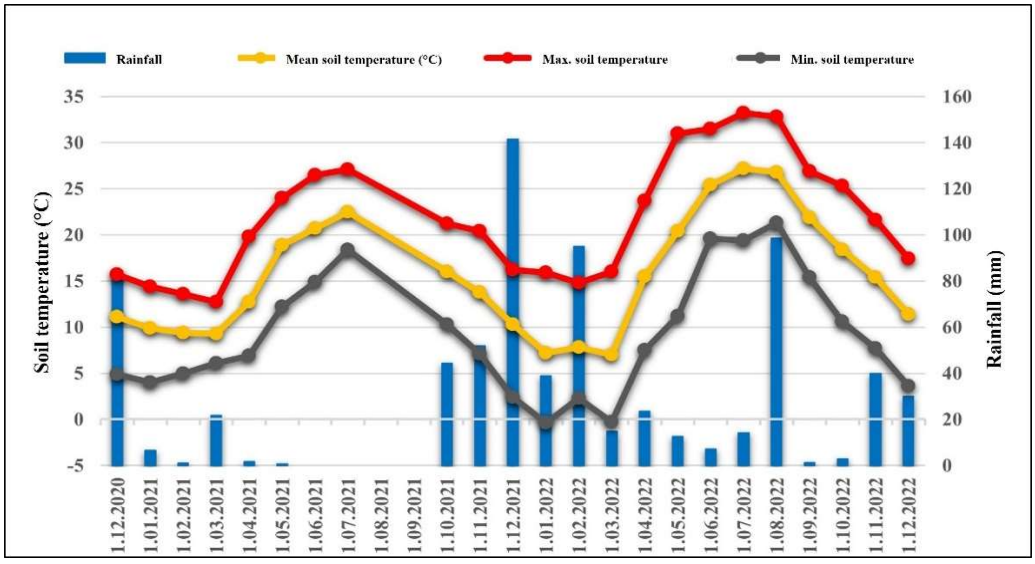


Figure 8. Rainfall and soil temperatures in Bayramiç district between 2021-2022

Additionally, a difference in soil temperatures between 2021 and 2022 might have contributed. Ceratitis capitata is highly sensitive to temperature drops, and temperatures below 1.5°C are known to be lethal to all its developmental stages (Bodenheimer, 1951; İleri, 1961; Elekçioğlu, 2009). In January

2021, the minimum soil temperature dropped to 4°C, while in January 2022 it fell to -0.4°C, and in March of the same year, it dropped again to -0.3°C. This drastic drop is thought to have significantly reduced the population of C. capitata pupae that overwintered in the soil (Figure 8).

Another contributing factor to the very low population development in the second year could be the much higher rainfall during the winter months compared to the previous year. Excessive moisture shortens the lifespan of C. capitata or even kills it (Bodenheimer, 1951). In regions like the Eastern Black Sea, where rainfall is high, the pest cannot survive, and pupal mortality is particularly high in very moist soils (Bodenheimer, 1951; İleri, 1961; Elekçioğlu, 2009). When comparing the rainfall between December and June (the potential pupal stage) of both years, it was found that in 2021, the total rainfall during this period was 115.8 mm, while in 2022, it was 333.6 mm. This substantial increase in rainfall in 2022 likely exposed the pupae overwintering in the soil to about three times the moisture compared to the previous year, which is believed to be another factor contributing to the reduction in the pest population (Figure 8).

Considering the numbers of Ceratitis capitata individuals captured in the traps, the highest numbers of the pest caught in 2021 were as follows: 2155 individuals in peach orchards, with 1252 captured in McPhail traps and 903 in delta traps, 1222 individuals in persimmon orchards, with 670 in McPhail trap and 452 in delta traps, 814 individuals in quince orchards, with 468 in McPhail traps and 346 in delta traps, 280 individuals in Bayramiç beyazı (Saçaklı) nectarine orchards, with 173 in McPhail traps and 107 in delta traps, 270 individuals in Tepecik apple orchards, with 184 in McPhail traps and 86 in delta traps, 150 individuals in Tepecik cherry orchards, with 96 in McPhail traps and 54 in delta traps, 8 individuals in Bayramiç beyazı (Evciler) nectarine orchards, with all captured in McPhail traps.

This study marks the first time the population dynamics of the C. capitata in Bayramiç district have been documented. It was also determined that C. capitata now uses Bayramiç beyazı, a local nectarine variety, as a new host plant. Regarding the pest's preference for different fruits based on population density, the highest population development was observed in persimmon, peach, and quince orchards. In contrast, the population density was much lower in Bayramiç beyazı, apple, and cherry orchards. This indicates a higher pest preference and development in certain fruit types, while others are less susceptible.

In this study, the effectiveness of McPhail and delta-type pheromone traps in capturing C. capitata individuals was evaluated. A total of 2865 individuals were captured in McPhail traps, while 1977 individuals were captured in delta traps. The results showed that McPhail traps captured a higher number of pests compared to the delta traps. However, in seasons with lower pest populations and in the initial stages of capture, delta traps were observed to be more successful than McPhail traps. In the first year of the study, C. capitata caused damage in some orchards. The damage levels were as follows:15.6% in persimmon orchards, 14% in peach orchards, 8.6% in Bayramiç Beyazı nectarine orchards, 6.1% in quince orchards.

One of the most critical aspects of C. capitata management is determining the time when the pest first appears in the environment and transitions to its host plants. The correct and widespread use of biotechnical methods is crucial for successful pest management. The use of monitoring traps can increase the chances of success in pest control by enabling timely insecticide applications. Moreover, given the wide range of host plants, developing an İntegrated Pest Management program tailored to the region could enhance the effectiveness of pest control strategies.

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