Population Dynamics of Arthropod Pests on Grapevine and Chemical Control of the Grape Berry Moth *Lobesia botrana* Schiff. (Lep., Tortricidae) in Jerash Area, Jordan

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ABSTRACT

Grapevine, *Vitis vinifera* L. is infested by several pests in Jordan, especially grape berry moth, *Lobesia botrana* Schiff. (Lep., Tortricidae), which inflicts heavy losses to the crop. Therefore, population dynamics of arthropod pests were studied on grapevine in 1995 and 1996 seasons in Jerash area. Also, four insecticides were tested to control *L. botrana*.

The results indicated that *L. botrana* attacked grapevine during the whole season. The insect has four generations a year, where the second and third ones are the important on grapevine; therefore, it is considered a key pest. Leafhopper, *Empoasca lybica* and eriophid mite, *Eriophyes vitis* found in large numbers, so that, they are considered potential pests. Aphid, *Aphis gossypii*; thrips, *Thrips tabaci* and black vine thrips, *Retithrips syriacus* were present in small numbers, therefore, they are considered non-significant pests. Also, the results showed that all the tested insecticides significantly reduced the infestation by *L. botrana*.

KEYWORDS: Arthropod pests, chemical control, grape berry moth, grapevine, *Lobesia botrana*, population dynamics.

1. INTRODUCTION

Grapevine, *Vitis vinifera* L. is one of the most widely planted fruit crop in the world. It grows from temperate to tropical regions, but most vineyards are planted in areas with temperate climate (Pearson and Goheen, 1988). In Jordan, grapevine is considered one of the most grown fruit crops.

The grape berry moth, *Lobesia botrana* Schiff. (Lep., Tortricidae) attacks grapevine in Europe, North Africa and West Asia (Roehrich and Boller, 1991). In Jordan, grapevines are infested by several arthropod pests, especially *L. botrana* (Haddadin, 1990), which inflicts heavy losses to the crop. Farmers in Jordan depend entirely on the use of chemical pesticides to control arthropod pests. This situation may create problems in pest control and to human health as well as environment. Therefore, due to these problems, man started to look for new control programs where he finally focused on Integrated Pest Management (IPM) (Falcon and Smith, 1973). However, many people erroneously understand that IPM means the use of non-chemical control

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measures. If used correctly, and despite of their side effects, pesticides remain an important component of IPM (Stern et al., 1959). The concept of IPM depends on several components, among these, understands the agro-ecosystem (Metcalf and Luckmann, 1975).

Arthropod pests and plants are major biotic elements of the agro-ecosystem. In addition, changes in weather conditions can be either helpful or harmful to pests' population, and understanding of such factors will contribute markedly to a successful IPM program (Frisbie, 1984). Therefore, in the present study, data were taken on population dynamics of arthropod pests in relation to phases of grapevine growth and development. Also, four synthetic insecticides were evaluated for controlling *L. botrana*. Finally, it is hoped that this work will help in laying the foundation for IPM program of grapevine in the future.

2. MATERIALS AND METHODS

The study was conducted in a vineyard in Um-Btaimah village (10 km North East of Jerash city). Hundred and fifty, 10-year-old, vines of Salti cultivar were used in this work. The vines were under rainfed conditions, and without any addition of fertilizers. The study was carried out during 1995 and 1996 growing seasons for all the pest species, except *L. botrana* adults, which was set up during 1996 season only.

In order to investigate the population dynamics of *L. botrana*, two sex pheromone traps were installed in the vineyard between January 1, 1996 and December 30, 1996. The trap is made of weatherproof cardboard with a changeable plate lined with adhesive substance, and open into a triangle shaped tunnel (Gabel and Renczes, 1985). The pheromone (E, Z-7, 9-dodecadienyl acetate) (El-Sayed et al., 2000) was dispensed from a polyethylene dispenser containing 1 mg of the pheromone. The pheromone dispensers were replaced in the traps every 21-30 days. The traps were suspended on poles 120 cm above ground (Gabel and Renczes, 1985). The numbers of male moths caught in the traps were counted weekly. In addition, to determine the starting time of the infestation by *L. botrana* larvae, 50 bunches were selected randomly in the field and were monitored visually twice a week till harvesting time. The period of activity of *L. botrana* larvae was determined depending on the point of entrance on the skin of the berries, which is surrounded by a patch of reddish skin and has lived larvae inside the berries of the selected bunches.

To study the population dynamics of other arthropod pests, sample of 30 leaves were randomly collected from different sites of the grapevine trees twice a week in 1995 and 1996 growing seasons. The collected leaves were placed in plastic bags, and then taken to the laboratory. All moving stages of leafhopper, *Empoasca lybica* Berg.; aphid, *Aphis gossypii* Glover; thrips, *Thrips tabaci* Lind. and black vine thrips, *Retithrips syriacus* Mayet found on both sides of each leaf were counted by a Binocular Microscope. For eriophid mite, *Eriophyes vitis* Pgst., the number of galls on each leaf was counted.

The annual cycle of grapevine growth and development may be divided into three periods. The first of these is prior to fruit set period, which occurs between bud burst and fruit set, where vegetative growth dominates. The second period is that of fruit growth and development, which begins with fruit set and continues until harvest. The third period is that of post harvest, which starts after fruit picking until leaves defoliation. Therefore, the different phases of annual cycle of grapevine were recorded during both growing seasons. Records of temperature and relative humidity were obtained from the meteorological station at the Jordan University of Science and Technology (16 km North of the experimental site).

Four insecticides, Malathion® (malathion, Organophosphorus (OP)), Perfekthion® (dimethoate, OP), Karate® (lambda-cyhalothrin, Synthetic Pyrethroid

(SP)) and Cymbush® (cypermethrin, SP) (Worthing and Walker, 1987) were evaluated for controlling *L. botrana*. They were used at the concentration recommended by the manufacturer, i. e., 35 ml/20 L, 25 ml/20 L, 9 ml/20 L and 8 ml/20 L, respectively. The quantity (ml) of recommended concentrations of the four used insecticides, was non-active ingredients in the formulation. Each treatment comprised three vines, replicated four times. In addition, a control treatment using water only was set up. In order to prevent spray drift of the insecticides, the treated vines were at least 10 m far from each other. The vines were sprayed twice by a knapsack sprayer. The first application was carried out on June 12, 1996, and the second one on July 16, 1996. Time of applications depended on the period of activity of *L. botrana* larvae in 1995 growing season and the number of *L. botrana* adult males caught by the sex pheromone traps in 1996 growing season. Data were taken at three days, one week, two weeks and one month after spraying. A total of 24 bunches/treatment were randomly examined to determine the percentage of infested bunches at a rate of 2 bunches/vine. One bunch per vine was randomly examined to determine the percentage of infested berries (12 bunches/treatment). Bunches and berries are considered infested if there is one or more larvae (live) per bunch or berry. Data were analyzed by using the Statistical Analysis System (SAS Institute, 1996) based on Duncan's Multiple Range Test as a Randomized Complete Block Design.

3. RESULTS

3.1 Population dynamics of arthropod pests

3.1.1 Grape berry moth, *Lobesia botrana*

The average weekly numbers of male *L. botrana* per trap in 1996 season are represented in Figure (2). The moths started in early March, and the numbers increased and reached a peak in early April. The numbers fluctuated until a second peak was reached in early June. The numbers then increased sharply and reached a third peak in mid July. Thereafter, they fluctuated in low numbers, and reached a fourth peak in late September. Then the numbers decreased sharply until no moths were found in late November.

3.1.2 Other arthropod pests

The leafhopper, *E. lybica* was found in the vineyard from April until mid October in 1995 growing season (Fig. 1). The insect appeared in early April and continued in low numbers until early May. Thereafter, the numbers increased until early June, and fluctuated until early July. Then they increased sharply, and a peak was reached in mid July. Hereafter, numbers decreased until mid August, and after that increased again until end of August. Thereafter, the numbers continued to decrease until they terminated in mid October. In 1996 growing season (Fig. 2), the insect appeared in late April, and started to increase gradually and a peak was reached in early June. Then numbers started to decrease until early July. Hereafter, they increased sharply, and a second peak was reached in late July, then started to decrease until the end of October.

(Figures 1 and 2) show the population dynamics of the eriophid mite, *E. vitis* in 1995 and 1996 growing seasons, respectively. In 1995, convexities (galls) appeared in mid June and started to increase gradually until mid August. Hereafter, the numbers increased sharply and a peak was reached in late September, then numbers decreased until late October. In 1996, convexities appeared on grape leaves mid April, and then the numbers increased sharply and reached a peak in late May. Thereafter, they fluctuated and increased gradually until a second peak reached in early October, then decreased gradually until early November.

The aphid, *A. gossypii* occurred in low numbers in 1995 and 1996 growing seasons (Figs. 1 and 2). In 1995, the insect appeared from mid March to end May. While in 1996, it appeared from mid April to end May. The thrips, *T. tabaci* appeared in 1995 in mid April, started to increase, and reached a peak in late May. The numbers then decreased sharply and terminated in early June (Fig. 1). In 1996 as Figure (2) indicates, the insect appeared in mid April, and then increased gradually and then sharply until a peak was reached end May, and the numbers terminated in late June. The black vine thrips, *R. syriacus* appeared in the vineyard in very small numbers in 1996 season only. It appeared late in the growing season in mid July, then the numbers fluctuated until no thrips were found late September (Fig. 2).

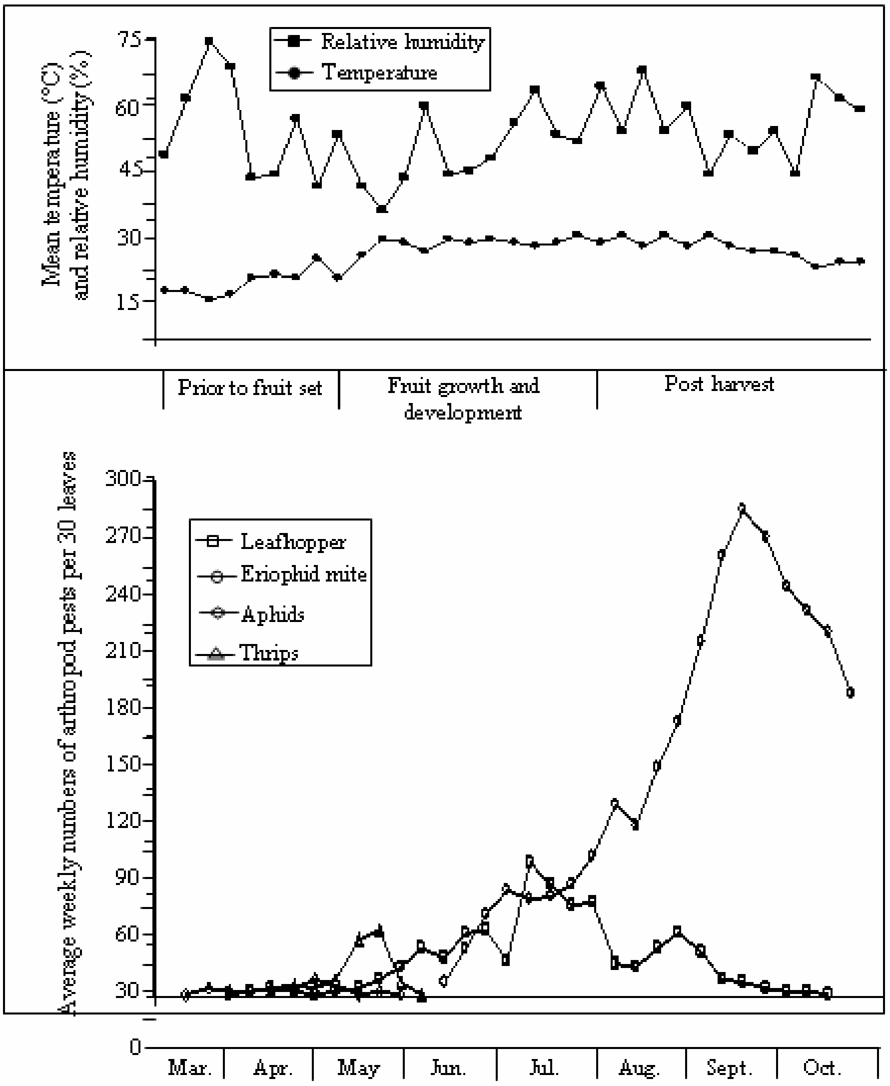

Fig. 1. Population dynamics of various arthropod pests and number of convexities of eriophid mite on grapevine (Salti cultivar) in Um-Btaimah, Jerash in 1995 growing season.

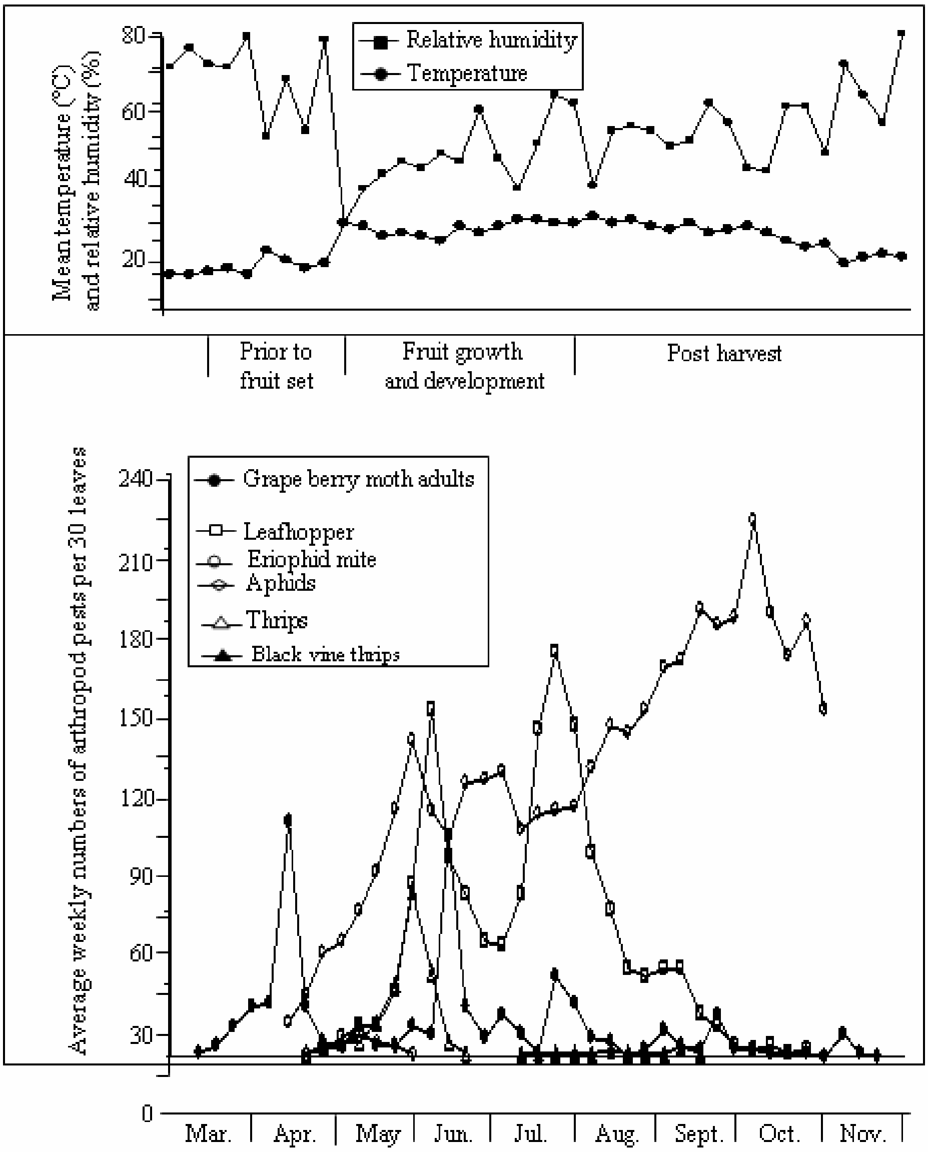

Fig. 2. Population dynamics of various arthropod pests and number of convexities of eriophid mite on grapevine (Salti cultivar) in Um-Btaimah, Jerash in 1996 growing season.

3.2 Phases of plant growth and development in relation to patterns of pest problems

This refers to the chronology of various pests according to phases of growth and development of grapevine. In 1995 growing season and as figure 3 indicates that aphid, leafhopper and thrips were found during prior to fruit set period. Eriophid mite and grape berry moth larvae were present in addition to the three previously mentioned pests in fruit growth and development period. At post harvest period, the pests found were leafhopper and eriophid mite. In 1996 growing season and as figure 4 shows that grape berry moth adults, eriophid mite, aphid, thrips and leafhopper were present during prior to fruit set period. Grape berry moth larvae and black vine thrips were present in addition to the five above-mentioned pests in fruit growth and development period. At post harvest period, the pests present were grape berry moth adult, eriophid mite, leafhopper and black vine thrips.

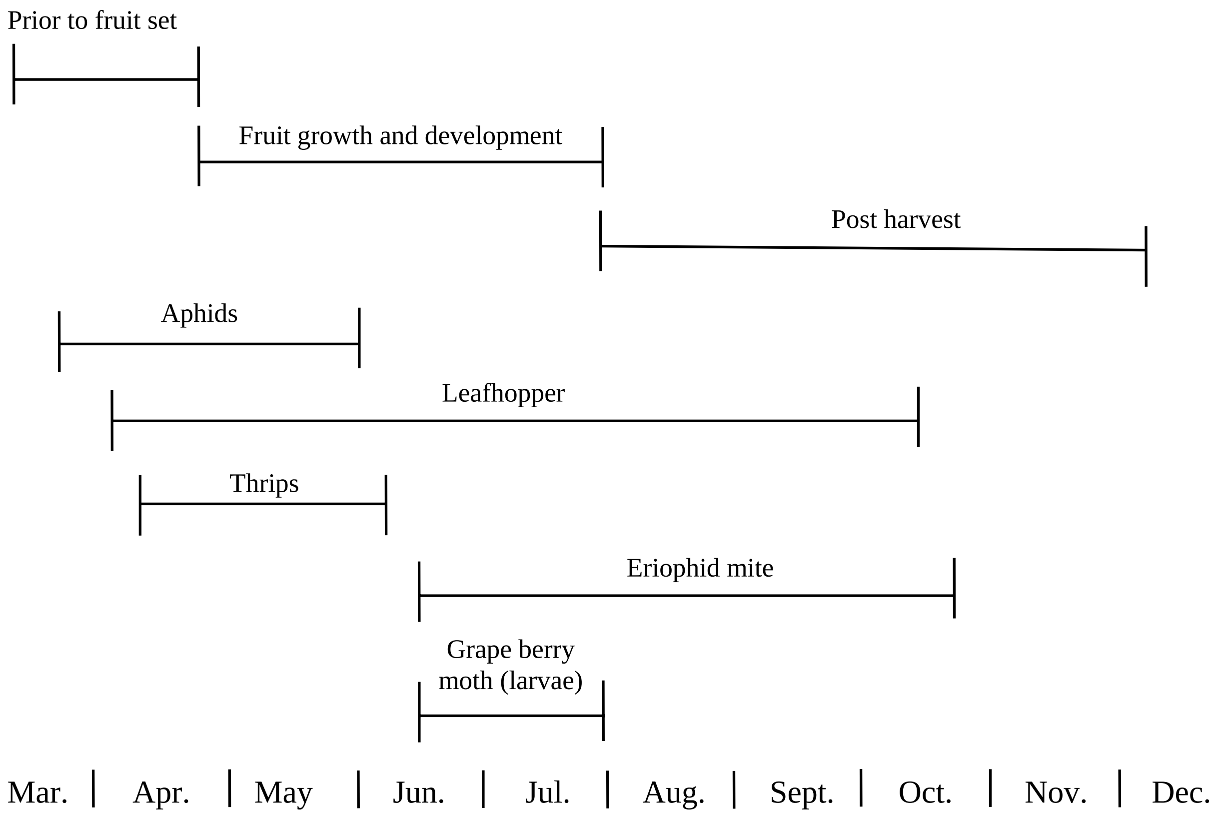

Fig. 3. General periods of growth and development of grapevine (Salti cultivar) and periods of activity of arthropod pests in Um-Btaimah, Jerash in 1995 growing season.

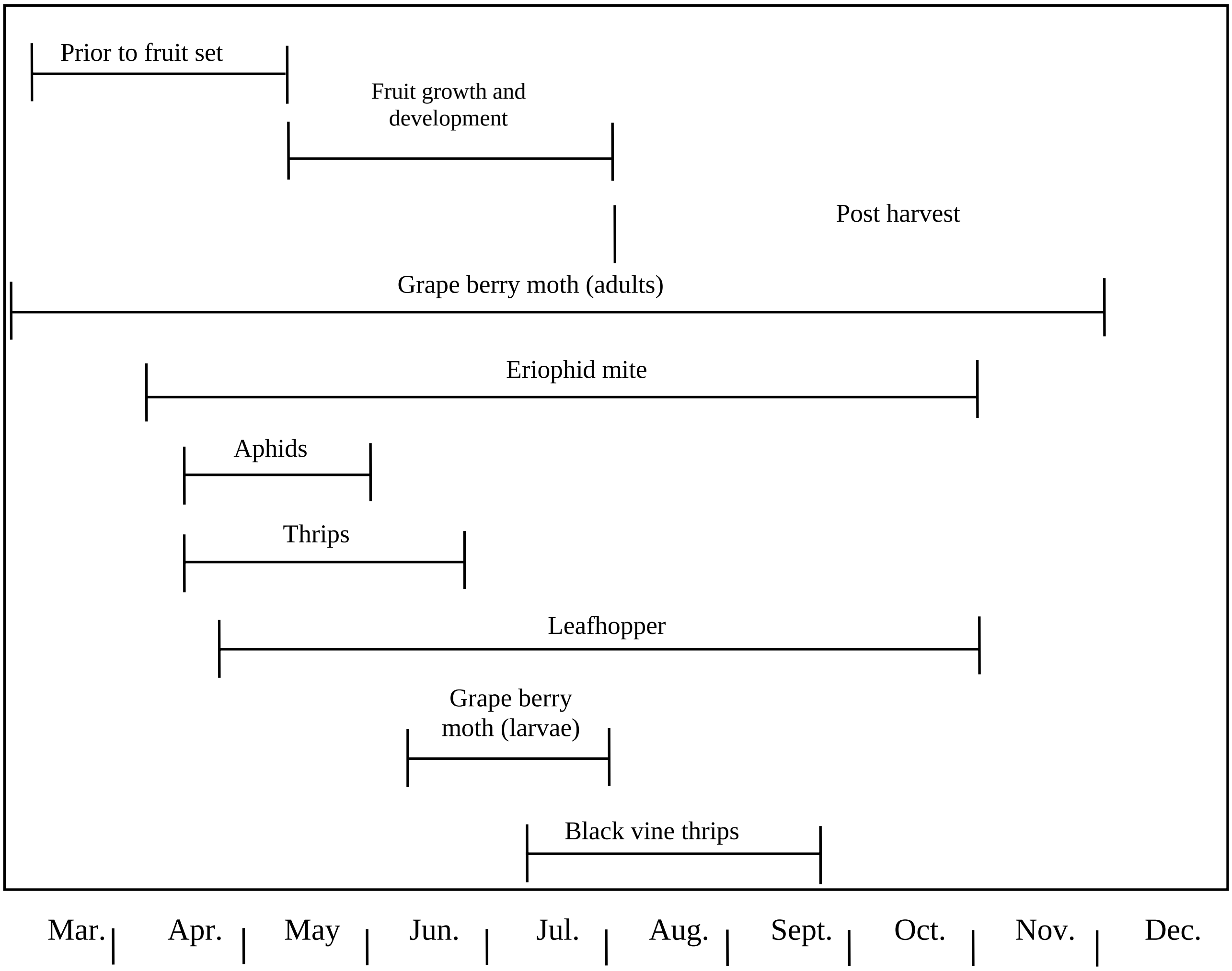

Fig. 4. General periods of growth and development of grapevine (Salti cultivar) and periods of activity of arthropod pests in Um-Btaimah, Jerash in 1996 growing season.

3.3 Chemical Control

The results of the first application of insecticides to control the grape berry moth (bunches) presented in table 1 show that after three days, one week and two weeks of application, all insecticides tested showed no significant differences from the control. While, after one month of application, the infestation was significantly reduced when compared with the control for all the tested insecticides. The results of the first application of insecticides to control *L. botrana* (berries) presented in Table (2) indicate that after three days and one week of application, all insecticides showed no significant differences compared to the control. While, after two weeks and one month, the infestation of the berries was significantly reduced for all the tested insecticides.

The results of the second application of insecticides to control *L. botrana* (bunches) presented in Table (3) indicate that after three days, one week and two weeks of application, all the tested insecticides resulted in significantly reduction in the pest infestation. As for the second application of insecticides to control the grape berry moth (berries) presented in Table (4) indicates that after three days, one week and two weeks of application, the infestation was significantly reduced than the control for all the tested insecticides.

Table(1): Results of the first application of insecticides to control the grape berry moth (bunches).

Insecticides and formulation	**Rate per 20 liters (ml)**	**Means percent infested bunches ± SE after different periods of insecticides' application**			
		Three days	**One week**	**Two weeks**	**One month**
Perfekthion 40% E.C.* (Dimethoate)	25	25.0±9.7 a	29.2±9.7 a	29.2±11.5 a	33.3±11.2 ab
Karate 5% E.C. (Lambda-Cyhalothrin)	9	29.2±7.4 a	29.2±11.5 a	33.3±11.2 a	33.3±9.4 ab
Cymbush 10% E.C. (Cypermethrin)	8	25.0±9.7 a	25.0±7.5 a	20.8±7.4 a	25.0±7.5 b
Malathion 50% E.C.	35	25.0±7.5 a	41.7±12.1 a	37.5±10.9 a	41.7±12.1 ab
Control	--	37.5±10.9 a	50.0±10.7 a	50.0±8.7 a	62.5±10.9 a

Means in columns with different letters are significantly different at 5% probability level (Duncan's Multiple Range Test).
* Emulsifiable Concentrate.

Table(2): Results of the first application of insecticides to control the grape berry moth (berries).

Insecticides and formulation	**Rate per 20 liters (ml)**	**Means percent infested berries ± SE after different periods of insecticides' application**			
		Three days	**One week**	**Two weeks**	**One month**
Perfekthion 40% E.C.* (Dimethoate)	25	1.7±0.7 a	2.0±0.7 a	2.3±1.1 ab	3.1±1.3 ab
Karate 5% E.C. (Lambda-Cyhalothrin)	9	1.2±0.5 a	1.5±0.7 a	1.4±0.5 ab	1.7±0.5 b
Cymbush 10% E.C. (Cypermethrin)	8	0.8±0.3 a	1.2±0.4 a	0.9±0.4 b	1.3±0.5 b
Malathion 50% E.C.	35	1.3±0.5 a	1.7±0.5 a	2.6±1.0 ab	3.1±1.0 ab
Control	--	2.3±0.8 a	2.9±0.7 a	3.7±0.8 a	5.2±1.0 a

Means in columns with different letters are significantly different at 5% probability level (Duncan's Multiple Range Test).
* Emulsifiable Concentrate.

Table (3): Results of the second application of insecticides to control the grape berry moth (bunches).

Insecticides and formulation	Rate per 20 liters (ml)	Means percent infested bunches ± SE after different periods of insecticides' application		
		Three days	One week	Two weeks
Perfekthion 40% E.C.* (Dimethoate)	25	37.5±10.9 ab	41.7±12.1 ab	41.7±12.1 ab
Karate 5% E.C. (Lambda-Cyhalothrin)	9	37.5±10.9 ab	37.5±12.5 b	41.7±10.4 ab
Cymbush 10% E.C. (Cypermethrin)	8	29.2±11.4 b	33.3±11.2 b	33.3±11.2 b
Malathion 50% E.C.	35	50.0±10.7 ab	50.0±13.7 ab	54.3±13.0 ab
Control	--	70.8±11.5 a	75.0±09.7 a	75.0±09.7 a

Means in columns with different letters are significantly different at 5% probability level (Duncan's Multiple Range Test).

* Emulsifiable Concentrate.

Table(4): Results of the second application of insecticides to control the grape berry moth (berries).

Insecticides and formulation	Rate per 20 liters (ml)	Means percent infested berries ± SE after different periods of insecticides' application		
		Three days	One week	Two weeks
Perfekthion 40% E.C.* (Dimethoate)	25	3.7±1.4 ab	4.0±1.1 b	3.8±1.2 b
Karate 5% E.C. (Lambda-cyhalothrin)	9	2.2±0.7 b	2.0±0.6 b	2.4±0.7 b
Cymbush 10% E.C. (Cypermethrin)	8	1.8±0.8 b	2.2±0.9 b	2.5±0.8 b
Malathion 50% E.C.	35	3.2±0.9 ab	3.8±1.1 b	4.1±1.1 ab
Control	--	5.6±1.2 a	7.1±1.0 a	6.7±1.0 a

Means in columns with different letters are significantly different at 5% probability level (Duncan's Multiple Range Test).

* Emulsifiable Concentrate.

4. DISCUSSION

The grape berry moth**,** *L. botrana* is found in the Mediterranean countries, and considered one of the most important insect pests of grapevines, damaging mainly flowers and fruits (Caffarelli and Vita, 1988). In Jordan, the insect is considered the most important pest, which infests grapevines and causes yield reduction (Sudah, 1966; Abed Al-Majeed, 1974). However, in the present study, the insect has four peaks, which may represent four generations. The first generation appeared in March and terminated in May. In this period, grapevines were at the prior to fruit set period, which indicates the presence of secondary hosts for the insect, which is in agreement with results obtained by Genduso (1985). In addition, this generation contained high population, which may be the progeny of large numbers of pupae hibernating from the last season. The second generation occurred from May to July. This generation infested the berries in early fruit growth and development and caused damage to berries. The third generation started from July and ended in August. Larvae of this generation infested berries in late fruit growth and development period, and caused damage to the berries. The fourth generation occurred between August and November at time grapevines, were in the post harvest period. This means that this generation is of no importance on Salti cultivar, and it may attack secondary hosts. The infestation by *L. botrana* larvae started in both growing seasons from mid June until late July. This may indicate that harvesting the fruits as early as possible after ripening would escape further infestation by the insect. It is to be noted that infestations in berries coincided with the second and third generations, which indicates that these generations are very important in grapevine culture, which agreed with results obtained by Fermaud (1998) and Badenhausser et al. (1999). Therefore, the insect is considered a key pest in vineyards in Jerash area. In this regard, Kabour and Sudah (1983) found that the insect has also four generations per year in Fuhais and Zei (10-20 km west of Amman). The 1^{st}, 2^{nd}, 3^{rd} and 4^{th} generations appeared from April to May, June to July, August to September and September to October, respectively. In addition, Haddadin (1990) reported that this insect has four generations a year in central Jordan Valley. These generations appeared in the period between February and April, April and July, July and September as well as September and November for the 1^{st}, 2^{nd}, 3^{rd}, and 4^{th} generations, respectively. The number of generations is determined by several factors i.e., photoperiod, temperature, humidity and food quality (Gabel and Mocko, 1984).

Moderate mean temperature and RH, which occurred in early March to late November (around 20°C and 54%) seem to be favorable for the insect since most of adults emergence occurred during this period. Haddadin (1990) reported that low mean temperature accompanied by high mean RH as well as high mean temperature, accompanied by low mean RH has negative effects on the insect in central Jordan Valley. In addition, Kabour and Sudah (1983) found that the suitable temperature for the insect is between 18.5-24.0°C. Moreover, optimal conditions for moth activity occur at temperatures over 20°C and RH of 40-70% (Roehrich and Boller, 1991).

The leafhopper, *E. lybica* was present in the vineyard from April to October in both 1995 and 1996 growing seasons. It is clear that the leafhopper is present in the vineyard for long period of time, and during the whole season in high numbers. Therefore, the insect is considered as a potential pest in vineyard in Jerash area. It is to be noted that Haddadin (1990) considered it a non-significant pest on grapevine in central Jordan Valley. Ibrahim (1986) reported that the insect is found in many countries of the Mediterranean basin, and known as a pest of numerous plant species including grapes. High mean temperature (24ºC) and moderate mean RH (52%) occurred from May to October were most favorable for the insect, which is completely in agreement with Haddadin (1990).

In the current study, the eriophid mite, *E. vitis* appeared from June to October and from April to November in 1995 and 1996, respectively. It is clear that the mite is present in the vineyard for long period of time and in high numbers. Therefore, the insect is considered as a potential pest in vineyards in Jerash area. Sudah (1966) reported that this mite infested grapevines in Jordan, and infestation differs from one area to another. Haddadin (1990) found that the mite infested Salti cultivar in the central Jordan Valley, and the mite was considered a non-significant pest. This mite is widespread throughout the world being a pest of grapevines in nearly every area, where the vine is grown (Jeppson et al., 1975). In the present work, it seems that eriophid mite influenced by temperature, where high temperature (24ºC) occurred from June to October in both seasons was most favorable to the mite.

The present work showed that both aphid, *A. gossypii* and thrips, *T. tabaci* appeared in low numbers and for a short period from April to June in both growing seasons. Therefore, they were considered of no economic importance in grapevine culture in Jerash area. Haddadin (1990) reported that these two insects are of no significance to grapevine culture in central Jordan Valley. The black vine thrips, *R. syriacus* appeared in the vineyard in very small numbers in 1996 season only. It appeared late in the growing season from July to September. The insect is considered of no importance on grapevines in Jerash area. Sudah (1966) reported that the insect infested grapevines especially Salti cultivar in Salt area.

The current results on chemical applications indicated that all the tested insecticides were significantly reduced the infestation by *L. botrana*, when compared to the control. It is to be mentioned that in Jordan, Al-Sannea (1970) and Sudah et al. (1977) found that dimethoate gave good results in controlling the pest. Dimethoate and carbaryl were widely used to control the insect (Sudah, 1984). Fenvalerate, lambda-cyhalothrin and esfenvalerate were effective in controlling the moth in France (Goarant, 1988).

In conclusion, basic data on the population dynamics of arthropod pests in relation to phases of growth and development of grapevines of Salti cultivar were obtained. Therefore, it is recommended that much attention should be directed to *L. botrana* as a key pest. Since leafhopper and eriophid mite are considered potential pests, therefore, care must be taken not to disrupt the ecosystem but to prevent potential pest from becoming key pests. Moreover, chemical control may be attempted during fruit growth and development period, because it is the most important period in grapevine culture from the standpoint of pest control.

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التغيرات في أعداد مفصليات الأرجل على العنب والمكافحة الكيماوية لعثة ثمار العنب في منطقة جرش، الأردن

فراس الزيود ✉* ***وحسين الموسى*** **

ملخـص

يصاب العنب في الأردن بالعديد من الآفات وخصوصاً عثّة ثمار العنب، التي تسبب خسائر جسيمة للمحصول. لذا تم إجراء دراسة لمعرفة التغيرات في أعداد الآفات على العنب في الموسمين الزراعيين 1995 و 1996 في منطقة جرش. كما تم اختيار أربعة مبيدات حشرية لمعرفة فعاليتها في مكافحة عثّة ثمار العنب.

بينت النتائج أن عثة ثمار العنب توجد طيلة الموسم إلا إنها كانت خطرة في مرحلة نمو الثمار وتطورها. ويظهر أن لهذه الحشرة أربعة اجيال في السنة. ويعتبر الجيلان الثاني والثالث هما الأخطر على محصول العنب في منطقة جرش، ولذاك اعتبرت الحشرة آفة رئيسة. وجد قفاز الأوراق وحلم العنب بأعداد كبيرة خلال الموسمين الزراعيين، ولذا تم اعتبارها آفات كامنة على العنب. كما وجد المن والتربس وتربس العنب الأسود بأعداد قليلة خلال الموسمين الزراعيين، لذاك اعتبرت من الآفات غير المهمة اقتصادياً. كما بينت النتائج أن جميع المبيدات الحشرية المستخدمة قللت معنويا من الإصابة الناتجة عن عثّة ثمار العنب مقارنة بالشاهد.

الكلمات الدالة: تغيرات الأعداد، افات مفصليات الأرجل، العنب، المكافحة الكيماوية، عثة ثمار العنب، *Lobesia botrana*.

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