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# Ovicidal Activity and Biological Effects of Radiant and Hexaflumuron Against Eggs of Pink Bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae)

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## ABSTRACT

Under the laboratory conditions, toxicological evaluation of two compounds, Radiant SC 12% and Hexaflumuron (IGR) EC 10% against eggs of *Pectinophora gossypiella* (Saund.) and biological effect of these compounds on larvae, pupae and adult emergence resulted from treated eggs was also studied. The results revealed that $LC_{50s}$ were 3.15, 0.811and 0.522 ppm., when one, two and prehatching days old eggs, respectively were treated with Radiant, while $LC_{50s}$ were 3.754, 2.863 and 2.004 ppm, respectively for Hexaflumuron. The obtained results show a prolongation in larval and pupal developments resulted from treated eggs by Radiant, estimated by 20.8, 18.5 and 8.2 days, respectively for larvae and 8.9, 8.8 and 7.9 days for pupae. In case of Hexaflumuron, duration were 22.3, 20.6 and 20.4 days, respectively for larvae after egg treated and 10.8,10.0 and 11.3 days, respectively for pupae. In contrast, in adult stage, the results indicated high reduction in total eggs laid, percentage of hatchability and longevity.

**Key words:** Radiant SC12%, Hexaflununon EC 10%, *Pectinophora gossypiella*

## INTRODUCTION

Cotton is one of the major economics crops in Egypt. Throughout cotton growth season, it is attacked by many pests, from the seedling stage to harvest causing different degrees and types of damage. Among these pests, the bollworms like pink bollworm (*Pectinophora gossypiella*) is considered the most destructive pest infesting cotton bolls causing severe damage resulting in high loss in both quality and quantity of cotton yield **(Lohag and Nahyoon 1995) .**

In the recent years, the toxicity of insecticides to humans and wildlife has caused much public concern and lead to the use of more target-specific chemicals **(Paoletti and Pimentel 2000)**. A new approach to insect pest control is to use substances that affect insect growth and development. These substances are insect growth regulators ($IGR_s$) which receiving more practical attention to provide for safer foods and cleaner environment. The first chitin synthesis inhibitor introduce into the market as a novel insecticide was benzoylphenylurea (BPU), or diflubenzuron (DFB) **(Miyamoto *et al.* 1993)**. Some of the structural modifications (derivatives) of the compounds are more active than the parent compound. It was found to be effective on several insect species **(Grosscurt, 1978, Soltani, 1984, Soltani, *et al..*, 1984, Soltani and Soltani-Mazouni, 1992 and Khebeb *et al.*. 1997).** Since the introduction of DFB, a number of other BPU derivatives have been developed such as hexaflumuron, Flucycloxuron and Triflumuron **(Soltani *et al.*, 1996 & 1999; Peppuy *et al..*, 1998, Bendjedou *et al..*, 1998; Rehimi and Soltani, 1999).** These compounds have been found to interfere with chitin biosynthesis **(Soltani *et al.*, 1993, 1996).** Diflubenzuron and its derivatives were effective against Coleoptera, Diptera and Lepidoptera **(Goktay and Kismali 1990),** it also effective against insect pests and mites infesting field crops and were relatively harmless to beneficial insect species.

Conventional insecticides have not provided a long-term solution to the pink bollworm problem **(Henneberry, 1986).** Spinosad is a mixture of Spinosyns A and D, which are fermentation products of the soil actinomycete *Saccharopolyspora spinosa* **(Mertz and Yae 1990, and Thompson *et al..*, 1997).** Spinosad is a natural bio-insecticide offered a new mode of action and relatively safe on natural enemies and no significant difference was recorded for the hatchability between 1&3 day old eggs of pink bollworm **(Temerak 2003)**. He expect that Spinosad may have a great future in the integrated pest management of cotton leafworm in Egypt. Spinosad has been shown to be an effective pest control agent **(Brickle *et al..*, 2001**) particularly for control of Lepidopteran insect pests **(Wanner *et al..*, 2000), Aydin and Gurkan (2006) and Al-Shannaf (2007).** Spinosad could play a significant role to combat conventionally resistant insect as a result of its novel mode of action **(Bret *et al..*, 1997).** The objective of the present study was to investigate the effect of Hexaflumuron (IGR) and Radiant SC12% (the second generation of Spinosad) on pink bollworm eggs and the effect of these compounds on biological characteristics of the first generation of *Pectinophora gossypiella* which produced from treated different ages of eggs, including developmental duration, mortality, fecundity, fertility and adult emergence.

## MATERIALS AND METHODS

**Insecticides used:-**

**1) Radiant SC12%** :-

Common name:- Radiant SC12% (Spinetoram), it is new product from spinosyns group with the same mode of action. It is a trademark of Dow Agro Science Co.

**2) Hexaflumuron**:-

Trade name:- Consult

Classification:- Benzoylphenylurea.

Serial concentrations of the two compounds were prepared in water.

**Insect used:**

The susceptible laboratory strain of pink bollworm, *P. gossypiella* was reared for several generations under the laboratory conditions at 26±1$^0$C and 75±5 R.H. at Bollworms Research Department, Plant Protection Research Institute, Agriculture Research Center as a described by **Rashad and Ammer (1985).**

**Eggs used:**

Four groups of freshly emerged moths of *P. gossypiella* each group 10 pairs(♂♂ X ♀♀) were confined in a glass chimney cage (17 cm height and 7.12 cm in diameter), inside which a piece of cotton wool previously soaked in 20% sugar solution was suspended to be renewed 48 hr for moths' nutrition. The top and bottom of each cage were covered with screening mesh kept in position by rubber bands for stimulating eggs laying response in the females. Eggs were deposited thought the screening mesh, one piece of paper placed upper and lower the cages in open petri-dish that served as an ovipostion site, eggs were collected daily and kept in glass jars (1/2 kg). These eggs were maintained at 26±1$^0$ C and 75±5 R.H. One day, two days and 3-4days old eggs (before hatching, when head capsule appeared ) were used.

**Procedure**

To study the ovicidal activity of Radiant and Hexaflumuron against *P. gossypiella* eggs, Serial concentrations in water were prepared. Six concentrations (6, 3, 1.5, 0.75, 0.375 and 0.178 ppm) for Radiant and five concentrations (6.25, 3.12, 1.56, 0.78 and 0.39 ppm) for Hexaflumuron were freshly prepared for the stock solution of each compound (1ml/1 liter water).

Treatment of eggs was done by dipping a piece of paper containing eggs on the different tested concentrations of the two compounds. Three replicates from each age were used, each replicate (from 100 to 150 eggs on paper) was dipped in each concentration of each compound. After that the papers were left until dried. Other three replicates of similar eggs were dipped in water and left as control. Then, the treated and control eggs were kept in an incubator under constant conditions 26±1°C and 75±5% R.H. The percentages hatchability were estimated after three days to nine days. Data were corrected and $LC_{50s}$ of Radiant and Hexaflumuron were calculated by using proban software.

For the same biological aspects studies, three replicates of 40 tubes, each tube (2 X 7.5 cm) containing 4 gm of diet were used. Newly hatched larvae resulted from treated eggs with $LC_{50}$ of Radiant or Hexaflumuron were transferred individually to the diet tubes by camel hair brush. The same was done with the newly hatched larvae resulted from untreated eggs. The tubes were capped with cotton and kept in laboratory under the previous conditions in an incubator and inspected daily until pupation. Pupae resulted from each treatment were removed from all tubes and placed in clean tubes till adults emergence. Some biological aspects such as: percentage of larval mortality, larval malformation, larval duration, pupal duration, percentage of adult emergence, malformation and sex ratio, fecundity and fertility were determined.

Newly emerged moths resulted from larvae hatched from different eggs ages treated by $LC_{50s}$ of Radiant and Hexaflumuron were sexed and transferred to chimney glass cage (six pairs /cage). Each treatment was replicated three times. The moths were fed on 20% sucrose solution. Cages were examined daily to record pre ovipostion, ovipostion and post ovipostion periods and the numbers of eggs laid, percentage of hatchability and estimated the females and males longevity for each treatment.

## RESULTS AND DISCUSSION

### Toxicological effect of Radiant and Hexaflumuron:

The susceptibility of different eggs ages of *P. gossypiella* to Radiant and Hexaflumuron was showed in Table (1).

Table (1): Toxicological evaluation of Radiant and Hexaflumuron against eggs of pink bollworm.

| Treatment | Ages of eggs (days) | Toxicity | | |
|---|---|---|---|---|
| | | $LC_{50}$(ppm) | $LC_{25}$ (ppm) | Slope |
| Radiant | One | 3.15 | 1.13 | 1.521 |
| | Two | 0.811 | 0.143 | 0.897 |
| | prehatching | 0.522 | 0.242 | 1.162 |
| Hexaflumuron | One | 3.754 | 1.15 | 0.445 |
| | Two | 2.803 | 0.64 | 1.052 |
| | prehatching | 2.004 | 0.473 | 1.076 |

The $LC_{50s}$ values for one day old eggs were nearly similar for both Radiant and Hexaflumuron, with an $LC_{50s}$ were 3.15 and 3.75, on contrast there was more variation with $LC_{50}$ values of two days old and prehatching eggs, whereas Radiant had $LC_{50}$ values of 0.811 and 0.522 ppm, respectively, but Hexaflumuron had a highly variable values of 2.803 and 2.004 ppm. This data revealed that the one day old eggs less susceptible to Radiant and Hexaflumuron than two days old eggs and prehatching eggs. The results of our study confirmed with **Peterson *et al.* (1998)** whose found the newly laid eggs may be slightly less susceptible to spinosad action than one day old eggs for *Heliothis zea* and *H. virescens*. This phenomenon may be elucidated to the lower penetration of spinosad through the chorion of

newly deposited eggs **(Smith and Salkeld, 1966)**. Also, **Al-Shannaf and Kandil (2005)** recorded that the $LC_{50}$ of spinosad for one and two days old eggs of *Helicoverpa armigera* were 2.56 and 1.31 ppm, respectively. **Ascher et al (1983)** treated 0-3 day old eggs of *Lobesia botrana* with diflubenzuron, he found a $LC_{50}$ of 70 ppm at 27 ℃.

**Ovicidal effects:**

**Effect on hatchability and incubation period of eggs:**

Date in Table (2) showed the effect of Radiant and Hexaflumuron on hatchability and incubation period of pink bollworm eggs. It is obvious that the Hexaflumuron at the tested level $LC_{50}$ reduced the percent of hatchability with 53, 52 and 53 for one, two days old and prehatching eggs, respectively than the control. Also Radiant at the $LC_{50}$ level reduced the hatchability percent with 51, 50 and 46 for one, two days old and prehatching eggs, respectively. These data showed that no difference was recorded for the hatchability between one, two days old eggs treated with $LC_{50}$ of Radiant and Hexaflumuron. However, the older eggs were the most sensitive to Radiant than Hexaflumuron. **Temerak (2003**) found no significant difference was recorded for the hatchability between 1&3 days old eggs of pink bollworm treated by spinosad.

Table (2): Effect of Radiant and Hexaflumuron on Hatchability and Incubation period of pink bollworm eggs

| Type of treatments | $LC_{50}$ | % hatchability | One day old eggs | | | |
|---|---|---|---|---|---|---|
| | | | Incubation period | Range | LSD | P |
| Hexaflumeron | 3.75 | 53.00 | 6.6±0.2b | (6-9) | 0.96 | 0.0001*** |
| Radiant | 3.15 | 51.00 | 8.3±0.3a | (5-9) | | |
| Control | | 97.30 | 3.9±0.03c | (3-5) | | |
| Two days old eggs | | | | | | |
| | $LC_{50}$ | % hatchability | Incubation period | Rang | LSD | P |
| Hexaflumeron | 2.803 | 52.00 | 6.5 ±0.2a | (5-8) | 1.03 | 0.001** |
| Radiant | 0.811 | 50.00 | 7.1±0.4a | (6-8) | | |
| Control | | 96.00 | 3.8±0.1b | (3-5) | | |
| Eggs prehatching eggs | | | | | | |
| | $LC_{50}$ | % hatchability | Incubation period | Rang | LSD | P |
| Hexaflumeron | 2.004 | 53.00 | 5.5±0.1a | (5-7) | 0.688 | 0.0001*** |
| Radiant | 0.522 | 46.00 | 5.9±0.2a | (5-7 ) | | |
| Control | | 98.10 | 4.0±0.3b | (3-5) | | |

*Significant at 0.05

**High significant at 0.01

***Very high significant at 0.001

The present results are in agreement with those obtained by **Allen *et al.* (1997)** recorded that ovasyn treatment was markedly more effective against 3-4 days old eggs than against 0-2 days old eggs of bollworm. **Ioriatti *et al.* (1992)** treated 0-3 day old eggs of *Lobesia botrana* with different Benzoylphenylureas and found 60% eggs mortality for lufenuron and 20-30% for both flufenoxuron and hexaflumuron. **Cabezon *et al.*(2006)** found that lufenuron significantly reduced hatchability on all eggs age classes of *Lobesia botrana*. **Temerak (2007),** who found that Radiant at 5.76 gram active/HA showed 100% mortality of the entire hatched egg masses of *S. littoralis* after spray in field. **Nolting *et al.*.(1997)** indicated that mortality in treated eggs of *Heliothis* was from larvae ingesting Spinosad as they feed on the chorion of eggs during hatching.

The incubation period of three different ages of pink bollworm eggs was high significant and affected by $LC_{50}$ treatment of Radiant and Hexaflumuron (Table 2). These incubation period estimated by 8.3 and 6.6 days when one day old eggs treated with Radiant and Hexaflumuron, respectively compared with 3.9 days for control, this data indicated that when one day old eggs treated by the two tested compounds, the incubation period of eggs

increased to (2.13-1.7) times than control. On the other hand, when the two days old eggs were treated, these periods were 7.1 and 6.5 days compared to 3.8 days for control. At the same time this period decreased to 5.9 and 5.5 days when the prehatching eggs treated with Radiant and Hexaflumuron, respectively compared to 4.0 days for control. This results indicated that the susceptible of all ages of eggs to Radiant than Hexaflumuron. Also, the incubation period of one day old eggs treated was longer than prehatching from 1.5-1.2 times for two treatment. This may be due to the differences in the penetration of Radiant and Hexaflumuron to eggs and different embryonic development inside the eggs from day to day. These results are in agreement with **Sammour *et al.* (2008).** They found a reduction in fecundity and egg hatchability of cotton leafworm after treated larval instar with Chlorfluazuron and Leufenuron. This preventation of egg hatchability may be due to the penetration of these compounds into the eggs and prevents hatching by interfering with embryonic cuticle synthesis, so the new hatch probably cannot use its muscles to free itself from egg wall **(Marco and Vinuela 1994)** and **Mass *et al*., (1980).** In addition, it is possible that reduced hatchability in *S. littoralis* is caused by defects in the differentiation of oocytes and sperms **Meola and Mayer 1980** and **Horowitz *et al*., (1992).**

**Biological effects of the two tested compounds:**

The data in Table (3) revealed that the duration of larvae, pupae and adult emergence from newly hatched larvae resulted from eggs with different of ages treated with $LC_{50}$ of Radiant and Hexaflumuron.

Table (3) Biological effect of Radiant and Hexaflumuron on larval, pupal and adult emergence resulted from treated one, two days old and prehatching eggs.

| Treatment | Egg stage | Larval stage | | | Pupal stage | | | Adult stage | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Duration ± S.E. | Total mortality | Malformed | % pupation | Duration ± S.E. | Malformed | % emergence | Malformed | Sex ratio as female |
| Radiant | One day old | 20.8±0.4a | 65.00a | 9.00 | 91.00 | 8.9±0.2a | 8.5 | 94.9b | 7.3 | 57.0 |
| | Two day old | 18.5±0.5b | 58.00b | 8.00 | 92 | 8.8±0.4a | 6.0 | 88.6d | 9.3 | 58.0 |
| | pre hatching | 18.2±0.2b | 53.00c | 3.00 | 96.9 | 7.9±0.3 | 7.3 | 91.9c | 11.1 | 67.0 |
| Control | | 15.26±0.1c | 7.00d | 0 | 99.2 | 8.6±0.3b | 0 | 100.0a | | 58.0 |
| LSD 0.05% | | 1.61 | 2.505 | | | 0.68 | | 2.08 | | |
| P | | *** | *** | | | ** | | *** | | |
| Hexaflumuron | One day old | 22.3±0.3a | 40.00c | 13.00 | 86.5 | 10.8±0.6a | 11.0 | 87.0b | 8.7 | 65.59 |
| | Two day old | 20.6±0.5b | 47.00b | 11.00 | 88.9 | 10.0±0.01b | 9.7 | 85.0b | 6.5 | 69.00 |
| | pre hatching | 20.4±0.2b | 51.1a | 7.00 | 93.00 | 11.3±0.4a | 5.3 | 85.0b | 5.7 | 63.59 |
| Control | | 15.26±0.1c | 7.00d | 0 | 100 | 8.6±0.1c | 0 | 100.0a | 0 | 58.0 |
| LSD 0.05% | | 1.07 | 1.76 | | | 0.633 | | 1.539 | | |
| P | | *** | *** | | | ** | | * | | |

***Larval stage:***

It is clear that the two tested compounds significantly prolonged the duration of the larval stage than that of the untreated check. Table (3) revealed that larval duration were 20.8, 18.5 and 18.2 days resulted from treated eggs (one, two days old and prehatching eggs), respectively for Radiant and 22.3, 20.6 and 20.4 days for Hexaflumuron, respectively.

***Larval mortality:***

Data in Table (3) indicated that the percentage larval mortality estimated by 65.0, 58.0 and 53.0 resulted from one, two days old and prehatching eggs treated with Radiant, respectively, and 40.0, 47.0 and 51.0 % resulted from treated the same ages of eggs by Hexaflumuron, respectively.

***Malformation larvae:***

As shown in Table (3) and Fig. (1), the high percentage malformed appeared in larvae resulted from one day old eggs estimated by 9 and 13% and the lowest percentage of malformation recorded by 3.0 and 7.0% prehatching eggs treated by Radiant and

Hexaflumuron, respectively. Generally, Radiant treatment caused very small larvae and dark larvae after dead. While in IGR, Hexaflumuron caused larval- pupal intermediate stage and the color was dark brown after death.

***Pupal stage:***

The data illustrated significant increased in pupal duration of *P. gossypiella* resulted from the treated one day old eggs with both Radiant and Hexaflumuron, this durations were 8.9 and 10.8 days, respectively and 8.8 & 10.0 days for pupae resulted from two days old eggs, respectively but in case of pupae resulted from prehatching eggs treated by Radiant, the duration decreased to 7.9 days at the same time there is an increase in pupal duration to 11.3 days resulted from treated by Hexaflumuron compared to control 8.6 days. The obtained data indicate a high increase in pupal duration when resulted from Hexaflumuron compared to treated Radiant and control (Table 3).

***Pupal malformation:***

The data in Table (3) and Fig. (2) indicate that the used IGR Hexaflumuron caused high increased in malformation of pupal than Radiant, these malformation recorded by 11.0, 9.7 and 5.3 % for pupae resulted from one, two days old and prehatching eggs, respectively. The most morphological deformation was pupal-adult intermediate resulted from IGR treatment Fig. (2c). While in case of Radiant treated this percentage recorded by 8.5, 6.0 and 7.3 %, respectively. The most pupae was dead and appeared malformed in upper parts of pupae Fig. (2b).

Hexaflumuron and Radiant used in this study were significantly affected on different biological parameters as compared to control. The increase in larval and pupal duration stage and the decrease in the percentage of pupation and adult emergence due to used chitin synthesis inhibitors Hexaflumuron and Radiant are similar to the data obtained by many authors using different IGRs against many Lepidopterous insects, e.g., *P. gossypiella* **Flint *et al.*. (1978), Moawad and Khidr, (1982).** Also, *Spodoptera littoralis* **Ismail, (1980)**; **El-Deeb *et al..*, (1991); Sokar, (1995); Shaurub *et al..*, (1999)** and **Abdel-Aal, (2003). Yin *et al.*. (2008)** reported that prolonged in the immature stage and the survival rat of *Plutella xylostella* was lower in the $LC_{25}$ and $LC_{50}$ for spinosad.

***Adult stage***

The percentages of adult emergence were 94.9, 88.6 and 91.9 resulted from treated one, two days old eggs and prehatching eggs, respectively with Radiant while, the percentages reduced to 87.0, 85.0 and 85.0 after treated the one, two days old and prehatching eggs, respectively with Hexaflumuron (Table 3).

***Adult malformed:***

Data in Table (3) showed that, the malformation in adult emergence increased to 11.1 % in adult emerged from treated prehatching eggs and decreased to 7.3% in adult emergence from eggs one day old treated with Radiant. This compound reduced adult size and shortened abdomen, antenna and legs. Also, disappear all patches or scales on the moth Fig. (3b). On the contrast, in treated Hexaflumuron the high percentage of adult malformed was 8.7 which appeared in adult emergence from eggs one day old treated and the lowest in eggs before hatched treated was 5.7 %, Also, the most malformed appeared in wings and abdomen with giant adult Fig. (3c).

***Sex ratio:***

Table (3) illustrated that the all eggs ages of *P. gossypiella* treated with IGR at the $LC_{50}$ shifted the sex ratio as it increased the females and decreased the males ratio than that of control, this percent ranged from 63.6 to 69.0 females, compared to 58.00 for control. On contrast, in case of Radiant treated the percent ranged from 57.0 to 67.0 female. These data indicated that Hexaflumuron was more affected on male than female emergence.

***Ovipostion periods of emerged females:***

Pre-ovipostion, ovipostion and post-ovipostion periods, total number of deposited eggs (fecundity) and the total number of hatching larvae from the eggs (fertility) for the two tested compounds in comparison to the control were recorded in Table (4).

As shown clearly in Table (4) that the pre-ovipostion period was highly significant influenced by both tested compounds. The Radiant compound caused considerable shortage in female pre-ovipostion period, this period were 1.36 & 1.9 days, respectively when females resulted from treated eggs one and two days old. But this period increased to 3.2 days when treated prehatching eggs. On contrast, in case of used Hexaflumuron, it caused high significant increased in pre-ovipostion periods, theses periods were 3.2, 3.1 and 3.8 days, respectively resulted from the three olds eggs treated.

Table (4): Effect of Radiant and Hexaflumuon on Longevity, fecundity and fertility of *P. gossypiella* adults resulted from treated eggs.

| Treatments | Ages of Eggs (day) | Conc. (ppm) | Ovipositional period | | | Total eggs | % hatch | Adult longevity | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-ovi | Ovi | Post-ovi | | | ♀♀ | ♂♂ |
| Radiant | One | 3.15 | 1.36±0.2d (1-2) | 8.56±0.4b (7-11) | 1.1±0.1d (1-2) | 53.3±3.1c (46-89) | 40.0c | 11.9±0.78c (9-15) | 7.26±0.2d (6-11) |
| | Two old | 0.811 | 1.9±0.2c (1-2) | 8.86±0.4b (7-16) | 1.6±0.1c (1-2) | 57.0±0.5c (50-90) | 66.6b | 12.4±0.4c (8-14) | 8.9±0.2c (5-10) |
| | prehatching | 0.523 | 3.2±0.2a (3-4) | 8.9±0.5b (8-13) | 3.9±0.1a (3-5) | 94.6±0.8b (80-120) | 68.0b | 15.46±0.2b (13-29) | 9.7±0.2b (8-13) |
| Control | | | 2.46±0.1b (1-3) | 14.2±0.2a (12-18) | 2.8±0.17b (2-3) | 204.6±3.5a (190-240) | 97.3a | 18.8±0.4a (15-20) | 15.4±0.3a (10-17) |
| LSD 0.05% | | | 0.498 | 1.2019 | 0.470 | 8.730 | 7.876 | 1.546 | 0.824 |
| P | | | *** | ** | ** | ** | *** | ** | ** |
| Hexaflumuron | One | 3.75 | 3.2±.35ab (2-4) | 12.4±0.3b (9-18) | 3.9±0.06a (3-5) | 61.6±2.06d (53-97) | 57.0c | 18.9±0.3b (17-19) | 16.7±0.2b (15-19) |
| | Two | 2.803 | 3.1±0.1ab (2-4) | 13.16±0.1b (10-18) | 4.0±0.5a (3.9-4.1) | 89.6±0.6c (73-105) | 73.0b | 20.3±0.1b (17-25) | 17.0±0.1b (16-18) |
| | prehatching | 2.004 | 3.8±0.1a (2-5) | 14.5±0.3a (12-17) | 4.2±0.2a (3-5) | 160.6±2.5b (130-180) | 50.0d | 23.16±0.5a (18.27) | 18.13±0.1a (15-20) |
| Control | | | 2.46±0.1b (1-3) | 14.2±0.2a (12-18) | 2.8±0.17b (2-3) | 204.6±3.5a (190-240) | 97.3a | 18.8±0.4b | 15.4±0.3c (10-17) |
| LSD 0.05% | | | 0.636 | 0.857 | 0.489 | 6.960 | 6.960 | 1.796 | 0.793 |
| P | | | ** | *** | *** | *** | *** | ** | ** |

*Significant at 0.05
**High significant at 0.01
***Very high significant at 0.001

The two tested compounds caused high significant shortage of the ovipostion periods**,** 8.56, 8.86 and 8.9 days resulted from treated one, two days and prehatching eggs, respectively with Radiant, while, this periods were 12.4, 13.16 days resulted from treated one, two days old eggs with Hexaflumuron and this period increased to 14.5 days resulted from prehatching eggs compared to 14.2 days for control. From this data indicated that Radiant high effected and high toxic on females resulted from three old eggs treated. This compound caused reduction in period nearly half time (Table 4).

Analysis of variance of the results arranged in Table (4) proved that post ovipostion period of emerged females from different egg ages treated with Radiant was significant by affected as it was shorted to 1.1, 1.6 days on one and two days old eggs and increased to 3.9 days when resulted from treated prehatching eggs. But in case of treated with Hexaflumuron the post-oviopostion periods were 3.9, 4.0 and 4.2 days when female resulted from one, two days old eggs and prehatching eggs, respectively compared to 2.8 days for control.

***Female fecundity and fertility:***

The results showed a significant reduction of the number of deposited eggs per each female (fecundity). The mean numbers of deposited eggs were 53.3, 57.00 and 94.6 eggs

/female resulted from treated with Radiant and 61.6, 89.6 and 160.6 eggs/female resulted from treated with Hexaflumuron for one and two days old eggs and prehatching eggs, respectively, as compared with in check 204.6 eggs/female. Also, the percentage of hatchability was high affected by treatment. The hatchability percentages were 40.00, 66.6 and 68.00 % for eggs deposited females resulted from Radiant treatment, respectively and 57.00, 73.00 and 50.00% for eggs deposited by females resulted from Hexaflumuron treatment as compared with that in check 97.3% (Table 4).

***Adult longevity:***

As clearly shown from the data in Table (4) that females and males longevity highly significant affected by Radiant and Hexaflumuron.

It was clearly that shortening the longevity of females and males resulted from eggs treated by Radiant, these periods were 11.9, 12.4 and 15.46 days for females and 7.26, 8.9 and 9.7 days for males resulted from one, two days old egg and before hatching, respectively. In case of Hexaflumuron the longevity of females and males longer than control this periods were 18.9, 20.3 and 23.16 days for females and 16.7, 17.00 and 18.13 days for males, respectively compared with 18.8/♀ and 15.4/♂ days for control.

These results are in agreement with **Hewady *et al.*, (2002).** They found that Neemazal influences larval and pupal development of pink bollworm, resulted deformation, reduction in fecundity, fertility and longevity of resulted moth. Also **Sammour *et al..*, (2008)** investigated the effect of Chlorfluazuron and Leufenuron on *S. littoralis*, the results indicated that all treatments decrease adult emergence, reduction in longevity and fecundity and egg hatchability. **Moursy and Salem (1995), Macro and Vinuela (1994)** and **Lyra *et al..*, (1999)** attributed the fecundity reduction to the morphological alternations of ovipositor, inhibition of the ovarian growth, reduction in testicular size and inability from sperm transfer and the toxic effects on the synthesis and metabolism of proteinaceous constituents during the oogensis. According to **Kellouche and Soltani (2006),** Hexaflumuron reduced the longevity and fecundity of *Callosobruchus maculates*, in addition, it affected growth and development of oocytes and egg viability, but IGR don't induced reduction of percentage hatchability. **Yin *et al..*, (2008)** recorded that the fecundity of *Plutella xylostella* was strongly reduced when treated the larvae with spinosad, also it reduced the adult longevity, population growth and reproduction. The adult pre-ovipostion period and total oviposition period tended to be longer in treatment than control. **Amer (2004)** recorded that spinosad caused reduction in adult longevity and fecundity and fertility of *P. gossypiella*. Also, **Liu and Trumble, (2005)** and **Zalizniak and Nugegod, (2006)** reported that spinosad high affected on fertility and fecundity of *Bactericerca cockerelli*. **Abdel-Ghany *et al..*, (1985)** found that treatment of both larval and pupal stages of *S. littoralis* with low concentration of IGRs reduced the fecundity and egg hatching and increased the sterility of adults.

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**(a)** **(b)** **(c)**

(a) Normal larva.
(b) Morphological deformation of larval stages resulted from different eggs ages treated by Radiant SC12%.
(c) Larval-pupal intermediate resulted from treatment eggs by Hexaflumuron.

**Fig (1)**

**(a)** **(b)** **(c)**

(a) Normal pupa.
(b) Deformed pupae resulted from treated different ages of eggs by Radiant SC12%.
(c) Deformed pupa resulted from treated eggs by Hexaflumuron.

**Fig (2)**

**(a) Normal adult.**

**(b) Deformation of adults after treated eggs by Radiant SC12%.**

**(c) Deformation of adults after treated eggs by Hexaflumuron.**

**Fig (3)**

## ARABIC SUMMARY

**دراسه التأثير البيضى و البيولوجي لمركب الرادينت و الهيكسافلوميرون ضد بيض دوده اللوز القرنفليه**

**نهاد محمد البرقي [1] - عادل السيد عامر [2] - ميرفت عبد السميع قنديل [2]**
1- مدرس بقسم علم الحشرات-كلية العلوم-جامعة بنها
2- معهد بحوث وقاية النباتات-مركز البحوث الزراعية-الدقي-الجيزة

تم دراسه التأثير الأبادي لمركبي الراديانت ( الجيل الثاني للسبينوساد) و الهكسافلوميرون (أحد منظمات النموالحشريه) علي ثلاث أعمار مختلفه لبيض دوده اللوز القرنفليه وقد تم متابعه التأثير علي النواحي البيولوجيه لليرقات و العذاري و الطورااليافع الناتجه من كل عمر. وقد أظهرت النتائج أن بيض عمر واحد يوم أقل حساسيه للمركبيين من عمريومان و عمر قبل الفقس( ثلاثه الي أربعه أيام). و من متابعه التأثير المتأخر لهذان المركبان على اليرقات والعذارى والعشرات الكاملة فقد أظهرت النتائج حدوث اطالة في عمر اليرقات والعذارى وزيادة في نسب التشوه في كل من المركبين ولكن الاطالة في مركب الهكسافلوميرون أعلى من مركب الراديانت ولكن في الأطوار الكاملة أظهرت النتائج حدوث نقص شديد في عمر الفراشات التي نتجت من معاملات البيض بالراديانت بالاضافة الى نقص شديد في عدد البيض الموضوع. وقد أظهر الراديانت تأثير أعلى من مركب الهكسافلوميرون.