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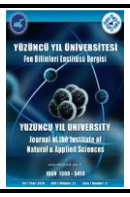

Research Article

Adult Population Dynamics of the European Grapevine Moth [*Lobesia botrana* Denis & Schiffermüller (Lepidoptera: Tortricidae)] in Midyat Vineyards

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Abstract: The study was conducted to determine the adult population change, the period when they are active in nature, and the number of generations of the European grapevine moth, *Lobesia botrana* [Denis & Schiffermüller (Lepidoptera: Tortricidae)]. The study was carried out in vineyards having the Mazruni variety (unregistered), which is the most common grape in Midyat district of Mardin province, between 2014 and 2015. The results indicated that adults of the moths were first encountered in the pheromone traps in early April, and the pest population was high in both years (an average of 2173 adults/traps in 2014 and 1615 adults/traps in 2015). According to the results, the pest gives three generations, and three or four peaks (three main peaks during the season and a low peak at the end of the season) occur in the vegetation period of grapes. These peaks coincide with the flowering period (May 8-16), the berry (chickpea size) period (June 27-July 6), the sweetening period of the grains (July 27-August 15), and the sweetening-harvest period (September 17-19), respectively. The pest remains active in vineyards for approximately seven months, thereafter overwinters between late October and early November. The results obtained provide essential information that helps pest control at the appropriate time.

Salkım güvesi [*Lobesia botrana* Denis & Schiffermüller (Lepidoptera: Tortricidae)]'nin Midyat Bağ Alanlarındaki Ergin Popülasyon Dinamiği

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Anahtar Kelimeler
Feromon tuzağı,
Popülasyon dinamikleri,
Salkım güvesi,
Üzüm

Öz: Bu çalışma Salkım güvesi [*Lobesia botrana* Denis & Schiffermüller (Lepidoptera: Tortricidae)]'nin ergin popülasyon değişimi, doğada aktif olarak bulunduğu süre ve döl sayısının belirlenmesi amacıyla yapılmıştır. Çalışma, 2014 ve 2015 yılları arasında Mardin ilinin Midyat ilçesindeki bağlarda yaygın olarak yetiştirilen yerel 'Mazruni' üzüm çeşidi üzerinde yürütülmüştür. Çalışma sonucunda, her iki yılda da *L. botrana* popülasyonunun yüksek yoğunluğa (2014 yılında ortalama 2173 ergin/tuzak ve 2015 yılında 1615 ergin/tuzak) sahip olduğu ve eşeysel çekici tuzaklarda kelebeklerin ilk olarak Nisan başında görüldüğü belirlenmiştir. Elde edilen sonuçlara göre, zararlının üç döl verdiği ve bağın fenolojisi boyunca üç veya dört tepe noktası (sezon boyunca ana üç tepe noktası ve sezon sonunda zayıf bir tepe noktası) oluşturduğu tespit edilmiştir. Bu tepe noktalardan birincisi çiçek dönemine (8-16 Mayıs), ikincisi koruk (nohut büyüklüğü) dönemine (27 Haziran-6 Temmuz) üçüncüsü tanelerin tatlanma (ben düşme) dönemine (27 Temmuz- 15 Ağustos) dördüncüsü de tatlanma-hasat dönemine (17-19 Eylül) denk gelmektedir. Çalışma sonucunda zararlının

kışlamaya Ekim ayı sonu ile Kasım ayı başları arasında girdiği, doğada yaklaşık olarak yedi ay aktif kaldığı gözlenmiştir. Elde edilen sonuçlar, zararlı ile mücadeledenin uygun zamanda yapılabilmesine yardımcı olan temel bilgileri sağlamaktadır.

1. Introduction

Turkey has an ancient and deep-rooted viticulture culture; it is ranked 5th globally in vineyards area and ranks 6th in the amount of grape production (OIV, 2022). About 54% of Turkey's grape production is used for table, 31% for drying, and 15% for wine production (TÜİK, 2021).
The importance of viticulture in the South East Anatolia Region has increased with the introduction of the Southeastern Anatolia Project (Güneydogu Anadolu Projesi, GAP). This region has approximately 23.93% of the total vineyard areas of Turkey and realizes 13.68% of the total grape production. In terms of viticulture, the province of Mardin, which is the most important of the southeastern Anatolia region in terms of viticulture, ranks third in Turkey (TÜİK, 2021).

Pests are among the important factors that reduce yield and quality in vineyards, thus increasing input costs and decreasing the market value of the product. Many harmful pest species damage vineyards. The European vine moth [*Lobesia botrana* Denis-Schiffermüller (Lepidoptera: Tortricidae)] is the main pest of vineyards in the world (Öztürk et al., 2005; Kaplan, 2020; Rank et al., 2020). Its larvae can feed on flower buds or berries and cause significant direct losses in grape production (Thiéry et al., 2014). These losses are frequently made worse by fungi, such as the grey mold (Fermaud & Le Menn, 1989), *Aspergillus carbonarius*, and *A. niger* (Cozzi et al., 2006), which can create ochratoxins, a subclass of mycotoxins. In some circumstances, primary berry damage can also result in secondary insect infestations such as Drosophila, which can increase the prevalence of sour rot (Barata et al., 2012).

Viticulture has been practiced in the Mardin region for hundreds of years. Currently, *L. botrana* is the main pest of vineyards in Mardin, as in other provinces in the Southeastern Anatolia Region (Diyarbakır, Şanlıurfa, Adıyaman) (Kaplan & Çınar, 1998; Mamay & Çakır, 2014; Çakmak & Mamay, 2021; Mamay & Çakmak, 2021). The control of this pest mainly relies on chemical pesticides. Because of the well-known side effects of chemical pesticides on human health and the environment, it is essential to establish ecosystem-friendly and effective control methods against *L. botrana*. Ecologically sound management programs require a greater understanding of seasonal population dynamics and related information. The aim of this study was to examine the seasonal occurrence of *L. botrana*'s adult population dynamics, the first adult emergence, the duration of being active in nature, and the number of offspring per year in vineyards ecosystems in the Mardin province, Turkey.

2. Material and Methods

The study was carried out in the vineyards composed of the non-registered grape, Mazruni (Synonym: 'Mazrone'), which has grown in the Midyat country of Mardin province since ancient times. Mazruni grape is a serpentine variety that stands on its roots and grows longitudinally. However, its shoots extend towards the soil in a way that wraps the trunk (the shoots extend towards the soil since the vine shoots are not suspended). The samplings were conducted in the most important grape-grown neighbourhoods (Barıştepe, Budaklı, and Mercimekli) of Midyat between March and October 2014 and 2015. The first adult emergence, the adult population dynamics, the duration of being active in the orchards, and the number of generations per year of the pest were determined using Delta-type pheromone traps (Trece® incorporated Pherocon® CAP, E-7, Z-9-dodecadienyl acetate). A GPS device was used to determine the coordinates, and climate data were obtained from Diyarbakır Meteorology's 15th Regional Directorate. With the help of these meteorological data, the total maximum temperatures (TMT) and the total effective temperatures (TET) of Midyat were calculated.

To decide on spraying against *L. botrana*, TET is crucial in addition to criteria such as population status, egg hatching, and phenological periods of the vine. TMT was calculated by adding the daily highest temperatures as of January 1, and TET was calculated by adding the daily effective temperature values obtained by subtracting 12°C, which is the development threshold temperature of the *L. botrana*, from the daily mean temperature value [(min.+max.): 2]. Spraying is recommended for

the 1st, 2nd, and 3rd generation when TET reaches 120, 520, and 1047 degree days, respectively, from 1 January (Ünlu & Güleç, 2018; Anonymous, 2023).

The trials were established in three different vineyard areas consisting of serpene goble type Mazruni grape variety, which represents the Midyat district and is grown in arid conditions. The sizes, ages, and coordinates of vineyards where pheromone traps were placed are given in Table 1.

Table 1. Information on the location, sizes, ages, and coordinates of vineyards

City	District	Neighbourhood	Area (da)	Age	Coordinate
Mardin	Midyat	Barıştepe	9.00	15	N: 41°22'40.10" E: 37°27'01.85"
		Budaklı	7.00	15	N: 41°20'20.22" E: 37°22'19.49"
		Mercimekli	5.00	20	N: 41°19'34.34" E: 37°27'29.48"

The pheromone traps were hung at the cluster level (about one meter) in the direction of the prevailing wind (north-south) when the temperature approached 1000 degrees as of January 1 (March 18 in 2014, March 25 in 2015) (Anonymous, 2023; Aslan & Gülser, 2018; Ünlü & Güleç, 2018). The shoots and bud break were observed in this period in the vineyards. The controls of the traps were done periodically once a week, and the adults caught in the traps were collected and recorded. The pheromone capsule in the traps was changed once a month.

3. Results and Discussion

We obtained that the *L. botrana* has three generations in the Midyat district, and its population formed peaks after the emergence of adults of every generation. The adults of the pest were actively present in nature from the beginning of April until the end of October when pupation began. The emergence and population dynamics of the adults of the pest in Mazruni, an unregistered grape, in different locations of the Midyat district (Barıştepe, Budaklı, Mercimekli) in 2014 and 2015 are shown in Figures 1, 2, and 3.

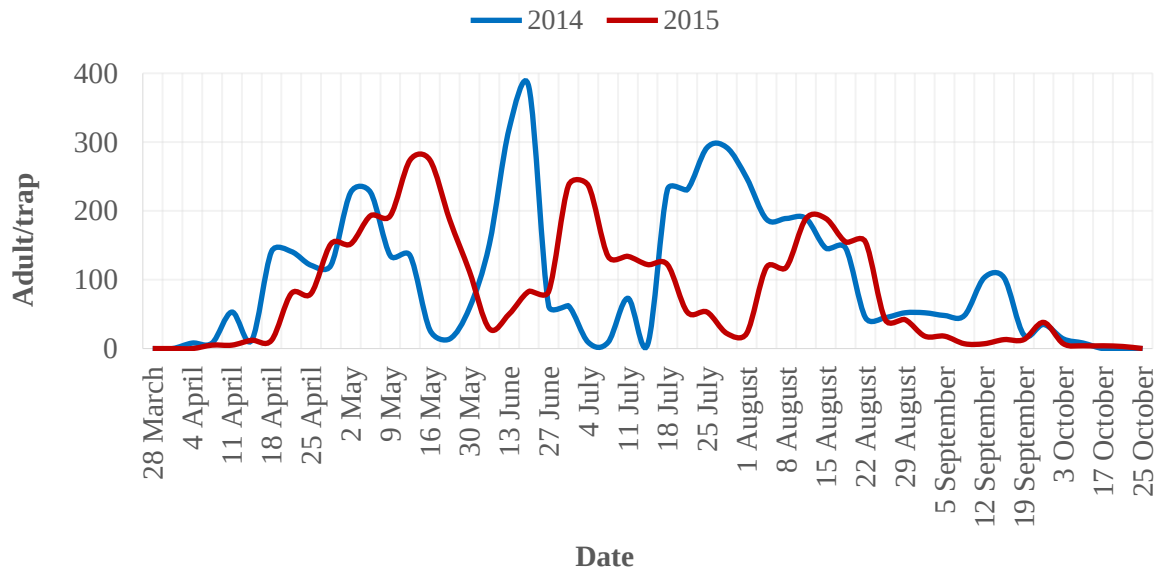

Figure 1. Adult population change of European grapevine moth in the vineyard of Mardin Midyat Barıştepe neighbourhood in 2014 and 2015.

The number of *L. botrana* adults caught in the pheromone traps and its population fluctuations in the Barıştepe neighbourhood in 2014 and 2015 are given in Figure 1. The adults were detected for the first time in the first week of April (04-09 April) in both years. When the adults were seen in the traps for the first time, the temperature was 10.9 °C, and the relative humidity was 44.4% in 2014, and they were 17.8 °C and 39.7%, respectively, in 2015 (Figure 4). The pest formed three peaks in both years; however, the peaks occurred earlier in 2014, and the values of the second and third peaks detected in that year were higher than those obtained in 2015. The results indicate that the pest population density was higher in 2014 compared to 2015; the total number of adults caught in traps was 3210 and 2399 in 2014 and 2015, respectively. The adults of the pest were last encountered on October 10 in 2014, and October 20 in 2015.

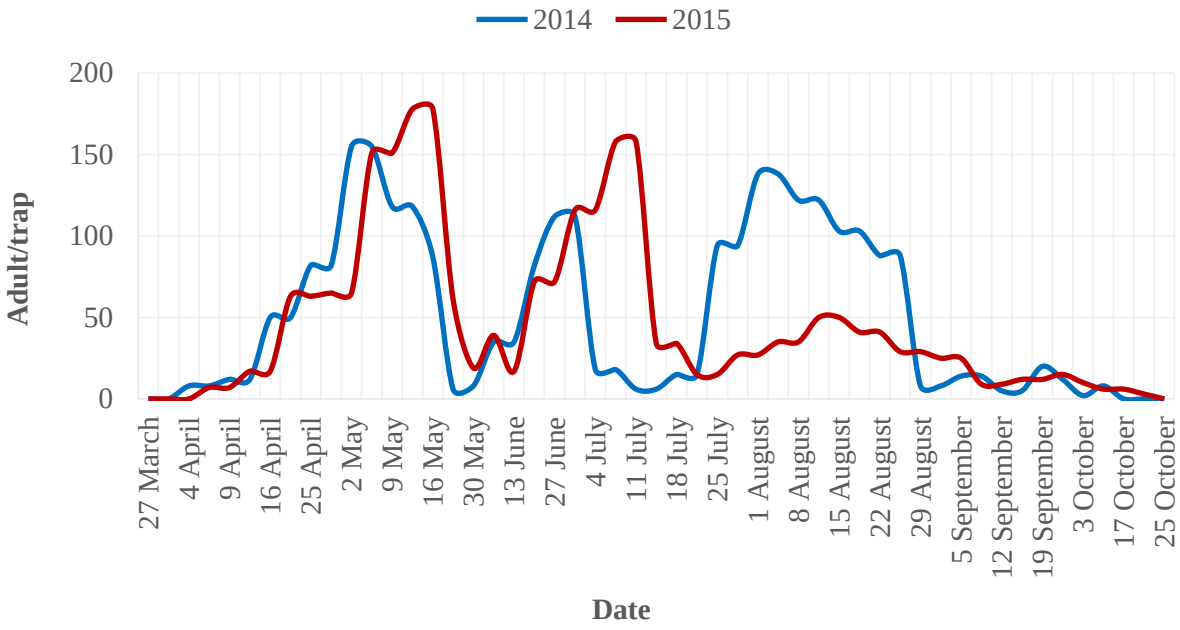

Figure 2. Adult population change of the European grapevine moth in the vineyard of Mardin Midyat Budaklı neighbourhood in 2014 and 2015.

Adults of the pest were first encountered in the traps in Budaklı in the first week of April 2014 (04 April). The pest population showed high fluctuation during the season and formed three peaks (May 2, 155 adults/trap, June 20, 120 adults/trap, and August 1, 188 adults/trap). Adults were last seen in traps on October 10 (8 adults/trap). Adults of the pest were caught in the trap in the first week of April (06 April) in 2015 as in 2014. When the adults were caught in the traps for the first time, the temperature and humidity values were 10.9 °C and 44.4% in 2014 and 15 °C and 67% in 2015, respectively (Figure 4).

The population of the pest began to develop in the first week of April (April 4) and reached its first peak level on May 15 (178 adults/trap). Thereafter, the population declined sharply until June 13 (17 adults/trap), and shortly after, it started to increase and reached the second peak (July 6; 158 adults/trap). The population density declined greatly after the second peak occurrence and fluctuated at low levels until the end of the season. The pest adults were encountered in the vineyards until 20 October. The results indicate that the pest population density was higher in 2014 than that in 2015; the total number of adults caught in traps was 1578 and 1275 in 2014 and 2015, respectively.

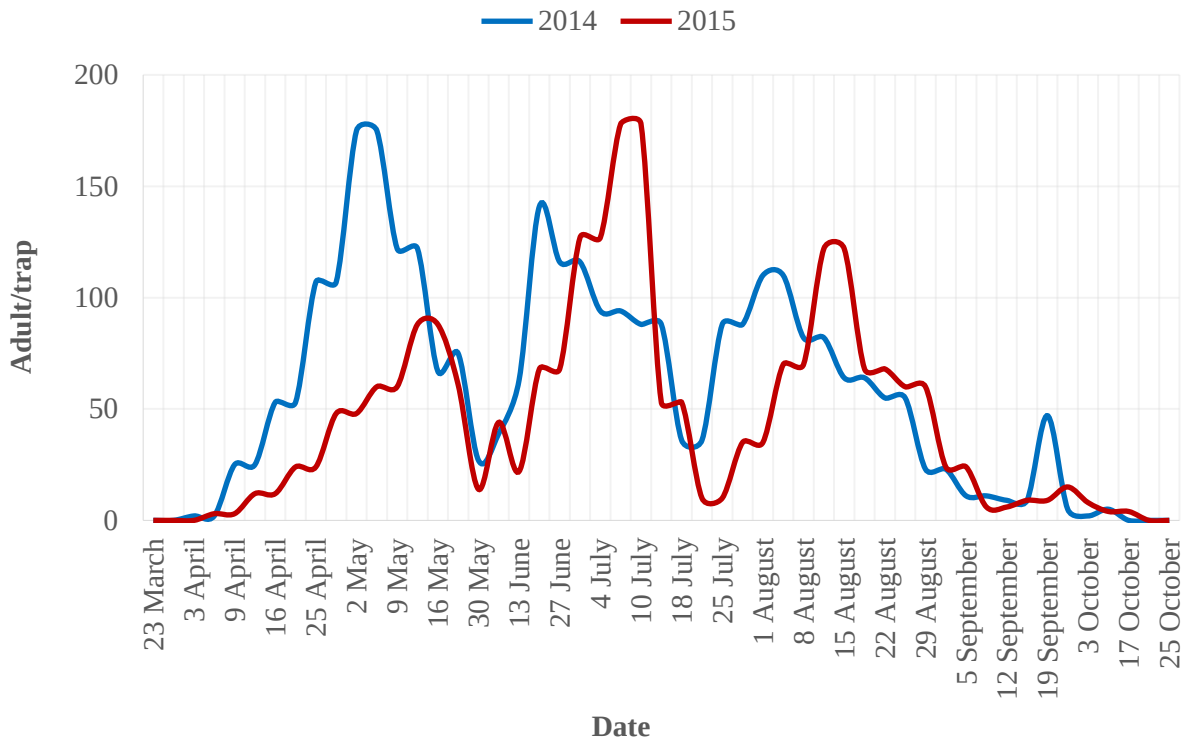

Figure 3. Adult population change of the European grapevine moth in the vineyard of Mardin Midyat Mercimekli neighbourhood in 2014 and 2015.

The adult numbers of *L. botrana* caught in pheromone traps in the vineyard in the Mercimekli neighbourhood, and their population fluctuations are given in Figure 3. The adults were seen for the first time in the first week of April (03-06 April) in both years. The average temperatures were 8.8 °C and 15 °C, and relative humidities were 45.3% and 67% in 2014 and 2015 when the adults were encountered for the first time in the traps. The adults were encountered in pheromone traps for the first time on April 3 (2 adults/trap) in 2014, then the population began to increase and reached a peak level (175 adults/trap) on May 2. Later on, the population dwindled until second-generation adults appeared in traps (30 May). With the increase in the number of adults belonging to the second generation, the pest population formed its second peak on June 20 with 141 adults/trap. The population started to decline rapidly after the peak formation and continued its decline until the adults of the third generation were caught in a trap (18 July). The pest formed the third peak (110 adults/trap) on August 1, and thereafter population gradually declined until September 12, then increased, and a small peak occurred on September 19 (47 adults/trap).

The adults of the pest were caught in traps for the first time (3 adults/trap) on April 6 in 2015. The first peak occurred on May 15 with 88 adults, and the population then decreased until the adults of the second generation were seen in the pheromone traps (14 June). The pest population formed two other peaks with each new generation of adults, the second peak occurred on July 6 with 178 adults/trap, and the third peak occurred on August 13 with 122 adults. Thereafter the population decreased gradually until October 10, when the adults were caught for the last time in the traps.

The total density of *L. botrana* adults caught in the pheromone traps in the vineyard in the Mercimekli neighbourhood was higher in 2014 (1731 adult/trap) compared to 2015 (1233 adult/trap). The study by Mamay & Çakır (2014) found that the pest population in Şanlıurfa (Öğütçü) was considerably high (1333 adults/trap in 2010 and 520 adults/trap in 2011). This finding is consistent with previous studies showing that *L. botrana* populations can vary significantly by regions and years.

The shoots of the Mazruni variety wrap around the trunk and spread toward the ground, therefore, the humidity rate is high in the vineyards of this variety since the air cycle is insufficient in the inner parts of the vineyards, and the clusters are not exposed to sunlight. This creates a suitable environment for the pest activity in terms of temperature and humidity. The population dynamics and status of insect pests on crops are known to be significantly influenced by temperature. These may occur

from both direct effects on the distribution and abundance of pest populations as well as indirect effects on host plants, competitors, and pests' natural enemies (Uygun & Atlihan, 2000; Atlıhan & Özgökçe, 2002; Atlihan & Chi, 2008; Satishchandra et al., 2018; Özgökçe et al., 2018). It has been seen that the temperature increase stimulated the pest population to increase. The temperature also has an indirect effect on the population growth of the pest by affecting plant phenology. Temperature and humidity data were given in Figure 1 to illustrate the interaction between meteorological data and the pest population density and fluctuation. Temperature values are important in chemical control against *L. botrana* damage in vineyards. As reported in Aslan & Gülser (2018) and Anonymous (2023), The TET values required for the control of the first, second, and third-generation *L. botrana* are 120, 528, and 1047 degree days, respectively. These values were obtained on May 03, June 16, and July 26 in 2014, and on May 18, June 22, and July 25 in 2015. Based on these results, it would be appropriate to apply chemical control against *L. botrana* in Mardin in mid-May, late June-early July, and early August in case the population of the pest is dense enough to require control.

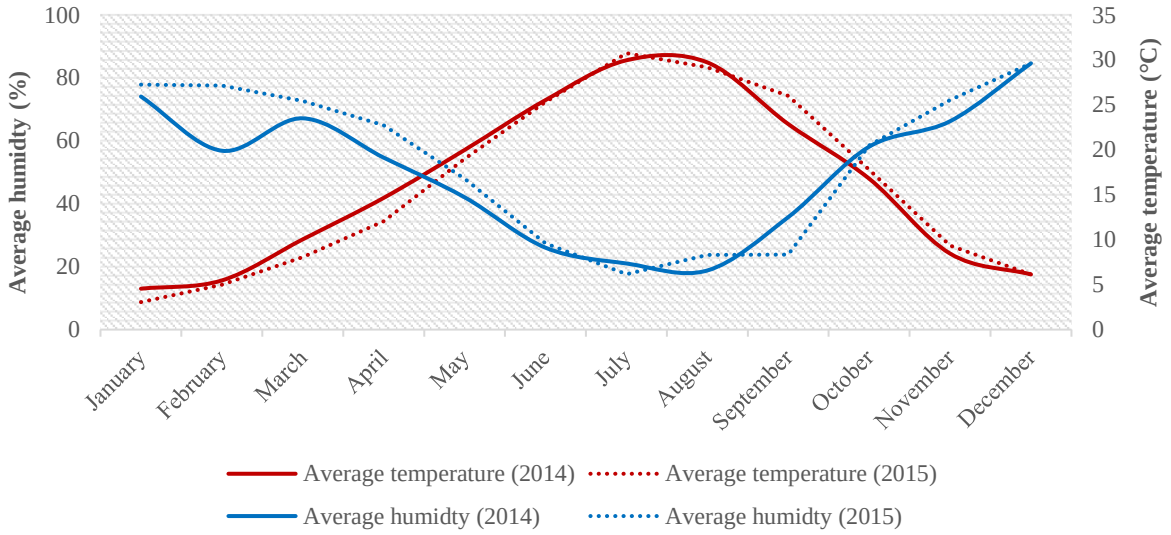

Figure 4. The average temperature and relative humidity values in the Midyat district in 2014 and 2015.

In the Midyat district, the average temperature and relative humidity values of 2014 and 2015 and their trend throughout both years were similar (Figure 4).

Adults of the pest emerge for the first time at different times in the grape-grown regions of Turkey, depending on ecological conditions. For instance, the adults of the pest appear for the first time at the end of April in Diyarbakır, Şanlıurfa, and Elazığ provinces located in the same region as the Midyat district of Mardin (South Anatolian region of Turkey) (Kaplan & Çınar, 1998, Mamay & Çakır, 2014; Kaplan et al., 2016; Kaplan, 2019), between late February and early March in Mersin-Tarsus (Öztürk & Acıöz, 2010), between late April-first half of May in the Çanakkale vineyards (Özpinar et al., 2004), in the second half of April in İzmir, Denizli, Manisa (Önçağ, 1975; Kovancı et al., 2005), and Bursa (Altındişli et al., 2005), in Mid-April and at the beginning of May in Gaziantep (Aslan & Gülser, 2018). Depending on the environment and annual weather circumstances, *L. botrana* completes two or three generations in transitional locations. It generally completes two generations per year in central Europe and three generations in southern Europe, however, during the warmest years and in some southern grape-growing regions, a partial fourth generation can be seen (Charmillot, 2005; Pavan et al., 2006; Ioriatti et al., 2011). According to recent studies, the *L. botrana* first appears in April in Diyarbakır province, located in the Southeastern Anatolia region of Turkey, and Ankara province, located in the Central Anatolian region. Although it is active in nature for seven months in Diyarbakır and six months in Ankara, it produces three generations in both provinces annually (Kaplan, 2020; Özdem et al., 2022). The difference between regions regarding the first occurrence of the pest in nature might be attributed to the differences between climatic conditions, especially temperature and relative humidity. *L. botrana*'s first generation typically has no negative economic effects. Due to their activity, the second and third generations can reduce yields and inflict quality harm (Moschos, 2006; Pavan et al., 2014).

We obtained that the pest has three generations in the Midyat district. Our result is in following that of Kaplan & Çınar (1998), who stated that the pest gives three generations per year in Diyarbakır, Şanlıurfa, and Elazığ provinces located in the same region with Midyat district. The pest formed four peaks (three main peaks during the season and a low peak at the end of the season) in Barıştepe and Mercimekli and three peaks in Budaklı in 2014, and three peaks in all neighbourhoods in 2015. The peaks coincided with the flowering period (May), the berry (chickpea size) period (June-July), the sweetening period of the grains (July-August), and the sweetening-harvest period (September), respectively. After the harvest, the population decreased in all neighbourhoods, and overwintering occurred in October-November.

4. Conclusion

In this study, the time of the first emergence of *L. botrana* adults and the period they were active in nature and population fluctuation in this period, and the number of generations were investigated in the vineyard areas of the Midyat district of Mardin province. The results obtained provide important information for pest control at the appropriate time.

Our results indicated that *L. botrana* first appears at the beginning of April in the pheromone traps and reaches the high density that needs to be controlled. It gives three generations and generally forms three or four peaks in the phenology of the vineyard and remains active in nature for approximately seven months, thereafter overwinters between the end of October and the beginning of November.

According to the results, three sprayings should be applied against *L. botrana* in the vineyards in the Midyat district in the first half of May (first generation), in the second half of June (second generation), and in the last week of July (third generation).

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