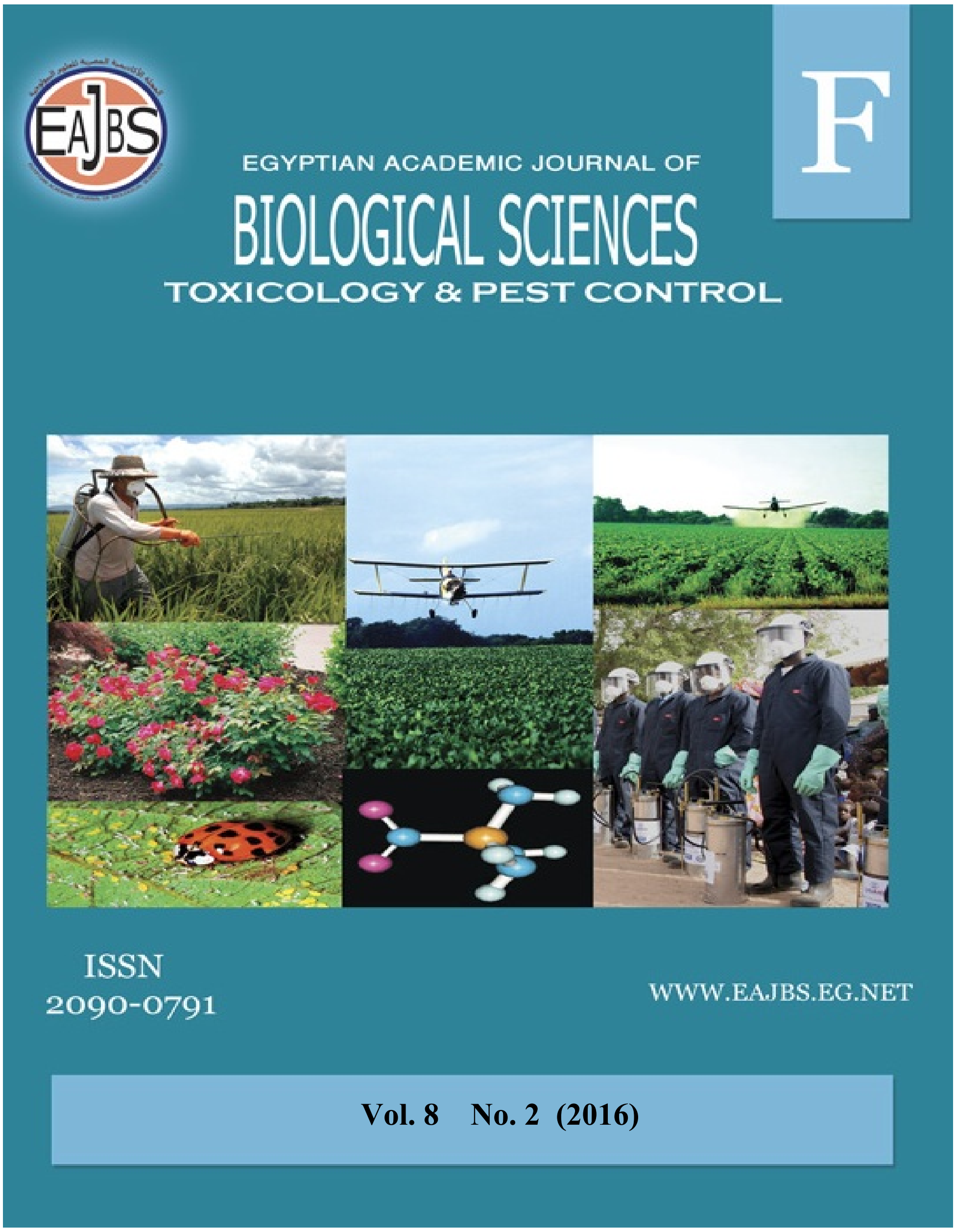

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Efficacy of Three Bioinsecticide and A methomyl Insecticide Against Cotton Leafworm Larvae, *Spodoptera littoralis* under Controlled Semi-field Conditions at El-Behara Governorate

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ABSTRACT

In order to evaluate the effect of time elapse and field conditions on the efficacy of three bioinsecticides and a methomyl insecticide against cotton leafworm, *Spodoptera littoralis*, 2nd and 4th instar larvae, a semi-field experiment was designated. The study was carried out throughout 2015 and 2016 growing seasons at El-Dakhaly village, the western side of Rashid branch, Kom Hamada Center, Beheira Governorate. Obtained results showed gradual increased mortality rates when 2nd and 4th instar larvae of *S. littoralis* fed on treated cotton leaves with LC_{50} of tested bioinsecticides until reaching the 5th day post application. Starting from the 6th day post application a gradual increased larval mortality rates were observed in both 2nd and 4th instar larvae in both growing seasons. Obtained data also showed gradual decrease in mortality rates was observed along nine days post application with LC_{25} of Kuik® in both 2015 and 2016 growing seasons.

INTRODUCTION

The cotton leafworm *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae) is an extremely dangerous pest, the larvae of which can defoliate many economically important crops cutting across over 40 families (EPPO, 2008) or 112 plants belonging to 44 families (Moussa *et al.*, 1960 and Hatem *et al.*, 2009) in a broad geographical area including Southern Spain, the Middle East, and both Northern and Central Africa (Carter, 1984 and Gómez and Arroyo, 1994). In Egypt, it is destructive phytophagous lepidopterous pest causing various ravages not only for cotton plants (Ahmad, 1988 and Hatem *et al.*, 2009) but also for other field crops, vegetables (Hosny*et al.*, 1986), ornamentals and orchard trees (Domínguez and Plagas, 1993 and Belda *et al.*, 1994) all over the year in Egypt (Hamouda and Dahi, 2008). Without a hibernation period, cotton leafworm is active all year round, attacking cotton as well as more than 29 hosts from other crops and vegetables. The rate of cotton leafworm infestation can reach up to 50,000 egg-masses/acre, causing severe damage to leaves, buds, flowers, and bolls (Temerak, 2006).

Development of an effective control method against the cotton leaf worm, *Spodoptera littoralis*is urgently needed since it does serious damage to many important agricultural crops in Egypt (Ahmed and El-Katatny, 2007). To control the attacks of this pest several types of insecticides have been used, including synthetic pyrethroids, organophosphates, and non-steroidal compounds (Casida and Quistad, 1998). The extensive use of these insecticides has caused resistant insect strains to emerge (Davies *et al*., 2007 and Mosallanejad and Smagghe, 2009) and serious toxicological problems to humans and the environment (Costa *et al*., 2008 and Relyea, 2009). There is a serious interest in the use of microbial insecticides for biological control of the cotton leafworm, as alternatives to chemical control, since they neither leave toxic chemical residues in the environment nor do they develop resistance in their insect hosts. A promising strategy with good potential to control insect pests and, at the same time, to minimize the adverse effects of chemical insecticides is the use of microbial agents (Ahmed and El-Katatny, 2007). These groups have unique modes of action (Asher, 1993 and Thompson *et al*., 1999) and their properties may differ considerably from the conventional agents with which growers are familiar. In order to accomplish this purpose, three bioinsecticides ((Protecto® (*Bacillus thuringiensis kurstaki*), Viruset® (*Spodoptera littoralis* NPV), and Profect® (*Btk* & *Spl*iNPV)), and the organic insecticide (KUIK®), a carbamate acetylcholinesterase inhibitor, were applied against the 2nd and 4th instar larvae of *S. littoralis* to evaluate their durability under semi-field conditions through two consecutive growing seasons; 2015 and 2016.

MATERIALS AND METHODS

Insects used:

A laboratory susceptible strain of the cotton leaf worm *Spodopter littoralis* (Boisd.) (Lepidoptera: Noctuidae), reared for more than 10 generations was obtained from the Research Division of the cotton leaf worm, Plant Protection Research Institute. Insects were reared under controlled conditions in an incubator at 26 ± 2º C, of 65 ± 10% R. H., and 8:16 L: D photoperiod at the Plant Protection Research Institute, Dokki-Giza, Egypt (El-Sawaf, 1971).

Tested compounds:

Three commercial bioinsecticides; Protecto® (*Bacillus thuringeinsiskurstaki*), Viruset® (*Spodoptera littoralis* NPV), and Profect® (mixture of *Btk* & *SL*NPV); as wettable powders, and the organic insecticide (KUIK®); as soluble powder, were evaluated for their toxicity on the 2nd and 4th instar larvae of the cotton leaf worm, *Spodoptera littolaris*. All tested bioagents were obtained from Plant Protection Research Institute Biopesticide Unit Production, while the organic insecticide, KUIK, was obtained from ROTAM Agrochemical Company- Egypt. The previously assignedLC_{50} of tested bioinsecticides and LC_{25} of the organic insecticide were used (Abd El-Kareem, 2012).

Semi-field studies:

In order to evaluate the effect of time elapse and field conditions on the efficacy of tested compounds, a semi-field experiment was designated. The study was carried out throughout 2015 and 2016 early spring cotton season at El-Dakhaly village, the western side of Rashid branch, Kom Hamada Center, Beheira Governorate. The field area was cultivated with Giza88 cotton variety on March 15th, 2015 and March 15th 2016, respectively. The standard agricultural practices were applied. The experimental area was divided into plates of 1/16 feddan (262.5 m^2). The treatment was arranged in randomized complete blocks design (RCBD) with four replicates each. Application of tested compounds was on July11th in both growing seasons. Temperature degrees in the experiment area were 35-38 ± 2° C and the relative humidity was 65-75 ± 10%.The cotton leaves were sprayed using a backpack sprayer and collected on a daily basis for nine sequential days. Treated and untreated leaves were then supplied daily to separate sets of 2nd and 4th instar larvae of the cotton leaf worm. Mortalities were recorded daily 24 and 48 hrs after treated cotton leaves with chemical insecticide and bioinsecticides, respectively, were offered to larvae.

Statistical analysis:

Data were statistically analyzed by ANOVA procedure (Snedecor and Cochran, 1980) at $P<0.05$ using SPSS statistics 17.0 release 17.0.0 software. When the ANOVA statistics were significant at ($P\leq 0.01$), means were compared by the Duncan's multiple range test using SPSS 17.0 software. Mortality percentage was corrected according to Abbott's formula (Abbott, 1925).

RESULTS

Data presented in tables (1 and 2) show the efficiency of the tested compounds against 2nd and 4th larval instars under semi-field conditions during 2015 growing season.

Table 1: Effect of treated cotton leaves with tested compounds on the 2nd instar larvae of cotton leafworm, *Spodoptera littoralis* under semi-field conditions during 2015 growing season

Tested compounds	% Corrected mortality after										% General mean
	0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	
Protecto®	22.20	37.80	46.60	62.20	66.60	71.10	37.80	20.00	11.10	5.50	42.32
Viruset®	26.60	35.50	42.20	51.10	62.20	66.60	35.50	17.80	16.60	8.90	40.33
Profect®	26.60	37.80	44.40	53.30	66.60	73.33	37.80	17.80	13.30	11.10	42.45
Kuik®	55.50	48.90	42.20	33.30	28.90	22.20	20.00	17.80	16.60	13.30	33.19
Control	0	1	0	2	1	1	2	0	0	1	0.89

Table 2: Effect of treated cotton leaves with tested compounds on the 4th instar larvae of cotton leafworm, *Spodoptera littoralis* under semi-field conditions during 2015 growing season

Tested compounds	% Corrected mortality after										% General mean
	0 day	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	
Protecto®	23.90	34.80	39.10	45.60	52.20	67.40	63.00	56.50	32.60	28.20	49.25
Viruset®	13.00	28.20	34.80	39.10	45.60	60.80	56.50	50.00	23.90	19.50	41.26
Profect®	13.00	28.20	34.80	41.30	45.60	63.00	58.70	52.20	23.90	18.50	42.13
Kuik®	50.00	45.60	41.30	34.80	32.60	23.90	18.50	13.00	10.80	7.60	30.90
Control	0	1	2	2	1	2	0	1	0	1	1.11

Obtained results showed gradual increased mortality percentage of the 2nd and 4th instar larvae of *S. littoralis* from day one till day five when the LC_{50} of tested bioinsecticides were applied. After the 5th day of application, a gradual decrease in mortality rates in 2nd and 4th instar larvae was detected till the 9th day post application with bioinsecticides. Obtained data also showed gradual decrease in mortality rates was observed along the nine days post application with LC_{25} of Kuik®. Results also showed that the both Profect® and Protecto® exhibited the highest larval mortality percentage at the 5th day post application when applied on 2nd instar larvae (73.33% and 71.10%, respectively) and 4th instar larvae (63.00% and 67.40%, respectively). The lowest larval mortality rate was observed on the 9th day post treatment with LC_{50} of Protecto® in case of the 2nd instar larvae (5.50%). The lowest larval mortality was obtained when 4th instar larvae were treated with LC_{25} of Kuik® (7.60%).

Data presented in tables (3 and 4) show the efficiency of the tested compounds against 2nd and 4th larval instars under semi-field conditions through 2016 growing season.

Table 3: Effect of treated cotton leaves with tested compounds on the 2nd instar larvae of cotton leafworm, *Spodoptera littoralis* under semi-field conditions during 2016 growing season

Tested compounds	% Corrected mortality after										% General mean
	0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	
Protecto®	20.90	35.80	44.55	60.24	67.64	73.11	37.80	24.03	13.12	9.58	42.97
Viruset®	19.33	35.53	43.23	56.15	66.66	68.61	35.51	19.89	16.25	8.90	41.11
Profect®	25.33	36.98	44.40	59.87	69.60	74.33	34.89	18.99	14.25	12.11	43.41
Kuik®	49.97	43.55	39.87	29.78	22.06	20.50	17.80	16.60	13.30	8.89	29.14
Control	0	1	0	2	1	1	2	0	0	1	0.89

Table 4: Effect of treated cotton leaves with tested compounds on the 4th instar larvae of cotton leafworm, *Spodoptera littoralis* under semi-field conditions during 2016 growing season

Tested compounds	% Corrected mortality after										% General mean
	0 day	1 day	2 days	3 days	4 days	5 days	6 days	7 days	8 days	9 days	
Protecto®	22.09	33.67	39.12	46.62	55.25	69.45	60.33	56.34	30.60	28.20	49.07
Viruset®	10.22	25.25	33.81	37.11	46.66	59.89	56.54	50.22	22.91	19.98	40.28
Profect®	13.50	28.11	34.44	43.33	47.66	68.09	58.76	53.13	23.90	20.01	43.43
Kuik®	47.77	39.87	33.87	27.78	20.36	19.09	16.80	14.62	11.33	7.80	26.58
Control	0	1	2	2	1	2	0	1	0	1	1.11

Obtained results showed gradual increased mortality rates when 2nd and 4th instar larvae of *S. littoralis* fed on treated cotton leaves with LC_{50} of tested bioinsecticides until reaching the 5th day post application. Starting from the 6th day post application a gradual increased larval mortality rates were observed in both 2nd and 4th instar larvae. Obtained data also showed gradual decrease in mortality rates was observed along nine days post application with LC_{25} of Kuik®.

DISCUSSION

Obtained results showed gradual increased larval mortality rates in 2nd and 4th instar larvae in all tested bioinsecticides in both growing season till the 5th day post application. In addiotion, gradual decrease in larval mortality was detected started from the 6th day of application. Moreover, the 2nd instar larval mortality was greater than the 4th instar larval mortality suggesting that the 2nd instar larvae were more susceptible than the 4th instar larvae. These results agreed with Alaa-Eddeen (2008) who found that the newly molted 2nd instar larvae of *S. littoralis* were susceptible to *Spli*NPV. Furthermore, our results agreed with Schroer *et al.* (2005) who indicated that use *Bacillus thuringiensis* and *Bacillus subtilis* in field experiment to controlling larvae of *Spodoptera littoralis* was efficient compared with Reldan as a phosphorus compound. Our results were also consistent with those of Abdel-Hai and El-Sherif (2012) who found gradual larval mortality rates of the 2nd instar larvae of *S. littoralis* when fed on cotton leaves treated with the same tested bioinsecticides.

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ARABIC SUMMERY

تقييم فاعلية بعض المركبات الحيوية ومركب كيميائي ضد دودة ورق القطن على نبات القطن فى محافظة البحيرة

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تم إجراء تجربة شبه حقلية لتقييم تأثير مرور الوقت والظروف الحقلية على فعالية ثلاثة مركبات حيوية ومركب ميثوميل ضد دودة ورق القطن يرقات العمرين الثاني والرابع على نبات القطن. وتمت الدراسة على مدار موسمين ٢٠١٥ و ٢٠١٦ في قرية الدخلي، على الجانب الغربي من فرع رشيد، مركز كوم حمادة، محافظة البحيرة.وأظهرت النتائج التي تم الحصول عليها زيادة تدريجية فى معدل موت يرقات العمرين الثاني والرابع حتى اليوم الخامس من المعاملة بالتركيز القاتل للنصف للمركبات الحيوية خلال موسمي المعاملة. كما أظهرت النتائج انخفاض تدريجي فى معدل موت اليرقات للعمرين الثاني والرابع خلال الموسمين. عند المعاملة بالتركيز القاتل ل٢٥% من مركب الميثوميل كما وجد انخفاض تدريجي فى معدل موت يرقات كلا العمرين.