THE INFLUENCE OF SOME INSECT GROWTH REGULATORS AND BIO-INSECTICIDES AGAINST COTTON LEAFWORM AND SOME ASSOCIATED PREDATORS UNDER FIELD CONDITIONS

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Abstract

Experiments were carried out at Zagazig district, Sharqia Governorate during two successive seasons, 2007 & 2008 to evaluate the toxicity of some insecticides against *S. littoralis* larvae infesting cotton cultivations and some associated common predators.

Chlorpyrifos and methoxyfenozide were the most potent insecticide in both initial and residual effect that caused highly significant reduction in the infestation rates of the pest as compared to other treatments at the initial and residual effects that recorded (98.21±0.783, 82.55±2.444%) as initial effect and (93.34±2.599, 85.32±2.195%) as residual effect during 2007 while during 2008 season it recorded (96.01±.0.723, 83.97±3.462%) and (89.89±2.715, 86.34±3.398 %) for initial and residual effect, respectively. Considering the initial and residual effects of the rest treatments, it could be arranged descendingly as teflubenzuron, tebufenozide, Tracer and finally Dipel 2X at both tested seasons.

Chlorpyrifos and methoxyfenozide were the most toxic insecticides causing the highest significant reduction in the predator numbers that recorded (79.81±3.544, 24.73±2.162%) and (66.81±5.418, 29.36±3.468%) at 2007 and (71.60±3.84, 23.50±1.799%) and (64.91±3.569, 26.78±3.548) at 2008 in the initial and residual effects, respectively. Followed by Tracer, teflubenzuron, tebufenozide and Dipel 2X during the two successive seasons

INTRODUCTION

Cotton, *Gossypium barbadense* (L.) occupies a prominent position in Egyptian agriculture. It is still the main cash crop for a sizeable selection of Egyptian farmers. Besides it is the main raw material for the largest national industry, the textile industry, as well as the main source of locally produced cotton seed oil. However, cotton plants are liable to be attacked by several pests all over the growing stages that affected and negatively its productivity.

The noctuid *Spodoptera littoralis* (Boisduval) is a major polyphagous pest, widely distributed throughout Africa, Mediterranean Europe, and several parts of Asia (Hosny and Isshak, 1967). To combat the pest, growers use synthetic organic insecticides and some biorational agents such as *Bacillus thuringiensis* Berliner, but

the control achieved is not successful because of the insect's high capacity to develop resistance toward the majority of conventional compounds. Therefore, scientists and growers are seeking alternative materials that are effective against this pest, safe to humans, environmental friendly, and compatible within targeted pest management (IPM) practices. The alternative control tactics that show promise as a potential tool in *S. littoralis* resistant management programs is the use of biorational control agents such as synthetic insect growth regulators (IGRs) and those based on naturally derived products. IGRs are claimed to be safer for beneficial organisms such as predators than conventional products, and they have been successfully used in IPM programs against many tree and small fruit pests. Many predatory insects recorded in the cotton fields in Egypt and the reverse action of applied insecticides against them was studied (Desuky, 2002).

The objective of this study was to evaluate the toxicity of Teflubenzuron, Tebufenozide, Methoxyfenozide, Spinosad, Dipel 2x and chlorpyrifos against cotton leafworm, *S. littoralis* larvae and associated predators under field conditions.

MATERIALS AND METHODS

1. Tested compounds:

1.1. Insect growth regulators:

A. Trade name: **Nomolt® 15%** Suspension Concentrate (SC).

Common name: Teflubenzuron.

Rate: 50 cm^3 / 100 L.

Basic product: BASF Co.

B: Trade name: Mimic® 24% Emulsifiable Concentrate (EC).

Common name: Tebufenozide.

Rate: 350 cm^3 /feddan.

Basic product: Dow AgroSciences.

C: Trade name: Runner® 24% Suspension Concentrate (SC).

Common name: Methoxyfenozide.

Rate: 150 cm^3 / feddan.

Basic product: Dow AgroSciences Co.

1.2. Bio-insecticides:

A. Trade name: Tracer®

Common name: Spinosad 24% Suspension Concentrate (SC). Tracer is comprised primarily of two macrocyclic lactones, Spinosyn A and D, secondary metabolites produced by the actinomycete, *Saccharopolyspra spinosa* under natural fermentation condition.

Rate: 50 cm^3 / feddan.

Basic product: Dow AgroSciences Co.

B: Trade name: Dipel 2X® (6.4 % WP).

Common name: *Bacillus thuringiensis* subsp. *Kurstaki* 32, 000 International Units of potency per mg.

Rate: 500 gram / feddan

Basic product: Chemical and Agricultural Products Division, Abbott Laboratories USA.

1.3. Organophosphorus insecticide:

- **Trade name: Dursban ® (48% EC).**

Common name: Chlorpyrifos.

Rate: 1 liter / feddan.

Basic product: Dow AgroSciences.

2. Methods of application

These trials were carried at Zagazig district, Sharqia Governorate, during 2007 and 2008 cotton growing seasons to evaluate the efficiency of six insecticides against the cotton leafworm, *S. littoralis* and some common predators. This evaluation was assessed on the basis the reduction percentages in both *S. littoralis* and predators.

An area of about quarter feddan cultivated with cotton variety (Giza 86) was chosen for each insecticide and control as well. Each area was divided into four experimental plots as replicates. Untreated belt (42 x 7m) was left between each two treatments as a border.

Larvae were counted while newly hatched ones were neglected from counting. A pre-treatment count was made for each treatment. Post treatments counts were recorded after 1, 3, 5, 7, and 9 days for chlorpyrifos, Dipel 2X and Tracer, 5, 10 and 15 days for IGRs (teflubenzuron, tebufenozide and methoxyfenozide).

The tested insecticides were applied at the recommended field rate, while control was sprayed with water only using a knapsack motor sprayer, 20 liter in capacity used with 200-liter volume of insecticidal solution per feddan. The

percentage of reduction in the population density of *S. littoralis* was estimated using the equation of Henderson and Tilton (1955).

The initial kill was calculated at one day post treatment for chlorpyrifos, Dipel 2X and Tracer, whereas after 5 days was determined IGRs (teflubenzuron, tebufenozide and methoxyfenozide). While, the general mean residual effect was calculated as the mean reduction percentages of larvae observed at days 3, 5, 7, and 9 post treatment for chlorpyrifos, Dipel 2X and Tracer, compared to 10, 15 for IGRs (teflubenzuron, tebufenozide and methoxyfenozide), (Badr, 2000).

At the same inspected times, the lethal effects of different insecticides and control against common predators: ladybird beetles, *Coccinella* spp., *Scymnus* spp., the aphid lion, *Chrysoperla carnea* Steph., the staphylinid beetle, *Paederus alfierii* Koch, the anthocorid bugs, *Orius* spp. and true spider were also studied using Henderson and Tilton equation (1955).

The significance of the main effects was determined by analysis of variance (ANOVA). The significance of various treatments was evaluated by Duncan's multiple range test ($p < 0.05$) (Snedecor & Cochran 1980). Data were subjected to statistical analyses using a software package CoStat® Statistical Software (2005) a product of Cohort Software, Monterey, California.

RESULTS AND DISCUSSION

1. Effects of the tested insecticides against larvae of cotton leafworm, *S. littoralis* under field conditions:

Data concerning Tables (1 & 2) summarize the efficiency of some insecticides against *S. littoralis* infestation during 2007 and 2008 seasons. All the investigated insecticides at the recommended concentrations exhibited reduction in infestation of *S. littoralis* on cotton plants compared to control.

The initial effect measured as the reduction percentages of *S. littoralis* larvae at the first day post treatment for chlorpyrifos, at the third post treatment for Tracer and Dipel 2X and at the fifth day post treatment for IGRs was determined. The difference in the times of initial effect was due to the mode of action of each insecticide.

Through the season 2007 the initial effect of chlorpyrifos methoxyfenozide, teflubenzuron, tebufenozide, Tracer and Dipel 2X, respectively recorded 98.21±0.783, 82.55±2.444, 80.83±2.151, 72.70±1.910, 39.57±2.030 and 16.20±1.720% (Tables 1 & 2).

The same trend was recorded in season 2008, showing chlorpyrifos as the highest initial effect (96.01±0.723%) while Dipel 2X gave the lowest effect (15.29±1.401%).

As for IGRs, the initial effect ranged between 73.23±4.084% for tebufenozide and 83.97±3.462% for methoxyfenozide. There were non significant differences among treatments. Whereas the residual effect measured as the mean reduction percentages of larvae at days of 3, 5, 7 and 9 post treatment for chlorpyrifos, compared to 5, 7 and 9 days post treatment for Tracer and Dipel 2X, whereas the residual effect of IGRs was assed at 10 and 15 days post treatment .

The values of residual effect were recorded 93.34±2.599% for chlorpyrifos, 85.32±2.195 for methoxyfenozide, 81.59±2.777% for teflubenzuron 77.93±2.125 for Tracer and 20.55±1.798 for Dipel 2X at the first implemented season.

During the second season 2008, the residual effect of the tested insecticides ranged between 18.82±2.038% for Dipel 2X to 89.89±2.751% in case of chlorpyrifos. The residual effect of methoxyfenozide recorded 86.34±3.398% followed by 83.34±3.353% for teflubenzuron and 52.21±2.931% for Tracer, (Tables 1 & 2).

The obtained results raveled that chlorpyrifos (Dursban) was the most potent insecticide in both initial and residual effect that caused highly significant effect as compared to the other treatments during 2007 and 2008, seasons. Considering the initial effects, the rest of treatments could be arranged descendingly as follows: methoxyfenozide teflubenzuron, tebufenozide, Tracer and finally Dipel 2X at both tested seasons.

Only chlorpyrifos have higher initial effects than its residual effects comparing to the other tested insecticides. The results are in agreement with the data recorded by Abd El-Latief, (2001) who reported that, the organophosphorus compound (chlorpyrifos) exhibited high initial kill against the cotton leafworm larvae after three days of treatment, then the mortality was decreased steadily. Chlorpyrifos was the superior insecticide in activity followed by profenofos.

The residual reduction percentages of (IGRs) and bio-insecticides increased than that of initial effects during the two successive seasons, indicating that the effectiveness of both insecticides increased with increasing the time. The present results corroborates those of El-Maghraby *et al.*, (1999) who investigated three IGRs applied at the recommended and half recommended rates, compared to three conventional insecticides against *S. littoralis* during 1997 and 1998 seasons. Different rates of spinosad were applied to lettuce and compared to a normal dose of deltamethrin (pyrethroid). All spinosad rates applied 20 days after transplanting

controlled *S. littoralis* for the whole crop. They stated that the persistence of spinosad reached up to 45 days after treatment.

Dipel 2X (*B. thuringiensis*) gave the least significant effective in the initial and residual effects during the two successive seasons. Also, Cordero *et al.*, 2006 found that Acetamiprid, *B. thuringiensis* was inconsistent in its performance in field experiments against some lepidopteran pests and Dipel 2X produced similar level for *S. littoralis* control as thecarbamate insecticide, Lannate. Whereas, *B. thuringiensis* compounds, Dipel 2X, MVPII and Dipel ES/NT revealed initial mortality lower than that obtained with the chemical insecticides, Lannate and Reldan, but residual toxicity after 7 days of application for the entomopathogenic bacteria was higher than the chemical insecticides**.**

2. Effects of the tested insecticides on some common predators associated with the cotton leafworm under field conditions:

The aim of this experiment is to investigate the side effect of the tested insecticides on reducing populations of some common predators associated with cotton leafworm population, i.e. ladybird beetle, *Coccinella* spp., *Scymnus* spp., the aphid lion, *Chrysoperla carnea* Steph, the staphylinid beetle, *Peaderus alferii* Koch, the anthocorid bugs, *Orius* spp. and the true spiders in cotton fields during the two successive seasons, 2007 and 2008. The initial and residual effects of the tested insecticides were assessed using the reduction percentages of predators and calculated at the same inspected times of the precedent trial against the cotton leafworm, *S. littoralis*.

During the first inspected season 2007, data illustrated in Tables (3 & 4) showed that chlorpyrifos recorded the highest significant initial and residual effects that gave reduction of 74.81±3.544 and 66.81±5.418%, respectively. The other tested compounds caused moderate effects that manifested (24.73±2.162 and 29.36±3.468%) for methoxyfenozide, 21.58±3.453 and 29.17±3.612% for Tracer, 20.18±1.449 and 25.28±2.644% for teflubenzuron. While Dipel 2X had the least values (12.71±2.099 and 16.46±2.890%), respectively.

The same trend was observed during 2008 season, with the exception of teflubenzuron and tebufenozide that changed their places between initial and residual effects as shown in Tables (3 & 4). Chlorpyrifos recorded the highest significant initial and residual effects on the previous predators, which being 71.60±3.84 and 64.91±3.569% followed descendingly order of methoxyfenozide (23.50±1.799 and 26.78±3.548%), Tracer (22.42±2.931 and 26.92±3.24%), teflubenzuron (21.65±2.496 and 23.66±2.969%), (19.70±2.047 and 24.34±2.781),

respectively whereas Dipel 2X occupied the last category that recorded (14.60±2.072 and 17.68±3.586%), respectively

The mean number and reduction percentages in the population of the abovementioned predators that affected by the tested insecticides were tabulated in Tables (5 – 8) through the two successive seasons 2007 and 2008.

During 2007 season methoxyfenozide recorded the highest initial and residual effect among all tested IGRs against true spiders, *Orius* spp. and *Scymnus* spp. that manifested (38.63±3.49 and 27.27±3.51%), (20.63±3.29 and 37.50±2.84%) and (17.44±2.39 and 21.94±2.72%), respectively.

Methoxyfenozide gave the highest initial effect on *Chrysoperla carnea*, *Peaderus alfierii* and *Coccinella* spp. that recorded reduction of 39.71±3.52, 28.89±2.58 and 20.95±3.13%, respectively.

The highest residual effects were obtained by tebufenozide against both *Coccinella* spp. (28.73±3.43%) and *Peaderus alfierii* (20.00±2.48%) and by teflubenzuron against *Chrysoperla carnea* (54.89±4.01%).

No significant differences were observed among the treatments in the initial and residual effect with the exception of tebufenozide and methoxyfenozide on *Coccinella* spp. and *Scymnus* spp., respectively in the residual effect (Table 5).

As for bio-insecticides and chlorpyrifos insecticide, the initial effects of chlorpyrifos ranged between a minimum value of (65.28±4.77%) for *Orius* spp. to a maximum value of (77.52±3.63%) for *Scymnus* spp., whereas the initial effect of Tracer ranged between (3.10±0.40%) for *Scymnus* spp. to (37.78±3.50%) for *Peaderus alfierii*. Dipel 2X ranged between (4.51±0.62%) for *Orius* spp. to (24.71±2.77) for *Chrysoperla carnea*.

Chlorpyrifos caused the highest significant reduction percentages against tested predators, while Dipel 2X gave the lowest reduction percentages (Table, 7).

In case of season 2008, methoxyfenozide recorded the highest significant decrease in the population of *Chrysoperla carnea* (34.91±2.23 and 49.91±4.59%) and true spiders (31.37±3.84 and 21.42±1.64%) in the initial and residual effect, respectively. Also, recorded the highest reduction percentages than the other treatments against *Peaderus alfierii* (41.67±3.50%) and *Scymnus* spp. (19.41±1.46%) in the initial effect and *Orius* spp. (30.66±2.73%) in case of residual effect (Table, 6). Tebufenozide gave the highest decrease in the population of *Coccinella* spp. (20.63±2.33%) and *Orius* spp.(19.84±2.18%) in the initial toxicity and *Peaderus alfierii* (55.75±2.41%) and *Scymnus* spp. (3.91±3.85%) in the residual toxicity without any significant differences among tested IGRs.

Regarding the bio-insecticides and chlorpyrifos group, chlorpyrifos caused the highest significant reduction percentages in the initial and residual effect that ranged between minimum values of (81.25±3.35 and 77.19±3.38%) for *Coccinella* spp. Both Tracer and Dipel 2X gave the highest initial and residual toxicity against populations of *Chrysoperla carnea* that manifested (55.56±3.21 & 55.92±2.57) and (38.46±3.04 & 36.18±2.65%) in the initial and residual effects, respectively (Table, 8).

Populations of the predatory insects found in all treated areas with tested insecticides were significantly reduced comparing to predator numbers registered in the untreated areas during the two successive seasons.

Insect growth regulators and bio-insecticides caused lower effects against tested predators than chlorpyrifos. This may be attributed to the supposed selectivity of such insecticides that had low contact toxicity against insect species. Mandour (2009) found that spinosad was harmless to *Chrysoperla carnea* eggs and pupae irrespective of concentrations or method of application and he reported that buprofezin and cyromazine (IGRs) were innocuous to larvae and eggs of *Chrysoperla* spp. and were selective to immature phase. The results obtained in this topic are in complete agreement with the data recorded by (Duffie *et al*., 1998) when they tested different classes of insecticides against predators. They found that pyrethroid and organophosphorus classes were the most toxic causing dramatic reductions in the predator numbers, carbamate was moderately toxic. While bio-insecticides, IGRs and the naturalyte (spinosad) had low toxicity to predators.

Similarly, when adults obtained from laboratory colonies of predators were exposed to ten insecticides including four newer insecticides with novel modes of action there was considerable variation in response among the predators tested to the insecticides. In general, Malathion (organophosphorus) was the most toxic one, whereas spinosad was less toxic than the other insecticides against the tested predators, the same conclusions were also obtained by several authors (Desuky, 2002) when tested different insecticides against some common predators.

In addition, Cordero *et al*., (2006) found that among a group of different tested insecticides, spinosad and methoxyfenozide are relatively less toxic to natural enemies and thus can fit well into integrated pest management programs. All the tested insecticides with exception of chlorpyrifos have residual effects higher than their initial ones.

Among the tested IGRs, methoxyfenozide was the most toxicant against the tested predaceous insects than both teflubenzuron and tebufenozide during the two successive seasons. In contrary, when Angeli *et al.*, (2000) exposed the 4th instar nymph of *Orius laevigatus* to eleven insect growth regulators. They found that methoxyfenozide, tebufenozide and triflumuron had no effect, teflubenzuron and buprofezin had slightly harmful and hexaflumuron, flufenoxuron and lufenuron had moderately harmful.

In general, *Chrysoperla carnea* was the most susceptible predators towards all tested insecticides whereas *Scymnus* spp. was the most tolerant one. These results are in harmony with findings of Fayad and Ibrahim (1988) who found *C. Carnea* was highly susceptible to deltamethrin, chlorpyrifos, diflubenzuron and profenofos, the first insecticide was the most critical in the disturbance of *Scymnus* and *Orius* spp. No significant differences were noted between the insecticides or interval between treatments. *Peaderus alfierii* and spiders appeared to tolerate the effects of the insecticides and were encountered in moderate numbers throughout the study, the same symmetry was ordered by same authors who reported that *C. carnea* was highly sensitive to most tested insecticides including spinosad that was less toxic than other insecticides tested against these species.

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تأثير بعض منظمات النمو الحشرية و المركبات الحيوية على دودة ورق القطن و بعض المفترسات المصاحبة لها تحت الظروف الحقلية

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أجريت تجارب حقلية فى منطقة الزقازيق بمحافظة الشرقية خلال موسمى زراعة القطن 2007 و 2008 لتقييم سمية بعض المبيدات ضد يرقات دودة ورق القطن التى تصيب زراعات القطن بهذه المنطقة كذلك التاثير على بعض المفترسات المصاحبة لها، و قد أشارت النتائج الى ان مركبى كلوربيريفوس و ميثوكسيفينوزيد هما أكثر المبيدات المختبرة فعالية حيث سجلا نسب إبادة بلغت (0.783 ± 98.21٪، 2.444 ± 82.55 ٪) فى التأثير الفورى، (2.599± 93.34 ٪، 2.195±85.32 ٪) فى التأثير المتبقي فى موسم 2007، مقارنة بقيم (0.723±96.01٪ ، 3.462±83.97٪) و(2.715±89.89٪ ، 3.398±86.34٪) فى موسم 2008 على الترتيب.

بالنسبة للتأثيرين الفورى و المتبقى لباقى المركبات المختبرة فيمكن ترتيبها تنازلياً كما يلى: تيفلوبنزيرون و تيبوفينو زيد و تراسر و دايبل تو اكس على مدار موسمى الدراسة.

اظهر مركبا كلوربيريفوس و ميثوكسيفينوزيد التأثير الأكثر سمية على المفترسات المصاحبة لدودة ورق القطن فى حقول القطن حيث أعطيا اكبر نسبة خفض فى التعداد بلغت 3.544±79.81 و 2.162±24.73 ٪، 5.418± 66.81، 3.468± 29.36٪ فى موسم 2007 بينما بلغت 3.84±71.60 و 1.799±23.50٪، 3.569± 64.61، 3.548± 26.78 ٪ فى موسم 2008 فى التأثيرين الفورى والمتبقي على الترتيب متبوعا بكل من تراسر و تيفلوبنزيرون و دايبل تواكس خلال موسمى الدراسة.