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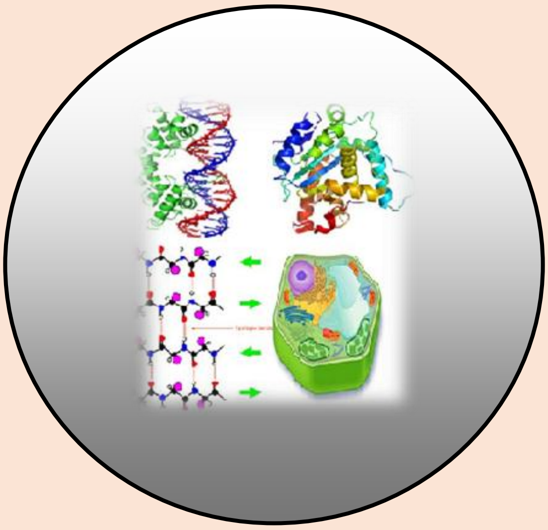

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RESEARCH PAPER

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Field Evaluation of Recommended Compounds to Control Some Pests Attacking Cotton and Their Side Effects on Associated Predators

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ABSTRACT
Field experiments were conducted in El-Behera Governorate during the growing in 2018 cotton season to study the efficiency of certain recommended agricultural insecticides and some new insecticides to control some pests cotton bollworms, pink bollworm, Pectinophora gossypiella (Saund.) and spiny bollworm, Earia sinsulana (Boisd.) attacking cotton and to study their probable side effect on associated predators and cotton yield. Results indicated that the cotton bollworms, the higher reduction was recorded with emmamectin benzoate (85.7%) followed by indoxacarb (83.7%) while, chloropyrifos gave lower reduction of 74.2%. The evaluated percentages of reduction values for other evaluated insecticides were 81%, 79.9% and 76.7% for imidacloprid, alpha-cypermethrin and chloropyrifos + cypermethrin (M) respectively. According to their side-effects against associated predators, the tested insecticides could be arranged descendingly as follows: alpha-cypermethrin, chloropyrifos + cypermethrin (M), chloropyrifos, imidacloprid, indoxacarb and emmamectin benzoate respectively. The obtained results indicated that, the new tested insecticides exhibit additional advantages where, gave higher reduction of cotton bollworms with higher percentage increase of cotton yield and did not harmful to the associated predators, as opposed the conventional insecticides.
Key words: Pectinophora gossypiella, Earia sinsulana, Cotton yield and Predators.

INTRODUCTION
In Egypt, cotton plants are usually subjected to be attacked by numerous insect pests cotton bollworms, pink bollworm, *Pectinophora gossypiella* (Saund.) and spiny bollworm, *Earia sinsulana* (Boisd.), are the most destructive pests infesting cotton plants, cause the greatest number of yield losses Al-Shannaf (2010). Where chemical control is still considered one of the most important methods for controlling control cotton bollworms effectively to overcome the losses and to increase the yield, and increase agricultural productivity continuously however, the extensive and continuous use of insecticides several problems Allen *et al*., (2000). In Egypt, mostly 70% from the total amount of insecticides, used for pest control in all crops combined, is used in cotton fields. Such applications showed a negative impact as a sharp decline (about 70–80% reduction in the numbers of predatory species populations) occurred in cotton fields post applications of insecticides (El-Heneidy *et al*., 1987).

Therefore, the continuous evaluation of the insecticides efficiency for controlling the insect in different areas became urgent. This will give the chance to replace the failed controlling agents by the effective alternatives. Commonly, to reduce insecticides risks to be safer for human health and environment, numerous institutions have extensively implemented alternative methods such as use of insecticides with modes of action differed from conventional insecticides (McKinley *et al.*, 2002). Among the most promising alternatives to conventional insecticides are noval insecticides including oxadiazines, avermectins and neonicotinoide which characterized with their new and/or unique modes of action, they have the potential for crop protection against economic pests and low toxicity to environment components and natural enemies (Michaud and Grant 2003).

It is important to compare the efficacy of insecticides against pests for effective pest management and to reduce indiscriminate use of insecticides. The aim of this study were carried out to evaluate the effectiveness of recommended agricultural insecticides and some new insecticides against cotton bollworms, (pink and spiny bollworms) infesting cotton green bolls and side effect on some important predators in Egyptian cotton fields and side effect on cotton yield.

MATERIAL AND METHODS

1. Tested insecticides

The experiment was consisted of ten compounds, these compounds were used at experimental plot according to their recommended doses (Table 1).

Table 1. Recommended and used doses of the tested compounds insecticides.

Common name	Trade name	Rate of application Feddan
Emmamectin benzoate	(Radicl®) 0.5% EC	800 cm^3
Indoxacarb	(Abizo®) 30% WG	125 cm^3
Imidacloprid	(Jaucho®) 70% WS	7 gm
Chloropyrifos	(Dursban®) 48% EC	2400 (mg AI/L)
Alpha-cypermethrin	(Alphazid®) 10% EC	125 (mg AI/L)
Chloropyrifos 24% + cypermethrin 5%	(Chlorosan®) 29% EC	1090 (mg AI/L)

Thus, the present study was conducted to evaluate different products available in the market for their efficacy against bollworms complex fective pest management and to reduce the indiscriminate use of insecticides. Thus, the present study was conducted to evaluate different products available in the market for their efficacy against bollworms Complex fective pest management and to reduce the indiscriminate use of insecticides. Thus, the present study was conducted to evaluate different products available in the market for their efficacy against bollworms complex.

2. Field trial

Field experiments were carried out at the Abou-El-Matameer city, El-Behera Governorate, Egypt during season of2018 whereas, in season an area was cultivated with cotton variety "Giza 70".The experimental area was consists of five feddans for each treatment which divided into four replicates and involved an untreated check. The spraying was carried out on July, the 26th 2018. The performed treatments were also evaluated against the cotton leafworm and cotton bollworms. For all tested compounds three sprays were done with two weeks interval between sprays. Sprays were done on July26th,1st and 23rdAugustfor 1st, 2nd and 3rd sprays, respectively in 2018 cotton season. A plastic curtains used as borders between treatments during spray. In all treatments one back motor was used with 80 litter of spraying preparation / feddan, for each compound as shown in Table (1).

3.1. Samples

Weekly inspections were done to determine the infestation levels of cotton bollworms, *Pectinophora gossypiella* (Saund.) and *Earia sinsulana* (Boisd.), samples of 100green bolls were collected randomly from each replicate (400 bolls per each treatment) just before spraying and after 7 & 14 days of each spray; they were externally and internally examined. 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 numbers of inspected larvae in green bolls were calculated to compare the efficacy of the tested insecticides were applied at the recommended field rate, while control plots were sprayed with water only. The equation of Henderson and Tilton (1955) was used to calculate the reduction percentage of infestation.

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

The most prevailing predacious species in cotton fields, (*Chrysoper lacarnea*; *Coccinella* spp.; *Orius* sp.; *Scymnus*s pp and true spiders were investigated according to Hafez technique (1960) to determine the side-effects of 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).

3.3. Cotton yield

In each treatment ripened open bolls from thirty cotton plants were collected to estimate the cotton yield / plant, from which, the total yield / feddan was relatively calculated.

4. Statistical analysis

Mean number 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, Cost at Program (2006).

RESULTS

Effectiveness of the tested compounds on cotton bollworms

The implied results in (Table 2) elucidate that after the first sprat, imidacloprid gave the least mean number of infested bolls (1.0 /100bolls), while, for the other treatments ranged from 1.3 for indoxacarb to 4.0 /100bolls forchloropyrifos compared to the untreated check(11.5 /100bolls). However, after the second and third sprays, there were significant differences between the tested compounds where they gave means values of infested bolls ranged between 1.3 to 7.5 /100 bolls after the second spray and from 1.0 to 6.5 /100bolls after the third sprayin comparison with the untreated check (13 and 16.3 infested bolls /100bolls, respectively). The calculated overall means of infested bolls \100 bolls amounted to1.3, 6.5, 7.4, 1.8, 1.5 and 6.0 for emmamectin benzoate, chloropyrifos + cypermethrin (M), alpha-cypermethrin, indoxacarb, imidacloprid and chloropyrifos respectively.

Moreover, the exhibited data in (Table 3) show that the performed treatments of emmamectin benzoate, chloropyrifos, and indoxacarb gave high reduction of infested bolls after the first spray comprised 87%, 86% and 85.6% respectively, but these values consequently, more or less decreased after the 2nd spray up to 85.5%, 77.5% and 82.2% respectively; and after the 3rd spray up to 84.5%, 83.2% and 82.5% respectively, in respect. Moreover, the treatment of M gave the lower of 79.1% reduction after the first spray, then increased to 83.3 to 87.5% after the second and third spray respectively. In general, the overall means reduction values were higher for the treatments of reduction of emmamectin benzoate and indoxacarb (85.7% and 83.7% respectively), while they were 76.7, 79.9, 81 and 74.2 for M, alpha-cypermethrin, imidacloprid and chloropyrifos respectively. It clear that the population of *Pectinophora gossypiella* and *Earia sinsulana* were less observed on treated cotton as compared to untreated cotton, furthermore, from selected insecticides, the emmamectin benzoate was the most potent compound followed by indoxacarb and imidacloprid were observed much effective in controlling the larval population of *Pectinophora gossypiella* and *Eariasinsulana* with maximum reduction percentage in treated cotton field while the chloropyrifos was the least toxic one.

Table 2. Means numbers of infested bolls with bollworms before and after insecticides spraying.

N.S	Ins.	Re.	Treatments													
			Emmamectin benzoate		M		Alpha-cypermethrin		Indoxacarb		Imidacloprid		chloropyrifos		Untreated Check	
			N.B.S*	N.A.S**	N.B.S	N.A.S	N.B.S	N.A.S	N.B.S	N.A.S	N.B.S	N.A.S	N.B.S	N.A.S	N.B.S	N.A.S
1st Spray	1st Ins.	1	3	2	2	3	2	3	2	2	2	1	3	4	3	13
		2	3	1	3	3	3	2	3	1	3	1	1	3	2	12
		3	2	1	2	4	2	1	2	1	1	1	3	5	3	11
		4	2	1	3	2	3	2	3	1	2	1	2	4	3	12
		Av.	2.5	1.3	3	3	2.5	2	2.5	1.3	2	1	2.3	4	2.8	12
	2nd Ins.	1	3	3	2	2	2	3	2	2	2	1	3	2	3	11
		2	3	1	3	3	3	3	3	1	3	1	1	4	2	10
		3	2	2	2	1	2	3	2	1	1	1	3	4	3	11
		4	2	1	3	2	3	3	3	1	2	1	2	6	3	12
		Av.	2.5	1.8	2.5	2	2.5	3	2.5	1.3	2	1	2.3	4	2.8	11
G.M.N.S.***			------	1.6b	------	2.5b	-------	2.5b	-----	1.3b	-----	1b	-----	4b	-----	11.5a
2nd Spray	3rd Ins.	1	3	3	4	8	3	10	3	2	2	1	3	8	3	13
		2	1	1	1	6	1	8	1	1	1	1	1	6	2	12
		3	2	1	2	6	1	10	1	2	1	1	3	8	3	12
		4	1	1	1	8	1	8	1	2	1	2	2	6	3	13
		Av.	1.8	1.5	2	7	1.5	9	1.5	1.8	1.3	1.3	1.3	7	2.8	12.5
	4th Ins.	1	3	1	4	7	3	6	3	3	2	1	3	9	3	14
		2	1	1	1	5	2	5	1	2	1	1	1	9	2	14
		3	2	1	2	6	1	6	1	1	1	1	3	7	3	13
		4	1	1	1	2	2	7	1	2	1	2	2	7	3	14
		Av.	1.8	1	2	5	2	6	1.5	2	1.3	1.3	1.3	8	2.8	13.8
G.M.N.S.***			------	1.3c	------	6b	------	7.5b	------	1.9b	------	1.3c	----	7.5b	-----	13a
3rd Spray	5th Ins.	1	1	1	2	12	1	4	3	4	2	2	3	7	3	15
		2	1	1	1	9	2	4	1	1	1	1	1	7	2	15
		3	1	1	1	12	1	3	2	3	2	3	1	7	3	17
		4	1	1	1	11	2	5	1	1	2	3	1	7	3	16
		Av.	1	1	1.3	11	2	4	1.8	2.3	1.8	2.3	1.5	7	2.8	15.8
	6th Ins.	1	1	1	2	13	1	4	3	4	2	2	3	7	3	16
		2	1	1	1	10	2	4	1	1	1	1	1	5	2	18
		3	1	1	1	11	1	4	2	3	2	3	1	5	3	16
		4	1	1	1	10	2	4	1	1	2	3	1	7	3	17
		Av.	1	1	1.3	11	2	4	1.8	2.3	1.8	2.3	1.5	6	2.8	16.8
G.M.N.S.***			-------	1b	------	11ac	------	4b	------	2.3b	------	2.3b	-----	6.5c	-----	16.3a
O.M.N.****			-----	1.3b	-----	6.5c	-----	4.7c	----	1.8b	----	1.5b	----	6c	----	13.6a

Means followed by the same letter are not significantly different according to DMRT ($P<0.05$)
G.M.N.S.*** = General Mean Numbers of spray
O.M.N.**** = Overall Man Numbers each insecticide
N.B.S* = Number Before Spray N.A.S** = Number After Spray

Table 3. The calculated percentage of reduction of infested bolls with bollworms after application of evaluated insecticides.

N. Spray	Inspections	Replicates	The percentage reduction %					
			Emmamectin benzoate	M	Alpha-cypermethrin	Indoxacarb	Imidacloprid	chloropyrifos
1st Spray	1st Ins.	1	86	71	85	86	84	65
		2	89	73	78	89	84	58
		3	94	67	80	85	80.9	60
		4	91	69	77	87	83.1	57
	2nd Ins.	M. R. %	90	70.1	80	86.8	83	60
		1	90	88.5	89	85.8	88	80
		2	87	86	78.5	82.4	87	82
		3	82	87	82	84	76	73.5
		4	77	91	80	85	85	70.5
		M. R. %	84	88.1	82.4	84.3	84	76.5
General Means Reduction % of Spray			87	79.1	83	85.6	83.5	86
2nd Spray	3rd Ins.	1	84	70	61.5	89	80	69
		2	84	64.5	53	86	73	66.5
		3	80	70	59	77.5	78	67
		4	84	62	55	88	77	64
		M. R. %	83	66.6	57.1	85.1	77	66.6
	4th Ins.	1	89	84.5	73	85.5	86	72.5
		2	91	77.5	81	75.5	79	68.5
		3	89	79.5	79	80.5	70	65.5
		4	83	79	71	75.5	73	66
		M. R. %	88	80.1	76	79.3	77	68.1
General Means Reduction % of Spray			85.5	87.5	76	82.2	77	77.5
3rd Spray	5th Ins.	1	78	87	91.5	87	80.5	92
		2	84	76	95	84	75	83
		3	88	83	95	75	85.5	89
		4	81	74	89	85	83	85
		M. R. %	83	80	92.6	83	81	87.3
	6th Ins.	1	95	70	92.5	87	80.5	88
		2	84	72	88	83.5	86	90.5
		3	80	77	89.5	78	88	84.5
		4	85	81	94	85	81	82.5
		M. R. %	86	75	91	83.4	83.9	86.4
General Means Reduction % of Spray			84.5	83.3	81	83.2	82.5	82.5
Overall Mean of Reduction			85.7	76.7	79.9	83.7	81	74.2

Q. Abbas, M.J. Arif, M.D. Gogi, S.K. Abbas and H. Karar, "Performance of imidacloprid, thiomethoxam,
W. C. Hoffmann, "Evaluation of toxicity of selected insecticides against thrips on cotton in laboratory bioassays", The J. Cotton
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Side effect of the tested compounds against the common predators in cotton fields

The hazardous effects of the tested conventional insecticides and tested new insecticides on the most abundant predatorsin cotton fields, (*Chrysoper lacarnea*; *Coccinella* spp.; *Orius* sp.; *Scymnus*spp and true spiders were evaluated and the obtained results are presented in (Table, 4 & 5). Table (4) showed that, the average numbers of studied predators/20 cotton plants were significantly decreased after application of tested conventional insecticides comparing to the check treatment, insignificant differences were observed between the tested insecticides in this respect. Concerning the reduction percentages in studied predators, data presented in Table (5) cleared that pyrethroid compound was the most harmful recording 87% reduction for alpha-cypermethrin while new compounds were the least harmful causing 10.73, 15.02 and 19.69% reduction for emmamectin benzoate, indoxacarb and imidacloprid respectively. Based on the general means of reduction percentages, allconventional insecticides were destructive and reduced the population density of the studied predators, where alpha-cypermethrin gave higher reduction of predators followed by chloropyrifos + cypermethrin (M) and chloropyrifos, while emmamectin benzoate was the least reduction of predators. The descending order of the tested compounds in this respect was as follows: alpha-cypermethrin, M, chloropyrifos, imidacloprid, indoxacarb and emmamectin benzoate respectively.

Table 4. Mean number of common predators /20 cotton plants as influenced by application of various compounds during 2018 season.

Treatments	Pre-spray	Mean number of common predators /20 cotton plants after indicated spray						Mean
		1st spray		2nd spray		3rd spray		
		1 week	2 weeks	1 week	2 weeks	1 week	2 weeks	
Emmamectinbenzoate	50	14	8	10	6	10	7	9.2 b
M	41	13	3	0	0	10	3	4.8 b
Alpha-cypermethrin	45	9	4	1	1	7	3	4.2 b
Indoxacarb	42	13	8	7	4	11	5	8.0 b
Imidacloprid	47	8	7	6	4	12	9	7.7 b
Chloropyrifos	59	5	7	0	0	14	8	5.7 b
Check	42	24	24	23	22	25	20	23 a

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

Table 5. Mean of reduction percentage in predators population after application of various compounds during 2018 season.

Treatments	% Reduction in predators population after indicated sprays						Mean ± SD
	1st spray		2nd spray		3rd spray		
	1 week	2 weeks	1 week	2 weeks	1 week	2 weeks	
Emmamectinbenzoate	6.00	14.40	8.00	10.00	17.00	9.00	10.73 ± 5.14
M	84.52	88.33	83.50	87.98	80.82	82.00	84.53 ± 3.08
Alpha-cypermethrin	60.491	92.58	100.0	100.0	73.17	95.77	87.00 ± 3.26
Indoxacarb	10.80	16.55	12.00	18.34	15.16	17.27	15.02 ± 3.08
Imidacloprid	15.20	20.00	20.51	23.02	18.30	21.13	19.69 ± 4.3
Chloropyrifos	50.11	86.01	100.0	100.0	63.33	88.41	81.31 ± 2.68

Effect of certain insecticides on cotton yield

The higher percentage of cotton yield increase than the untreated check was recorded after application with the insecticides. Emmamectin benzoate which gave 77.7 % increase followed by indoxacarb 74.6% versus, the lower increase of cotton yield 41.9% after chloropyrifos application. For the other treatments, the calculated percentage values of cotton yield increase ranged from 71, 59.5 and 55.7 % for the imidacloprid, alpha-cypermethrin and chloropyrifos + cypermethrin (M) respectively (Table 6).

Table 6. Effect of certain insecticides on cotton yield.

Insecticides	Cotton yield	
	Weight /fdd. Kg (Kent.)	% Increase*
Emmamectin benzoate	1527.8 Kg (9.7 Kent.)	77.7 %
M	1338.8 Kg (8.5 Kent.)	55.7 %
Alpha-cypermethrin	1372 Kg (8.7 Kent.)	59.5 %
Indoxacarb	1501.8 Kg (9.5 Kent.)	74.6 %
Imidacloprid	1470.8 Kg (9.3 Kent.)	71 %
Chloropyrifos	1220Kg (7.7 Kent.)	41.9%
Untreated check	860 Kg (5.4 Kent.)	------

*expressed as % of increase than the untreated check, according to

DISCUSSION

The results of this study have shown that the new insecticides are effective for the management of cotton bollworms and yield more, and do not have any adverse effects of the abundance of generalist predators. Emmamectin benzoate was the most effective insecticide in reducing the population of *P. gossypiella* and *E. insulana* followed by indoxacarb and imidacloprid while, with regard the effective conventional synthetic insecticides, alpha-cypermethrin, chloropyrifos + cypermethrin (M) and chloropyrifos it showed a low effect. These results agreed with the previous finding of Gosalwad *et al*., (2009) showed that thenewer insecticides significantly reduced bollworms infestation in cotton. However, emamectin benzoate was the most effective followed by spinosad and indoxacarb. Also, Shekeban *et al*., (2010) and Amer *et al*., (2012) reported that emamectin benzoate was the most toxic insecticide between the tested insecticides against pink bollworm. In addition, Iqbal *et al*., (2014), reported that that the pyrethroids were more effective in reduction bollworms infestation than organophosphorous compounds.

All the tested conventional insecticides were very destructive to *Chrysoperlacarnea*; *Coccinella* spp.; *Orius* sp.; *Scymnus*s pp and true spiders while we found the tested new insecticides not effective on natural enemies. In general, El-Zahi and Arif (2011) reported that the pyrethroids and organophosphorous compounds 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. Also Zidan *et al*., (2012) indicated that the pyrethroids were more toxic against predators than organophosphorous which induced moderate toxicity. Working on the side effect on non-target pests, Dar *et al*., (2015) evaluated the toxicity of selecron and trebon against the spiny bollworm, *Eariasinsulana* and recorded that reduction percentages in the pest ranged between 79.01 and 94.57 % a decrease in spider populations as a result of pesticide use can result in an outbreak of pest populations.

So, new insecticides are focused on used into IPM against cotton bollworms under field conditions, because most effective in reducing the population of cotton bollworms compared tested conventional insecticides without any apparent effects on the non-target insects and natural enemies.

This experiment has shown that the lowest cotton bollworms infestation and highest cotton yield is recorded with emmamectin benzoate. This is followed by indoxacarb and imidacloprid. Overall, chloropyrifos records the highest infestation and the lowest seed cotton yield. Farmers should be applied emmamectin benzoate, indoxacarb and imidacloprid for comparable control and yield. Identical results were mentioned inthe works of Gupta *et al*., (2005) and Sontakke *et al*., (2007) reported that emamectin benzoate was the most potent treatment in reducing *P. gossypiella* and *Earias* sp. and causing significantly higher yields. Also, Sanaa (2010) showed that the synthetic pyrethroids induced the reduction in bollworms infestation that was associated with the high amount of seed cotton yield compared to the untreated check.

Finally, the present study indicated that new insecticides are effective for the management of cotton bollworms and yield more, and do not have any adverse effects of the abundance of generalist predators, and such effects if any, are much lower than those of conventional insecticides.

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