Toxicological and Latent Effect of Chromens on Biological Parameters of *Earias insulana* and *Spodoptera littoralis* Under Laboratory Conditions

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Abstract

El-Tahawe, H.S., W.A.Z. El-Medany, E.M. Abd-ElAzeem and M.H.A. Metayi. 2024. Toxicological and Latent Effect of Chromens on Biological Parameters of *Earias insulana* and *Spodoptera littoralis* Under Laboratory Conditions. Arab Journal of Plant Protection, 42(1): 88-93. https://doi.org/10.22268/AJPP-001203

This study focused on toxicological and biological consequences of three chromens synthesized chemical compounds against spiny bollworm, *Earias insulana* (Boisd.) 1st instar larvae and cotton leafworm, *Spodoptera littoralis* (Boisd.) 2nd and 4th instar larvae under constant conditions of 26±1ºC. temperature and 70±5% relative humidity. The study investigated toxicological and latent effects of chromens on freshly hatched *E. insulana* larvae and 2nd and 4th instar larvae of *S. littoralis*. Synthetic chromene compounds were found to be particularly harmful to newly hatched spiny bollworm larvae, followed by 2nd and 4th instar larvae of *S. littoralis*. The results obtained indicated that the range of the LC_{50} values of the three compounds was 126.85-364.39 ppm against newly hatched *E. insulana.* Whereas, the LC50 range of the three compounds against the 2nd instar larvae of *S. littoralis* was 31671-103006 ppm. The weight of the two insects' larvae and pupae, as well as male and female longevities and fertility, were all significantly reduced. Furthermore, results showed that the tested chemical compounds reduced hatchability rates significantly.

Keywords: Chromens, toxicity, spiny bollworm, cotton leafworm, *Earias insulana*, *Spodoptera littoralis*

Introduction

Cotton, *Gossypium hirsutum* (L.), is a major crop in many parts of the world, and it is a crucial crop for Egypt's national income. During the growing season, cotton plants, like many other field crops, were attacked by a variety of insect pests. Cotton plants are affected by the spiny bollworm (SBW) *Earias insulana* (Boisduval). The American bollworm was controlled with a variety of insecticides. Resistance to some pesticides has increased, necessitating the use of a new class of chemicals to manage resistant populations in cotton fields. Chromenes, which are active against a limited number of insects, biodegradable to harmless compounds, and potentially suited for use in integrated pest management programs, could lead to the development of new classes of safer insect control applications (Mansour *et al.*, 2004; Park *et al.*, 2002).

Chromenes include a variety of biologically active compounds with different actions, including molluscicidal (Hmamouchi *et al.*, 2000), larvicidal (Kim *et al*., 2002), and repellant (Hadis *et al.*, 2003; Kim *et al.*, 2002). These chemicals also act as a feeding deterrent for *S. littoralis* and *Heliothis virescens* (Fabricius) (Lepidoptera: Noctuidae) larvae (Enriz *et al.*, 2000). Chromenes have insecticidal and repellant activities against a variety of insects (Hazarikaa *et al.*, 2012; Khanikor & Bora, 2011; Soares *et al.*, 2010).

The current study seeks to investigate the harmful and latent effects of various synthetic organic chemicals (chromenes) on freshly hatched *E. insulana* larvae and 2nd, 4th instar *S. littoralis* larvae under laboratory conditions.

The primary goal of this research was to investigate the latent influence of chromenes on several biological characteristics of survived larvae and future development stages of *E. insulana* and *S. littoralis* 2nd and 4th instar larvae.

Materials and Methods

Insects

Abd El-Hafez *et al.* (1982) characterized a sensitive strain of the spiny bollworm *Earias insulana* and *S. littoralis.* Larvae were grown under constant temperature of 26°C and 70% relative humidity on an artificial diet under laboratory conditions (El-Defrawi *et al.*, 1964).

Chemical compounds

The chemical compounds that were tested in this study were manufactured in the Faculty of Science laboratories at Zagazig University during 2020. The chemical substances investigated were as follows: A= 7-(5-amino-1-(2-oxo-2H-chromene-3-carbonyl)-1H-pyrazol-3(2H)-one, B= (2-(2-oxo-2H-chromene-3-carbonyl)-N-phenylhydrazine carbothioamide), C= (2-oxo-N-(1-phenyl ethylidene-2H-chromene-3- carbohydrazide). Those chemicals were derived from 2-amino-4-phenyl-7-hydroxychromene-3-carbonitrile (Elagami *et al.*, 1988).

The acute toxicity of the above three chemical compounds were tested against newly hatched *E. insulana* larvae and *S. littoralis* 2nd and 4th instar larvae were determined. Four serial aqueous dilutions of the three investigated compounds in distilled water were prepared from the stock solution. The amounts of each component caused 20–80 percent larval mortality in *E. insulana* and 2nd and 4th instar larvae of *S. littoralis.* The stock solution for each of the investigated compounds was made by adding five grams of each compound to 25 ml acetone (solvent) as the

https://doi.org/10.22268/AJPP-001203

first concentration, followed by serial concentrations of ppm. All of the chemical concentrations were tested against *E. insulana* and *S. littoralis* larvae.

Acute toxicity of some tested chemical compounds against 1st instar larvae of *E. insulana*

Ten grams of artificial food were placed into 9 cm diameter Petri dishes. The artificial media were treated with three different doses of the three chemicals investigated by adding 3 ml of each concentration. All Petri dishes were treated with all concentrations of each compound, which was spread on the upper surface of the poured diet using a volume syringe and by gently moving the dish in circles, as well as an untreated control, and the Petri-dish treatment was then allowed to dry at room temperature. Each concentration was tested three times by using a camel hair brush, and twenty newly hatched larvae (0-6 hr old) from *E. insulana* were transferred over treated artificial diet in the Petri-dish and incubated under the parameters described above.

Acute toxicity of some tested chemical compounds against 2nd and 4th instar larvae of *S. littoralis*

Castor bean leaf discs (9 cm in diameter) were dipped in the tested concentrations of each of the three chemical compounds for about 10 seconds, and then dried under room conditions before being fed to larvae that were fasted for 4-6 hours before treatment. Larvae were placed in 5 pound glass jars, each treatment was reproduced 5 times (10 larvae for each treatment), and untreated discs were merely dipped in distilled water. After 48 hours, dead larvae were counted in all of the investigated compounds and the untreated control. For each insect studied, the larval mortality rate (%) was calculated. The LC_{50}, LC_{90}, and slope values of each tested compound against first instar larvae of *E.insulana* and 2nd and 4th instar larvae of *S. littoralis* were computed using Finney's method (Finney,1971).

Latent effect of the tested chemical compounds against 1st instar larvae of *E. insulana*

To investigate the latent effects of the tested chemical compounds on the first instar larvae of *E. insulana*, the concentrations tested were 175.07, 271.27 and 229.08 ppm A, B, and C compounds, respectively. The living larvae were put into glass tubes (27.5 cm) containing around five grams of untreated artificial diet after 48 hours of treatment with LC_{25} for each of the tested chemicals and the control. The tubes were covered with absorbent cotton and kept under the same conditions as before, and the weight of the 4th instar larvae was determined, as well as various biological factors such as larval and pupal duration, weight of 4th instar larvae and pupae, and pupation rate. According to precious work, the *E. insulana* sex was determined at the fourth larval stage (Raslan, 1994). Pupae were transferred individually to clean vials with cotton stoppers after insect pupation and kept at 26°C temperature until moth emergence. Adults emergence rate and the sex ratio of adult moths were calculated. The emerging moths from each treatment and control were placed in a glass jar (7.00 cm in diameter) in pairs (male and female) under the previously specified rearing conditions and covered with muslin cloth as an oviposition site. Moths were fed a 10% sucrose solution in a soaked cotton wool that was replaced once a day. Each replicate contained 5 pairs of newly emerged moths, which were counted daily to determine the quantity of eggs laid/ female, and the male and female adults' longevity. The hatchability rate (%) of all placed eggs per female compared with untreated moths, were also determined.

Latent effect of the tested chemical compounds against 2nd and 4th instar larvae of *S. littoralis*

The following concentrations were employed to evaluate the latent effects of the tested chemical compounds on certain biological characteristics of the 2nd instar larvae of *S. littoralis*: 373.89 ppm, 493.01 ppm and 568.54 ppm for the compounds A, B and C, respectively. The concentrations of the three chemical compounds used for the 4th instar larvae were 453.19 ppm, 550.93 ppm and 650.91 ppm, respectively. The alive larvae were moved individually into clean glass containers and fed fresh castor leaves until pupation, 48 hours after treatment with the LC_{50} concentration for each tested chemical and the control, with five replicates for each treatment. Pupae were collected and placed in large, clean jars until adults emerged. The emerging adults were then placed on a piece of cotton soaked in a 10% sugar solution and tafla, *Nerium oleander* branches were added as suitable material for laying eggs. Every day, fresh egg masses were gathered and placed in jars (Gaaboub *et al.*, 2012). The following biological characteristics were assessed: larval and pupal period, pupation and adult emergence rates, larval and pupal weight, fertility, male and female adult longevity, sex ratio of adults, and hatchability rate.

Statistical analysis

To determine the significance of the toxic and latent effects of the several tested chemicals against *E. insulana* and *S. littoralis* larvae, the acquired findings of larval mortality for each treatment and biological measurements were subjected to analysis of variance. Proper "F" and LSD values were determined as described by Fisher (1950).

Results and Discussion

Acute toxicity of the three tested chemical compounds against 1st instar larvae of *E. insulana*

LC_{50} and LC_{90} values **-** The LC_{50} values of the three chemical compounds A, B, and C against *E. insulana* were 126.85, 227.71, and 364.39 ppm, respectively. Results obtained also indicated that chemical A was the most toxic, followed by chemicals B and C with LC_{90} values of 1218.17, 1539.73 and 3967.24 ppm, respectively (Table 1). Chemical A was the most promising compound for controlling *E. insulana*, based on LC_{50} and LC_{90} values. On the other hand, chemical C, had the least harmful effect on *E.insulana* 1st instar larvae.

Slope values **-** The toxicity effect of the three tested chemical compounds against *E. insulana* 1st instar larvae indicated that chemical B had the steepest toxicity line, with a slope value of 1.5440, whereas chemical C had the flattest line, with a slope value of 1.2360. Compound A was in between B and C, with a slope value of 1.304. The data obtained revealed that *E. insulana* 1st instar larvae were more responsive to B compound than the other compounds (Table 1).

Table 1. Toxicity of three chromene compounds against 1st instar larvae of *E. insulana* laboratory strain 48 hrs. after treatment.

Chemical compounds*	LC_{50} (ppm)	LC_{90} (ppm)	Slope values
A	126.85	1218.17	1.3045
B	227.71	1539.73	1.5440
C	364.39	3967.24	1.2360

* A= 7-(5-amino-1-(2-oxo-2*H*-chromene-3- carbonyl)-1*H*-pyrazol-3(2H)-one, B= (2-(2-oxo-2*H*- Chromene-3- carbonyl)-*N*-phenyl hydrazine carbothioamide, C= (2-oxo-*N*-(1-phenyl ethylidene)-2*H*-chromene-3- carbohydrazide)

Acute toxicity of the three tested chemical compounds against 2nd and 4th instar larvae of *S. littoralis*

LC_{50} and LC_{90} values- The LC_{50} of the three investigated compounds C, A and B against *S. littoralis* 2nd instar larvae are as follows: 31671.2, 65919.9 and 103006 ppm, respectively. However, the results of LC_{90} values revealed that the chemical C was the most dangerous, followed by A and B chemicals, with respective LC_{90} values of 260373.0, 997214.5 and 2149952.7 ppm. The LC_{50} of the three investigated chemical compounds B, A and C against the 4th instar larvae can be arranged in ascending order as follows: 6423.6, 27116.4 and 33228.6 ppm, respectively. The data revealed that chemical B was the most toxic, followed by chemicals A and C, with LC_{90} values of 150548.2, 153945.9 and 385370.9 ppm, respectively (Table 2).

Slope values - Chemical C had the steepest toxicity line against 2nd and 4th instar larvae of S. *littoralis*, with the highest slope value of 1.40 and 1.20, whereas chemical B had the flattest line, with the lowest slope value of 0.97 and 0.94, and fell in between A and C chemicals, which recorded slope values of 1.09, 1.69 and 1.40,1 .20. The 2nd and 4th instar larvae of *S. littoralis* were more vulnerable to C compound than other compounds (Table 2). Results obtained indicated that B compound was far less toxic against 2nd instar larvae than against 4th instar larvae (Table 2).

The latent influence of chromenes on several biological characteristics of survived larvae of *E. insulana*

Mortality rate - The three tested chromenes caused a significant increase in *E. insulana* larval mortality when compared with the control. Compound C gave the highest average mortality rate of 91.43% as compared to the control (9.0%) (Table 3).

Larval duration - Chromenes increased the duration of the larval stage of *E. insulana*, but the effect was minor when compared to untreated larvae. The average larval durations for the A, B, and C compounds were 14.33, 16.33, and 16.00 days, respectively, compared to 15.00 days for the control (Table 3).

Larval weight - The statistical analysis of the data in Table (3) revealed that all of the tested compounds caused a substantial drop in *E.insulana* larval weight when compared to the control.

Table 2. Toxicity of three chromene compounds against the 2nd and 4th instar larvae of *S. littoralis* laboratory strain 48 hrs after treatment.

Chemical compounds*	Larval instars	LC_{50} (ppm)	LC_{90} (ppm)	Slope values
A	2th	65919.9	997214.5	1.09
	4th	27116.4	153945.9	1.69
B	2th	103006.7	2149952.7	0.97
	4th	6423.6	150548.2	0.94
C	2th	31671.2	260373.0	1.40
	4th	33228.6	385370.9	1.20

* See table 1.

Pupal weight - The effect of the investigated chemicals on the pupal weight of *E. insulana* was found to have a substantial effect (Table 3), between the substances that were tested and the control.

Pupal duration - Table 3 shows that every of the tested chemicals induced significant increases in pupal lengths of *E.insulana* when compared to control. For the table 3, C chromene cause longest period recording 11.33 days followed by the control (10.0 days), and treatment with B compound produced the shortest pupal time of 5.0 days.

Pupation rate - Statistical analysis of the data (Table 3) revealed that the effect of the tested compounds on pupation rate was significant. The A compound produced the highest average pupation rate of 31.25%. The lowest rate of 15.65% was for the B compound, compared to 91.0% for the untreated check. In general, all of the chemical substances studied resulted in lower pupation rate than the control.

Adult emergence - Statistical analysis of adult emergence revealed that compound C produced the lowest adult emergence rate of 73.33%, compared to 96.0% for control (Table 4). In general, chromene compounds resulted in lower adult emergence rate than the control treatment.

Sex ratio - The effect of the investigated chemicals on the sex ratio of *E. insulana* adults was insignificant when compared to the control (Table 4).

Adult longevity - The B compound produced the shortest mean longevity periods of 13.66 and 12.66 days, for both males and females of *E. insulana*, respectively, compared to 15.40 and 17.76 days for the control group (Table 4).

Fecundity - Treatment with the three chemicals examined had no effect on the quantity of eggs laid by *E. insulana* when compared with the control. The B compound produced the lowest mean number of laid eggs, averaging 63.39 eggs per female compared to 107.86 eggs per female in the control group (Table 4).

Hatchability rate - Compound A had the highest effect on hatchability rate (Table 4). In addition, the investigated chemicals had no effect on the viability of *E. insulana* deposited eggs. In general, the hatchability rate was reduced more by the chromene compounds compared to the control.

Table 3. Latent effect of three chromene compounds on treated 1st instar larvae of *E. insulana* laboratory strain with LC_{25} concentration.

Chemical compounds*	Larval mortality rate (%)	Larval duration (days)	Larval weight (gram)	Pupal weight (gram)	Pupal duration (days)	Pupation rate (%)
A	79.043 a	14.33 b	0.035683 a	0.0700 a	10.00 a	31.25 b
B	84.76 a	16.33 a	0.058533 a	0.07103 a	5.00 b	15.65 c
C	91.43 a	16.00 ab	0.03850 a	0.02746 b	11.33 a	16.71 c
Control	9.00 b	15.00 ab	0.08340 b	0.0630 a	10.00 a	91.00 a

* See table 1.
Values followed by the same letters in the same column are not significantly different at P= 0.05.

Table 4. Latent effect of three chromene compounds on mature stages when 1st instar larvae of *E. insulana* laboratory strains were treated with LC_{25} concentration.

Chemical compounds*	Adult emergence rate (%)	Female ratio (%)	Adult longevity (days)		Fecundity/ female	Hatchability rate (%)
			Male	Female		
A	84.33 b	52.00 a	15.00 a	16.33 a	108.38 a	78.77 ab
B	75.00 c	27.86 a	13.66 a	12.66 b	63.39 a	64.73 ab
C	73.33 c	36.66 a	14.00 a	15.33 ab	100.76 a	60.32 b
Control	96.00 a	45.33 a	15.40 a	17.76 a	107.86 a	95.66 a

* See table 1.
Values followed by the same letters in the same column are not significantly different at P= 0.05.

The latent influence of chromenes on several biological characteristics of survived larvae *S. littoralis*

Accumulative larval mortality **-** All three tested chemicals resulted in a significant increase in the mortality rate of *S. littoralis* 2nd and 4th instar larvae (Table 5). The compound B had the highest average larval mortality rate of 36.99 and 20.96%, for the 2nd and 4th instar larvae, respectively, compared to 3.66 and 3.99 % larval mortality for the control.

Larval duration **-** Chromenes treatment lengthened the duration of *S. littoralis* 2nd instar larvae, with a significant difference between treated and untreated larvae for all three compounds. The average 2nd instar larvae duration following treatment with A, B, and C compounds were 20.66, 21.22, and 20.76 days, respectively, compared to 17.19 days for the control. The average 4th instar larval duration following treatment with A, B, and C compounds were 19.62, 17.97, and 17.66 days, respectively, compared to 13.66 days for the control (Table 5).

Larval weight **-** The statistical analysis of the data revealed that all of the chemicals examined caused a highly significant drop in the weight of 2nd instar larvae of *S. littoralis*, but had no effect on the weight of 4th instar larvae (Table 5).

Pupal duration **-** All of the chemicals tested induced significant reduction in pupal duration of *S. littoralis* 2nd and 4th instar larvae when compared to control. Pupal duration of 2nd and 4th instar larvae treated with B compound were 12.93 and 11 days, respectively, compared to 8.40 and 8.70 days for the control (Table 5).

Pupal weight **-** The effect of the investigated compounds on the pupal weight of *S. littoralis* 2nd and 4th instar larvae revealed a significant difference between treatment with the tested compounds and the control treatment (Table 5).

Pupation rate **-** The effect of treatment of 2nd instar larvae of *S. littoralis* with the investigated chemicals on pupation rate was significantly different compared to the control, but the same was not true for treatment of the 4th instar larvae (Table 5). The A compound had the highest average pupation rate of 61.33 and 73.88% following treatment of 2nd and 4th instar larvae, respectively. The lowest pupation rate for the 2nd and 4th instar larvae was 50.76 and 57.13% for the C compound, compared to 99.32 and 98.88% for the untreated check, respectively. In general, all of the substances studied resulted in lower pupation rate than the control.

Adult emergence **-** The investigated chemicals significantly reduced adult emergence for treated 2nd and 4th instar larvae of *S. littoralis* (Table 6). The compound C had the lowest mean of adult emergence of 64.32 and 67.24%, compared to 86.99 and 95.90 percent for control for the treated 2nd and 4th instar larvae, respectively.

Sex ratio (female:male) **-** The effect of treating *S. littoralis* 2nd and 4th instar larvae with the three tested chemicals on the sex ratio of emerging adults was significant and is summarized in Table 6.

Adult longevity - Treatment of 4th instar larvae with the three investigated substances significantly influenced the longevity of emerging *S. littoralis* males and females (Table 6). Adults longevity of males and females emerged from treated 2nd and 4th instar larvae with compound A was 8.55, 4.86, and 8.66, 5.77 days, compared to 7.95, 8.42, and 9.88, 7.8 days for control, respectively.

Fecundity **-** Treatment of 2nd and 4th instar larvae with A and B compounds had a significant effect on the number of laid eggs by the emerged females of *S. littoralis* when compared with the control (Table 6). The compounds A and B caused high reduction in number of eggs laid, which reached 125.55, 197.22, and 159.88, and 136.66 eggs/female, respectively, compared to 746.66 and 777.11 eggs/female for the control. In general, the fertility of females born from freshly hatched

larvae treated with chromene compounds was much lower than that of the control larvae.

Hatchability rate **-** The current findings revealed that there were substantial differences between the effect of the tested three chromenes and the untreated control. Compound B had the greatest impact on hatchability rate of laid egg masses, with 57.04 and 56.22% for the treated *S. littoralis* 2nd and 4th instar larvae, respectively, compared to 94.33 and 96.49% for the control.

Chromene derivatives are highly toxic and effective on both mature and juvenile stages of three cotton bollworm species, according to El-Tahawe (2020). Chromenes were found to have larvicidal and antifeedant properties against *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae) larvae (Emam *et al*., 2009). Chromenes have insecticidal and repellant properties against a variety of insects (Hazarikaa *et al*., 2012; Khanikor & Bora, 2011; Soares *et al*., 2010).

Table 5. Latent effect of the three chromene compounds A, B and C when immature 2nd and 4th instar larvae of *S. littoralis* were treated with LC_{50} concentrations.

Chemical compounds*	Larval mortality rate (%)	Larval duration (days)	Larval weight (gram)	Pupal weight (grams)	Pupal duration (days)	Pupation rate (%)
Treated 2nd instar larvae						
A	27.66 b	20.66 a	0.02971 b	0.025436 b	13.16 b	61.33 b
B	36.99 a	21.22 a	0.0278 b	0.02584 b	12.93 b	56.19 c
C	25.66 b	20.76 a	0.0302 b	0.02767 b	14.73 a	50.76 d
Control	3.66 c	17.19 b	0.03832 a	0.03219 a	8.40 c	99.32 a
Treated 4th instar larvae						
A	17.66 b	19.62 a	0.03126 a	0.02636 a	13.4 a	73.88 b
B	20.96 a	17.97 b	0.03260 a	0.02832 a	11.00 b	66.68 c
C	16.99 b	17.66 b	0.03183 a	0.02849 a	12.93 a	57.13 d
Control	3.99 c	13.66 c	0.03786 a	0.03293 a	8.70 c	98.88 a

* See table 1.
Values followed by the same letters in the same column are not significantly different at P= 0.05.

Table 6. Effect of treatment of 2nd and 4th instar larvae of *S. littoralis* with LC_{50} concentration of three chromene compounds on biological traits at maturity stage.

Chemical compounds*	Adults emergence rate (%)	Females ratio (%)	Adult longevity (days)		Fecundity	Hatchability rate (%)
			Male	Female		
Treated 2nd instar larvae						
A	65.43 bc	64.35 a	8.55 bc	8.66 b	125.55 b	72.07 b
B	66.66 b	65.63 a	8.77 ab	9.88 a	159.88 b	57.04 c
C	64.32 c	54.44 b	9.33 a	10.55 a	206.66 b	63.33 c
Control	86.99 a	63.00 a	7.95 c	9.88 a	746.66 a	94.33 a
Treated 4th instar larvae						
A	76.66 b	70.68 a	4.86 b	5.77 c	197.22 b	77.65 a
B	75.83 b	53.24 c	5.33 b	7.33a	136.66 b	56.22 b
C	67.24 c	46.77 d	5.55 b	6.66 b	123.77 b	54.29 b
Control	95.90 a	64.88 b	8.42 a	7.80 a	777.11 a	96.49 a

* See table 1.
Values followed by the same letters in the same column are not significantly different at P= 0.05.

الملخص

الطحاوي، هند سعد، وردة أحمد زكي المدني، إيمان محمد عبد العظيم وميرفت حسنين أبو الحمد مطاوع. 2024. التأثير السام والمتأخر لمركبات الكرومين في المؤشرات الحياتية لنوعي الديدان *Earias insulana* و *Spodoptera littoralis* تحت ظروف المختبر. مجلة وقاية النبات العربية، 42(1): 88−93. https://doi.org/10.22268/AJPP-001203

أجريت التجارب المختبرية في معهد بحوث وقاية النباتات، فرع الشرقية، قسم بحوث ديدان اللوز، لدراسة التأثير السام والحيوي لثلاثة مركبات عضوية مخلّقة للكرومين ضد العمر اليرقي الأول لدودة اللوز الشوكية والعمر اليرقي الثاني والرابع لدودة ورق القطن تحت ظروف ثابتة (حرارة 27±1°س ورطوبة نسبية 70±5%). أشارت النتائج بأن المركبات المخلقة للكرومين أظهرت سمية مرتفعة ضدّ العمر اليرقي الأول لدودة اللوز الشوكية والعمر اليرقي الثاني والرابع لدودة ورق القطن. ومن

جهةٍ أخرى، سبّبت التاثيرات المتأخرة لمركبات الكرومين إطالة في مدة حياة اليرقات والعذارى لكلا الحشرتين. كما سببت هذه المركبات خفضاً معنوياً فى أوزان كل من طوري اليرقات والعذارى لكلا الحشرتين، وتقصير طول مدة حياة الحشرات الكاملة وعدد البيض الموضوع ونسبة الفقس لكلا الحشرتين.

كلمات مفتاحية: مركبات الكرومين، سمية، دودة ورق القطن، دودة اللوز الشوكية، *Spodoptera littoralis*، *Earias insulana*.

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Received: July 3, 2022; Accepted: September 22, 2023

تاريخ الاستلام: 2022/7/3؛ تاريخ الموافقة على النشر: 2023/9/22