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The effectiveness of mass trapping of *Ceratitis capitata* (Wiedemann,1824) (Diptera: Tephritidae) in peach orchards in İzmir, Aydın and Mersin

Ceratitis capitata (Wiedemann,1824) (Diptera: Tephritidae)'nin İzmir, Aydın ve Mersin şeftali bahçelerinde kitle yakalama tekniğinin etkinliğinin belirlenmesi

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ABSTRACT

Ceratitis capitata (Wiedemann,1824) (Diptera: Tephritidae) is a species which is known as one of the most important quarantine pests with a zero-tolerance. Due to its high capacity of reproduction and direct damages on fruits, it is not possible to reach higher yield rates without management of this pest. Mass trapping, which is a biotechnical control method, is an alternative control method that is considered to be successful in low populations of this pest. This study carried out in peach orchards simultaneously and the effectiveness of traps were determined according to population differences between Aegean and Mediterranean regions. Experiments were conducted in 2018 in Kuşadası (Aydın), Selçuk (İzmir) and Erdemli (Mersin) in peach orchards. The population dynamics and the effectiveness of mass-trapping were detected during this study. Pheromone traps, Decis Trap (Bayer), were used to monitor the population change of the pest. The daily number of adult individuals was 4.8, 149.1 and 166.9 in Kuşadası, Selçuk and Erdemli, respectively, in July. Accordingly, effectiveness of traps was 94.19% in Kuşadası, 95.6% in Selçuk and 56.35% in Erdemli. Due to the higher population in the Mediterranean region than the Aegean region and longer duration of the peach vegetation in the Mediterranean Region, required control level of success was not provided.

INTRODUCTION

The Mediterranean fruit fly *Ceratitis capitata* (Wiedemann,1824) (Diptera: Tephritidae), has been causing economic losses by spreading to all tropical and subtropical regions since 1829 it was first noticed as a pest (Headrick 1996) until nowadays. Several researchers have reported that the Mediterranean fruit fly is a polyphagous species and causes economically important damages on hundreds of agricultural products (Elekçioğlu 2009, 2013, Orono 2006, Satar and Tiring 2016, Satar et al. 2016). Zümreoğlu (1986) reported that this species was found in 21 host plant species and varieties in Turkey, and it causes significant damages in 17 products. Among these 17 plant species and varieties,

it is the main pest of citrus fruits. Peaches, apples, quinces, apricots, persimmons, plums, pomegranates and avocados are among its hosts (Demirdere 1961, Demirel 2016, İleri 1961, Karsavuran et al. 1988, Kaya and İpekdal 2018, Tiring and Satar 2017, Tunçyürek 1972, Zümreoğlu 1986, 1990), while it leads to significant economic losses in these products. Today, this pest may cause widespread epidemics especially in Mediterranean and Aegean regions in Turkey, and it may cause significant economic losses in almost unexpected locations (Satar et al. 2016). According to İleri (1961), C. capitata has entered Turkey in the 1890s, according to CABI (2019) citing Fimiani (1989) and 1915 according to Demirdere (1961) citing Bodenheimer (1951). Ceratitis capitata is a quarantine pest, and its tolerance is assumed to be zero. Due to the suspicions that there was the Mediterranean fruit fly on mandarin fruits exported to the Russian Federation, the products were sent back to Turkey (Özbay 2011). It is not possible to achieve production without the control of this pest.

There are four different approaches to control the Mediterranean fruit fly. These are sterile insect technique, mass trapping, protein bait spraying and foliar pesticide applications (Yayla and Satar 2017). The control methods that are prevalently used in Turkey are chemical pesticide application and mass trapping. In chemical control, in the case that insecticides are not applied at the suitable dose and on time, issues of residues in fruits are encountered. In residue screenings of insecticides that were used to control Mediterranean fruit fly in Satsuma mandarin and pomegranate, the residue value of Malathion was found to be higher than the MRL levels of the European Union (Dinçay et al. 2017). High MRL values of insecticides firstly pose a risk for human health, and they lead to problems in international trade. In addition to these control methods, for the first time in Turkey, the infestation of the pest could be prevented by perimetric trapping around the transportation and attachment source of the pest outside agricultural areas in the district of Çivril in Denizli (Tolga et al. 2018).

Instead of traditional chemical control, biotechnical methods integrated with alternative control programs have been studied and utilized all over the world for years. The biotechnical methods that are the most frequently used against this pest and provide successful results from the mass trapping, and attract and kill methods. The objective of mass trapping and 'Attract and Kill' is to eliminate the usage of insecticides or minimizing the number of insecticide applications by combining the method with other control methods within the framework of an integrated control program (Layık and Kısmalı 1994).

To increase the usage of alternative control methods, starting with 2010, the Turkish Ministry of Agriculture and Forestry has been providing producers with incentives in different products under the declaration of "Payment for Supporting Biological and/or Biotechnical Control in Plant Production" (Declaration no.: 2018/22)". However, utilization of the assistance by producers and usage of traps are not on the desired level. There are several studies conducted in Turkey on trapping against Mediterranean fruit fly (Akman and Zümreoğlu 1973, Akyol 2014, Başpınar et al. 2009, Delrio and Zümreoglu 1983, Elekçioğlu et al. 2011, Kahyaoğlu and Gürkan 2010, Satar and Tiring 2016, Sierras et al. 2012, Yayla and Satar 2017). However, these studies were carried out at different times, in different regions and separately. There are no data on which results were shared in the same year that were studied simultaneously in two different regions. This study aimed to determine the usability of traps employed in the same numbers per hectare at peach orchards in İzmir, Aydın and Mersin in Turkey. Additionally, trials of biological effectiveness were conducted to contribute the increase in usage of traps and minimization of costs.

MATERIALS AND METHODS

Determination of the population of the Mediterranean fruit fly

The trials were carried out on the peach variety of extreme Great in 1 ha of area in Kuşadası (Aydın) and 2 ha of area in Selçuk (İzmir) and on the Hale variety of peach in 1 ha of area in Erdemli (Mersin) in 2018. The trials were conducted according to 'Large Parcel' experimental design. The characters of experiments were Mass Trapping and Control parcels. Experiments were 10 da and the numbers of traps were determined as 5 traps per da. Control parcel was determined as 1 da and there was at least 100 m distance between control and trial parcels (Anonymous 2020).

The land was divided into 10 plots of 0.1 ha each, and trial traps were placed in Kuşadası-Aydın. A total of 50 Decis traps were installed and there would be 50 traps per ha. The counting was done on a total of 25 trial traps, including at least 2 in each plot. A control plot of 0.1 ha was left at a 100 m of distance from the Decis trap plots, and one delta-type pheromone (Trimedlure) trap was hanged for observation purposes. All traps were hanged on 11 June 2018 when the fruits were in their green period, and with the harvest on 19 July 2018, the trial was ended.

The land was divided into 20 plots of 0.1 ha each, and trial traps were placed in Selçuk-İzmir. A total of 100 Decis traps were hanged therefore there would be 50 traps per ha. Counting was made on a total of 40 trial traps. A control plot of 0.1 ha was left at a 100 m of distance from the Decis trap plots, and one delta-type pheromone (Trimedlure) trap was hanged for observation purposes. All traps were hanged on 13 June 2018 when the fruits were in their green

period, and with the harvest on 25 July 2018, the trial was ended.

The land was divided into 10 plots of 0.1 ha each, and trial traps were placed in Erdemli-Mersin. A total of 50 Decis traps were installed so that there would be 50 traps per ha. Counts were made on a total of 10 trial traps, including 1 in each plot. A control plot of 0.1 ha was left at a 100 m of distance from the Decis trap plots, and one delta-type pheromone (Trimedlure) trap was hanged for observation purposes. All traps were hanged on 6 June 2018 when the fruits were in their green period, and with the harvest on 13 August 2018, the trial was ended.

For biological activity, counting were made and recorded weekly in the trial traps, and the individuals of C. capitata in the trap were removed after counting. In the pheromone traps, the capsules were replaced once every 4-5 weeks, and the trays were replaced every two weeks. All traps were installed at a height of 1.5-1.8 meters from the ground and on the southern side of the trees. Counting was done at the pheromone traps weekly, and it was aimed to determine the population change of the pest. The results of the pheromone traps and Decis traps were presented in figures.

Determination of the effectiveness of the mass trapping product

One or two trees in the middle of each plot were marked, and dents were checked on an average of 50 fruits on the tree and all fruits that fell off the tree in trial areas (Kuşadası/Aydın, Selçuk/İzmir, Erdemli/Mersin). The counts were carried out by checking the fruits of 12 trees in Kuşadası, 40 trees in Selçuk and 10 trees in Erdemli. In the control plots, the fruits on and those that fell off one or two trees were checked each week, and the dented and intact ones were recorded. The effectiveness in percent was determined with Abbott's formula [(Percentage effect = (% intact in control - % intact in trap plot)/(% intact in control) x 100)] (Abbott 1925, Karman 1971), while the statistical difference was determined with the Chi-Squared analysis method. The SPSS 23.0 package software was utilized for the statistical analyses.

Comparison of populations among the districts

The daily numbers of flies (DNF) per pheromone and Decis trap in the trial orchards of each district were calculated with the formula given below. The calculations that were made to determine the population differences among the districts were statistically analysed. The results that were obtained based on the DNF values were subjected to ANOVA in the SPSS 20.0 package software. The statistical differences were determined by using Tukey's HSD test (P=0.05) (Radonjic et al. 2013).

DNF=TNF/NTxNDT

DNF: the daily number of flies caught per each trap

TNF: total number of flies caught in all traps

NT: total number of traps

NDT: number of days traps stay in the orchard

RESULTS AND DISCUSSION

Population change of the Mediterranean fruit fly

The population changes were shown based on the mean numbers of adult individuals per trap in the Decis traps in all studied districts and the Mediterranean fruit fly numbers in all pheromone traps hanged at the control plots. The population changes in Kuşadası, Selçuk, and Erdemli were given in Figure 1, 2, and 3, respectively.

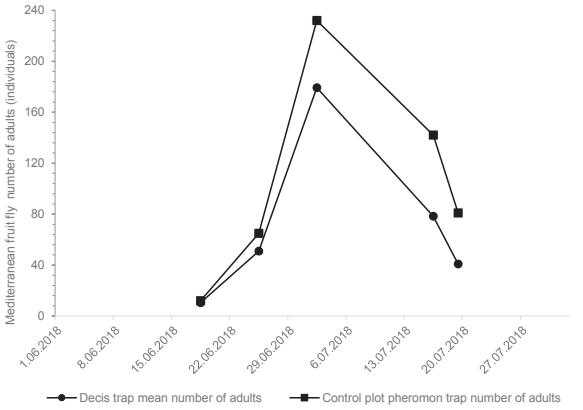

Figure 1. Population changes based on the mean number of adults in Decis traps and the number of adults in pheromone traps in the control plot in the district of Kuşadası

The mean of adults was 10.4 in Decis traps and 12.0 adults in the pheromone trap in the control plot were counted on 18 June 2018 in Kuşadası. The population raised to the highest level on 2 July 2018 in Decis traps and control plot pheromone trap respectively as 179.2 individuals/trap and 232.0 individuals/trap during this study (Figure 1).

The mean number of adults was 0.7 individuals/trap counted in Decis traps on 20 June 2018 in Selçuk, while there was no adult in the pheromone trap on the same date. The population raised to the highest level on 25 July 2018 in Decis traps (the number of the adult was 78.2 per trap). The control plot reached the highest level with 49 individuals/trap on 1 August 2018 in the pheromone trap (Figure 2).

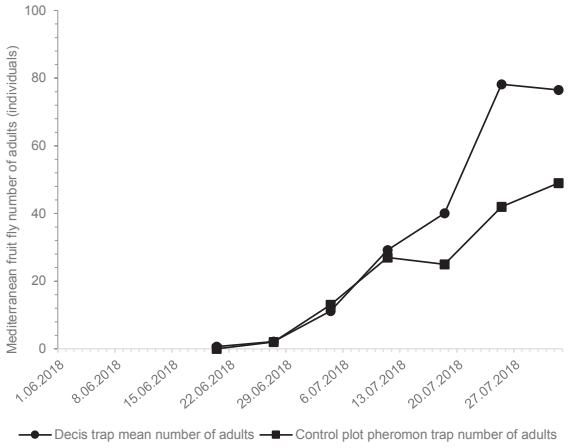

Figure 2. Population change based on the mean number of adults in Decis traps and the number of traps in pheromone traps in the control plot in the district of Selçuk

The mean of adults was 57.5 individuals/trap on 11 June 2018 in the Decis traps and 250 individuals/trap in the pheromone trap in the control plot in Erdemli. The highest population was observed in the pheromone trap on 09 July 2018 by 1025 individuals/trap. The highest level of population in Decis traps was found as 132.5 individuals/trap on 30 July 2018 (Figure 3).

To reveal the differences among the populations, the daily numbers of flies caught in the Decis and pheromone traps were calculated. The calculations were made based on the counts made during the trial months of June and July in Kuşadası and Selçuk and June, July and August in Erdemli.

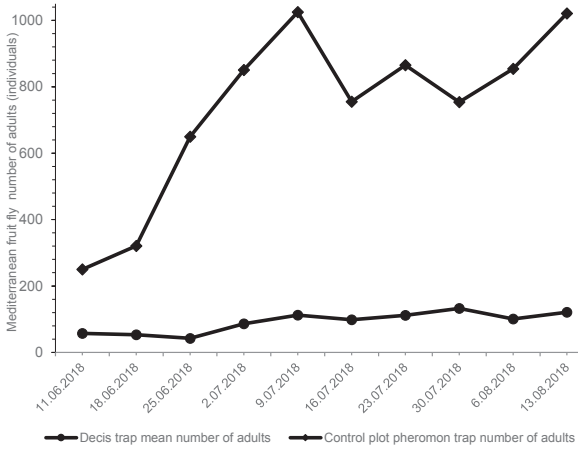

Figure 3. Population change based on the mean number of adults in Decis traps and the number of traps in pheromone traps in the control plot in the district of Erdemli

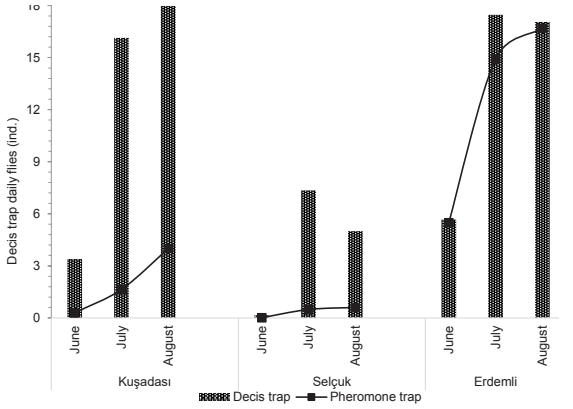

Figure 4. Daily numbers of flies caught in the Decis and pheromone traps

The daily numbers of flies in the pheromone traps for Kuşadası and Selçuk were 2.9 and 0.1 in June and 16.4 and 4.8 in July, respectively. These numbers for June, July and August were 54.8, 149.1 and 166.9, respectively, in Erdemli. In July, where the population increased, the number of flies caught per day in Selçuk was lower than that in Kuşadası. The numbers of flies in the traps in Erdemli were much higher than those in the other districts, and 9-18 times more flies were caught per day within the season (Figure 4).

Fruit infestation rates and effects of traps

The results of fruit counting in Kuşadası, Selçuk and Erdemli were given respectively in Tables 1, 2 and 3.

As a result of the counting in Kuşadası, the infestation rate in the Decis trap plots was (N:3328) 0.9%, while that in the control plot was (N:756) 15.5% (Table 1). Accordingly, the

Table 1. Crosstabs on fruit counts, infestation rates in treatments in Kuşadası (fruit*treatment Crosstabulation)

			treatment		Total
			trap	control	
fruit	non-damaged	Count	3298	639	3937
		% within fruit	83.8%	16.2%	100.0%
		%within treatment	99.1%	84.5%	96.4%
		% of Total	80.8%	15.6%	96.4%
	damaged	Count	30	117	147
		% within fruit	20.4%	79.6%	100.0%
		%within treatment	00.9%	15.5%	3.6%
		% of Total	0.7%	2.9%	3.6%
	Total	Count	3328	756	4084
		% within fruit	81.5%	18.5%	100.0%
		%within treatment	00%	100.0%	100.0%
		% of Total	81.5%	18.5%	100.0%

effectiveness of the trap was calculated as 94.19%. It was determined that there was a significant difference between the treatment plots and the control plot in the trial area (x2: 377.14; P < 0.05; df:1).

As a result of the counting in Selçuk, the infestation rate in the Decis trap plots was (N:6740) 0.9%, while that in the control plot was (N:622) 18.6% (Table 2). Accordingly, the effectiveness of the trap was calculated as 95.16%. It was determined that there was a significant difference between the treatment plots and the control plot in the trial area (x2: 747.95; P < 0.05; df:1).

Table 2. Crosstabs on fruit counts, infestation rates in treatments in Selçuk (fruit*treatment Crosstabulation)

			treatment		Total
			trap	control	
fruit	non-damaged	Count	6676	639	7182
		% within fruit	93.0%	7.0%	100.0%
		%within treatment	99.1%	81.4%	97.6%
		% of Total	90.7%	6.9%	97.6%
	damaged	Count	64	116	180
		% within fruit	35.6%	64.4%	100.0%
		%within treatment	00.9%	1.6%	2.4%
		% of Total	0.7%	2.9%	3.6%
	Total	Count	6740	622	7362
		% within fruit	91.6%	8.4%	100.0%
		%within treatment	100.0%	100.0%	100.0%
		% of Total	91.6%	8.4%	100.0%

As a result of the counting in Erdemli, the infestation rate in the Decis trap plots was (N:6392) 15.89%, while that in the control plot was (N:4195) 36.2% (Table 3). Accordingly, the effectiveness of the trap was calculated as 56.35%. The effectiveness of the control trap in the counts made in Erdemli was lower than those of the other districts. The main reason for this situation was the population densities and numbers of offspring were different among the regions. The population density in Erdemli was higher than Kuşadası and Selçuk. It was determined that there was a significant difference between the treatment plots and the control plot in the trial area (x2: 582.47; P < 0.05; df:1).

The mean numbers of flies caught in Erdemli in terms of both the Decis traps and the pheromone trap were higher than Kuşadası and Selçuk's results. As it can be seen in the data that were obtained here, it was also reported by El-Gendy (2014) that population could increase in peach orchards between regions and years based on the presence

Table 3. Crosstabs on fruit counts, infestation rates in treatments in Erdemli (fruit*treatment Crosstabulation)

			treatment		Total
			trap	control	
fruit	non-damaged	Count	5383	2675	8058
		% within fruit	66.8%	33.2%	100.0%
		%within treatment	84.2%	63.8%	76.1%
		% of Total	50.8%	25.3%	76.1%
	damaged	Count	1009	1520	2529
		% within fruit	39.9%	60.1%	100.0%
		%within treatment	15.8%	36.2%	23.9%
		% of Total	9.5%	14.4%	23.9%
	Total	Count	6392	4195	10587
		% within fruit	60.4%	39.6%	100.0%
		%within treatment	100.0%	100.0%	100.0%
		% of Total	60.4%	39.6%	100.0%

of hosts and prevalence of offspring. The population of the pest in Erdemli showed an increase in July and August in this study. Different researchers have reported in Adana, which has similar climate characteristics to those in the studied regions, that populations of the pest increased in peach orchards between the last week of May and the first week of July, in grapefruit orchards between May and September, in persimmon orchards in July, September and November and in pomegranates in September, October and November (Kasap and Aslan 2016, Satar et al. 2016, Tiring and Satar 2017). In a different study that we carried out in Karaburun and Menderes districts of İzmir, it was observed that the pest was seen between April and November, and its population increased especially in August and September (Tolga et al. 2019).

The control process with traps provided success rates of 94.19% in Kuşadası and 95.15% in Selçuk, while it provided a success rate of only 56.35% in Erdemli. As a result of examining these data, it was determined that the success of control decreases in areas where populations are high levels. Likewise, Hafsi et al. (2016) examined the activities of two different bait stations in early and mid-late peach varieties and reported that the number of adult flies on the late varieties was two times higher than those caught in the early varieties, and therefore, the effectiveness dropped in late varieties. Additionally, they recommended increasing the number of traps per hectare for the control process to be successful due to the high populations observed in the late varieties. Tiring and Satar (2017) determined that the population of the pest was not dense in the varieties that were harvested in June-July, and there was no problem, but

populations increased in the varieties that were harvested later, and this constituted a thread for peaches. Penarrubia (2010) reported that control processes carried out in peach orchards in Spain by mass trapping were successfully effective on low populations, but these should be supported with chemical control in the case of high populations. They also recommended increasing the number of traps to be used in the control process so that there would be no damage in years where the population increases by two times. Elekçioğlu et al. (2011) found that the population of the pest was high in Adana in August and September, and in the study, they carried out with traps containing Trimedlure and DDVP capsules, they managed to decrease the number of control processes with insecticides from nine to five. Papadopoulos et al. (2001) investigated the effects of low-density (1.5 traps/ha) and high-density (15 traps/ha) by using traps containing attractants with the same properties as Decis traps. They reported that traps hanged in peach orchards with high intensity attracted more individuals, traps that were hanged with high density at fruit areas caught Mediterranean fruit fly earlier, and the type of trap and the host were key factors in early monitoring of the pest. In parallel to the results and recommendations proposed by different researchers, in areas like Erdemli where the population is constantly high or in years where the population is determined to increase, the number of traps per hectare should be increased to prevent damage in the fruits. In cases where it is not possible to increase the number of traps, the control process should be supported by at least one application of insecticides. Yayla and Satar (2017) emphasized that there is a need to apply integrated fruit fly control techniques in cases of high population levels. The traps were kept in the land for 5 weeks in Kuşadası, 6 weeks in Selçuk and 10 weeks in Erdemli, and during these times, these traps were observed to catch the adults of C. capitata. As in the case that was observed during our study, dry traps such as Decis trap and similar ones that are used against the Mediterranean fruit fly are effective for 6-10 weeks (Jang et al. 2007).

Biotechnical methods are some of the most significant practices that are among the integrated control methods. However, it was presented with this study that biotechnical control alone would not be sufficient in cases where pest populations are higher levels. However, the number of traps may be increased to reduce damage levels of this pest. Similarly, in this study, it was determined that the density of the pest was high during this study especially in the Erdemli district of the province of Mersin in Turkey, and trap control was not sufficient by itself. It is considered that usage of different numbers of traps (traps/ha) in areas where the population of the pest is high and those where it is low may be effective in suppressing this population. In cases where it is not possible to increase the numbers of traps, it is recommended to carry out the control process by combining biotechnical control with methods such as chemical control, early harvest, and especially cultural control. The rates of damages, especially on the economic concerns of the producers, may increase in products that are harvested late. For this reason, the harvesting process should be completed without delay, and the pest should be controlled with an integrated approach.

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ÖZET

Ceratitis capitata karantina zararlısı ve toleransı sıfır olarak kabul edilen bir türdür. Üreme kapasitesinin yüksek olması ve doğrudan meyvede zarar yapması nedeniyle zararlı ile mücadele yürütülmeden üretim yapmak mümkün olamamaktadır. Kimyasal mücadeleye alternatif olarak biyoteknik mücadele yöntemi olan kitle halinde tuzakla yakalama, zararlının çok yüksek olmayan popülasyonlarında başarılı sayılan bir mücadele şeklidir. Tuzaklar ile mücadelede farklı besin cezbedici materyaller kullanılarak bireylerin tuzağa çekilmesi sonucu öldürülmesi sağlanmaktadır. Bu çalışma, Ege ve Akdeniz Bölgelerinde şeftali bahçelerinde eş zamanlı yürütülmüş ve bölgeler arasındaki popülasyon farklılığına göre tuzakların etkinliğinin belirlenmesi amaçlanmıştır. Denemeler 2018 yılında Kuşadası (Aydın), Selçuk (İzmir) ve Erdemli (Mersin) ilçelerinde yürütülmüştür. Zararlının feromon tuzaklar ile popülasyon değişimi ve kitle halinde yakalama tuzaklarının etkinliği saptanmıştır. Mücadele tuzağı olarak Decis Trap (Bayer) isimli ürün kullanılarak tuzağın etkinlikleri saptanmıştır. Temmuz ayında Kuşadası, Selçuk ve Erdemli ilçelerinde sırasıyla 4.8, 149.1 ve 166.9 adet/tuzak ergin birey yakalamıştır. Buna göre Kuşadası ilçesinde %94.19, Selçuk ilçesinde %95.6 oranlarında etkili bir başarı sağlarken Erdemli ilçesinde %56.34 oranında etkili olmuştur. Akdeniz Bölgesi popülasyonunun Ege Bölgesine göre daha yüksek seyretmesi ve şeftali üretim sezonun daha uzun sürmesinden dolayı istenilen düzeyde başarı sağlanamadığı belirlenmiştir.

Anahtar kelimeler: biyoteknik mücadele, *Ceratitis capitata*, İzmir, Mersin, şeftali

REFERENCES

Abbott W.S., 1925. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology, 18 (2), 265-267.

Akman K., Zümreoğlu A., 1973. Ege turunçgillerinde Akdeniz meyvesineği (Ceratitis capitata Wied.)'nin surveyi. Zirai Mücadele Araştırma Yıllığı, 7, 41-42.

Akyol E., 2014. Determination of population density and damage rates of a Mediterranean fruit fly, Ceratitis capitata (Wiedemann) (Diptera: Tephritidae) in the mandarin garden by using mass trapping method in Hatay province. MSc thesis, Mustafa Kemal University, Hatay, 88 pp.

Anonymous, 2020. Tarımsal Araştırmalar ve Politikalar Genel Müdürlüğü, Bitki Zararlıları Standart İlaç Deneme Metotları, 3 (2020): 158 pp.

Başpınar H., Çakmak İ., Koçlu T., Başpınar N., 2009. Aydın ili meyve bahçelerinde Akdeniz meyve sineği Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)'nin biyo-ekolojisi, zararı, yayılışı ve turunçgil bahçeleri üzerindeki çalışmaları. TOVAG 105O17, 56 s., Isparta.

CABI 2019. Datasheet Ceratitis capitata (Mediterranean fruit fly). https://www.cabi.org/isc/datasheet/12367). (accession date: 14 April 2019).

Delrio G., Zümreoğlu A., 1983. Attractability range and capture efficiency of medfly traps, 445-45. In: Fruit flies of economic importance. R. Cavalloro (Ed.). Proceedings of the CEC/IOBC International Symposium, Athens, Greece, 16-19 November 1982. A. A. Balkema, 642 p.

Demirdere A., 1961. Çukurova bölgesinde Akdeniz meyvesineği (Ceratitis capitata Wied.)'nin biyolojisi ve mücadelesi üzerinde çalışmalar. Tarım Bakanlığı, Zirai Mücadele ve Zirai Karantina Umum Müdürlüğü, Ayyıldız Matbaası, Ankara 118 s.

Demirel N., 2016. Population density and damage ratios of the Mediterranean fruit fly, Ceratitis capitata (Wiedemann) (Diptera: Tephritidae) on pomegranate orchards in Turkey. Entomology and Applied Science Letters, 3 (5), 1-7.

Dinçay O., Civelek H.S., Görmez E., 2017. Residue analysis of insecticides used for control of Mediterranean fruit fly [Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)] in Izmir's satsuma (mandarin) and Antalya's pomegranates. Ege Üniversitesi Ziraat Fakültesi Dergisi, 54 (2), 231-238.

El-Gendy I.R., Nassar A.M.K., 2014. Delimiting survey and seasonal activity of peach fruit fly, Bactrocera zonata and Mediterranean fruit fly, Ceratitis capitata (Diptera: Tephritidae) at El-Beheira Governorate, Egypt. Egyptian Academic Journal of Biological Sciences, 7 (2), 157-169.

Elekçioğlu N.Z., 2009. Akdeniz meyvesineği. Biyoloji Bilimleri Araştırma Dergisi, 2 (1), 61-65.

Elekçioğlu N.Z., 2013. Fruit flies of economic importance in Turkey, with special reference to the Mediterranean fruit fly, Ceratitis capitata (Wied.). Türk Bilimsel Derlemeler Dergisi, 6 (2), 33-37.

Elekçioğlu N.Z., Güneş A., Yıldız A., 2011. The population development and mass trapping studies of the Mediterranean fruit fly, Ceratitis capitata Wied. (Diptera: Tephritidae) in Adana. In: Proceedings of The Forth Plant Protection Congress of Turkey, Kahramanmaraş, 244 pp.

Hafsi A., Abbes K., Harbi A., Duyck P.F., Chermiti B., 2016. Attract-and-kill systems efficiency against Ceratitis capitata (Diptera: Tephritidae) and effects on non-target insects in peach orchards. Journal of Applied Entomology, 140, 28-36.

Headrick D.H., Goeden R.D., 1996. Issues concerning the eradication or establishment and biological control of the Mediterranean fruit fly, Ceratitis capitata (Wiedemann) (Diptera: Tephritidae), in California. Biological Control, 6 (3), 412-421.

İleri M., 1961. Türkiye'de Akdeniz meyvesineği (Ceratitis capitata wield.) durumu ve mücadelesi. Ankara Zirai Mücadele Enstitüsü Müdürlüğü Sayı: 17, 38 pp.

Jang E.B., Holler T.C., Moses A.L., Salvato M.H., Fraser S., 2007. Evaluation of a single-matrix food attractant Tephritid fruit flies bait dispenser for use in federal trap detection programs. Hawaiian Entomological Society, 39, 1-8.

Kahyaoğlu M., Gürkan M.O., 2010. Development of new bait formulations for Mediterranean fruit fly [Ceratitis capitata Wiedemann, 1824 (Diptera: Tephritidae)]. Türkiye Entomoloji Dergisi, 35 (3), 485-494.

Karman M., 1971. Bitki koruma araştırmalarında genel bilgiler, denemelerin kuruluş ve değerlendirme esasları, İzmir, Turkey: Tarım Bakanlığı Zirai Mücadele ve Karantina Genel Müdürlüğü Yayınları, 279 pp.

Karsavuran Y., Karsavuran H., Zümreoğlu A., 1988. Some investigations on the effects of different pH values on artificial diet concerning some biological aspects of Ceratitis capitata (Wied.) (Diptera: Tephritidae). Türkiye Entomoloji Dergisi, 12 (3), 161-170.

Kasap A., Aslan M.M., 2016. The monitoring the population and detection of the loss ratio of the Mediterranean fruit fly (Ceratitis capitata Wied.) (Diptera: Tephritidae) by pheromone traps in pomegranate and persimmon varieties. KSU Journal of Natural Sciences, 19 (1), 43-50.

Kaya T., İpekdal K., 2018. The first record and barcoding of the Mediterranean fruit fly Ceratitis capitata (Diptera: Tephritidae) in Kırşehir, Turkey. Mediterranean Agricultural Sciences, 31 (2), 101-105.

Layık F.Ö., Kısmalı Ş., 1994. Use of mass-trapping method to control with biotechnical aspects against pests. Türkiye Entomoloji Dergisi, 18 (4), 245-259.

Oroño L.E., Albornoz-Medina P., Núñez-Campero S., Van Nieuwenhove G.A., Bezdjian L.P., Martin C.B., Ovruski S.M., 2006. Update of host plant list of Anastrepha fraterculus and Ceratitis capitata in Argentina. In: Proceedings of the 7th International Symposium on Fruit Flies of Economic Importance (pp. 207-225).

Özbay F., 2011. Turkey-Russia relations in the post-cold war period: 1992-2010. Bilge Strateji, 2 (4), 35-77.

Papadopoulos N.T., Katsoyannos B.I, Kouloussis N.A., Hendrichs J., Carey J.R., Heath R.R., 2001. Early detection and population monitoring of Ceratitis capitata (Diptera: Tephritidae) in a mixed-fruit orchard in Northern Greece. Journal of Economic Entomology, 94 (4), 971-978.

Penarrubia M.I.E., 2010. Biology studies and improvement of Ceratitis capitata (Wiedemann) mass trapping control technique. Doctoral Thesis, University of Lleida (Unpublished), Spain, 208 pp

Radonjic S., Cizmovic M., Pereira R., 2013. Population dynamics of the Mediterranean fruit fly in Montenegro. International Journal of Insect Science, 5, 35-40.

Satar S., Tiring G., 2016. Determined the effectiveness of the use of traps against the Ceratitis capitata Wied. (Diptera: Tephritidae) in Okitsu wase mandarin and relationship between fruit pomological characteristics and infestation. Derim, 33 (2), 221-236.

Satar S., Tiring G., İşpınar D., Algan A.R., 2016. Population fluctuation of Ceratitis capitata Wied. (Diptera: Tephritidae) in grapefruit orchards and the effect of temperature on its development. Bitki Koruma Bülteni, 56 (4), 429-440.

Sierras N., Pala Y., Özakman M., Altın N., Levent G., Kunter E., 2012. Control of Ceratitis capitata in oranges by the mass trapping system Cera Trap® in Turkey, 111. In: Proceedings of the 8th International Conference on Integrated Fruit Production 7, Kuşadası, 133 pp.

Tiring G., Satar S., 2017. Population fluctuation of Ceratitis capitata (Wiedemann) (Diptera: Tephritidae) in some fruit orchards. Türkiye Entomoloji Bülteni, 7 (3), 239-247.

Tolga M.F., Erkan A., Yıldırımoğlu H., Şengün A., Yanarca B., 2018. Akdeniz meyvesineği [Ceratitis capitata (Wiedemann,1824) (Diptera: Tephritidae)] istilasının engellenmesi, 13-14". In: Proceedings of the Uluslararası Tarım, Çevre ve Sağlık Kongresi, Aydın, 283 pp.

Tolga M.F., Akkan Ü., Helvacıoğlu Ö., Fırat F., 2019. İzmir ili Karaburun ilçesinde izole alanda Akdeniz meyvesineği, Ceratitis capitata (Diptera:Tephritidae) popülasyon değişimi ve toplu mücadelenin etkisi. In: Proceedings of the 4th International Anatolian Agriculture, Food, Environment and Biology Congress, Afyon, 1065 pp.

Tunçyürek M., 1972. Recent advances in the bio-ecology of Ceratitis capitata Wield. in Turkey. OEPP/EPPO Bulletin, 2 (6), 77-81.

Yayla M., Satar S., 2017. Efficacy of different methods to control Mediterranean fruit fly. Türkiye Entomoloji Bülteni, 7 (4), 267-276.

Zümreoğlu A., 1986. İzmir ve civarında turunçgil ve meyve ağaçlarında zarar yapan Akdeniz meyvesineği (Ceratitis capitata Wield.)'nin önemi ve popülasyon dalgalanmasına etki eden faktörler. Ege Üniversitesi Ziraat Fakültesi Dergisi, 23 (2), 30-40.

Zümreoğlu A., 1990. Standardization of medfly (Ceratitis capitata Wied.) trapping for use in sterile insect technique programmes: two-year investigations on the efficiency of various medfly trapping systems in Western part of Turkey. Türkiye Entomoloji Dergisi, 14 (3), 155-166.

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