

# Influence of some New Insecticides Mixtures against Cotton Bollworms and Their Side Effects on Associated Predators

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## ABSTRACT

Bollworms resistance to most registered insecticides has become a major obstacle to their successful chemical control with conventional insecticides. Therefore, field experiments were conducted at Sakha Agricultural Research Station in 2010 and 2011 cotton seasons to study the efficiency of four new mixtures (M) of insecticides, i.e. chloropyrifos + cypermethrin (M1), chloropyrifos + lufenuron (M2), flufenoxuron + alpha-cypermethrin (M3) and thiamethoxam + lambda-cyhalothrin (M4) and two conventional insecticides, chloropyrifos and alpha-cypermethrin, against cotton bollworms, *Pectinophora gossypiella* (Saund.) and *Earias insulana* (Boisd.). Also, their side effects on associated predators were studied. In 2010 season, M3 and alpha-cypermethrin in three successive sprays of each proved to be the superior recording 81.58 and 79.85% reduction in larval infestation, respectively. M4, M1 and chloropyrifos came in the second order without significant differences causing 77.38, 76.65 and 75.27% reduction, respectively. M2 was the least effective with reduction percentage of 74.15. The results of 2011 season showed the same trend of effect for all the tested compounds. According to their side-effects against associated predators, the tested toxicants could be arranged descendingly as follows, alpha-cypermethrin (81.00), M4 (77.96), M3 (76.68), M1 (69.02), M2 (66.07) and chloropyrifos (64.28) % reduction. The obtained results indicated that, the new tested mixtures of insecticides did not exhibit additional advantages in control of the cotton bollworms comparing to the conventional toxicants, where they showed approximately the same effectiveness against the pest and were harmful to the associated predators. Moreover, cross-resistance could be developed after repeated application of these mixtures.

## INTRODUCTION

Cotton bollworms, *Pectinophora gossypiella* (Saund.) and *Earias insulana* (Boisd.) are considered of the most serious pests attacking cotton plants during flowering and later stages and cause about 30-40% losses of seed cotton yield (Haque, 1991). Insect resistance to insecticides has become a major obstacle to successful chemical control with conventional insecticides. The evolution of insecticides resistance is governed by a complex of factors such as intense and repeated application of insecticides from the same chemical group or employs the same mode of action. To avoid the insect resistance development, there is need

for different compounds with different modes of action (Aydin and Gürkan, 2006). Insecticides mixtures are usually applied in the field to enhance the spectrum of the control when multiple pests attack simultaneously. Mixtures are available as pre-mixes from pesticides companies or they are tank-mixed by farmers. Ideally, the insecticides with different modes of action are mixed on the assumption that they would complement the action of each other for killing the target pests. When two compounds are mixed, they can be potentiating, additive or antagonistic in an insect species. These effects can be varied on different insect species or strains depending upon their physiology and the mechanisms of resistance developed. The occurrence of insect resistance to an insecticide is mainly due to the action of enzymes which are either insensitive to the insecticide or able to degrade it to non-toxic metabolites. Because of their dissimilar mode of action, pyrethroids and organophosphates have commonly been mixed to control pests of cotton and other crops (Mushtaq, 2004). Insect growth regulators have a much slower mode of action than conventional insecticides, so their mixtures with conventional toxicants may give high initial and residual activities against the targeted pests; this procedure is very common to control the cotton leafworm and have taken several investigations (Ravi and Verma, 1997; El-Aswad, 2007). The aim of this work was to study the effectiveness of some new mixtures of insecticides against cotton bollworms, *Pectinophora gossypiella* and *Earias insulana*, comparing to conventional insecticides with respect to their side effects on associated predators.

## MATERIALS AND METHODS

### 2.1. Tested compounds:

Trade names, formulations, active ingredients and concentrations of two conventional insecticides and four new mixtures are presented in Table (1).

### 2.2. Experimental design:

The experiments were carried out at the Farm of Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, where an area of 4200 m<sup>2</sup> was selected to be sown with cotton seeds var. Giza 86 on April 15, 2010 and 2011 seasons and divided into plots (replications)

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**Table 1. Tested compounds against bollworms and their details**

Trade name	Formulation	Active ingredient	Concentration (mg AI/L)
Dursban <sup>a</sup>	EC 48%	Chloropyrifos 48%	2400
Alphazid <sup>b</sup>	EC 10%	Alpha-cypermethrin 10%	125
Chlorosan <sup>b</sup>	EC 29%	Chloropyrifos 24% + cypermethrin 5%	1090
Feroban <sup>c</sup>	EC 50%	Chloropyrifos 47.5% + lufenuron 2.5%	2500
Cygron <sup>c</sup>	EC 10%	Alpha-cypermethrin 7% + flufenoxuron 3%	125
Engeo <sup>d</sup>	SC24.7%	Thiamethoxam 14.1% + lambda-cyhalothrin 10.6%	197.6

\* Field recommended rate expressed in mg AI/L

a. Dow AgroScience Co.

b. Kafr El-Ziat for Pesticides and Chemical Co.

c. National Co. for Agrochemical Production.

d. Syngenta Agrochemical Co.

each of 175 m<sup>2</sup>. Recommended agricultural practices were followed all through the season. Treatments were distributed in complete randomized block design with four replications. Four plots were taken as check without any insecticidal treatments. Each of the tested compounds was applied three times at two weeks intervals. The recommended field rate of each compound was diluted using irrigation water to give final volume of spray solution 476 L/ha; sprayed using a knapsack sprayer equipped with one nozzle (CP<sub>3</sub>). Sprays were done on July 19, August 2 and August 17 for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> sprays, respectively in 2010 and 2011 cotton seasons.

### 2.3. Representative samples of bollworms infestation:

For assessing the infestation with cotton bollworms *Pectinophora gossypiella* (Saund.) and *Earias insulana* (Boisd.), 100 green bolls were picked up weekly at random from both diagonals of the inner square area of each plot according to the method of Shaaban and Radwan (1974). Inspections were started on July 19 and continued till September 1 of each season. The collected bolls were transmitted directly to the laboratory and inspected carefully to find out the infested bolls with pink and/or spiny bollworms. The equation of Henderson and Tilton (1955) was used to calculate the reduction percentages of infestation.

### 2.4. Assessing the side effects of the tested compounds on some associated predators:

The most prevailing predacious species in cotton fields, i.e. *Chrysoperla carnea*, *Coccinella* spp., *Orius* sp., *Scymnus* spp and true spiders were investigated according to Hafez technique (1960) to determine the side-effects of the tested compounds. From each plot, five cotton plants were chosen at random at the same dates of green bolls sampling and examined carefully using lens (5x) to count the number of studied predators/cotton plant. The reduction percentages were calculated using the equation of Henderson and Tilton (1955).

### 5. Statistical analysis:

Mean number of bollworms/100 green bolls and mean number of predators/20 cotton plants for each treatment were calculated and compared with one-way analysis of variance (ANOVA). Duncan's multiple range test was used to determine significant differences ( $P < 0.05$ ) between treatments by Costat system for windows, Costat Program (2006).

### RESULTS AND DISCUSSION

Field experiments were conducted at Sakha Agricultural Research Station in 2010 and 2011 cotton seasons to study the efficiency of four new insecticides mixtures viz., chloropyrifos + cypermethrin (M1), chloropyrifos + lufenuron (M2), flufenoxuron + alpha-cypermethrin (M3) and thiamethoxam + lambda-cyhalothrin (M4) and two conventional insecticides, chloropyrifos and alpha-cypermethrin, against cotton bollworms *Pectinophora gossypiella* (Saund.) and *Earias insulana* (Boisd.) as well as their side effects on common predators in cotton fields.

#### 3.1. Effectiveness of the tested compounds on cotton bollworms:

The average numbers of bollworms larvae per 100 green bolls during 2010 and 2011 are presented in Table 2. It is quite clear that the infestation with both insects in the two seasons started with few numbers in the 1<sup>st</sup> and 2<sup>nd</sup> sprays and increased gradually till the end of each season. The average number of bollworms was higher in 2010 than in 2011. Comparing between the efficiency of the tested compounds against bollworms in 2010, data in Table (3) showed that M3 and alpha-cypermethrin in three successive sprays of each were the superior recording 81.58 and 79.85% reduction of larval populations. M4, M1 and chloropyrifos came in the second order causing 77.38, 76.65 and 75.27% reduction, respectively. M2 was the least effective with 74.15 reduction percentage.

**Table 2. Number of bollworms, *Pectinophora gossypiella* and *Earias insulana*, larvae/100 cotton green bolls as influenced by different treatments during 2010 and 2011 seasons**

Treatment	No. of bollworms larvae/100 green bolls pre- and after spray						Mean	
	Pre-spray	After indicated sprays:						
		1 <sup>st</sup> spray		2 <sup>nd</sup> spray		3 <sup>rd</sup> spray		
		1 week	2 weeks	1 week	2 weeks	1 week		2 weeks
<b>Season 2010</b>								
Chloropyrifos	3.0	5.0	4.0	4.0	7.0	9.0	5.0	5.67 b
Alpha-cypermethrin	3.0	2.0	3.0	9.0	6.0	4.0	4.0	4.67 b
Chlorosan (M1)	3.0	3.0	2.0	7.0	5.0	11.0	11.0	6.50 b
Feroban (M2)	3.0	4.0	4.0	7.0	8.0	7.0	6.0	6.00 b
Cygron (M3)	4.0	3.0	4.0	8.0	7.0	7.0	6.0	5.83 b
Engeo (M4)	2.0	2.0	1.0	4.0	4.0	5.0	9.0	4.17 b
Check	3.0	10.0	17.0	21.0	25.0	55.0	44.0	28.67 a
<b>Season 2011</b>								
Chloropyrifos	4.0	6.0	3.0	3.0	5.0	2.0	3.0	3.67 b
Alpha-cypermethrin	3.0	2.0	2.0	3.0	2.0	1.0	2.0	2.00 b
Chlorosan (M1)	3.0	5.0	4.0	2.0	3.0	4.0	2.0	3.33 b
Feroban (M2)	3.0	3.0	3.0	3.0	2.0	4.0	4.0	3.17 b
Cygron (M3)	5.0	4.0	3.0	2.0	3.0	4.0	4.0	3.33 b
Engeo (M4)	2.0	3.0	2.0	2.0	3.0	3.0	3.0	2.67 b
Check	2.0	8.0	10.2	14.0	11.0	25.0	21.0	14.83 a

Means followed by the same letter are not significantly different using DMRT (P<0.05)

**Table 3. Reduction percentages of bollworms, *Pectinophora gossypiella* and *Earias insulana*, after application of various compounds in 2010 and 2011 seasons**

Treatment	% reduction in bollworms larvae after indicated sprays:						Mean ± SD
	1 <sup>st</sup> spray		2 <sup>nd</sup> spray		3 <sup>rd</sup> spray		
	1 week	2 weeks	1 week	2 weeks	1 week	2 weeks	
	<b>2010 season</b>						
Chloropyrifos	50.0	76.5	80.9	72.0	83.6	88.6	75.27±3.9
Alpha-cypermethrin	80.0	82.4	57.1	76.0	92.7	90.9	79.85±4.89
Chlorosan (M1)	70.0	88.2	66.7	80.0	80.0	75.0	76.65±4.97
Feroban (M2)	60.0	76.5	66.7	68.0	87.3	86.4	74.15±5.35
Cygron (M3)	77.5	81.3	71.4	79.0	90.5	89.8	81.58±5.89
Engeo (M4)	70.0	91.2	71.4	76.0	86.4	69.3	77.38±6.53
<b>2011 season</b>							
Chloropyrifos	62.5	85.0	89.3	77.3	96.0	94.4	84.08±1.63
Alpha-cypermethrin	83.3	86.7	85.7	87.9	98.6	95.1	89.55±3.26
Chlorosan (M1)	58.3	73.3	90.5	81.8	89.3	95.1	81.30±2.45
Feroban (M2)	75.0	80.0	85.7	87.9	89.3	90.1	84.70±4.08
Cygron (M3)	80.0	88.0	94.3	89.1	92.0	94.1	89.60±1.63
Engeo (M4)	62.5	80.0	85.7	72.7	88.0	88.1	79.50±2.44

With respect to the percentage of reduction in 2011, data in Table (3) showed the same trend with all tested compounds against bollworms infestation comparing to 2010 data, where the tested compounds could be arranged descendingly according to their efficiency as follows: M3 (89.60), alpha-cypermethrin (89.55), M2

(84.70), chloropyrifos (84.08), M1 (81.30) and M4 (79.50%) reduction.

Majority of previous studies indicated that protective control programs using insecticidal treatments are considered the most effective procedure for controlling cotton bollworms mainly before the formation of greenbolls. Watson *et al.* (1981) & Bramhanker *et al.*

(1990) reported that pyrethroids alternation with endosulfan, carbaryl and triazophos significantly provided the highest reduction in bollworms infestation. Pyrethroids were the most efficient in controlling bollworms and were superior to all other types of insecticides (Khurana and Verma, 1991; El-Hamaky *et al.*, 1993; Sharaf, 2003; El-Basyouni, 2003). Moreover, the synthetic pyrethroids, lambda-cyhalothrin and deltamethrin, exhibited the greatest reduction in bollworms infestation comparing to the organophosphates, chloropyrifos and profenofos (Khan *et al.*, 2007; Younis *et al.*, 2007; Zidan *et al.*, 2012). The insecticide mixture, Feroban, was the most potent against *Spodoptera littoralis* under the field conditions comparing to the other mixtures: Chlorosan, Cygron, Engeo and Kingbo (Abd El-Mageed and Shalaby, 2011). Accordingly, the results in Table (3) revealed that the new mixtures of insecticides are not preferable to be used to control the cotton bollworms, where the average reduction percentages of the tested mixtures approximately caused the same effectiveness comparing to alpha-cypermethrin and chloropyrifos. In addition to that, cross-resistance could be developed by using insecticides have the same mode of action in these mixtures.

### 3.2. Side effect of the tested compounds against the common predators in cotton fields:

The hazardous effects of the four new insecticides mixtures and the two conventional insecticides on the most abundant predators in cotton fields, i.e. *Chrysoperla carnea*, *Coccinella* spp., *Scymnus* spp., *Orius* sp. and true spiders were evaluated and the obtained results are presented in Tables 4 and 5. The results in Table 4 showed that, the average numbers of studied predators/20 cotton plants were significantly decreased after application of all tested compounds

comparing to the check treatment. Insignificant differences were observed between the tested toxicants in this respect. Concerning the reduction percentages in studied predators, data presented in Table (5) cleared that alpha-cypermethrin was the most harmful recording 81.00% reduction, while chloropyrifos was the least harmful causing 64.28% reduction. Based on the general mean of reduction percentages, all treatments were destructive and reduced the population density of the studied predators. The descending order of the tested compounds in this respect was as follows: alpha-cypermethrin (81.01), M4 (77.96), M3 (76.68), M1 (69.02), M2 (66.07) and chloropyrifos (64.28) % reduction.

The current results agreed with the findings of many investigators (Abbas and El-Deeb, 1993; Kostandy, 1995; Al-Beltagy *et al.*, 1999; Salama *et al.*, 2006). In the same direction, El-Dewy (2006) found that alpha-cypermethrin, chloropyrifos and carbaryl significantly reduced the population densities of *Chrysoperla carnea*, *Coccinella* spp., *Scymnus* spp. and true spiders. Also, Yousif-Khalil *et al.* (2008) mentioned that the organophosphate insecticide, chloropyrifos, caused the highest percentage of reduction in all investigated predators comparing to spinosad and methoxyfenozide. Moreover, El-Zahi and Arif (2011) reported that the conventional insecticides: lambda-cyhalothrin, alpha-cypermethrin, deltamethrin, methomyl, profenofos and chloropyrifos were ultimately toxic to the common predators in cotton fields recording 82.76 – 94.80 % reduction comparing to thiamethoxam and imidacloprid which caused less than 50 % reduction. In addition, Zidan *et al.* (2012) indicated that alpha-cypermethrin, lambda-cyhalothrin and profenofos were more toxic against predators than chloropyrifos and methomyl which induced moderate toxicity.

**Table 4. Mean number of common predators /20 cotton plants as influenced by application of various compounds during 2010 and 2011 seasons**

Treatment	Pre-spray	Mean number of common predators/20 cotton plants after indicated spray						Mean
		1 <sup>st</sup> spray		2 <sup>nd</sup> spray		3 <sup>rd</sup> spray		
		1 week	2 weeks	1 week	2 weeks	1 week	2 weeks	
Chloropyrifos	45	15	9	8	5	12	6	9.17 b
Alpha-cypermethrin	48	14	4	0	0	11	3	5.33 b
Chlorosan (M1)	50	24	8	7	1	8	5	8.83 b
Feroban (M2)	53	7	11	11	8	15	9	10.33 b
Cygron (M3)	57	12	6	8	5	8	6	7.50 b
Engeo (M4)	44	5	2	4	2	13	9	5.83 b
Check	45	26	26	24	25	28	23	25.17 a

Means followed by the same letter are not significantly different using DMRT (P<0.05)

**Table 5. Mean of reduction percentage in predators population after application of various compounds during 2010 and 2011 seasons**

Treatment	% Reduction in predators population after indicated sprays						Mean $\pm$ SD
	1 <sup>st</sup> spray		2 <sup>nd</sup> spray		3 <sup>rd</sup> spray		
	1 week	2 weeks	1 week	2 weeks	1 week	2 weeks	
Chloropyrifos	42.55	65.38	66.67	80.00	57.14	73.91	64.28 $\pm$ 5.1
Alpha-cypermethrin	49.52	85.58	100.00	100.00	63.17	87.77	81.00 $\pm$ 2.68
Chlorosan (M1)	16.92	72.31	73.75	96.40	74.29	80.43	69.02 $\pm$ 4.3
Feroban (M2)	77.14	64.08	61.08	72.83	54.51	66.78	66.07 $\pm$ 3.08
Cygron (M3)	63.56	81.78	73.68	84.21	77.44	79.41	76.68 $\pm$ 3.08
Engeo (M4)	88.33	92.13	82.95	91.82	52.52	59.98	77.96 $\pm$ 4.64

In conclusion, the new insecticides mixtures proved to be unprofitable in controlling cotton bollworms according to the results of the current study, where the average reduction percentages occurred in bollworms infestation for the tested insecticide mixtures were nearly the same compared to the conventional insecticides, alpha-cypermethrin and chloropyrifos. Also, all the tested compounds were very destructive to *Chrysoperla carnea*, *Coccinella* spp., *Orius* spp., *Scymnus* spp and true spiders.

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## الملخص العربي

# تأثير بعض المخاليط الجديدة للمبيدات الحشرية ضد ديدان اللوز وتأثيراتها الجانبية على المفترسات المصاحبة

مدیحة الصباحی حامد الدیوی، الزاهی صابر الزاهی

المخلوط الرابع والمخلوط الأول ومبيد الكلوروبيريغوس بدون فروق معنوية بينهم مسجلين نسبة خفض 77.38، 76.65، 75.27٪ على التوالي، وسجل المخلوط الثاني أقل نسبة خفض وهي 74.15٪. كانت النتائج في موسم نمو القطن 2011 تقريبا لها نفس الإتجاه لكل المركبات المختبرة. أما بالنسبة لتأثير هذه المركبات على المفترسات المصاحبة في حقول القطن، فيمكن ترتيب المركبات تنازليا حسب النسبة المئوية للخفض الحادث في تعداد المفترسات كما يلي: الفاسيسيرميثرين (81.00)، المخلوط الرابع (77.96)، المخلوط الثالث (76.68)، المخلوط الأول (69.02)، المخلوط الثاني (66.07)، الكلوروبيريغوس (64.28)٪. أوضحت هذه الدراسة أن المخاليط الجديدة من المبيدات لم تثبت مميزات إضافية مقارنة بالمبيدات التقليدية في مكافحة ديدان اللوز حيث أنها أعطت تقريبا نفس الفاعلية ضد الآفة كما كانت ضارة بالمفترسات المصاحبة وأيضا ربما تزيد المقاومة المشتركة للمبيدات بإستخدام هذه المخاليط.

أصبحت مقاومة ديدان اللوز الشوكية والقرنفلية لفعل معظم المبيدات الحشرية المسجلة عائقا في نجاح عملية مكافحة المبيدات التقليدية، لذا تم إجراء تجارب حقلية لدراسة فعالية أربعة مخاليط حشرية جديدة وهي كلوروبيريغوس + سبيرميثرين (مخلوط 1)، كلوروبيريغوس + لوفينورون (مخلوط 2)، فلوفينكسورون + الفاسيسيرميثرين (مخلوط 3)، ثيو ميثوكسام + لامدا سيهالوثرين (مخلوط 4) وكذلك إثنين من المبيدات التقليدية وهي الكلوروبيريغوس والفاسيسيرميثرين على خفض تعداد ديدان اللوز القرنفلية و *Pectinophora gossypiella* والشوكية *Earias insulana* وأيضا تم دراسة تأثير هذه المواد المختبرة على بعض المفترسات المصاحبة. أوضحت النتائج المتحصل عليها في موسم نمو القطن 2010م أن المخلوط الثالث والفاسيسيرميثرين في ثلاث رشات متتالية من كلاهما من أفضل المعاملات المختبرة حيث كانت نسبة الخفض في تعداد ديدان اللوز هي 81.58، 79.85٪ على التوالي، يليهم في الفاعلية