

Efficiency of four bioinsecticides and their combinations with chlorpyrifos as a new approach for integrated management of *Spodoptera littoralis*

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ABSTRACT

The efficiency of four bioinsecticides; XenTari, Rokur, Ecotech Bio and Dipel-2X applied at recommended rate and their combinations with insecticide, chlorpyrifos at 0.25 and 0.5 of its rate alone, compared with chlorpyrifos at 0.25, 0.5 and 1 of recommended rate, was investigated against the cotton leafworm, *Spodoptera littoralis*. The results showed that the synthetic insecticide chlorpyrifos with all tested concentrations was rapid effective at zero time. The mixtures of 0.5 and 0.25 fold of recommended dose of chlorpyrifos gave less LT_{50} values compared to each bioinsecticide alone. The activity of chlorpyrifos appeared and disappeared rapidly with the time. To kill 95% of second and fourth instar larvae after 24h feeding by pretreated cotton leaves, needs about 36 hours for chlorpyrifos alone while about 6 days for Dipel-2X and Ecotech Bio and 10 days for other tested bioinsecticides. The bioinsecticides Ecotech Bio alone and Dipel-2X alone were statistically lowest active. Although, the combination of Ecotech Bio with chlorpyrifos and Dipel-2X with chlorpyrifos at 0.5 and 0.25 its rate were highest active treatments against fourth instar larvae. Mixtures of Dipel-2X and Ecotech Bio with chlorpyrifos at 0.25 of its rate or XenTari and Rokur with chlorpyrifos at 0.5 its rate can be integrated in IPM programm of cotton.

INTRODUCTION

The alternative methods for controlling agricultural pests have received a great deal of attention in the last couple of decades because of the deleterious side effects resulted from the intensive use of conventional insecticides. The use of natural plant products as insect toxicants, antifeedants, oviposition deterrents, insect growth inhibitors and biopesticides is considered one of the promising tactics in insect pest

management (Freeman and Andow, 1983; Klocke, 1987; Srivastava *et al.*, 1990; Hough-Goldstein and Hahn, 1992 and Menn and Hall, 1999). Implementation of integrated pest control tactics will help to reduce pests and environmental hazard problems. This strategy involved use of the lowest possible level of a pesticide, restricting chemical application to part of the crop fields and timing the treatments (El-Saedy *et al.*, 1998). Although pest-controlling by chemical pesticides have an important role in management insect pest attacking crops, the extensive use of synthetic pesticides has inevitably been followed by target pest resurgence, secondary pest outbreaks, development of insecticide resistance in target pests and disruption of the natural enemies (Chao and Allen, 1986 and Kristensen *et al.*, 1998) and increased pesticide residues in the agriculture ecosystem (Metcalf, 1980).

The Egyptian cotton leafworm, *Spodoptera littoralis* Boisduval, (Lepidoptera : Noctuidae) is one of the major pests in the near east. It has quickly developed resistance to chemical pesticides (Chung and Cote, 1992). Therefore, the cotton leafworm in Egypt exhibits multiple resistance to nearly all insecticides used (El-Sebae, 1977).

In recent years, much attention has been paid to the use of the *Bacillus thuringiensis* (B.t.) against *S. littoralis* (Klein *et al.*, 1996 and Abdel-Halim, 1997). *B.thuringiensis* is completely compatible with some insecticides and fungicides (Hardman and Gaul, 1990). The mixtures of B.t. and synthetic insecticides, endosulfan and chlorpyrifos-methyl (Pree and Daly, 1996) cypermethrin and deltamethrin (Hardman and Gaul, 1990) fenvalerate and pyriproxyfen (Abou-Taleb, 2000) have been evaluated against various insects.

The present investigation aimed to study the efficiency of some bioinsecticides either alone or in their combination with different ratio of chlorpyrifos against the cotton leafworm, *S. littoralis*.

MATERIALS AND METHODS

Experimental design: The experiment was conducted during 2001 cotton season at Alexandria University Experiment Station at Abees area. The

cultivated cotton variety was Giza 70. The treatments were arranged in a complete randomized block design. Four replicates (1/100 feddan "fed.", 6x7m² per each) were used for each treatment including the check. All cultural methods were carried out according to good agricultural practice.

Tested chemicals: Chlorpyrifos (Chlorozan), 48% (EC) [O,O-Diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate]; 1 L/fed. Biological insecticides *Bacillus thuringiensis subsp. Aizawai*; XenTari, 10.3% (Water Dispersible Granule), 300g/fed. and *subsp. Kurstaki*; Roker, 10% (WP), 300g/fed., Ecotech Bio, 10% (WP), 300g/fed. and Dipel 2X, 6.4% (WP), 500 g/fed.

Tested insect: The cotton leafworm, *S. littoralis* (Boisd), was obtained from a stock culture maintained under constant condition of 28±1°C and 65±5% R.H. The culture started with egg-mass introduced from the Plant Protection Research Center, Dokki, Giza Governorate. The larvae provided with fresh castor oil leaves daily.

Field application: The following treatments were tested by spraying the calculated amounts in 400 liter water/fed. using a hand pressure sprayer equipment; chlorpyrifos at a rate of 1 L/fed., 0.5 L/fed. and 0.25 L/fed., Dipel 2X at a rate of 500 g/fed. and its mixtures with chlorpyrifos at 0.5 L/fed. and 0.25 L/fed., XenTari at a rate of 300g/fed. and its mixtures with chlorpyrifos at 0.5 L/fed. and 0.25 L/fed., Roker at a rate of 300g/fed. and its mixtures with chlorpyrifos at 0.5 L/fed. and 0.25 L/fed. and Ecotech Bio at a rate of 300g/fed. and its mixtures with chlorpyrifos at 0.5 L/fed. and 0.25 L/fed. Cotton leaves from treated and untreated plots were collected from three levels of plants in perforated paper bags at intervals 0, 1, 4, 9 and 12 days after application.

Bioassay procedure: Three leaves of each sample were placed in 1 liter glass jar containing 20 larvae of second instar or 10 larvae of fourth instar cotton leafworm. Larvae were exposed to collected treated cotton leaves at 0, 1, 4, 9 and 12 days for 24h, then untreated cotton leaves were replaced and changed daily over consecutive 9 days. Five replicates were made for each treatment besides the check one. Second and fourth larval instars of laboratory colony were used and mortality counts were recorded daily over 10 days for each interval. The toxicity index was obtained according to Finney (1971). Also, the data were subjected to analysis of variance (ANOVA) (CoStat Statistical Software, 1990).

RESULTS AND DISCUSSION

Insect pathogens are considered today as possible substitute and as means of reducing the use of chemicals in the environment (Ali, 2001). Numerous investigations have been published on the use of B.t. for the control of lepidopteran insects, but the variability in the results obtained in the field has not been adequately explained (Abd-Allah, 2000). Application of bioinsecticides alone or in combination with chemical insecticides would consider being the future challenge in the practical application of B.t. in insect control. Thus, present work shows the results of a field study using several bioinsecticides and synthetic insecticide, chlorpyrifos and their combinations to control this insect.

Data presented in Table (1) indicate that all the tested concentrations of chlorpyrifos gave fast effective against the second instar larvae at zero time with LT_{50} being 0.4, 0.39 and 0.99 days for the concentrations of 1, 0.5 and 0.25 recommended rate, respectively. The highest LT_{50} values were observed by all bioinsecticides at zero time then these values decreased with the time sampling but increased again at day 9 and day 12. This result indicates that the important of application time, it is a good agreement with results of Abou-Taleb (2000) who reported that the use of B.t. with careful appropriate time of application. Mixtures of 0.5 and 0.25 recommended rate of chlorpyrifos gave less LT_{50} values compared to each bioinsecticide alone at zero time. Also, Pree and Daly (1996) obtained the data suggest that the mixtures of B.t. and small quantities of endosulfan could result in increased effectiveness over B.t. alone.

The LT_{50} values of tested bioinsecticides and their mixtures with chlorpyrifos against 4th instar *Spodoptera* larvae are shown in Table (2). The LT_{50} values of XenTari and Rokur were less than that of Ecotech Bio and Dipel-2X at all time intervals. The LT_{50} values of mixture chlorpyrifos, 0.5 or 0.25 recommended rate with Rokur, Ecotech Bio or Dipel-2X were less than that of each tested bioinsecticide alone at all time intervals. The LT_{50} value of synthetic insecticide chlorpyrifos alone was 0.5 day at zero time while 6.5 days at day 12. This result indicated that the residual activity of chlorpyrifos disappeared rapidly. Most of the insecticides were more active through the first week of treatment then the efficacy declined afterwards, that may be due to their fast degradation rate at the field (Rezk *et al* 1996).

Table (1): LT₅₀ Values (days) of tested bioinsecticides and their blends with chlorpyrifos at recommended rate (1F), 0.5 rate (0.5F) and 0.25 rate (0.25F) against second *Spodoptera* instar larvae fed on pretreated leaves for 24h

Treatments	Rate	LT ₅₀ at intervals in days				
		0	1	4	9	12
XenTari	1F	LT ₅₀ 1.07 Slope (± SE) 1.72 (± 0.04)	LT ₅₀ 1.58 Slope (± SE) 3.42 (± 0.06)	LT ₅₀ 1.16 Slope (± SE) 2.68 (± 0.08)	LT ₅₀ 2.99 Slope (± SE) 1.57 (± 0.02)	LT ₅₀ 16.38 Slope (± SE) 0.97 (± 0.03)
Rokur	1F	2.09 2.25 (± 0.03)	1.94 2.79 (± 0.04)	1.6 3.00 (± 0.06)	3.06 2.19 (± 0.02)	7.03 1.60 (± 0.06)
Ecoleth Bio	1F	3.05 2.89 (± 0.04)	1.55 1.99 (± 0.03)	0.8 1.88 (± 0.06)	2.03 1.50 (± 0.03)	4.23 2.65 (± 0.04)
Dipel 2X	1F	2.19 3.39 (± 0.05)	1.87 2.94 (± 0.04)	1.73 3.12 (± 0.06)	2.48 2.10 (± 0.03)	6.74 1.49 (± 0.05)
Chlorozan	1F	0.4 1.73 (± 0.10)	1.02 2.56 (± 0.07)	1.7 2.95 (± 0.07)	2.77 1.98 (± 0.03)	6.72 2.66 (± 0.06)
XenTari + Chlorozan	1F + 0.5F	0.19 1.28 (± 0.07)	1.38 2.37 (± 0.04)	1.57 2.49 (± 0.04)	1.99 2.13 (± 0.03)	3.81 2.32 (± 0.04)
Rokur + Chlorozan	1F + 0.5F	0.67 1.46 (± 0.03)	1.88 2.07 (± 0.03)	1.32 2.54 (± 0.06)	2.9 2.10 (± 0.03)	6.38 5.70 (± 0.22)
Ecoleth Bio + Chlorozan	1F + 0.5F	0.15 1.50 (± 0.17)	1.09 2.11 (± 0.04)	1.61 2.09 (± 0.04)	2.68 2.27 (± 0.03)	3.35 2.67 (± 0.04)
Dipel 2X + Chlorozan	1F + 0.5F	0.35 2.46 (± 0.49)	1.32 2.40 (± 0.04)	1.19 2.47 (± 0.06)	1.55 2.71 (± 0.04)	1.79 2.94 (± 0.04)
Chlorozan	0.5F	0.39 3.08 (± 0.89)	1.37 2.62 (± 0.06)	2.04 4.79 (± 0.13)	2.17 3.81 (± 0.07)	2.33 2.82 (± 0.05)
XenTari + Chlorozan	1F + 0.25F	0.89 2.15 (± 0.05)	2.36 2.90 (± 0.05)	1.6 3.12 (± 0.06)	2.16 1.57 (± 0.03)	7.84 1.81 (± 0.04)
Rokur + Chlorozan	1F + 0.25F	0.39 1.92 (± 0.12)	2.21 2.28 (± 0.03)	1.31 4.56 (± 0.15)	2.17 2.67 (± 0.03)	4.44 3.85 (± 0.07)
Ecoleth Bio + Chlorozan	1F + 0.25F	0.17 2.12 (± 0.92)	3.94 2.80 (± 0.03)	1.55 3.69 (± 0.07)	2.5 3.45 (± 0.05)	4.00 3.32 (± 0.05)
Dipel 2X + Chlorozan	1F + 0.25F	0.03 0.98 (± 0.21)	1.72 2.60 (± 0.05)	1.35 4.54 (± 0.14)	2.25 2.67 (± 0.04)	3.53 2.88 (± 0.04)
Chlorozan	0.25F	0.99 3.00 (± 0.10)	1.79 3.06 (± 0.05)	3.21 4.05 (± 0.08)	3.34 3.75 (± 0.05)	3.78 3.68 (± 0.06)

Table (2): LT_{50} Values (days) of tested bioinsecticides and their blends with chlorpyrifos at recommended rate (1F), 0.5 rate (0.5F) and 0.25 rate (0.25F) against fourth *Spodoptera* instar larvae fed on pretreated leaves for 24h

Treatments	Rate	LT_{50} at intervals in days				
		0	1	4	9	12
Xentari	1F	LT_{50} 1.92 Slope ($\pm$ SE) 2.95 ($\pm$ 0.04)	LT_{50} 1.45 Slope ($\pm$ SE) 2.81 ($\pm$ 0.05)	LT_{50} 1.03 Slope ($\pm$ SE) 2.11 ($\pm$ 0.05)	LT_{50} 2.26 Slope ($\pm$ SE) 2.24 ($\pm$ 0.03)	LT_{50} 4.24 Slope ($\pm$ SE) 3.42 ($\pm$ 0.05)
Rokur	1F	1.89 2.47 ($\pm$ 0.03)	1.95 3.18 ($\pm$ 0.05)	1.48 2.60 ($\pm$ 0.05)	2.36 2.32 ($\pm$ 0.03)	3.98 2.93 ($\pm$ 0.05)
Ecotech Bio	1F	2.15 2.90 ($\pm$ 0.04)	1.77 3.03 ($\pm$ 0.05)	2.56 4.35 ($\pm$ 0.09)	3.48 3.16 ($\pm$ 0.05)	5.25 3.17 ($\pm$ 0.06)
Dipel 2X	1F	2.63 3.13 ($\pm$ 0.04)	1.86 2.88 ($\pm$ 0.05)	3.05 3.35 ($\pm$ 0.04)	3.87 2.12 ($\pm$ 0.02)	6.91 1.61 ($\pm$ 0.03)
Chlorozan	1F	0.5 3.03 ($\pm$ 0.48)	1.08 3.24 ($\pm$ 0.08)	1.17 3.44 ($\pm$ 0.10)	2.39 1.62 ($\pm$ 0.02)	6.45 1.90 ($\pm$ 0.04)
Xentari + Chlorozan	1F + 0.5F	2.08 2.84 ($\pm$ 0.04)	1.79 2.80 ($\pm$ 0.04)	1.95 2.61 ($\pm$ 0.04)	3.06 2.53 ($\pm$ 0.04)	4.6 3.80 ($\pm$ 0.07)
Rokur + Chlorozan	1F + 0.5F	0.41 1.50 ($\pm$ 0.05)	1.69 3.11 ($\pm$ 0.05)	1.39 1.86 ($\pm$ 0.02)	2.52 2.43 ($\pm$ 0.03)	3.96 3.32 ($\pm$ 0.05)
Ecotech Bio + Chlorozan	1F + 0.5F	0.15 1.21 ($\pm$ 0.11)	1.07 3.20 ($\pm$ 0.09)	1.08 1.86 ($\pm$ 0.03)	1.77 1.86 ($\pm$ 0.03)	3.04 2.33 ($\pm$ 0.04)
Dipel 2X + Chlorozan	1F + 0.5F	0.41 1.75 ($\pm$ 0.07)	1.69 3.27 ($\pm$ 0.06)	1.38 3.03 ($\pm$ 0.08)	2.6 2.25 ($\pm$ 0.03)	5.39 3.39 ($\pm$ 0.07)
Chlorozan	0.5F	0.43 1.39 ($\pm$ 0.04)	1.42 2.78 ($\pm$ 0.04)	0.82 2.57 ($\pm$ 0.10)	1.39 1.87 ($\pm$ 0.03)	2.66 2.28 ($\pm$ 0.03)
Xentari + Chlorozan	1F + 0.25F	1.83 2.94 ($\pm$ 0.04)	1.28 2.75 ($\pm$ 0.05)	0.99 1.70 ($\pm$ 0.03)	1.76 2.24 ($\pm$ 0.03)	2.85 3.15 ($\pm$ 0.04)
Rokur + Chlorozan	1F + 0.25F	1.18 2.75 ($\pm$ 0.05)	2.01 3.22 ($\pm$ 0.05)	0.64 1.70 ($\pm$ 0.05)	1.82 2.10 ($\pm$ 0.03)	3.62 3.43 ($\pm$ 0.05)
Ecotech Bio + Chlorozan	1F + 0.25F	0.59 1.80 ($\pm$ 0.05)	1.97 2.63 ($\pm$ 0.03)	1.31 2.48 ($\pm$ 0.04)	2.04 2.48 ($\pm$ 0.03)	3.1 2.63 ($\pm$ 0.04)
Dipel 2X + Chlorozan	1F + 0.25F	0.49 2.01 ($\pm$ 0.11)	2.1 2.50 ($\pm$ 0.03)	1.73 2.29 ($\pm$ 0.03)	2.45 2.10 ($\pm$ 0.03)	3.96 2.03 ($\pm$ 0.03)
Chlorozan	0.25F	1.32 2.41 ($\pm$ 0.03)	1.79 2.88 ($\pm$ 0.04)	0.74 2.13 ($\pm$ 0.08)	0.94 2.24 ($\pm$ 0.08)	1.45 2.48 ($\pm$ 0.07)

The results in Table (3) show the toxicity index of tested treatments against second and fourth instar larvae exposed 24h to pretreated cotton leaves which sampled at zero time. The most active compound is chlorpyrifos alone. Mixture of XenTari + chlorpyrifos at 0.5 or 0.25 of its rate reduced the LT_{95} of second and fourth instar larvae by approximately 55% compared to XenTari alone. Rokur + chlorpyrifos at 0.25 of its rate reduced the LT_{95} values by 40% for fourth instar larvae and by 75% for second instar larvae compared to Rokur alone. Also, LT_{95} values of mixture Ecotech Bio or Dipel-2X + 0.5 or 0.25 recommended rate of chlorpyrifos were reduced by about 80% and 60% against second and fourth instar larvae, respectively. It was observed that the kill 95% of second and fourth instar larvae, at zero time, needs about 36 hours in the case of chlorpyrifos alone while about 6 days in the case of Dipel-2X and Ecotech Bio and 10 days in the case of other tested bioinsecticides. In other words, response of *S. littoralis* to tested bioinsecticides takes long period of time than chlorpyrifos and the response to Dipel-2X and Ecotech Bio takes short period of time than the other tested bioinsecticides to occur. This is consistent with the finding of Ali (2001).

The means of mortality percentages resulted from exposing 2nd and 4th instar larvae to different tested treatments are summarized in Table (4). The statistical analysis indicated that the high percentage of second instar larvae mortalities was recorded as 98% at zero interval time for chlorpyrifos, half recommended rate and mixture of chlorpyrifos + Ecotech Bio or Dipel-2X. The average of mortality percentage for second instar larvae throughout the experiment time indicated that mixture of Dipel-2X + chlorpyrifos, half rate was the most active treatment (88% mortality), while all tested bioinsecticides were less active. No statistical differences among the mixtures of tested bioinsecticides and chlorpyrifos in both concentrations 0.5 or 0.25 its rate. The bioinsecticides Ecotech Bio alone and Dipel-2X alone were statistically lowest active. Although, the combination of Ecotech Bio with chlorpyrifos and Dipel-2X with chlorpyrifos in both concentrations 0.5 and 0.25 its rate were highest active treatments against fourth instar larvae. Hardman and Gaul (1990) indicate enhanced effects of B.t. in combination with various insecticides. In addition, Ali (2001) found that the efficacy of Bts has a very good additive toxicity for chlorpyrifos either in laboratory or the field *Spodoptera* strains.

Table (3): Toxicity index values (Ti) of tested bioinsecticides and their blends with chlorpyrifos at recommended rate (1F), 0.5 rate (0.5F) and 0.25 rate (0.25F) against second and fourth Spodoptera instar larvae fed on pretreated leaves at zero time for 24h

Treatments	Rate	Toxicity index at 95% Confidence limits					
		Second instar larvae			Fourth instar larvae		
		LT ₅₀	LT ₅₀	LT _i	LT ₅₀	LT ₅₀	LT _i
Xentari	1F	233 (323.3 - 173.5)	25.7 (33.4 - 19.4)	2.88 (5.8 - 1.2)	156 (189.8 - 146.4)	46.08 (51.12 - 41.28)	12.72 (15.32 - 9.84)
Rokur	1F	271 (337.9 - 220.3)	50.2 (56.9 - 44.2)	9.36 (13.2 - 6.5)	211 (245.3 - 181.9)	45.36 (51.36 - 40.10)	9.84 (13.2 - 7.20)
Ecotech Bio	1F	272 (322.8 - 230.6)	73.2 (79.7 - 67.2)	19.7 (24.5 - 15.8)	190 (220.3 - 164.6)	51.6 (56.88 - 46.56)	13.92 (17.76 - 10.80)
Dipel 2X	1F	160 (183.6 - 140.6)	52.6 (57.4 - 48.0)	17.3 (21.1 - 13.9)	211 (243.4 - 184.1)	63.12 (68.64 - 53.12)	18.72 (23.04 - 15.12)
Chlorozan	1F	31.9 (42.5 - 25.4)	9.6 (16.8 - 4.6)	0.96 (3.8 - 0.2)	41.5 (55.2 - 34.1)	12 (17.52 - 6.00)	3.36 (7.68 - 0.72)
Xentari + Chlorozan	1F + 0.5F	87.8 (122.9 - 65.5)	4.6 (12.0 - 1.2)	0.24 (1.68 - 0.02)	190 (221 - 163.9)	49.92 (55.2 - 44.88)	13.2 (16.8 - 10.08)
Rokur + Chlorozan	1F + 0.5F	215 (302.2 - 158.6)	16.1 (24.0 - 10.3)	1.21 (3.4 - 0.5)	121 (160.6 - 94.8)	9.84 (16.56 - 5.04)	0.72 (2.4 - 0.19)
Ecotech Bio + Chlorozan	1F + 0.5F	44.6 (62.9 - 31.7)	3.6 (12.2 - 0.5)	0.24 (3.1 - 0.01)	84.2 (139.9 - 57.12)	3.6 (13.44 - 0.5)	0.17 (2.64 - 0.002)
Dipel 2X + Chlorozan	1F + 0.5F	38.9 (54.0 - 30.5)	8.4 (15.8 - 2.2)	1.68 (6.7 - 0.1)	86.4 (110.9 - 69.12)	9.84 (16.32 - 5.3)	1.2 (3.36 - 0.24)
Chlorozan	0.5F	85.2 (119.5 - 64.8)	9.4 (16.1 - 2.4)	2.64 (8.16 - 0.2)	126 (166.6 - 98.4)	10.32 (15.12 - 4.08)	0.48 (1.92 - 0.12)
Xentari + Chlorozan	1F + 0.25F	124 (153.8 - 102.2)	21.4 (27.1 - 16.3)	3.6 (6.5 - 1.9)	159 (182.2 - 140.4)	43.92 (48.96 - 39.12)	12 (15.4 - 9.36)
Rokur + Chlorozan	1F + 0.25F	66.7 (88.6 - 52.6)	9.4 (16.1 - 4.3)	1.2 (4.1 - 0.2)	113 (131.5 - 97.7)	28.32 (33.12 - 24.0)	7.2 (10.1 - 4.8)
Ecotech Bio + Chlorozan	1F + 0.25F	25.0 (37.9 - 9.4)	4.1 (20.2 - 0.01)	0.72 (12.7 - 0.01)	116 (146.2 - 94.3)	14.16 (20.4 - 9.36)	1.68 (3.84 - 0.72)
Dipel 2X + Chlorozan	1F + 0.25F	29.3 (59.8 - 8.4)	0.72 (26.9 - 0.01)	0.002 (16.1 - 0.001)	76.8 (101.5 - 60.7)	11.76 (18.00 - 6.72)	1.68 (4.56 - 0.50)
Chlorozan	0.25F	84.0 (102.5 - 71.3)	23.8 (28.1 - 19.7)	6.72 (9.8 - 4.3)	152 (179.5 - 130.8)	31.68 (36.96 - 26.64)	6.48 (9.36 - 4.32)

Table (4): Effect of tested bioinsecticides and their blends with chlorpyrifos at recommended rate (1F), 0.5 rate (0.5F) and 0.25 rate (0.25F) against second and fourth Spodoptera instar larvae during 10 days at each sampling interval

Treatments	Rate	Mortality percentage of second instar larvae at						Mortality percentage of fourth instar larvae at					
		0	1	4	9	12	Average	0	1	4	9	12	Average
XenTari	1F	83.0 de	85.3 a	89.0 a	60.6 f	29.2 b	69.5 c	79.7 cde	85.2 abcd	87.0 ab	72.5 bcd	56.8 bc	76.3 bcde
Rokur	1F	74.7 f	53.5 a	84.5 a	62.9 ef	35.8 b	67.4 c	77.7 de	80.3 cde	84.3 ab	71.4 bcd	57.5 bc	74.3 cde
Ecoleach Bio	1F	67.3 g	81.0 a	89.5 a	67.7 def	55.5 ab	71.9 de	76.8 de	82.2 cde	75.8 bc	64.0 de	50.8 bc	70.0 e
Dipel 2X	1F	77.7 ef	77.8 a	82.5 a	68.2 def	39.0 b	69.6 c	71.7 c	79.8 cde	67.3 c	55.8 e	42.0 c	63.4 f
Chlorozan	1F	94.8 abc	87.2 a	83.7 a	65.7 ef	40.2 b	75.1 cde	97.8 a	90.7 ab	90.7 ab	66.4 cde	41.3 c	77.4 bcde
XenTari + Chlorozan	1F + 0.5F	95.5 ab	84.5 a	82.2 a	74.2 bcd	58.2 ab	79.0 bcd	77.5 de	80.7 cde	77.7 abc	65.7 cde	52.3 bc	70.8 de
Rokur + Chlorozan	1F + 0.5F	87.5 cd	78.5 a	85.0 a	65.2 ef	36.7 b	70.0 c	93.0 ab	82.8 bcde	79.8 abc	69.7 bcd	58.3 bc	76.7 bcde
Ecoleach Bio + Chlorozan	1F + 0.5F	98.0 a	84.0 a	79.0 a	67.3 def	62.5 ab	78.6 bcd	95.3 ab	91.7 a	84.7 ab	75.4 bcd	64.8 bc	82.4 abc
Dipel 2X + Chlorozan	1F + 0.5F	98.8 a	87.0 a	87.7 a	83.9 a	83.7 a	88.0 a	94.8 ab	83.7 bcde	87.2 ab	68.4 bcd	48.2 bc	76.5 bcde
Chlorozan	0.5F	99.0 a	88.7 a	82.2 a	79.7 ab	77.8 a	85.0 ab	93.0 ab	85.3 abcd	92.8 a	81.0 b	68.5 b	84.1 ab
XenTari + Chlorozan	1F + 0.25F	89.5 bcd	79.3 a	84.8 a	69.1 cde	41.0 b	72.0 de	80.8 cde	87.5 abc	84.7 ab	78.8 bc	71.7 b	80.7 abc
Rokur + Chlorozan	1F + 0.25F	96.2 ab	71.8 a	90.0 a	76.0 bc	54.5 ab	78.1 bcd	88.5 abc	79.3 cde	91.0 ab	77.5 bcd	63.3 bc	80.0 abc
Ecoleach Bio + Chlorozan	1F + 0.25F	99.5 a	64.5 a	85.7 a	75.5 bc	60.3 ab	75.4 cde	91.7 ab	77.5 de	85.3 ab	75.9 bcd	64.7 bc	79.0 bcd
Dipel 2X + Chlorozan	1F + 0.25F	99.0 a	69.7 a	89.7 a	74.0 bcd	63.8 ab	81.5 bc	95.2 ab	75.2 c	79.3 abc	69.5 bcd	57.8 bc	75.4 cde
Chlorozan	0.25F	91.2 abc	82.2 a	67.7 b	65.4 ef	63.3 ab	73.9 cde	85.0 bcd	81.2 cde	92.3 a	90.3 a	87.0 a	87.2 a
LSD _{0.05}		5.54	21.74	7.41	5.16	20.79	5.5	6.95	5.29	8.83	8.34	14.86	5.2

Values within the same column having the same letters are not statistically different from each other, $p < 0.05$

According to Ministry of Agriculture recommendation for using the natural products and safe materials on controlling pests, succeeded material should give initial effect more than 70% reduction and residual effect not less than 40% reduction (Rizk *et al.*, 1999). Therefore, the results obtained could be evaluated according to the initial and residual effect. The mortality percentage of *Spodoptera* larvae, second and fourth instar larvae together carried out within the first 24h, during feeding of pretreated leaves sampled at zero time called initial effect and that carried out within the followed 9 days called latent effect. The mortality percentage carried out within all time intervals except the first 24h of the first interval time called residual effect and the average of mortality percentage at all time intervals called general effect. As shown in Fig. (1) that the high initial effect (80% mortality) was recorded by chlorpyrifos while low initial effect (< 40% mortality) was recorded by all tested bioinsecticides. Concerning the latent effect, chlorpyrifos caused 98% mortality, while each tested bioinsecticide caused about 80% mortality. The residual effect of all tested treatments ranged from 75% to 80% mortality. Regarding to general effect, the most active treatment was chlorpyrifos, while the lowest active treatment was Dipel-2X. Clearly, chlorpyrifos and tested bioinsecticides have been equal residual effects, however, chlorpyrifos was only compound caused high initial effect. The synthetic insecticide, chlorpyrifos at 0.5 rate and its mixtures with Ecotech Bio and Dipel-2X caused about 85% mortality as initial effect and 95% mortality as latent effect. Although in the case of chlorpyrifos alone at 0.25 of its rate, the initial effect was only about 50%. The mixtures of chlorpyrifos + Ecotech Bio and + Dipel-2X were the most toxic treatments (85% mortality). The residual effect and general effect of all treatments were almost the same, ranged from 75 to 80% mortality. In general, the synthetic insecticide, chlorpyrifos had initial effect at both concentrations half and normal rate of recommended dose. The tested bioinsecticides cause slight initial effect. All tested treatments chlorpyrifos, XenTari, Rokur, Ecotech Bio and Dipel-2X had high latent and residual effect.

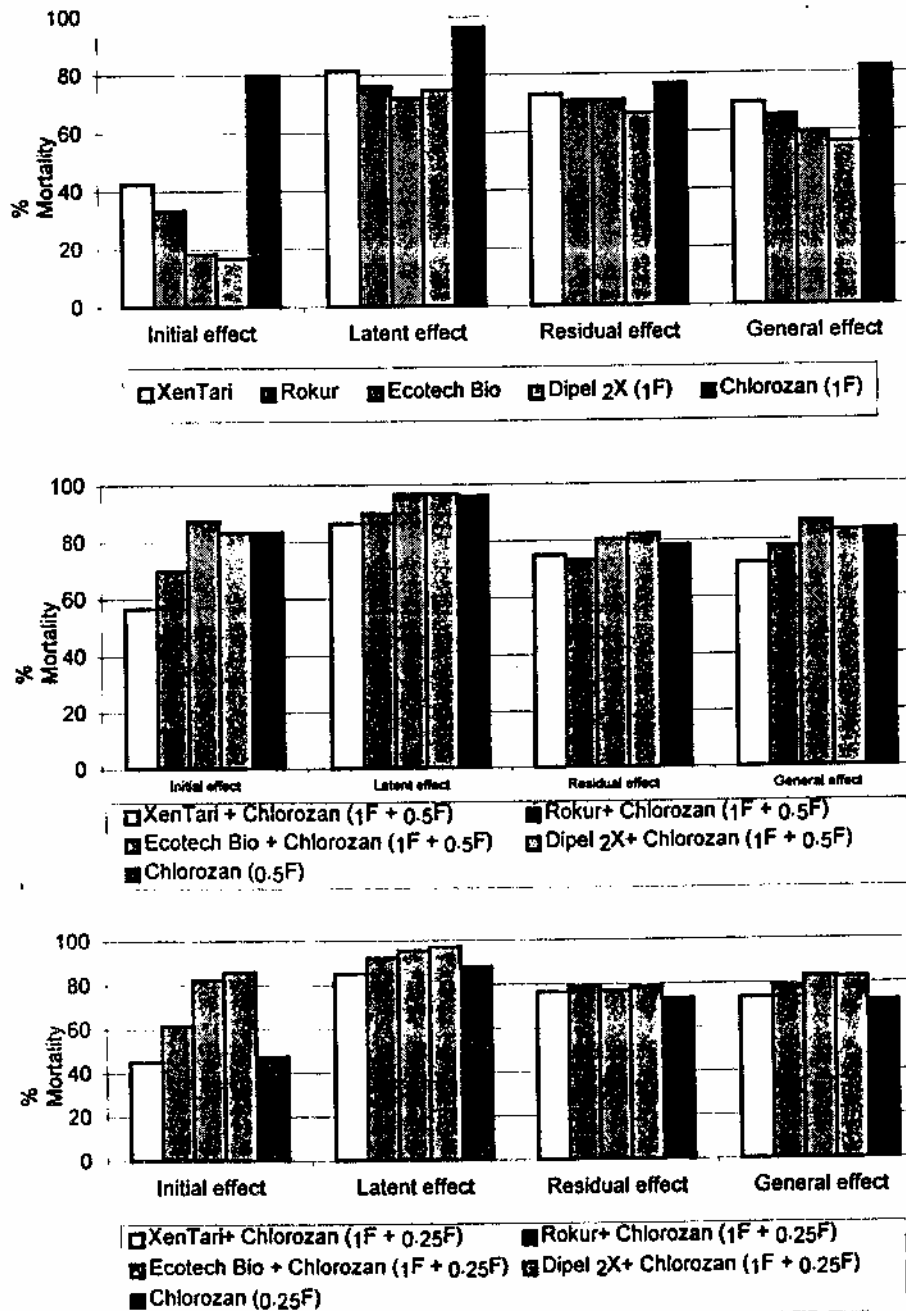


Fig. (1): Effect of tested bioinsecticides and their blends with chlorpyrifos at recommended rate (1F), 0.5 rate (0.5F) and 0.25 rate (0.25F) against second and fourth *Spodoptera littoralis* instar larvae

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دراسة كفاءة أربعة مبيدات حيوية ومخاليطها مع الكلوربيريفوس كاتجاه حديث للمكافحة المتكاملة لدودة ورق القطن

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تم تقييم كفاءة أربعة مبيدات حيوية هي زنتارى ، روكر ، ايكوتيك بيو ، دايبيل ومخاليطها مع المبيد الحشرى كلوربيريفوس (كلوروزان) والذي استعمل بتركيزين هما ٠,٢٥ ، ٠,٥ من المعدل الحقلى وكذلك درست تركيزات ٠,٢٥ ، ٠,٥ ، ١ معدل حقلى لمركب الكلوروزان كل بمفرده على دودة ورق القطن بعمرها الثانى والرابع. ولقد أجريت المعاملة بالحقل وأخذت العينات على فترات زمنية صفر ، ١ ، ٤ ، ٩ ، ١٢ يوم من المعاملة. تم تغذية اليرقات بالمعمل لمدة ٢٤ ساعة على العينات المعاملة ثم على أوراق قطن غير معاملة لمدة ٩ أيام تالية وذلك لكل زمن لأخذ العينات. أوضحت النتائج أن المبيد الحشرى كلوروزان بمفرده كان سريعاً فى إحداث موت لليرقات أى بعد التغذية مباشرة كما هو متوقع ولكن هذا التأثير يظل لفترة قصيرة بعكس المبيدات الحيوية والتي لا يظهر تأثيرها إلا بعد حوالى ٦ أيام فى حالة دايبيل و بعد ١٠ أيام فى حالة المعاملات الأخرى. ومن الجدير بالذكر أن كل نوع من هذه المركبات يحتفظ بالصفة المميزة له فى تأثير المخلوط المكون من المبيد الحيوى والمبيد الكيماوى. وافضل المخاليط كانت دايبيل أو ايكوتيك بيو مع ٠,٢٥ من المعدل الحقلى للكلوروزان وكذلك زنتارى أو روكر مع ٥ من المعدل الحقلى للكلوروزان حيث تعطى كفاءة عالية فى موت الحشرة سريعاً ولمدة طويلة. تعتبر هذه الدراسة خطوة فى اتجاه استخدام هذه المخاليط كأحد عناصر مكافحة المتكاملة لدودة ورق القطن ويتطلب ذلك إجراء المزيد من الدراسة حول ثبات هذه المخاليط وتأثير العوامل البيئية عليها وأنسب زمن للتطبيق.