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The effect of droplets distribution of insecticides on bioresidual activity of piercing sucking insects (Hemiptera) infesting eggplant by using ground spraying equipment

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Abstract:

Eggplant is one of the most common tropical vegetables cultivated of the world. It contains a good amount of vitamins, minerals and fiber in few calories. Piercing and sucking insects (Hemiptera) damage crops by inserting their mouthparts into plant tissue and sucking juices. Heavily infested crops become yellow, wilted, deformed or stunted and may eventually die. Some sucking insects inject toxic materials into the plant while feeding and some transmit virus diseases. Field experiments were carried out in an area of about 19 Kirats planted with eggplant varity (Soma kafear) during two successive seasons 2017 and 2018 in 7th August at Qaha, Qalyubiya Governorate. The selected area was split into 9 plots and control plots. Three products were sprayed Imidaclopride, Acetampirid (Neonicotinoids) and Lufenuron (IGRs) of recommended dose rates and one treatment left without spraying as control by using Knapsack motor sprayer (Cifarilli) (20 L./ fed.), Economy Micron ULVA sprayer (15 L/Fed.) and Hand-Held compression sprayer (Kwazar) (94 L/Fed.). Data indicated that, all tested compounds induced significant negative influenced on both *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) and *Aphis gossypii* Glover (Hemiptera: Aphididae) nymphs survival. Both Imidaclopride and Acetampirid revealed successful results followed by Lufenuron. It could be recommended that using those compounds with low volume spraying equipment with not less than (15L/ fed.). The data showed that Knapsack motor sprayer (Cifarilli) was the best equipment to control both *B. tabaci* and *A.gossypii* infesting eggplant. The rate of performance of Knapsack motor sprayer (Cifarilli) was 12 fed./day. It was the best equipment, but the lowest rate of performance was Hand Held compression sprayer (Kwazar) since it could spraying only 2.5 fed./day.

Introduction

Eggplant has a very low caloric value and is considered among the healthiest vegetables for its high content of vitamins, minerals and bioactive compounds for human health (Docimo *et al*., 2016). The top five producing countries are China (28.4 million tons), India (13.4 million tons), Egypt (1.2 million tons), Turkey (0.82 million tons) and Iran (0.75 million tons) (FAO, 2014). Piercing and sucking insects are dangerous pests which infested eggplant (*Solanum melongena* L.) and cause great hazarads to it. In Egypt, majority of interest was directed to the type, dosage rate of insecticides used, while a lesser attention was given to the application methods.

A comparative studies on the efficiency of different ground sprayers was carried out by (Hindy, 1992 and Hindy *et al*.,1997) who found a significant variation in the spray deposit due to arrangement of the nozzles, spray technique and rate of application. The world global attention was directed to minimization of spraying volumes and the control costs which may be achieved by using a cheap and effective insecticides or using developmental ground spraying technique with low application costs per feddan (Magdoline *et al*., 1992 and Matthews, 1992). Maintaining sprayers for pesticide application in a good state of repairing and proper working in order to reduce their harmful effects on human health and environment (Dokic *et al.*, 2018). The aim of this work is to determine the best insecticide and equipment controlling *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) and *Aphis gossypii* Glover (Hemiptera: Aphididae) on eggplant with conservation of agricultural environment.

Materials and methods

1. Tested compunds:

1.1. Imidaclopride (Qwadoor ®), 20% S.L. , 100 cm^3/ 100L. water, (Neonicotinoids) , Acetylcholinesterase inhibitor .

1.2. Acetamiprid (Plan ex®), 70 % W.G. , 50 gm /fed. , (Neonicotinoids),Acetylcholinesterase inhibitor.

1. 3. Lufenuron (Match®), 5%E. C. , 160 / cm^3 / fed. (IGRs), Chitin synthesis inhibitor.

2. Spraying equipment tested on eggplant:

Three ground application equipments were selected to perform the scope of this work, as commonly used equipment in applying pesticides on eggplant. These are, Economy Micron ULVA sprayer, spraying volume (15L./fed.), UK made; Knapsack motor sprayer (Cifarilli), Spraying volume (20 L./fed.) ,Italy made and Hand- Heldcompression sprayer (Kwazar), Spraying volume (94 L./fed.), Poland made. The tested equipments could be represented according to the technical categorization mentioned in Table (1). Calculations of productivity and rate of performance were recorded as described by Hindy (1992).

Table (1): Techno-Operational data of certain ground sprayers applied on eggplant field during seasons (2017-2018).

Equipment	Motorized Knapsack sprayer (Cifarilli)	Spinning disc (ULVA) sprayer	Hand- Held compression sprayer(Kwazar)
Type of atomization	Pneumatic Mechanical	Rotary*	Pneumatic manual
Nozzle type	Air shear nozzle	Spinning disc	Hollow cone nozzle
Pump type	Centrifugal fan	-	Compression air pump
Number of nozzles	1	1	1
Pressure (bar)	-	-	From 7 to 1
Spray tank (L.)	20	1+10	8
Rate of application (L/fed.)	20	15	94
Working speed (Km/h.)	2.4	2.4	2.4
Swath width (m.)	5	1.0	1.0
Flow rate (L/Min.)	1	0.150	0.90
Spray height (m.)	0.5	0.5	0.5
Type of Spraying	Target spraying technique in all treatments .		
Productivity * (fed./h.)	2.85	0.571	0.425
Rate of performance* (fed./day)	12	3.04	2.5

* Number of spraying hours=8hours daily.
*Number of workers=2
* Hand carried-4 Battery operated spinning disc sprayer.
* Calculations of productivity and rate of performance after Hindy (1992).

3. Execution of field experiments:

3.1. Arrangements of the experiments:

Field experiments were carried out during two successive seasons 2017 and 2018 on 9th August in private eggplant field located at Qaha District, Qalyubiya Governorate . The eggplant cultivated varity was Soma Kafear planted at 10th of April in the two seasons, the experiments were done under local meteorological conditions of 37°C average temperature, 60% average R.H. and 2.5 m/sec. as an average wind velocity during spraying operations. The selected area of 19 Kirats was split into 9 plots and control plot. The area of each plot was 2 Kirats , two rows of eggplant plants between treatments were not sprayed as barrier zones to avoid drift spray between treatments, spraying operations have not been done with insecticides before execution the field experiment. The experimental fields were sprayed with recommended dose rate and one treatment left separated without spraying as a control, with three alternative insecticides Imidaclopride, Acetamiprid and Lufenuron, respectively. All treatments sprayed as target spraying technique. In each plot five eggplant plants were selected and remarked to define *B. tabaci* and *A. gossypii* nymphs numbers and follow

the results before and after one , five and seven days from spraying.

3.2. Bioassay procedure:

Field experiments were conducted on eggplant field highly infested with *B. tabaci* and *A. gossypii* nymphs. In order to evaluate the tested compounds on them, pre-treatment count was recorded before spraying at five marked plants for each treatment and post-treatment counts was recorded after 1,5 and 7 days from spraying treatments to determine the effect of the tested chemicals by different spraying equipment.

3.3. Phytotoxic effect:

Determined by recording any colour change, leaf curling or flaming up to 8 days after spraying, according to Badr *et al*. (1995).

4. Calculation and data analysis:

4.1. The reduction percentages in the field experiment was calculated according to Henderson and Tilton (1955).

4.2. The statistical analysis of results was achived according to SAS (1996) program for biological studies: Duncan's (Duncan, 1955) for biological evaluation of insecticides in field.

5. Calibration and performance adjustment of the tested equipment:

5.1. Collection of spray deposit:

Before spraying each eggplant field treatments, a sampling line was constructed of five wire holder fixed in diagonal line at each treatment to collect the lost spray between plants; each wire holder top has a fixed with water sensitive paper (Novartis Cards) on it. Also, each five eggplant plants, the water sensitive paper cards were put at plant; to collect the droplets deposit on eggplant leaves, were designed according to the method described by Hindy (1989). All cards were collected and transferred carefully to the laboratory for measuring and calculating the number of droplets/cm² and its volume (VMD) µm in all treatments.

5.2.Determination of spray deposit:

Number and size of blue spots (deposited droplets) on water sensitive papers (Novartis cards) measured with a special scaled monocular Japanies lens (Strüben)® (15X).The volume mean diameter (VMD) µm and number of droplets in one square centimeter (N/cm²) were estimated according to Hindy (1992).

Results and discussion

1. Bioresidual activity of Imidaclopride against *Bemisia tabaci* and *Aphis gossypii* infesting eggplant :

Efficiency of Imidaclopride represented as mortality percentages after 24 hours of spraying as presented in Tables (2 and 3). The highest reduction in population of *B.tabaci* nymphs was occurred by Economy Micron ULVA sprayer (15 L/fed.) the droplet sizes were 153 , 129 and 156 and N/cm^2 were 156, 312 and 176.The mean mortality percentages after one day of the two seasons (2017 and 2018) were 84,81.5 and 63% for initial for recommended dose sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) sprayer and Hand-Held compression (Kwazar) sprayer and the general mean reduction % of two seasons 94.7,93.8 and 84.3 for residual sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) and Hand-Held compression (Kwazar) sprayer , respectively . The highest reduction in population of *A.gossypii* nymphs were occurred by Economy Micron ULVA sprayer. The mean mortality percentages of *A.gossypii* nymphs of the two seasons (2017 and 2018) after one day of treatment by using Imidaclopride formulation were 92 ,88 and 72 % for initial and the general mean reduction % of two seasons were 97.3 , 96 and 88 for

residual for recommended dose sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) sprayer and Hand-Held compression (Kwazar) sprayer ,respectively.

2. Bioresidual activity of Acetamprid against *Bemisia tabaci* and *Aphis gossypii* infesting eggplant :

Efficiency of Acetamprid represented as mortality percentages after 24 hours of spraying as presented in Tables (2 and 3). The highest reduction in population of *B.tabaci* nymphs was occurred by Knapsack motor sprayer (Cifarilli) (20 L/fed.) the droplet sizes were 156 , 126 and 156 and N/cm^2 were 152, 344 and 183, respectively . The mean mortality percentages after one day of the two seasons (2017 and 2018) were 80, 81.5 and 66.5% for initial for recommended dose sprayed with Economy Micron ULVA sprayer, sprayer and Hand-Held compression (Kwazar) sprayer ,and 93.3 ,93.8 and 87 the general mean reduction % of two seasons for residual sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) and Hand-Held compression (Kwazar) sprayer , respectively . The highest reduction in population of *A.gossypii* nymphs were occurred by Knapsack motor sprayer (Cifarilli) (20 L/fed.) The mean mortality percentages of *A. gossypii* nymphs by using Acetamprid formulation after one day of the two seasons (2017 and 2018) were 85.5 ,87 and 74.5 % for initial for recommended dose sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) sprayer and Hand-Held compression (Kwazar) sprayer, the general mean reduction % of two seasons were 87.5 , 91 ,89.1 % for residual with recommended dose sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) sprayer and Hand-Held compression(Kwazar) sprayer ,respectively.

3.Bioresidual activity of Lufenuron formulation against *Bemisia tabaci* and *Aphis gossypii* infesting eggplant :

Efficiency of Lufenuron represented as mortality percentages after 24 hours of spraying as presented in Tables (2 and 3). The highest reduction in population of *B.tabaci* nymphs were occurred by Knapsack motor sprayer (Cifarilli) (20 L/fed.) the droplet sizes were 132 , 147 and 156 (VMD) µm and N/cm^2 were 148,329 and 176 the droplet sizes were 156 , 126 and 156 and N/cm^2 were 344,131 and 183. The mean mortality percentages after one day of the two seasons (2017and 2018) were 63.5, 66.5 and 63.5% for initial for recommended dose sprayed with Economy Micron ULVA sprayer, sprayer and Hand-Held compression (Kwazar) sprayer ,and 84.1 , 86.7 and 84.4% the general mean reduction % of two seasons for residual sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) and Hand-Held compression(Kwazar) sprayer, respectively .The highest reduction in population of *A.gossypii* nymphs was occurred by Knapsack motor sprayer (Cifarilli) (20 L/fed.) The mean mortality percentages of *A. gossypii* nymphs by using Lufenuron formulation after one day of the two seasons (2017 and 2018) were 71 ,73.5 and 73.5 % for initial for recommended dose sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) sprayer and Hand-Held compression(Kwazar) sprayer, the general mean reduction % of two seasons were 87.5, 91 ,89.1 % for residual with recommended dose sprayed with Economy Micron ULVA sprayer, Knapsack motor sprayer (Cifarilli) sprayer and Hand-Held compression(Kwazar) sprayer ,respectively.

Table (2): The relation between droplets distribution obtained by the tested ground spraying equipment and the corresponding mortality of *Bemisia tabaci* nymphs infesting eggplant during seasons (2017-2018) in Qalubyia Governorate.

Insecticide and dose rate/ fed.	Tested sprayer	VMDμm	N / cm^2	% Mortality	
				Initial mean *	Residual mean *
Imidaclopride (400 cm^3)	Micron ULVA	153	156	84	94.7
	Cifarilli	129	312	81.5	93.8
	Kwazar	156	176	63	84.3
Acetamprid (50 gm)	Micron ULVA	156	131	80	93.3
	Cifarilli	126	344	81.5	93.8
	Kwazar	156	183	66.5	87
Lufenuron (160 cm^3)	Micron ULVA	132	148	63.5	84.1
	Cifarilli	147	329	66.5	86.7
	Kwazar	156	176	63.5	84.4

VMD = Volume Mean Diameter. N / cm^2 = Number of droplets per square centimeter.
*Average of two seasons.

Table (3): The relation between droplets distribution obtained by the tested ground spraying equipment and the corresponding mortality of *Aphis gossypii* nymphs infesting eggplant during seasons (2017-2018) in Qalubyia Governorate.

Insecticide and dose rate/ fed.	Tested sprayer	VMDμm	N / cm^2	% Mortality	
				Initial mean	Residual mean
Imidaclopride (400 cm^3)	Micron ULVA	153	156	91	97
	Cifarilli	129	312	87.5	95.8
	Kwazar	156	176	71	87.7
Acetamprid (50 gm)	Micron ULVA	156	131	85.5	95.2
	Cifarilli	126	344	87	95.7
	Kwazar	156	183	74.5	89.8
Lufenuron (160 cm^3)	Micron ULVA	132	148	71	87.5
	Cifarilli	147	329	73.5	91
	Kwazar	156	176	73.5	89.1

VMD = Volume Mean Diameter. N / cm^2 = Number of droplets per square centimeter.
*Average of two seasons.

4.Relationship between lost spray on ground and the bioresidual activity of insecticides used:

Data in Tables (4 and 5) showed that there were a negative correlation between lost spray on ground equipment and the bioresidual activity of insecticides used.

4.1.Economy Micron ULVA spryer (15 L/fed.) :

Data in Tables (4 and 5) showed that the lost spray percentages were 6, 6.1 and 5.7 % from the total spray volume in the case of Imidaclopride, Acetamprid and Lufenuron and the general mean reduction % of two seasons (2017-2018) were 94.7 ,93.3 and 84.1 % *B.tabaci* nymphs at total recommended doses, respectively, in the case of the same insecticides and the general mean reduction % of two seasons of *A.gossypii* nymphs were 97 ,95.2 and 87.5 for the same insecticides, respectively.

4.2.Knapsack motor sprayer (Cifarilli) (20 L/fed.):

Data in Tables (4 and 5) showed that the lost spray percentages were 9.3, 9.2 and 9.4 % from the total spray volumes in the case of Imidaclopride, Acetamprid and Lufenuron and the general mean reduction % of two seasons (2017-2018) were 93.8 ,93.8 and 86.7 % *B.tabaci* nymphs at total recommended doses, respectively, in the case of the same insecticides and the general mean reduction % of two seasons of *A.gossypii* nymphs were 95.8 ,95.7 and 91 for the same insecticides,respectively.

Table (4): Lost spray on ground as produced by low volume ground spraying equipment against *Bemisia tabaci* nymphs during seasons (2017-2018).

Insecticide and dose rate / fed.	Tested sprayer and spray volume (L / fed.)	*N / cm^2 of total spray droplets	N / cm^2 droplets lost (on ground)	% N/cm^2 (ground) ——— x 100 N/Cm^2 (Plants+ground)	% Mortality	
					Intial mean *	Residual mean *
Imidaclopride (400 cm^3)	Micron ULVA (15)	166	10	6	84	94.7
	Cifarilli(20)	344	32	9.3	81.5	93.8
	Kwazar (94)	216	40	18.5	63	84.3
Acetamprid (50 gm)	Micron ULVA (15)	162	10	6.1	80	93.3
	Cifarilli(20)	379	35	9.2	81.5	93.8
	Kwazar (94)	216	35	16	66.5	87
Lufenuron (160 cm^3)	Micron ULVA (15)	157	9	5.7	63.5	84.1
	Cifarilli(20)	363	34	9.4	66.5	86.7
	Kwazar (94)	207	31	14.9	63.5	84.4

N / cm^2 = Number of droplets per square centimeter. * On Eggplant and lost spray on ground.
*Average of two seasons.

Table (5): Lost spray on ground as produced of low volume ground spraying equipment by using certain insecticides at total recomı Dar, 2019
***gossypii* nymphs during seasons (2017-2018).**

Insecticide and dose rate / fed.	Tested sprayer and spray volume (L / fed.)	*N / cm^2 of total spray droplets	N / cm^2 droplets (on ground)	% N/cm^2 (ground) ——— x 100 N/Cm^2 (Plants+ground)	% Mortality	
					Intial mean*	Residual mean*
Imidaclopride (400 cm^3)	Micron ULVA (15)	166	10	6	91	97
	Cifarilli(20)	344	32	9.3	87.5	95.8
	Kwazar (94)	216	40	18.5	71	87.7
Acetamprid (50 gm)	Micron ULVA (15)	162	10	6.1	85.5	95.2
	Cifarilli(20)	379	35	9.2	87	95.7
	Kwazar (94)	216	35	16	74.5	89.8
Lufenuron (160 cm^3)	Micron ULVA (15)	157	9	5.7	71	87.5
	Cifarilli(20)	363	34	9.4	73.5	91
	Kwazar (94)	207	31	14.9	73.5	89.1

4.3.Hand- Held compression sprayer (Kwazar) (94L/fed.):

Data in Tables (4 and 5) showed that the lost spray percentages were 18.5, 16 and 14.9 % from the total spray volumes in the case of Imidaclopride, Acetamprid and Lufenuron and the general mean reduction % of two seasons (2017-2018) were 84.3, 87 and 84.4% *B.tabaci* nymphs at total recommended doses, respectively, in the case of the same insecticides, and the general mean reduction % of two seasons of *A.gossypii* nymphs were 87.7, 89.8 and 89.1 for the same insecticides,respectively .

5.Relationship between the tested chemicals, techniques and the mortality percentages of *Bemisia tabaci* and *Aphis gossypii* infesting eggplant :

5.1.Bioassay evaluation:

To study the influence of various compounds and spraying equipment before and after application Hendresson and Tilton's formula (1955) was adopted to calculate the reduction percentages in the population. Tables (6,7,8 and 9) showed that, the percentages of reduction of *B.tabaci* and *A.gossypii* infesting eggplant affected by certain insecticides sprayed with certain ground application techniques during the seasons of (2017-2018) using total recommended dose rate. The performance rate of Knapsack motor sprayer (Cifarilli) was 12 fed./day. It was the best equipment, but the lowest performance rate was Hand-Held compression sprayer (Kwazar) since it could spray only 2.5 fed./day.

5.2.The following remarks and results were obtained:

5.2.1. There was no phytotoxic effect on eggplant leaves after treatments, no change in the leaves color, no leaf curling or flaming up phenomena was happened.

5.2.2. Insecticides treated plants revealed the lowest eggplant yield loss in comparison with untreated plots; their application reduced the incidence of whitefly and cotton aphid infestation on eggplant and decreased the percent loss of eggplant yield in all treatments and with all sprayers.

5.2.3. There was a significant differences between both the distribution percentages of droplets numbers/cm^2 (LSD=2.8255for Imidaclopride, 3.8257 for and Acetamprid 3.9958 for Lufenuron) , for droplet sizes (LSD=3.4605 for Imidaclopride, 2.5793 for Acetamprid and 2.8255 for Lufenuron) and for reduction percentages(LSD=1.8238 for Lufenuron, 1.9979 for Acetamprid and 1.2896 for Imidaclopride ,for white fly and(LSD=1.7302 for Lufenuron, 1.6313 for Acetamprid and 2.8255 for Imidaclopride ,for aphid.

Table (6): Reduction percentages in *B. tabaci* nymphs affected by certain insecticides sprayed with certain ground equipment during the season (2017) data were averages of five replicates.

Equipment / treatments	Counted nymphs before treatmen			% Reduction after spraying																							
				2 nd						5 th						7 th						General mean					
	Micron ULVA	Cifarilli	Kwazar	Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)	
				C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %
Imidaclopride (400 cm ^{3}/fed)	100	115	120	14	86	20	83	43	64	0	100	0	100	12	**90**	_	_	_	_	0	100	4.6	95.3	6.6	94.3	18.3	84.6
Acetampirid (50 gm/fed)	125	117	127	25	80	20	83	41	67	0	100	0	100	7	95	_	_	_	_	0	100	8.3	93.3	6.6	94.3	16	87.3
Lufenuron (160 cm^3/fed)	130	105	123	47	64	35	67	41	67	13	90	6	95	10	92	0	100	0	100	0	100	20	84.6	13.6	87.3	17	86.3
Untreated (control)	117	122	127	117	_	122	_	127	_	116	_	120	_	126	_	116	_	120	_	126	_	116.7	_	121.4	_	126.7	_

C = Count of life nymphs after treatment.

R = % Reduction of nymphs.

Table (7): Reduction percentages in *B. tabaci* nymphs affected by certain insecticides sprayed with certain ground equipment during the season (2018) data were averages of five replicates.

Equipment / treatments	Counted nymphs before treatmen			% Reduction after spraying																							
				2 nd						5 th						7 th						General mean					
	Micron ULVA	Cifarilli	Kwazar	Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)	
				C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %
Imidaclopride (400 cm ^{3}/fed)	127	122	115	23	82	25	80	44	62	0	100	0	100	12	90	_	_	_	_	0	100	7.6	94	8.3	93.3	18.6	84
Acetampirid (50 gm/fed)	118	126	130	24	80	26	80	45	66	0	100	0	100	7	95	_	_	_	_	0	100	8	93.3	8.6	93.3	17.6	86.6
Lufenuron (160 cm^3/fed)	120	118	127	45	63	41	63	51	60	15	88	10	92	10	92	0	100	0	100	0	100	20	83.6	17	86	25.3	82.6
Untreated (control)	119	120	125	119	_	120	_	125	_	118	_	118	_	124	_	118	_	118	_	124	_	118	_	118	_	124	_

Table (8):Reduction Percentages in *A.gossypii* nymphs affected by certain insecticides sprayed with certain ground equipment during the season (2017), data were averages of five replicates.

Equipment / treatments	Counted nymphs befor treatment			% Reduction after spraying																					
				2 nd						5 th						7 th						General mean					
	Micron ULVA	Cifarilli	Kwazar	Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)	
				C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %
Imidaclopride (400 cm ^{3}/fed)	55	60	70	6	90	8	87	21	70	0	100	0	100	6	92	_	_	_	_	0	100	2	96.6	2.6	95.6	9	87.3
Acetampirid (50 gm/fed)	67	75	64	10	85	11	86	17	74	0	100	0	100	4	95	_	_	_	_	0	100	33	95	3.6	95.3	7	89.6
Lufenuron (160 cm^3/fed)	59	69	72	18	70	17	75	19	73	6	90	4	95	5	93	0	100	0	100	0	100	8	86.6	7	90	8	88.6
Untreated (control)	65	71	58	65	_	71	_	58	_	64	_	57	_	62	_	62	_	68	_	55	_	63	_	69	_	56	_

C = Count of life nymphs after treatment.

R = % Reduction of nymphs.

Table (9):Rduction Percentages in *A.gossypii* nymphs affected by certain insecticides sprayed with certain ground equipment during the season (2018),data were averages of five replicates.

Equipment / treatments	Counted nymphs treatment			% Reduction after spraying																					
				2 nd						5 th						7 th						General mean					
	Micron ULVA	Cifarilli	Kwazar	Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)		Micron ULVA (15 L/fed.)		Cifarilli (20 L/fed.)		Kwazar (94 L/fed.)	
				C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %	C	R %
Imidaclopride (400 cm ^{3}/fed)	72	65	69	6	92	8	88	19	72	0	100	0	100	6	92	_	_	_	_	0	100	2	97.3	26	96	8.3	88
Acetampirid (50 gm/fed	70	74	68	10	86	9	88	17	75	0	100	0	100	3	96	_	_	_	_	0	100	3.3	95.3	3	96	6.6	90
Lufenuron (160 cm^3/fed)	65	59	74	18	72	13	78	19	74	5	93	2	98	4	95	0	100	0	100	0	100	7.6	88.3	5	92	7.6	89.6
Untreated (control)	68	75	65	68	_	75	_	65	_	67	_	73	_	64	_	66	_	72	_	64	_	67.6	_	74	_	64.7	_

Field experiment was carried out on infested area with *B.tabaci* and *A.gossypii* adults at early season on eggplant. For evaluation the field performance of Low-Volume spraying machines; Economy Micron ULVA sprayer (15 L/fed.), Knapsack motor sprayer (Cifarilli) (20L/ fed.) and Hand-Held compression sprayer (Kwazar) (94 L/fed.); to spray Imidaclopride, Acetamprid and Lufenuron with full recommended dose . A satisfactory coverage was obtained on eggplant, the droplets spectrum was obtained in field experiment was agreed with the optimum droplet sizes which mentioned by Himel (1969). The best obtained result was 20 L/fed. as spray volume, 146 μm and 123 droplets/cm^2 , these results agreed with (Himel and Moore, 1969) in the optimum droplet size to control cotton leafworm in cotton fields by ground equipment. Acetamiprid revealed the best bioefficiacy results with the three tested sprayers. Also , Imidaclopride for whitefly and cotton aphid revealed the best bioefficiacy results with Economy Micron Ulva sprayer (15 L/fed.). Acetamiprid revealed higher mortality than Imidaclopride with Kwazar sprayer (94 L/fed) and these results agreed with Hindy *et al.* (2004) and Genidy *et al.* (2005) which recommended KZ oil and Pyriproxyfen followed by Agerin by using low volume spraying because of reducing the time lost in process filling the machines, improve the homogeneity of the spray solution on the plant leaves and saving the lost spray on the ground,these results also in agreement with Bakr *et al*. (2014) recommendation by using Profenofos followed by Pyriproxyfen and Spinosad with Agromondo motorized knapsack sprayer (20L/fed.) and Morsy *et al.*(2015) whom recommended using Carbosolvan ,Acetamprid and Deltamethrin with low volume machines not less than (15 L/fed.), also Dar (2016) recommendation whenever using Lufenuron followed by Spinosad in controlling cotton leafworm on Clover with low volume machines .

Finnally, the data showed that, low application technique revealed by Knapsack motor sprayer (Cifarilli) (20L/ fed.) and Economy Micron ULVA sprayer (15 L/fed.) were best equipment to control whitefly and cotton aphid infesting eggplant . Also , the lowest spray volume and the lowest percentages of lost spraying between plants, these results were agreed with Hindy *et al.* (1997) , who mentioned that, there was a positive correlation relationship between rate of application and lost spray on ground. There was a negative complete correlation between (VMD) and the mean residual mortality of *B. tabaci* and *A.gossypii* while there was a positive complete correlate between N/cm² and the mean residual of mortality of *B.tabaci* and *A.gossypii* in all treatments.

It could be concluded that , using Imidaclopride and Acetamprid followed by Lufenuron with low volume (LV) ground spraying equipment with not less than (15L./fed.) by using recommended doses which revealed successful management against piercing and sucking insects infesting eggplant under our local conditions.

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