

Evaluation of microbial and chemical insecticides for the control of *Spodoptera exigua* (Lep., Noctuidae) on soybean plants

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With 2 tables

Abstract

Field experiments have been carried out to evaluate the potency of the biological control agent *Bacillus thuringiensis* (Dipel), the pyrethroid Fenvalerate and their combinations for the control of the lesser cotton leafworm *Spodoptera exigua* on soybeans in Qualubia governorate. Molasses was combined with all treatments to enhance their effectiveness. One spray application with either Dipel or Fenvalerate showed an obvious reduction in larval counts of *S. exigua*, associated with a significant increase in the crop yield but in varying degrees, in correlation with the tested dose.

Treatments with combinations of both biological and chemical insecticides at the lowest tested doses (62 g of *B. t.* + 50 ml of Fenvalerate/feddan) showed to be highly potential, and caused 2.8 fold increase in the crop yield. It may be recommended that a combination of both preparations may be used for the control of *S. exigua*.

1 Introduction

The lesser cotton leafworm *Spodoptera exigua* has been observed during the last few years as a major pest of soybean plants in Egypt.

Among the disease producing microorganisms, *Bacillus thuringiensis* proved to be of great potential as a biotic control means of some lepidopterous pests in Egypt and elsewhere (DULMAGE et al., 1978; PERIMMER, 1979; MORRIS, 1980; BELL & ROMINE, 1980; ABDUL-SATTAR & WATSON, 1982; JOHNSON, 1982; SALAMA & FODA, 1982; SALAMA et al., 1981, 1984, 1987).

In the present study, field tests have been carried out

to evaluate the effect of the commercial product of *Bacillus thuringiensis* "Dipel 2X" singly and in combination with the pyrethroid "Fenvalerate" against *S. exigua* on soybean plants in Qualubia governorate.

2 Materials and methods

An area of 5 feddans cultivated with soybeans (clark var.) on April 1988, was selected for the field experiments. The plants received the normal agricultural practices during the growing season. Heavy infestation with *S. exigua* was observed on May 15, 1988. The cultivated area was divided into plots each 400 m² (10 × 40 m) for the replication of ten treatments. Each treatment was replicated four times in a complete randomized block design. In the first set of experiments, Dipel 2Xx (containing 32,000 IU/mg) was used at three different rates 250, 125 and 62 gm/feddan. In a second set of experiments, Fenvalerate was also sprayed at three different rates 200, 100 and 50 ml. Molasses (3, 1.5 and 0.75 liters) was combined with either Dipel or Fenvalerate at the rates of 3, 1.5 and 0.75 liters, respectively, as a photoprotectant and adjuvant. An area was left without treatment as a control and sprayed only with molasses (3 liters/feddan). Knapsack sprayer (20 liters) was used in field experiments.

Larval counts were made immediately before spray application and then 7–10 days after application.

For analysis of data, the interaction F-test was adopted and DUNCAN's (1951) multiple range test was used for comparison between the means. Percentages of larval reduction (L.R.) were estimated according to LEWIS & LYNCH (1978) as follows:

$$(\% \text{ L.R.} = 100 - [\text{No. of larvae in a certain treatment} / \text{No. of larvae in the control}] \times 100).$$

Table 1. Effect of Dipel 2X (*B. thuringiensis*) in combination with Fenvalerate on *S. exigua* infesting soybeans^a

Treatment	Dose tested / feddan	* Mean no. of larvae \pm S.E. / 10 plants			% L.R.**	
		Before treatment	7 days	10 days	7 days	10 days
			After treatment	After treatment		
Control	3 liters	39.8 \pm 2.270 a	42.0 \pm 5.404 a	48.0 \pm 5.020 a	–	–
Dipel 2X	250 gm	38.4 \pm 2.238 a	10.6 \pm 1.081 d	3.4 \pm 0.669 def	74.8	92.9
	125 gm	37.2 \pm 3.638 a	18.0 \pm 3.039 c	9.6 \pm 0.830 c	57.1	80.00
	62 gm	40.8 \pm 1.795 a	29.6 \pm 1.536 b	25.4 \pm 1.587 b	29.5	47.10
Fenvalerate	200 ml	38.8 \pm 4.728 a	5.4 \pm 0.456 e	4.2 \pm 0.334 de	87.1	91.3
	100 ml	41.8 \pm 7.576 a	14.8 \pm 2.644 cd	11.2 \pm 1.034 c	64.8	76.7
	50 ml	42.4 \pm 1.886 a	25.8 \pm 1.244 b	21.6 \pm 0.455 b	38.6	55.00
Dipel 2X + Fenvalerate	250 gm + 200 ml	45.4 \pm 3.780 a	2.0 \pm 0.283 f	1.4 \pm 0.219 f	95.2	97.08
	125 gm + 100 ml	52.8 \pm 3.434 a	3.2 \pm 0.335 ef	2.4 \pm 0.456 ef	92.4	95.00
	62 gm + 50 ml	48.2 \pm 3.205 a	11.6 \pm 2.071 cd	5.2 \pm 1.180 d	72.4	89.2

* Average of 5 counts, 10 plants / each count.

** Larval reduction.

Means followed by similar letters are not significantly different at P = 0.05 according to Duncan's multiple range test.

Yield assessment at the harvest time was done by collecting the free seeds of soybean plants from representative plots each $10 \times 10 \text{ m} = 100 \text{ m}^2$. Each plot was considered as one replicate. The average weight of the yield from five plots was calculated for each treatment.

3 Results and discussion

The data given in table 1, clearly indicate that the average rate of *S. exigua* infestation/10 plants before treatment in the cultivated area of soybeans ranged between 37.2 ± 6.38 and 52.8 ± 3.434 larvae with no significant differences in the tested plots. Treatments with Dipel showed a significant reduction in the larval count 7 and 10 days after treatment as compared to the control. So, spraying Dipel at 250 g/feddan reduced the larval counts to 10.6 ± 1.081 and 3.4 ± 0.669 /10 plants, 7 and 10 days after treatments, respectively. This means a percentage of larval reduction which amounts to 74.76 and 92.92, 7 and 10 days after application. With lower doses of Dipel, the percentage of larval reduction significantly decreased being 29.52 and 47.10, 7 and 10 days after application.

Treatments with Fenvalerate showed a similar trend in reducing the larval counts. The percentage of larval reduction ranged between 87.14 and 91.25 %, 7 and 10 days after spraying with Fenvalerate at a dose of 200 ml/feddan, compared to 38.57 and 55.00 % after spraying with a dose of 50 ml/feddan. These data showed a progressive decrease in the larval count with increase of the insecticide concentration.

The larval reduction was almost similar (97.08 to 95.00), 10 days after spraying with combinations of *B. t.* (250 or 125 gm) with Fenvalerate (200 or 100 ml). Even, on using a combination of *B. t.* and Fenvalerate at the lowest tested dose (62 gm + 50 ml), an obvious reduction in larval count (89.17 %) was observed.

Assessment of the crop yield as affected by different treatments is given in table 2. The yield showed 2.5 and 2.3 fold increase as a result of treatment with Dipel at 250 or 125 g/feddan, respectively, and the average production was 1345.2 and 1245.2 kg/feddan. Application of Dipel at the rate of 62 g/feddan showed a fold of increase of 1.8 associated with a significant reduction in the yield com-

pared to that obtained after spraying with higher doses (125 or 250 g/feddan).

Fenvalerate showed a similar effect to that of Dipel, when used at the rate of 200 or 100 ml/feddan, and the fold of increase in the yield ranged between 2.5–2.6, respectively. The lowest tested dose of Fenvalerate (50 ml/feddan) showed a lesser fold of increase in the yield being 1.7.

Application of combinations of Dipel and Fenvalerate clearly indicate that the lowest tested doses of (62 g Dipel + 50 ml Fenvalerate) were as effective as combination of the two tested compounds at the higher tested doses (250 g Dipel + 200 ml Fenvalerate). The fold of increase in the yield ranged between 2.8–2.7.

The foregoing results indicate that all the treatments of Dipel 2x, Fenvalerate and their combinations at the previous tested dosages were effective against the larvae of *S. exigua* and significantly reduced the larval counts on the soybean plants. This coincides with PRISTAVKO's (1967) report on *B. thuringiensis* insecticide trials against several lepidopterous species and later confirmed by SALAMA et al. (1984) and where synergistic effects were observed when low doses of the bacterial preparations were combined with low doses of the pyrethroids. The pyrethroids affected the peripheral and central nervous system causing paralysis. It may also affect sodium and potassium permeability of insect cells and nitrogen metabolism (O'BRIEN, 1967). The endotoxin of *B. thuringiensis* causes rapid paralysis of the midgut and relative permeability of the midgut epithelium (FAST & ANGUS, 1965). Thus, the stress placed on the target insect must be high and may account for the high potentiation of *B. thuringiensis* by Fenvalerate (SALAMA et al., 1984).

Thus, it may be recommended to use a combination of *B. t.* (62 g/feddan) and pyrethroid Fenvalerate (50 ml/feddan) for the control of *S. exigua* on soybeans. This would reduce the cost of spray application, in addition to the minimization of the environmental pollution.

Zusammenfassung

Zur Wirkung eines biologischen und eines chemischen Insektizids sowie einer Mischung beider auf die Rau-

Table 2. Yield assessment of soybeans after treatment with Dipel 2X, Fenvalerate and their combination against *S. exigua*.

Treatment	Dose tested / feddan	* Mean yield (kg) per $100 \text{ m}^2 \pm \text{S.E.}$	feddan	Fold increase in yield
Control	—	$13.40 \pm 0.572 \text{ a}$	536.0	—
Dipel 2X	250 gm	$33.63 \pm 1.385 \text{ c}$	1345.2	2.5
	125 gm	$31.13 \pm 1.016 \text{ c}$	1245.2	2.3
	62 gm	$24.40 \pm 0.668 \text{ b}$	976.0	1.8
Fenvalerate	200 ml	$33.40 \pm 2.378 \text{ c}$	1336.0	2.5
	100 ml	$35.13 \pm 3.798 \text{ c}$	1405.2	2.6
	50 ml	$22.20 \pm 2.004 \text{ b}$	888.0	1.7
Dipel 2X + Fenvalerate	250 gm + 200 ml	$36.13 \pm 1.985 \text{ c}$	1445.0	2.7
	125 gm + 100 ml	$36.45 \pm 1.853 \text{ c}$	1458.0	2.7
	62 gm + 50 ml	$37.45 \pm 1.958 \text{ c}$	1498.0	2.8

* Yield was assessed from 5 plots each 100 m^2 to represent each treatment.

Means followed by similar letters are not significantly different at $P = 0.05$ according to Duncan's multiple range test.

pen von *Spodoptera exigua* (Lep., Noctuidae) auf Sojabohnen

Freilandexperimente mit Dipel (*Bac. thuringiensis*) und einem Pyrethroid (Fenvalerat) sowie einer Mischung aus beiden, in allen Fällen zur Wirkungssteigerung auf Molasse-Basis, ergaben, daß beide Insektizide einzeln eine mit der Dosis steigende starke Verminderung (Dipel max. 74,8 %, Fenvalerat max. 87,1 %) der Raupenzahl von *S. exigua*, verbunden mit einer max 2,5fachen Steigerung der Erntemenge von Sojabohnen zur Folge hatten.

Die Wirkung einer Kombination beider Wirkstoffe bei niedrigerer Dosis (62 g *Bacillus* + 50 ml Fenvalerat/feddan) ging über jene der Einzelbehandlungen hinaus und führte zu einer 2,8fachen Erhöhung des Ertrages. Es wird daher empfohlen, zur Bekämpfung von *S. exigua* diese die Umwelt weitgehend schonende Wirkstoffmischung zu verwenden.

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