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Impact of chromenes compounds on some biological aspects of the three cotton bollworm species under constant temperature.

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Abstract:

The experiments were conducted in Plant Protection Research Institute, Sharkia branch, Agriculture Research Center to study the toxic and biological effects of chromens compounds against the pink bollworm (PBW), *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) the spiny bollworm (SBW) , *Earias insulana* (Boisd.) and the American bollworm (ABW) , *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae). Data revealed that chromens compounds had highest toxic effect against newly hatched larvae attained of American followed by spiny and pink bollworms larvae. On the other hand, the latent effects of the chromens compounds on the three insect species were presented in increasing the accumulated of larval and pupal mortality percentages, non-significant increasing on larval duration of the three cotton bollworms insects, and significantly decreased in larval and pupal weight, increasing pre and post-oviposition periods, decreasing oviposition periods, male and female longevities and also reduced fecundity, while the highest reduction in laid eggs recorded on spiny followed by pink and American bollworms compared with untreated control, while the hatchability percentages decreased significantly with pink bollworm and highly significant with spiny and American bollworms compared with untreated control.

Introduction

Cotton plants are one of the most important economical crops in Egypt and all over the world. The pink bollworm (PBW), *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) the spiny bollworm (SBW), *Earias insulana* (Boisduval) and the American bollworm (ABW), *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae). The pesticides were used to control the American bollworm. The level of resistance to some insecticides has increased and new group of chemicals was needed to manage resistant populations in cotton fields. Chromenes showed larvicidal and antifeedant activities against the larvae of *Spodoptera littoralis* (Boisduval)

(Lepidoptera: Noctuidae) (Emam *et al*., 2009). Chromenes are often active against a limit number of insects, biodegradable to nontoxic products and potentially suitable for use in integrated pest management programs, they could be lead to the development of new classes of safer insect control agents (Park *et al*., 2002 and Mansour *et al*., 2004). Also, chromenes have many biological activities such as molluscicidal activity (Hmamouchi *et al*., 2000), larvicidal activity (Mookey *et al*., 2002), and repellent activity (Hadis *et al*., 2003). Also, this compound has a play role as feeding deterrent to larvae of *S. littoralis* and *Heliothis virescens* (Fabricius) (Lepidoptera: Noctuidae) (Enriz *et al*., 2000). Chromenes exhibit insecticidal and well as repellency against several insects (Soares *et al*., 2010; Khanikor *et al*., 2011 and Hazarikaa *et al*., 2012).

The aim of the present study was to evaluate the toxic and latent effects of chromens compounds against the pink, spiny and American bollworms infested cotton crop in Egypt.

Materials and methods

1.Chemicals used:

Three synthetic chemical compounds namely:

A= (3-(3- phenyl-1,4-dihydro-1,2-diazete-1-carbonyl)-2H-chromene-2-one).

B= (5-amino-1-(2- oxo-2H-chromene-3-carbonyl)-3-phenyl-1H-pyrazole-4-carbonitrile).

C= (3-(5-methyl-1,3,4- oxadiazol-2-yl)-2-chromene-2-one).

were synthesized at the laboratory of faculty of science – Zagazig University.

2.Rearing technique:

The proper conditions diet for maintaining a mass culture of *P. gossypiella*, *E. insulana* and *H. armigera* were followed according to the method described by Abd El-Hafez *et al.* (1982). The artificial diet was changed after 7 days of treatment in case of spiny and American bollworms with fresh one (Amer *et al.*, 2010).The larvae were incubated at constant conditions of 26± 1oc. and 70 ± 5% relative humidity (RH.) in an electrical incubation in bollworms laboratory, Plant Protection Research Institute (Sharkia branch) at Zagazig district , Sharkia Governorate , Egypt.

3.Methods of procedure:

3.1. Toxicity tests:

One gram of each chromen compound from each three compounds were dissolved in 30 ml ethyl alcohol 95% mixed with 30 ml of deionized water and put in a dark bottle color as stock solution . The concentrations / compound were prepare, each concentrate per compound was replicated four times compared with untreated check .

3.2. Toxicity effect on larvae:

Five grams of artificial diet were put on a petri-dish (7.50 x 2.00 cm). One ml of the tested concentration/ compound alone were added to the surface of the diet , homeopathic , one ml of ethyl alcohol mixed with water as control, and then left until dryness added concentration . Twenty five newly hatched larvae of PBW, SBW and ABW, each species were transferred and separately put on to treated artificial diet then left to fed. The alive and dead larvae of three insects were recorded after 48 hrs. The LC_{50} and LC_{90} values were determined according to Finney method (1952).

3.3. Latent effect on larvae:

The alive larvae under test , which exposed to different concentrations in treatments and control were transferred individually into glass tube (2×7.5 cm) and incubated under the previous condition. The tubes were inspection daily until pupation to recorded weight and mortality of larval and pupal . The pupae were separated on glass jar (half kg.) until moth's emergence. The newly emerged moths were sexed and put in glass jar (half kg.). Each jar contains two pair of moths and replicated four times for each treatment and control. The emerged moths were fed on 10% sugar solution. Pre-oviposition periods, oviposition and post-

oviposition , longevity of adult males and females, hatchability percentage and number of deposited eggs were recorded.

4. Statistical analysis:

The obtained results of biological measurements were subjected to analysis of variance between the different tested compounds against each insect using Costate computer program Cohort Software. P. O. Box 1149, Berkeley CA 9471 **(Costat Statistical Software, 2005)**.

Results and discussions

1.Toxicology test:

1.1. Larvae:

Results in Table (1), indicated that at LC50 and LC90 values were 146.95, 212.65, 364.39 and 1112.33, 2421.94, 3967.24 ppm for A,B,C on newly hatched larvae of PBW, while mortality concentrations were 126.8512, 227.71, 330.64 and 1218.17, 1539.73, 2364.25 ppm for A,B,C for SBW, meanwhile, the LC50 and LC90 values were 258.70, 442.79, 220.83 and 876.03, 3130.10, 741.89 ppm for A,B,C for ABW after 48hs from treatment. The slope value was (1.3045, 1.5440, 1.5001) for A,B,C for SBW, while these value was (1.4579, 1.2131, 1.2360) for A,B,C for PBW. On the other hand, the slope value was (2.4194, 1.5089, 2.4353) for A, B, C for ABW. Data obtained showed that the newly hatched larvae of PBW was the highest susceptible for chromenes compound than other insects.

Table (1): Toxicity of chromenes compounds against larvae of the *Pectinophora gossypiella*, *Earias insulana* and *Helicoverpa armigera.*

Insects	Compounds	LC_{50}	LC_{90}	Slop
Pectinophora gossypiella	**A**	146.95	1112.33	1.4579
	B	212.65	2421.94	1.2131
	C	364.39	3967.24	1.2360
Earias insulana	**A**	126.85	1218.17	1.3045
	B	227.71	1539.73	1.5440
	C	330.64	2364.25	1.5440
Helicoverpa armigera	**A**	258.70	876.03	2.4194
	B	442.79	3130.10	1.5089
	C	220.8351	741.8863	2.4353

A= (3-(3- phenyl-1,4-dihydro-1,2-diazete-1-carbonyl)-2H-chromene-2- one).
B= (5-amino-1-(2- oxo-2H-chromene-3-carbonyl)-3-phenyl-1H-pyrazole-4-carbonitrile).
C= (3-(5-methyl-1,3,4- oxadiazol-2-yl)-2-chromene-2-one).

2.Effect of chromenes compound on some biological aspects of the pink, spiny and American bollworms:

2.1. Larval duration:

Data in Table (2) indicated that it can be concluded that the chromenes caused prolongation in duration of the larval stage of PBW and ABW, which was significant only with compound C as compared with untreated larvae.

2.2. Larval weight:

Statistical analysis of data presented in Table (2) showed that all tested compounds significant decreased larval weight of bollworms.

2.3. Larval mortality percentage:

Results presented in Table (2) indicated that the larval mortality percentages of PBW, SBW and ABW increased significantly than untreated larvae. The highest average percentage of larval mortality (52.00%) was obtained with ABW for compound A compared with (5.00%)with control. while, the lowest percentage (22%) was recorded for SBW for compound B compared with control which was (4.00%) larval mortality.

2.4. Pupal duration:

Data presented in Table (2) indicated that all compounds caused more significant increases on pupal durations of SBW and ABW compared with control. The mean pupal durations of PBW were 9.99, 10.25and

9.39 for A, B and C. respectively, while it was 9.50 for control . The longest pupal period was 10.25 days for B compound, while the lowest one was 9.39 days for C compound compared with 9.50 days for untreated..

2.5. Pupal weight:

Concerning the effect of the tested compounds on the pupal weight of SBW and ABW, the result indicated highly significant effect than PBW as shown in Table (2).

2.6. Pupal mortality percentage:

Data in Table (2) indicated that it can be concluded that the chromenes caused increased in pupal mortality percentages of bollworms compared with untreated.

Table (2): Effect of treated newly hatched larvae of the *Pectinophora gossypiella, Earias insulana* and *Helicoverpa armigera* with chromenes compounds on the immature stages.

Insects	Compound	Larval duration (days)	Larval weight (gram)	larval Mortality %	Pupal weight (grams)	Pupal duration (days)	Pupal Mortality %
Pectinophora gossypiella	A	15.33 a	0.0263 a	45.00 a	0.0222 a	9.99 a	13.00 b
	B	14.33 a	0.0271 ab	25.00 c	0.0226 a	10.25 a	15.00 a
	C	15.50 ab	0.0313 b	35.00 b	0.0231 a	9.39 a	12.00 b
	Control	13.50 b	0.0356 b	5.00 d	0.0244 a	9.50 a	0.00 c
	F-test	NS	**	***	NS	NS	***
	$LSD_{0.05}$	1.607	0.00489	1.8828	0.00223	1.882	1.631
Earias insulana	A	15.83 ab	0.06303 b	40.00 a	0.05356 b	10.75a	23.00 ab
	B	15.00 b	0.06053 b	22.00 c	0.0507 b	10.25ab	25.00 a
	C	16.33 a	0.05723 b	31.00 b	0.05003 b	10.33ab	18.00 b
	Control	15.59 ab	0.0743 a	4.00 d	0.0618 a	10 b	6.333 c
	F-test	NS	*	***	**	NS	***
	$LSD_{0.05}$	1.2453	0.009804	3.7656	0.00607	0.5435	6.2682
Helicoverpa armigera	A	17.26ab	0.036b	52.00a	0.0325b	16.07a	13.00a
	B	16.66b	0.0368ab	50.00a	0.0324b	16.38a	10.00b
	C	18.10a	0.03893ab	49.66a	0.0319b	16.06a	11.00ab
	Control	15.33c	0.0422a	5.00b	0.0432a	14.66b	5.00c
	F-test	***	N. S	***	***	**	***
	$LSD_{0.05}$	1.22	--	8.55	0.02	0.81	2.66

***Means followed by the same litter vertically did not differ significantly.**

2.7. Pre-oviposition period:

Data presented in Table (3) showed that the chromenes have non-significant effect on pre-oviposition period of bollworms.

2.8. Oviposition period:

The egg laying period of the emerged female from treated newly hatched larvae of PBW & SBW were highly significant shortened compared with the untreated Table (3). Also, the mean oviposition periods of ABW were 4.27, 4.60 and 4.78 days for A, B and C compound, while, the untreated control was 6.00 days.

2.9. Post -oviposition period:

Date in Table (3) indicated that the post-oviposition period of the bollworm female developed from newly hatched larvae treated with the three compounds were nonsignificant compared with control.

2.10. Adult longevity:

Data in Table (3) indicated that the chromenes had highly significant effect on male and female longevity of PBW. Also, the three compounds had most significant effect on the ABW male longevity.

2.11. Number of deposited eggs / female :

The number of eggs deposited by female was most significantly affected by chromenes compound compared with untreated. Generally, the fecundity of female produced from newly hatched larvae treated with chromene compounds were greatly reduced than that obtained from control.

2.12. Hatchability of eggs:

Data presented in Table (3) showed that chromenes compounds caused more significant reduction in the viability of eggs deposited by ABW, PBW and SBW survived from treated newly hatched larvae. Generally, the chromenes compounds caused higher reduction than that of control on the hatchability rate.

Table (3): Effect of treated newly hatched larvae of the *Pectinophora gossypiella*, *Earias insulana* and *Helicoverpa armigera* with chromenes compounds on the mature stages.

Insects	Compound	Oviposition period (days)			Adult longevity (days)		No. of eggs/Female	% Hatchability
		Pre-	Ovi	Post	Female	Male		
Pectinophora gossypiella	A	3.66 a	8.33 b	3.166 a	15.16 b	16.00 c	91.00 b c	69.66 b
	B	5.33 a	6.00 c	4.33 a	15.66 b	17.3 bc	106.66 b	81 ab
	C	3.5 a	9.33 b	4.16 a	17.00 ab	18.66 ab	75 c	70.66 b
	Control	3.33 a	11.66 a	3.50 a	18.5 a	19.33 a	210 a	96.33 a
	F-test	NS	***	NS	*	**	***	*
	$LSD_{0.05}$	2.157	2.105	1.823	2.0337	1.631	22.502	17.282
Earias insulana	A	5.50 ab	6.00 bc	4.50 a	16.00 a	13.33 a	68.33 b	82.66 b
	B	6.50 a	5.00 c	4.66 a	16.16 a	13.5 a	76.66 b	67.33 c
	C	5.33 b	6.66 b	5.00 a	17.00 a	13.83 a	62.33 b	58.00 d
	Control	5.00 b	8.33 a	4.00 a	17.33 a	14.00 a	112.00 a	91.33 a
	F-test	NS	**	NS	NS	NS	**	***
	$LSD_{0.05}$	1.087	1.215	1.513	2.4307	1.6077	20.431	17.721
Helicoverpa armigera	A	2.40 a	4.27 a	2.87 a	9.54 b	8.00 d	251.66 b c	40.00 c
	B	3.60 a	4.60 a	2.13 ab	10.33 ab	9.00 c	273.33 b	50.00 bc
	C	3.63 a	4.78 a	1.66 b	10.07 b	9.66 b	213.33 c	60.00 b
	Control	3.20 a	6.00 a	2.57 ab	11.77 a	10.00 a	507.66 a	80.00 a
	$LSD_{0.05}$	N.S.	N.S.	N.S.	N.S.	***	***	***
	F-test	--	--	--	--	0.27	40.73	18.83

***Means followed by the same litter vertically did not differ significantly.**

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