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FIELD EVALUATION AND RESIDUAL BIOASSAY OF CERTAIN INSECTICIDES TO DETECT THE TOLERANCE CHANGES IN PINK BOLLWORM

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ABSTRACT

A study was carried out on the potential impact of certain insecticides on the abundance of the pink bollworm, *Pectinophora gossypiella* (Saunders) on cotton in Kafr El-Sheikh Governorate, Egypt, during 2002 and 2003 seasons. Results showed that fenpropathrin and thiodicarb were the most effective toxicants, whereas, profenofos occupied the last class in reducing the pink bollworm population. Deltamethrin and chloropyrifos were of moderate effect in this respect. Also, the changes in susceptibility of the larvae to insecticides were studied using the residual vial bioassay technique. Data showed that the pink bollworm larvae were more tolerant to the tested pyrethroids than the carbamates and organophosphates insecticides. The study indicates the potentiality of the vial bioassay technique to give data that may serve as reference values to determine if tolerance to any of the insecticides develops in field populations of the pink bollworm.

INTRODUCTION

Pink bollworm, *Pectinophora gossypiella* (Saunders), causes considerable damage to cotton in Egypt. The primary method used to control damaging infestations of the pink bollworm during the cotton growing season is repeated application of insecticides. Development of resistance to insecticides in pest insects is a severe problem in many crops. Strategies to slow the development of resistance all emphasize the need to develop accurate and rapid monitoring techniques (Roush and Miller, 1986).

Resistance monitoring techniques for the assessment of bollworms resistance to insecticides include: adult topical application (Bariola and Lingren, 1984), larval topical application (Pan *et al.*, 1997), larval Petri-dish residual film method (Guirguis and Watson, 1981), adult pheromone attracticide sticky-trap (Haynes *et al.*, 1987, Li *et al.*, 1992, Sorenson *et al.*, 1995), adult vial bioassay technique (Schouest and Miller, 1988, Al-Beltagy *et al.*, 2001), larval vial bioassay technique (Campanhola and Plapp, 1989).

Schreiber and Knowles (1989) conducted adult vial, adult topical, larval vial and larval topical bioassays on tobacco budworm, *Heliothis virescens* (F.), to determine the relationships between these different tests in describing resistance. They found that larval vial bioassay provides a rapid and valid description of resistance phenomenon. However, development of resistance in adult pink bollworm may be less likely than in larva, since the detoxification system has been reported to be less complex in adult *Spodoptera littoralis* (Boisd.) (Dittrich *et al.*, 1979).

In the present study, experiments were conducted in 2002 and 2003 cotton seasons which describe results of the efficiency of certain insecticides against the pink bollworm and the level of susceptibility of the full-grown larvae using larval vial bioassay technique.

MATERIALS AND METHODS

Field evaluation:

The experiment was conducted at Sakha Agricultural Research Station during 2002 and 2003 cotton seasons. The experimental field was divided into plots of 1/24 of a feddan each and arranged in complete randomized blocks with 4 replicates for each treatment including the untreated control. The insecticides used and their rates per feddan were:

- **Organophosphates:** profenofos (Curacron), EC, 72%, 750 ml and chlorpyrifos (Dursban), EC, 48%, 1 L.
- **Synthetic Pyrethroids:** fenpropathrin (Meothrin), EC, 20%, 750 ml and deltamethrin (Decis), EC, 2.5%, 750 ml.
- **Carbamates:** thiodicarb (Larvin), FL, 37.5%, 1 L.

Spraying with insecticides was achieved 3 times at 15-day intervals, starting when the percent of infested bolls by pink bollworm larvae reached 3%. A low volume sprayer (model CP_3) with one nozzle was used. The volume of spray solution was 300 litre/feddan.

Weekly samples of 25 green bolls were picked up at random from both diagonals of the inner square area of each plot. The number of pink bollworm larvae in each sample was recorded and the mean percentages of reduction in the larval population due to insecticidal treatments were calculated by using Henderson and Tilton equation (1955). Also, the toxicity index was calculated according to the method of Sun (1950), to compare the relative toxicity of the tested insecticides.

Vial bioassay:

Full-grown larvae of *P. gossypiella* were collected from infested bolls obtained form untreated cotton plants during 2002 and 2003 seasons. Toxicity measurements were made by exposing larvae to films of insecticides on the inner surfaces of 20-ml glass vials supplied by A and M University of Texas, USA, as described by Plapp and Vinson (1977). One ml of acetone per each vial containing the appropriate insecticide was evaporated by manually rotating the vials on their sides. Seven concentrations for each insecticide were achieved and replicated 12 times to compute its LC-p line. One larva was introduced into each vial, which was plugged loosely with cotton.

Mortality counts were made 24 h after initial exposure. Concentration-probit lines were plotted and the LC_{50}, LC_{90} and slope values were calculated according to Litchfield and Wilcoxon (1949). Resistance ratio was calculated by dividing the LC_{50} or LC_{90} of the tested insecticide in 2003 season by the LC_{50} or LC_{90} of the same insecticide in 2002 season (Guirgius and Watson, 1981).

RESULTS AND DISCUSSION

1. Effect of insecticidal application on the percentage reduction of larval population:

The mean number of larvae/25 bolls and the percentage reduction of pink bollworm population followed 3 sprays of 5 insecticides in cotton fields during 2002 and 2003 seasons are shown in Table 1.

Table (1): Percent reduction in the larval population of the pink bollworm *P. gossypiella* and toxicity index of the tested insecticides during 2002 and 2003 cotton seasons.

Insecticides	2002 season			2003 season		
	Mean no. of* larvae/25 bolls	Percent reduction	Toxicity index	Mean no. of* larvae/ 25 bolls	Percent reduction	Toxicity index
Organophosphates:						
Profenofos	2.04 b	58.28	76.82	3.00 b	56.71	80.37
Chlorpyrifos	1.71 b	65.03	85.71	2.68 b	61.33	86.92
Synthetic Pyrethroids:						
Fenpropathrin	1.18 c	75.87	100.00	2.14 bc	69.12	97.96
Deltamethrin	1.64 b	66.46	87.60	2.76 b	60.17	85.27
Carbamates:						
Thiodicarb	1.36 bc	72.19	95.15	2.04 c	70.56	100.00
Control	4.89 a	-	-	6.83 a	-	-

* Average of 7 inspections and 4 replicates
By Duncan's multiple range test, means followed by the same letter are not significantly different at 5% level.

The statistical analysis of the data during 2002 and 2003 seasons represented significant differences between the larval population in the experimental fields treated by fenpropathrin and thiodicarb, and those treated by profenofos, chlorpyrifos and deltamethrin.

Data indicate that in 2002, all tested insecticides caused more than 58% reduction in larval population compared to 56% in 2003. In 2002, the synthetic pyrethroid insecticide fenpropathrin was the most effective toxicant giving 75.87% reduction in larval population. The other toxicants could be arranged descendingly as follows: thiodicarb (72.19%), deltamethrin (66.46%), chlorpyrifos (65.03%) and profenofos (58.28%). In 2003, the carbamate insecticide thiodicarb recorded the highest percentage reduction in pink bollworm population (70.56%) followed descendingly by fenpropathrin (69.12%), chlorpyrifos (61.33%), deltamethrin (60.17%) and profenofos (56.71%).

Also, Table 1 presented the toxicity index of the tested insecticides. The data indicate that fenpropathrin induced the highest toxicity index at 2002 season, while thiodicarb recorded that degree of toxicity at 2003 season.

2. Changes in susceptibility to insecticides:

Tested insecticides, toxicity data (LC_{50}s, LC_{90}s and slopes of the concentration-mortality lines) and resistance ratios of the full grown larvae of *P. gossypiella* at LC_{50} and LC_{90} levels to each insecticide during two successive seasons are listed in Table 2. There were no consistent differences in the slops of the dosage-mortality lines, it could be seen that the two LC-probit lines of the same toxicant during the two seasons are considered parallel.

Table (2): Changes in susceptibility of *P. gossypiella* larvae during 2002 and 2003 cotton seasons.

Insecticides	LC_{50} µg/vial		LC_{90} µg/vial		Slope		Resistance ratio (RR)*	
	2002	2003	2002	2003	2002	2003	LC_{50}	LC_{90}
Organophosphates:								
Profenofos	42.65	54.65	406.15	544.95	1.42	1.45	1.28	1.34
Chlorpyrifos	53.85	55.45	455.70	496.20	1.61	1.41	1.03	1.09
Synthetic Pyrethroids:								
Fenpropathrin	72.25	149.20	609.15	1099.15	1.72	1.44	2.07	1.80
Deltamethrin	61.70	132.05	494.90	1045.85	1.50	1.40	2.14	2.11
Carbamates:								
Thiodicarb	44.85	45.90	392.35	550.25	1.30	1.50	1.02	1.40

$$* RR = \frac{LC_{50} \text{ or } LC_{90} \text{ of the tested insecticide in 2003}}{LC_{50} \text{ or } LC_{90} \text{ of the tested insecticide in 2002}}$$

As regards the resistance ratio (RR), the 2003 larvae were more tolerant to the tested insecticides than that of 2002 larvae. Tolerance to the organophosphates insecticides (profenofos and chlorpyrifos) and thecarbamate insecticide (thiodicarb) at either LC_{50} or LC_{90} is low. As the LC_{90}s are the most important from economic point of view, RR were 1.34, 1.09 and 1.40, respectively. Meanwhile, the tolerance to the synthetic pyrethroids (fenpropathrin and deltamethrin) was rather high (RR 1.80 and 2.11 at LC_{90}).

Discussing the aforementioned results, it could be concluded that fenpropathrin and thiodicarb were the most effective compounds against the pink bollworm, however, the insect was more tolerant to the pyrethroid insecticide. Such findings are in agreement with those obtained by Guirguis and Watson (1981), Watson *et al.* (1981), Bariola and Lingren (1984), Watson *et al.* (1986), Gupta *et al.* (1990), Osman *et al.* (1991), Al-Beltagy *et al.* (2001).

Resistance management should work to conserve pesticides as resources for crop protection and to provide a strategy for their elective use. Better monitoring of field resistance could lead to reduce pesticide use that will increase the potential for integration of biological and chemical pest control (Tabashnik, 1986). Using the new monitoring techniques, it is now possible to determine more easily how, where and in what manner, resistance in a population may vary during the season (Schouest and Miller, 1988).

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فعالية بعض المبيدات والتغيرات فى حساسية دودة اللوز القرنفلية

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أجريت هذه الدراسة فى محطة البحوث الزراعية بسخا – محافظة كفرالشيخ لمعرفة التأثير الإبادى لبعض المبيدات على مستوى الاصابة بدودة اللوز القرنفلية فى حقول القطن موسمى ٢٠٠٢ ، ٢٠٠٣. وقد أظهرت النتائج تفوق المبيدين فنبروبثرين (ميوثرين) وثيوديكارب (لارفين) فى هذا المجال. بينما حقق المبيد الفوسفورى بروفينفوس (كوراكرون) أقل النتائج. فى حين أعطى المبيدان كلوربيرفوس (دورسبان) ودلتامثرين (ديسز) نتائج متوسطة.

كما تم دراسة التغيرات فى حساسية يرقات دودة اللوز القرنفلية باستخدام تقنية الزجاجات المعاملة أسطحها الداخلية بالمبيدات. وأوضحت النتائج زيادة فى درجة تحمل اليرقات المعاملة بمركبات البيرثرويدز عن المركبات الفوسفورية العضوية والكرباماتية. ولهذا فإن هذه التقنية قد تعطى نتائج تساهم فى معرفة أى تغيرات تحدث فى مدى حساسية السلالات الحقلية للحشرة لاى من المبيدات المستخدمة.