

## V. SUMMARY

This study demonstrates the response of the eggs to the effect of eight compounds related to 8 different growth regulators groups (i.e. hexaflumuron, flufenoxuron, lufenuron, diflubenzuron. Chlofluazuron, fenoxycarb pyriproxyfen and tebufenozide).

The laboratory of 8 regulators (3 JHA and 5 IGI) were tested against the eggs of three important economic insects (*O. nubilalis*, *A. ipsilon* and *S. littoralis*).

The direct effect of these compounds on eggs was studied as results on hatchability and relative susceptibility of different ages of eggs (i.e. one, two and three days old eggs) of *O. nubilalis*, *A. ipsilon* and *S. littoralis*. On the other hand, the indirect effects were, also, studied as latent effect of these compounds on the subsequent stages of the previous insects resulted from treated eggs.

### **Part 1.-Effect of some insect growth regulators (IGRs) on the hatchability of different ages of eggs:**

#### **1- *Ostrinia nubilalis* :**

Data in these investigations revealed that on one day old eggs, lufenuron increased percentage mortality of the tested eggs than the other tested compounds. Flufenoxuron was the second in its effect followed by pyriproxyfen, while tebufenozide was the least effective. Lufenuron at (8000 ppm) on one day old eggs, completely, blocked the embryonic development and all the treated eggs failed to hatch, while it

gave the highest mortality (58.13 and 50.23%) after treating the two and three days old eggs, respectively.

### **2-*Agrotis ipsilon*:**

Hexaflumuron increased percentage mortality than the other tested compounds on one day old eggs. In the same time lufenuron occupied the second rank, followed by flufenoxuron, while the last degree of efficiency caused by pyriproxyfen.

Hexaflumuron (8000 ppm) on one day old egg, completely, blocked the embryonic development and all the treated eggs failed to hatch, while it produced the highest mortality (96.11 and 90.82%) after two and three days old eggs, respectively.

### **3-*Spodoptera littoralis*:**

Flufenoxuron was more effective on all ages of eggs (i.e. one, two and three days old), while lufenuron occupied the second order followed by pyriproxyfen. On the other hand, the least degree of efficiency caused in the case of tebufenozide. The highest concentration of flufenoxuron (8000 ppm) gave the highest mortality (97.85, 96.02 and 93.15%) on one, two and three days old eggs, respectively. On the other hand, the effect of tebufenozide was lower than other compounds, rates of mortality were (41.2, 38.84 and 37.27%) at concentration of (8000 ppm) on the same previously ages of egg.

In general, an increase of  $LC_{50}$  values of all tested compounds on *O. nubilalis*, *A. ipsilon* and *S. littoralis* led to increase the eggs mortality percentages when the different ages of eggs dipped in different concentrations of these compounds.

Also, the freshly deposited eggs of the previous insects were most sensitive than the other ages of eggs and the sensitivity decreased in older eggs when treatment with different concentrations of lufenuron, flufenoxuron, pyriproxyfen and tebufenozide, while older eggs of *O. nubilalis* and *S. littoralis* (i.e. two and three days old eggs) were most sensitive for hexaflumuron and the sensitivity decreased in the freshly deposited eggs.

**Part 11-Relative susceptibility of different egg ages of *O. nubilalis*, *A. ipsilon* and *S. littoralis*.**

Five compounds were used directly against one, two and three days old eggs, (i.e. flufenoxuron, lufenuron, hexaflumuron, pyriproxyfen and tebufenozide).

The LC<sub>50</sub> values, representing the ovicidal effect against *O. nubilalis*, *A. ipsilon* and *S. littoralis* on one and two day old eggs revealed the following:

**1-*Ostrinia nubilalis* eggs:**

Pyriproxyfen was more potent as an ovicide than the other compounds on both developmental ages (one and two day old eggs) where the LC<sub>50</sub> values were (423.2 and 562.7ppm). On the other hand, hexaflumuron was more toxic on the three days old eggs than the others where LC<sub>50</sub> value was (812.3ppm).

Concerning, the potency levels of the five tested compounds at LC<sub>50</sub> levels, pyriproxyfen toxicity exceed with 7.94 folds than hexaflumuron, (3.69, 2.58 and 1.39) folds than flufenoxuron, lufenuron and tebufenozide, respectively for one day old eggs. While on two days old eggs pyriproxyfen toxicity

exceed with 8.5 folds than lufenuron, 3.42, 2.83 and 1.07 folds than flufenoxuron, hexaflumuron and tebufenozide, respectively.

### **2-*Agrotis ipsilon* eggs:**

Flufenoxuron was highly toxic as an ovicide than other tested compounds on all development ages, the  $LC_{50}$  values were (30.1, 52.2 and 60.4 ppm) for one, two and three days old eggs, respectively. On the other hand, tebufenozide showed lower effect where  $LC_{50}$  values were (2115, 4947 and 5695 ppm) on the same previously ages of egg, respectively.

According to the toxicity index, flufenoxuron was the most potent (toxicity index, 100 at the three  $LC_{50}$  levels, (i.e. one, two and three days old eggs).

In regard to relative potency levels, flufenoxuron toxicity exceeded 70.42 folds than tebufenozide, (4.09, 2.39 and 1.18) folds than hexaflumuron, pyriproxyfen and lufenuron, respectively for one day old eggs. The same trend was obtained on two and three days old eggs.

The tested compounds could be arranged according to ovicidal activity on one day old eggs as follows:

Flufenoxuron, hexaflumuron, pyriproxyfen, lufenuron and tebufenozide, where the  $LC_{50}$  values were (30.1, 518.1, 884.1, 1790.0 and 2115 ppm), respectively.

### **3-*Spodoptera littoralis* eggs:**

Tested compounds could be arranged according to  $LC_{50}$  in the following ascending order for one day old eggs, pyriproxyfen, lufenuron, hexaflumuron, flufenoxuron and tebufenozide.

The toxicity index, for tebufenozide, flufenoxuron, hexaflumuron and lufenuron were (2.14, 2.52), (12.79, 14.2), (15.21, 26.36) and (32.46, 31.03) as pyriproxyfen for one and two days old eggs, respectively, at LC<sub>50</sub> level. On the other hand, for three days old eggs, tebufenozide, flufenoxuron pyriproxyfen and lufenuron were (7.06, 35.45, 57.78 and 66.3) as toxic as hexaflumuron.

The relative potency levels of the tested compounds at LC<sub>50</sub> level compound, pyriproxyfen, flufenoxuron, hexaflumuron and lufenuron toxicity against one, two and three days old eggs exceeded (46.72, 39.68, 8.18), (5.98, 5.63, 5.02), (7.11, 10.46, 14.16) and (15.17, 12.31, 3.39) folds than tebufenozide for each, respectively.

In general, the effectiveness of tested compounds varied according to the stage of development of the egg. Also, the younger eggs were generally more susceptible to the tested compounds than older ones except with hexaflumuron.

#### **Part-111-Latent effect of IGRs on different ages of eggs of *O. nubilalis*, *A. ipsilon* and *S. littoralis*.**

Biological aspects of different stages resulted from treated eggs. The result could be summarized as follows:-

##### **1-*Ostrinia nubilalis*:**

Flufenoxuron produced the highest larval mortality percentages (87.5 and 80.0%) for larvae resulted from treated one and two day old eggs, respectively. While, hexaflumuron gave (72.5%) as highest larval mortality percentage for larvae resulted from treatment of three days old eggs.

For, pupation percentages, flufenoxuron revealed the least percentages of pupation 60.0, 62.5 and 80.0% recorded after treatment of one, two and three days old eggs, respectively.

Meanwhile, for malformed pupae, the application with LC<sub>50</sub> values of flufenoxuron, pyriproxyfen, and hexaflumuron were (40.0, 38.59 and 21.54%, respectively compared with 2.78% for untreated eggs.

Hexaflumuron and flufenoxuron produced (16.36, 35.0%), (11.12, 25.0%) and (4.54, 18.18%) malformed adults recorded after treatment of one, two and three days old eggs, respectively.

For pupal mortality, hexaflumuron, pyriproxyfen and flufenoxuron gave (28.67, 21.44 and 21.0), (25.17, 19.22 and 13.5) and (18.18, 16.16 and 7.76%) pupal mortality after treatment of one, two and three days old eggs, respectively.

### **2-*Agrotis ipsilon* :-**

Larval mortality percentages were (83.33, 56.67, 46.67 and 43.33%) and (60.0, 41.67, 20.0 and 11.67%) recorded after treatment two and three days old eggs by LC<sub>50</sub> values of lufenuron, flufenoxuron, hexaflumuron and pyriproxyfen, respectively.

While, for pupation percentages, the application with hexaflumuron, lufenuron pyriproxyfen and flufenoxuron gave (96.87, 80.0, 66.28 and 61.54%) and (97.89, 83.34, 81.99 and 77.14%) recorded after treatment of two and three days old eggs, respectively.

For deformed pupae, flufenoxuron gave (38.39 and 22.76%) as highest percentages of deformed pupae recorded after treatment of two and three days old eggs, respectively.

Pupal mortality percentages were (46.18, 33.33, 21.43 and 5.83%) and (28.47, 20.0, 25.0 and 20.0%) resulted from treatment two and three days old eggs with lufenuron, flufenoxuron, pyriproxyfen and hexaflumuron, respectively.

Concerning, rate of adults emergence, the percentages were (91.04, 40.85, 33.82 and 28.21%) and (77.92, 56.99, 54.87 and 57.14%) recorded after treatment of two and three days old eggs with hexaflumuron, pyriproxyfen, lufenuron and flufenoxuron, respectively.

Malformed adult percentages were (50.0, 41.12, 17.65 and 2.1%) and (37.5, 33.33, 30.0 and 1.67%) produced after treatment of two and three days old eggs old by pyriproxyfen, flufenoxuron, hexaflumuron and lufenuron, respectively.

### **3- *Spodoptera littoralis* :**

Larval mortality percentages, tebufenozide was more effective on one day old eggs (92.5%) while, lufenuron was more effective on two and three days old eggs where it caused 100.0% mortality for larvae hatched from these eggs.

While, for pupation percentages, the highest percentage pupation were (85.45, 77.75 and 77.34%) in the case of pyriproxyfen treatment after one, two and three days old eggs, respectively.

For, pupal mortality percentages, the highest were (49.5, and 47.61%) recorded after treatment of one and two days old

eggs by flufenoxuron, respectively. On the other hand, it was 27.27% produced after treatment three days old eggs with hexaflumuron.

While, for deformed pupae recorded (44.0, 33.34, 25.68 and 22.66%) were produced after treatment two and three days old eggs with pyriproxyfen, tebufenozide and hexaflumuron, respectively.

Concerning, the adult emergence percentages, those were (49.99, 46.86, 45.94 and 21.56%) and (55.56, 51.4, 50.07 and 48.01%) recorded after treatment of two and three days old eggs by tebufenozide, pyriproxyfen, hexaflumuron and flufenoxuron, respectively, compared with 88.86% for untreated eggs.

Tebufenozide caused the highest percentages of malformed adult percentages (65.18 and 39.14%) resulted from treatment one and two days old eggs, respectively.

#### **Part-1V. Effect of insect growth regulators on the reproductive potential of *S. littoralis*:**

The average number of eggs of crosses ( $T\text{♀} \times U\text{♂}$ ) and ( $U\text{♀} \times T\text{♂}$ ) were 664 and 368.4 when moths were fed on fenoxycarb sugar solutions while, for the control were 709.6 eggs. The highest percentage of sterility was obtained with cross ( $T\text{♀} \times U\text{♂}$ ) feeding on pyriproxyfen 79.73% followed by cross ( $T\text{♀} \times U\text{♂}$ ) feeding on fenoxycarb while the lowest level of sterility was 3.56% resulted from feeding males of *S. littoralis* on 50 ppm of chlorfluazuron in sugar solution.

#### **Part. V-Effect of some growth regulators on the embryonic development:**

Fenoxycarb, pyriproxyfen and tebufenozide have direct effect on the embryological development of the egg between the



4<sup>th</sup> hour and the 11<sup>th</sup> hour. It was between the 4<sup>th</sup> hour and ten<sup>th</sup> hour in the case of fenoxycarb pyriproxifen, but in the case of tebufenozide the direct effect was between 5<sup>th</sup> hour and 11<sup>th</sup> hour. While, in the case of the other 4 tested IGI, the effective time of treatment was between the 14<sup>th</sup> hour and 19<sup>th</sup> in the case of diflubenzuron and it was between the 20<sup>th</sup> hr. and 42<sup>nd</sup> hour, in the case of flufenoxuron but in the case of hexaflumuron and lufenuron the effective time for treatment was late (between the 23<sup>rd</sup> hr. and 36<sup>th</sup> hr. and between 30<sup>th</sup> hour and 42<sup>nd</sup> hour, respectively).

That meant that the embryology of the tested eggs is affected during a fixed time of development, this time was in the early age in the case of JHAs (between the 4<sup>th</sup> and 11<sup>th</sup> hours, but this time was late in the case of IGIs, normally in the second day of embryonic development).

#### **Part V1. The embryonic development of the cotton leaf worm *S. littoralis*:**

From the result about the bioactivity of different tested compounds at different age of the embryonic development it seems clearly that the JHA compounds tested (Pyriproxifen, tebufenozide and fenoxycarb) have direct effect on the cleavage nuclei, on blastoderm and the germ band.

No remarkable, morphological changes were detected after treatment in cleavage nuclei or in blastoderm and germ band.