



Control of citrus mealybug *Planococcus citri* (Risso) on three grapevines varieties and its effect on fruits quality

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Abstract

Grape mealybug consider the most universally important vineyard insect pest. Insecticides are the main strategy to grapevine insect control. The result showed that the recommended rate of Imidacloprid is succeeded in controlling of mealybug since its initial reduced of the infestation were 89.26, 84.21 and 85.71 % for first season and 82.71, 82.94 and 83.56 % for second season for Flame seedless, Early sweet seedless and Sugraone seedless, respectively. Meanwhile, the total mean of reduction after 3, 7, 14 and 30 days were 95.79, 64.83 and 72.82 % for first season and 85.20, 66.33 and 69.84 % for second season on Flame seedless, Early sweet seedless and Sugraone seedless, respectively. On the other hand, the total mean of reduction after 3, 7, 14 and 30 days were 72.56, 80.40 and 82.50% for first season and 68.88, 76.13 and 75.56% for second season on Flame seedless, Early sweet seedless and Sugraone seedless, respectively. In addition, all of them are above 70% reduction. From these results, it should be suggested using some effective alternatives such as Palmito compound in controlling mealy bug incompatible program with chemical insecticides instead of conventional individuals' insecticides. The grapevine variety, Early sweet seedless showed the significant superiority in the quality traits. Under conditions of this investigation, the grapevine variety, Early sweet seedless was recorder the highest values for yield per vine, TSS and total sugar% in both seasons.

Keywords: Insecticide grapevine; Citrus mealybug; Variety.

1. Introduction

Grapevine, *Vitis vinifera* L. is traditionally cultivated as fruit crop all over the world, which it used as wines or food tables. In Egypt, the grape as fruit summer is very essential to most Egyptian people as food table and exportation to some European countries. The quantity and quality properties of fruit are very important for direct feeding or integrated industries of grape food. One of the most important factors that affected grape productions is insect pests. *Planococcus citri*, Risso (Hemiptera: Pseudococcidae), known as citrus mealybug, is a most crucial polyphagous

pest on many plants around the world including the grapevine (Özgökçe *et al.*, 2018). It is a highly polyphagous and most crucial pest around the world. In addition, it is a common pest on citrus, grapevine, ornamental plants, cocoa, bananas, tobacco, coffee, passionfruits, pineapples, figs, taro, date palms, pomegranates, potatoes, and greenhouse plants (Williams and Watson 1988). *Planococcus citri* and *P. ficus* is morphologically very similar, and their separation is very difficult (Williams and Granar de Willink, 1992). It was reported that *Pl. citri* is the most abundant in vineyards (Morandi Filho *et al.*, 2008) than *P. ficus* (Foldi and Kozar, 2006). The biology of *Pl. citri* is little known, although it is native to Eurasia, and has recently been regarded as an

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economically important pest (Daane *et al.*, 2012).

The importance of the grape mealybug, as a pest of wine grapes, *Vitis vinifera* L. (Vitaceae), has increased because of recent reports that it can transmit at least one of the viruses associated with grapevine leafroll disease. The grape mealybug is a pest of various tree fruits (including pears, apples, and apricots) as well as grapes (Doutt & Hagen, 1950; Madsen & McNelly, 1960; Grasswitz & Burts, 1995). The most important vineyard mealybugs belong to the subfamily Pseudococcinae (Hardy, *et al.*, 2008). Although, there are numerous mealybug species are found in vineyards. Mealybugs are phloem feeders that use long, slender mouthparts to suck out plant fluids (McKenzie, 1967). Most of the vineyard mealybugs can feed on the vine's root, trunk, canes, leaves, or berry clusters. There are, however, differences in the amount of damage caused by each species. This is often related to those factors that determine population size (e.g., number of annual generations and female fecundity), preferred feeding locations, and temperature tolerances. As the mealybugs feed, they eliminate carbohydrate-rich honeydew, which can accumulate on the leaves and in the grape clusters, especially in late summer and early fall (Charles, 1982). The mealybug honeydew away from its location, but it still accumulates on the vine. It has long been noted that honeydew serves as a substrate for the development of sooty mold fungi that can result in further vine damage. For table grape growers, any live or dead mealybugs and the honeydew or sooty molds will cause cosmetic damage to the grape cluster and reduce its marketability (Daane, *et al.*, 2011).

Newer materials, with more novel modes of action, have also gained in popularity,

including neonicotinoids, bio pesticides, (Daane *et al.*, 2006; SunithaS *et al.*, 2009; Lo and Walker, 2010). A major difference between the older and newer materials is the importance of coverage, a portion of the mealybug population is often under the bark, and for some species, on the vine roots. Many of the older foliar sprays did not effectively contact and kill mealybugs in these more protected locations. Some of the more novel materials have systemic properties, either applied through the irrigation system or as a foliar spray. For organic or sustainable farming programs, bio pesticides have been used. The few studies of these products have provided mixed results (Srinivas, *et al.*, 2007). Applications with systemic insecticides near bloom are often used as the insecticide moves quickly in the vines to the leaves. After bloom, foliar materials are applied beneath the leaf canopy and aimed towards the grape clusters and interior canes.

Therefore, this study was aimed to the screening of the selected insecticides represented from different groups for citrus mealybug under open field conditions, efficiency of the selected insecticides using manufactures labels rate on the mealybug populations obtained from grape varieties was evaluated.

2. Materials and methods

2.1. Tested insecticides

The tested insecticides were:

- 1- Dursban 75 WG 250 cm. / 100 L water (Chlorpyrifos).
- 2- Pestador 25 % WP, 150 gm. / 100 L water (Imidacloprid).
- 3- Palmito compound, (Fe 1.5%, Zn 1.5%, Mn 1.5%) 200 cm. /100 L water

2.2. Field experiment

The present experiment was conducted during two successive seasons 2018/2019 and 2019/2020. Seven years old, Flame seedless, Sugraone seedless and Early sweet seedless grafted on freedom root stock grown in private vineyard (*Vitis vinifera* L.), located at, Luxor Governorate, Egypt. Vines were planted in sandy soil at 2m between vines and 3m between rows under drip irrigation system, 0.5m distance between drippers. The soil texture was sand 85, silt 9.5, clay 4.5, pH 7.5 and EC 1.9 dSm⁻¹. The main goal of the trial to evaluate influence of some insecticides on the infected vines with mealybug *P. citri*.

The experimental design was a split plot with three replications each contained 12 plots. Each replicate was a plot of 30 m² (5 vines grown (2*3 m). Insecticides (Factor A) were distributed in the main plot and table grapes varieties (Factor B) as a split plot. Foliar treatments were applied once at 15 of March and during the two successive seasons of 2018/2019 and 2019/2020.

The insecticides were sprayed using knapsack sprayer with one nozzle, as a foliar treatment, at a total volume of 200 liters per feddan. The control plots were sprayed with water. In addition, care was taken to avoid any drift among the treated plots.

The samples representing upper, middle, and lower leaves of the chosen trees were randomly picked and preserved in paper bags. All samples were transferred to the laboratory for an inspection, by a binocular microscope. Inspection of infestation was carried out just before spraying and 3,7,14 and 30 days after spraying. However, the infestation by this insect was determined by finding out number of different insect's phases on injured vines per plot. This pest identifies by specialists in the Research Department of Scale Insects and

mealybugs, Plant Protection Research Institute, Agricultural Research Center. in Egypt.

Reduction percentages of infestation were estimated by (Henderson and Tilton, 1955) formula as follow: -

$$\text{Reduction \%} = [1 - (\text{Ta} / \text{Tb} \times \text{Cb} / \text{Ca})] \times 100$$

Where: -

Ta = number of insects in treatments after application.

Tb = number of insects in treatments before application.

Ca = number of insects in check after application in treatment.

Cb = number of insects in check before application in treatment.

2.3. Yield and Fruit Quality

Yield/vine was calculated in kg was expressed as average weight of cluster (kg) x number of cluster/vines using the digital scale. Berry diameter was calculated per mm using hand sizer all measurements were in the field at harvest time.

Berry chemical quality characteristics: Sample of 12 clusters per treatment, each replicate consists of four clusters were harvested to measure the physical and chemical characteristics of clusters.

- 1- Total soluble solids content (TSS) % was measured as a percent in juice of fresh berries, the hand refractometer was used in that respect.
- 2- Reducing sugar according to A.O.A.C (1985).
- 3- Titratable acidity (%) was measured as mg of tartaric acid using titration of 5 ml clear juice against (0.1 N) NaOH after the addition of a little drops of phenol pthalene indicator. A.O.A.C (1985).

4- Berry diameter (mm): The average diameter of berries was measured by using a hand sizer caliper.

2.4. Statistical analysis

Statistical analysis of data was carried out by using a computer software package "MSTATC". L.S.D test was used to differentiate between means.

3. Results and discussion

3.1. Field application of insecticides and their alternatives

The field experiments were carried out to evaluate the reduction of three insecticides

namely, Palmito, chlorpyrifos and Imidacloprid on three different variety namely Flame seedless, Early sweet seedless and Sugraone seedless during 2018/2019 and 2019/2020 seasons.

Data in table (1) showed that reduction percent of infestation by mealybug due to the application of tested insecticides and their alternatives indicated that Imidacloprid was the most effective insecticides in reducing the infestation. It exhibited that the initial reduction was 89.26, 85.71 and 84.21% on Flame seedless, Sugraone seedless and Early sweet seedless respectively during 2018/2019 season.

Table 1. Effect of Imidacloprid, Chlorpyrifos and Palmito on citrus mealybug infesting grapevines during 2018/2019 for first season.

Insecticides	Varieties	Before	% Reduction				mean
			3	7	14	30	
Palmito	Flame seedless	10.00	72.09	54.06	85.12	78.98	72.56
	Early sweet seedless	10.67	70.06	62.70	94.43	94.43	80.40
	Sugraone seedless	8.67	72.12	65.52	96.18	96.18	82.50
Chlorpyrifos	Flame seedless	9.00	76.33	59.19	61.13	61.61	64.56
	Early sweet seedless	8.00	82.03	76.44	87.82	80.04	81.58
	Sugraone seedless	6.33	78.28	97.22	91.27	97.22	91.00
Imidacloprid	Flame seedless	7.33	89.26	93.89	100.00	100.00	95.79
	Early sweet seedless	16.00	84.21	62.23	67.43	45.45	64.83
	Sugraone seedless	12.33	85.71	62.52	76.32	66.86	72.85

According to the recommendation of the Egyptian ministry of agriculture for using insecticides and their alternatives in controlling pests, effective materials should give initial effect not less than 70% reduction and residual effect not less than 40% reduction (Anonymous, 2001). The present data stated that tested insecticides could be arranged in descending order according to their potency as follows: Imidacloprid > Chlorpyrifos > Palmito.

Based on this recommendation, the result in Tables 1 and 2 showed that the recommended rate of Imidacloprid is succeeded in controlling of mealybug since its initial reduced of the infestation

were 89.26, 85.71 and 84.21% for first season and 83.56, 82.94 and 82.71% for second season, respectively. Meanwhile, the total mean of reduction after 3, 7, 14 and 30 days were 95.79, 72.82 and 64.83% for first season and 85.20, 69.84 and 66.33% for second season on Flame seedless, Sugraone seedless and Early sweet seedless, respectively. While the initial reduction of Chlorpyrifos were 82.03, 78.28 and 76.33% on Early sweet seedless, Sugraone seedless and Flame seedless, respectively at first season. While the initial reduction of Chlorpyrifos were 78.41, 77.72 and 66.03% on Early sweet seedless, Flame seedless and Sugraone seedless, respectively at second season. These results in agree with Kent *et*

al. (2020) stated that there was little difference in infestation levels between plots treated with imidacloprid ($50.5 \pm 0.1\%$) and buprofezin ($47.6 \pm 0.1\%$) and for that reason, data were combined.

While the initial reduction of Palmito were 72.12, 72.09 and 70.06% on Sugraone seedless, Flame seedless and Early sweet seedless, respectively at first season. While the initial reduction of Palmito were 71.05, 71.00 and 70.90% on Early sweet seedless, Flame seedless and Sugraone seedless, respectively at second season. Meanwhile, the total mean of reduction after 3, 7, 14 and 30 days were 72.56, 80.40 and 82.50% for first season and 68.88, 76.13 and 75.56% for second season on Flame seedless, Early sweet seedless and Sugraone seedless, respectively. In addition, all of them are above 70% reduction. From these results, it should be suggested using some effective alternatives such as Palmito in controlling mealybug incompatible program

with chemical insecticides instead of conventional individuals' insecticides.

These results agreed with those of (Chowański, *et al.*, 2014) stated that, insecticides extracted from plants have less negative environmental effects and create comparatively low risk of insecticide resistance than synthetic insecticides; therefore, they can be proposed as a safe tool for management of pests.

Several problems have resulted from the intensive use of conventional pesticides for pest control such as insect resistance; outbreaks of pest population; destruction of non-pest species; environmental pollution and human health hazards. Palmito compound could be considered promising alternatives to conventional insecticides for use against the citrus mealybug. These findings agreed with those reported by many investigators (Maurya and Malik, 2016).

Table 2. Effect of Imidacloprid, Chlorpyrifos and Palmito on citrus mealybug infesting grapevines during 2019/2020 for second season.

Insecticides	Varieties	Before	% Reduction				mean
			3	7	14	30	
Palmito	Flame seedless	11.33	71.00	54.70	81.15	68.65	68.88
	Early sweet seedless	11.00	71.05	58.05	89.41	86.00	76.13
	Sugraone seedless	9.00	70.90	64.81	82.75	83.80	75.56
Chlorpyrifos	Flame seedless	9.67	77.72	64.19	59.02	54.86	63.95
	Early sweet seedless	9.33	78.41	74.39	79.37	74.00	76.54
	Superior seedless	7.00	66.03	81.55	77.51	70.61	73.92
Imidacloprid	Flame seedless	9.00	82.71	84.22	89.83	84.05	85.20
	Early sweet seedless	16.33	82.94	69.01	62.94	50.41	66.33
	Sugraone seedless	13.33	83.56	62.87	70.52	62.41	69.84

The initial deposit of Imidacloprid was above 80% which indicate that the conventional insecticides exhibited outstanding potency in reducing infestation by citrus mealybug as compared with alternatives insecticides. However, this is not enough to recommend using these insecticides widely in controlling this pest species. It is better to suggest using

alternatives of insecticides in controlling mealybug incompatible program with other controlling agents instead of the conventional insecticides.

Data are presented in Tables (1 and 2) indicated that all the used insecticides had affected the insect population. The insecticides could be arranged according to their potency

as follow: Imidacloprid > Chlorpyrifos > Palmito.

The most effective insecticide was Imidacloprid while Palmito compound was the least effective one. On the other hand, Chlorpyrifos located in between. Data clearly show that there is a wide range in the response of the insects to the action of the three tested compounds. It is obvious that percent reduction of infestation depended on the type of used compounds and grape varieties.

The present study recommends that Imidacloprid insecticide was better than chlorpyrifos in control of citrus mealybug. Palmito compound give good control of citrus mealybug and should use as alternative candidate, so it should be considered in integrated pest management (IPM) programs of control programme of citrus mealybug.

3.2. Yield and Fruit Quality

2.2.1. yield /vine (kg)

Data in Table (3) showed that the yield per vine (kg) was significantly affected by spraying with different insecticides in the 1st and 2nd seasons. Imidacloprid recorded highest yield per vine (7.69 and 7.36) in the 1st season and 2nd season, respectively compared with untreated vines (4.98 and 4.64). Meanwhile, Palmito compound was recorded the least yield per vine (7.22 and 6.88) in the 1st and 2nd seasons, respectively. Decreasing yield per vine due to mealybugs feed on plant sap they often excrete a sugary, sticky liquid called honeydew. While the honeydew usually does not cause severe damage by itself, it frequently attracts ants and other insect pests, can cause mold which leaves grapes cosmetically damaged and can prevent a good drying of the grapes if producing raisins. The honeydew of mealybugs can also encourage the development of bacteria or fungus, such as black sooty mold which prevents sunlight from penetrating the leaves and cane inhibit plant growth.

Table 3. Effect of grape varieties and different application insecticides on the yield per vine (kg) at harvest in the 1st and 2nd seasons, 2018/2019 and 2019/ 2020.

Insecticides	Yield per vine (kg) 2018/2019			Mean	Yield per vine (kg) 2019/2020			Mean
	Flame seedless	Early sweet seedless	Sugraone seedless		Flame seedless	Early sweet seedless	Sugraone seedless	
Palmito	6.73	7.47	7.45	7.22	6.40	7.13	7.12	6.88
Chlorpyrifos	6.90	8.03	7.63	7.52	6.57	7.70	7.30	7.19
Imidacloprid	6.87	8.20	8.00	7.69	6.53	7.87	7.67	7.36
Nun insecticides	4.33	5.53	5.07	4.98	4.00	4.73	5.20	4.64
Mean	6.21	7.31	7.04		5.88	6.86	6.82	
L.S.D. at 0.05								
Insecticides (A)		0.32				0.57		
Grape varieties (B)								
A×B		0.58				0.42		
		NS				0.84		

Data presented in Table (3) suggested that, the grape varieties differed significantly in yield per vine (kg). The yield (7.31 and 6.86) was observed in Early sweet seedless during the first and second seasons, respectively. Whereas the lowest yield per vine (6.21 and

5.88 kg) was observed in Flame seedless in both seasons, respectively. These results agreed with Bashandy *et al.* (2020) found that, there were significant differences between the studded cultivars in physical quality parameters. The interaction between grape

varieties and different insecticides showed the significant differences in second season.

Table 4. Effect of grape varieties and different application insecticides on the Total soluble solids (TSS) at harvest in the 1st and 2nd seasons, 2018/2019 and 2019/ 2020.

Insecticides	TSS (2018/2019)			Mean	TSS (2019/2020)			Mean
	Flame seedless	Early sweet seedless	Sugraonese edless		Flame seedless	Early sweet seedless	Sugraonese edless	
Palmito	14.13	14.80	14.13	14.36	13.80	14.47	13.80	14.02
Chlorpyrifos	14.80	14.93	14.47	14.73	14.47	14.60	14.13	14.40
Imidacloprid	14.93	14.90	14.73	14.86	14.57	14.60	14.40	14.52
Nun insecticides	12.40	13.33	12.53	12.76	12.07	13.00	12.20	12.42
Mean	14.07	14.49	13.97		13.73	14.17	13.63	
L.S.D. at 0.05								
Insecticides (A)		0.52				0.55		
Grape varieties (B)						0.38		
A×B		0.47						
		NS				NS		

Table 5. Effect of grape varieties and different application insecticides on the Reducing sugars % at harvest in the 1st and 2nd seasons, 2018/2019 and 2019/ 2020.

Insecticides	Reducing sugars % (2018/2019)			Mean	Reducing sugars % (2019/2020)			Mean
	Flame seedless	Early sweet seedless	Sugraone seedless		Flame seedless	Early sweet seedless	Sugraone seedless	
Palmito	11.30	11.47	11.47	11.41	11.45	11.68	11.58	11.57
Chlorpyrifos	11.42	11.66	11.47	11.52	11.56	11.76	11.57	11.63
Imidacloprid	11.48	11.73	11.61	11.61	11.75	11.87	11.70	11.77
Nun insecticides	9.38	9.73	9.54	9.55	9.64	9.92	9.92	9.82
Mean	10.90	11.15	11.02		11.10	11.31	11.19	
L.S.D. at 0.05								
Insecticides (A)		0.22				0.19		
Grape varieties (B)		0.49				0.23		
A×B		NS				NS		

3.2.2. Total soluble solids (TSS)

Data presented in Table (4) indicated the TSS was significantly affected by spraying with different insecticides in the 1st and 2nd seasons. Imidacloprid recorded highest TSS (14.86 and 14.52) in the 1st season and 2nd season respectively, compared with untreated vines (12.76 and 12.42). Meanwhile, Palmito compound was recorded the least TSS (14.36 and 14.02) in the 1st and 2nd seasons, respectively.

Results given in Table (4) show that the grape varieties differed significantly in TSS. The highest TSS (14.49 and 14.17) was observed in Early

sweet seedless during the first and second seasons, respectively. Whereas the lowest TSS (13.97 and 13.63) was observed in Sugraone seedless in both seasons, respectively. The obtained results matched with El-Salhy *et al.* (2019) stated that, TSS and reducing sugar values in Early sweet cultivar were 14.9 and 12.11, respectively, these results are close to our results.

The interaction between grape varieties and different insecticides showed the insignificant differences in both seasons.

3.2.3. Reducing sugars %

Data in Table (5) showed that the Reducing sugars % was significantly affected by spraying with different insecticides in the 1st and 2nd seasons. Imidacloprid recorded highest Reducing sugars % (11.61 and 11.77) in the 1st season and 2nd season, respectively, compared with untreated vines (9.55 and 9.82). Meanwhile, Palmito compound was recorded the lowest reducing sugars % (11.41 and 11.57) in the 1st and 2nd seasons, respectively.

Data arranged in Table (5) showed that the grape varieties differed significantly in reducing sugars %. The highest reducing sugars % (11.15 and 11.31) was observed in Early sweet seedless during the first and second seasons, respectively. Whereas the lowest Reducing sugars % (10.90 and 11.10) was observed in Flame seedless in both seasons, respectively. The obtained results matched with El-Salhy *et al.* (2019) reported that TSS and reducing sugar values in Early sweet cultivar were 14.9 and 12.11, respectively, these results are close to our results. The interaction between grape varieties and different insecticides showed the insignificant differences in both seasons.

Table 6. Effect of grape varieties and different insecticides on the Titratable acidity % at harvest in the 1st and 2nd seasons, 2018/2019 and 2019/ 2020.

Insecticides	Titratable acidity % (2018/2019)			Mean	Titratable acidity % (2019/2020)			mean
	Flame seedless	Early sweet seedless	Sugraonese edless		Flame seedless	Early sweet seedless	Sugraonese edless	
Palmito	0.50	0.47	0.55	0.51	0.53	0.47	0.56	0.52
Chlorpyrifos	0.48	0.46	0.50	0.48	0.50	0.46	0.53	0.50
Imidacloprid	0.47	0.44	0.50	0.47	0.49	0.45	0.52	0.49
Nun insecticides	0.89	0.87	1.10	0.95	0.93	0.90	1.13	0.99
Mean	0.59	0.56	0.66		0.61	0.57	0.69	
L.S.D. at 0.05								
Insecticides (A)		0.07				0.05		
Grape varieties (B)		0.05				0.03		
A×B		NS				0.06		

3.2.4. Titratable acidity %

Results obtained in Table (6) pointed out that Titratable acidity % was significantly affected by spraying with different insecticides in the 1st and 2nd seasons. Imidacloprid recorded lowest Titratable acidity % (0.47 and 0.49) in the 1st season and 2nd season, respectively, compared with untreated vines (0.95 and 0.99). Meanwhile, Palmito compound was recorded the highest Titratable acidity % (0.51 and 0.52) in the 1st and 2nd seasons, respectively.

Data arranged in Table (6) showed that the grape varieties differed significantly in Titratable acidity%. The highest Titratable acidity% (0.66 and 0.69) was observed in Sugraone seedless during the first and second season, respectively. Whereas the lowest Titratable acidity% (0.56 and 0.57) was observed in Early sweet seedless in both seasons, respectively. These results agreed with those of Karibasappa and Adsule, 2008 & Muhammed *et al.*, (2018) who reported that, lowest acidity value in grapes varieties were because of subtropical climatic conditions. As

high temperature during berry development, maturation and ripening increases the malic acid consumption and lower the acid accumulation which ultimately decreases the acidity level in fruit at maturity.

The interaction between grape varieties and different insecticides showed the significant differences in the second season.

3.2.5. Berry diameter (mm)

Table 7. Effect of grape varieties and different application insecticides on the Berry diameter (mm) at harvest in the 1st and 2nd seasons, 2018/2019 and 2019/ 2020.

Insecticides	Berry diameter (mm) (2018/2019)			Mean	Berry diameter (mm) (2019/2020)			Mean
	Flame seedless	Early sweet seedless	Sugraonese edless		Flame seedless	Early sweet seedless	Sugraonese edless	
Palmito	17.00	20.00	18.67	18.56	16.67	19.67	18.33	18.22
Chlorpyrifos	17.67	20.33	20.00	19.33	17.33	20.00	19.67	19.00
Imidacloprid	17.67	21.00	20.00	19.56	17.33	20.67	19.67	19.22
Nun insecticides	15.33	17.00	16.33	16.22	15.00	17.67	16.67	16.44
Mean	16.92	19.58	18.75		16.58	19.50	18.58	
L.S.D. at 0.05								
Insecticides (A)		1.75				1.30		
Grape varieties (B)		0.96				0.70		
A×B		NS				NS		

Data illustrated in Table (7) recorded that the grape varieties differed significantly in Berry diameter. The highest Berry diameter (19.58 and 19.50) was observed in Early sweet seedless during the first and second season, respectively. Whereas the lowest Berry diameter (16.92 and 16.58) was observed in Flame seedless in both seasons, respectively. These results agreed with Bashandy *et al.* (2020) found that, there were significant differences between the studded cultivars in quality parameters. Concerning, the interaction between grape varieties and different insecticides showed the insignificant differences in both seasons.

4. Conclusion

Data in Table (7) showed that the Berry diameter was significantly affected by spraying with different insecticides in the 1st and 2nd seasons. Imidacloprid recorded highest Berry diameter mm (19.56 and 19.22) in the 1st season and 2nd season, respectively, compared with untreated vines (16.22 and 16.44). Meanwhile, Palmito was recorded the lowest Berry diameter mm (18.56 and 18.22) in the 1st and 2nd seasons, respectively.

On the light of the previous results, it could be recommending that Imidacloprid insecticide was better than chlorpyrifos in control of grape mealybug. Palmito compound give good control of grape mealybug and should use as alternative candidate, so it should be considered in integrated pest management (IPM) programs of control programme of grape mealy bug.

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