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EVALUATION OF TWO GROUND SPRAYING EQUIPMENTS FOR CONTROLLING SPINY BOLLWORM *Earias insulana* (BOISD.) IN COTTON FIELD

Rehab, A. A. Dar; M. S. M. Salem; Hemat, Z. Moustafa and Nabiela, S. A. Hiekel
Plant Protection Res.instit.Agric.Res.Center, Dokki, Giza.

ABSTRACT

Three insecticides; Selecron, Trebon and Patron were sprayed using Knapsack motor sprayer Cifarilli (20 L./Fed.) and Economy Micron ULVA (15 L./Fed.) in cotton field infested with the cotton spiny bollworm *Earias insulana* (Boisd.) larvae during 2014 cotton season at Qaha district, Qalyoubia Governorate. The spectrum of droplets size ranging between 140-169 microns (VMD) with sufficient number ranging from 14-276 droplets/cm². The productivity of motor sprayer Cifarilli was 12 Fed./day. It was the best equipment, but the lowest productivity was 3.04 Fed./day by using Economy Micron ULVA. Results indicated that Trebon and Selecron insecticides were almost behave to be equitoxic effective in controlling larvae of cotton bollworm on cotton plants than the Patron insecticide with Economy Micron ULVA (15 L./Fed.) followed by Knapsack motor Cifarilli sprayer (20L./Fed.). The efficiency of the tested insecticides could be descendingly arranged as follows: Trebon, Selecron and Patron. The corresponding general reduction rates were 91.۱٥, 55.99 and 92.51% in case of using Micron ULVA equipment and 91.13, 55.19 and 92.20% in case of using Knapsack motor Cifarilli sprayer, respectively. 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 via run off on the ground.

Keywords: *Earias insulana* - Selecron – Batron - Trebon - Knapsack motor sprayer Cifarilli (20 L./Fed.) and Economy Micron ULVA (15L./Fed.).

INTRODUCTION

The spiny bollworm *Earias insulana* (Boisd.) (Lepidoptera: Noctuidae) is considered as a major lepidopteron pest of many crops and distributed in North Africa and Sub continent (Indo-Pak) Abdul-Naser *et al.* (1973), spiny bollworm is main cotton pest, larvae infesting bolls, damaging cotton squares, flower buds, flowers, seeds and fiber, especially at the late growing stage of the cotton plants that cause decreasing in the quality and quantity in the lint and oil of the obtained yield Salem (2008).

During the cotton-growing season, chemical control is still one of the major tools for controlling bollworms. The control of this pest depended on the stages, which are found outside the fruit bodies, mainly egg, newly hatched larvae as well as moths. So, it is important to determine the generations of the pest and the time of insecticidal application with the appearance of the target stage Zaki (2006).

Insect growth regulators (IGRs) have a more specific mode of action on pests and are not highly toxic to non- target organisms when compared to many conventional insecticides. These characteristics allowed the use of chitin synthesis inhibitors to be included promising in Integrated Pest Management programs (IPM) (El- Shennawy 2009 and Kandil *et al.* 201٣).

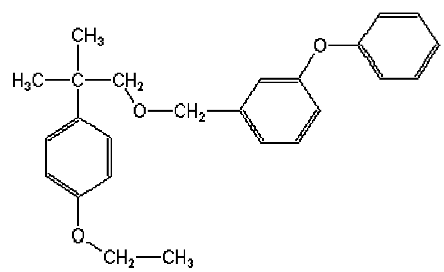
In the present study, considerable effort was devoted to search for some new compounds containing pyrethriod and IGR that have insecticidal activities against the spiny bollworm which represents one of the most destructive cotton pests in Egypt and many other countries beside one organophosphorus compound. Cotton plants were sprayed with the previous compounds using Knapsack motor (Cifarilli) and Economy Micron ULVA sprayer to study the relationship between spray quality and the infestation percentages of *E. insulana*.

MATERIALS AND METHODS

1-Insecticides used:

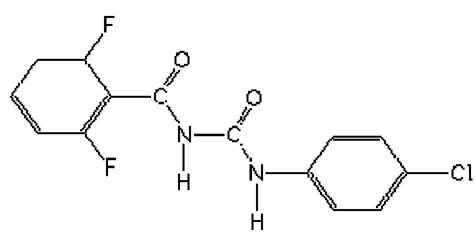
- etofenprox (Pyrethroid): Trebon 30%EC.

Chemical name: (2,(4-ethoxyphenyl)-2-methylpropyl 3-phenoxybenzyl ether).

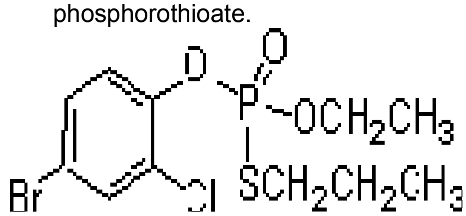


- diflubenzuron (Chitin synthesis inhibitor): Patron 25% WP.

Chemical name: N-[[(4-chlorophenyl)amino]carbonyl]-2,6-difluorobenzamide.



-profenofos (Organophosphorus**):** Selecron 72%.
Chemical name: O-(4-bromo-2-chlorophenyl) O-ethyl S-propyl phosphorothioate.



2-Spraying equipment tested on cotton field:

Two 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 Tables (1&2).

Calculations of productivity and rate of performance were recorded as described by Hindy (1992).

Table (1): Techno-Operational data of the Economy-Micron - ULVA sprayer used in lab.

Item	**Spining disc ULVA sprayer**	**Remarks**
Type of spraying	**Target**	**Direct spray**
Nozzle type	**Rotary (spinning disc)**	**Restrictor**
Number of nozzles	1	
Spray tank (L.)	1+10	10 L. spray attached.
Rate of application (L/fed.)	15	
Working speed (Km/h.)	2.4	$\pm$ 5%
Effective swath width (m.)	1.0	
Flow rate (L/min.)	0.150	Total of the sprayer
Spray height (m.)	0.5	
Productivity * (fed./h.)	0.571	
Rate of performance* (fed./day)	3.04	daily hours =8h.~

*** Number of spraying hours = 8 hours daily.**
*** Calculations of productivity and rate of performance after Hindy (1992).**

3-Calibration and performance adjustment of the tested equipment:

- **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 droplets deposit on cotton 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) in all treatments.

able (2):Techno-Operational data of certain ground sprayers applied on cotton field during season (2014).

Type of sprayer / Item	Motorized Knapsack sprayer Cifarilli
Model	Cifarilli
Manufacturing	Italy
The pump	-
Type of atomization	Mechanical Pneumatic
Nozzle type	Pneumatic
Number of nozzles	One
Pressue (bar)	-
Total Tank capacity (L.)	20.0
Rate of application (L/fed.)	20.0
Working speed (Km/h.)	2.4
Swath width (L/m)	5.0
Flow rate (L/min.)	1.0
Spray height (m.)	0.5
Type of spraying	Drift
Sprayer weight (Kg)	12.2
Productivity (Fed./h.)	2.85
Rate of performance (Fed./day)	12.0
No. of worker's	2

*** Number of spraying hours = 8hours daily.**
*** Calculations of productivity and rate of performance after Hindy (1992).**

-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) were estimated according to Hindy (1992).

4-**Execution of field experiments:**

- Arrangements of the experiments

Field experiments were carried out on April 15th during 2014 cotton season at Qaha district, Qalyoubia Governorate, cultivated with Giza 86 cotton variety. The experimental design was randomized complete block with 3 replicates, the whole cultivated area (700 m^2) was divided into equally 6 plots, each plot was treated with one of the tested compounds as well as one of the tested equipment; while the remaining plot was left as control. Cotton seeds were sown at 20 cm distance between hills. Spraying of the tested insecticides took place on cotton plants three times in July, 7th, 21st and 4th August, respectively, with two motor sprayers (Cifarilli, Knapsack-motor sprayer and Economy

Micron ULVA sprayer). Each compound was applied individually. The experiments were done under local meteorological conditions of 32°C average temperatures, 60 % R.H. and 4.6 m/sec. as an average wind velocity during experiment.

To evaluate the effect of the three treatments against spiny bollworm, samples of 25 bolls/ plot were randomly picked before and week after application. Sampling continued weekly until harvest. The collected bolls were transported to the laboratory, where they were carefully dissected and percent of larval infestation was recorded and the reduction percentages in green boll (or increase) infestation were determined according to Henderson and Tilton (1955).

RESULTS AND DISCUSSION

Data presented in **Table (3),** showed that application of the tested pesticides with Micron ULVA sprayer caused significant reduction in percentages of infested cotton bolls caused by the spiny bollworm *E. insulana*. It was obvious that the reduction percentages in the green bolls caused by *E. insulana* using Micron ULVA sprayer increased gradually from July till September. In case of Selecron treatment, the reduction percentages in the green bolls infestation during July, August and September were 80.17, 92.96 and 93.89%, respectively and 43.80, 48.89 and 66.51%; respectively for Patron application. On the other hand the reduction percentages in the green bolls infested by this pest associated to Trebon spraying recorded 81.82, 90.07 and 94.57%; respectively during the three months that mentioned previously.

As shown in Table (3), Trebon is considered the most promising insecticide for controlling *E. insulana* followed by Selecron compound. On the other hand, Patron treatment showed the least reduction in the green bolls infestation caused by the spiny bollworm. General reduction percentages in the green bolls infestation caused by *E. insulana* larvae in the whole season associated to the treatments with Selecron, Patron and Trebon were 91.15, 55.99 and 92.51%; respectively.

As shown in Table (3), rates of infestation with *E. insulana* in the plot treated with Trebon were lower by 8.33 & 67.65; 15.79 & 88.41; 11.11.& 83.79 and 11.75 & 82.98% during the months of July, August, September and the whole season, respectively compared with the two plots applied with Selecron and Patron. On the other hand, rates of infestation in the plot received Selecron were lower by 64.71, 86.23, 81.76 and 80.71% during the months of July, August, September and the whole season; respectively.

Table (3): Effect of spraying three tested compounds on infestation percentages by spiny bollworm *E. insulana* larvae during season 2014 with Micron ULVA sprayer.

Treatments / Inspection date	Control	Selecron	Patron	Trebon
30/6	2	2	2	2
7/7 1st spray	7	7	7	7
14/7	18	4	11	4
21/7 2nd spray	44	7	24	5
28/7	50	4	24	4
July mean	24.2	4.8	13.6	4.4
% reduction	-	80.17	43.80	81.82
4/8 3rd spray	60	5	36	4
11/8	65	4	37	4
18/8	69	5	37	4
25/8	76	5	28	4
August mean	67.5	4.75	34.5	4
% reduction	-	92.96	48.89	90.07
1/9	77	5	27	4.5
8/9	73	4.5	25	4
15/9	71	4	22	3.5
September mean	73.67	4.5	24.67	4
% reduction	-	93.89	66.51	94.57
General mean	55.12[a]	4.68[c]	24.26[b]	4.13[c]
L.S.D.between treatments	1.08			
F value	1.09 [ns]			
General reduction	**-**	91.15[b]	55.99[c]	92.51[a]
F value	6.69 [ns]			

As illustrated in Table (4), highly significant differences were obtained in the mean infestation of *E. insulana* between treatment with Patron and both Trebon and Selecron treatments in case of using motor sprayer Cifarilli. Earliest incidence of the spiny bollworm larvae of the experimental trails was on June, 30th. Number of spiny bollworm larvae was mostly lower in the two treatments of Selecron and Trebon than Patron treatment. Reduction means in the infestation percentages of bollworm larvae of plots treated with Selecron, Patron and Trebon attained 79.01, 42.56 and 81.**57%** during July; 92.70, 47.88 and 93.7% during August; 93.67, 66.02 and 94.30 during September and 91.13, 55.19 and 92.20% in the whole season, respectively.

Table (4): Effect of spraying three tested compounds on infestation percentages by spiny bollworm *E. insulana* larvae during season 2014 with motor sprayer Cifarilli.

Treatments / Inspection date	Control	Selecron	Patron	Trebon
30/6	2	2	2	2
7/7 1st spray	7	7	7	7
14/7	18	4.3	11.4	4
21/7 2nd spray	44	7.4	24.5	5.2
28/7	50	4.7	24.6	4.1
July mean	24.2	5.08	13.9	4.46
% reduction	-	79.01	42.56	81.57
4/8 3rd spray	60	5.3	36.4	4.3
11/8	65	4.1	37.5	4.2
18/8	69	5.2	37.8	4.1
25/8	76	5.1	29	4.3
August mean	67.5	4.93	35.18	4.23
% reduction	-	92.70	47.88	93.73
1/9	77	5.2	29	4.7
8/9	73	4.6	26	4.3
15/9	71	4.2	23	3.6
September mean	73.67	4.67	25.03	4.2
% reduction	-	93.67	66.02	94.30
General mean	55.12[a]	4.89[c]	24.70[b]	4.30[c]
L.S.D. between treatments	1.51			
F value	0.44[ns]			
General reduction	-	91.13[b]	55.19[c]	92.20[a]
F value	6341.95[***]			

-Comparison on basis of controlling index and potency levels:

It seams always convenient to consider the efficiency on the degree of toxicity of different insecticides by comparing them with a standard compound. In the present work, comparisons among the tested compounds are based on the control index method developed by Khidr *et al.* (2003) and the potency levels expressed as number of folds frequently used in this respect. Control index was obtained by comparing the mean reduction percentages in standard compound with each of the tested insecticides. The following equation was employed to determine the control index:

Control index= mean of % reduction of tested compound / mean of % reduction of standard insecticide X 100.

The potency levels expressed as number of folds were determined by divided reduction percentages of the tested insecticides by the standard showed the least reduction percentages.

On the other ground of the control index as shown in Table (5), the efficiency of Selecron and Patron insecticides recorded 98.92 and 60.52% as effective to Trebon against *E. insulana* respectively when the micron ULVA equipment was used for the three insecticides application and 98.84 and 55.19%; respectively in case of using Cifarilli motor sprayer for the used insecticides application.

Concerning the potency levels expressed as number of folds compared with the efficiency of Patron insecticide, the efficiency of selecron and Trebon attained 1.63 and 1.65 times as he efficacy of Patron; respectively in case of using micron ULVA equipment and 1.65 and 1.67 times as to Patron insecticide, respectively when the Cifarilli motor sprayer was used for the three insecticides application.

Table (5): Relative comparison between three insecticides applied by micron ULVA and Civarilli motor sprayer for controlling *E. insulana* in cotton field.

Insecticide used	Control index		Potency levels	
	Micron ULVA	Cifarilli motor sprayer	Micron ULVA	Cifarilli motor sprayer
Selecron	98.92	98.84	1.63	1.65
Patron	60.52	55.19	1.00	1.00
Trebon	100	100	1.65	1.67

In a similar study Salem (2002) recorded that the chemical insecticide (Herculis) was the most effective in reducing the infestation and larval content in green cotton bolls. Also, Al-Shannaf (2010) found that all the tested sprays (Profenofos, S-fenvalerate and Chlorpyrifos methyl caused highly decreasing in cotton bollworms larvae compared with untreated area.

Also, Abdalla (1991) stated that the effects of chemical control programs on the rate of infestation of cotton bolls by the *E. insulana* in Egypt. The obtained results revealed that three or four sprays through the season caused a satisfactory decrease of infestation and loss of yield. Simwat and Dhawan (1992) assessed the efficacies of conventional insecticides were the most compounds potent against cotton bollworms, while diflubenzuron alone reduced pest infestation, although diflubenzuron was less effective than the other insecticides. Abdel Megeed (2008) found that foliar treatment of Eastena Aminofert with spinosad and chloropirifos reduced levels of spiny bollworm infestation.

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/cm^2 distributed homogeneously on the treated target Himel (1969). The following general trends could be extracted from the obtained data and may help in better understanding to the experimental results, Table (6).

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. The range of droplets spectrum (VMD and N/cm^2) deposited on the natural targets by using total recommended dose, insecticides used were 140 & 169μm, and 14 & 276 N/cm^2.

Table (6)Spraying coverage on cotton plants and ground holders produced by certain ground spraying equipment, at season 2014 using total recommended dose rate tested insecticides against *Earias insulana* at Qalubiya Governorate.

Equipment	Economy Micron ULVA						Cifarilli Knapsack-motor-sprayer					
Application rate L./fed.	15						20					
Insecticide	Selecron		Patron		Trebon		Selecron		Patron		Trebon	
	N/cm^2	VMD	N/cm^2	VMD	N/cm^2	VMD	N/cm^2	VMD	N/cm^2	VMD	N/cm^2	VMD
Upper level	172	157	180	157	154	163	268	156	276	149	272	158
Middle level	170	165	140	150	134	164	252	142	268	147	260	154
Lower level	216	162	104	158	120	166	240	154	184	140	222	148
Mean	156	161	141	155	136	164	253	151	243	145	251	153
Ground	31	159	23	155	14	162	44	160	53	169	48	164
% N/Cm^2 on ground (spray lost)	6.6	-	5.4	-	3.4	-	5.8	-	4.8	-	6.4	-

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 Table (6) 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 /cm^2 in the case of Cifarilli Motor sprayer were 21.4, 20.8& 20.4 in the case of Selecron, Patron and Trebon, respectively. But, in the case of Economy Micron ULVA sprayer the percentage of the same droplets number/cm^2 were 13.3, 11.9 & 11.2 for Selecron, Patron and Trebon, respectively.

In the other hand, there were no significant differences between both the distribution percentages of droplet sizes and the droplets number/cm^2 at all targets (cards on cotton plants and cards on ground between cotton plants).

In the same time, there were a significant differences between both the distribution percentages of droplet sizes (LSD= 0.82 for equipment, 1.16 for levels and 1.006 for compounds) and for the droplets number/cm^2 (LSD=0.8 for equipment, 1.13 for levels and 0.98 for compounds).

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

Data in Table (6) showed that, Selecron at its recommended rate 750 ml/fed., Patron its recommended rate 20 gm/20L., and + its recommended rate was 625 cm/100L., using two 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 / cm^2, and droplet sizes ranged from 140 to 169 μm (VMD). The difference in the mortality percentage was due to the different mode of action of the three insecticides.

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 15 L/Fed. As spray volume, 156.9 μm and 155.5droplets/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. Tribon and Selecron revealed the best bio-efficiency results followed with Patron with the two tested sprayers (Cifarilli) motor sprayer (20 L./fed.) and Economy Micron ULVA sprayer (15 L./fed.), these results agreed with Hindy *et al.*, (2004) and Genidy *et al.,* (2005) which recommended KZ 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 and Bakr *et al*.,(2014). The data showed that Economy Micron ULVA sprayer (15 L./fed.) is the best equipment to control Spiny bollworm 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) and (2011) who mentioned that, there was a positive relationship between rate of application and spray lost on ground. Generally, Patron and Trebon are recent insecticides that avoid the activity of Spiny bollworm 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.

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تقييم نوعين من آلات الرش الأرضية فى مكافحة دودة اللوز الشوكية فى حقول القطن

رحاب عبد المطلب عبد المقصود ، محمد سالم محمد سالم ، همت زكريا محمد مصطفى و نبيله سعد احمد هيكل

معهد بحوث وقاية النباتات – الدقي – الجيزة

ثلاث مبيدات (سليكرون ، تريبون ، باترون) تم رشهم باستخدام وسيلتين رش أرضية و هما موتور الرش الظهري (سيفاريللي) بحجم رش قدره (٢٠ لتر\فدان) و الرشاشة الاقتصادية ذات القرص الدوار (ميكرون اولفا) بحجم رش قدره (١٥ لتر\فدان) على حقل قطن مصاب اصابة شديدة بيرقات دودة اللوزالشوكية موسم قطن ٢٠١٤ .

تم الحصول على تغطية مرضية على نباتات القطن المعاملة و تراوح مدى طيف قطيرات الرش ما بين ١٤٠-١٦٩ ميكرون مع أعداد كافية من القطيرات/سم² تراوحت ما بين ١٤-٢٧٦ قطيرة/سم² في المعاملات المختلفة . وكانت انتاجية الموتور الظهري ١٢ فدان/يوم باثنان من العمال بينما أقل كفاءة كانت الرشاشة الاقتصادية ذات القرص الدوار تستطيع رش 3.04 فدان/يوم باثنين من العمال .

كما أوضحت النتائج أن مبيدى تريبون والسليكرون يعتبرا متساويين فى السمية تقريبا لتكون فعالة فى مكافحة يرقات دودة اللوز الشوكية على نباتات القطن عن مبيد الباترن بحجم الرش ١٥ لتر/فدان الناتج من استخدام ا لرشاشة ميكرون اولفا حقق أعلى النتائج يليه موتور الظهر سيفاريللي بمعدل ٢٠ لتر/فدان .

فعالية المبيدات المختبرة مكن ترتيبها تنازليا كالآتى : تريبون ، سيليكرون وباترون . معدلات الخفض العام كانت ٩١.١٥ و ٥٥.٩٩ و ٩٢.٥١ % فى حالة إستخدام الرشاشة الاقتصادية ذات القرص الدوار و ٩١.١٣ و ٥٥.١٩ و ٩٢.٢٠ % فى حالة إستخدام موتور الرش الظهري (سيفاريللي) ، على التوالى .

يمكن التوصية بأن استخدام أحجام القليلة أكثر اقتصادية في مكافحة دودة اللوز الشوكية وتقليل الوقت في اعادة التعبئة وتحقيق تجانس محلول الرش على نباتات القطن المعاملة توقير الفاقد من الرش على نباتات القطن .