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ORIGINAL ARTICLE / ORIGINALBEITRAG

Determining the Adult Population Fluctuation and Infestation Rate of European Grapevine Moth (*Lobesia Botrana* (Denis & Schiffermüller) (Lepidoptera: Tortricidae)) in the Vineyards in Turkey

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Abstract

This study has been conducted in 2014 and 2015 in vineyards in Çermik district of Diyarbakır province where 'Mazruni' variety is grown commonly. Purpose of the study was to determine some control criteria of grapevine moth (*Lobesia botrana* Denis & Schiffermüller (Lepidoptera: Tortricidae)) such as the first sight of adults in nature, adult population fluctuations, active period of adults in nature, number of seeds and infestation rate of the European grapevine moth (*Lobesia botrana* Denis & Schiffermüller (Lep.: Tortricidae)) in vineyards.

Conclusion of the study was that in both years, the first flight of *L. botrana* adults was observed in 6–14 April and the pest had three peaks a year (5–11 May, 29 June–7 July, 11–17 August). Furthermore, it was observed that the first peak coincided with flowering period (May, 1. generation), the second occurred during unripe grape period (June and July 2. generation), and the third coincided with the beginning of sweetening period (August, 3. generation). Adult flights of *L. botrana* ended on 12–20 October and it was determined that it was active for seven months in nature (mid-April to late October) and it completed 3 generations per year. The infestation rate of *L. botrana* was determined as 12% and 15% respectively for the two years in the vineyards of Bintaş village-1 while the rates were only 10% and 18% in the vineyards of Bintaş village-2.

Keywords Vineyards · Lobesia botrana · Population fluctuations · Infestation rate

Untersuchung der Populationsschwankungen und der Befallsrate des Europäischen Traubenwicklers (*Lobesia botrana* (Denis & Schiffermüller) (Lepidoptera: Tortricidae)) in Weinbergen der Türkei

Schlüsselwörter Weinberge · Lobesia botrana · Populationsschwankungen · Befallsrate

Introduction

With a significant importance in human nutrition, grape is a fruit type consumed both fresh and dry. It is also one of the important export items for the economy of Turkey. In terms of vineyard sizes, Spain is ranked first in the world, followed by Italy, France and Turkey. And in terms of grape production, Italy, China, USA, France and Spain is followed by Turkey in 6th place (Anonymous 2013a).

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The vineyard area in Turkey is 4,170,410 decares and grape production amount is 3,933,000 tons. In South Eastern Anatolian Region, Diyarbakır Province is an important centre of vine cultivation and a total of 109,938 tons grapes have been produced in 178,359 decares. Grapes are mostly produced for table consumption, drying and wine making (Anonymous 2018).

In previous studies several pests and diseases with an impact on quality and yield have been detected in vineyards in Turkey. One of the most significant of those is grapevine moth (*Lobesia botrana* Denis & Schiffermüller (Lepidoptera: Tortricidae)) (Günaydın 1972; İren 1976; Maçan 1984; Erkılıç et al. 1995; Öncu 1998; Erkan et al. 1999; Çakırbay et al. 2000; Öztürk et al. 2005; Mamay and Çakır 2014). *L. botrana* is harmful through larvae, and

also by feeding on buds, flowers, unripe and ripe grains. It leads to falling off during the bud and flowering stages followed by decaying during unripe and ripe periods, hence it degrades the quality of the product and reduces the market price (Anonymous 1992, 2008; Erkan et al. 1999).

The study has been conducted in the vineyards of Diyarbakır province Çermik district Bintaş village where 'Mazruni' grape is being commonly grown.

The purpose of the study was to determine some bio-ecologic criterion related to controlling grapevine moth, such as first sight of adults in nature, population fluctuation, active duration in nature, number of seeds under natural conditions and infestation rate in vineyards. The findings acquired from this very first study of its kind in the vineyards in Mardin province should not only shed light for future studies but also provide information on protecting human health, environment and natural balance whilst controlling the pest in a correct manner.

Materials and Methods

Materials

The main material of the study consists of grapes in organic vineyards infested with grapevine moth, Delta type sexually attractive traps (Trece® incorporated Pherocon® CAP) used to determine the adult population of the pest and population fluctuation and Onset Hobo Data Loggers (U-10-003) data device used to record climate data. *L. botrana*'s population monitoring has been performed in two non-disinfected vineyards in Çermik district of Diyarbakır province in 2014–2015. Trials have been set in two vineyards in Bintaş village producing 'Mazruni' grape, one a 30-year-old 20 da yard and the other a 25-year-old 25 da yard using gobble system. The outstanding features in terms of quality grape variety 'Mazruni' grape (Synonym: 'Mazrone') are: total soluble solids % 18.60—pH 3.38—tartaric acidity 4.25 g/l—berry weight 0.80 gr (Tanrısever 2016).

Methods

Adult Population Fluctuation in Grapevine Moth

With the purpose of determining adult population fluctuation, sexually attractive traps have been set starting from 1 January once maximum temperature total reached 1.000 °C, with 3 traps each in both vineyards and towards the south of the vine stock. Traps have been set at grape bunch level and towards the dominant wind direction (Erkan et al. 1999; Anonymous 2008). While controlling the traps, butterflies caught in adhesive traps have been counted and logged weekly. The pheromone-containing capsules of the traps have been replaced once every 4–6 weeks as per the manufacturer instructions while the other parts have been replaced as they became stained. The temperature and % proportional humidity values have been taken from the climate data device.

Infestation Rate of Grapevine Moth in Grape Bunches

With the purpose of determining the grapevine moth infestation rates in grape bunches, 20 vine stocks have been randomly selected in the two vineyards in Bintaş village during harvest period, and a total of 100 bunches have been controlled from 4 different parts of the vine stock (Kısakürek 1972). Observing any damage or biologic period of the pest on the bunches meant the bunch was infested. The infection rate percentage (%) has been determined by proportioning the infected bunch number to the total number of bunches.

Results and Discussion

Adult Population Fluctuation of Grapevine Moth

With the purpose of determining the adult population fluctuation value of grapevine moth, sexually attractive traps have been set starting from 1 January in each year once the maximum temperature total reached to 1.000 °C, and they were also set during mid-March. The population fluctuations determined on the basis of *L. botrana* (butterfly) caught in traps during the study are given in Fig. 1.

Figs. 1 and 2 indicate that in Bintaş village, where the population fluctuation has been observed weekly, during the first year the first adults of *L. botrana* have been observed in sexually attractive traps on 14 April (3–6 adults/trap) when average temperature in vineyard areas number 1 and 2 was 17.5 °C and relative humidity was 46% and during the second year the first adults have been observed on 6 April (7–4 adults/trap) when average temperature was 13 °C and relative humidity was 70%. During the first year, the highest number of butterflies has been observed on 5 May by 93–124 adults/trap, on 7 July by 67–84 adults/trap and on 11 August by 64–45 adults/trap. And during the second year of the study, the highest number of butterflies has been observed on 11 May by 205–237 adults/trap, on 29 June by 97–127 adults/trap and on 17 August by 72–92 adults/trap. The chart drawn regarding the population fluctuations based on the number of butterflies caught in sexually attractive traps indicates that *L. botrana* has formed three peak points. Depending on the connection phenology, it has been concluded that the flight of the adult butterflies in Bintaş village has ended on 20 October in the first year and on 12 October in the second year and hence the active dura-

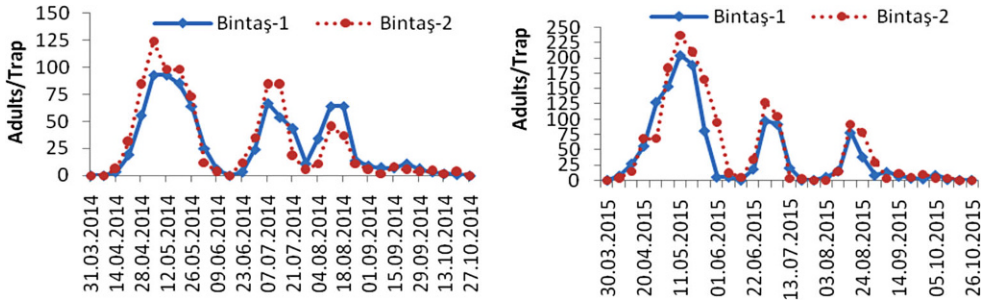

Fig. 1 Change of adult population of Grapevine Moth in the vineyards in Bintaş Village-1-2, in 2014 and 2015 years

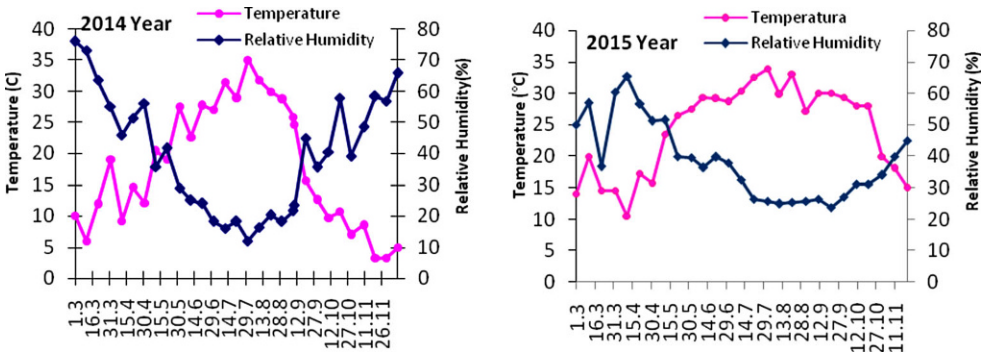

Fig. 2 The values of monthly average temperature and humidity of Diyarbakır Province Çermik district in 2014 and 2015 years

tion of the pest in nature has been observed to be around 7 months.

In both study years, the average temperatures during the active months of the pest were over 12 °C (Anonymous 2008), the growth threshold of *L. botrana*, and relative humidity ranged between 15 and 70% (Fig. 2). During the first appearance periods of *L. botrana* adults, the average temperature values were 17.5–13 °C and humidity values were 46–70%. Other similar studies reported pentad temperature values of 13.3–15.3 °C and relative humidity values of 67–71% during the first flight of *L. botrana* adults in İznik (Bursa) vineyards (Kovancı et al. 2005), and 13.3–14.1 °C and 66.5–70.6% during the same period in Tarsus (Mersin) vineyards (Öztürk and Acıöz 2010). Making a joint assessment of Fig. 1 indicates that in the vineyards in Çermik (Diyarbakır) district where *L. botrana*'s population monitoring has been performed, the first adult butterfly sightings in the attractive traps took place between 6 and 14 April in both years, and through relation phenology the figures formed three peaks on 5–11 May, 7–13 July and 11–17 August. The first one of those peak points coincided with the flowering period (May), the second one with the unripe period (size of a pea) (July) and the third one coincided with the ripening period (veraison) (August). Following the harvest, adult population drops and by November they start wintering. According to a study from Özpınar et al. (2004), held in Çanakkale vineyards, the first sighting of *L. botrana* adults was in late April and early May and the pest formed three peak points through the vegetation period in mid-May, late June and mid-August and it had three annual generations but in some years a fourth generation appeared following harvest. In another similar study held in Menemen (İzmir) vineyards, sighting of *L. botrana* first adults was reported in second half of March, all four generations have been observed on bunches in Central Manisa, the first sighting in İznik (Bursa) was in second half of April had four generations through the vegetation period by completing 4 flight periods (Altındişli et al. 2002; Kovancı et al. 2005). Another study held in Tarsus/Mersin yielded a different conclusion, indicating that the grapevine moth starts flying by late February and early March and stays active in nature for seven months and form four peak points, even though the final two peak points following harvest are not clearly obvious (Öztürk and Acıöz 2010). In Hatay vineyards the flight of *L. botrana*'s first adults was observed in March and they had three annual generations, once each in April, June and July (Şekerden Çağlar 2009). In Gaziantep İslahiye vineyards, the first adult sighting of *L. botrana* took place on 12–20 March, they actively stayed in nature for eight months, formed four peak points in flowering, unripe, veraison and post-harvest periods, hence indicating four generations (Öztürk and Şahin 2013). A study held in Şanlıurfa vineyards reported the first sighting of *L. botrana* adults towards the end of April and concluded that they are actively present in nature until the first half of October and can form 3–4 generations in nature (Mamay and Çakır 2014).

All these studies indicate that the first adults of *L. botrana* appear in different times of the year in different parts of Turkey and have different number of generations depend-

Table 1 Infestation rate of Grapevine moth in grape bunches in vinyards of Diyarbakır (Çermik) province in 2014 and 2015 years

Province	District	Vilage	The infestation rate (%)		
			2014	2015	Average
Diyarbakır	Çermik	Bintaş-1	12	15	13.5
		Bintaş-2	10	18	14

ing on climate conditions. *L. botrana* is reported to have two generations in Northern Europe, three in Southern Europe and partial four generations in warmer regions such as Spain, Greece, Jordan and Egypt (Anonymous 2013b). It is reported that *L. botrana* has two generations in Germany and the second generation causes more damage in vineyards (Louis and Schirra 2001). Studies held in different vineyards in Israel have all reported three generations of *L. botrana* (Sharon et al. 2009).

Infestation Rate of Grapevine Moth in Grape Bunches

The *L. botrana* infestation rates of bunches from Diyarbakır (Çermik) province vineyards are given in Table 1. With the increase in population in the vineyards in both years, there was an increased infestation rate in bunches. As Table 1 indicates, bunches in Bintaş Village vineyards are infested with *L. botrana* in an average rate of 13.5–14%. Studies held by Kısakürek (1972) in vineyards in Southern Anatolian Region during 1969–1970 concluded an infestation rate of 26% in Gaziantep and 17.5% in Kahramanmaraş. Another study held in Aegean Region to determine the *L. botrana* infestation rates in different types of grapes reported the highest infestation rates in 'Razakı' (47.2%) and 'Black Muscat' (7.7%) varieties during the ripe stage, while 'Cardinal' variety had the lowest infestation rate (1.5%) (Kaçar 1982). A study held in İslahiye/Gaziantep in a vineyard where a technique was employed to prevent mating with 'Antep Karası' variety, the rate of damaged fruits per 100 bunches was 6% in the first generation, 3% in the second generation and 5% in the third generation, while in the control vineyards the rates of damaged fruits were 17–21%, 2–24% and 0–3% respectively in the 1st, 2nd and 3rd generations (Aslan et al. 2007). It has been reported that in Manisa vineyards 'Yalova İncisi' variety had a higher *L. botrana* infestation rate while 'Flame Seedless' variety had a lower infestation rate (Turanlı et al. 2011). Some varieties are attracting the pest more because of their grain frequency and corolla structure among others and therefore 'Yalova İncisi' and 'Pafi' varieties are at higher risk (Şekerden Çağlar 2009). In another study conducted in Şanlıurfa vineyards, the average rate of grapevine moth infestation has been reported to be 43% in Öğütçü village and 3% in Ulubağ village (Mamay and Çakır 2014). A study held in Greece concluded that the first generation of *L. botrana* led to 13.3% product loss while the second generation led to 27% of product loss (Theodoros 2006).

Conclusions

The butterflies have been first observed in the attractive traps in mid-April in both years of the study monitoring grapevine moth population in Mardin vineyards, they formed three peak points through relation phenology in May, July and August, they starting wintering by mid-October and were actively present for 7 months in nature. This indicated that grapevine moth had three generations in the vineyards. When the data of both years are assessed together, it has been concluded that the bunches in the vineyards have been infested with grapevine moth in an average rate of 13.5% and 14%. It is believed that two disinfections, one in May-June (flowering) and one in August (sweetening) period would be sufficient, on condition that larva formation is monitored. Furthermore, application of cultural measures is important to mitigate pest activities.

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Conflict of interest M. Kaplan declares that he has no competing interests.

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