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Investigations on Efficiency of Mating Disruption Technique Against the European Grapevine Moth (*Lobesia botrana* Den. Et. Schiff.) (Lepidoptera; Tortricidae) in Vineyard, Turkey

Burak Akyol and M. Murat Aslan
Department of Plant Protection, Faculty of Agriculture,
Kahramanmaras Sutcu Imam University, 46060 Kahramanmaras, Turkey

Abstract: This study was conducted in Province of South-East of Turkey (Islahiye District, Gaziantep) in 2005 and 2006 to test efficacy of mating disruption technique with Isonet-L dispensers against the european grapevine moth (*Lobesia botrana* Den. et. Schiff.) in a vineyard of the variety Antep Karasi of about 1.8 ha. Control plots (about 2.1 ha of the variety Antep Karasi) was ptotected by insecticides. The infestation rates were found as 6, 3 and 5% for the 1st, 2nd and 3rd generations, respectively in 2005. *Bacillus thuringiensis* sp. *kurstaki* were used two times against it's 1st and 3rd generation in the plots with mating disruption treatment. The corresponding levels of infestation rates of 20, 18 and 3% for the 1st, 2nd and 3rd generations, respectively in the control area, where chemical insecticides were used 5 times. In 2006, in the plots with mating disruption treatment, infestation rates were found as 5, 2 and 3% for the 1st, 2nd and 3rd generations respectively. *Bacillus thuringiensis* sp. *kurstaki* were used once against 1st generation in plots with mating distruption treatment. Chemical insecticides were used 7 times in control plots in 2006 and infestation rates were found as 3, 0 and 0% per 100 cluster for the 1st, 2nd and 3rd generations respectively. In conclusion, this study suggests that mating disruption technique can be used against *L. botrana* on a large scale, unless it should be supported by a biological insecticide as *Bacillus thuringiensis* sp. *kurstaki* as infestation rate exceeds the economical threshold levels.

Key words: Mating disruption, dispensers, isonet-L, grape, *Lobesia botrana*, fheromone, *Bacillus thuringiensis* sp. *kurstaki*

INTRODUCTION

Province of South-East of Turkey (Gaziantep, Adiyaman and Kahramanmaras) contain 12.4% vineyard in total vineyard cultivation of Turkey. As known in other cultivation, vineyard has also important pest problems. Among the plant protection problems in vineyard, *Lobesia botrana*, *Arboridia adanae* and *Viteus vitifolii* are the most significant insect pests. From these pests, chemical application against grapevine moth *L. botrana* reaches 6-7 times in South-East of Turkey. Therefore, forecasting-warning system to reduce number of pesticide application, investigation of visibility of alternative methods to chemical control (i.e., mating disruption).

The grapevine moth (*Lobesia botrana* Den.-Schiff.) is major pest of vines in Turkey and more generally in Europe (Altindisli *et al*., 2001). The grapevine moth (*L. botrana*) adults appear in the vineyard in early spring and 3-4 generations are common before harvest per year in Turkey. The damage to clusters caused by this pest is 2 fold; a direct damage is caused to clusters, when the larvae feed their ways into the berries and indirect damage is caused, when additional infestation by rot fungi develops in the injured berries (Fermoud and Menn, 1992). Feeding and reproduction of *L. botrana* occurs mainly, on the flowers and fruits of grapes. In most areas where low populations develop, treatment is not required for the 1st generation. On the contrary, 2nd and 3rd generations need chemical applications due to losses caused by larvae on the quantity and quality of grapes (Altindisli and Kismali, 1998). Especially, the third generation is the most destructive because it feeds on more than one mature berry (Tzanakakis and Katsoyiannos, 2003). Chemical pesticides has led to many problems, environmental pollution, including pesticide resistance, human and other mammalian health problems. In this study, new plant protection techniques have been implemented in many countries aiming to reduce pest population density and the damage or risk caused by insect pests, while minimizing negative impact to the

Corresponding Author: M. Murat Aslan, Department of Plant Protection, Faculty of Agriculture, Kahramanmaras Sutcu Imam University, 46060 Kahramanmaras, Turkey

environment. The mating disruption technique with pheromones was first put into practice in the middle 1970's to control the grapevine moth but more so against its relative the grape berry moth, *Eupoecilia ambiguella* Hb (Moschos *et al*., 1998). Experiences with this technique are being increasingly gained all over Europe. For example, about 2000 ha in Italy (Mauro *et al*., 2001) and 5000 ha in Switzerland (Charmillot *et al*., 2000) are subjected to mating disruption.

The effectiveness of the MDT appears to be dependent upon biotic foctors such as the population density and other factors, such as weather conditions, including temperature and wind speed, intensity of pheromone release, area size and cultural practices. This technique can not the effective on its own, when populations densities are high (Charmillot and Pasquier, 2001); it seems the most effective at low to moderate densities (Pierre-Joseph, 1997) but this varies by pest species. MDT has also showed different results for each generation of *L. botrana* (Moschos *et al*., 2004).

The aim of this study was to investigated the efficacy of the mating disruption methods as control of *L. botrana*.

MATERIALS AND METHODS

The treatments were conducted during the years 2005-2006 in Islahiye District, Gaziantep (South-East of Turkey) province. The grape variety was 'Antep Karasi'. Mating disruption (Isonet-L, Shin-Etsu dispensers, containing 172 mg of active substance each) was applied 1.8 ha and the trial control area 2.1 ha, being the 2, the total area of the vineyard. During the treatment period 2 pheromone traps were set up in the area of Mating disruption and the control area to record the density and fluctuations of the adult grapevine moth.

In 2005, the dispensers (Isonet-L) were placed 31 March, at the beginning of the first flight of the *Lobesia botrana* adults. The ISONET-L dispensers were distributed at location, at 2 m intervals along the borders and the shoots with 6 m intervals on the rows (appr., 20 m^2/1 dispenser in the center) (Charmillot *et al*., 1995), corresponding to 500 sources per ha. *Bacillus thuringiensis* sp. *kurstaki* were used two times (once against 1st and once against 3rd generation) per years in mating distruption area. Chemical insecticides were used 5 times (once against 1st, twice against 2nd and twice against 3rd generation) in control area.

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RESULTS AND DISCUSSION

The seasonal fluctuation of the number of *L. botrana* adults captured in pheromone traps in the control area, which was treated with insecticides (Fig. 1). This method of trapping allows the monitoring of the active period of the adults and the fluctuations of the male population density. As shown in Fig. 1, large fluctuations were observed depending not only on the year but also on the generation within the same year. During the cultivating period three main flights, which correspond to the three generations of the insect, were observed in each of the 2 years. An average of 226 adults were captured per trap in the 1st, 339 in the 2nd and 289 in the 3rd generation but the *L. botrana* adults captured in the treatment area of mating disruption were reduced practically by about 94% in the 1st, the 2nd and the 3rd flights (Fig. 2).

Between 2005 and 2006 the mating disruption technique and *Bacillus thuringiensis* sp. *kurstaki* used in treatment area was very succesful. In most cases, the degree of effectiveness was >94% for the 1st generation, 96% for the 2nd generation and >98% 3rd in 2005 (Fig. 3). The corresponding levels of infested grapes in the control area, although chemical insecticides were used 5 times for the first generation the average rates of infestation ranged between 17 and 21 infested grapes per 100 inflorescences, for the second generation 2 and 17 infested grapes and thirth generation approximately 0 and 3 infested grapes per 100 clusters (Fig. 3). Due to intense spraying against the 3rd generation with the ripening of the grape in the control plot, infestation of the 3rd generation decreased significantly.

In 2006, in the trial with Mating Disruption, degree of effectiveness was >94% for the 1st generation, 98% for the 2nd generation and >100% 3rd in 2006 (Fig. 4). The corresponding levels of infested grapes in the control area, although chemical insecticides were used 7 times for the first generation the average rates of infestation ranged between 0 and 3 larvae per 100 inflorescences, for the second and thirth generation 0 infested grapes per 100 clusters (Fig. 4).

When the control plot is compared to 2005, with the effect of climatic conditions in 2006 as well, spraying against the 2nd and the 3rd generations increased and

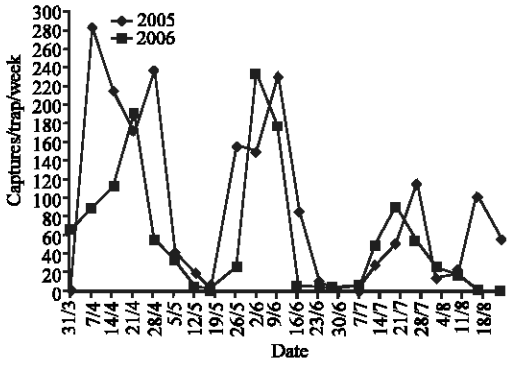

Fig. 1: Captures of adults of *L. botrana* in pheromone traps in the control vineyard during the years 2005-2006

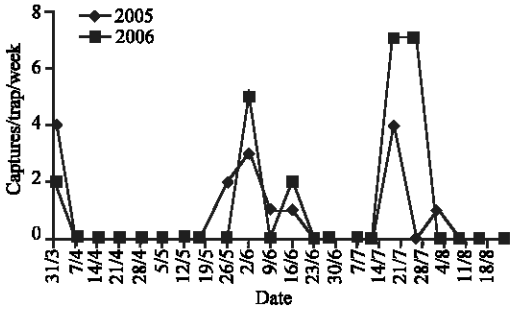

Fig. 2: Captures of adults of *L. botrana* in pheromone traps in the Isonet-L (Mating disruption) vineyard during the years 2005-2006

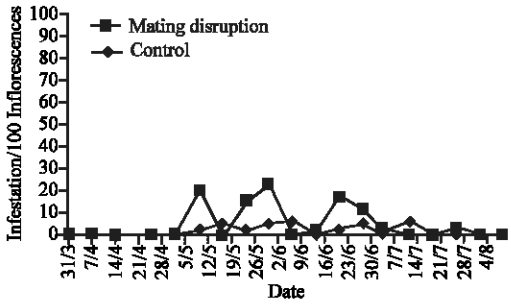

Fig. 3: Infestation data of the *L. botrana* in 2005

infestation rates for 2nd and 3rd generations were 0. With the start of adult emergence of the first generation of *Lobesia botrana* in 2005 and 2006, Isonet-L dispensers were placed into the trial area on 07/04/2005 and 31/03/2006.

Among the dispensers, 5 were fetched weekly and were weighed in the laboratory. While the weights of the Isonet-L dispensers at the initial weighing was 1.19 on average, it was observed that the average weight at the last weighing on 15/08/2005 was 0.93 g and 0.96 g at the

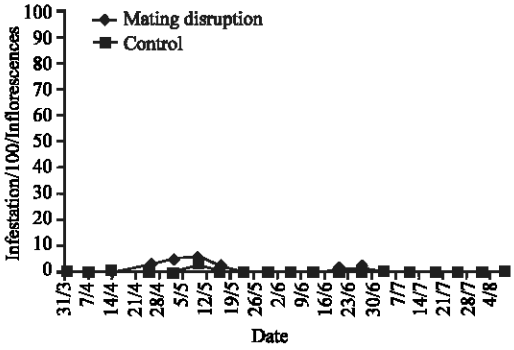

Fig. 4: Infestation data of the *L. botrana* in 2006

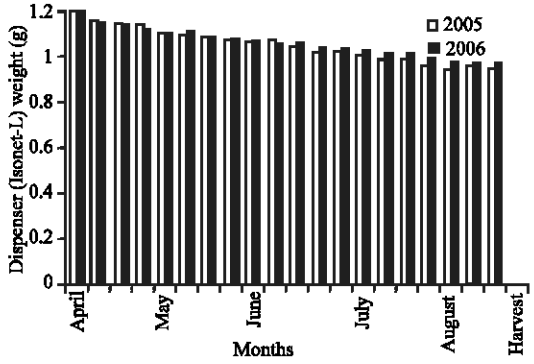

Fig. 5: Weights of Isonet-L dispensers during the years 2005-2006

last weighing on 17/08/2006. When the initial quantity of the Isonet-L dispensers placed on 07/04/2005 and 31/03/2006 and their quantities during the harvest are studied, 78.15% of the pheromone in 2005 and 80.67% of the pheromone in 2006 was dispensed. When studied as of 15/08/2005 and 17/08/2006, which are the harvest dates (Fig. 5), period of time, which passed until these dates were 140 and 147 days in 2005 and 2006, respectively. As Shin Etsu company states that the expire date of the Isonet-L dispensers is 150 days, it is determined that it is appropriate to use it on Antep Karasi grape cultivar once in a season in the region. When the pheromone of approximately 0.172 g dispensed from each dispenser in this 140 days period in 2005 is multiplied to the number of 750 Isonet-L dispensers, total number of dispensers, placed into the trial area, it was found that the total quantity of dispensed pheromone was 129 g and it was 0.9214 g day^{-1}, when divided by the total number of days and 0.8775 g day^{-1}, when divided by the total number of days in 2006.

According to Millar *et al.* (1997), it is so difficult to develop a dispenser, which can dispense high quality pheromone of enough quantity for months. Ideally, the dispenser must have a constant dispensation rate life

long. Although, dispensation rate decreases at constant temperature due to the aging of the dispenser, it is balanced by the increase caused by the high temperature on the field. In other words, at high temperatures, quantity of the dispensed pheromone is also high. Although, the species of the Totricidae family gain sexual activity during the evening and night, when the temperatures are low, an important part of the pheromone is wasted during the daytime in summer with the effect of high temperatures (Arn *et al*., 1997).

In this study, carried out in 2005 and 2006, with the placement of Isonet-L dispensers in the area, where mating disruption was to be implemented, the number of the *Lobesia botrana* adults trapped in pherocone type traps decreased to 0 (Fig. 2).

However it is known that the absense of male captures of the pheromone traps although, is an essential requirement for the success of controlling the grape moth with the MDT, The result are not always guarantied by this factor alone (Charmillot, 1992; Roehrich *et al*., 1979). However, scarcity of the adults trapped in the pherocone type traps in the area where mating disruption is applied was the most reliable indicator of the efficacy of Isonet-L dispensers. As reported by other researchers, it is observed that the population of *L. botrana* is reduced significantly by pherocone type traps (Stockel *et al*., 1994). In this study, it is observed that the efficacy of Mating disruption method over years and on different generations of the insect differs. When the results obtained in 2005 are examined, *Bacillus thuringiensis* sp. *Kurstaki*, which is a bacterial preparation was used to reduce the population on 12/05/2005 as the infestation rate of 6% at the end of the 1st generation of *Lobesia botrana* was much above 1%, which is the economical damage threshold. About 20% infestation rate, despite the use of chemical insecticides in the control plot, indicated that the initial population of European grapevine moth in the first year of the study was quite high. After the application of *Bacillus thuringiensis* sp. *kurstaki*, infestation rates in MD vineyard was 1% during the measurement at the end of the 1st generation and 13% lower compared to the control zone. Thus, no action was taken as the 2% infestation rates of the grapes at the measurement performed on 02/06/2006 after the adult flights of the 2nd generation was close to the economical damage threshold of 1%. During the same period, chemical insecticides were used twice at one week intervals in the control zone vineyard. Louis *et al*. (1999) reports that increased european grapevine moth population decreases the success of the method and that it is necessary to decrease the initial population with an insecticide application suitable for the useful species. Kast (2001) notes that an infestation rate of european grapevine moth, which is to be above 10% for the 1st generation in Germany arouses an increased infestation rate for the 2nd generation. Although, 3rd generation European grapevine moth larvae were found in the 3rd generation in MDT vineyard on 07/07/2005, no pesticide application was performed due to the low number; however, *Bacillus thuringiensis* sp. *kurstaki* was applied for the 2nd time on 11/07/2005 upon the gradual increase in the infestation rate. In the control vineyard, insecticide was used three times at 5 days intervals and the infestation rates in MD vineyard and control vineyard zone were found to be 1 and 0%, respectively, at the last evaluation measurement.

Moreover, according to the research in this field, efficiency increases when the same method irregularly applied in the same vineyard or in an other place in successive years (Moschos *et al*., 1998; Kast, 2001). Therefore, the experiment was carried out in the same areas in 2006.

In 2006 in the MDT vineyard, *Bacillus thuringiensis* sp. *kurstaki* was used on 05/05/2005 to decrease the population as the infestation rate 6%, at the end of the 1st generation of *Lobesia botrana* was much above 1%, which is the economical damage threshold and the infestation rate decreased down to 0%. With the application of chemical insecticides twice in the control zone, infestation rate was 3%. No measures were taken as the infestation rates of the grapes at the measurement performed on 02/06/2006 after the adult flights of the 2nd generation was approximately 1% in MDT vineyard. During the same period, chemical insecticides were used twice at one week intervals in the control zone vineyard and the infestation rate was 0%. Although, 3rd generation European grapevine moth larvae were found in the 3rd generation in MDT vineyard on 21/07/2007, no pesticides were applied as their number were low. On the control vineyard, insecticides were used three times at short intervals by taking spraying warnings and the infestation rate in both MDT and control vineyard areas was found 0% at the last evaluation measurement. When compared to the economical damage threshold (1%) at the end of a years study in Aegean region, Altindisli *et al*. (2001), states that mating disturbance method can be applied with Isonet-L dispensers in raisin grape vineyards in controlling the European grapevine moth in 600-650 ha^{-1} and the use of a biological preparation in preserving and supporting the useful organisms in case of an infestation rate above 5% for the 1st generation in the first year will decrease the risk.

That the infestation rate realized in 2005 was above the economical damage threshold of the European grapevine moth indicated that the pest population was high. The study in which the efficiency of Mating disruption technique against the european grapevine moth in Greece, which has similar economical conditions as Turkey, Moschos *et al*. (1998) attributes the low efficiency compared to pesticide application to the high population increasing mating opportunity to the high temperature and strung winds affecting the pheromone concentration in the vineyard and the uneven and low distribution of the pheromones, which are inadequate in the competition against the natural female pheromone in the vineyard. Besides, it was stated that enough isolation or application of the method in broad areas is necessary to decrease the threat of mated female from the environment as much as possible. Casagrande and Jones (1997) reported results supporting these findings. If the population of the pest against, which the method is applied is not low, the application zone is so broad or it is not broad enough, it must be isolated from exterior infestation resources. Ogawa (1997) states that applications performed in broad areas decrease the risk of fertilized female that can emigrate.

CONCLUSION

At the end of this study, it was determined that it is necessary to isolate MDT vineyard, where the experimentation was performed from the other areas to hang enough number of dispensers and at the same time to take the mated *Lobesia botrana* female individuals from the neighbouring vineyards under control.

The selected specie of grape was of great importance with regard to the 150 days efficiency of the dispensers as Antep karasi, the grape specie used in the experiment is harvested early and the 3rd generation of *Lobesia botrana* is found. Thus, it is determined that early or late harvesting of the grape species in the vineyards, where Mating Disruption technique will be applied.

When compared to the economical damage threshold 1%, it is determined that the possibility of the success of Mating Disruption method in controlling the European grapevine moth is low but its application along with bacterial preparations such as *Bacillus thuringiensis* sp. *kurstaki*, which doesn't have negative impact on human and environmental health will increase success. This method needs to be applied in vineyard areas and developed because the growers give harm to human and environmental health as a result of the unconscious random chemical application as the growers can't determine the emergence time of insect.

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