FIELD AND SEMI-FIELD TRIALS FOR EVALUATING THE EFFICIENCY OF CERTAIN PESTICIDES AGAINST SOME COTTON PESTS (MINIA UNIVERSITY, EGYPT)

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Abstract

Field and semi-field studies were conducted in the 2011 cotton growing season to evaluate 7 commercial pesticides against the key pests of cotton in Egypt. In the current study, 2 systemic pesticides, imidacloprid and thiamethoxam, were compared for their efficiency as seed treatments against cotton aphid infesting cotton during the seedling stage. In addition, a chitin synthesis inhibitor, leufenuron and an OP, profenofos were compared for their efficiency against cotton leafworm larvae in the middle of cotton season. Also, 3 synthetic pyrethroids were compared for their efficiency against cotton bollworms, pink and spiny bollworms infesting cotton in the late stages of the season. Results revealed that imidacloprid, at 7 gm (4.9 gm AI)/kg seeds, was more effective against cotton aphid than thiamethoxam, at 2 gm (1.4 gm AI)/kg seeds. However, in the treatment of imidacloprid, the population of predators was significantly reduced compared to thiamethoxam. Profenofos and leufenuron are similar in their initial and residual efficiency against cotton leafworm larvae; however, leufenuron was safer against associated predators than profenfos. The 3 synthetic pyrethroids that were tested in the present study similarly reduced cotton bollworms infestation by more than 80%. In addition, they negatively impacted associated predators by about 27% with no significant differences between them in this respect.

Introduction

Cotton is considered one of the most economic crops worldwide. In Egypt, it is exposed to infestation by many insect pests throughout the entire season. It is attacked by sucking pests (thrips, jassid and aphid) during the seedling stage. Late in the season, it is also attacked by aphid, white fly and cotton bollworms. In the middle of the season, it is attacked by cotton leafworm. In Egypt, cotton aphid, cotton leafworm, and cotton bollworms are the key pests of cotton. Heavy populations of cotton aphid on cotton seedling can cause crinkling and cupping of leaves, a failure of leaves to expand, defoliation and a severe stunting of seedling growth. In addition, honeydew contamination on leaves may make the leaves appear wet and shiny. Cotton leafworm infestation mostly appears in the middle of the season starting from June. Heavy infestation of this insect species damages cotton leaves and indirectly delays the flowering and blooming. The pink and spiny bollworms are the common bollworms in Egypt. Both species significantly affect seed cotton yield. Cotton pests have developed resistance to many chemical classes, including organochlorine, organophosphate, carbamate, and pyrethroid insecticides. In addition, these broad-spectrum pesticides kill the natural enemies. The Egyptian Ministry of Agriculture funded a project to evaluate those pesticides against the key pests of cotton in Egypt. Those pests are cotton aphid, cotton leafworm and cotton bollworms. The objective of this study is to evaluate the efficiency of 2 neonictonoids against cotton aphid and to compare the efficiency of an IGR, leufenuron with a conventional OP insecticide, profenofos, against the cotton leafworm. In addition, 3 formulations of synthetic pyrethroids were assayed against cotton bollworms. The negative impact of all tested chemicals on beneficial arthropods was also considered.

Materials and Methods

1**-Egyptian Cotton (Giza-80) was cultivated in the farm of the Faculty of Agriculture - Minia University-Egypt on April 1st, 2011.**

2- Pesticides tested in the present study (Tables 1-3)

Table (1): Pesticides tested against cotton aphid

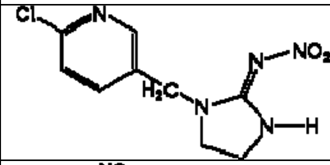
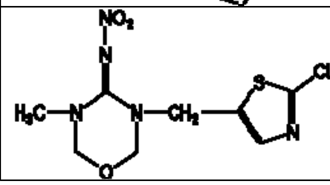
Trade name, formulation and %AI	Common name	Producing company	Chemical structure	Rate of application from formulated material
Gaucho, WP-70%	imidacloprid	Bayer Crop Science		7- gm / kg seed
Cruiser WS-70%	thiamethoxam	Syngenta		2- gm / kg seed

Table (2): Pesticides tested against cotton leafworm

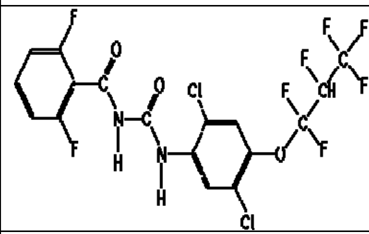
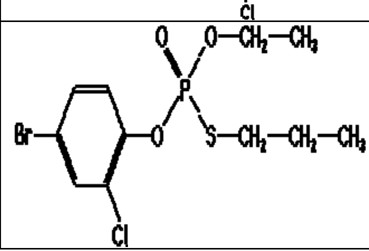
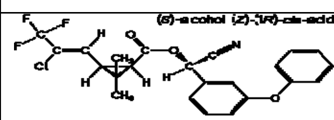
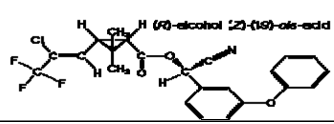
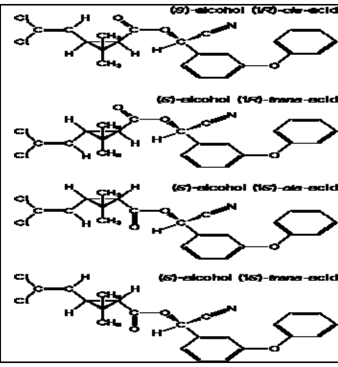
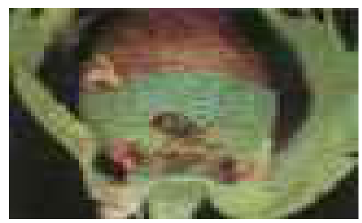
Trade name, formulation and %AI	Common name	Producing company	Chemical structure	Rate of application from formulated material
Match, EC-5%	leufenuron	Syngenta Agro-Suizerland		160ml /feddan
Adwiprof, EC-72%	profenofos	Jining Shengcheng Chemical Experimental Company, Ltd.		750ml / feddan

Table (3): Pesticides tested against cotton bollworms.

Trade name, formulation and %AI	Common name	Producing company	Chemical structure	Rate of application from formulated material
Lambda cyhalothrin, EC-5%	Lambda-cyhalothrin	Beta Chemicals Ltd., China	 	375ml / feddan
Kapot, EC-5%		Akko, B. V.		375ml / feddan

Fury EW-10%	Zeta cypermethrin	FMC-France		200ml / feddan

3- Targeted pests

 Cotton aphid	 C.L.W. larva	 C.L.W. adult
 S.B.W adult	 S.B.W larva	 Infestation with S.B.W
 P.B.W adult	 Infestation with P.B.W	 P.B.W larvae

4- Testing procedures

4.1- Seed treatments against cotton aphids, *Aphis gossypii*

An experimental area of 2100 square meters was divided into 12 plots of 175m^2 each (4 replicates for each chemical treatment and the control). The treatment replicates were distributed in completely randomized block design. Seeds were treated with tested chemicals using the rate of application as recorded in Table 1. Treated seeds were cultivated on April 1st. The treatments received the recommended agricultural practice amounts as the control. After complete emergence of cotton seedlings, 25 seedlings from each plot were randomly chosen and inspected to count the number of aphid nymphs and adults. These counts were repeated at weekly intervals up to 6 weeks. For each inspection interval, means were calculated from the 4 replicates of each treatment, then the general average of the 6 counts for each treatment were calculated and percentages of reduction in aphid population was calculated using the following formula:

%Reduction = ((Mean number in control treatment – Mean number in chemical treatment) / Mean number in control treatment)) * 100

4.2- Foliage treatments against cotton leafworm larvae

An area of about 525 square meters was divided into 3 strips of 175 m^2; each strip was divided into 4 equal plots as replicates for each treatment. On June 16, cotton plants were sprayed with the recommended rate of each chemical (Table 2). Samples of treated and untreated leaves were randomly collected from the replicates of each treatment at 0-3, 7-9 and 10-12 days after treatment. For each time interval, larvae of 2nd and 4th instars from the field-collected colony were allowed to feed on treated leaves for 72 hrs and then mortality was recorded. At each time interval, fresh leaves were used and mortality data was recorded 72 hrs post treatment. For each time interval, mortality in each chemical treatment was corrected with the control using Abbot's formula **(Abbott, 1925)**.

%Corrected mortality = ((%mortality in the treatment - %mortality in the control)/ (100 - %mortality in the control)) * 100

The number of predators was counted on 25 plants in each replicate. The counts were recorded before treatment and at 1, 7 and 10 days after treatment. For each chemical treatment, percentages of reduction in predators were calculated (Henderson and Tilton, 1955).

4.3- Foliage treatments against cotton bollworms

An area of about one feddan (4200 square meters) was divided into 12 experimental plots of 350 square meters each. Replicates of each treatment were distributed in completely randomized block design. A separate area in the same location was used as a control treatment to prevent the overlapping of pesticides. At weekly intervals during June, 100 green bolls were randomly collected and dissected. When percent infestation reached ~5%, cotton plants were sprayed with the recommended rates of tested chemicals. At 3 and 6 weeks after the first spray, treatments were repeated. Percent infestation and number of larvae per 100 green bolls were recorded in each plot just before the first spray and at weekly intervals up to 9 weeks post-treatments. At each time interval, means were calculated from the 4 replicates of each treatment and the control. Mean percentages of reduction in bollworm infestation and larval content were calculated using Henderson and Tilton, 1955.

$$\%\text{Reduction} = (1-((C_B * T_A) / (C_A * T_B))) * 100$$

A = after spray, **B** = before spray, **C** = control treatment and **T** = pesticide treatment.

At the same time intervals for monitoring bollworm infestations, the number of predators was counted on 25 randomly chosen plants from each plot. Then mean number of predators was calculated and %reduction in predator population was calculated using the same equation.

Results and Discussion

1-Evaluating the efficiency of 2 systemic pesticides (seed treatments) against aphid infesting cotton during the seedling stage.

As shown in Figure 1, imidacloprid, tradely named Gaucho, at 7gm (4.9gm AI)/kg seeds was more effective against cotton aphid than thiamethoxam tradely named Cruiser at 2gm (1.4gm AI)/kg seeds. The general average of reduction was 91.04% in imidacloprid treatment compared to 74.9% in thiamethoxam treatment. It was evident that seedlings emerging in imidacloprid plots were greater in length than those in thiamethoxam treated plots. After one month of cultivation, the average weight of 20 seedlings was 49.25, 35.40 and 28.39 gm in imidacloprid, thiamethoxam and control treatments, respectively. In the other hand, the side effect of both chemicals on the biological control agents was evaluated (Figure **2**). In the plots treated with imidacloprid, the number of predators was significantly reduced as compared with those in thiamethoxam treatment probably because of the absence of the host in this treatment. Compared to the control, reduction percentages in the predator's populations were 11.3% and 29.0% in thiamethoxam and imidacloprid treatments, respectively.

Data summarized in seed treatment study, revealed that imidacloprid was more effective against cotton aphid, however less safe on the associated predators than thiamethoxam. However, in previous studies by Zhang *et al* (2009) with different insect species, the authors concluded that imidacloprid and thiamethoxam treated seeds can be an important alternative for management of whiteflies on cotton. In addition, they observed that cotton seeds treated with imidacloprid and thiamethoxam were effective against *B. tabaci* for up to 2 months under field conditions. Magalhaes *et. al.* (2010) used imidacloprid and thiamethoxam seed treatments to control soybean aphid *Aphis glycines* Matsumura (Hemiptera: Aphididae) in Nebraska. In contrast to our results, the authors found that imidacloprid was less effective than thiamethoxam, however in a different country, on a different host plant and with different aphid species. Mohamed and Mohamady (2010) treated field strains of cowpea aphid *Aphis craccivora* by different groups of insecticides and found that thiamethoxam (neonicotinoid) was the most effective one followed by diafenthiuron (thiourea compounds), carbosulfan (carbamate) and esfenvalerate (pyrethroid). Herron and Wilson (2011) reported that the neonicotinoid group of insecticides has provided a good control against *Aphis gossypii*, when used as seed treatment; however, resistance of *Aphis gossypii* to thiamethoxam is documented for the first time in Australia. Prabhaker *et al* (2011) demonstrated that imidacloprid and thiamethoxam are widely used for residual control of several insect pests in cotton; also, they suggested that their toxicity to some predators might be related to their feeding on foliage and not just contact with surface residues. Shi *et al* (2011) mentioned that the imidacloprid has been a major neonicotinoid insecticide for controlling *Aphis gossypii* (Glover).

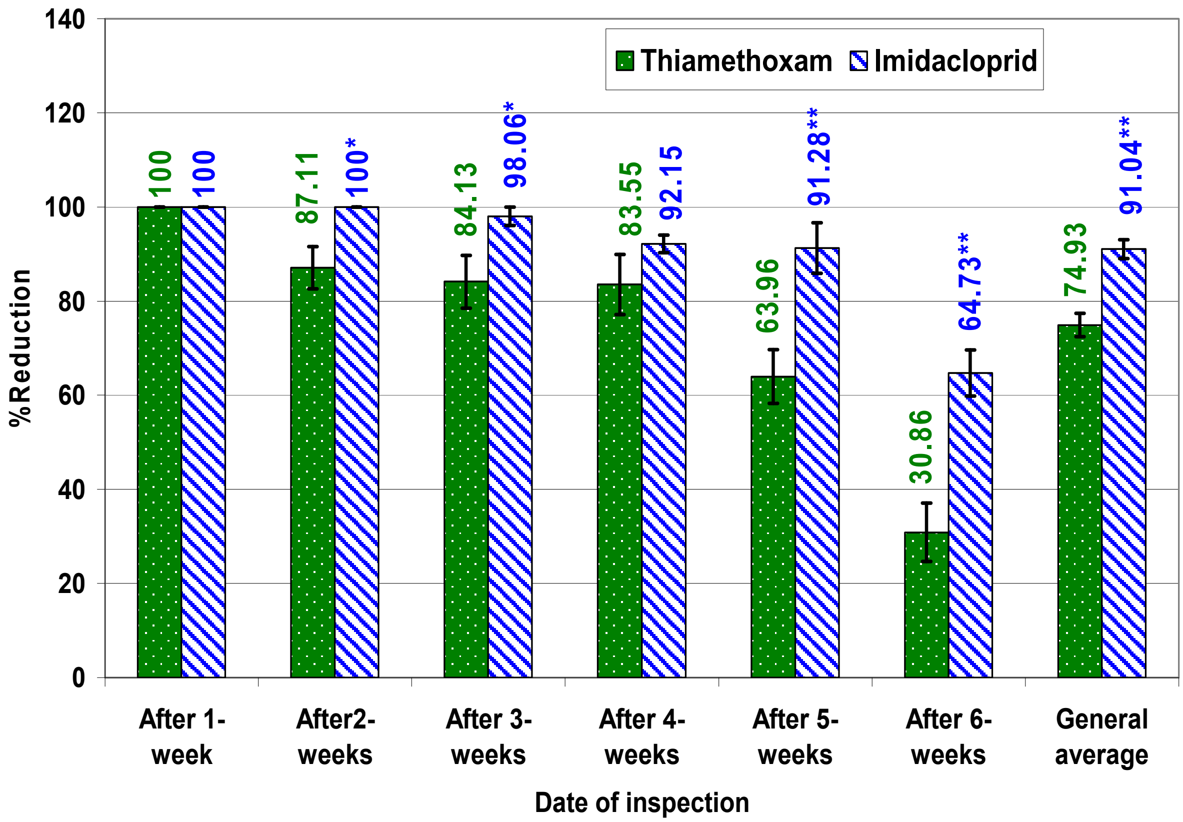


Figure 1. Reduction percentages in aphid populations at weekly intervals.
* Significant differences exist (unpaired t-test) between the two pesticide treatments.
** Highly significant differences exist.

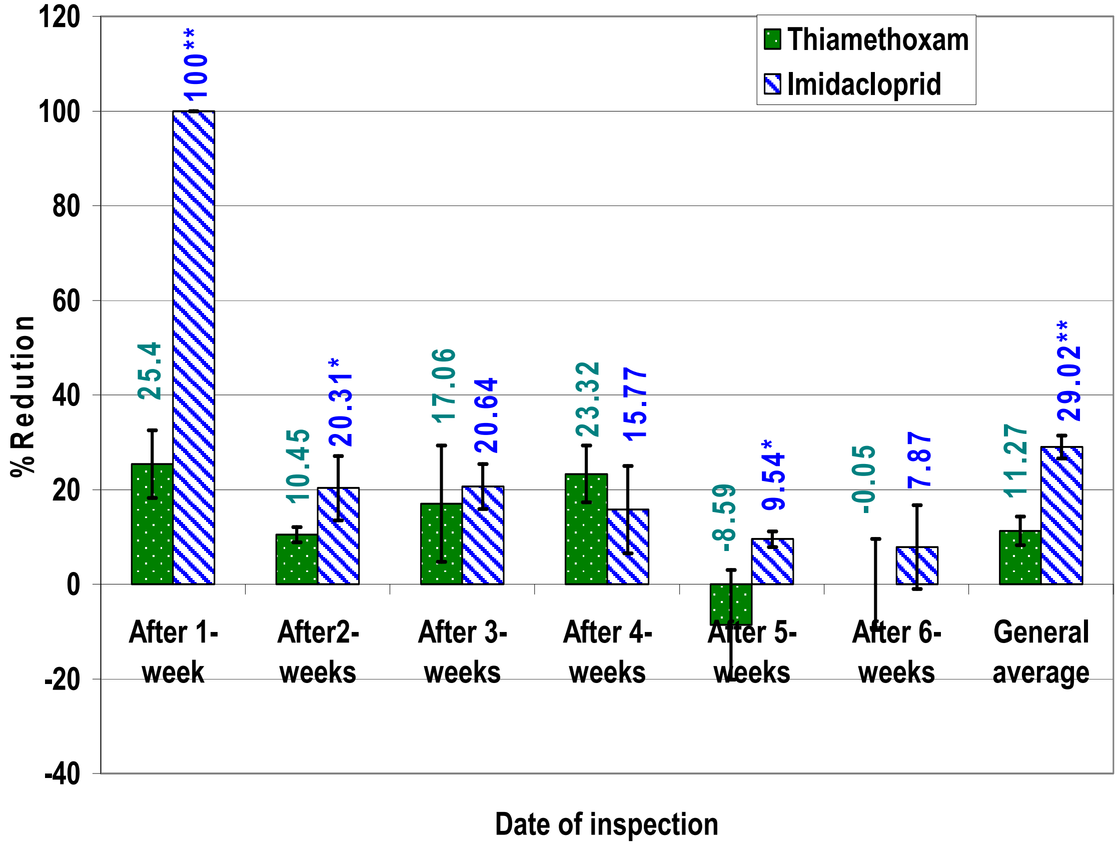


Figure 2. Reduction percentages in predator populations at weekly intervals.
* Significant differences exist between the two pesticide treatments.
** Highly significant differences exist.

<u>2- Semi-field trial to compare the initial and residual performance of leufenuron and profenofos against *Spodoptera littoralis* larvae.</u>

In the current study, profenofos and leufenuron were compared for their efficiency against cotton leafworm larvae. The obtained results confirmed that Profenofos and leufenuron were statistically similar in their effects against the 2nd and 4th instars larvae and maintained their excellent performance up to 10 days post-treatment. (Figures 3-5). However, leufenuron was safer than profenofos from the point view of the negative impact against associated predators (Figures 6-7). In addition, there is Phytotoxicity observed on plants treated with profenofos. Purple spots were observed on cotton leaves and white spots were observed on milky mother weeds (*Euphorbia scordifolia*), however plants recovered at 7 days post treatment (Photo 1).

In this study, larval mortality was recorded 72 hrs post treatment for both tested chemicals because the IGR, leufenuron induced its effect during molting process. In a previous study by Scarpellini (2001), high larval mortality on leaves treated with leufenuron was recorded 48 hrs after feeding started. In another study, Abdel-aal (2007) found moderate latent toxicity to 2nd and 4th instars of cotton leafworm treated with leufenuron and spinosad. The performance of profenofos was confirmed in a previous study by Hindy *et al* (2011) who mentioned that Profenofos (OP) and Pyriproxyfen (IGR) were more effective in controlling larvae of cotton leafworm on cotton plants followed by Spinosad (Bioagent).

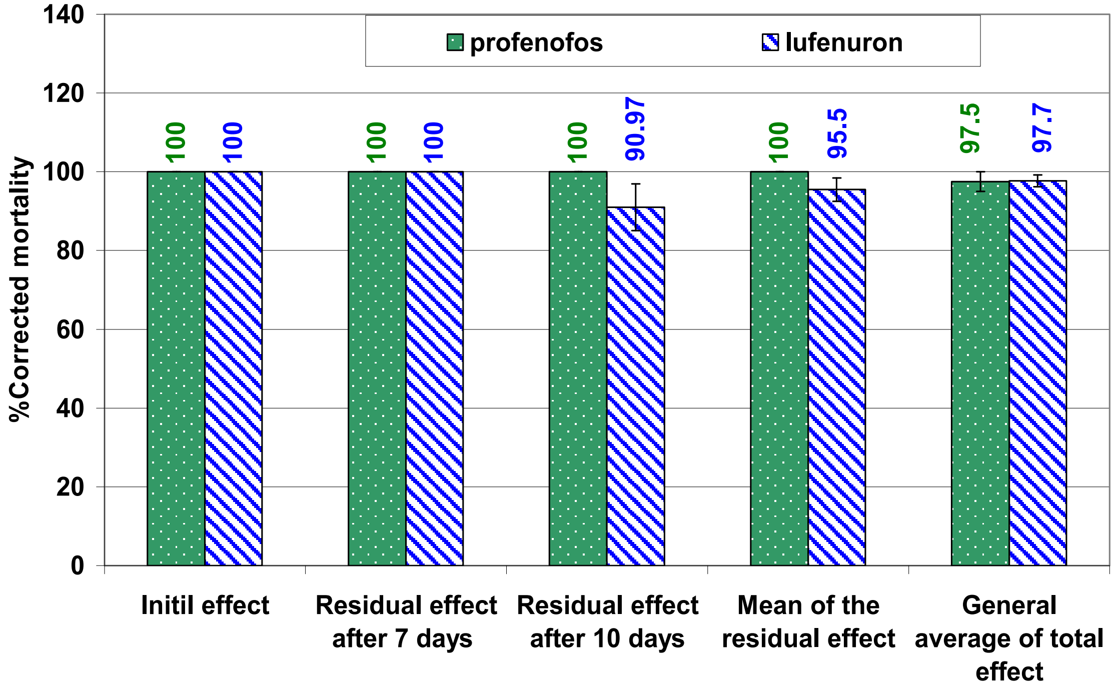


Figure 3. Initial and residual performance of tested pesticides against 2nd instars larvae of cotton leafworm, *S. littoralis*. No significant differences exist between initial and residual effect.

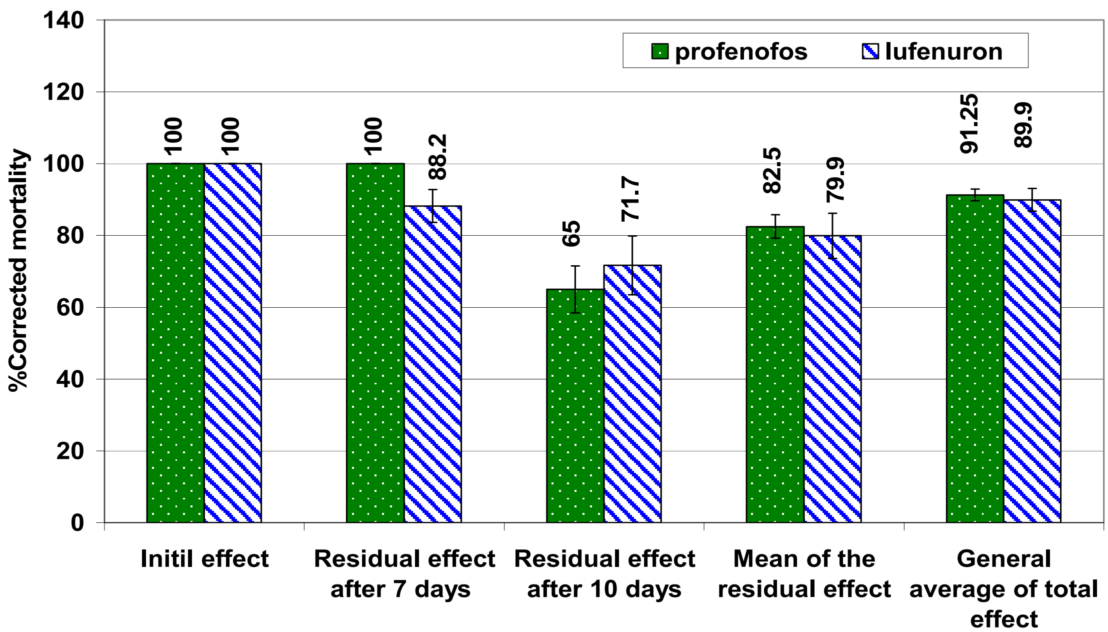


Figure 4. Initial and residual performance of tested pesticides against 4th instars larvae of cotton leafworm, *S. littoralis*. No significant differences exist between initial and residual effect.

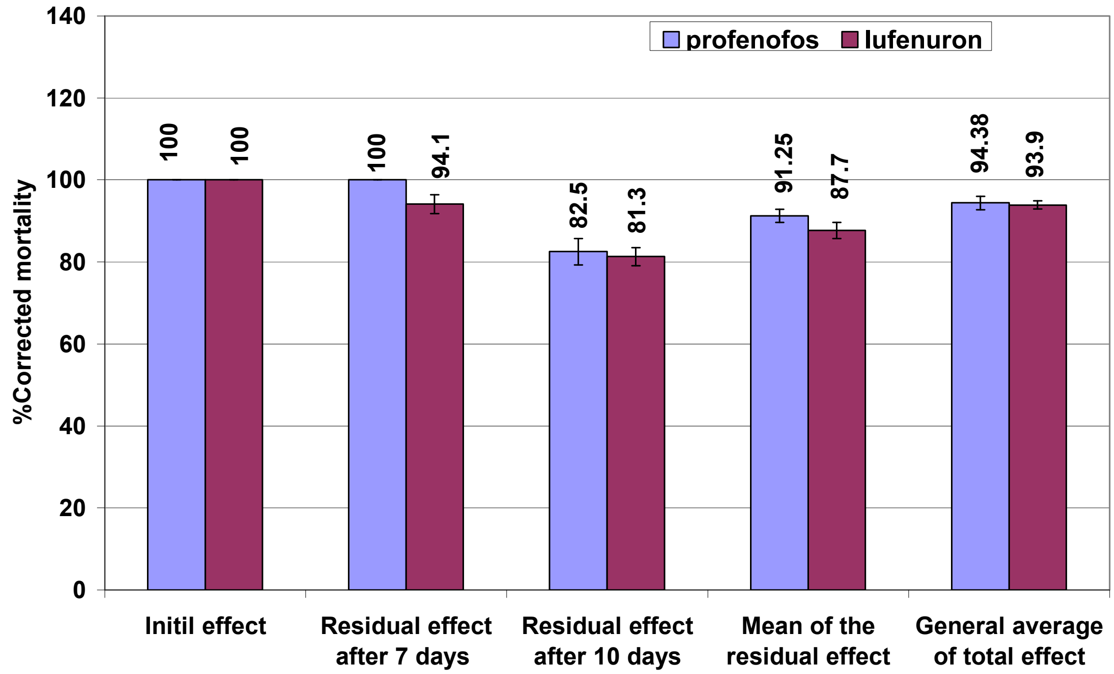


Figure 5. Initial and residual performance of tested pesticides against both 2nd and 4th instars larvae of cotton leafworm, *S. littoralis*.

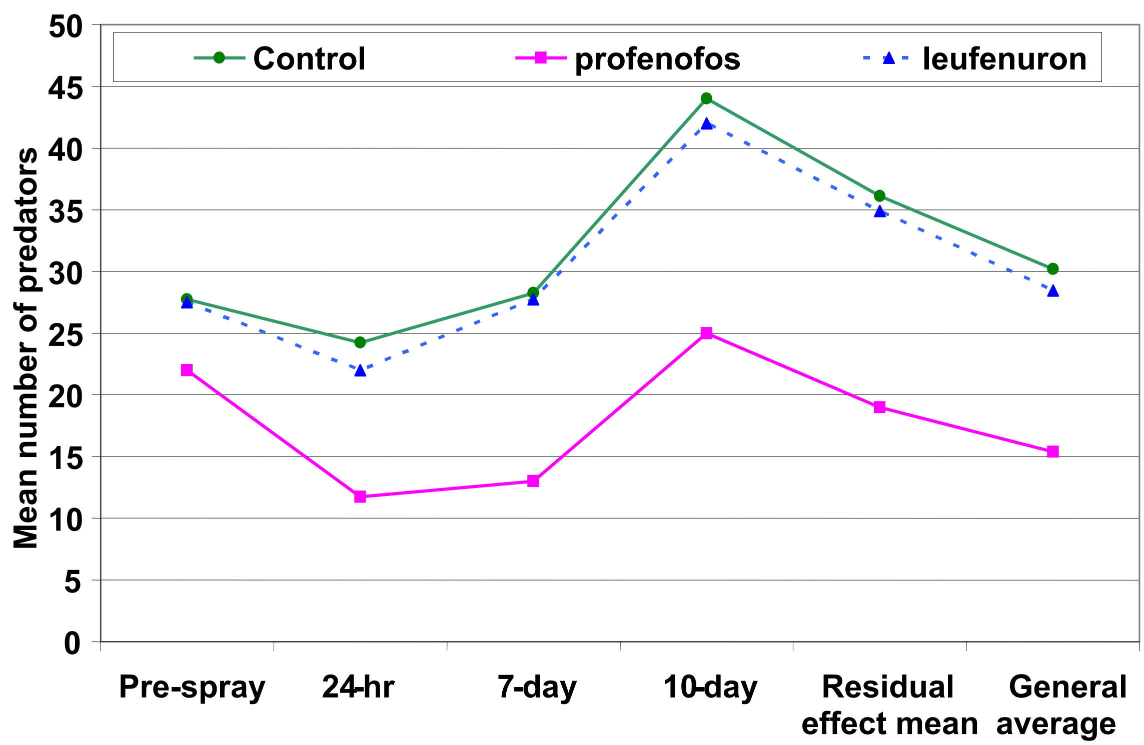


Figure 6. Mean numbers of predators recorded in chemical and control treatments.

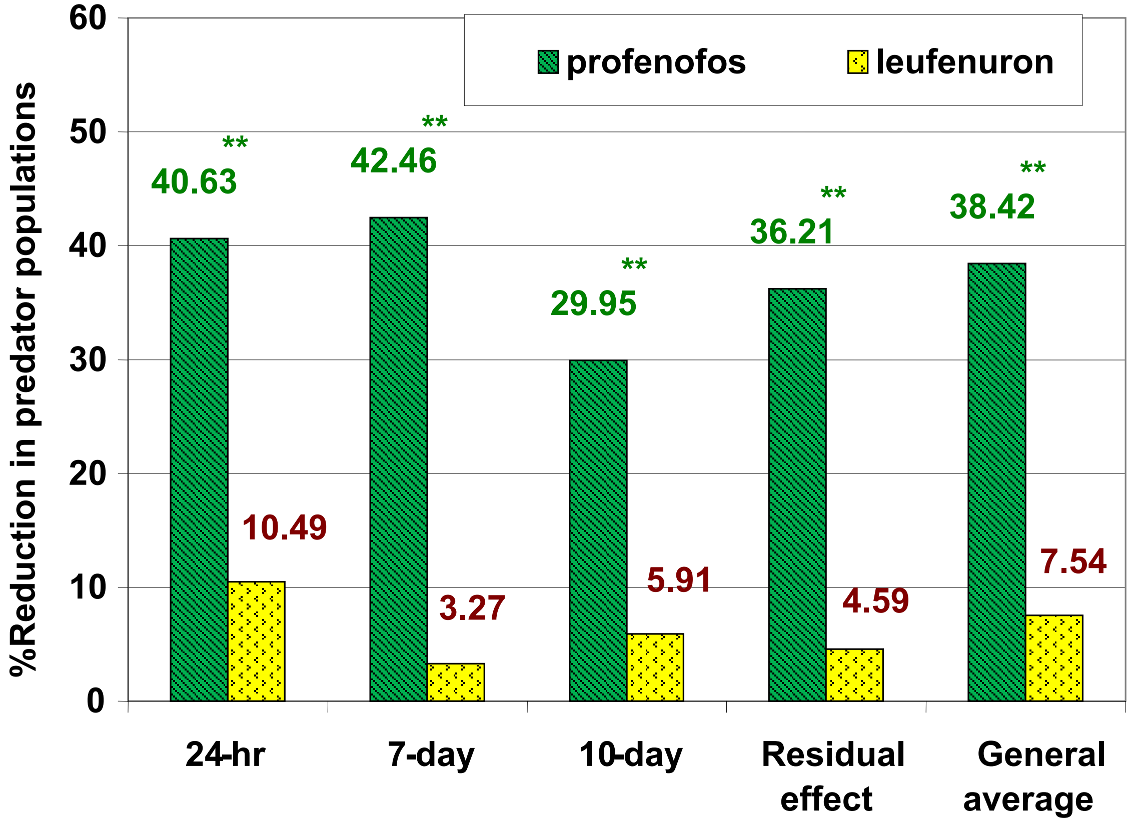


Figure 7. Reduction percentages in predator populations in the two chemical treatments.

Photo 1: Phytotoxicity observed on plants treated with profenofos. Purple spots were observed on cotton leaves and white spots were observed on milky mother weeds (*Euphorbia scordifolia*).

3-Field evaluations of Lambd-cyhalothrin and Zeta-cypermethrin against two bollworms infesting cotton in Egypt.

There were no significant differences among tested chemicals regarding their effects on cotton bollworms and the associated predators. The reduction on bollworms larvae was greater than 80% for the three chemicals. A similar negative impact on predators was achieved with %reduction in predator population around 27%.

Two formulations of lambda-cyhalothrin and one formulation of zeta-cypermethrin were evaluated for their performance against cotton bollworms in Egypt. Also, their negative impact on beneficial arthropods was also taken into consideration. There were no significant differences among tested chemicals regarding their effects on cotton bollworms (Figs. 8-11) and the associated predators (Fig. 12). The reduction on bollworms larvae was greater than 80% for the three chemicals. A similar negative impact on predators was achieved with %reduction in predator population around 27%. The efficiency of synthetic pyrethroids was confirmed in previous studies. Khanzada (2002) mentioned that 2 synthetic pyrethroids, cypermethrin and cyfluthrin, gave significantly higher reduction of the spiny bollworm, *Earias insulana* in Pakistan. Similar results were obtained by Younis *et al* (2007) who found that synthetic pyrethroids exhibited the greatest reduction in pink and spiny bollworm infestation in Egypt. The greatest reduction in bollworm infestation was associated with the highest amount of seed cotton yield. Similarly, Gupta *et al* (2011) reported that field trials conducted on the bioefficacy and persistence of 2 dosages of synthetic pyrethroids showed effectiveness of both dosages in control cotton bollworms in comparison to the recommended dose of conventional insecticide, carbaryl. However, there is 2 concerns with the usage of pyrethroids against cotton bollworms as reported by Martin *et al* 2007 who confirmed that cotton bollworm, *Helicoverpa armigera* in West Africa has recently developed resistance to deltamethrin and cypermethrin. Also, Younis *et al* (2007) confirmed the negative impact of synthetic pyrethroids on beneficial arthropods.

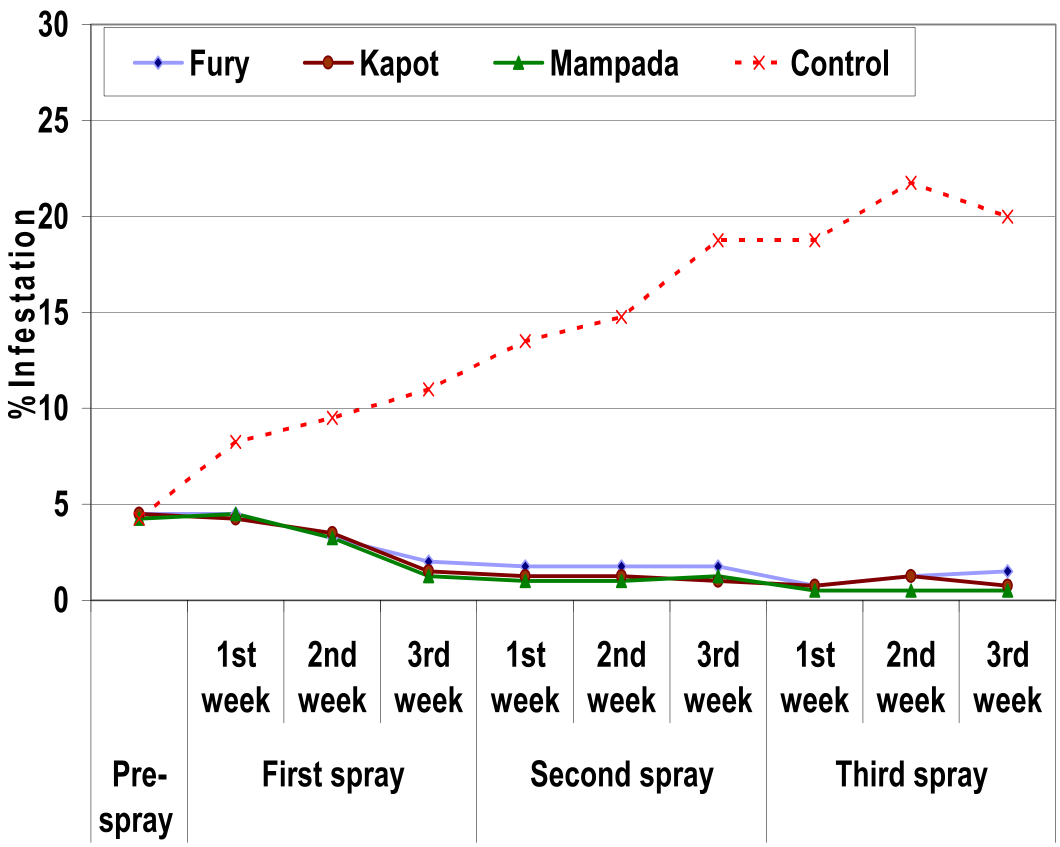


Figure 8. Percentages of infested green bolls monitored just before spray and at weekly intervals post spray.

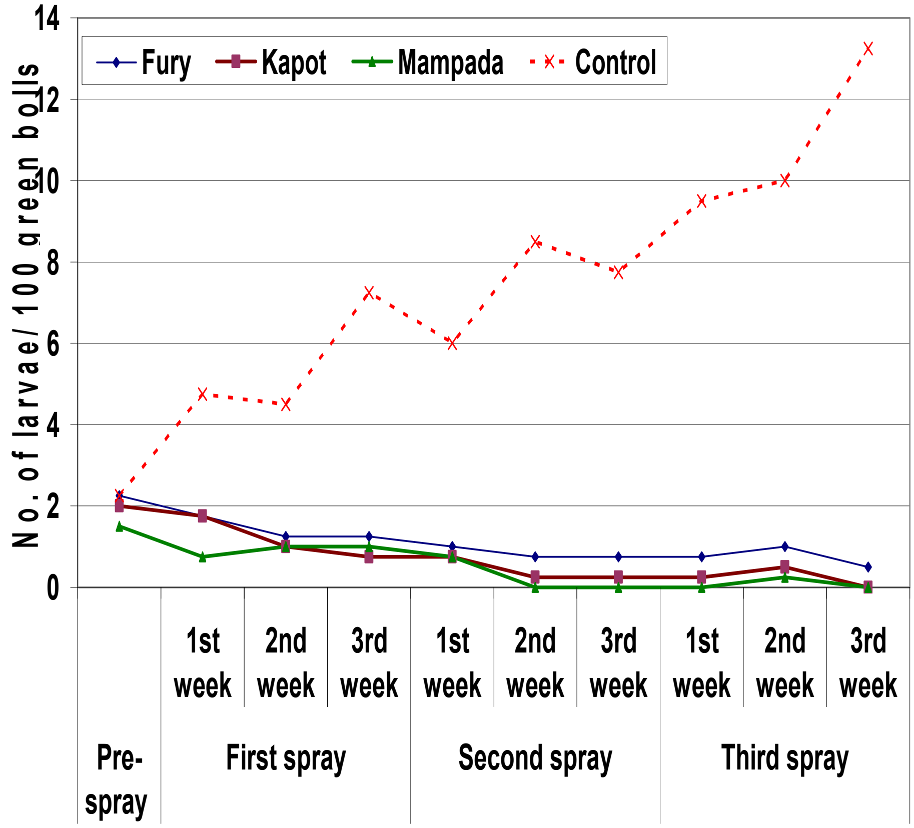


Figure 9. Number of larvae counted in 100 green bolls randomly collected from each treatment just before spray and at weekly intervals after the three successive sprays.

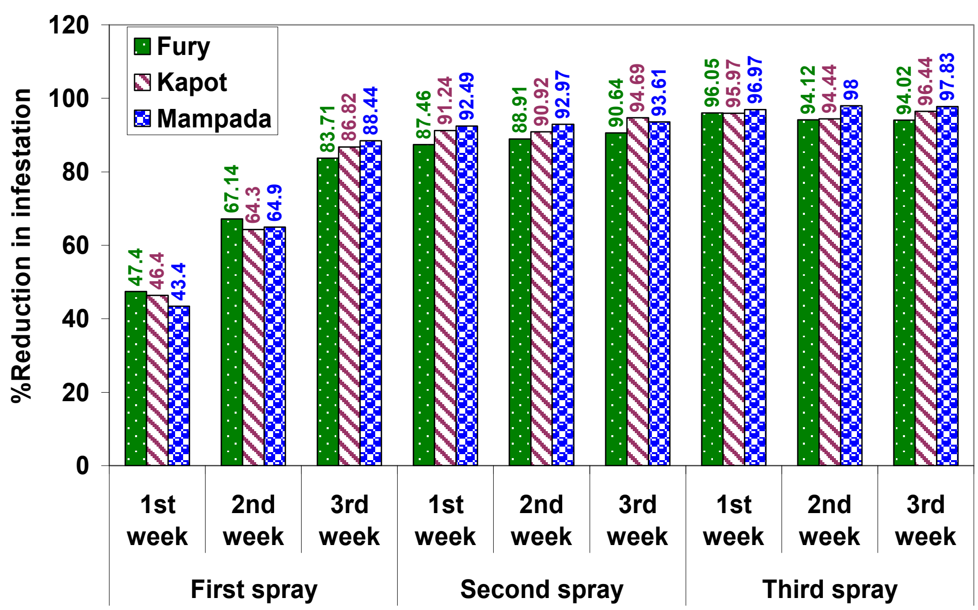


Figure 10. Percentages of reduction in bollworm infestation calculated from the data collected at weekly intervals post the three successive sprays.

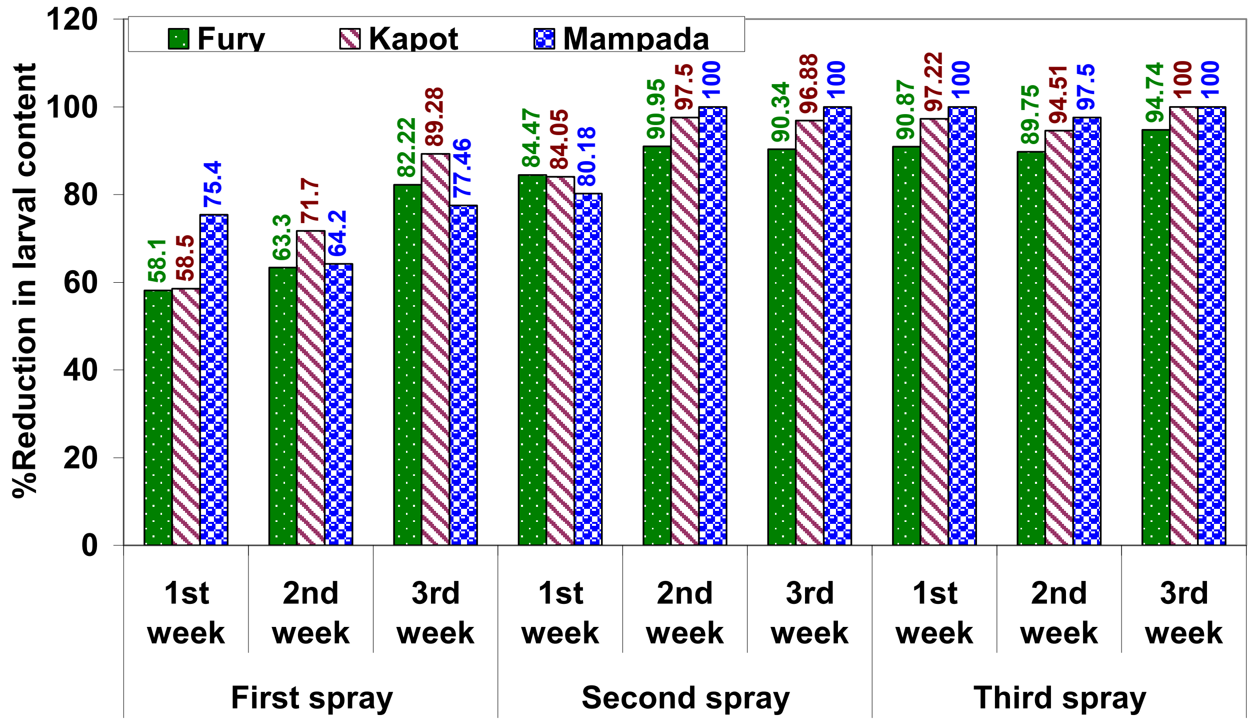


Figure 11. Percentages of reduction in bollworm larval content calculated from the data collected at weekly intervals post the three successive sprays.

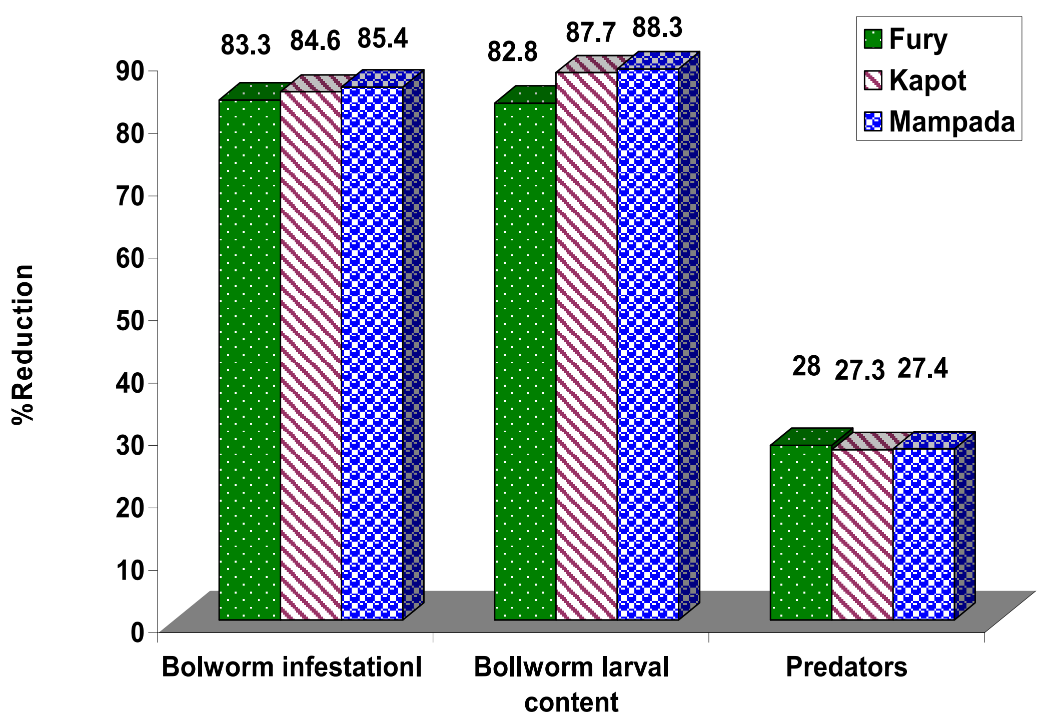


Figure 12. Summary of all bollworms data expressed as general average of reduction in bollworm infestations, bollworm larval content and predator populations after the three successive sprays.

Summary

Imidacloprid was more effective than thiamethoxam in controlling cotton aphid during seedling stage. In addition, Imidacloprid negatively impacted the population of predators, probably because of its strong effect on their hosts.

Leufenuron and profenofos were statistically similar when their initial and residual effects against cotton leafworm were compared. Also leufenuron was safer than profenofos on the biological control agents. Profenofos caused phytotoxicity on cotton plants; however the plants recovered after 7 days.

There were no significant differences between the two pyrethroids tested regarding their positive effect on bollworms and their risk on associated predators.

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