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Full Length Research Paper

Seasonal flight activity of the grape berry moth, *LOBESIA BOTRANA* Den. and Schiff. (Lepidoptera: Tortricidae) in Sisakht region, Iran

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Grape berry moth, *LOBESIA BOTRANA* Den. and Schiff. is one of the most important pests of grape vine in most parts of the country. Losses caused by larval feeding lead to disrupted plant activities, reduction in flower buds and ultimately decreased quality and quantity of the crop. In order to study seasonal flight activity of *L. BOTRANA* and to determine spraying time, experiments were conducted for two consecutive years at two different orchards in Sisakht region in 2008-2009. The seasonal flight of *L. BOTRANA* was investigated by using pheromone traps and collecting samples from eggs, larva and pupa stages of the pest. The results showed that *L. BOTRANA* has three generations with an incomplete 4th in the region. Damage of first and fourth generation was very low. The grape vine fruits were mainly damaged by the second and third generation of *L. BOTRANA* that happened about ten days after the adult emergency.

Key words: *Lobesia botrana*, flight activity, population dynamics, pheromone traps, spraying.

INTRODUCTION

Grape is one of the major economical products in Iran. According to statistics of 2005, there was 1900 hectares under cultivation (700 ha of sapling and 1200 ha of fruitful trees) with the production of 1250 metric ton, an average of 12500 Kg per ha (Gharib, 1960; Esmaeili et al., 1990). The vineyards of Kohgiloyeh va Boyer-ahmad are mostly in the counties of Boyer-Ahmad, Sisakht (Dena) and Kohgiloyeh (Moghadam, 1990).

Lobesia botrana is one of the most important pests causing serious damages to vineyards in Iran and around the world. In some years, they appear in high population in vineyards in central and western Europe (Revzvani, 1981 and Salahi-Ardakani, 1998), Mediterranean costs (Stora, 1983), and Iran (in the provinces of eastern and western Azerbaijan, Hamedan, Ghazvin, Tehran, Isfahan, Chahar-Mehal-Va-Bakhtiyari and Fars) (Esmaeili, 1983; Gabel and Stockel, 1989; Eghtedar, 1993; Nasirzadeh and Basiri, 1994; Hassanpour, 1999; Hoffman et al., 1999). The first reports of *L. botrana* in Iran goes back to Kosari in 1945 (Behdad, 1984; Eghtedar, 1994). Currently, this is a major pest of grape in Iran (Nasirzadeh and Basiri, 1994; Hoffman et al., 1999). In Sisakht, cold regions of Kohgiloyeh-Va-Boyer-Ahmad, *L. botrana* has been reported by Moghadam (1990) for the first time in 1990. It is known as the main pest of vineyards in this province. The main host of *L. botrana* is grape.*Daphne gnidium*, a ubiquitous wild plant in southern part of France is also a good host to this pest (Stora, 1983; Tobion et al., 2002). In Bulgaria, the first generation of this insect attacks Persimmon, olive, barberry and raspberry (Nagarkatti et al., 2002). Kiwi has been reported as a host of this insect as well (Rezvani, 1981).

Despite using different insecticides around the world, new biotype resistive to these chemicals has emerged (Salahi-Ardakani, 1998; Witzgall et al., 2000). The fear that this might happen in Sissakht, prevents us of using insecticides in this region. Due to this problem and other issues related to chemical substance control such as destruction of natural enemies and environmental

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Abbreviation: IPM, Integrated pest management.

damages, a non-chemical method and integrated management control must be used to fight this pest. Development of an integrated pest control management requires knowledge of biology, ecology, economic threshold level and changes in population dynamic of that pest. Artificial pheromone of *L. botrana* has been produced (Rajabi, 1986; Salahi-Ardakani, 1998). Commercial products in the plastic capsules are already obtainable in the market by American and European companies. This product has been used in studies of manipulation and fluctuations in pest population by Eghtedar (1993). Nasirzadeh and Basiri (1994) have defined the different generation's population and the best point in time for fighting this pest in Fars Province by using pheromone traps (Nagarkatti et al., 2001). According to their studies, this pest has four generations in Shiraz (Capital of Fars). The first generation appears at the end of March. The outbreak of the first generation is by mid-April. The second generation outbreak is in the middle of June. The outburst of the third and the fourth generations are mid-July and end of August respectively. The mean sums of effective temperatures for the above stages are respectively 38.6, 186.1, 774.5, 1614.8 and 2312.3°C. (Esmaeili, 1983; Hofbig et al., 1999) have used artificial Pheromone to control the damages of *L. botrana* in West Azerbaijan and Fars Provinces. Pheromone traps have been also used in conjunction with research at Integrated Pest Management (I.P.M.) in vineyards of Bandan region of Sisakht in the years of 1996 to 2001 (Saeidi, 2002). Based on the experience of local vineyard owners of Sisakht, the best schedule for spraying against *L. botrana* is as follow: the first spray should be done when the grapes are as big as lentils and then every 20 – 25 days till 15 days to harvesting. Though this recommendation has been used for years, due to following arguments:

i. High costs of repetitive sprays;
ii. Use of too much chemicals;
iii. Environmental pollution;
iv. Appearance of a new resistant biotype of *L. botrana*;
v. Destruction of natural enemies.

Formation of imbalance in natural ecosystems in the farm Due to above issues and the importance of vineyards in Sisakht, changes in population of *L. botrana* and the best points in time for spraying has been investigated in Sisakht.

MATERIALS AND METHODS

The most part of this study has been performed on the vines infected by *L. botrana* in Sissakhtregion. In some cases where performing of the research was difficult or impossible, the experiments have been carried out under laboratory condition (natural room temperature of 13 - 24°C and relative humidity of 34 - 58%).

To investigate the biological status of *L. botrana* in 2008 and 2009, two vineyards, one in the Plains (Amirabad, Sisakht) and another in the mountains (Bandan region, Sisakht) have been chosen. Firstly, these two were good examples in the 1900 ha of vineyards and secondly they have been reported of being infected by *L. botrana*. To gather information regarding overwintering of *L. botrana*during the winters of 2008 and 2009, twice a week samples of the soil and from the vines has been collected. Each time ten vines in four geographical directions have been chosen randomly.

Then under loose barks, at the base of branches and in the trunk gaps of the shrubs have been observed and investigated by lens. The soil and the fallen leaves in different random places have been collected in plastic bags and sent to the laboratory for test. With the knowledge about overwintering of *L. botrana*, twenty shrubs were chosen, pupae under loose barks, in the trunk gaps and in the soil around the ring been counted and collected. Four pheromone traps, two in each vineyard have been installed to determine the flight activity of *L. botrana*, the first outbreak of the butterflies in spring, the flight climax of each generation and the number of generations. The traps have been installed at the height of 1.5 m from ground, 200 m way from the vineyard edge and 500 m apart from each other. The pheromone capsules have been replaced every 30 days and the interior parts of the trap which loses its adhesion property have been replaced every 35 days. Observation of eggs were conducted to determine the beginning date of laying eggs, the exact hatching date and the first damages on berries has been recorded at Pest Investigation Laboratory of Agricultural and Natural Resources Research Center of Yasuj by collecting and investigating 50 branches bearing grapes every other day after the first appearance of each generation of the grape berry moth.

Data of observations and observations on different growth stages in the field and in Laboratory including: beginning of laying eggs, hatching date of different generations, the start and appearance of damages on berries and infection percentage have been recorded. The trapped moths have also been counted and presented in related tables. To calculate the average infection of shrubs in percentage, twenty trees of each variety (Asgari, Red, Rish-Baba and Kalehee) has been chosen in random. Then the total grape bunches and the number of infected bunches been counted.

To investigate the different life stages of each generation of *L. botrana* in laboratory (natural room temperature of 13 - 24°C and relative humidity of 34 - 58%), fifty larvae of first instar have been collected from each vineyard one week after flight climax. They have been placed in bowl of 30 cm in diameter and 50 cm depth along with a bunch of grapes .

Data regarding temperature changes, precipitation and relative humidity have been collected from Yasuj Meteorological Center. Minimum, maximum and average values of temperature and relative humidity have been calculated and their effects on growth of larvae have been explored .

RESULTS AND DISCUSSION

The researches done in the falls of 2008 and 2009 and the consecutive winters of 2008 and 2009 revealed that *L. botrana* overwinters as a pupa in a white silk cocoon. The highest pupal population has been observed under loose barks and in trunk gaps. Field observations have discovered overwintering pupae among leaves under shrubs, in the soil and even in the gap of walls.

The flight activity of different generations of *L. BOTRANA*

The results of researches during the years of 2008 - 2009

Table 1. First appearance of different generation, caught in pheromone traps.

Year	First generation	Second generation	Third generation
2008	21st, April	14th, June	17th, August
2009	15th, April	15th, June	16th, August
2010	18th, April	18th, June	13th, August

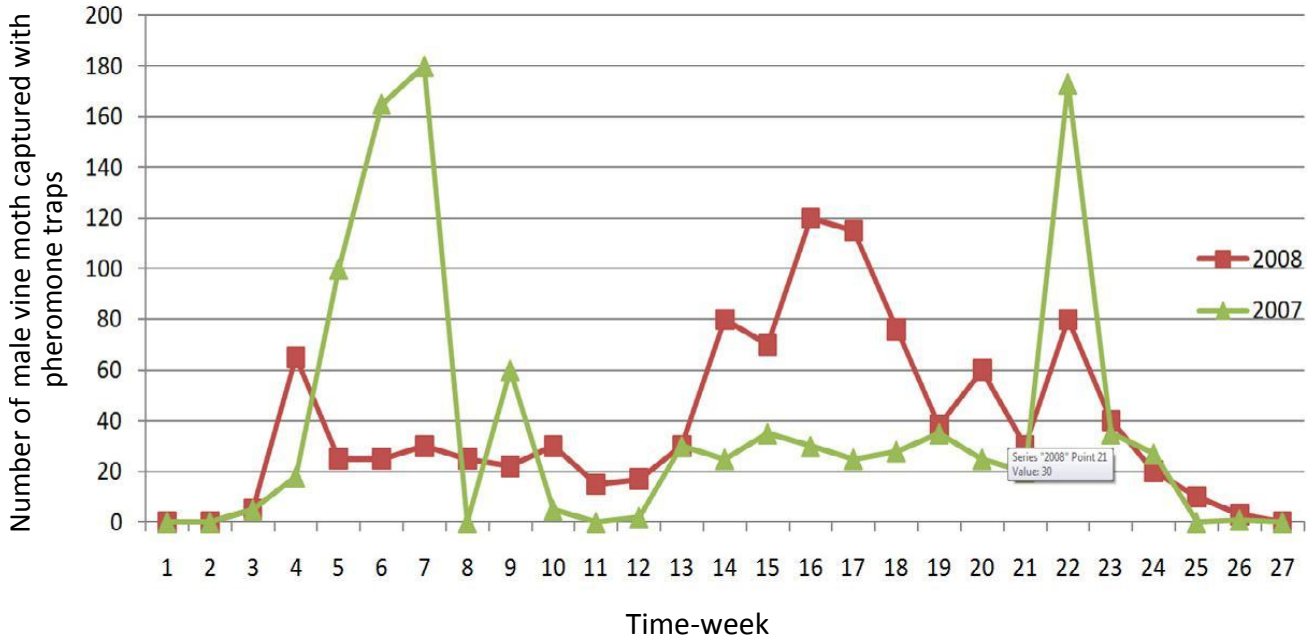

Figure 1. Flight activity of grape berry moth in Sissakhat region (plain) 2008-2009.

regarding the flight activity of different generations of *L. botrana* in the cold regions of Sisakht (plains and mountains) shows that the first generation of this insect appears at the end of April, the second generation in mid-June and the third generation in mid-August (Table 1).

Outbreak of adult moth

Figures 1 and 2 show adult male moth caught by female pheromone traps in two vineyards, in the plains (Figure 1) and in the mountains (Figure 2) from 16th of April to 10th of October in 2008 and 2009. Figure 1 reveals that outbreak of adult moth from overwintering cocoons in the plains beginning early April (2, April 2008 and 4, April 2009) and by increasing temperature, the number of trapped males were growing rapidly so that the flight climaxes were within 20 days (23rd of April 2008 and 20th of April 2009). In the mountain area (Figure 2) the outbreak started in the late of April (21st of April 2008 and 23rd of April 2009) with the flight climax in the late of April (27, April 2008 and 29, April 2009). The outbreak in the warmer areas of Fars Province (for example, Shiraz) has been recorded in mid-March (Esmaeili, 1983). This difference between warm and cold areas is due to longer and colder winters in Sisakht. Figures 1 and 2 proved that transforming from pupa to adult moth follows the changes in temperature in the region and reached its peak in mid-May. However, it can be seen that there wasn't a significant variation in the start, end and fluctuation of population in respect to geographical characteristics (plains or mountains). Figure 3 shows minimum and maximum of temperature during the pest activities.

The results of bio-ecological and population dynamic studies showed that in the cold regions of Sissakht, *L. botrana* lived in white silk cocoons in winter diapauses mode from the early of October onward. According to the researches, daily temperature was a major factor in the start and end of winter diapauses. Figure 3A and 3B reveals that the insect development activities started after reaching the minimum threshold temperature of 10°C. The results tell us that if the mean daily temperature is 10°C for 8 – 11 days, the pupae will transform into adult moth and come out of the cocoons.

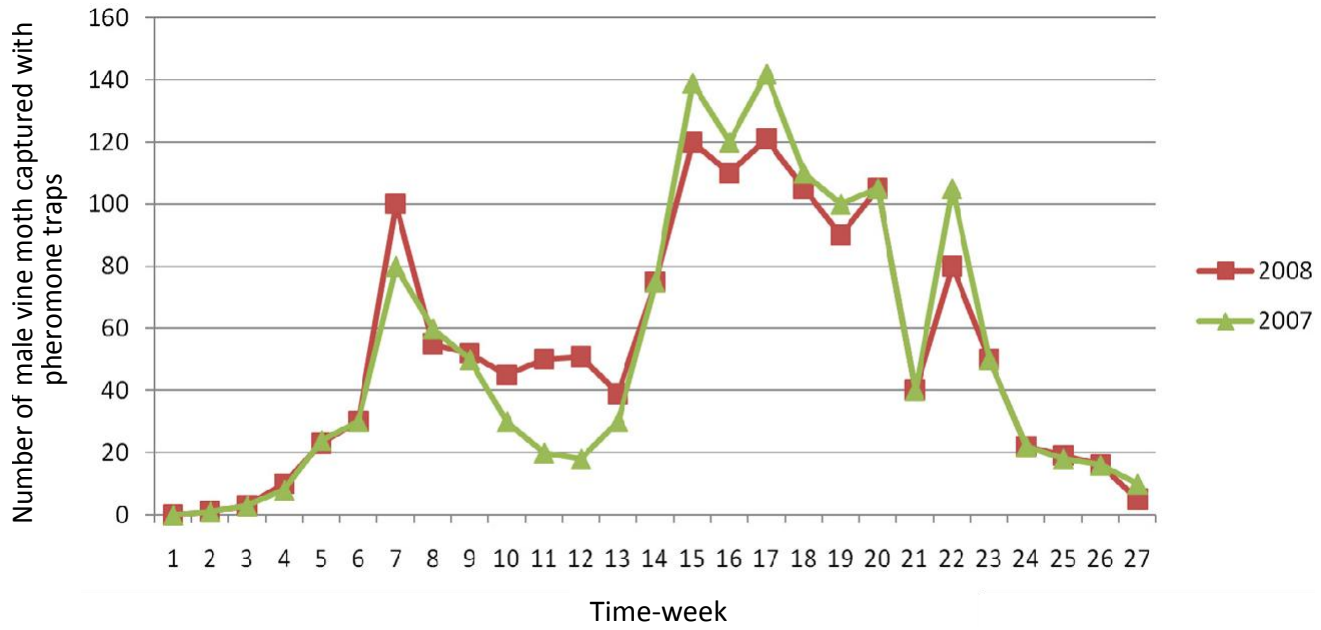

Figure 2. Flight activity of grape berry moth in Sissakhat region (Mountain). 2008-2009.

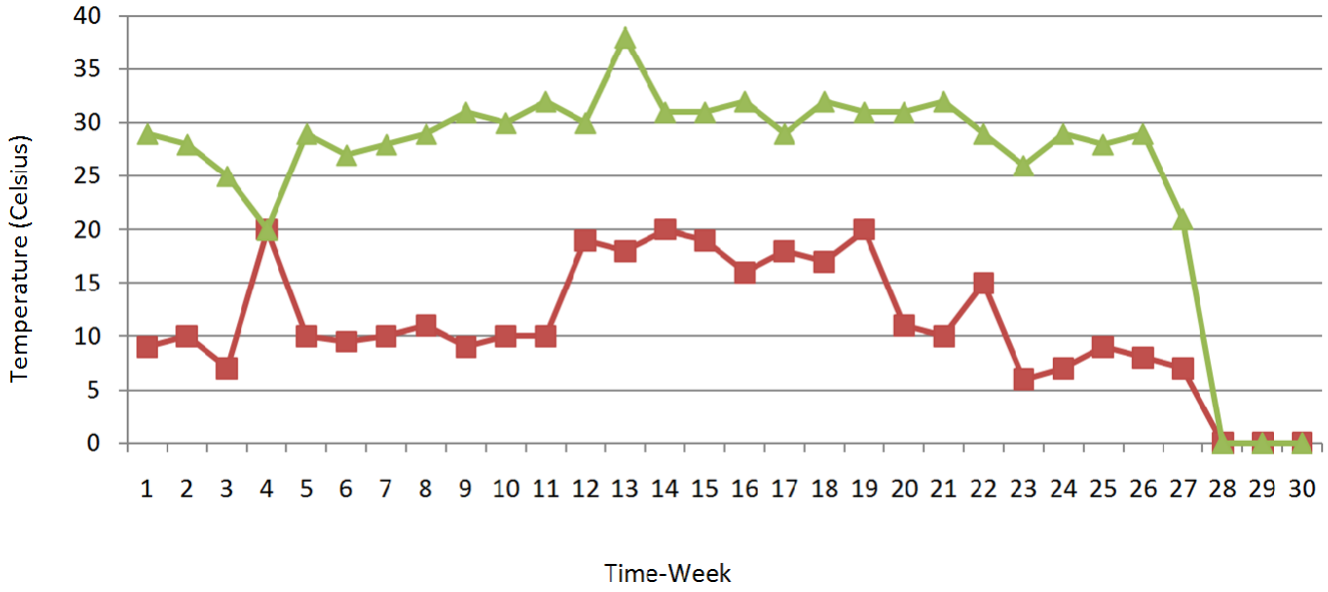

Figure 3a. Fluctuation curve daily Min and Max temperature (Celsius) 2008. The sheet must end by the week No. 27.

In Table 2, the start and the period when effective temperature is 10°C or higher along with the outbreak dates of moths in years of 2008 -2009 are presented. Throughout these two years in Sissakht, the effective temperature started in the mid of April and after 8 – 11 days adult moths haves been seen in the field. In the summer because temperatures was higher than lower temperature threshold temperature (33°C), continuous in growth and different life stages of *L. botrana* has caused interference of the second and third generations (Figure 1 and 2). Also, it was found that after the 25th week, due to falling of temperature under the lower threshold temperature, the growth activities of the third generation ended. So, this insect had only three generations in the studied region and the fourth generation are been aborted. To compare this with other places in Iran and the world, in Romania there are 1 – 3, in Spain 3 – 4, in Sweden and Finland 1, in Turkey 3 – 4, around Shiraz 4

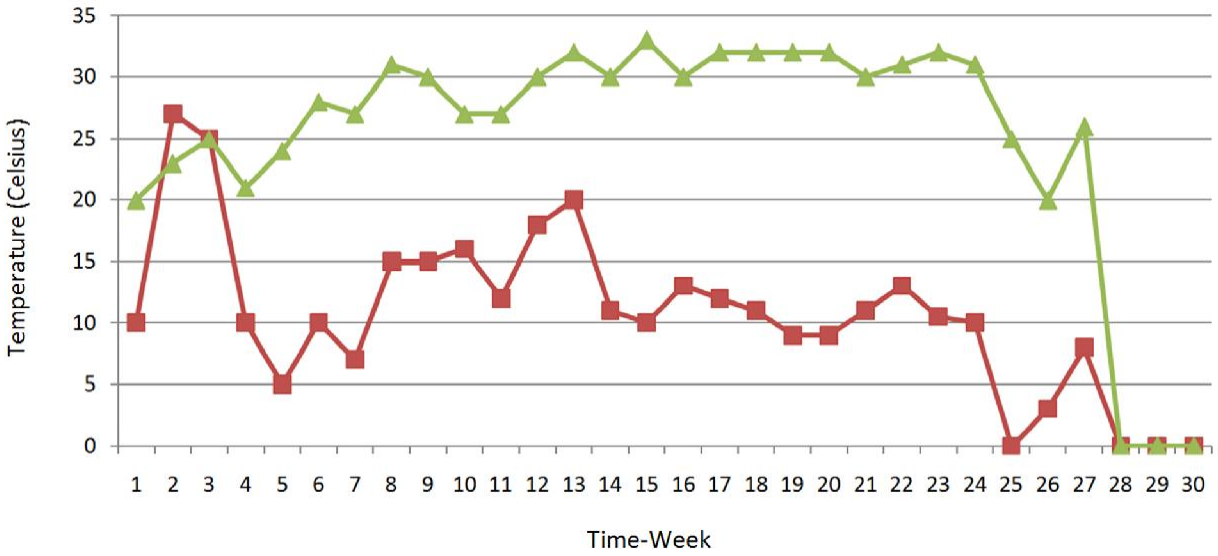

Figure 3b. Fluctuation curve daily Min and Max temperature (Celsius) 2009. The sheet must end by the week no. 27.

Table 2. Appearance of the first grape berry moths from overwintering pupae in relation to effective temperature in Sissakht in year of 2008 – 2010.

Year	Start of the effective temperature	Length of the effective temperature (days)	Sum of effective temperature (°C)	Appearance of the first moth
2008	12th April	9	112	21st April
2009	7th April	8	105	15th April
2010	9uı April	11	96	18uı April

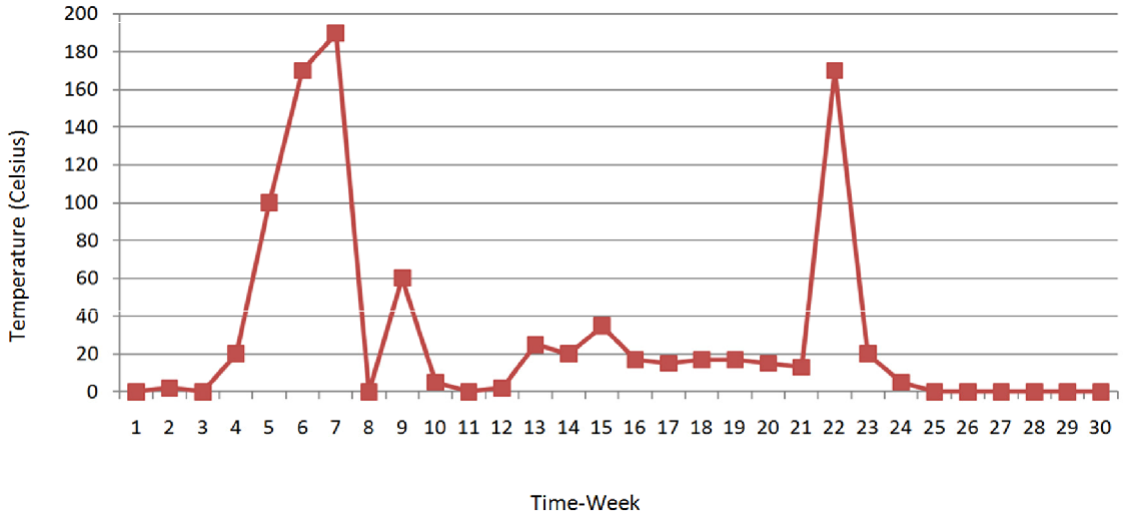

Figure 4. Exit trend adults overwintering in laboratory conditions (2008).The title of the Y axis must be: Number of adult moth emerged. The sheet must end at week no. 24.

and in Tehran 3 generations in a year (Rezvani, 1981; Esmaeili, 1983; Stora, 1983; Hoffman et al., 1999; Witzgall et al., 2000).In the laboratory, the outbreak of a complete insect of overwintered generation started 10th of April with the climax on 25th of April (Figure 4).

In this region, the outbreak of the adult males of *L. botrana* starts after mid-April of each year with the climax in the end of April. Due to the lower threshold

Table 3. Comparing stages flight activity of the three generations of *Lobesia botrana* in the Mountains and in Plains of Sissakht 2008 (Week period at which flight activity occurred). Flight activity of each generations Plains Mountains.

Stages of generations	Plains	Mountains
Start of 1st gen.	18th, April – 25th, April	24th, April – 1st, May
Flight climax of 1st gen.	4th –11th, May	13th –18th, May
End of 2nd gen	26th, May – 5th, June	25th, May – 4th, June
Start of 2nd gen.	5th –12th, June	4th –11th, June
Flight climax of 2nd gen.	19th –26th, June	18th –25th, June
End of 2nd gen	17th –31st, July	13th –28th, July
Start of 3rd gen.	31st, July – 11th, August	28th, July – 13th, August
Flight climax of 3rd gen.	20th –27th, August	22nd –29th, August
End of 3rd gen	3rd –9th, September	6th –16th, September
Start of 4th gen.	9th – 16th September	16th – 24th, September

temperature for the larvae (10°C) and based on data received from meteorological institute center in Sisakht, the insect activities – transformation of pupa to insect – start around 5th of April and by mid-April adult moth population grew fast. The flight climax of the first generation was around 5th of May. Based on frequent sampling of pheromone traps in the field, the peak of laying eggs of the first generation is was 10 – 15 days after appearance of the moths in the vineyard. Due to embryonic length, the peak of larvae hatching is 10 days after the flight climax. The dates of laying eggs and hatching of larvae is very important in preparation for insecticidal activities. Based on observation and frequent sampling, the time period of laying eggs has been determined as 5th to 20th of May for the first generation, 1st to 5th of August for the second generation and 1st to 5th of September for the third generation (Table 3).

Based on observations, the results of catching males of grape berry moth by pheromone traps and fluctuations in moth's population of the first generation, the first spraying is recommended to be done from 10th of May to end of May. This is to control the second generation of *L. botrana*. To get a better result and protecting the vineyards from damages of this pest, another spraying is done in the 3rd late of July. This reduced the infested grape bunches and the population of *L. botrana* in the next year drastically.

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