Evaluation of Certain Ground Spraying Equipment by the Mean of Qualitative Distrubtion of Certain Insecticides Deposits and Artificial Targets on the Cotton Leaf Worm on Cotton Plants

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Abstract: Three alternative products include BioAgent (Spinosad), OP (Profenofos) and IGR (Pyriproxyfen) were sprayed by using Knapsack motor sprayer Agromondo (20 L./Fed.) and Hand held compression sprayer Kwazar (94 L./Fed.) on cotton field highly infested with cotton leaf worm larvae. A satisfactory coverage was obtained on cotton plants and spray receptors. The spectrum of droplets ranging between 103-191 microns (VMD). With sufficient number ranging from 80-225 n/cm². The productivity of motor sprayer Agromondo was 12 Fed./day. It was the best equipment, but the lowest productivity was Kwazar sprayer since it could spray only 5 Fed./day. Results indicated that Profenofos and Pyriproxyfen is more effective in controlling larvae of cotton leaf worm on cotton plants followed by ,Spinosad, with Knapsack motor sprayer (20 L./Fed.) followed by Kwazar sprayer (94 L./Fed.). Data showed that, low volume spraying may be recommended because of reducing the time lost in the process filling the machines of reducing the time lost of the spray solution on the plant leaves and saving the lost spray on the ground. Also there was no significant difference between recommended dose rate and ¾ recommended does with using low volume spraying.

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Key Words: *Spodoptera Littoralis* (Boisd) - Pyriproxyfen - Profenofos Spinosad – Knapsack motor sprayer Agromondo (20 Liter per Feddan.) - Hand held compression sprayer Kwazar (94 Liter per Feddan.)

1. Introduction

Insecticides had great hazards on man, animal, plant and environment rather than the development of resistance of insects to most conventional insecticides which leads scientists to search on new, alternative insecticides like biotic agents and IGRs which achieved a great success in controlling many insects such as Spodoptera Littoralis with safe, cheap and effective methods. Also, suitable ground equipment for spraying in field has a great importance in controlling pests a definite amount of insecticide & water and minimum spray loss on ground to avoid environmental contamination.

In the present study, considerable effort was devoted to search for some new compounds containing bio-agents and IGT that have insecticidal activities against the Egyptian leaf worm, Spodoptera Littoralis (Boisd), which represents one of the most destructive cotton pests in Egypt and many other countries.

The previous compounds and one OP compound were tested in cotton field with Knapsack motor (Agromondo) and hand-held compression sprayer (Kwazar) to study the relationship between spray quality and the larval survival of Spodoptera Littoralis produced by the previous spraying equipment in field were determined.

2. Material and Methods

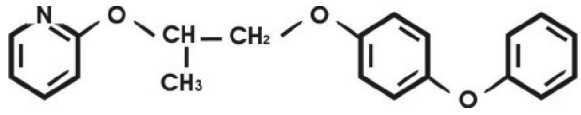
1-The tested compounds:

Pyriproxyfen One of IGR compounds; Juvenile Hormone Mimic (JHM) Common name: Pyriproxyfen.

Trade name : Admiral® .

Chemical name: 4-Phenoxyphenyl (RS) -2-(2Pyridyloxy) propyl ether.

Chemical structure:



Empirical formula: C20H19NO3.

Concentration: 10% E.C.

Molecular weight: 321.37.

Physical properties : Colourless crystals, Melting point, 45-47°C.

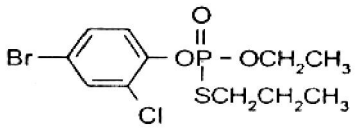
Solubility : In hexane 400, methnol 200, xylene 500 (all in g/kg, 20-25°C)

10% E.C., 750ml/fed. For total recommended dose

rate and 562.5 ml/fed. for ¾ recommended dose rate.

Profenofos :

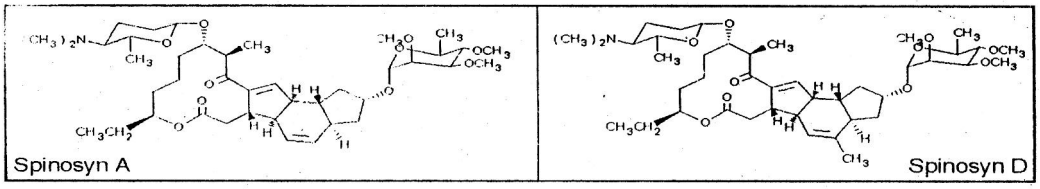
One of Organophosphorous compounds, acetyl cholinestease inhibitors.
Common name : Profenofos.
Trade name : Selecron ®
Formulation : 720 E.C.
Concenteration: 72 % weight/volume.
Chemical name :
O(4-bromo-2-chlorophenyl)O-ethyl-S-propylphos-phorothiate.
Chemical structure:



720 E.C., 750 ml/fed. For total recommended dose rate and 562.5 ml/fed. For ¾ recommended dose rate.

Spinosad:

One of the new class of insect control products, the Naturalytes, derived from the metabolites of the naturally occurring bacteria, Saccharopolyspora spinosa.
Active ingredient: Spinosad .
Common name: Spinosad
Trade name: Tracer ®
Chemical Structure: Spinosad is a mixture of spinosyn A and spinosyn D:



24 E.C., 50ml/fed. For total recommended dose rate and 37.5ml/fed. For ¾ recommended dose rate.

2-Spraying equipment tested on cotton field:

Three ground application machines were selected to perform the scope of this work, as commonly used equipment in applying pesticides on cotton plants.

The tested equipment could be represented according to the technical categorization mentioned in table (1). Calculations of productivity and rate of performance after Hindy (1992).

Table (1): Techno-Operational data of certain ground sprayers applied on cotton field during season (2005).

Type of SprayerItem	Motorized Knapsack sprayer	Hand held compression sprayer
Model	Agromondo	Kwazar
Manufacturing	Italy	Poland
The pump	-	Manual piston
Type of atomization	Mechanical Pneumatic	Manual Hydraulic
Nozzle type	Pneumatic	Hollow cone
Number of nozzles	One	One
Pressue (bar)	-	7.0
Total Tank capacity (L.)	20.0	8.25
Rate of application (L/fed.)	20.0	94.0
Working speed (Km/h.)	2.4 in all treatments	
Swath width (L/m)	5.0	1.0
Flow rate (L/min.)	1.0	0.90
Spray height (m.)	0.5	0.5
Type of spraying	Drift	Target
Sprayer weight (Kg)	12.2	2.5
Productivity (Fed./h.)	2.85	0.57
Rate of performance (Fed./day)	12.0	2.5
No. of worker's	2	2

* Number of spraying hours = 6 hours daily. n* Calculations of productivity and rate of performance after Hindy (1992).

Fig.(1): Motorized Knapsack Sprayer (Agromondo)

Fig.(2): Hand-held Compression (Kwazar) Sprayer

3-Calibration and performance adjustment of the tested equipment:

To fulfill the technical needs of the required field test. The program of calibration tests for ground spraying machines suggested by Gabit (1995).

. Collection and measurement of Spray deposit:

. Collection of spray deposit

Before spraying each cotton field treatments, a sampling line was constructed of five wire holder fixed in diagonal line inside each treatment to collect lost spray between plants; each wire holder top has a fixed water sensitive paper (Novartis Cards) on it. Also, each five cotton plants, the water sensitive paper cards were put at three levels of cotton plant; upper, middle and lower to collect the spray deposit on cotton leaves. At the front of each plant, four spray receptors were put at each treatment coated with water sensitive paper at two levels; upper and lower levels to make comparison with the spray deposit which fallen on cotton plants. Receptors were fixed in the experiments were designed after Hindy (1989). All cards were collected and transferred carefully to the labroratory for measuring and calculating the number of droplets/cm² its volume (VMD) in all treatments.

Determination of spray deposit:

Number and size of blue spots (deposited droplets) on water sensitive papers (Novartis cards) were measured with a special scaled monocular lens (Strüben)®.The volume mean diameter (VMD) and number of droplets in one square centimeter (N/cm²) was estimated according to Gabir (1995).

-4-Execution of field experiments:

. Arrangements of the experiments

Field experiments were carried out during season 2005 on 28th June in private cotton field located at Kafr Bany Ghrian, Koiesna district, Monofiya Governorate. The cotton cultivated was Giza 89. The experiments weredone nder local meteorological conditions of 32°C average temperature, 58% average RH and 2 m/sec. average wind velocity during experiment.

The Selected are of 1.9 Fadden split into 19 plots and control plot. The area of each plot was about 420 m², two taws of cotton plants between treatments were not spraying as barrier zones to avoid drift spray, spraying operations have not been done with any insecticides before execution the field experiment. The experimental field was divided into nine plots were sprayed with recommended rate, nine plots were sprayed with ¾recommended rate and one alternative insecticides Spinosad, Profenofos and Pyriproxyfen, respectively.

3. Results

The optimum spectrum of droplets for controlling insects of field crop should be sized between 140 and 200 μm (VMD) with number not less than 30 and 50 droplets/cm2 distributed homogeneously on the treated target Himel (1969) and (Burt et al., 1970) The following general trends could be extracted from the obtained data and may help in better understanding to the experimental results(Tables 2,3 and Figures 3-8).

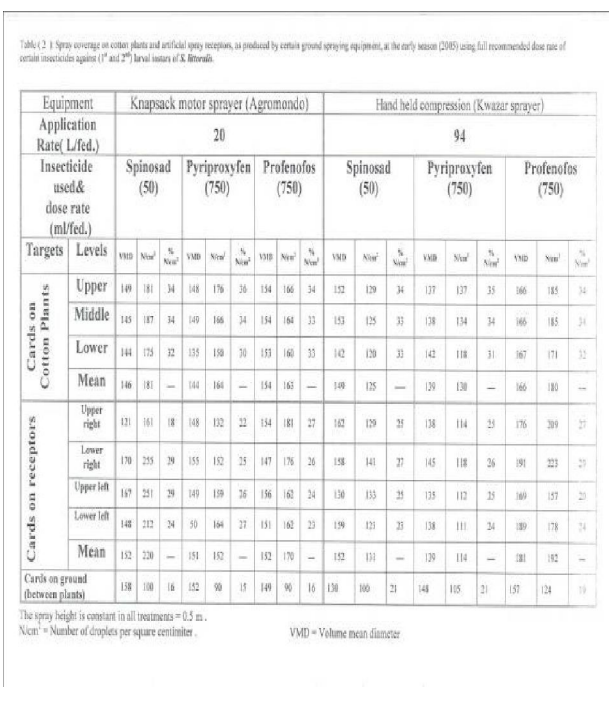


Table (2): Spray coverage on cotton plants and artificial spray receptors, as produced by certain ground spraying equipment, at the early season (2005) using full recommended dose rate of certain insecticides against (1st and 2nd) larval instars of *S. littoralis*.

Equipment		Knapsack motor sprayer (Agromondo)								Hand held compression (Kwazar sprayer)								
Application Rate(L/fed.)		20								94								
Insecticide used& dose rate (ml/fed.)		Spinosad (50)			Pyriproxyfen (750)			Profenofos (750)		Spinosad (50)			Pyriproxyfen (750)			Profenofos (750)		
Targets	Levels	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²
Cards on Cotton Plants	Upper	149	181	34	148	176	36	154	166	34	152	129	34	137	137	35	166	185	34
	Middle	145	187	34	149	166	34	154	164	33	153	125	33	138	134	34	166	185	34
	Lower	144	175	32	155	158	30	153	160	33	142	120	32	142	118	31	167	171	32
	Mean	146	181	—	144	164	—	154	163	—	149	125	—	139	130	—	166	180	—
Cards on receptors	Upper right	131	161	18	148	132	22	154	181	27	162	129	25	138	114	25	176	209	27
	Lower right	170	255	29	155	152	25	147	176	26	158	141	27	145	118	26	191	223	29
	Upper left	167	251	29	149	139	26	156	162	24	150	133	25	135	112	25	169	157	23
	Lower left	148	212	24	50	164	27	151	162	23	159	121	23	138	111	24	189	178	24
	Mean	152	220	—	151	152	—	152	170	—	152	131	—	129	114	—	181	182	—
Cards on ground (between plants)		138	100	16	152	90	15	149	90	16	130	100	21	148	105	21	157	124	19

The spray height is constant in all treatments = 0.5 m .
N/cm² = Number of droplets per square centimiter . VMD = Volume mean diameter

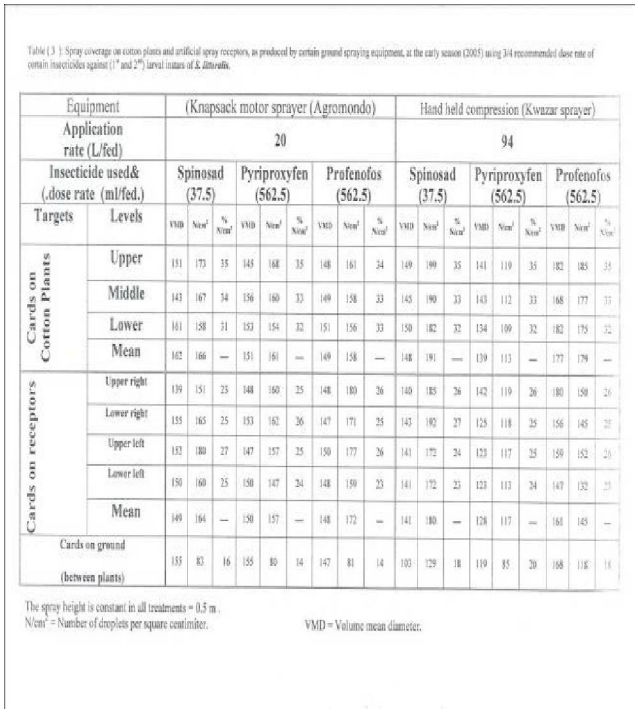


Table (3): Spray coverage on cotton plants and artificial spray receptors, as produced by certain ground spraying equipment, at the early season (2005) using 3/4 recommended dose rate of certain insecticides against (1st and 2nd) larval instars of *S. littoralis*.

Equipment		(Knapsack motor sprayer (Agromondo)								Hand held compression (Kwazar sprayer)								
Application rate (L/fed)		20								94								
Insecticide used& (.dose rate (ml/fed.)		Spinosad (37.5)			Pyriproxyfen (562.5)			Profenofos (562.5)		Spinosad (37.5)			Pyriproxyfen (562.5)			Profenofos (562.5)		
Targets	Levels	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²	VMD	N/cm²	% N/cm²
Cards on Cotton Plants	Upper	151	173	35	145	168	35	148	161	34	149	199	35	141	119	35	182	185	35
	Middle	143	167	34	136	160	33	149	158	33	145	190	33	143	112	33	168	177	33
	Lower	161	158	31	153	154	32	151	156	33	150	182	32	134	109	32	182	175	32
	Mean	162	166	—	151	161	—	149	158	—	148	191	—	139	113	—	177	179	—
Cards on receptors	Upper right	139	151	25	148	160	25	148	180	26	140	185	26	142	119	26	180	150	26
	Lower right	155	165	25	153	162	26	147	171	25	143	192	27	125	118	25	156	145	25
	Upper left	152	180	27	147	157	25	150	177	26	141	172	24	123	117	25	159	152	26
	Lower left	150	160	25	150	147	24	148	159	23	141	172	23	123	113	24	147	132	25
	Mean	149	164	—	150	157	—	148	172	—	141	180	—	128	117	—	161	145	—
Cards on ground (between plants)		155	83	16	155	80	14	147	81	14	103	129	18	119	85	20	168	116	18

The spray height is constant in all treatments = 0.5 m .
N/cm² = Number of droplets per square centimiter. VMD = Volume mean diameter.

Fig (3) Spray coverage on mean level of cotton planys,as produced by volume ground sprying equipment,at the early cotton season(2005)using certain insecticides at total and 3|4 of its recommended dose rate against(1st,2nd)larval instar,of S.littoralis.

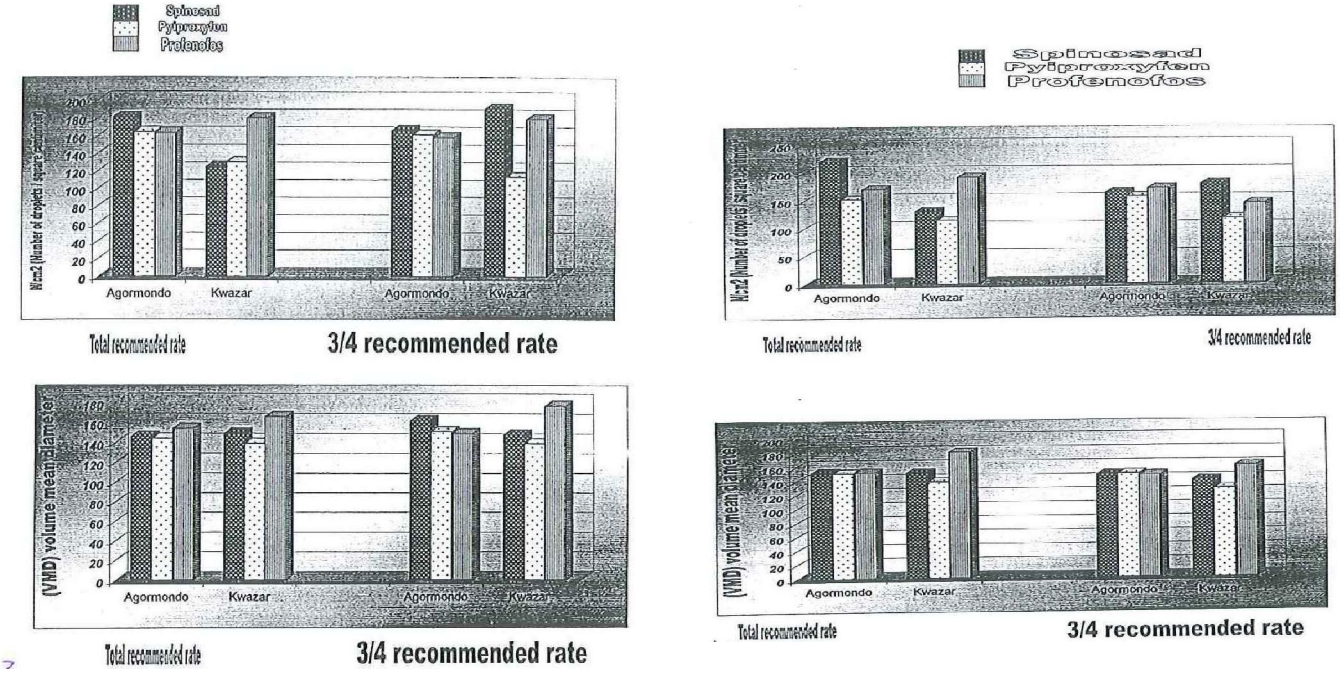
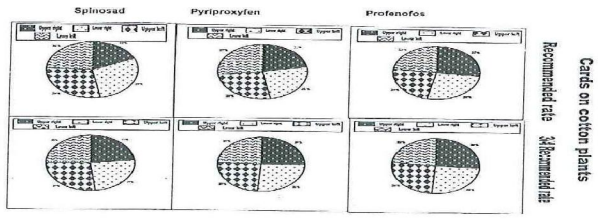
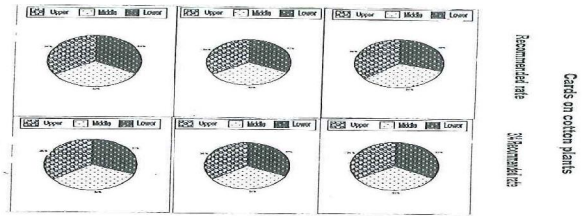
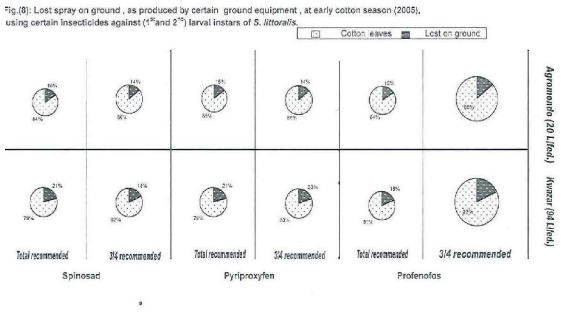
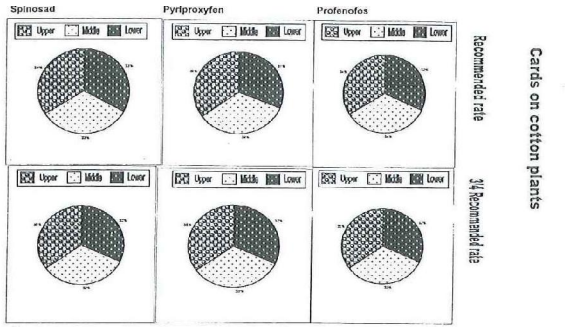


Fig (4) Spray coverage on mean level of cards on receptors,as produced by low volume ground spraing equipment at the early cotton season2005,using certain insecticides total and3|4 of its recommended dose rate against(1st, 2nd) larval instar.









I) In this work, the minimum size of measured spots was however about 50µm. This is due to the limited capability of the available technique of measurement, which means logically that a lot of invisible fine spots smaller than 50µm should occurred within the measured spots. This might clarify the appearance of certain non-reasonable killing results in some experimental treatments.

II) The range of droplets spectrum (VMD and N/cm2) deposited on both the artificial and natural targets by using total recommended dose, and 3/4 recommended dose of the same insecticides used were 121 & 191µm, and 90 & 255 N/cm2 , and 103 & 182µm, and 80 & 199 N/cm2, respectively.

III) Data showed in Table (2) indicated that, the percentage of droplets/cm2 more increased on the spray receptors than droplets/cm2 on cotton plants in the case of Agromondo Motor sprayer by using Spinosad and Profenofos, except for Pyriproxyfen were 39.2, 8.5 and 15.2, respectively. But, the percentage of droplet sizes on spray receptors were more bigger than on cotton plants for the same sprayer by using Spinosod and Pyriproxyfen, except for Profenofos were 8, 9.5 and 2.6, respectively. In the case of Kwazar sprayer, the percentage of droplets/cm2 more increased on the spray receptors than on cotton plants by using Spinosad and Profenofos, except for Pyriproxyfen were 9.4, 12.9 and 26.3%, respectively. But, the percentage of droplet sizes on spray receptors were more bigger than on cotton plants. They were 4&17.3% in the case of Spinosad and Profenofos, while the percentage of droplet sizes on spray receptors were equal to droplet sizes on cotton plants by using Pyriproxyfen

IV) The spray lost on ground, between plants, was the only measured loss, whereas other sources of loss such as by wind (drift), evaporation,... etc, were not subjected to investigation throughout this work.

The obtained results in Tables (2-3) and Figures (1-3) confirmed the positive relationship between spray volume and droplet sizes, which affects negatively the number of formed droplets. Taking into account that the main studied factors affecting the spraying, were the rate of insecticide application, the specifications of the pesticide, its formulation and its mode of action, age of cotton plant and level, position of deposited spray and the meteorological conditions during application of the treatments. The percentages of number of droplets /cm2 in the case of Agromondo Motor sprayer, were 16, 16 & 15 in the case of Profenofos, Spinosad and Pyriproxyfen, respectively. But, in the case of Kwazar sprayer the percentage of the same droplets number/cm2 were 19, 21 & 21 for Profenofos, Spinosad and Pyriproxyfen, respectively.

V) Data in Tables (11,12) and Figures(19-21) showed that, there was no significant differences between both the distribution percentages of droplet sizes and the droplets number/cm2 at all targets (cards on cotton plants, cards on spray receptors and cards on ground between cotton plants).

Relations between spray quality and bioresidual effects of certain insecticides applied early in cotton

season.

Data in Table (4,5) showed that, Profenofos at its recommended rate 750 ml/fed., Spinosad its recommended rate 50ml/fed., and Pyriproxyfen its recommended rate was 750 ml/fed., using three ground spraying equipment and varied spraying volumes depending on the sprayer used. Data indicated that, in general all the tested spraying equipment gave satisfactory coverage on cotton plants i.e. more than 50 droplets / cm2, and droplet sizes ranged from 139 to 166 µm (VMD).There was no significant difference between total recommended and ¾ recommended dose in Profenofos, but the difference in the mortality percentage was due to the different mode of action of the three insecticides used Profenofos repeated 100% mortality percentage as initial and residual mortality in all treatments with both total and ¾ recommended dose rate because it is an Organophosphorus insecticides whereas the IGR compound .Pyriproxyfen began by a high mortality then increased till reached to 100% mortality in all treatments with both total and ¾ recommended dose rate, final the Biotic insecticide Spinosad began by relatively high mortality then increased till reached to 100% mortality in all treatments with both total & ¾ recommended dose rate.

Table (4): The relation between droplet distribution obtained by the tested ground spraying equipment and the corresponding mortality of ($1^{st} - 2^{nd}$) larval instars of *S. littoralis*, using the total recommended rate of insecticides on cotton field.

Insecticide & dose rate (ml / fed.)	Tested sprayer	VMD	N / cm^2	% Mortality	
				After 1 day of treatment	Average (Mean Residual)
Profenofos (750)	Agromondo	154	163	100	100
	Kwazar	166	180	100	100
Spinosad (50)	Agromondo	146	181	85	92.5
	Kwazar	149	125	75	88
Pyriproxyfen (750)	Agromondo	144	164	95	97.5
	Kwazar	139	130	84	92

VMD = Volume Mean Diameter.

N / cm^2 = Number of droplets per square centimeter.

Table (5): The relation between droplet obtained by the tested ground spraying equipment and the corresponding mortality of ($1^{st} - 2^{nd}$) larval instars of *S. littoralis*, using 3/4 recommended rate of insecticides on cotton field.

Insecticide & dose rate (ml / fed.)	Tested sprayer	VMD	N / cm^2	% Mortality	
				After 1 day of treatment	Average (Mean Residual)
Profenofos (562.5)	Agromondo	158	149	100	100
	Kwazar	177	179	100	100
Spinosad (37.5)	Agromondo	162	166	85	92.5
	Kwazar	148	191	70	86
Pyriproxyfen (562.5)	Agromondo	151	161	91	95.5
	Kwazar	132	113	82	91

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

4. DISCUSSION

A satisfactory coverage was obtained on cotton plants, the droplet 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, 154 mm and 163 droplets/cm^2, these results agreed with (Himel et aL., 1969) in the optimum droplet size to control cotton leaf worm in the cotton fields by ground equipment, Profenofos revealed the best bio-efficiency results with the three tested sprayers (Agromondo) motor sprayer (20 L./fed.), Kwazar sprayer (94 L./fed.) and wisconson motor sprayer (600 L./fed.). Also, Pyriproxyfen revealed the best bio-efficiency results woth motor sprayer Agromondo (20 L./fed.) followed by Spinosad with the same sprayer and these results agreed with Hindy et aL. (2004) and Genidy et aL. (2005) which recommended K2 oil and Pyriproxyfen followed by Agerin 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 of the ground. Also, there was no significant difference between recommended dose rate and ¾ recommended dose with low volume spraying. The data showed that Agromondo motor sprayer (20 L./fed.) is the best equipment to control cotton leaf worm on cotton

plants. Also, the lowest spray volume and the lowest percentage of lost spraying between plants, these results were agreed with Hindy et aL. (1997) who mentioned that, there was a positive relationship between rate of application and spray lost on ground. Generally, Spinosad and Pyriproxyfen are recent insecticides that avoid the activity of cotton leaf worm on cotton plants, and safe the children who were picked manually egg masses during hot days and saving also the traditional insecticides which injures the human body and the agricultural environment.

Conclusion

The used Spinosad, Profenofos and Pyriproxyfen produce a great and strong proof to be used as controlling agents against S. Littoralis in both lab. and field. The main factor governing the present study is formation of spray quality of the combined action of atomization process (sprayer) and the rate of application under the specific physical properties of the tested formulations, fixed operational conditions and suitable ambient climatic conditions according to the nature of the tested insecticides. The spray bulk produced by the tested spraying techniques was distributed mainly on the different surfaces and levels of the treated plants and spray receptors, as well as lost spray on the ground between plants, By using various spraying volumes rates, through various atomization methods with a certain ground equipment used, bio-efficacy results of pesticides against cotton leaf worm infesting cotton plants during early season showed a significant effect with Profenofos full dose and Spinosad ¾ dose whereas no significant indication was remarked with full dose and ¾ recommended dose between all the treatments. It could be recommended to utilize ¾ recommended dose for field operation to control S. Littoralis on cotton field. Another category from statistical aspect, that both of Profenofos and Pyriproxyfen with full dose revealed a highly significant indication was remarked. Profenofos, Pyriproxyfen is more effective than Spinosad in controlling larvae of cotton leaf worm on cotton plants. It could be recommended that the most cheap available and effective with Knapsack motor sprayer Agromondo (20L./fed.) for controlling cotton Kwazar sprayer (94 L./fed.). The third groups of treatments were revealed no significant difference between them are Aromondo motor sprayer and wisconson motor sprayer in bio-efficacy.

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