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The Determination of Population Development and Infestation Rate of Mediterranean Fruit Fly (*Ceratitis capitata* (Wied)) in Peach Orchards in Meram (Konya) Province

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ABSTRACT

This study was carried out in 2017 and 2018 in Meram district (Konya) in order to determine the population development and infestation rate of the Mediterranean fruit fly (MFF) (*Ceratitis capitata* (Wied)) (Dip.: Tephritidae) in the peach orchards. In the study, traps called Decis Trap were used to catch the adults of the MFF. As a result of the study, adult population development determined different in two years, two population peaks occurred in 2017 and four times in 2018. The pest may give two to four generation in Meram district according to climatic conditions and years. The first adults of the MFF appeared in 2017 in the third week of August and were active for four months, and appeared in 2018 in the third week of July and were determined to be active in the nature for about five months. In addition to the results of the study conducted in the years 2017-2018, the infestation rates were 5% and 2% in Ekmekkoçu, 3% and 2% in Hasanköy, 96% and 96% in Hatıp, 94% and 100% in Karahüyük, 0% and 2% in Yenibahçe location, respectively. Farmers are advised to use Decis Trap at the beginning of July and to carry out other maintenance work in orchards, especially the destruction of the fruit falling on the ground.

1. Introduction

Mediterranean fruit fly (MFF) (*Ceratitis capitata* (Wied)) (Dip.: Tephritidae) is an external quarantine pest and has a zero tolerance in export. It causes economic losses in our country. The presence of a single infested fruit with this pest in export leads to the return of the whole product (Başpınar et al. 2009). *C. capitata* is a member of the Tephritidae family, order Diptera, which has more than 4500 species in the world (Liquido et al., 1990, Bayrak and Hayat, 2012). MFF is one of 118 species of fruit fly pests recorded in Turkey (Kütük et al., 2013). The most important hosts identified in our country are mainly citrus fruits, peaches, figs, persimmon and pomegranates, but it also causes damage in apricot, apple, pear, quince, plum and avocado (Alkan, 1953; Demirdere, 1961; İleri, 1961; Giray, 1966; Elekçioğlu, 2009; 2013). However, there is no serious damage to lemons (Kaygısız and Aybak, 2005).

One of the most suitable hosts of the MFF is peach fruits among many kind of fruits such as pepper, loquat, guava, orange, mandarin and feijoa (Medeiros et al., 2007). Estimated world production of peach and nectarines are 24.665.205 tons with 152.803-hectare total cultivated area. In Turkey, there are 771.459 tons' production from 46.299 ha cultivated area. Konya province is one of the leading provinces of peach and nectarines production. Meram district shares 25.7% of total production in Konya province (Anonymous, 2018).

Females of MFF lay eggs to the mature fruits at the time of maturity, where they leave brownish spots. The main damage caused by larval stage of the pest by feeding in the fleshy part of the fruit. This leads to the softening and rotting of fruits by the time. Infested fruits usually ripen ahead of time and poured to the ground. Infested fruits rot as a result of the development of microorganisms such as fungus and bacterial species (Anonymous, 2008; Elekçioğlu, 2009).

The presence of MFF in the Central Anatolia region of Turkey has been detected in Ankara and Kırşehir

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(Kansu, 1988; Kaya and İpekdal, 2018). Previous studies conducted by different researchers were related to population development and infestation rates of the pest, including, in pomegranate orchards (Yıldırım and Başpınar, 2011; Çardak and Demirel, 2014), in mandarin orchards; satsuma variety (Akyol, 2014), in persimmon fruit orchards (Kılıç, 2015), in pomegranate and persimmon fruit orchards, in fig, peach and avocado orchards (Tiring and Satar, 2017), in orange orchards (Çatak, 2017), in citrus orchards (Gürbüz, 2018). However, there is no study on the current status of the pest in Konya province.

In this study, it was aimed to determine the population development, infestation rates and some biological characteristics of MFF in peach orchards in Konya province.

2. Materials and Methods

2.1. Materials

The basic materials of this research were peach orchards located in Meram district of Konya province and MFF population in these orchards. Decis trap (Bayer CropScience) containing 0,015g Deltamethrin + 7.8g Ammonium acetate + 0.5g Chloro hydra tetrimethyl amine + 0.03g + 1.5g Diamineopentane was used for mass trapping of the pest.

2.2. Methods

2.2.1. Selecting Trial Orchards

Five peach orchards with late-pruning varieties selected for determining population development of the pest. Details of the orchards are given in Table 1.

Table 1
General properties of the trial orchards

Location	Orchard age (Year)	Variety	Orchard size (ha)	Coordinates	
Ekmekkoçu	15	Monroe	0.2	37˚82934000	32˚49852200
Hasanköy	12	Monroe	0.6	37˚81058500	32˚47958700
Hatıp	9	Monroe	1.2	37˚76671000	32˚11560000
Karahüyük	14	Monroe	0.5	37˚77437910	32˚44906390
Yenibahçe	9	Monroe	1.2	37˚75861900	32˚47456200

2.2.2. Population Development of Mediterranean fruit fly

Five Decis type traps for per 0.1 hectar were hung on August 6th in 2017 and July 13th in 2018 in each orchard. The traps were hung 1.5-2 m high from the ground in the south-east direction of the trees. Trap controls were performed twice a week until the first adult was captured, and once a week after the first adult was captured, the number of captured adults was recorded. The same traps used till harvesting.

2.2.3. Infestation Rates of Mediterranean fruit fly

Infestation rates of MFF in peach orchards determined by sampling infested fruits at harvesting time. Twenty-five peach trees selected in each orchard and four fruits collected from those trees. Collected fruits number was 100 fruit from each orchard. Abbott formula was used to determine infestation rates for each orchard (Abbott, 1925).

3. Results

3.1. Population Development of Mediterranean fruit fly

Population development of the pest has been determined in five locations in Meram district, Konya. Population development of *C. capitata* in 2017 and 2018 in Ekmekkoçu location is given in Figure 1.

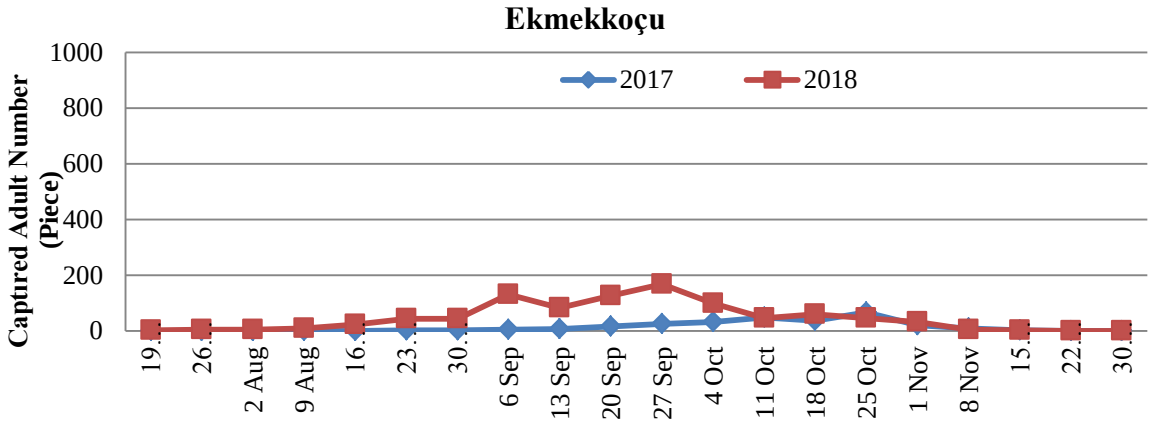

Figure 1
Two years' population development of *Ceratitis capitata* in peach orchard in Ekmekkoçu location.

In Ekmekkoçu location, in 2017, the adults of the pest were first captured on 20 August. The pest has been determined to be active from the end of August until the middle of November (Figure 1). When the

data is examined, it is seen that there are two peaks of population. The first peak reached 47 adults per week on October 8, and the second peak on October 22 with 66 adults per week. During the entire flight period, an average of 261 adult MFF were caught in the traps.

However, population was more intense in 2018; the first adult in the traps was caught on July 19th. Pest was determined as active from mid-July to the last week of November. Population peak was also three time in season (Figure 1). The first peak was 130 adults / week on the 6th of September, the second peak on the 27th of September with 168 adults / week, and the third peak on October 18 with 60 adults / week. During the entire flight period, an average of 912 adult individuals was caught in traps.

In 2018, the number of adults caught in traps increased three-fold compared to 2017. When the population curves are examined, the date of emergence, the active period and the different peaks they create may be considered as a result of climate change as well as many ecological factors.

Population development of *C. capitata* in 2017 and 2018 in Hasanköy location is given in Figure 2.

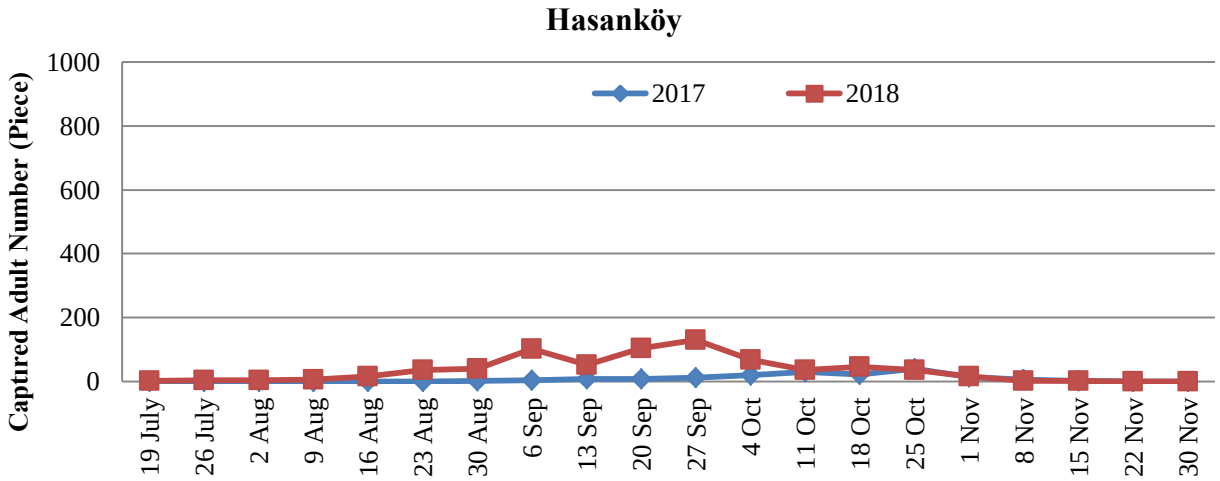

Figure 2
Two years' population development of *Ceratitis capitata* in peach orchard in Hasanköy location.

In Hasanköy location, in 2017, the adults of the pest was first caught in traps on 23 August. Pest activity was determined from the last week of August to 15 November (Figure 2). When the number of captured adults is examined, it is seen that there are two peaks. The first peak point was 29 adults / week on 8 October and the second peak on October 22nd, 41 adults / week. During the entire flight period, 169 median MFF were caught in the traps.

The adults of the pest were first caught on July 19th in 2018. Pest activity was from mid-July to the last week of November and it was three peaks of population. The first peak was 101 adults / week on the 6th of September, the second peak on September 27th, 130 adults / week, the third peak on October 18, 47 adults / week. An average of 696 adults was caught in the traps during the entire flight period (Figure 2).

It was detected that, emergence and population density are different in 2017 and 2018 years and this may be considered as the winter months was more temperate in 2018 comparing to 2017. It is believed that the farmer used intensive insecticide to avoid any risk during the season and to collect the harvest residues in the garden at the end of season may affect pest population development.

Figure 3 shows population development of *C. capitata* in 2017 and 2018 in Hatıp location.

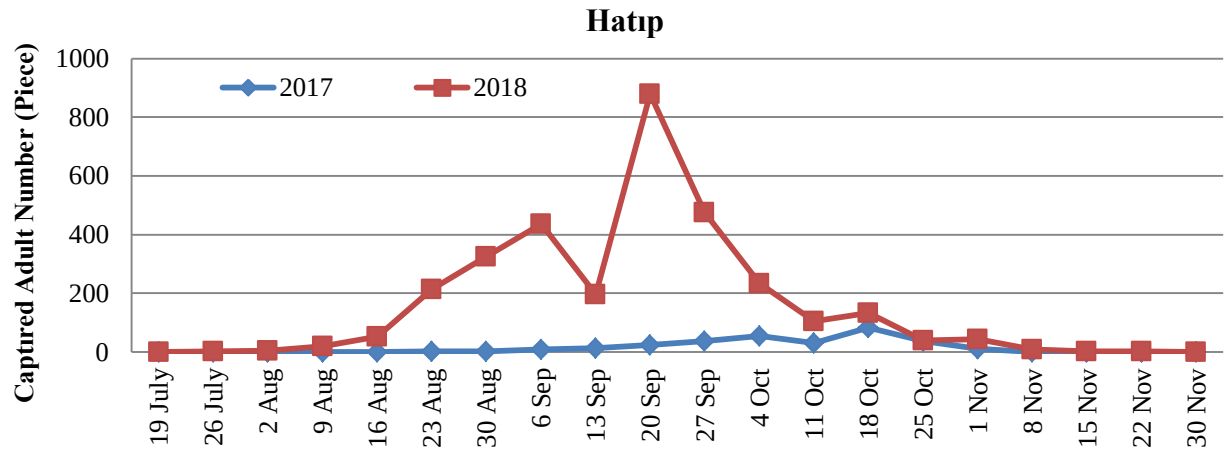

Figure 3
Two years' population development of *Ceratitis capitata* in peach orchard in Hatıp location.

In Hatıp location, in 2017, the adults of the pest were first captured on 23 August. Pest active period was determined from the last week of August until 8 November. When the number of adults is examined, it is seen that there are two peaks. The first peak occurred on October 8th, 55 adults / week, the second peak on October 22nd, 83 adults / week. During the entire flight period, an average of 307 adult MFF was caught in the traps (Figure 3).

But, in 2018, the pests were first caught in the traps on 26 July. Pest activity was from mid-July to the last week of November. When the data is examined, it is seen that there are four peaks in 2018. The first peak point was 436 adults / week on September 6th, the second peak was 878 adults / week on September 20th, the third peak on October 18th, 133 adults / week and finally on November 1st, 43 adults / week. During the entire flight period, 3169 adult individuals were caught in the traps (Figure 3).

In Hatıp location, the total number of adults in 2018 is 10 times higher than the total number of adults in 2017. The owner of the garden has applied tillage, pruning and bordeaux mixture in the garden in 2017, but, did not applied any chemicals during season against pests. In the 2018 season, he did not apply any procedures to the garden. Therefore, it is thought that *C. capitata* population is higher than other gardens. In addition, many harmful pests also were seen in these infested fruits.

Figure 4 shows population development of *C. capitata* in 2017 and 2018 in Karahüyük location.

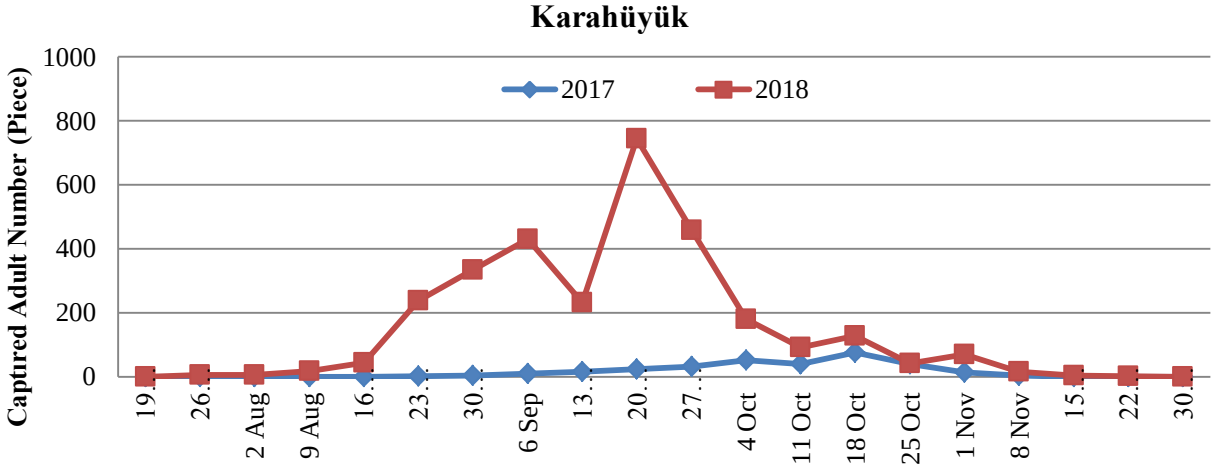

Figure 4
Two years' population development of *Ceratitis capitata* in peach orchard in Karahüyük location.

In Karahüyük location, in 2017, the adults of the pest were first captured on 23 August. Pest active period was from the last week of August until November 8th. When the number of adults is examined, it is seen that there are two peaks. The first peak was 52 adults/ week on October 8th, and the second peak on October 18th with 76 adults / week. During the whole flight period, 307 adult MFF were caught in the traps (Figure 4).

In 2018, the pests were first caught in the traps on 26 July. Pest was determined as active from mid-July to 22 November. Population peaks were four peaks in 2018 season. The first peak was 430 adults / week on the 6th of September, 743 adults / week on the second

peak on September 20th, 128 adults / week on the third peak on October 18th and last peak on the 1st of November, 70 adults/week. An average of 3034 adult individuals was caught in traps during the entire flight period (Figure 4).

In this location, the total number of adults in 2017 is less than the number of 2018. Application procedures were in Karahüyük location the same with Hatıp location, the owner of the garden did not apply even its primary preventive controls in both years. In 2018 season, the garden was left without harvesting.

Population development of *C. capitata* in 2017 and 2018 in Yenibahçe location is given in Figure 5.

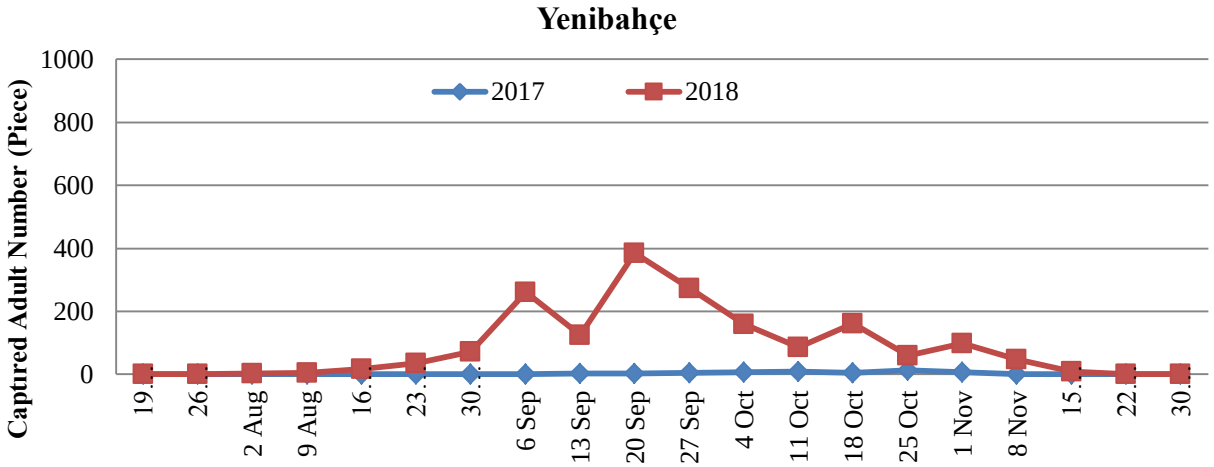

Figure 5
Two years' population development of *Ceratitis capitata* in peach orchard in Yenibahçe location.

In Yenibahçe location, the adults of the pest were first caught on August 30 in 2017. It was determined that pest was active from the last week of August until November 22nd. When the number of adults is examined, it is seen that there are two peaks. The first peak was 9 adults / week on October 8th, and the second peak on October 22nd, 14 adults / week. During the entire flight period, an average of 56 adult MFF was caught in the traps (Figure 5).

In 2018, the pests were first caught in the traps on 26 July. Pest activity prolonged from mid-July to 22 November. When the number of adults is examined, it is seen that there are four peaks. The first peak point was 261 adults / week on 6 September, the second peak on 386adults / week on September 20, the third peak on October 18, 161 adults / week, and finally on November 1, 99 adults / week. During the entire flight period, an average of 1807 adult individuals was captured in the traps (Figure 5).

Numerous ecological factors are thought to be effective for population curve of the pest. Furthermore, the low population in 2017 can be attributed to the fact that in 2016, the farmer made maintenance work regularly and especially the destruction of fruit residues at the end of harvest.

Infestation Rates of Mediterranean fruit fly

The rate of infestation of fruits by MFF in Meram district is given in Table 2.

Table 2
Ceratitis capitata infestation rate in Meram in 2017-2018.

Location	Infestation Rate (%)	
	2017	2018
Ekmekkoçu	5	2
Hasanköy	3	2
Hatıp	96	100
Karahüyük	64	100
Yenibahçe	0	2

Harvest was performed in the first week of September in Hasanköy, Ekmekkoçu and Yenibahçe location in 2017. Owners of the gardens, in order not to take the risk, they applied chemicals to their gardens in addition to the warnings of the technical staff of Meram District Directorate of Agriculture. Although unnecessary applications were made, the chance of success against the pest has increased when the pesticides are applied on time. In these locations, the rate of infestation in 2017 was determined as 0-5%. The owner of the garden in the Hasanköy location in 2016 and in 2017 destroyed fruit debris in the garden after harvesting, and the owner of the garden in the Yenibahçe location destroyed it only in 2016. For this reason, infestation rates in these orchards were observed as highly lower than others. Infestation in Hatıp location was 96% and 94% in

Karahüyük location in 2017. Both gardens have been maintained in 2017 early spring, but not applied any control against disease and pests in the production season.

Harvesting was done in Hasanköy, Ekmekkoçu and Yenibahçe location in 2018, 5-10 days early compared to 2017, and the rate of infestation was determined in 2% of all three gardens. Harvest dates are thought to be 5-10 days early in 2018 with the increase in temperature compared to 2017 and the shift of phenological periods to early. In Hatıp and Karahüyük locations, the infestation rate in 2018 was 100% in both gardens. Due to the proximity of the gardens in Hatıp and Karahüyük locations, the infestation rate and population changes were similar. Both gardens were left without harvesting in 2018.

4. Discussion

The MFF, which is the main detrimental factor in the loss of citrus fruits, has begun to cause significant and economic damage in different hosts in recent years. One of these hosts is peach.

In this study, the population development and infestation rates of MFF in the peach orchards in the district of Meram (Konya) in the locations of Ekmekkoçu, Hasanköy, Hatıp, Karahüyük, Yenibahçe, were determined to be active in the peach areas from mid-July to the end of November for about five months.

It was determined that the pest does not cause harm in the early peach varieties. Tiring and Satar (2017) found that early peaches in Balcalı (Adana) did not cause any damage due to harvesting in the first week of May.

As a result of the study conducted in Konya, depending to the climatic conditions in the peach orchards, the pest formed 2 to 4 peak in the season. Tiring and Satar (2017) reported that this pest has 7-8 generations in avocado, fig and peach orchards in Balcalı (Adana), Başpınar et al. (2009) detected 4-5 generations in the province of Aydin in citrus orchards, Kızılyamaç (2016) determined 3-7 generations at different elevations; Kasap and Aslan (2016) reported, 5-6 generations in the persimmon and 6-7 generations in the pomegranate orchards in Adana province. As a result of all these studies, it was stated that the pest has a large number of generation in different hosts.

The highest point of the population with the increase of temperatures reached in September-October. The highest number of adults in 2017 and 2018 was in Hatıp location, number of captured adults was 106 adults / week on October 22, and 878 adults / week on September 20, respectively. Akyol and Demirel (2014) reported that captures of the adults in traps in the satsuma mandarin orchards in Hatay were maximum number in September. The reason for the high population density in Hatıp location is that the orchards are located close to each other which may be host of the pest, and that the garden is neglected and not sprayed in the season.

In general, it was determined that the pest increased in 2018 compared to the previous year. This is due to the fact that the climate conditions are a little more moderate, the farmers do not spray against increasing pest populations and the number of host increases.

As a result of the study, the highest infestation rates were determined as 96 to 100% in Hatıp location, and 94 to 100 in Karahüyük location, in 2017-2018, respectively. Yıldırım and Başpınar (2011) found that the infestation rate of pomegranate orchards during harvest time was 2.20%. Although Demirel (2014) reported that the infestation rates in pomegranate orchards was between 3-43.5% according to varieties of pomegranate. Kasap and Aslan (2016) indicated that the infestation rates in pomegranate was 1.35% in date was 5.2% in Adana province.

The importance of the chemical application for the MFF is understood from the loss in the gardens that are left without harvesting. In peach gardens, the damage rate of the pest may reach up 100% if the control tactics not applied. It is recommended that our farmers need to use Decis traps widely, and if they do not use it, they should fight with chemical at least twice on the dates proposed by the technical staff.

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