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A Comparison of the Parasitoids of Grapevine Moths *Lobesia botrana* (Denis et Schiffermuller) in the Vineyards where Conventional and Mating Disruption Techniques are Applied

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Abstract: *Lobesia botrana* (Denis and Schiffermuller) grapevine moth is the most harmful pest in the fields of grape cultivation in Turkey. The present study compared the parasitoids of *Lobesia botrana* obtained from control area and the area where mating disruption method is applied. *Pimpla spuria*, *Exochus erythronotus* and *Mesostenus transfga* were the species among parasitoid species that were found at highest rate in the pupae collected in mating disruption area and the control area. In 2005, the parasitism rates were found 3.7% in *Pimpla spuria*, 1.3% in *Exochus erythronotus* and below 1% in *Mesostenus transfga* in mating disruption area and 1.7% in *Pimpla spuria*, 1% in *Exochus erythronotus* and below 1% in *Mesostenus transfga* in control area. In 2006, the parasitism rates were found 8.3% in *Pimpla spuria*, 3% in *Exochus erythronotus* and 1.5% in *Mesostenus transfga* in mating disruption area and 1.6% in *Pimpla spuria*, 1% in *Exochus erythronotus* and 1% in *Mesostenus transfga* in control area. In mating disruption vineyards and control area, especially *L. botrana* among the parasitoids caught with CDC Backpack insect aspirator was determined to be intensely caught in the 1st and 2nd generations. In these areas where intense disinfection is applied as a result of using bacterial preparation *Bacillus thuringiensis* ssp. *kurstaki* instead of chemical pesticide for 2 years, a remarkable increase was observed in the number of the parasitoids, especially in *Pimpla spuria* parasitoid species, obtained from the mating disruption vineyard in 2006.

Key words: *Lobesia botrana*, parazitoids, grape, mating disruption, *Bacillus thuringiensis* ssp. *kurstaki*

INTRODUCTION

There are 479.000 ha vineyard area in Turkey. The 35.4% of the total production is used for table grape and 41.7% is dried. Only 5.5% of grapes are used in wine production.

Grapevine moth, *Lobesia botrana* (Denis and Schiffermuller) is the most hazardous vineyard pest observed in the vineyards in Turkey. In addition, it is the most economically hazardous pest in Europe, Southeastern Russia, Japan, Middle East, Near East and Northern East of West Africa (Venette *et al*., 2003). As in the other European countries, they are directly and indirectly harmful for the vineyards. Its direct harms includes damages to blooms, sour grapes and grapes in their sweetening period and its indirect harms includes the development of the diseases in the grapes in their riping and sweetening period caused by grapevine moth, *Lobesia botrana* (Colombera *et al*., 2001). In vineyards, chemical control is the most common method used in the control against *Lobesia botrana*.

It was reported that biological control against the aforementioned pest would be possible in the future (Roehrich and Boller, 1991). However, literature includes few studies on control against vineyard pests, particularly *L. botrana* so (Xuereb and Thiery, 2006). The number of disinfection against this pest ranges from 5-8 basing on the regions, grape type and cultivation system in the vineyards of Turkey. As in Turkey, mating disruption technique was found effective and applied successfully in countries like Germany, France, Italy and Switzerland which have major vineyards with *Lobesia botrana* is as the most harmful pest (Charmillot *et al*., 1995; Kast, 1999; Louis and Schirra, 2001). Altindisli *et al*. (2002) conducted a study examining the possibilities to control against grape moth, *L. botrana* by using mating disruption method in Izmir-Menemen and the Provincial Center of Manisa in Aegean region between 1999-2001. In addition, Akyol and Aslan (2010) examined the same subject in Kahramanmaras and its surrounding cities between 2005-2006.

The studies conducted about the parasitoids and predators found in the vineyards in Turkey are known to be limited (Altindisli *et al*., 2002; Koclu *et al*., 2002). Among the studies conducted in Turkey, Kisakurek (1972) reported that grapevine moth pupae were parasitized by *Ascogaster* sp. and *M. rupens* in Southeastern Anatolia region, Oncag reported the presence of 4 parasitoid species which are *Ascogaster quadridentatus* Wesm., *Bassus conspicus* Wesm., *Habrobracon hebetor* Say and *Phytomytera nitidiventris* Rond. in Aegean Region. The number of grapevine moth parasitoids species is quite high but their parasitizing rates are different. Coscolla suggests 97 parasitoid species, four of which are dipter (Tachinidae) 93 of which are Hymenopter (64 in Ichneumonidae, 9 in Braconidae, 8 in Pteromalidae, 3 in Chalcididae, 2 in Trichogrammatidae, 2 in Trymidae and 1 in Elasmidae, Eulophidae, Eurytomidae, Eupelmidae, Perilampidae families). Some parasitoid species from Ichneumonidae, Braconidae and Pteromalidae families were stated to decrease *L. botrana* larva and pupae in the majority of the European vineyards (Marchesini and Monta, 1994; Schirra and Louis, 1998). In addition, literature includes very limited number of studies regarding larva and pupa parasitoids controlling lepidopteras harmful for the vineyards and regarding their importance. In addition, the existing studies are generally in report form and include insufficient information regarding the biology and effectiveness of parasitoids (Moreno *et al*., 2000).

Currently, chemical insecticides are extremely used in the control against *L. botrana* in vineyards which results in a threat against environment and human health. The present study examines the changes in the grapevine moth parasitoids in vineyard ecosystem through comparing vineyards where mating disruption technique is applied with conventional vineyards where chemical methods are used.

MATERIALS AND METHODS

The present study which was conducted between 2005 and 2006, applied mating disruption method in the control against grapevine moth (*Lobesia botrana*) in 1.8 ha Horoz Karasi (Antep Karasi) vineyard in Islahiye Karapinar village of Gaziantep Province. Mating disruption method was applied the whole vineyard and the nearby 2.1 ha Horoz Karasi vineyard (nearly 1 km away from mating disruption area) was left to the cultivator as the control area.

Sexually attractive traps (Pherocon type) for grapevine moths, specific bar diffusers involving E1 7-Z+9 dodecadienyl acetate (Isonet-L) and preparations with *Bacillus thuringiensis* were used. The first adults were caught between 07. 04. 2005 and 31. 03. 2006 and Isonet-L diffuser were hanged at every 20 m^2 (in 6 m distance in row spacing and in 2 m distance on edges) as stated by Charmillot *et al*. (1995).

Parasitoids in mating disruption and control vineyards were collected using CDC Backpack pest aspirator for every 15 min. The collected samples were decomposed upon counting in the laboratory. In mating disruption and control areas, 100 pupae of *L. botrana* wintering over for 2 months were collected from vine stock sapwoods and plant residues in November and December and therefore 3600 pupa were taken to the culture. The collected pupae were put into jars in a dark room at 25±1°C temperature and with 60±10% relative humidity and were monitored daily. Parasitoids obtained from the pupae were separated according to their morphological characterisitcs and were sent to identification upon being put into small glass bottles including 70% alcohol.

Conducted between 2005 and 2006, the present study used *Bacillus thuringiensis* ssp. *kurstaki* was once on the 1st and 3rd generations of *L. botrana* in mating disruption vineyard in 2005 and applied 5 times different insecticides against 1st, 2nd and 3rd generations of *L. botrana* in control area. In 2006 in mating disruption vineyard, *Bacillus thuringiensis* ssp. *kurstaki* was once used against the 1st generation of *L. botrana* once and in control vineyard, 7 different insecticides were used against the 1st, 2nd and 3rd generations of the *L. botrana*.

SPSS Software (Version 22) statistical program was used in statistical analysis in order to compare of the parasitoids found in mating disruption and control area and the changes according to the years. Pearson Chi-square test was used in order to determine the parasitoid rates in mating disruption and control areas.

RESULTS AND DISCUSSION

Pimpla spuria, *Exochus erythronotus* and *Mesostenus transfga* parasitoid were the species that were found in mating disruption and control area vineyards at highest rates. The rates of other species were insignificantly low. In 2005, the parasitism rates were found 3.7% in *Pimpla spuria*, 1.3% in *Exochus erythronotus* and below 1% in *Mesostenus transfga* in mating disruption area and 1.7% in *Pimpla spuria*, 1% in *Exochus erythronotus* and below 1% in *Mesostenus transfga* in control area (Table 1). In 2006, the parasitism rates were found 8.3% in *Pimpla spuria*, 3% in *Exochus erythronotus* and 1.5% in *Mesostenus transfga* in mating disruption area and 1.6% in *Pimpla spuria*, 1% in *Exochus erythronotus* and 1% in *Mesostenus transfga* in control area (Table 2). In these areas where intense disinfection was applied as a result of the use of bacterial preparation *Bacillus thuringiensis* ssp. *kurstaki* instead

Table 1: Population density of parasitoid species obtained from the pupae of *Lobesia botrana* wintering over in mating disruption and control area in 2005

			Percentage of the parasitoids			
Dates	No. of collected pupae	Vineyard area	*Pimpla spuria*	*Exochus erythronotus*	*Mesostenus transfga*	Total
03.11.05	100	MD	8	3	4	15
	100	KA	3	2	1	6
10.11.05	100	MD	9	3	-	12
	100	KA	7	3	-	10
17.11.05	100	MD	6	1	-	7
	100	KA	4	4	1	9
24.11.05	100	MD	3	-	1	4
	100	KA	1	-	4	5
01.12.05	100	MD	4	2	1	7
	100	KA	-	-	-	0
08.12.05	100	MD	1	2	-	3
	100	KA	-	-	-	0
15.12.05	100	MD	1	1	-	2
	100	KA	-	-	-	0
22.12.05	100	MD	-	-	-	0
	100	KA	-	-	-	0
29.12.05	100	MD	1	-	1	2
	100	KA	-	-	-	0
Total	900	MD	33 p<0.05	12	7	52 *p<0.05
	900	KA	15*	9	6	30
Total						82

Table 2: Population density of parasitoid species obtained from the pupae of *Lobesia botrana* wintering over in mating disruption and control area in 2006

			Percentage of the parasitoids			
Dates	No. of collected pupae	Vineyard area	*Pimpla spuria*	*Exochus erythronotus*	*Mesostenus transfga*	Total
02.11.06	100	MD	11	3	2	16
	100	KA	4	2	3	9
09.11.06	100	MD	15	4	1	20
	100	KA	5	4	1	10
16.11.06	100	MD	21	8	1	30
	100	KA	2	3	-	5
23.11.06	100	MD	12	5	4	21
	100	KA	1	-	4	5
30.11.06	100	MD	7	5	1	13
	100	KA	-	-	-	-
07.12.06	100	MD	4	-	-	4
	100	KA	1	-	1	2
14.12.06	100	MD	3	2	1	6
	100	KA	1	-	-	1
21.12.06	100	MD	1	-	3	4
	100	KA	-	-	-	0
28.12.06	100	MD	1	-	1	2
	100	KA	-	-	-	0
Total	900	MD	75* p<0.05 p<0.01	27* p<0.05 p<0.01	14	116* p<0.05 p<0.01
	900	KA	14	9	9	32
Total						148

of chemical pesticides in the areas where intense disinfection was applied in 2005 caused a significant increase in the number of the parasitoids, especially *Pimpla spuria*, obtained from mating disruption vineyard in 2006.

The comparison of parasitoids obtained from the pupae of grapevine moth, *L. botrana* in 2005 through Chi-square analysis (χ^2 = 1.458, p = 0.482) determined no statistically significant difference in moth disruption and control area vineyards (Table 1) (p>0.05). The comparison of parasitoids obtained from the pupae of grapevine moth, *L. botrana* in 2006 (χ^2 = 13.195, p = 0.001) determined statistically significant difference between mating disruption and control area (Table 2) (p<0.01):

$$\chi^2\text{-test statistics} = \sum \frac{(G_i - B_i)^2}{B_i} \sim \chi^2_{\alpha, SD\ (k-1)}$$

Where:

- G_i = The value observed for the ith class (observed frequency)
- B_i = The value expected for the ith class (expected frequency)
- $\chi^2_{\alpha, SD}$ = Scale value

Figure 1 shows that *Pimpla spuria* Gravenhorst parasitoid began to be caught with CDC-Backpack aspirator in the 1st generation of grapevine moth, *Lobesia botrana* in mating disruption vineyard and the rate of catching increased between 02.06.2005 and 23.06.2005 which is the same date when 2nd generation adults of *L. botrana* were caught in the traps at highest rate.

In 2005, *P. spuria* was caught beginning from the 1st generation of *L. botrana* in mating disruption vineyard and the number of the individuals caught in the 2nd generation of *L. botrana* growingly increased. This rate decreased in the 3rd generation of *L. botrana* and continued to be caught along with the *M. transfga* despite low rates until the end of harvest (Fig. 1). In control vineyard while the population of *P. spuria* in the 1st and 2nd generations of *L. botrana* was observed to be dense, *M. transfga* was caught in the 2nd generation of *L. botrana* and *E. erythronotus* was caught in the 1st, 2nd and 3rd generations of *L. botrana* at low rates (Fig. 2).

In 2006, *P. spuria* was caught at high rates in the 1st and 2nd generations of *L. botrana* in mating disruption vineyard *E. erythronotus* was caught at low rates in the 2nd generation of *L. botrana*. In addition, *M. transfga* was also caught at low rates in the 1st and 2nd generations of *L. botrana* (Fig. 3). In control vineyard while *P. spuria* was caught at high rates in the 1st generation of *L. botrana* it was almost not caught at all in the 2nd and 3rd generations of *L. botrana* (Fig. 4).

The present study determined seven parasitoid species belonging to the Ichneumonidae and Braconidae families of the Hymenoptera group of *Lobesia botrana* parasitoid species obtained through CDC Backpack pest aspirator and from wintering over pupae in mating disruption and control vineyard areas. Those species are *Campoplex capitator* Aubert, *Dicaelotus erythrostoma* Wesmael, *Exochus erythronotus* Gravenhorst, *Pimpla spuria* Gravenhorst, *Habrobracon hebetor* (Say), *Mesostenus transfga* Gravenhorst and *Cotesia* sp.

Excessive chemical intervention was known to be applied in the areas where the study lasting for 2 years was conducted. Koclu *et al.* (2005) examined predator and parasitoids in the vineyard area applied with mating disruption method and control area and determined higher numbers of predator and parasitoids mating disruption

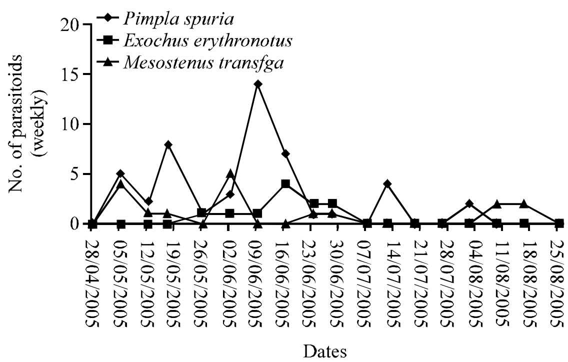

Fig. 1: Population density of *Lobesia botrana* parasitoids collected with CDC-Backpack pesticide aspirator in mating disruption vineyard (2005)

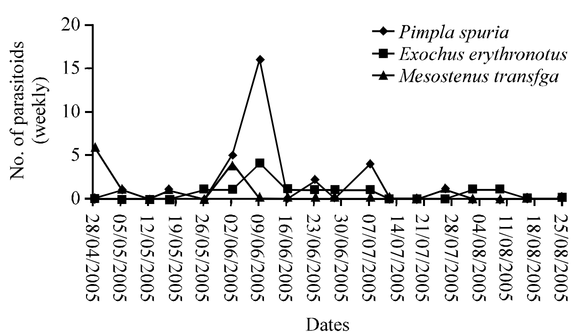

Fig. 2: Population density of *Lobesia botrana* parasitoids collected with CDC-Backpack pesticide aspirator in control vineyard area (2005)

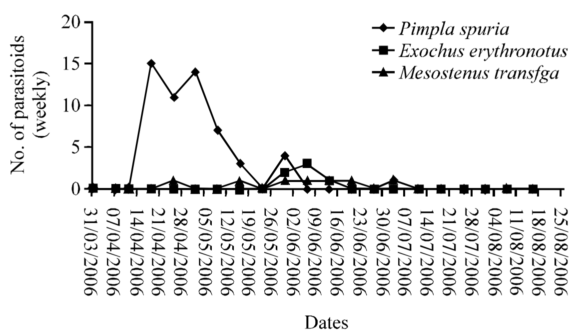

Fig. 3: Population density of *Lobesia botrana* parasitoids collected with CDC-Backpack pesticide aspirator in mating disruption vineyard (2006)

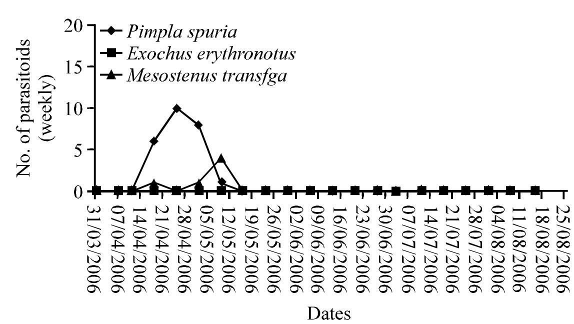

Fig. 4: Population density of *Lobesia botrana* parasitoids collected with CDC-Backpack pesticide aspirator in control vineyard area (2006)

areas compared to the control area. Colombera *et al.* (2001) conducted a study comparing the areas where chemical disinfection was applied and IPM (integrated pest management) area in terms of the parasitoids of *Lobesia botrana* and *Eupoecilia ambiguella* and obtained parasitoids belonging to the Ichneumonidae, Braconidae, Elasmidae, Eulophidae and Tachinidae families and reported that some from Hymenopteras family and *Phytomyptera nigrina* (Meigen) from Diptera team were particularly effective against the 1st generations of these moths and the population and species number of the Hymenopteras were higher in the area where IPM was applied. The present study determined that in mating disruption and control areas, the parasitoids caught using CDC Backpack pesticide aspirator were intensely caught especially in the 1st and 2nd generations of *L. botrana.* In addition, the parasitoids were determined to be higher in the number of species and population compared to predators. Schirra and Louis (1998) stated that parasitoids are more effective than predators in the vineyards, 70% of especially *L. botrana* pupae have parasites and the 4th and 5th larva periods of *L. botrana* is parasitized at low rates. Moreau *et al.* (2010) found 10 larva parasitoids and reported the differentiation of parasitizing rate according to year and geographical regions, cultural implementations and the size of the parasitized individuals. In their study conducted in the Southeastern part of Romania between 1996-2003, Barbuceanu and Jenser (2009) determined 8 larva and pupa parasitoids of *L. botrana* and stated that intense chemical control decreased parasitizing rates. In a study conducted in Orumieh vineyards of Iran, 6 parasitoid species of *L. botrana* were found and parasitizing was determined to vary according to vineyard areas and parasitizing was found to be at the highest rate especially in the first generation of *L. botrana* (Shoukat, 2012). Another study conducted in Iran determined 17 species of *L. botrana* 2 of which were egg parasitoids, 9 of which were larva parasitoids and 6 of which were pupa parasitoids (Lotfalizadeh *et al.*, 2012).

CONCLUSION

The present study concluded that parasitoid population in the vineyard area where mating disruption technique was applied was higher than the parasitoid population of the control area, implementations applied in 2005 supported parasitoid population and therefore, the density of the parasitoid population was higher in mating disruption vineyard in the studies in 2006.

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