بسم الله الرحمن الرحيم

Hebron University

College of Graduate Studies

M.Sc. Program in Plant Protection

Field Studies on Biology, Ecology and Management of Grape Berry Moth, *Lobesia (polychlorosis) botrana* Den & Schiff. [Lepidoptera: Tortricidae] on Some Grapevine Cultivars *Vitis vinefera* L. in Al-Arroub Agricultural Experimental Station, Palestine

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This thesis is submitted in partial fulfillment of the requirements for the degree of Master of Science in Plant Protection, College of Graduate Studies, Hebron University, Hebron - Palestine

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DEDICATION

To My Parents

ACKNOWLEDGEMENTS

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ABSTRACT

Grapevine is one of the most important fruits planted in Palestine. The grape berry moth, ***Lobesia (polychlorosis) botrana*** Den & Schiff. [Lepidoptera: Tortricidae] is considered as a key pest of grapevine that is distributed in the Mediterranean countries. This study investigated the flight activity and the abundance of infestation on grapevine cultivars planted in Al-Aroub Agricultural Experimental Station in Hebron District, Palesine, during 2004 and 2005 growing seasons. In addition, experiments were done by using sex pheromone of ***L. botrana*** [(***E***,***Z***)-7,9-dodecadienyl acetate (***E***7,***Z***9-12:OAc)] as mating disruption in comparison to current insecticides used against the grape berry moth.

Results show that seasonal flight activity of the berry moth started on beginning of April, and extended till end of November, with four peaks that were recorded during April, May, September and November. Halawani, Shami and Salti-khdari were the most preferred cultivars for start of infestation and, upon ripening of the grape, all cultivars were with economic level of infestation exceeded 5% of clusters.

Results also show that, pheromone treatment was without significant effect on percentage of infestation; Cypermethrin & Chloropyrifos treatments were with significantly lower percentage of infestation. However, traces of residue of Diazinon, Cypermethrin and Chlorpyriphose that were detected in grape leave as well as in fruits were higher than the

tolerance levels even after the safety period that recommended for these insecticides.

Therefore it is recommended not to collect grape leaves that are intended to be used for grape leaf roll meal from insecticide treated vineyards. In addition, it is recommended to conduct residue analysis for the grape fruits before harvesting to be sure that residues are below the tolerance levels for the used insecticides.

Finally, it is recommended to use sex pheromone in order to effectively monitor the flight activity of the grape berry moth that helps in reducing the amount of insecticides applied, while maintaining acceptable insect control.

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Grapevine is one of the most important crops planted in Palestine with acreage of 76220 dunums; 40584 dunums of the vine is in Hebron district (PCBS**,** 2005).

Sultan (2005) mentioned that the most popular grape varieties planted in Palestine are: White varieties including Dabouki , Zainy, Salty, Hamdany, Jandaly, Bairoty, and the Sultanina white varieties which were imported to Palestine such as Sultanina, Perlette, Delight; Black varieties including Darawishi, Ballouty, Beitony, and Shami; and Red varieties including Halawani , Emperor, Cardinal, and Fhaisy.

Grape vine in Mediterranean was reported to be infested by several insect pests especially grape berry moth *Lobesia botrana* (Haddadin, 1990). The larvae of this insect can cause serious damage to commercial vineyards by feeding on the blossoms and berries. Infested berries may appear shriveled with fine webbing (Al-Zyoud, 1997).

Sultan (2005) mentioned that, several pests were reported in Palestine attacking grapevine in including grape berry moth *L. botrana,* leafhopper, *Empoasca lybica*, thrips, *Thrips tabaci* and eriophid mite*, Eriophyes vitis.* Sultan (2005) considered *L. botrana* as the key pest attacking grape, it had great damage on yield quality and quantity; therefore, intensive control program using chemical pesticides only was applied.

During the last decade, many human lethal cases had occurred in Hebron district as a result of toxicity by pesticides sprayed on grape vine. However, on grapes no studies have been conducted in Palestine to observe the level of pesticide residues, the safety period and the alternative methods to chemical control.

Due to these problems which have been created by the intensive use of chemical pesticides, this research was designed to investigate the population dynamics and flight activity of the grape berry moth in the southern highlands of Palestine. Results Obtained are expected to help in introducing an integrated pest management program as an alternative to the current programs which concentrated mainly on use of broad spectrum insecticides.

The **objectives** of this research are:

1. To monitor the flight activity of the grape berry moth, *L. botrana* the years 2003/2004 and 2004/2005 seasons.
2. To record the abundance of infestation of the grape berry moth, *L. botrana* on different European grapevine cultivars.
3. To study the uses of pheromone as mating disruption in comparison with chemical control measures against the Grape berry moth.
4. To examine the residue levels of some chemical insecticides that are used in Hebron district against *L. botrana*.

Chapter One:

Literature Review

Chapter One: Literature Review

1.1 Biology of *Lobesia botrana*

1.1.1 Life Cycle

Three main species of grape berry moth: *Endopiza viteana*; *Lobesia botrana* and, *Eupoecilia ambuguella* are reported to be infesting grapevine in several countries including Latvia, Norway, Greece, Yugoslavia, Russia and the Ukraine. Those grape berry moth species were also recorded in Western Europe, the Balkans, Iraq and the area east and west of the Caspian Sea in Asia (Avidov & Harpaz, 1969).

The grape berry moth, *L. botrana* was recorded as a key pest of grapevine that is distributed in the Mediterranean countries (Tzanakakis, 1972; Caffarelli & Vita, 1988; Haddadin, 1990; Nikos *et al.,* 2001; Sultan, 2005). The grape berry moth, *L. botrana* is considered as a polyphagous insect that can develop on plants from different families where more than 40 species have been reported to be attacked by this moth (Stoeva, 1982; Moleas, 1988; Ben-yehoda *et al.*, 1993).

L. botrana, also known as the European Grapevine Moth (Zhang, 1994). feeds not only on grapes, but also on olive, privet, lilac, black currant and persimmon (Avidove & Harpaz, 1969; CIE, 1974).

L. botrana is a multivoltine species inhabiting region between 29 and 47 altitudes across the Mediterranean basin and Asia Minor. It is the most serious pest of grape berries, whose importance decreases gradually northward (Roditakis & Karandinos, 2001).

The number of generations is determined by several factors including photoperiod, temperature, humidity, latitude, food quality, and the effects of predators and diseases (Deseo *et al*., 1981; Gabel, 1981; Gabel & Mocko, 1984). Thus, both humidity and temperature simultaneously influence the development (Ali *et al*., 1978, Abashidze, 1991), particularly at the microclimate level (Reichart, 1968). Even, under optimal temperature and humidity conditions, low reproduction can occur, suggesting that diapause and unknown factors may also strongly influence population dynamics (Deseo *et al*., 1981).

Two to three and sometimes four generations of *L. botrana* were recorded on grapevine depending on the region and its climatic conditions (Marchesini & Dalla-Monta, 2004). In Palestine, Avidov and Harpaz (1969) reported that *L. botrana* female lays 300 or more eggs at a rate of more than 35 per day. The eggs hatch in 7-11 days during spring and in 3-5 days during summer, and up to four generations may occur (Avidov & Harpaz, 1969).

In mid to late July, larvae move to leaves where they make a semi circular slit, fold the flap over themselves and pupate. Adult moths emerge from the pupae in 10 to 15 days. Larvae of the later generations enter berries and feed within, passing from one berry to another under protection of webbing. Over wintering pupae of the later generations occur beneath bark in tissues of the stock. Some of the cocoons of the second or third generations, fall to the ground where they over winter (Avidov & Harpaz, 1969).

1.1.2 Flight Activity

Adults of the grapevine moth were observed emerging from the over-wintering sites from the middle of March to end of May (Thiery & Gabel, 2000). Avidov and Harpaz, (1969) reported that adults of grape berry moth observed to emerge at intervals and the flights spread over 2 to 3 weeks.

Depending on regional and climatic conditions, not all moths of the same generation emerged at the same time, several weeks passes between the emergence of the first and last moth of the same generation in Palestine Avidov & Harpaz, 1969. Mating was recorded to begin at nightfall and egg laying starts two to three days later. Adults of the first generation begin to lay eggs singly on fruit stems just before blossom time; and the second flight is recorded to takes place at end of June, and the third flight occurs between mid-August and the end of September (Avidov & Harpaz, 1969).

1.2 Damage

L. botrana was reported as one of the most damaging insects in the European vineyards and has been objected of intensive research during recent decades in order to improve the methods of phytosanitary control (Tio *et al.* 2001). In Jordan as well as in Palestine, *L. botrana* was recorded as the most important insect pest attacking grapevines and considered as the key pest to grapevines (Al-Zyoud, 1997; Sultan, 2005).

Visual inspection of the plant materials may be used to detect eggs, larvae, and pupae of *L. Botrana* where larvae might be found in flowers or fruit clusters covered with webbing produced by the insect (USDA, 1985). Superficial damage may be observed on remnants of flowers, partially eaten shriveled fruits, and rotting fruits with contamination by larval fraises and webbing (Roehrich & Boller, 1991; CAB International Encyclopaedic, 2003).

Damage was reported to be greater in grape cultivars with compact clusters and /or sensitive to rot (Pavan *et al.* 1993). The caterpillars gnaw the almost ripe fruits and various moulds, in particular Botrytis, develop very rapidly on the wound (Fermand & Giboulot, 1992).

1.3 Management

L. botrana is controlled by means of broad-spectrum neurotoxic insecticides, insect growth regulators and biological insecticides (Boselli &

Scannavini, 2001). Sprays are usually applied at the second and third generations, as injuries caused by the first generation are not considered to be relevant for the crop value (Marchesini & Dalla-Monta, 2004). It required a further pesticide application near the harvesting time which is potentially harmful for the consumers.

In the last decades, health aspects and environmental issues have challenged the whole agricultural world to move towards environmentally friendly techniques, therefore, the use of insecticides was limited due to deregistration of the most toxic compounds and due to strengthening of regulatory requirements for the registration of new active ingredients (Varner *et al.*, 2001).

In addition, both consumers' and growers' associations became conscious of the problems connected with pesticide residues, therefore, studies for alternative methods for management of insect pests were intensively conducted, including cultural, biological, crop plant resistant, use of pheromones and insect growth regulators (Louis & Schirra, 2001).

Evaluation of applications of pheromones for controlling the grape berry moth was first conducted in the state of New York (Taschenberg *et al*, 1974) and later on in Germany (Louis & Schirra, 2001) and in Israel (Wysoki, 1998).

1.3.1 Chemical Control

In Palestine many insecticides used to control *L. botrana*, especially the larval generation which causes the damage for the grape berries (Sultan 2005). A protective cover spray to prevent damage can be required in areas infested by grape berry moth. Early season control of this pest can prevent it from becoming well established within the vineyard and may eliminate the need for control later in the season. In vineyards where this pest is a problem every year, one spray is usually used for each of the two generations. In vineyards where this pest is not always a problem, one spray targeting the first generation is needed. (Ellis *et al*, 2004)

Threshold for spray applications needs, depend on the amount of infested berries that the grower is willing to accept. Corrective measures are usually suggested if more than 5% of the clusters are injured. Table grapes require more attention than grapes grown for juice. If berry cluster damage reaches 6% in grapes used for processing or 3% in those grown for fresh market, then a protective cover spray should be applied. (Ellis *et al*, 2004)

In Jordan, Al-Zyoud (1997) conducted an experiment to examine the uses of various insecticides against the grape pests including grape berry moth**.** Al-Zyoud concluded that, Malathion, Dimethoate, Lambda-Cyhalothrin, and Cypermethrin, can be used in different spraying schedules for the control of the grape berry moth. The result of the first application of insecticide to control the grape berry moth (clusters) show that after three days, one week and two weeks of application, all insecticides tested showed no significant differences from the control. However, after the second spray the result indicates that after three days and one week and two weeks of application the infestation were reduced slightly comparing with control.

1.3.2 Cultural Method

Bessin (2003) observed that, webbing over blossoms and berries, and leaf flap cocoons are indicative of grape berry moth, and during winter, the cocoons were found in leaf litter under the vines, therefore sanitation by cleaning up or burying leaf litter under vines was recommended to eliminate over wintering pupae.

1.3.3. Biological Control

Haddadin (1990) reported two parasitoids parasitizing the grape berry in Jordan vineyards namely, *Ascogaster quadridentata* W. and *Ichneumonid* sp. In addition, Haddadin reported that several predators were found in the vineyard including a phytoseiid mite; the green lacewing and the seven spotted lady beetle. Furthermore, Roehrich and Boller (1991) concluded that chrysopids were one of the main predators in summer season meanwhile phytoseiid mite were important predators on diapausing pupae of grape berry moth.

1.3.3 Pheromones as Mating Disruption

Insect pheromones are ectohormones that secreted by insects to communicate with other individuals from the same species. Virgin lepidopteran females were recorded emitting sex pheromone that attracts males which follow the odour trace upwind to find the calling females for mating (Baker & Vickers, 1996; Haynes & Baker, 1989; Witzgall, 1996; Wyatt, 2003).

Rafaeli (1998) suggested that the process of sexual communication is conducted in five stages:

1. Production of a blend of specific chemicals typical the species, making it possible the males to locate the female.
2. Timely production and release of the sex pheromone blend during active periods of the day, an event which is under endogenous control in the female.
3. Perception of this blend by the sensitive sensory mechanism of the male.
4. Receptivity level of the female to mating so that copulation may proceed.
5. After mating the female moth becomes non receptive, production of pheromone is terminated and ovipositional behavior is initiated.

Sex pheromones from the most economically important insect pests have been identified and pheromone based monitoring methods are nowadays applied for monitoring the flight activity of the leprdopteran and dipteran pests (Cardé & Minks, 1996). Detection and monitoring of the grapevine moth was achieved by using traps lured with sex pheromone to monitor for adult moth activity and to optimize the timing of insecticide applications (Cardé & Minks, 1995; Ridgway, *et al.*, 1990).

In addition, pheromone-mediated mating disruption is used to control several species (Cardé & Minks, 1995). Mating disruption relies on releasing enough of the pheromone in the vineyard so that males cannot find female moths. Mating disruption of insect pest (confusion) will soon be the major technique applied in integrated pest management (IPM). It is based on the finding that males are prevented from mating by a relative excess of pheromone in the environment, i.e., above the normal back ground due to natural pheromone release (Shani, 1998). Thus, by aerial dissemination of synthetic pheromone, olfactory communication between sexes and mate-finding can be disrupted, this method (termed mating disruption) is species specific and non-target organisms are not affected (Charmillot & Pasquier, 2000; Varner *et al.*, 2001).

Studies in some regions have shown mating disruption with synthetic pheromones to be an effective alternative in situations where there is no immigration of moths from outside sources (Louis & Schirra, 2001). However, despite considerable progress, mating disruption still cannot be universally applied as a pest control method. This may be due to specific insect characteristics, as well as to the a biotic factors including temperature, wind conditions, and characteristics of the plant canopy and leaf density, which vary between different plots and crops (Aylor *et al.*, 1976; Uchijima, 1988; Raupach, 1988). The sex pheromone of *L. botrana* has been identified as (*E*,*Z*)-7,9-dodecadienyl acetate (*E*7,*Z*9-12:OAc) (Roelofs *et al.*, 1973; Buser *et al.*, 1974). Other studies contributed to the identification of several other related compounds (Arn *et al.*, 1988; El-Sayed *et al.*, 1999).

El Sayed *et al.* (1999) optimized synthetic blends in the wind tunnel and concluded that none of these blends could mimic the female pheromone gland extract.

Pheromone dispensers were used for mating disruption of *L. botrana* in 15 vineyards plots of edible grape in central Palestine (Rubin, 1998). The dispensers were hung during the last 10 days of May 1997 at rate of 500 per ha. Because this was the pests active season, most of the vineyards has received one application of pesticides recommended by ministry of agriculture, prior to distribution of pheromone. The plots are varied in size between 0.2 and 1.2 ha.

In every experimental plot, grape berry moth infestation was checked 17 times between June 6th and September 2nd 1997, 25 grape clusters were examined in each plot for the presence of *L. botrana* larvae. Rubin, (1998) found that no marked differences were found between pheromone—treated and insecticides –treated plots because of the successful of chemical treatment.

Chapter Two:

General Materials and Methods

Chapter Two: General Materials and Methods

2.1 Vineyards: Three vineyards in Al-Arroub Agricultural Experimental Station were used for this research:

1. Hebron University vineyard
2. Agricultural Secondary School vineyard No.1.
3. Agricultural Secondary School vineyard No.2.

2.1.1. Hebron University vineyard:

Consists of grapevine plants >10 years old, planted in 10 columns and 10 rows with spaces of 4*4 meters between the columns and the rows (Diagram 2.1). Grapevine plants were planted in climbing system (Arbor) on iron net 1.9 m high. The vineyard included 7 grape cultivars (1: Sultanina, 2: Ballouti, 3: Shami, **4:** Salti-khdari**,** 5: Halawani, 6: Beitoni and 7: Jandali) as shown in Fig. 2.1.

♣	♣	♣	♣	♣	A	♣	♣	A	♣
♣	A	♣	♣	♣	♣	♣	♣	♣	♣
♣	A	♣	♣	♣	♣	♣	♣	♣	♣
♣	A	♣	A	♣	♣	♣	♣	♣	♣
♣	♣	♣	A	♣	♣	♣	♣	♣	♣
♣	A	♣	A	A	♣	♣	♣	♣	♣
♣	A	♣	♣	♣	♣	♣	♣	♣	♣
♣	A	♣	♣	♣	♣	♣	♣	A	♣
♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
Sultanina	**Balluti**	**Shami**	**Balluti**	**Salti-khdari**	**Sultanina**	**Halawani**	**Shami**	**Beitoni**	**Jandali**
1	2	3	2	4	1	5	3	6	7

Fig. 2.1: Hebron University Vineyard in Al-Arroub Agricultural Experimental Station (♣: Present plant, A: Absent plant).

2.1.2. Agricultural Secondary School Vineyard No.1:

Consists of grapevine plants >10 years old, planted in 12 columns and 20 rows, with spaces of 4*4 meters between the columns and the rows (Fig. 6.1).

2.1.3. Agricultural Secondary School Vineyard No.2:

Consists of grapevine plants, >10 years old, planted in 10 columns and 15rows with spaces of 4*4 meters between the columns and the rows (Fig. 7.1).

2.2 Chemical insecticides:

The following insecticides which are marketed by Mekhtashem Company were used in this research:

1. Dizictol (Diazinon 25% a.i): a semi-systemic organophosphate insecticide. It was used in the formulation of emulsifiable concentrate.

2. Sherbaz (Cypermethrin 10% a.i)): a synthetic pyrethroid insecticide. Cypermethrin is light stable contact poison. It was used in the formulation of emulsifiable concentrate.

3. **Dorbaz (Chlorpyriphos 47.9% a.i)**: a broad-spectrum a contact poison, with some action as a stomach poison organophosphorous insecticide. . It was used in the formulation of emulsifiable concentrate.

4. **Kotanion** (Azinphos-methyl 20% a.i): organophosphorous insecticide. It was used in the formulation of emulsifiable concentrate.

5. **Devipan** (Dichlorphos 1000gm/L a.i**)** organophosphorous insecticide. It was used in the formulation of emulsifiable concentrate

2.3 Pheromone Traps:

Delta shape pheromone sticky traps were used to monitor the flight activity of the grape berry moth within the three vineyards (Fig. 2.4).

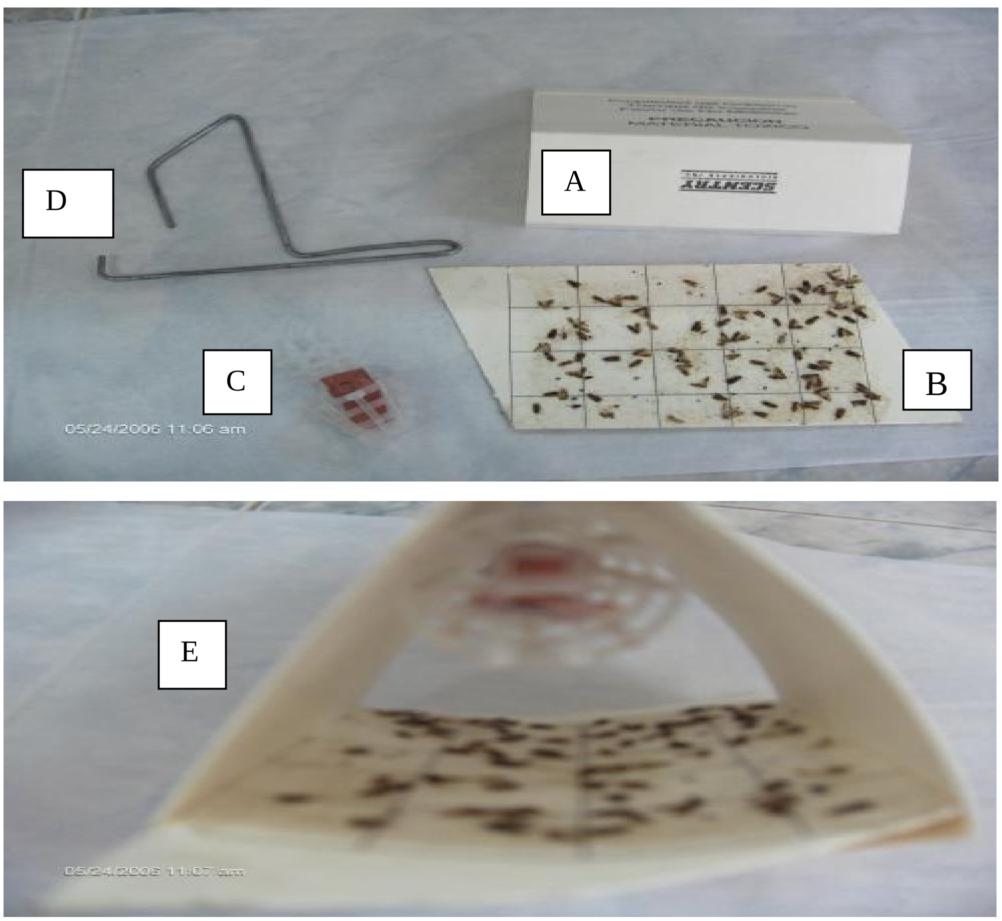

Fig. 2.2 Pheromone trap (a: delta shape carton, b: removable carton card, c: pheromone dispenser, d: wire trap holder, e: complete trap)

Each trap was composed of four components:

A. Delta shape carton;

2. Removable carton card painted with a light sticky material for capturing the insects inserted the internal basement of the trap;

3. Pheromone dispenser including sex pheromone of *L. botrana* [(*E*,*Z*)-7,9-dodecadienyl acetate (*E*7,*Z*9-12:OAc)] placed in a ventilated plastic basket and fixed on the internal upper side of the trap, and

3. Wire trap holder used to hang the trap on the specific site.

2.4 Methodology of the research: The following experiments were conducted in Al-Arroub Agricultural Experimental Station:

1st Experiment: Seasonal flight activity of grape berry moth, *L. botrana* within European grapevine cultivars in Al-Arroub Agricultural Experimental Station during 2004 and 2005 seasons.

2nd Experiment: Preliminary study on the abundance of infestation of grape berry moth on European grapevine cultivars in Hebron University Vineyard, under no chemical control measures during 2004 season.

3rd Experiment: Abundance of infestation of grape berry moth on European grape cultivars, in Hebron University Vineyard, under Conventional Chemical Control measures during 2005 season.

4th Experiment: Uses of pheromone as mating disruption against grape berry moth in comparison with of chemical control measures in Al-Arroub Agricultural Secondary School Vineyards No.1 during 2005 season.

5th Experiment: Effect of rate of application of pheromone as mating disruption on the seasonal abundance of infestation of grape berry moth in Al-Arroub Agricultural Secondary School Vineyards No.2 during 2005 season.

6th Experiment: Detection of the traces of residue in leaves and fruits of grapevine for the three chemical insecticides that used in the 4th experiment.

2.5 Statistical analysis: statistical analysis for the data of this research was done by using Minitab Package as shown under each table of results.

Chapter Three:

Seasonal Flight Activity of Grapevine Berry Moth, *L. botrana* within European Grapevine Cultivars in Al-Arroub Agricultural Experimental Station during 2004 & 2005 Seasons

Chapter Three: Seasonal Flight Activity of Grapevine Berry Moth, L. Botrana within European Grapevine Cultivars in Al-Arroub Agricultural Experimental Station during 2004 & 2005 Seasons

3.1 Objective:

The objective of this experiment is to observe and record the seasonal flight activity of *L. botrana* in Al-Arroub Agricultural Experimental Station.

3.2 Materials and Methods:

Flight activity of *L. botrana* was monitored within vineyards of Al-Arroub Agricultural Experimental Station during 2004 + 2005 years.

Three vineyards were used for monitoring of the flight activity of the grape berry moth as follow:

1. **Hebron University Vineyard:** where monitoring was done for two years (started on 1st April 2004 and continued for two years till 31st December 2005).

2. **Agricultural Secondary School Vineyard No. 1 and, Agricultural Secondary School Vineyard No. 2:** where monitoring started on 23rd March 2005 and continued till 31st December 2005.

One Delta shaped pheromone sticky traps was hanged in the middle of each vineyard at height of 1.9 m.

Observation of the flight activity of grape berry moth was done by weekly collection of the sticky card, counting the captured males on each sticky card in each vineyard. The sticky card was changed weekly while the pheromone dispenser was replaced monthly according to the instructions of the sales agent.

3.3 Results

Results in Fig. 3.1 show that, *L. botrana* started its seasonal flight activity on 1st April, and continued its activity through the season till the beginning of November during 2004 meanwhile, flight activity during 2005 was from late of May till late of November.

Results also show that, seasonal flight activity was in relationship to temperature as well as to rain, thus no flight activity occurred at temperature below 10°C and number of captured males/pheromone trap was observed to be increased with increasing temperature. In addition, very low flight activity was recorded during the rainy periods.

Furthermore, results show that, during 2004 & 2005, four peaks of flight activity of *L. botrana* were detected each year respectively as follow: 1st peak was recorded on 13th April 2004 and on 7th June 2005; 2nd peak on 11th May 2004 and on 20th July 2005; **3rd** peak on 8th Septembers 2004 and on 5th September 2005 and the 4th peak was recorded on 2nd November 2004 and on 30th October 2005 and finally the extinction of flight activity was recorded on 9th November 2004 and on 30th November 2005.

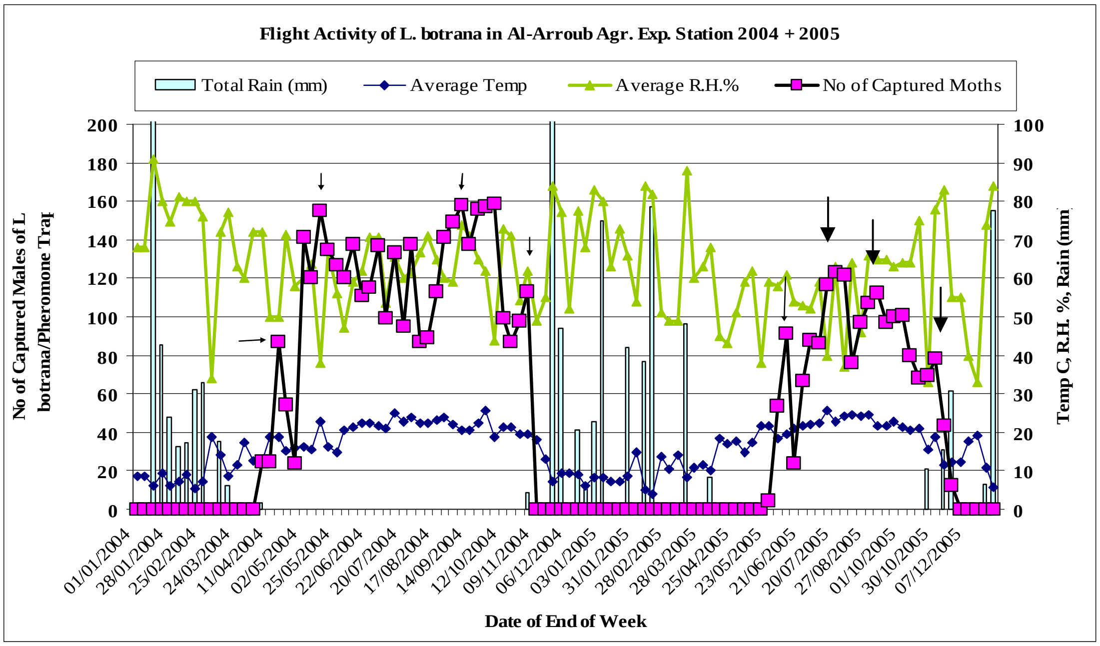

Fig. 3.1: Flight activity of *L. botrana* males in Hebron University vineyard during 2004 & 2005 seasons.

3.4 Discussion

Results of the present study show that, throughout two years study (2004 + 2005), flight activity of the grape berry moth was not recorded during periods with temperature below 10ºC; males of the grape berry moth were first captured at pheromone sticky traps at the beginning of April, and continued till end of November; and throughout each season, four peaks of males captures were recorded: 1st during April; 2nd during May; 3rd during September and the 4th during November and extinction occurred at the beginning of December.

Similar results were reported by several researchers (Avidove & Harpaz, 1969; Thiery & Gabel, 2000; Tio *et al.*, 2001). Avidov & Harpaz (1969) suggested that, the number of generations is determined by several environmental factors including photoperiod, temperature, humidity and rainfall, thus up to four generations of the grape berry moth may occur each season in Palestine. Thiery and Gabel (2000) mentioned that adults of grape berry moth were observed emerging from overwintering sites from the middle of March to end of May. Tio *et al.*, (2001) concluded that flight activity of ***L. botrana*** had linear relationship with the accumulated degree days throughout the season and throughout six years study (1990-1995), up to four peaks of pheromone trap catches were recorded within Sherry vineyards in South West Spain.

Chapter Four:

Abundance of Infestation of Grape Berry Moth on European Grapevine Cultivars in Hebron University Vineyard during 2004 Season, Under No Chemical Control Measures

Chapter Four: Abundance of Infestation of Grape Berry Moth on European Grapevine Cultivars in Hebron University Vineyard during 2004 Season, Under No Chemical Control Measures

4.1 Objective:

The objective of this experiment is to observe the seasonal abundance of infestation of the grape berry moth on European grapevine cultivars planted in Hebron University Vineyard under no chemical control measures.

4.2 Materials and Methods:

This experiment was conducted in Hebron University Vineyard which includes 7 European grapevine cultivars as shown in Fig 2.1.

Two-three grapevine plants per column were randomly observed every two weeks for grape berry moth infestation.

Observations included the following parameters:

1. Number of infested trees.
2. Number of infested clusters per plant.
3. Number of berries per infested cluster.
4. Number of infested berries per infested cluster.

4.3 Results:

First record of infestation of *L. botrana* on European grapevine cultivars in Hebron University Vineyard was observed to occur on 1st July 2004, and the last record of infestation was done on 18th July 2004 (two weeks before start of grapevine harvesting).

Results in Table 4.1 show the mean number and % of infested clusters/grapevine plant within seven local grapevine cultivars in Hebron University vineyard during 2004 season.

Table 4.1: Mean number and % of infested clusters/grapevine plant in Hebron University vineyard during 2004 season. (Mean* ± S.E)

Date of Observation		1/7/2004		18/7/2004	
Grapevine Cultivar	**Rep. (Plant)**	**Number of Infested Clusters/Plant**	**% of Infested Clusters/Plant**	**Number of Infested Clusters/Plant**	**% of Infested Clusters/Plant**
Sultanina	**6**	$1.00^{b} \pm 0.258$	$2.466^{b} \pm 0.512$	2.00±0.25	5.19± 1.01
Ballouti	**5**	$0.600^{b} \pm 0.400$	$1.77^{b} \pm 1.11$	2.00 ± 0.31	6.54 ± 106
Shami	**5**	$1.200^{ab} \pm 0.490$	$4.61^{ab} \pm 1.53$	2.60 ± 0.51	11.08± 3.62
Salti-khdari	**3**	$1.333^{ab} \pm 0.333$	$4.306^{ab} \pm 0.413$	3.33 ± 0.66	11.51 ± 3.05
Halawani	**3**	$2.33^{a} \pm 0.333$	$5.943^{a} \pm 0.489$	3.00 ± 0.57	7.65± 1.33
Baitouni	**2**	$0.000^{c} \pm 0.000$	$0.000^{c} \pm 0.000$	2.50 ± 0.50	7.85 ± 4.15
Jandali	**2**	$0.000^{c} \pm 0.000$	$0.000^{c} \pm 0.000$	2.50 ± 0.500	5.24± 1.73
P value		0.032*	0.018*	0.352NS	0.359NS

***:** Means within columns with different letters significantly differ at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

NS= Not significant at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

During 2004 season, the start of berry moth infestation was 1st recorded on 1st July on five cultivars (Halwani; Salti-khdari; Shami; Sultanina and Ballouti), meanwhile two cultivars were still free from infestation in the above mentioned date. However, on 18th July 2004, infestation with grape berry moth was observed in all cultivars of the vineyard.

Statistical analysis of the data presented in Table 4.1 show that local grapevine cultivars differ significantly in their susceptibility for the start of berry moth infestation. Thus, local cultivars can be classified according to preference for start of infestation into three categories: start of infestation was observed to be significantly higher on Halawani, Salti-khdari and Shami; medium on Sultanina and Ballouti while both Baitoni and Jandaly cultivars were without infestation up to the 1st of July 2004.

However, on 18th July (two weeks before harvesting), infestation exceeded 10% on both Shami and Salti-khdari; about 8% on both Halawani and Beitoni, and about 5% on Ballouti, Sultanina and Jandali. Statistical analysis of these results show that, even infestation were high on all cultivars (>5%) but no significant differences were observed between these cultivars at $P\ value \leq 0.05$ using Fisher's Pairwise Comparison.

4.4 Discussion

Results of the present study show that, when no control measures were applied, Halawani, Shami and Salti-khdari were the most preferred cultivars for start of infestation; and upon ripening of the grape, all local cultivars were with economic damage and infestation exceeded 5% of clusters.

Ellis *et al.*, (2004) concluded that the need for spray applications depends on the proportion of infested clusters that grower may accept, and curative measures to control the grape berry moth are usually suggested if more than 3% of the grape clusters were injured. Thus Ellis *et al.*, (2004), recommended that a protective cover spray should be done, if berry cluster damage reaches 6% in grapes used for processing or 3% in those grown for fresh market.

Chapter Five:

Abundance of Infestation of Grape Berry Moth on European Grape Cultivars, in Hebron University Vineyard, under Conventional Chemical Control Measures during 2005 Season

Chapter Five: Abundance of Infestation of Grape Berry Moth on European Grape Cultivars, in Hebron University Vineyard, under Conventional Chemical Control Measures during 2005 Season

5.1 Objectives:

The main objective of this experiment is to observe the seasonal abundance of infestation of the grape berry moth on European grapevine cultivars planted in Hebron University Vineyard under conventional control measures.

5.2 Materials and Methods

Following the observations and records of infestation of grape berry moth obtained from the preliminary study conducted in Al-Arroub Agricultural Experimental Station during 2004 season, second experiment was conducted during 2005 season, in the same vineyard, to observe the infestation of grape berry moth under **conventional chemical** control applications used against ***L. botrana***

Spraying started on 23rd March 2005 and continued till the 1st of August 2005. Spraying schedule of insecticides which are currently used in Hebron District was applied monthly on Hebron University Vineyard during 2005 season as shown in Table 5.1.

Table 5.1: Spraying schedule of insecticides applied on Hebron University Vineyard in Al-Arroub Agricultural Experimental Station during 2005 season

Date of Application	Trade Name	Active Ingredient	Chemical Group	Dosage (Conc. %)	Safety Period (Days)
23rd Mar.	Kotanion	Azinophos-methyl (20%)	Org. phosphorous	**0.2%**	**21**
26th Apr.	Sherpaz	Cypermethrin (10%)	Pyrethroid	**0.1%**	**21**
24th May	Sherpaz	Cypermethrin (10%)	Pyrethroid	**0.1%**	**21**
29th Jun.	Dorpaz	Chlorpyriphos (47.9%)	Org. phosphorous	**0.15%**	**7**
1st August	Devipan	Dichlorvos (100%)	Org. phosphorous	**0.1%**	**1**

5.3 Results:

Results in Tables 5.2 and 5.3 shows the level of infestation of *L. botrana* on European grapevine cultivars in Hebron University Vineyard under conventional chemical control program applied monthly as shown in the spray schedule presented in Table 5.1.

Results in Table 5.2 show that both mean number and % of infested clusters/plant on the European grapevine cultivars were with significant differences at the beginning of infestation on early of July but not significant on the end of season on 18th July 2005 (two weeks before start harvesting). Thus, on early of July 2005, start of infestation represented as number and % of infested clusters/plant were significantly high on Halawani, Salti-khdari and Shami; medium on Sultanina and Ballouti and low on Baitouni and Janadali.

Table 5.2: Mean number and % of infested clusters/grapevine plant in Hebron University vineyard during 2005 season. (Mean* ± S.E)

Date of Observation		1/7/2005		18/7/2005	
Grapevine Cultivar	**Rep.**	**Number of Infested Clusters/Plant**	**% of Infested Clusters/Plant**	**Number of Infested Clusters/Plant**	**% of Infested Clusters/Plant**
Sultanina	**6**	2.167^{b}±0.167	4.687^{b}±0.488	3.000±0.258	6.655±0.943
Ballouti	**5**	1.600^{b}±0.400	4.534^{b}±0.961	2.400±0.245	6.979±0.790
Shami	**5**	2.200^{ab}±0.490	7.16^{ab}±1.75	3.000±0.447	10.44±3.26
Salti-khdari	**3**	2.33^{ab}±0.333	6.708^{ab}±0.230	3.333±0.882	9.300±1.37
Halawani	**3**	3.667^{a}±0.333	8.551^{a}±0.825	4.000±0.577	9.38±1.610
Baitouni	**2**	1.000^{c}±0.000	2.663^{c}±0.909	1.500±0.500	4.450±2.69
Jandali	**2**	1.000^{c}±0.000	1.920^{c}±0.254	2.500±0.500	4.674±0.326
P value		0.007*	0.022*	0.103NS	0.395NS

***:** Means within columns with different letters significantly differ at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

NS= Not significant at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

Results also show that, under conventional chemical control program, on 18th July (two weeks before start harvesting), % of infestation was high (9-10%) on Halawani, Salti-khdari and Shami; medium (6%) on Sultanina and Ballouti and low (4%) on Baitouni, and and Jandali, however, statistical analysis of these results show that, this variation in % of infestation on those cultivars was not statistically significant at *P value* ≤ 0.05 using Fisher's Pairwise Comparison.

However, results in Table 5.3 show that under conventional control program, number of both parameters (infested berries/plant and % of infested berries/plant) on the tested cultivars were without significant differences.

Table 5.3: Mean number and % of infested berries/grapevine plant in Hebron University vineyard during 2005season. (Mean* ± S.E)

Date of Observation	1/7/2005		18/7/2005	
Grapevine Cultivar (n*)	**Number of Infested Berries/Plant**	**% of Infested Berries/Plant**	**Number of Infested Berries/Plant**	**% of Infested Berries/Plant**
Sultanina (6)	3.500±0.342	0.056±0.006	4.00±0.447	0.065±0.009
Ballouti (5)	2.800±0.490	0.066±0.009	2.800±0.200	0.070±0.013
Shami (5)	3.800±0.583	0.140±0.0431	3.800±0.374	0.144±0.048
Salti-khdari (3)	4.000±0.577	0.085±0.0177	4.33±0.667	0.104±0.043
Halawani (3)	4.667±0.667	0.096±0.028	4.667±0.333	0.093±0.017
Baitouni (2)	2.00±1.00	0.042±0.002	3.00±.000	0.086±0.0460
Jandali (2)	2.500±0.500	0.035±0.001	4.000±0.000	0.058±0.009
P value	0.116NS	0.111NS	0.070NS	0.430NS

*: n = number of replicates/cultivar

NS= Not significant at *P value* ≤ 0.05 (using Fisher's pairwise comparisons).

5.4 Discussion

Results of the present study show that, under the conventional control measures, local cultivars can be classified to three classes according to the % of infested clusters/plant that recorded just before start of harvesting as follow: high infestation on Shami (10.44%); Halawani (9.38%); Salti-Khdari (9.3%), medium on Ballouti (6.9%); Sultanina (6.6%), and Low on Jandali (4.7%); Baitouni (4.4%).

Thus, % of infested clusters on all cultivars under conventional control measures was higher than the threshold level (3%) that recommended by Ellis *et al.,* (2004). Therefore, an alternative control measures was needed to be investigated to keep the infestation by the grape berry moth below the accepted level.

Chapter Six:

Use of Pheromone as Mating Disruption Against Grape Berry Moth in Comparison with Chemical Control Measures in Al-Arroub Agricultural Secondary School Vineyard

Chapter Six: Use of Pheromone as Mating Disruption Against Grape Berry Moth in Comparison with Chemical Control Measures in Al-Arroub Agricultural Secondary School Vineyard

6.1 Objectives:

The objective of this experiment is to examine the uses of pheromone as mating disruption in comparison with chemical control measures against the grape berry moth.

6.2 Materials and Methods:

This experiment was designed in a complete randomized block design (Fig. 6.1), five treatments with four replicates were used, each replicate consist of four columns and three rows (4*3=12 plants / block).

This experiment included monthly application of five treatments:

A. Dizictol (Diazinon 25% a.i.).

B. Sherpaz (Cypermethrin 10% a.i.),

C. Dorpaz (Chlorpyriphos 47.9 % a.i),

D. Sex pheromone of *L. botrana* [(*E*,*Z*)-7,9-dodecadienyl acetate (*E*7,*Z*9-12:OAc)] used as mating disturbance treatment and

E. Control treatment (without spraying and without pheromone).

B B B B B **B** **B** B B B B B	E E E E E **E** **E** E E E E E	A A A A A **A** **A** A A A A A	D D D D D **D** **D** D D D D D	C C C C C **C** **C** C C C C C
E E E E E **E** **E** E E E E E	D D D D D **D** **D** D D D D D	A A A A A **A** **A** A A A A A	B B B B B **B** **B** B B B B B	C C C C C **C** **C** C C C C C
E E E E E **E** **E** E E E E E	B B B B B **B** **B** B B B B B	C C C C C **C** **C** C C C C C	A A A A A **A** **A** A A A A A	D D D D D **D** **D** D D D D D
C C C C C **C** **C** C C C C C	D D D D D **D** **D** D D D D D	B B B B B **B** **B** B B B B B	A A A A A **A** **A** A A A A A	E E E E E **E** **E** E E E E E

Fig 6.1: Design of experiment uses of pheromone as mating disruption in comparison with chemical control measures in Al-Arroub Agricultural Secondary School Vineyards No.1 during 2005 season (A: Diazinon, B: Cypermethrin, C: Chlorpyriphos, D: Pheromone, and E: Control treatment (without spraying and without pheromone).

The chemical characteristics of the used insecticides are presented in Table 6.1.

Table 6.1: Chemical insecticides used

Trade Name	Active Ingredient	Chemical Group	Dosage (Conc. %)	Tolerance level (ml/kg)	Safety Period (Days)
Sherpaz	Cypermethrin (10%)	Pyrethroid	0.1%	0.05	21
Dezictol	Diazinon (25%)	Org-phosphorous	0.3%	0.01	7
Dorpaz	Chlorpyriphos (47.9%)	Org. phosphorous	0.15%	0.01	7

The experiment started on 21st March 2005 when the first application of all treatments was done by spraying the chemical insecticides on their relevant blocks and hanging pheromone dispenser on each plant in the fourth treatment meanwhile blocks of the fifth treatment were left without spraying or pheromone.

Insecticide spraying and pheromone dispenser replacement were repeated monthly as shown in time schedule of the experiment (Table 6.2). Observations of insect infestation were done every two weeks started from 21st of March 2005. The middle two plants for each replicate were observed.

Table 6.2: Time schedule of insecticide spraying and pheromone dispenser replacement in Al-Arroub Agricultural Secondary School Vineyard No.1 during 2005 season

Research Activity	Date of Research Activity					
	March	April	May	June	July	August
Spraying of Insecticides	21st	26th	23rd	29th	30th	-
Pheromone Replacement	23rd	22nd	23rd	29th	27th	-
Collection of leaves for residue analysis	-	-	-	-	21st 28th	
Collection of clusters for residue analysis	-	-	-	-		21st

Weekly observations were done including the following parameters:

1. Number of clusters/tree,

2. Number of infested clusters/tree,
3. Number of berries/infested cluster and
4. Number of infested berries/infested cluster.

Observations were done on two plants that located in the middle of each block. However, 1st record of infestation occurred on 12th July 2005 and the last observation of infestation was recorded on 5th of August 2005 (just before start of harvesting) as shown in Table 6.2.

6.3 Results:

Results of this experiment show that first record of infestation occurred on 12th July 2005 on all treatments except cypermethrin treatment which was free from infestation till that date of observation.

Table 6.3: Mean number of infested clusters/grapevine plant at Al-Arroub Agricultural Secondary School Vineyard No.1 under various treatments. (Mean* ± S.E)

Treatments	Date of observation		
	12/7/05	**27/7/05**	**5/8/05**
Diazinon	0.143 ± 0.143	2.286 ± 0.474	2.429 ± 0.528
Cypermethrin	0.00 ±0.00	0.800 ± 0.374	1.20 ± 0.374
Chlorpyriphos	0.25 ± 0.25	0.375 ± 0.263	1.0 ± 0.327
Pheromone	0.375 ± 0.183	3.0± 0.463	3.375 ± 0.498
Control	0.167± 0.167	2.5± 1.02	2.833 ± 0.910
P value	0.731NS	0.006*	0.015*

***:** Means within columns with different letters significantly differ at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

NS= Not significant at *P value* ≤ 0.05 (using Fisher's Pairwise Comparisons)

However, results in Tables 6.3 and 6.4 show that start of infestation on 12th July was highest on pheromone treatments but those levels of infestation on various treatments were without significant differences at *P value* ≤ 0.05 (using Fisher's Pairwise comparisons).

In addition, results presented in Tables 6.3 and 6.4 show that, later on during the season, levels of infestation were with significant variations on the different treatments.

Table 6.4: Mean % of infested clusters/grapevine plant in Al-Arroub Agricultural Secondary School Vineyard No.1 under various control measures during 2005 season. (Mean* ± S.E)

Treatments	Date of observation		
	12/7/05	**27/7/05**	**5/8/05**
Diazinon	0.292 ± 0.292	6.12^{b} ± 2.09	6.42^{ab} ± 2.11
Cypermethrin	0.0 ± 0.0	2.21^{ab} ± 1.01	3.50^{a} ± 1.12
Chlorpyriphos	0.676 ± 0.676	0.94^{a} ± 0.69	2.67^{a} ± 0.92
Pheromone	0.802 ± 0.521	7.66^{b} ± 1.18	8.93^{b} ±1.75
Control	0.0078 ± 0.0078	6.82^{b} ± 2.63	10.53^{b} ± 2.24
P value	0.81NS	0.017*	0.036*

***:** Means within columns with different letters significantly differ at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

NS= Not significant at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

On 27th July, rate of infestation was significantly high (6-7%) on Pheromone, Diazinon and Control treatment; medium (2%) on Cypermethrin treatment and Low (<1%) on Chlorpyriphos treatment.

Furthermore, by the end of the season, on 5th August, rate of infestation was significantly highest on Control treatment (10.5%) followed by Pheromone treatment (8.9%); medium on Diazinon treatment (6.4%) and lowest infestation were on both Cypermethrin (3.55%) and Chlorpyriphos treatments (2.7%).

Results in Tables 6.5 and 6.6 show that same trend of effect of control measures was recorded on infestation in regard to number and % of infested berries/plant. Both number and % of infested berries/plant under the tested control measures were without significant differences on 12th July but with significant differences on later observations on 27th July and by the end of the season on 5th August.

Thus, results in Table 6.6 show that % of infested berries/plant were significantly low on both Cypermethrin and Chlorpyriphos treatments (0.8%); medium on both Diazinon and Control treatments and highest on Pheromone treatments (0.3%).

Table 6.5: Mean number of infested berries/grapevine plant in Al-Arroub Agricultural Secondary School Vineyard No.1 under various control measures during 2005 season. (Mean* ± S.E)

Treatments	Date of observation		
	12/7/05	**27/7/05**	**5/8/05**
Diazinon	0.143 ± 0.143	5.71± 1.15	6.43 ± 1.76
Cypermethrin	0.00 ± 0.00	1.600 ± 0.927	2.60 ± 0.927
Chlorpyriphos	0.750 ± 0.750	1.250 ± 0.996	3.37 ± 1.61
Pheromone	0.625 ± 0.324	8.0 ±1.60	10.5 ± 1.66
Control	0.50 ± .50	5.83 ± 3.06	7.17 ± 2.96
P value	0.793NS	0.027*	0.055*

***:** Means within columns with different letters significantly differ at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

NS= Not significant at *P value* ≤ 0.05 (using Fisher's Pairwise comparisons)

Table 6.6: Mean % of infested berries/grapevine plant in Al-Arroub Agricultural Secondary School Vineyard No.1 under various control measures during 2005 season. (Mean* ± S.E)

Treatments	Date of observation		
	12/7/05	**27/7/05**	**5/8/05**
Diazinon	0.002± 0.002	0.196^{b} ± 0.061	0.222^{ab} ± 0.078
Cypermethrin	0.0± 0.0	0.054^{a} ± 0.032	0.078^{a} ±- 0.032
Chlorpyriphos	0.016 ± 0.016	0.039^{a} ± 0.026	0.082^{a} ± 0.035
Pheromone	0.018 ± 0.010	0.199^{b} ± 0.028	0.272^{b} ± 0.045
Control	0.015 ± 0.015	0.145^{ab} ± 0.068	0.209^{ab} ± 0.064
P value	0.726NS	0.033*	0.05*

***:** Means within columns with different letters significantly differ at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

**: NS= Not significant at *P value* ≤ 0.05 (using Fisher's pairwise comparisons)

6.4 Discussion

Results of the present study show that the lowest level of infestation was recorded on both Cypermethrin and Chloropyriphos treatments which was with 3% of infested clusters/plant, meanwhile, level of infestation was medium on Diazinon treatment with 6.4% of infested clusters/plant and high on both pheromone and chick treatments with % of infested clusters/plant of 8.9 and 10.5 respectively.

Using of pheromone as mating disruption against ***L. botrana*** was without significant effect, and upon time for harvesting, level of infestation on pheromone treatments was as high as that on the control treatment. These results were in agreement with several studies don on using pheromone as mating disruption against *L. botrana* (Rubin, 1998; Wysoki, 1998; Louis & Schirra, 2001; Trimble *et al.,* 2003*;* Moschos *et al.,* 2004).

Rubin (1998) reported that no marked difference were found between pheromone treated and insecticide treated plots; in addition, Louis and Schirra, (2001), found that mating disruption technique can be used to effectively control *L. botrana* at low population densities but the technique was not as effective as at high population densities. Thus it was concluded that, a combined treatment of pheromone plus insecticides has to be repeated to reduce population densities to a lower level where mating disruption might perform effectively (Louis & Schirra, 2001; Trimble *et* *al.,* 2003). In addition, Moschos *et al.,* (2004), concluded that pheromone traps is necessary for constant monitoring of moth populations and that help for timely plan supplementary chemical treatments which eventually will be needed during the season. Furthermore, Wysoki (1998), recommended that principal benefit of pheromone is to effectively monitor the flight activity of the grape berry moth and that help in reducing the amount of insecticides applied, while maintaining acceptable insect control.

Chapter Seven:

Effect of Rate of Application of Pheromone as Mating Disruption on the Seasonal Abundance of Infestation of Grape Berry moth, *L. botrana* in Al-Arroub Agricultural Secondary School Vineyard

Chapter Seven: Effect of Rate of Application of Pheromone as Mating Disruption on the Seasonal Abundance of Infestation of Grape Berry moth, *L. botrana* in Al-Arroub Agricultural Secondary School Vineyard

7.1 Objectives:

The objective of this experiment is to examine the effect of rate of pheromone used as mating disruption on the rate of infestation of grape berry moth.

7.2 Materials and Methods:

The experiment was designed in a complete randomized block design. The vineyard was divided into 10 blocks, each block consist of three columns and 5 rows as shown in Fig 7.1.

A	**A**	**A**	**A**	**A**	**A**	B	**B**	B	B	**B**	B	**A**	**A**	**A**
A	**A**	**A**	**A**	**A**	**A**	B	**B**	B	B	**B**	B	**A**	**A**	**A**
A	**A**	**A**	**A**	**A**	**A**	B	**B**	B	B	**B**	B	**A**	**A**	**A**
A	**A**	**A**	**A**	**A**	**A**	B	**B**	B	B	B	B	**A**	**A**	**A**
A	**A**	**A**	A	A	A	B	**B**	B	B	**B**	B	**A**	**A**	**A**
B	**B**	B	B	**B**	B	**A**	**A**	**A**	**A**	**A**	**A**	B	**B**	B
B	**B**	B	B	**B**	B	**A**	**A**	**A**	**A**	**A**	**A**	B	**B**	B
B	**B**	B	B	**B**	B	**A**	**A**	**A**	**A**	**A**	**A**	B	**B**	B
B	**B**	B	B	**B**	B	**A**	**A**	**A**	**A**	**A**	**A**	B	**B**	B
B	**B**	B	B	**B**	B	**A**	**A**	**A**	**A**	**A**	**A**	B	**B**	B

Fig 7.1: Design of uses of two rates of pheromone as mating disturbance against L. botrana in Al-Arroub Agricultural Secondary School Vineyards No.2, during 2005 season (A: with one pheromone dispenser/plant on all plants of the replicate, B: with one pheromone dispenser/plant only on plants of the middle column of the replicate)

Two treatments with five replicates were used, each replicate consist of three columns and five rows (3*5=15 plants / block).

The experiment started on 23rd March 2005 when the first application of the pheromones was done by hanging one pheromone dispensers on each plant in the first treatment meanwhile pheromone dispenser was hanged only on the plants of the middle column for the second treatment.

Pheromone dispensers were replaced monthly. Observations for infestation were done weekly, however, 1st record of infestation occurred on 12th July 2005 and the last observation of infestation was recorded just before start of harvesting on 4th of August 2005 as shown in Table 7.1.

Table 7.1: Time schedule of application of two rates of pheromone as mating disruption against *L. botrana*, in Al-Arroub Agricultural Secondary School Vineyards No.2, during 2005 season.

	March	April	May	June	July	August
Pheromones replacement	23rd	26th	23rd	29th	30th	-
Record of Infestation	-	-	-	-	12th 27th	4th

Weekly observations included the following parameters:

1. Number of clusters/tree,
2. Number of infested clusters/tree,
3. Number of berries/infested cluster and
4. Number of infested berries/infested cluster.

Observations were done on all plant that located in the middle column of each block.

7.3 Results:

Table 7.2 shows that start of infestation with ***L. botrana*** recorded on 12th July and was much greater on pheromone treatments than that on the control treatment. Two weeks later, on 27th July, the mean number of infested clusters/plant of the control treatment exceeded that of the pheromone treatments and later on at the end of the season (just before harvesting), the mean number of infested clusters/plant were approximately equal on the three treatments.

However, statistical analysis shows that no significant differences were recorded between the three treatments. Thus, results of this experiment shows that, the rate of pheromone used as mating disruption was without significant effect on the rate of infestation of ***L. botrana*** in comparison to control treatment where no control measures where used.

Table 7.2: Mean No. of infested clusters/plant under two levels of pheromone mating disruption treatments (Mean No. of infested clusters/plant ± S.E)

	Date of observation		
Control Measure	12/7/05	27/7/05	4/8/05
A*	0.65 ± 0.21	1.90 ± 0.33	2.30 ± 0.40
B**	0.57 ± 0.18	1.52 ± 0.31	2.24 ± 0.33
Control	0.17 ± 0.17	2.50 ± 1.02	2.83 ± 0.91
P value*	0.462NS	0.410NS	0.755NS

*: A= with one pheromone dispenser/plant on all plants of the replicate,

**: B= with one pheromone dispenser/plant only on plants of the middle column of the replicate)

***: NS= Not significant at *P value* ≤ 0.05 (using Fisher's Pairwise Comparisons)

Table 7.3 also show that, the rate of infestation expressed as % of infested clusters/plant recorded on 12th July 2005 was with higher values on pheromone treatments than that on the control treatment; in addition, % of infested clusters/plant recorded on 27th July was approximately similar at pheromone treatments as well as on control treatment; however, at the end of the season, the % of infested clusters/plant recorded on 5th August (just before harvesting), was with higher values on the control treatment (10.53%) than that on the pheromone treatments (7.3%).

Table 7.3: Mean % of infested clusters/plant under two levels of pheromone mating disruption treatments (Mean % of infested clusters/plant ± S.E).

Control Measure	Date of observation 12/7/05	27/7/05	5/8/05
A*	2.024 ± 0.721	6.12 ± 1.22	7.36 ± 1.46
B**	2.074 ± 0.666	5.24 ± 1.23	7.53 ± 1.24
Control	0.521 ± 0.521	6.82 ± 2.63	10.53 ± 3.24
P value*	0.508NS	0.795NS	0.542NS

*: A= with one pheromone dispenser/plant on all plants of the replicate,

**: B= with one pheromone dispenser/plant only on plants of the middle column of the replicate)

***: NS= Not significant at *P value* ≤ 0.05 (using Fisher's Pairwise Comparisons)

Statistical analysis of the results presented in Table 7.3 show that no significant differences were found between the three treatments at *P value* 0.05%. Thus results show that the rate of pheromone application as mating disruption was without significant effect on the % of infested clusters/plant.

Results in Table 7.4 and Table 7.5 also show that rate of pheromone application was without significant effect on the grades of infestation presented either as number of infested berries/plant or as % of infested berries/plant at *P value* 0.05%.

Table 7.4: Mean No. of infested berries/plant under two levels of pheromone mating disruption treatments (Mean No. of infested berries/plant ± S.E).

Control Measure	Date of observation 12/7/05	27/7/05	5/8/05
A*	1.65 ± 0.646	5.35 ± 1.12	7.2 ± 1.45
B**	1.143 ± 0.392	4.476 ± 0.997	6.71 ± 1.12
Control	0.500 ± 0.500	5.83 ± 3.06	7.17 ± 2.96
P value*	0.529NS	0.794NS	0.964NS

*: A= with one pheromone dispenser/plant on all plants of the replicate,

**: B= with one pheromone dispenser/plant only on plants of the middle column of the replicate)

***: NS= Not significant at *P value* ≤ 0.05 (using Fisher's Pairwise Comparisons)

Table 7.5: Mean % of infested berries/plant under two levels of pheromone mating disruption treatments. (Mean % of infested berries/plant ± S.E).

Control Measure	Date of observation 12/7/05	27/7/05	5/8/05
A*	0.0438 ± 0.0177	0.136 ± 0.0302	0.185 ± 0.0403
B**	0.0333 ± 0.119	0.108 ± 0.0258	0.171 ± 0.037
Control	0.0153 ± 0.0153	0.145 ± 0.0676	0.2095 ± 0.0635
P value*	0.632NS	0.735NS	0.888NS

*: A= with one pheromone dispenser/plant on all plants of the replicate,

**: B= with one pheromone dispenser/plant only on plants of the middle column of the replicate)

***: NS= Not significant at *P value* ≤ 0.05 (using Fisher's Pairwise Comparisons)

7.4 Discussion

Results of the present study show that level of infestation of grape berry moth was not affected by the rate of sex pheromone used as mating disruption. Thus, using one pheromone dispenser/plant in the middle line of each plot (that consisted of three lines) was without significant differences from the other treatment where one pheromone dispenser was used/plant of all lines in the plot.

Therefore, it is recommended to use the second pheromone treatment as mating disruption, i.e., one pheromone dispenser per each third plant.

Chapter Eight:

Traces of Residue of Three Chemical Insecticides in Leaves and Fruits of Grapevine

Chapter Eight: Traces of Residue of Three Chemical Insecticides in Leaves and Fruits of Grapevine

8.1 Objectives:

The objective of this experiment is to detect the residue level of chemical insecticides in the 4^{th} experiment.

8.2 Materials and Methods:

For the purpose of residue analysis of the insecticides used in the experiment conducted for the comparison between insecticides and pheromone mating disruption treatment in Al-Arroub Agricultural Secondary School vineyards No.1 (Chapter 7), four samples of plant leaves and fruits per each insecticidal treatment (about one kg/each sample) were collected and sent to Bachtochem Laboratory to detect the residual levels of the traces of these chemicals.

Samples of leaves were collected after the third and fourth weeks of spraying after the end of recommended safety period (on 21^{st} and 28^{th} July 2005), but that for fruits analysis was collected after the third week of the last date of spraying (i.e., after the end of recommended safety period), just before start of harvesting (on 21^{st} August 2005).

Residue analysis was done in Bachtochem Laboratory for the residual levels of the traces of the three insecticides, Diazinon, Cypermethrin and Chlorpyriphos, using gas chromatography.

8.3 Results:

Results in Table 8.1 show that, after 21 days from spraying by Diazinon; Cypermethrin or Chlorpyriphos, the traces of residue in leaves of grapevine that was sprayed with these insecticides were 0.135; 2.827; 0.255 ppm respectively. Later on, after 28 days of spraying, the traces of residue in leaves were 0.015; 0.91; 0.177 respectively.

Table 8.1: Mean residue of three insecticides applied against *L. botrana* on grapevine plants sampled 21 and 28 days after the last application.

Insecticide	Mean (ppm) ± S.E After 21 days		Mean (ppm) ± S.E After 28 days	Tolerance level (ppm)	Safety period (days)
	Fruits	Leaves	Leaves		
Diazinon	0.02±0.0	0.135±0.17	0.015±0.03	**0.01**	**7**
Cypermethrin	1.015±0.96	2.83±1.85	0.91±0.92	**0.05**	**21**
Chlorpyriphos	0.18±0.26	0.255±0.12	0.177±0.11	**0.01**	**7**

Thus, traces of residue of the three insecticides that recorded in grapevine leaves were much higher than the acceptable level (tolerance level) of these insecticides which is recommended by international organizations as 0.01 ppm for Diazinon; 0.05 ppm for Cypermethrin and 0.01 ppm for Chloropyriphos. However, the safety period that is recommended by the manufacturers for these chemicals (Mekhtashem) on grapevine is 7 days for both Diazinon and Chlorpyriphos and 21 days for the Cypermethrin.

Furthermore, the traces of residue found in grapevine fruits, at 21 days after the last spraying, just before start harvesting, were 0.02 ppm for the Diazinon; 1.015 ppm for Cypermethrin and 0.18 ppm for Chloropyriphos. Thus, traces of residue of the these insecticides in fruits, upon harvesting were much higher than the tolerance level even after the safety period that was recommended to be taken in consideration before harvesting from vineyards sprayed by those insecticides.

Results also show that at 21 days after spraying with these insecticides, the traces of residue in fruits were lower than that detected in leaves after the same period.

8.4 Discussion

Results of the present study show that traces of residue of Diazinon, Cypermethrin and Chloropyriphos in leave as well as in fruits were higher than the tolerance levels even after the safety period of those insecticides. Results also show that residue of the three used insecticides traced in grape leaves were higher than that in fruits. Thus, it is concluded that, both fruits and leaves are not safe to be used as food for human even after the safety period recommended for those insecticides.

Therefore, precautions have to be taken in consideration before marketing the grape product for fresh use. In addition, people in Palestine used to collect young grape leaves to be used for a public food known as grape leaf rolls. Those leaves used for such cooking are always not more that two weeks age. Therefore, precautions have to be taken in consideration so as not to collect grape leaves from sprayed plants.

CONCLUSIONS

1. For two years of study (2005-2006), infestation with grape berry moth was not recorded in the southern highlands of west bank until the beginning of July.

2. Under conventional control measures, local cultivars can be classified to three classes according to level of infestation by grape berry moth as follow: high infestation on Shami, Halawani, Salti-Khdari and; medum on Ballouti and Sultanina and Low on Jandali and Baitouni.

3. Pheromone treatments show no significant effect on the rate of infestation of *L. botrana* on grapevine cultivars, and by the end of the season and upon time for harvesting, rate of infestation on pheromone treatments were as high as that of the control treatment where no chemical were used.

4. Lowest rate of infestation were recorded on both Cypermethrin and Chloropyriphos treatments which were with 3% of infested clusters/plant.

5. Residues of Diazinon, Cypermethrin and Chlorpyriphos in grape vine fruits and leaves were higher than the tolerance levels even after the safety period of those insecticides.

RECOMMENDATIONS

1. There is no need for any chemical control measures against the grape berry moth in the southern highlands of west bank until the beginning of July.

2. Precautions to be taken in consideration for detecting the residues of the insecticides before using of the edible grape fruits that are freshly marketed and before collection of grape leaves that used for preparation of the grape leaf roll meal.

3. Sex pheromone traps can be used effectively to monitor the flight activity of the grape berry moth.

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بسم الله الرحمن الرحيم

Abstract in Arabic

دراسة حقلية حول بيولوجيا و بيئة ومكافحة عثة قطوف العنب(*Lobesia Botrana*) في محطة العروب الزراعية، فلسطين

الملخص باللغة العربية:

يعتبر العنب من أهم أشجار الفاكهة المزروعة في فلسطين حشرة عثة قطوف العنب تعتبر من الحشرات الرئيسية التي تنتشر في منطقة حوض البحر الأبيض المتوسط. هدفت الدراسة إلى رصد طيران و تواجد الإصابة على أصناف العنب المزروعة في محطة العروب الزراعية في منطقة الخليل خلال العامين 2004 و2005 بالإضافة إلى دراسة استخدام الفيرومون كعامل تشويش على التزاوج بالمقارنة مع المبيدات المستخدمة في مكافحة عثة القطوف.

أظهرت النتائج أن طيران عثة القطوف السنوي يبدأ من بداية شهر نيسان ويمتد إلى نهاية شهر كانون أول بمعدل أربعة قمم لنشاط الطيران سجلت خلال اشهر نيسان، أيار،– تشرين أول و كانون أول.

وجد أن الأصناف حلواني، شامي، و سلطي خضاري هي أكثر الأصناف مفضلة للحشرة عند بداية الإصابة، أما في نهاية الموسم وقبل قطف المحصول فقد وجد أن مستوى الإصابة تجاوز الحد الاقتصادي الحرج (5% من القطوف) على جميع الأصناف الموجودة في الحقل

كما أظهرت النتائج أن استخدام الفيرومون كان بدون تأثير معنوي على نسبة الإصابة ،وان كلا من مبيدات السيبرمثرين و الكلوروبيريفوس كانت ذات تأثير معنوي في خفض نسبة الإصابة.كما

وجد أن متبقيات السمية للديازينون و السيبرمثرين والكلوروبيريفوس في الأوراق والثمار كانت أعلى من الحد المسموح به حتى بعد فترة الأمان الموصى بها لهذه المبيدات .

لهذا نوصى بعدم استخدام أوراق العنب من الحقول المعالجة بالمبيدات في إعداد وجبات الطعام للإنسان ، كما نوصى بتحليل مستوى السمية في عناقيد العنب قبل عملية القطف للتأكد من أن نسبة السمية اقل من الحد المسموح به.

أخيرا نوصي باستخدام الفيرومون كوسيلة فعالة لمراقبة نشاط طيران حشرة عثة القطوف من اجل خفض استخدام المبيدات لمكافحة الحشرة.