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Impact of adding chitosan on bioefficacy of insecticides against cotton spiny bollworm *Earias insulana* (Lepidoptera: Noctuidae) infesting cotton bolls and yield measurable under field conditions

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Abstract:

Cotton spiny bollworm (SBW) *Earias insulana* (Boisduval) (Lepidoptera: Noctuidae) is important pests of cotton. Its larvae bore into the growing shoots, flower buds, flowers and bolls of cotton resulting in considerable losses in quality and quantity. The aim of this research work is to study, adding impact of chitosan as newcomer material on bioefficacy of some insecticides against *E. insulana* infesting cotton bolls and on cotton yield measurable. The results of statistical analysis showed there are highly significant differences in case 1st and 2nd spray with initial and residual effect. In case initial effect , Tracer + chitosan come in the first group recorded 75.33 reduction % followed by indoxacarb (52.00), chitosan (47.09), runner (34.67), indoxacarb + chitosan (43.48), runner + chitosan (24.33) and tracer alone (16.29) reduction % , respectively. On the other hand , adding chitosan to indoxacarb increase residual effect to indoxacarb recorded 74.53 reduction %, compared with other treatments , while chitosan alone recorded less reduction % 37.36 against larvae of *E. insulana* . The 2nd spray, chitosan spray on cotton bolls recorded highest reduction % 75.51 % in case initial effect. But , indoxacarb + chitosan come in the first category 81.13 % reduction in residual effect. In addition to , runner + chitosan and tracer recorded the highly number of healthy bolls 8.8 and 8.2 bolls / plant and in case of boll weight, indoxacarb + chitosan record 3.40 gm / bool followed by indoxacarb 3.18, runner 2.26, control 2.89 , runner + chitosan 1.97, tracer 1.96, chitosan 1.93 and tracr + chitosan 1.44 gm / boll .

Introduction

Cotton spiny bollworm is the larva of *Earias insulana* (Boisduval) (Lepidoptera: Noctuidae). It is one of the most important pests infesting cotton allover the world (Mirmoayedi, 2009). There are varying amount of insecticides which are using regularly for controlling cotton spiny bollworm (SBW) (Gupta *et al*., 2005). Pesticides are comparatively better option to avoid economic damage to this high value crop (Shanower *et al*., 1994). However, chemicals pesticides cause healthy hazards, environmental pollution, resistance development in insects, resurgence of new insect pests and toxicity to natural biological agents (Croft, 1990; Bhati *et al*., 1993; Horowitz *et al.*, 1993 and Gill and Garg, 2014). In China, when spinosad was used for control of pests in vegetables such as eggplant, Chinese cabbages and cotton the quantities found in sprayed plants didn't surpassed, the norm of that country (Gao *et al*., 2007). Methoxyfenozide is new chemistry insecticide, the latest and most persuasive member of the moult-accelerating compounds (MACs) against Lepidoptera (Smagghe *et al.*,2003). MACs directly binding to the same natural hormone receptors stimulates, the molting hormone receptor and cause an anticipated lethal moult (Dhadialla and Carlson, 1998). Several new chemistries with unique modes of action spinosad and methoxyfenozide are useful for pests control and can use as an important pest control option for integrated pest management (IPM) because of their low eco-toxicological effects and short time persistence in the environment (Osorio *et al*., 2008 and Arif *et al*., 2009). The objective of this stidy is adding impact of chitosan as newcomer material on bioefficacy of some insecticides against *E. insulana* infesting cotton bolls and on cotton yield measurable.

Materials and Methods

1. Experimental design and insecticides :

A field trial was conducted at Plant Protection Research Station at Qaha, Qalubiya Governorate , on cotton seedling, cultivated on 15th March, 2018. Cotton plants was left for bolls production beginning from June 2018 till cutting at 23rd September, 2018. Used 7th treatments (Table, 1) was distributed in a randomized complete block design (RCBD) in field trial during 2018 , number of treatments were eight each treatment include three replicates and a plot area was 1/200 of faddan (6x7 m^2), experimental area was 1008 m^2. Cotton plants were examined after bolls production about 20th day from constitute. When observed attack bolls with young larvae of *E. insulana* in the field, the cotton plants was subjected to insecticide spray. For determination of quantity of water, calibration was done by spraying water in the nontreated plots.

Table (1): Information on used insecticides, trade name , common name , formulation and rate of application .

Compounds		Formulation types	Rate of application/ faddan
Trade Name	**Common Name**		
Runner	Methoxyfenozide	28%SC	105 ml
Tracer	Spinosad	48%SC	42 ml
Avento	Indoxacarb	15%Sc	42 ml
Chitosan	Chitosan	81.2WP	200 gm

Spraying was done using a knapsack sprayer. Before the application of each insecticide, the knapsack spray was cleaned before and after used with clean water to avoid pollution . Insecticides were sprayed alone and in binary mixtures with chitosan twice , 10th days between twice sprays. The bolls number were 10th bolls / plot (medium size) were collected randomly before directly application and after application 1,3,5,7 and 10 days, the samples were put in cloth bags, then transporting to the laboratory in Plant Protection Research Institute , Sharkia branch , to examine and data record. Reduction percentage was calculated by using **Henderson and Tilton formula (1955).**

2. Yield measurable:

Mean number of healthy bolls, 1/3 bolls, 2/3 infestation with larvae , bolls branch number and length of plant was recorded from each treatment .

3. Data Analysis :

Data related to the impact of different insecticides tested on reduction percentages of infestation bools with larvae in cotton plants were evaluated by analysis of variance using one-way ANOVA. Means of treatments were separated using Duncan's multiple range test at P = 0.05 .

Results and discussion

1. Adding impact of chitosan as newcomer material on bioefficacy of some insecticides against *Earias insulana* infesting cotton bolls after 1st spray:

The data in Tables (2 and 3) showed impact of adding chitosan on efficacy of various insecticides for the control of *E.insulana* in experimental cotton field during 2018 summer season, after twice spray. Statistical analysis illustrated that there are highly significant differences (***) and LSD_{05} values , recorded 3.914 and 2.98) in case 1st spray with initial and residual effect (Table, 2). In the same table, the treatments divided seven groups according to statistical analysis, tracer + chitosan come in the first group recorded 75.33 reduction % followed by indoxacarb (52.00), chitosan (47.09), runner (34.67), indoxacarb + chitosan (43.48), runner + chitosan (24.33) and tracer alone (16.29) reduction % , respectively. On the other hand , adding chitosan to indoxacarb increase residual effect to indoxacarb recorded 74.53 reduction %, compared with other treatments , while chitosan alone recorded less reduction % 37.36 in larvae of *E. insulana* after 1st spray.

2. Adding impact of chitosan as newcomer material on bioefficacy of some insecticides against *Earias insulana* infesting cotton bolls after 2nd spray :

Data tabulated in Table (3) , indicated that , adding effect chitosan on bioefficacy to insecticides against larvae of *E. insulana* infesting cotton bolls after 2nd spray . Chitosan spray on cotton bolls recorded highest reduction % 75.51 % , due to may be repellant effect or making cotton bolls are unpalatable , while the rest treatments are ordered a descending as follow , indoxacarb, runner, tracer + chitosan, indoxacarb + chitosan and tracer, respectively, while runner mixing with chitosan recorded less reduction %.

Table (2) : Impact of adding chitosan on bioefficacy to some insecticides after 1st spray during 2018 summer season.

Treatments	NO. of larvae before spray	No. of larvae and reduction % after 1st spray .						Residual effect
		Initial effect		3 Days	5 Days	7 Days	10 Days	
Indoxacarb	15	NO	10	6	5	3	2	4
		Red%	52.00b	69.34b	55.21b	69.00 b	71.99b	66.39 b
Runner	9	NO	8	6	4	1	3	2.25
		Red%	34.67d	50.66c	40.07d	81.99a	33.33e	51.51 d
Tracer	8	NO	9	1	2	3	3	2.5
		Red%	16.29f	89.62a	65.99a	42.41d	24.00 f	55.05 c
Chitosan	7	NO	5	5	4	3	2	3.25
		Red%	47.09c	45.75d	23.46e	36.37e	43.85d	37.36 e
Indoxacarb + chitosan	11	NO	10	5	3	1	1	4
		Red%	34.48d	66.56b	64.63a	85.69a	81.14a	74.53 a
Runner + chitosan	5	NO	5	1	2	3	3	2.25
		Red%	24.33e	86.00 a	47.67c	10.00 f	19.33g	40.75 e
Tracer+ chitosan	9	NO	3	4	4	3	2	2.5
		Red%	75.33a	67.45b	41.08 d	50.00c	56.32c	53.71 d
Control	12	NO	16	16	9	8	6	3.25
F-test		***		***	***	***	***	***
$LSD_{0.05}$		3.914		4.562	2.908	4.357	3.195	2.98

***Means of reduction % followed by similar letters and in the same column are not significantly different by LSD at P < 0.05 LSD = Least Significant Difference.**

In the same Table (3), data showed effect of mixing chitosan on residual effect to insecticides , noticed the same trend in Table (2) , Wherever, indoxacarb + chitosan come in the first category 81.13 % reduction while runner + chitosan recorded lowest reduction % (52.66) .

Table (3) : Impact of adding chitosan on bioefficacy to some insecticides after 2nd spray during 2018 summer season.

Treatments	NO. of larvae Before spray	No. of larvae and reduction % after 2nd spray .						Residual effect
		Initial effect		3 Days	5 Days	7 Days	10 Days	
Indoxacarb	**15**	**NO**	**3**	**1**	**2**	**2**	**2**	**1.75**
		Red%	66.04b	53e	73.33b	68cd	79.33d	**68.41c**
Runner	**9**	NO	2	2	2	1	1	1.5
		Red%	65.23 b	46.99f	55.89c	74.33b	83.34c	65.46d
Tracer	**8**	NO	3	1	1	1	1	1
		Red%	36.04d	70c	75.66b	69.33c	81.58cd	73.8 b
Chitosan	**7**	NO	1	1	2	1	2	1.5
		Red%	75.51a	66.37d	42.85d	66.04d	57.14e	58.43 e
Indoxacarb+Chitosan	**11**	NO	3	1	1	1	1	1
		Red%	53.24c	77.51a	82.81a	77.84a	86.36b	81.13 a
Runner + Chitosan	**5**	NO	2	2	2	1	-	1.25
		Red%	32.42e	40g	19e	52.66e	99a	52.66 f
Tracer+ Chitosan	**9**	NO	2	1	2	1	-	1
		Red%	63.9b	73.33b	55.56c	73.33b	97.66a	74.63 b
Control	**12**	NO	7	5	6	5	8	6
F-test		***		***	***	***	***	***
$LSD_{0.05}$		2.396		2.767	2.997	2.796	2.679	2.32

3.Adding impact of chitosan as a newcomer material on cotton yield measurable .

From data in Table (4), illustrateed adding impact of chitosan as a newcomer material on cotton yield measurableie (Mean Number of fruit branches / plant, total bolls / plant , healthy bolls / plant, infested bolls / plants and length of plants weight of plants . The results showed not significant differences between treatments in case of mean no. fruit branches / plant, no. total bolls / plant and no. infested bolls / plant, but there are significant differences between in case healthy bolls / plant, length of plant and weight of bolls /plant , wherever LSD values were 2.49, 3.96 and 1.07 , respectively. In the same table noticed that runner + chitosan and tracer recorded the highly healthy bolls 8.8 and 8.2 / plant, followed by other treatments, while control recorded 3.2 healthy bolls/ plant. Especially length of plant , control length of plant was 100.2 cm but tracer + chitosan recorded 79.8 cm , other treatments lie between it. On the other hand, indoxacarb + chitosan record 3.40 gm / bool followed by indoxacarb 3.18, runner 2.26, control 2.89 , runner + chitosan 1.97, tracer 1.96, chitosan 1.93 and tracer + chitosan 1.44 gm / boll .

Table (4): Impact of adding chitosan to insecticides on cotton yield .

Treatments	Mean No. fruit branches / plant	No. bolls of plant	Healthy bolls of plant	No. infested bolls of plant	Length of plant cm	Weight of bolls /plant gm	Mean weight / bool gm
Indoxacarb	6.00 a	6.80 a	4.60 bc	2.20 b	94.80 b	21.65 a	3.18
Runner	7.40 a	8.20 a	4.40 bc	3.80 ab	94.80 b	18.60 cd	2.26
Tracer	7.40 a	10.20 a	8.20 a	2.00 b	87.00 cd	20.05 b	1.96
Chitosan	7.00 a	9.80 a	4.80 bc	5.00 a	94.80 b	18.90 c	1.93
Indoxacarb +chitosan	6.20 a	9.60 a	6.20 ab	3.40 ab	89.80 c	21.51 a	3.40
Runner + chitosan	6.60 a	10.20 a	8.80 a	1.40 b	85.20 d	20.11 b	1.97
Tracer+ chitosan	6.00 a	10.80 a	6.40 ab	2.40 b	79.80 e	15.54 d	1.44
Control	5.20 a	6.60 a	3.20 c	3.40 ab	100.20 a	19.06 bc	2.89
F-test	NS	NS	***	NS	***	***	
$LSD_{0.05}$	2.0773	4.4230	2.4905	2.3269	3.9681	1.0778	

***Means followed by similar letters and in the same column are not significantly different by LSD at P < 0.05**
LSD = Least Significant Difference

Cultural, biological and chemical are being implemented globally for the management of lepidoptera on various crops. But the success of any control measure is judged by the outcome and the most acceptable control strategy is the one that gives appropriate control against the target organism, and saves the crop from economically important injury. Among various approaches of control, chemicals are considered as fast acting control measures. To overcome the lepidoptera insecticides are considered the only source of quick control measures that save the crop and prevent yield losses and is an important practice of IPM (Gogi *et al*., 2013). Similar results have been achieved by Stanley *et al.* (2009) who reported that the *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) larvae are highly susceptible to spinosad insecticides. Methoxyfenozide (ecdyson receptor agonist) significantly reduced the SBW population and bolls infestation. The possible reason might be due to their effect on insect blood cells like other reported insecticides to affect the blood cells in different insects (Iqbal *et al*., 2002).

The highest cotton yield was recorded in tracer and methoxyfenozide treated plots followed by chitosan (Iqbal *et al.*, 2014) who studied that methoxyfenozide gave good yield.These insecticides not only gave best control of this notorious pest but also increase in seed yield of berseem was recorded. Similar results were found by Meena *et al.* (2013). It is concluded that the results here provided information for making better management decisions and improving cotton production.

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