Impact of Certain Insecticide Treatments against Cotton Bollworms and their Side Effects on Lady Beetles

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Abstract: Field studies were conducted to evaluate insecticide treatments against cotton bollworms (pink bollworm (PBW), *Pectinophora gossypiella* and spiny bollworm (SBW), *Earias insulana*) in two cotton seasons 2018 and 2019. Side effect of these treatments against lady beetle, *Coccinella undecimpunctata* (Linnaeus**)**, was also considered. Results showed that, Chloroplus® 29%EC (Chlorpyrifos 24%, Cypermethrin 5%) and Cygron® 10%EC (Alpha-cypermethrin 7%, flufenoxuron 3%) recorded the highest control of PBW with %reduction in cotton bolls infestation 81.7 & 83.1% in 2018 and 78.7 & 77.7% in 2019, respectively. In addition, Cygron® and Chloroplus® recorded the highest reduction% in cotton bolls infested by SBW with 79.8 and 81.2% reduction in cotton bolls infestation in 2018 and 82.7 & 82.6% in 2019, respectively. On the other hand, Sumigold®, Carylite Elnasr®, Chlorzan® and Cord® achieved the least reduction percentages in cotton bolls infestation by PBW and SBW in both seasons. Chloroplus® and Fantex® have the highest side effects against lady beetle followed by Cord® and Carylite Elnasr®. From this study, the trend of registering insecticides in mixtures can be useful for management of cotton bollworms in the field.

Keywords: Cotton bollworms, Pink bollworm, Spiny bollworm, Insecticides

1.Introduction

Cotton is considered an important source of natural fibers. In addition, cotton seeds are an important source of food for livestock and humans **(Luttrell *et al.*, 1994)**. Cotton is liable to be attacked by different insects at all growing stages. During the flowering and fruiting stages, cotton is attacked by the pink bollworm (PBW), *Pectinophora gossypiella*, and spiny bollworm (SBW), *Earias insulana*. These two insects are the most injurious insects causing a severe reduction in cotton yield **(Ahmad *et al.*, 2003; El-Aswad and Aly, 2007)**.

Pink bollworm larvae attack plants at the beginning of the fruiting stage causing enormous loss to the cotton bolls, fibers and seeds **(Khurana and Verma, 1990)**. Spiny bollworm larvae attack soft and growing tissues especially terminal bud of main stem, flower buds and bolls **(Munro, 1987)**, which ultimately shed **(Atwal, 1994)**. When the control of these two bollworms was neglected, great damage and loss occurs, qualitatively and quantitatively to the crop **(El-Feel *et al.*, 1993)**. Cotton yield depends mainly upon the efficient control of these insects. Chemical control is still adopted as the main method for combating these serious insects. The effectiveness of different pesticides against bollworms was studied by several authors **(Khan *et al.*, 2007; Balakrishman *et al.*, 2009 and Magdy *et al.*, 2009)**.

Resistance development in those two insects against most tested insecticide groups **(Osman *et al.*, 1991 and Hassan, 2007)** leads to the continuing need for new, effective and economical insecticides for crop protection **(Casida and Quistad, 2005)**. Therefore, new insecticides will be required to replace the old one **(Argentine *et al.*, 2002)**. Also, improve new methods and strategies of insect control are mandatory to help in meeting the fiber and food requirements of an ever-expanding world population with a minimum impact on the environment. The aim of this study is to evaluate some insecticide treatments against two cotton bollworms and their side effects on lady beetles under field conditions

2.Material and Method

2.1.Insecticides: The evaluated insecticides were summarized in Table (1).

Table (1): Tested insecticides and their active ingredients.

Trade name	Common name	Field rate (cm^3/ fed.)
Cyperco® 20%EC	Cypermethrin	300
Chlorzan® 48%EC	chlorpyrifos	1000
Chloroplus 9%EC	Chlorpyrifos 24% , Cypermethrin 5%	750
Cord® 72%EC	Profenofos	750
Carylite Elnasr® 2.5%EC	Lambda-cyhalothrin	750
Fantex® 6%SC	Gamma-cyhalothrin	100
Sumigold® KZ 20%EC	Esfenvalerate	150
Cygron® 10%EC	pha-cypermethrin 7% , flufenoxuron 3%	250

2.2. Field trials and the experimental design:

Field trials were conducted during two cotton seasons 2018 and 2019 at Al-Amerya, Alexandria Governorate. Cotton variety Giza 86 was cultivated at May 15, and May 18, during 2018 and 2019 seasons, respectively. All cultural practices were carried out according to "recommended agricultural practice". Treatments were summarized in Table (1). All treatments in addition to control were arranged in a randomized complete block design with four replicates (each was 84 m^2 in area). Plots have been separated from each by unplanted rows. Insecticide applications were carried out using Knapsack sprayer equipment (CP3) at the rate of 200 liters per fed. Spraying took place at July 28, August 12, and August 27, during 2018 cotton season and July 31, August 14, and August 29, during cotton season 2019, respectively. Each treatment was sprayed three times with 14-days intervals.

Percent of boll infestation by the two bollworms (PBW and SBW), each alone, were assessed according to the technique of **El-Heneidy *et al.* (1987)**. Fifty green bolls were collected from each replicate (200 bolls from each treatment) at random from diagonals, where the counting was carried out before insecticides application and seven, and fourteen days after each spray. Boll samples were transferred to the laboratory, dissected and checked both externally and internally, and then percentages of boll infestations by PBW and that by SBW were calculated. At the same time, number of lady beetle was counted on ten cotton plants. The reduction percentages of PBW or SBW infestations which achieved by the treatments and the side effects on the lady beetles were calculated according to Henderson and Tilton equation (1955). Data was presented as a mean for each insecticide spray and a general mean for each insecticide three sprays. Means were compared for significance using analysis of variance (ANOVA) test (LSD at $P < 0.05$) **(SAS Statistical software, 1999).**

3.Results

3.1. Effect of tested insecticides on the infestation of cotton bolls by PBW:

Tables (2 and 3) represent the reduction percentages in cotton bolls infested by PBW after treatment by some insecticide at 2018 and 2019 cotton seasons. According to the statistical analysis, Chloroplus® 29%EC (Chlorpyrifos 24%, Cypermethrin 5%) and Cygron® 10%EC (Alpha-cypermethrin 7%, flufenoxuron 3%) recorded the highest %reduction in cotton bolls infested by PBW. The general mean of reduction percentages in cotton bolls infested by PBW achieved by Chloroplus® and Cygron® were 81.7 and 83.1% in 2018 cotton season, respectively (Table 2). In 2019 cotton season, Chloroplus® and Cygron® recorded 78.7 and 77.7% reduction in cotton bolls infested by PBW, respectively (Table 3). On the other hand, Sumigold®, Carylite Elnasr®, Chlorzan® and Cord® achieved the least reduction percentages in cotton bolls infested by PBW in both seasons.

3.2.Effect of tested insecticides on the infestation of cotton bolls by SPW:

Results in Table (4) revealed that, Cygron® and Chloroplus® recorded the highest reduction% in cotton bolls infested by SBW with 79.8 and 81.2% reduction in cotton bolls infestation, respectively, in 2018. Cyperco® and Fantex® become in the 2nd rank in terms of efficiency against the SBW with 71.5 and 68.8% reduction in cotton bolls infestation, respectively. Sumigold® achieved the least reduction% in cotton bolls infested by SBW. In 2019, reductions in percentages of cotton bolls infested by SBW were 82.7 and 82.6% when cotton plants were treated by Cygron® and Chloroplus®, respectively. Fantex® recorded 76.2% reduction in cotton bolls infested by SBW (Tables 5). Sumigold® and Chlorzan® achieved the least SBW control in 2019 cotton season (Tables 5).

3.3.Side effects of tested insecticides on the lady beetle:

Results in the present study revealed that, Chloroplus® and Fantex® have the highest side effects against lady beetle followed by Cord® and Carylite Elnasr®. The reduction% in lady beetle numbers caused by Chloroplus® and Fantex® were 49.5 and 48.5% in 2018, and 51.5 and 50.3 in 2019, respectively. On the other hand, Chlorzan® has the least side effects against lady beetle where reduction% was 29.9 and 29.3 in 2018 and 2019 seasons, respectively (Tables 6 and 7).

4.Discussion

Cotton bollworms are almost present during the whole cycle of cotton plants; it is therefore relatively more expensive because repeated spraying is necessary. In addition, insecticide resistance development of key insect continues to be a great problem in cotton production **(Cook *et al.*, 2005)**. For this reason, there is a greater need for continuous evaluation of alternative insecticides, which would allow a rational use of insecticides to provide enough crop protection for sustainable food, feed and fiber production. Between the tested treatments, Chloroplus® 29%EC (Chlorpyrifos 24%, Cypermethrin 5%) and Cygron® 10%EC (Alpha-cypermethrin 7%, flufenoxuron 3%) achieved the highest PBW and SPW control.

There is a tendency with insect pest management research to emphasize the insecticide mixtures in insect control **(Nathan and Kalaivani , 2006; Darriet and Corbel, 2006; Ahmad, 2008).** Chloroplus® 29%EC is a mixture between Chlorpyrifos 24% and Cypermethrin 5%. **Ahmad (2008)** recorded a potentiating effect between the organophosphate insecticide profenofos and the pyrethroid insecticide bifenthrin against resistant field populations of *Helicoverpa armigera*. Ethion showed a good potentiation with bifenthrin, lambdacyhalothrin, cyfluthrin, betacyfluthrin, fenpropathrin, esfenvalerate, fluvalenate and tralomethrin against resistant field populations of *H. armigera* **(Ahmad, 2008).** Methyl Paratha ion also potentiated fenvalerate in Oriental armyworm *Mythimna separata* (Walker), black bean aphid *Aphis fabae* Scop., and rice leafhopper *Nephotettics cincticeps* Uhler **(Qu, *et al.*, 2000).** insecticide and insect growth regulator mixtures were recorded to result in potentiating effects. **Barrania *et al.*, (2016)** showed a potentiating effect between lufenuron and cypermethrin**. Abd El-Razik and Mostafa (2013)** recorded potentiating effects between spinetoram and the tested IGR compounds. Mixtures of insect growth regulators with spinosad had resulted in potentiating effects on mosquitoes (Darriet and Corbel, 2006) and cotton leafworm **(El-Guindy *et al.*, 1983; Abdel Rahman and Abou-Taleb, 2007).**

Results of this study showed that using insecticides in formulation mixtures achieved a good PBW and SPW management. The potentiating effect among the tested insecticides depended on the type of insecticides used, ratios and insect strains. Therefore, it is recommended to carry out

Table (2): Reduction percentages of PBW larvae after insecticide treatments at different time intervals (season 2018)

Treatments	Reduction percentages									
	1st spray		Mean of	2nd spray		Mean of	3rd spray		Mean of	General mean of sprays
	Week 1	Week 2	1st week	Week 1	Week 2	2nd week	Week 1	Week 2	3rd week	
Cyperco® 20%EC	71.9	68.8	70.4	76.4	79.0	77.7	82.4	83.3	82.9	77.0 b
Sumigold KZ® 20%EC	67.4	69.3	68.4	71.5	73.7	72.6	69.1	72.4	70.8	70.6 c
Cygron® 10%EC	82.6	84.2	83.4	79.8	82.1	81.0	84.5	85.3	84.9	83.1 a
Fantex® 6%SC	77.3	76.5	76.9	73.2	75.4	74.3	76.9	75.1	76.0	75.6 b
Carylite Elnasr® 2.5%EC	72.5	70.9	71.7	74.3	71.3	72.8	68.1	70.5	69.3	71.3 c
Chlorzan® 48%EC	66.7	68.4	67.6	63.4	65.1	64.3	61.9	64.2	63.1	65.0 d
Chloroplus® 29%EC	78.3	80.6	79.5	81.4	84.7	83.1	81.6	83.5	82.6	81.7 a
Cord® 72%EC	71.2	68.5	69.9	67.3	68.6	68.0	67.5	69.2	68.4	68.8 c

General mean within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table (3): Reduction percentages of PBW larvae after insecticide treatments at different time intervals (season 2019):

Treatments	Reduction percentages									
	1st spray		Mean of	2nd spray		Mean of	3rd spray		Mean of	General mean
	Week 1	Week 2	1st week	Week 1	Week 2	2nd week	Week 1	Week 2	3rd week	
Cyperco® 20%EC	69.1	65.8	67.5	70.1	72.5	71.3	72.6	70.6	71.6	70.1 b
Sumigold KZ® 20%EC	60.5	59.1	59.8	62.3	60.7	61.5	58.6	62.7	60.7	60.7 d
Cygron® 10%EC	78.3	79.8	79.1	74.9	77.1	76.0	76.8	79.1	78.0	77.7 a
Fantex® 6%SC	71.5	73.1	72.3	69.2	71.6	70.4	73.9	71.2	72.6	71.8 b
Carylite Elnasr® 2.5%EC	64.2	61.5	62.9	65.7	62.4	64.1	62.7	62.4	62.6	63.2 cd
Chlorzan® 48%EC	61.5	64.3	62.9	59.9	63.2	61.6	58.4	61.2	62.2	62.2 cd
Chloroplus® 29%EC	75.3	78.9	77.1	78.3	80.6	79.5	78.1	81.0	79.6	78.7 a
Cord® 72%EC	67.2	65.7	66.5	63.4	64.1	63.8	63.8	62.1	63.0	64.4 c

General mean within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table (4): Reduction percentages of SBW larvae after insecticide treatments at different time intervals (season 2018):

Treatments	Reduction percentages									General mean
	1st spray		Mean of 1st week	2nd spray		Mean of 2nd week	3rd spray		Mean of 3rd week	
	Week 1	Week 2		Week 1	Week 2		Week 1	Week 2		
Cyperco® 20%EC	71.5	67.2	69.4	72.6	71.1	71.9	74.9	71.3	73.1	71.5 b
Sumigold KZ® 20%EC	63.5	60.3	61.9	63.3	59.9	61.6	61.3	60.7	61.1	61.5 e
Cygron® 10%EC	80.5	78.8	79.7	82.1	79.5	80.8	79.5	78.4	79.0	79.8 a
Fantex® 6%SC	72.5	69.4	71.0	66.2	65.8	66.0	70.1	68.4	69.3	68.8 bc
Carylite Elnasr® 2.5%EC	67.4	62.9	65.2	68.1	64.5	66.3	65.1	63.3	64.2	65.2 d
Chlorzan® 48%EC	67.8	69.2	68.5	65.6	68.1	66.9	64.7	67.5	66.1	67.2 cd
Chloroplus® 29%EC	81.8	80.6	81.2	83.1	81.5	82.3	80.5	79.9	80.2	81.2 a
Cord® 72%EC	69.4	67.2	68.3	66.6	65.1	65.9	65.9	64.6	65.3	66.5 cd

General mean within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table (5): Reduction percentages of SBW larvae after insecticide treatments at different time intervals (season 2019):

Treatments	Reduction percentages									General mean
	1st spray		Mean of 1st week	2nd spray		Mean of 2nd week	3rd spray		Mean of 3rd week	
	Week 1	Week 2		Week 1	Week 2		Week 1	Week 2		
Cyperco® 20%EC	73.6	75.3	74.5	71.8	73.5	72.7	73.2	72.6	72.9	73.4 c
Sumigold KZ® 20%EC	65.5	64.1	64.8	62.7	65.0	63.9	64.8	66.1	65.5	64.7 e
Cygron® 10%EC	82.9	83.1	83.0	80.9	84.3	82.6	81.4	83.6	82.5	82.7 a
Fantex® 6%SC	75.9	77.5	76.7	73.6	76.1	74.9	77.2	76.7	77.0	76.2 b
Carylite Elnasr® 2.5%EC	67.0	68.4	67.7	66.9	67.4	67.2	68.1	68.6	68.4	67.8 d
Chlorzan® 48%EC	64.9	66.7	65.8	64.8	67.0	65.9	64.8	67.4	66.1	65.9 de
Chloroplus® 29%EC	82.7	82.2	82.5	81.0	83.6	82.3	82.4	83.8	83.1	82.6 a
Cord® 72%EC	68.6	67.9	68.3	71.5	74.4	73.0	70.3	72.8	71.6	71.0 c

General mean within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table (6): Side effects of different insecticide treatments on the lady beetle in cotton field (season 2018):

Treatments	Reduction percentages									General mean
	1st spray		Mean of 1st week	2nd spray		Mean of 2nd week	3rd spray		Mean of 3rd week	
	Week 1	Week 2		Week 1	Week 2		Week 1	Week 2		
Cyperco® 20%EC	35.7	40.3	38.0	37.1	39.5	38.3	41.5	39.2	40.4	38.9 c
Sumigold KZ® 20%EC	32.1	31.8	32.0	33.4	30.7	32.1	34.4	31.9	33.2	32.4 e
Cygron® 10%EC	34.5	37.8	36.2	33.4	32.6	33.0	37.9	35.2	36.6	35.3 d
Fantex® 6%SC	45.9	48.2	47.1	50.1	49.5	49.8	49.9	47.4	48.7	48.5 a
Carylite Elnasr® 2.5%EC	40.2	38.7	39.5	42.7	41.8	42.3	39.5	41.3	40.4	40.7 b
Chlorzan® 48%EC	28.5	31.7	30.1	29.3	29.9	29.6	30.5	29.2	29.9	29.9 f
Chloroplus® 29%EC	48.5	47.9	48.2	49.4	51.2	50.3	50.9	48.8	49.9	49.5 a
Cord® 72%EC	42.3	41.6	42.0	43.5	40.8	42.2	38.7	40.5	39.6	41.3 b

General mean within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

Table (7): Side effects of different insecticide treatments on the lady beetle in cotton field (season 2019):

Treatments	Reduction percentages									General mean
	1st spray		Mean of 1st week	2nd spray		Mean of 2nd week	3rd spray		Mean of 3rd week	
	Week 1	Week 2		Week 1	Week 2		Week 1	Week 2		
Cyperco® 20%EC	40.9	42.5	41.7	41.8	44.3	43.1	39.5	42.8	41.2	42.0 d
Sumigold KZ® 20%EC	31.8	33.7	32.8	31.9	34.1	33.0	30.9	32.4	31.7	32.5 e
Cygron® 10%EC	31.9	32.4	32.2	34.0	31.8	32.9	31.9	31.8	31.9	32.3 e
Fantex® 6%SC	51.8	49.2	50.5	49.8	52.3	51.5	48.1	49.7	48.9	50.3 a
Carylite Elnasr® 2.5%EC	47.9	46.3	47.1	46.8	45.4	46.1	47.5	44.8	46.2	46.5 b
Chlorzan® 48%EC	27.5	30.4	29.0	29.1	30.0	29.6	28.2	30.1	29.2	29.3 f
Chloroplus® 29%EC	50.8	52.6	51.7	49.9	52.0	51.0	51.2	52.5	51.9	51.5 a
Cord® 72%EC	45.1	43.8	44.5	44.2	43.0	43.6	42.8	45.7	44.3	44.1 c

General mean within the same column followed by the same letters are not significantly different according to the $LSD_{0.05}$.

laboratory and field tests of the insecticides mixtures before registration and manufacturing. This trend can be useful for management of insects with resistance development.**Gunning *et al.*, (1999)** showed that organophosphate insecticides, particularly inhibit pyrethroid hydrolyzing esterases in *H. armigera*, and prevent the detoxification and enhance the activity of pyrethroids.

Cygron® 10%EC is a mixture between alpha-cypermethrin 7% and flufenoxuron 3%. Many insecticide and insect growth regulator mixtures were recorded to result in potentiating effects. Barrania et al., (2016) showed a potentiating effect between lufenuron and cypermethrin. Abd El-Razik and Mostafa (2013) recorded potentiating effects between spinetoram and the tested IGR compounds. Mixtures of insect growth regulators with spinosad had resulted in potentiating effects on mosquitoes (Darriet and Corbel, 2006) and cotton leafworm (El-Guindy et al., 1983; Abdel Rahman and Abou-Taleb, 2007).

Results of this study showed that using insecticides in formulation mixtures achieved a good PBW and SPW management. The potentiating effect among the tested insecticides depended on the type of insecticides used, ratios and insect strains. Therefore, it is recommended to carry out laboratory and field tests of the insecticides mixtures before registration and manufacturing. This trend can be useful for management of insects with resistance development.

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تأثير بعض المبيدات علي أثنين من ديدان اللوز و حشرة أبو العيد المصاحبة في محصول القطن

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الملخص العربى

اجريت دراسة حقلية خلال موسمى ٢٠١٨و٢٠١٩لتقيم كفاءة معاملة بعض المبيدات ضد ديدان لوز القطن "دودة اللوز) القرنفلية و دودة اللوز الشوكية " و التاثيرات الجانبية لهذه المعاملات اتجاه الاعداء الطبيعية مثل (الحشرة أبي العيد) . أوضحت النتائج أن خليط كلوروبلس ٢٩% (كلوروبيروفوس ٢٤ % , سبيروميثرن ٥%) و خليط سيجرون ١٠%(ألفا-سبيروميثرن ٧% , فلومنوكسلون ٣%) سجلت كفاءة عالية في خفض الذسبة المئوية للأصابة بديدان اللوز القرنفلية و كانت(٨٣,١, ٨١,٧%) في موسم ٢٠١٨ و (٧٧,٧% و٧٨,٧) في موسم ٢٠١٩ علي التوالي . بينما سجرون و كلوروبلس سجلت أعلي نسبة في خفض الاصابة بديدان اللوز الشوكية و كانت (٩٧,٧, ٨١,٢) خلال موسم ٢٠١٨ بينما كانت (٨٢,٧ و٨٢,٦%) خلال موسم ٢٠١٩ علي التوالي . من ناحيه أخري سومي جولد , و الكربوليت النصر و الكوروزان و الكورد اظهرت كفاءة عالية في خفض الذسبة المئوية للاصابة بديدان اللوز القرنفلية و الشوكية خلال موسم ٢٠١٨ و ٢٠١٩ . اما الكلوربلس و الفانتكس حقق اعلي تأثيرات جانبية ضد الاعداء الطبيعية يليها كورد و كارولبت النصر . برهن السيجرون علي أنه أفضل مبيد (خليط) حيث أنه أحصائيا وأبادةأعطي أعلي تأثير ضد حشرتي القرنفليه والشوكيه ونسبيا أقل تأثير لخنفساء أبو العيد . ولذا يمكن أستخدام السيجرون في برامج مكافحه دودة اللوز القرنفليه و الشوكيه دون تأثير كبير علي خنفساء أبو العيد .