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# Biological effects of some insect growth regulators on the house fly, *musca domestica* (diptera: muscidae).

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## ABSTRACT

The current work was carried out to evaluate the biological effects of five insect growth regulators; applaud (buprofezin), consult (hexaflumuron) and match (lufenuron) as chitin synthesis inhibitors (CSIs), mimic (tebufenozide) as ecdysone agonist (EA) and admiral (pyriproxyfen) as juvenile hormone analogue (JHA) against the housefly *M. domestica*. The IGRs were applied by feeding the 1$^{st}$ instar larvae on diets mixed with the selected IGRs at different concentrations (10, 100, 1000 and 2000 ppm).

The results demonstrated that mimic and admiral were the most effective compounds and induced 100 % larval mortalities at 2000 ppm. Mimic was the most toxic compound and its toxicity index was 100.The tested IGRs induced a significant prolongation in the larval and pupal duration.The percent pupation was highly decreased compared to the control. All the tested IGRs induced a reduction in the pupal weight as well as a reduction in the adult emergence, which was completely inhibited at 1000, and 2000 ppm. All the tested IGRs caused a significant decrease on the longevity of both sexes as compared to the control. The fecundity and fertility greatly decreased and the sterility increased with the all tested IGRs. Admiral was more effective than the others.

**Key words:** Insect growth regulators (IGRs)

## INTRODUCTION

The housefly, *Musca domestica* is found in homes, horse stables, poultry farms, and ranches in enormous numbers. The houseflies are carriers of more than 65 human and animal intestinal diseases, including bacterial infections such as salmonellosis, shigellosis and cholera; protozoan infections such as amoebic dysentery; helminthic infections such as pinworms, roundworms, hookworms and tapeworms as well as viral and rickettsial infections. Flies also transmit eye diseases such as trachoma and epidemic conjunctivitis and infectious wounds or skin diseases such as cutaneous diphtheria, mycoses, yaws and leprosy (Greenberg, 1965). Because of its importance as a public health pest, many insecticides have been used directly or indirectly in the control of *M. domestica*. Throughout the world, houseflies have developed resistance to these insecticides. Furthermore, resistance has been recorded for most conventional insecticides. As a consequence, it provides impetus to study new alternatives and more ecologically acceptable methods of insect control.

The insect growth regulators (IGRs) have been used in a variety of practical applications and were described as agents that elicit their primary action on insect metabolism, ultimately interfering and disrupting the process of growth, development and metamorphosis of the target insects, particularly when applied during the sensitive period of insect development (Ishaaya and Horowitz, 1997).

The biological effects of IGRs on the house fly were studied by many authors. The effects of dimilin (TH 6040) (diflubenzuron) were studied by (Grosscurt and Tipker, 1980; Bakr, 1986; Aguirre-Uribe *et al*., 1991; Das and Vasuki, 1992; Shalaby, 1994; Chung Gyoo *et al*., 1999 and Kocisova *et al*., 2004).

The effects of methoprene (altosid) on *M. domestica* were studied by(Breeden *et al*.,1981; Bakr, 1986; Vignau *et al*., 2003 and Kocisova *et al*., 2004).

The effects of triflumuron (Alystin) (BAY SIR) on *M. domestica* were studied by Weaver and Begley, 1982; Bakr, 1986; Mustafa, 1993; Srinivasan and Amalraj, 2003 and Vazirianzadeh *et al*., 2007).

The effects of cyromazine on *M. domestica* were studied by Awad and Mulla, 1984 and Vazirianzadeh *et al*., 2007).

The effects of pyriproxyfen (admiral) on *M. domestica* were studied by Hatakoshi *et al*., 1987; Kawada *et al*., 1992; Shalaby, 1994; El-Bermawy, 1994 and Assar and Abo-Shaeshae, 2004).

The biological effects of other IGRs on the house fly were studied, pyridyl ether compounds (S- 31183) (Kawada *et al*., 1987 ); IGI- DC, deenate, amix 500 (Yousssef *et al*., 1990); fenoxycarb (Fouda *et al*., 1991); non- steroidal ecdysone mimic (RH-5849) (Ghoneim *et al*., 1991); flufenoxuron, fasamine ammonium, and chlorfluazuron (IKI) (Moustafa, 1993); methoxyfenozide (Assar and Abo-Shaeshae ,2004) and novaluron (Cetin *et al*., 2006).

## MATERIALS AND METHODS

**1-Maintenance of culture**

**A-Origin of *Musca domestica***

The strain of *Musca domestica* was obtained from the Research Institute of Medical Entomology, Dokki, Giza.

**B-Rearing technique**

The colony was maintained under laboratory conditions of 27 ± 2 °C and 70 ± 5% relative humidity (Hashem and Youssef 1991). Adults were kept in rearing cages covered with wire screen. Their bottom was made of plywood. The cage size is 30x30x30 cm. Adults were fed on 10% sucrose solution soaked in cotton pads above the cages. Also, cotton pads thoroughly saturated with milk were put in Petri dishes to stimulate oviposition and as oviposition sites. Eggs were collected and transferred to larval medium. The newly-hatched larvae were left to grow and feed on synthetic medium formed of wheat bran 655 gram, milk powder 50 gram, and yeast powder 38 gram and 600 ml tap water. Larvae were grown in plastic jars and moult until they reach pupal stage. As soon as pupae were formed they were collected from the rearing medium with a soft forceps. The pupae were transferred into cages until adult emergence.

**2-The tested insect growth regulators:-**

**A-Chitin synthesis inhibitors:-**

**1- Buprofezin** (Applaud 25% WP): 2-[(1,1-dimethylethyl)imino] tetrahydro-3- (1 -methylethyl)-5-phenyl-4H-1, 3, 5-thiadiazin-4-one

**2-Hexaflumuron**(Consult 10% EC): 1-[3, 5-dichloro-4-(1, 1, 2, 2-tetrafluoroethoxy) phenyl]-3- (2, 6-difluorobenzoyl) urea

**3-Lufenuron** (Match 10% EC): N-[[[2, 5-dichloro-4-(1,1,2,3,3,3-hexafluoropropoxy) - = phenyl] amino] carbonyl]-2, 6-difluorobenzamide

**B-Ecdysone agonist:-**

**Tebufenozide**(Mimic 24 % EC): 3, 5-dimethylbenzoic acid 1-(1, 1-dimethylethyl)-= 2-(4-ethylbenzoyl) hydrazide

**C- Juvenile hormone analogue: -**
**Pyriproxyfen**(Admiral 10 % EC): 2-[1-methyl-2-(4-phenoxyphenoxy)ethoxy]pyridine

### 3-Biological studies:

All tests were carried out in laboratory conditions of 27 ± *2* °C and 70 ± 5 %relative humidity. Different concentrations 10, 100, 1000 and 2000 ppm of the selected insect growth regulators, buprofezin, hexaflumuron, lufenuron, tebufenzoide and pyriproxyfen were prepared by diluting with water. Larvae were kept in plastic cups containing media until pupation. Control groups were made with tap water only. Each concentration of each IGR and the control group were replicated 5 times each containing 20 1st instar larvae. Mortality was recorded daily until pupation.

The larval mortality were corrected according to Abbott's formula (1987). The data were subjected to probit analysis (Finney, 1971 and Le Ora Soft Ware 1987) to give values of $LC_{50}$. The toxicity index of the tested compounds was calculated according to Sun (1950).

Larvae, which survived, were followed up daily to estimate larval duration. The resultant pupae were counted and weighed to determine the percent pupation and pupal weight, followed up till adult emergence to estimate the pupal duration.The reduction in pupal weight and adult emergence was calculated according to Khazanie (1979).

The longevity of adult male and female was recorded. Eight pairs of the resulting adults were used to reveal the effect of the tested insecticides on fecundity which was measured as the total number of eggs laid per female. The oviposition deterrent index based on the number of eggs in treatment and control assays was calculated according to Lundgren (1975). The percent of egg hatch or fertility was determined. The sterility was calculated according to Toppozada *et al.* (1966).

### 4-Data Analysis

Data is classified into quantitative and qualitative type. Quantitative data was expressed as mean ± S.E., while qualitative data was expressed as number and percent.Tests of significance used were:
ANOVA "Analysis of variance" to measure the difference between means of more than two groups.Chi square test to assess the difference between qualitative data.Using SPSS Version (11) Statistical Package for Social Sciences for Windows XP.

## RESULTS AND DISCUSSION

### 1- Larval mortality

Table (1) shows the percentage of larval mortality of *M. domestica* treated with different concentrations of the tested IGRs.

Table 1: Effect of the tested IGRs on the larval mortality* of *M. domestica* treated as 1st larval instar

| IGRs / Conc. (ppm.) | larval mortality | | | | | χ2 | *p* |
|---|---|---|---|---|---|---|---|
| | Applaud | Consult | Match | Mimic | Admiral | | |
| 10 | 34.21 | 38.16 | 14.09 | 35.01 | 26.02 | 56.23 | <0.01*** |
| 100 | 54.79 | 42.11 | 32.60 | 79.03 | 67.76 | 25.22 | <0.01*** |
| 1000 | 79.96 | 86.19 | 66.86 | 97.49 | 98.39 | 7.98 | >0.05* |
| 2000 | 85.09 | 94.06 | 98.03 | 100.00 | 100.00 | 1.67 | >0.05* |
| χ2 | 62.41 | 39.08 | 78.15 | 5.41 | 49.15 | | |
| *p* | <0.01*** | <0.01*** | <0.01*** | <0.05** | <0.01*** | | |

Larval mortality was corrected according to Abott's formula (1987) *p>0.05= Non Significant **<0.05 = Significant ***p<0.01= Highly Significant

The results demonstrated that larval mortality was dose dependent and there was a highly significant difference for each IGR ($p < 0.01$). At the lower concentrations (10 and 100 ppm), the larval mortality was highly significant with all tested IGRs, while at high concentrations (1000 and 2000 ppm), there was insignificant difference.

The $LC_{50}$ was 35, 140, 180, 20 and 30 ppm with applaud (buprofezin), consult (hexaflumuron), match (lufenuron), mimic (tebufenozide) and admiral (pyriproxyfen), respectively. The toxicity index was 57.14, 14.28, 11.11, 100 and 66.67 at the above mentioned IGRs, respectively. These results shows that mimic was more toxic than admiral and followed by applaud, consult and match (Table 2).

Table 2: $LC_{50}$ and Toxicity index* of the tested IGRs

| IGRs | Applaud | Consult | Match | Mimic | Admiral |
|---|---|---|---|---|---|
| $LC_{50}$ (ppm) | 35 | 140 | 180 | 20 | 30 |
| Toxicity index | 57.14 | 14.28 | 11.11 | 100 | 66.67 |

Toxicity index was calculated according to Sun (1950).

These results were in accordance with those obtained on the effect of IGRs on *M. domestica* by [Weaver and Begley (1982) using BAY SIR 8514**;** Kawada *et al*. (1987)] using pyridyl ether; [Youssef *et al*. (1990) Das and Vasuki (1992) Shalably (1994) ChungGyoo *et al*. (1999) and Kocisova *et al*. (2004)] using dimilin (diflubenzaron); Fouda *et al*. (1991) using fenoxycarb; [El-Bermawy (1994) and Shalably (1994)]using admiral (pyriproxyfen); Assar and Abo-Shaeshae (2004) using admiral and methoxyfenozide; Kocisova *et al*. (2004) using methoprene;Cetin *et al.* (2006) using novaluron and Vaziriazadehl *et al*. (2007) using cyromazine and triflumuron.

Medina *et al*. (2002) reported that the differences in the toxicity of IGRs depend upon penetration through the cuticle, distribution inside the insect body and excretion.

## 2- Larval duration

Table (3) shows that the treatment of the 1st larval instar of *M.domestica* with the tested IGRs resulted in a significant prolongation in the larval duration. This prolongation was dose dependent and was more obvious with match and mimic than with consult and applaud. The larval duration with match was 5.27, 5.85, 6.37 and 7.99 days at 10,100,1000 and 2000 ppm, respectively, while it was 6.01, 6.50 and 7.91 days with mimic at 10, 100 and 1000 ppm, respectively. Admiral gave the lowest prolongation in the larval duration. This may be due to the delaying in the moulting process.

Table (3): Effect of the tested IGRs on the larval duration of *M. domestica* treated as 1st larval instar

| IGRs / Conc. (ppm.) | Larval duration | | | | | F-Value | *p* |
|---|---|---|---|---|---|---|---|
| | Applaud | Consult | Match | Mimic | Admiral | | |
| | Mean±S.E. (Days) | Mean±S.E. (Days) | Mean±S.E. (Days) | Mean±S.E. (Days) | Mean±S.E. (Days) | | |
| Control | 4.95±0.01 | 4.95±0.01 | 4.95±0.01 | 4.95±0.01 | 4.95±0.01 | | |
| 10 | 5.06±0.01 | 5.14±0.01 | 5.27±0.02 | 6.01±0.01 | 5.00±0.00 | 9862.5 | <0.01*** |
| 100 | 5.33±0.01 | 5.47±0.02 | 5.85±0.01 | 6.50±0.01 | 5.43±0.01 | 10169.5 | <0.01*** |
| 1000 | 6.16±0.01 | 6.28±0.01 | 6.37±0.02 | 7.91±0.01 | 5.56±0.01 | 33435.4 | <0.01*** |
| 2000 | 7.21±0.01 | 7.36±0.01 | 7.99±0.01 | - | - | 853879.6 | <0.01*** |
| F-Value | 67969.45 | 50721.29 | 53367.23 | 584070.09 | 200553.33 | | |
| *p* | <0.01*** | <0.01*** | <0.01*** | <0.01*** | <0.01*** | | |

Similar observation was also reported on *M.domestica* by Assar and Abo-Shaeshae (2004) using pyriproxyfen and methoxyfenozide. On the other hand, the larval duration of *M. domestica* decreased by diflubenzuron, altosid and BAY SIR 8514[Bakr (1986); fenoxycrab (Fouda *et al.*, 1991) and the ecdysone (RH-5849) (Ghoniem *et al.*, 1991)].

**3- The percent pupation**

The percent pupation resulted from treatment of 1$^{st}$ instar larvae of *M. domestica* with different concentrations of the tested IGRs was highly decreased compared to the control. This decrease was more pronounced at higher concentrations (1000 and 2000 ppm) than at lower ones (10 and 100 ppm) (Table 4). Also, the results showed that admiral and mimic were more effective than other IGRs where the percent pupation was zero at 2000 ppm with these two compounds.These results are in agreement with those obtained on *M. domestica* by Weaver and Begley (1982) using BAY SIR 8514; Fouda *et al.* (1991) using fenoxycarb; Ghoneim *et al.* (1991) using RH-5849 and Assar and Abo-Shaeshae (2004) using pyriproxyfen and methoxyfenozide.

Table (4): Effect of the tested IGRs on the percent pupation of *M. domestica* treated as 1$^{st}$ larval instar

| IGRs / Conc. (ppm.) | Percent pupation | | | | | χ2 | *p* |
|---|---|---|---|---|---|---|---|
| | Applaud | Consult | Match | Mimic | Admiral | | |
| Control | 98.40 | 98.40 | 98.40 | 98.40 | 98.40 | - | - |
| 10 | 63.60 | 60.40 | 83.60 | 64. 09 | 71.60 | 56.30 | <0.01*** |
| 100 | 43.60 | 55.60 | 64.40 | 20.40 | 31.60 | 25.09 | <0.01*** |
| 1000 | 18.60 | 12.60 | 31.60 | 2.00 | 1.40 | 8.09 | >0.05* |
| 2000 | 14.60 | 5.60 | 1.80 | 0 | 0 | 1.67 | >0.05* |
| χ2 | 25.81 | 37.76 | 78.15 | 5.09 | 48.56 | | |
| *p* | <0.01*** | <0.01*** | <0.01*** | >0.05* | <0.01*** | | |

*p>0.05= Non Significant ***p<0.01= Highly Significant

**4- The pupal weight**

From the data presented in Table (5), it may be concluded that the tested IGRs induced reduction in the pupal weight of *M. domestica*. This reduction was non significant at 10, 100 and 1000 ppm, between all the tested IGRs.

Table (5): Effect of the tested IGRs on the pupal weight of *M. domestica* treated as 1$^{st}$ larval instar

| IGRs / Conc. (ppm.) | Applaud | | Consult | | Match | | Mimic | | Admiral | | χ2 | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wt. Mean±S.E. | %R | Wt. Mean±S.E. | %R | Wt. Mean±S.E. | %R | Wt. Mean±S.E. | %R | Wt. Mean±S.E. | %R | | |
| Control | 12.66±0.24 | - | 12.66±0.24 | - | 12.66±0.24 | - | 12.66±0.24 | - | 12.66±0.24 | - | - | - |
| 10 | 9.25±0.07 | 27.57 | 8.76±0.04 | 32.45 | 8.54±0.03 | 33.33 | 10.74±0.02 | 16.35 | 9.92±0.01 | 22.66 | 7.47 | >0.05* |
| 100 | 7.85±0.01 | 38.78 | 7.32±0.02 | 40.34 | 7.26±0.04 | 43.30 | 8.23±0.02 | 35.74 | 8.32±0.01 | 35.12 | 1.07 | >0.05* |
| 1000 | 6.02±0.01 | 53.03 | 6.21±0.01 | 51.55 | 6.00±0.01 | 53.27 | 6.44±0.02 | 49.68 | 7.41±0.02 | 42.05 | 1.72 | >0.05 * |
| 2000 | 5.44±0.01 | 57.55 | 5.94±0.02 | 53.58 | 5.41±0.01 | 57.78 | - | - | - | - | 30.59 | <0.01*** |
| χ2 | 12.52 | | 7.26 | | 7.89 | | 76.25 | | 70.36 | | | |
| *p* | <0.01*** | | >0.05* | | <0.05** | | <0.01*** | | <0.01*** | | | |

Wt. = Mean Pupal Weight (mg) %R= Percent of Reduction in Pupal Weight

* p>0.05= Non Significant ** p<0.05= Significant ***p<0.01= Highly Significant

However, a highly significant difference was observed at 2000 ppm (p < 0.01). The pupal weight at 2000 ppm was 5.44, 5.94 and 5.41 mg with applaud, consult and match, respectively as compared with 12.66 mg in the control group. Also, from the same table it can be noticed that applaud and match were more effective on the pupal weight than the other tested IGRs. These results were in agreement with the results obtained on *M. domestica* by [Bakr (1986)] using diflubenzuron; Fouda *et al.* (1991) using fenoxycarb and Assar and Abo-Shaeshae (2004) using pyriproxyfen and methoxyfenozide on *M. domestica*.

Abdel-Aal (1996) attributed the decrease of pupal weight of *M. domestica* to the decrease in total water content or decreased intensity of protein biosynthesis. Also, it may be due to the lack of proper sclerotization of the newly formed puparium, or evaporation of body fluids leading to decreased pupal weight.

## 5- The pupal duration

The data presented in (Table 6) indicated that the tested IGRs prolonged the pupal duration of *M. domestica*. This prolongation was highly significant (P < 0.01) in both concentrations. Consult and applaud were more effective on the pupal duration, followed by match, mimic and admiral. The pupal duration with consult was 7.64 and 9.01 days at 10 and 100 ppm, respectively, while was 4.01 days in the control group. Such increase in pupal duration may reflect disruption in metamorphosis.

The prolongation of pupal duration of *M. domestica* following treatment with the tested IGRs is similar to the data obtained on the same insect, by Fouda *et al.* (1991) using fenoxycarb; Srinivasan and Amalraj (2003) using triflumuron and Assar and Abo- Shoeshae (2004) using pyriproxyfen and methoxyfenozide. In contrast, Ghoneim *et al.* (1991) reported that mimic shortened the pupal duration of *M. domestica*.

Table (6): Effect of the tested IGRs on the pupal duration of *M. domestica* treated as 1st larval instar

| IGRs / Conc. (ppm.) | Pupal duration | | | | | F- Value | *p* |
|---|---|---|---|---|---|---|---|
| | Applaud | Consult | Match | Mimic | Admiral | | |
| | Mean±S.E. (Days) | Mean±S.E. (Days) | Mean±S.E. (Days) | Mean±S.E. (Days) | Mean±S.E. (Days) | | |
| Control | 4.01±0.01 | 4.01±0.01 | 4.01±0.01 | 4.01±0.01 | 4.01±0.01 | | |
| 10 | 6.91±0.01 | 7.64±0.03 | 5.85±0.04 | 6.22±0.02 | 5.61±0.01 | 5303.74 | <0.01*** |
| 100 | 8.43±0.01 | 9.01±0.01 | 7. 92±0.02 | 7.43±0.02 | 7.34±0.01 | 10785.46 | <0.01*** |
| F- Value | 1442355.07 | 359911.04 | 154225.28 | 372014.77 | 1613789.58 | | |
| *p* | <0.01*** | <0.01*** | <0.01*** | <0.01*** | <0.01*** | | |

## 6- The adult emergence

Results in Table (7) clearly indicated that all the tested IGRs affected the adult emergence of *M. domestica*. This effect was dose dependent. The percent reduction in adult emergence was 62.10, 83.15**;** 49.47, 70.52**;** 66.31, 78.94**;** 66.31, 83.15 and 45.26, 74.73 due to treatment of *M. domestica* with applaud, consult, match ,mimic and admiral at 10 and 100 ppm, respectively.

Table (7): Effect of the tested IGRs on the adult emergence of *M. domestica* treated as 1st larval instar

| IGRs / Conc. (ppm.) | Applaud | | Consult | | Match | | Mimic | | Admiral | | $\chi 2$ | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | %AE | %R | % AE | %R | % AE | %R | % AE | %R | % AE | %R | | |
| Control | 95.00 | - | 95.00 | - | 95.00 | - | 95.00 | - | 95.00 | - | - | - |
| 10 | 36.00 | 62.10 | 48.00 | 49.47 | 32.00 | 66.31 | 32.00 | 66.31 | 52.00 | 45.26 | 6.83 | >0.05* |
| 100 | 16.00 | 83.15 | 28.00 | 70.52 | 20.00 | 78.94 | 16.00 | 83.15 | 24.00 | 74.73 | 1.39 | >0.05* |
| $\chi 2$ | 11.32 | | 23.03 | | 9.75 | | 9.11 | | 25.63 | | | |
| *p* | <0.05** | | <0.01*** | | <0.05** | | <0.05** | | <0.01*** | | | |

% AE = Percent of adult emergence %R= Percent reduction in adult emergence
*p>0.05= Non Significant **p<0.05= Significant *** p<0.01= Highly significant

The results demonstrated that all the tested IGRs caused complete inhibition of adult emergence at 1000 and 2000 ppm.

The decrease in the percentage of adult emergence of *M. domestica* due to treatment with the tested IGRs is similar to the data obtained on the same insect by other IGRs, methoprene [Breeden *et al*. (1981) and Vignau *et al*. (2003) ]; BAY SIR 8514 [Weaver and Begley (1982) and Bakr (1986)]; cyromazine (Awad and Mulla,1984);Pyriproxyfen [Hatakoshi *et al*. (1987) El-Bermawy (1994) Shalaby (1994) and Assar and Abo- Shaeshae (2004)]; fenoxycarb (Fouda *et al*., 1991); RH-5849 (Ghonim *et al*., 1991); flufenoxuron, triflumuron, fasamine and chlorofluzron (Moustafa, 1993) and hexaflumuron (Assar and Abo- Shaehae, 2004).

The decrease in the percentage of adult emergence could be due to the fact that IGRs block the maturation of imaginal discs which are the primordial of many adult integumentary structures in endopterygote insects (Schineidermann, 1972) or due to deformation of adult chitin.

## 7-Adult longevity

Data presented in (Table 8) indicated that the longevity of female *M. domestica* in control group was 21.73 days while in male was 19.51 days. The tested IGRs caused a significant decrease on the longevity of both sexes as compared to control and this effect was dose dependent. At 100ppm, the longevity of male was 9.21, 8.63, 10.27, 9.24 and 11.39 days with applaud, consult, match, mimic and admiral, respectively, while the longevity of female at 100 ppm of the above mentioned IGRs was 11.21, 10.91, 10.35, 8.95 and 10.17 days, respectively.These results are in conformity with those reported by Weaver and Begley (1982) when *M. domestica* larvae were treated with BAY SIR 8514.

Table (8): Effect of the tested IGRs on adult longevity of *M. domestica* treated as 1st larval instar

| IGRs / Conc. (ppm.) | Applaud | | Consult | | Match | | Mimic | | Admiral | | $\chi 2$ | | *p* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Longevity Mean±S.E. (days) | | Longevity Mean±S.E. (days) | | Longevity Mean±S.E. (days) | | Longevity Mean±S.E. (days) | | Longevity Mean±S.E (days) | | | | | |
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| Control | 19.51 ± 0.01 | 21.73 ± 0.02 | 19.51 ± 0.01 | 21.73 ± 0.02 | 19.51 ± 0.01 | 21.73 ± 0.02 | 19.51 ± 0.01 | 21.73 ± 0.02 | 19.51 ± 0.01 | 21.73 ± 0.02 | - | - | - | - |
| 10 | 15.46 ± 0.02 | 15.46 ± 0.01 | 12.37 ± 0.01 | 16.71 ± 0.01 | 14.96 ± 0.02 | 16.41 ± 0.01 | 16.50 ± 0.02 | 13.77 ± 0. 16 | 16.12 ± 0.01 | 14.85 ± 0.01 | 13.2 | 2.68 | < 0.01*** | > 0.05* |
| 100 | 9.21 ± 0.01 | 11.21 ± 0.01 | 8.63 ± 0.01 | 10.91 ± 0.01 | 10.27 ± 0.02 | 10.35 ± 0.01 | 9.24 ± 0.01 | 8.95 ± 0.02 | 11.39 ± 0.01 | 10.17 ± 0.01 | 1.32 | 1.32 | > 0.05* | > 0.05* |
| $\chi^2$ | 13.838 | 5.26 | 3.88 | 3.95 | 8.803 | 9.47 | 21.235 | 5.04 | 10.593 | 5.18 | | | | |
| *p* | < 0.01*** | < 0.01*** | < 0.01*** | < 0.05** | < 0.01*** | < 0.05** | < 0.01*** | < 0.05** | < 0.05** | < 0.05** | | | | |

*P > 0.05 = Non significant **P < 0.05 = Significant ***P < 0.01= Highly significant

## 8-The Fecundity

Data presented in Table (9) showed that the treatment of *M. domestica* larvae with the tested IGRs caused a significant decrease in the number of eggs deposited (laid) per resulting female.

The mean number of eggs at 10 ppm was, 162, 186, 140, 154 and 111 by applaud, consult, match, mimic and admiral, respectively, while the mean number of eggs at 100 ppm was 91, 100, 96, 86 and 74 by the above mentioned IGRs, respectively as compared with 360 eggs in the control group. Also, admiral was more effective on the fecundity than the other tested IGRs.

The oviposition deterrent index (O.D.I) at 10 ppm was 36.91, 30.91, 43.02, 39.07 and 52.03 by applaud, consult, match, mimic and admiral ,respectively while at 100 ppm was 58.88, 55.79,56.90, 60.47 and 64.98 at the same tested IGRs, respectively.

These results were in harmony with those obtained on *M. domestica* by [Grosscurt and Tipker (1980) and ChungGyoo *et al*.(1999)] using diflubenzuron; Fouda *et al*. (1991) using fenoxycarb; Ghoneim *et al*. (1991) using RH -5849; Kawada *et al*. (1992) using pyriproxyfen and Assar and Abo-Shaeshae (2004) using pyriproxyfen and methoxyfenozide.

The suppression of egg production may be due to the interference of the tested IGRs with oogenesis. Also, the reduction in number of eggs laid per female may be attributed to some disturbances in ovary structure and in the total protein, lipid and carbohydrate content in the ovaries.

Table (9): Effect of the tested IGRs on fecundity and oviposition deterrent index* of *M. domestica* resulted from treatment of 1st larval instar

| IGRs / Conc. (ppm.) | Applaud | | Consult | | Match | | Mimic | | Admiral | | F- Value | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of eggs Mean±S.E. | O.D.I (%) | No. of eggs Mean±S.E. | O.D.I (%) | No. of eggs Mean±S.E. | O.D.I (%) | No. of eggs Mean±S.E. | O.D.I (%) | No. of eggs Mean±S.E. | O.D.I (%) | | |
| Control | 360±10 | - | 360±10 | - | 360±10 | - | 360±10 | - | 360±10 | - | | |
| 10 | 162±7 | 36.91 | 186±7 | 30.91 | 140±5 | 43.02 | 154±6 | 39.07 | 111±5 | 52.03 | 5339.4 | < 0.01*** |
| 100 | 91±4 | 58.88 | 100±4 | 55.79 | 96±3 | 56.90 | 86±3 | 60.47 | 74±2 | 64.98 | 356.75 | < 0.01*** |
| F- Value | 110754 | | 143736 | | 90384 | | 91839 | | 125650 | | | |
| *p* | < 0.01*** | | < 0.01*** | | < 0.01*** | | < 0.01*** | | < 0.01*** | | | |

* O.D.I=Oviposition Deterrent Index [according to Lundgren (1975)]. ****P* < 0.01= Highly significant

## 9-The fertility (egg hatchability %) and sterility

Table (10) shows that the tested IGRs at 10 and 100 ppm significantly decreased the egg hatching percent (P < 0.01). This effect was more obvious in case of admiral and mimic treatments, followed by consult, applaud and match. The fertility followed the same pattern of the fecundity.

Table (10): Effect of the tested IGRs on fertility (egg hatchability) and sterility* of *M. domestica* resulted from treatment of 1st larval **instar**

| IGRs / Conc. ppm.) | Applaud | | Consult | | Match | | Mimic | | Admiral | | F- Value | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hatchability % | Sterility % | Hatchability % | Sterility % | Hatchability % | Sterility % | Hatchability % | Sterility % | Hatchability % | Sterility % | | |
| Control | 96.0 | - | 96.0 | - | 96.0 | - | 96.0 | - | 96.0 | - | | |
| 10 | 64.6 | 68.98 | 60.6 | 66.68 | 67.4 | 72.02 | 57.0 | 73.98 | 50.6 | 83.36 | 141.49 | < 0.01*** |
| 100 | 27.6 | 92.55 | 24.8 | 92.66 | 31.0 | 90.95 | 27.6 | 93.68 | 30.00 | 93.36 | 151.57 | < 0.01*** |
| F- Value | 74346.0 | | 87561.0 | | 7999.4 | | 18538.0 | | 133034.0 | | | |
| *p* | < 0.01*** | | < 0.01*** | | < 0.01*** | | < 0.01*** | | < 0.01*** | | | |

* Sterility was calculated according to Toppozada *et al.* (1966). ****P* < 0.01= Highly significant

Also, the tested IGRs increased the sterility percent which was 68.98, 66.68, 72.02, 73.98 and 83.36% at 10 ppm of applaud, consult, match, mimic and admiral, respectively. At 100 ppm, the sterility percent was 92.55, 92.66, 90.95, 93.68 and 93.36% with the above mentioned IGRs, respectively.

The reduction in fertility was also in agreement with the data on *M. domestica* obtained by Kawada *et al.* (1992) using pyriproxyfen; [ChangGyoo *et al.* (1999) and Kocisova *et al.* (2004)] using diflubenzuron (dimilin); and Assar and Abo-Shaeshae (2004) using pyriproxyfen and methoxyfenozide.

On the contrary, the fertility of *M. domestica* was not affected by dimilin (Grsscurt, 1976) and by fenoxycarb (Fouda *et al.*, 1991). Ismail (1980) reported that the reduction in fecundity and fertility may be attributed to partial sterilization of females and / or males, or due to inability of the sperms to be transferred to the females during copulation.

Taher and Cutkomp (1983) suggested that the sterility of females seems to be attributed chiefly to a delay or reduction of ova giving some opportunities not for retention but for possible resorption of eggs in ovaries. They also added that the cause for the delay could be due, in part, to a lower metabolic rate.

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## ARABIC SUMMARY

### التأثيرات البيولوجية لبعض منظمات النمو الحشرية على الذبابة المنزلية
### مسكا دومستيكا (ذات الجناحين- مسكيدي)

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استهدفت الدراسة الحالية تحديد التأثيرات البيولوجية لخمسة من منظمات النمو الحشرية وهى مثبطات تكوين الكيتين [البيبروفيزين (أبلويد) و الهيكسافلوميرون (كونسلت) و الليوفينورون (ماتش)] و التيبوفينوزيد (ميمك) كمشابه لهرمون الانسلاخ و البيربروكسيفين (أدميرال) كمشابه لهرمون الحداثة على الذبابة المنزلية. وتم تطبيق هذه المركبات عن طريق تغذية يرقات العمر الأول على بيئة غذائية معاملة بتركيزات مختلفة من هذه المركبات (10- 100- 1000- 2000 جزء فى المليون).

أظهرت النتائج أن الميمك و الأدميرال كانا أكثر المركبات تأثيرا؛ حيث أحدثا 100% معدل الموت لليرقات عند 2000جزء فى المليون وكان الميمك هو أكثر المركبات سمية وكان معامل السمية له 100.كما أحدثت منظمات النمو المستخدمة إطالة معنوية فى مدة العمر اليرقي و العمر العذرى وأدت أيضا الى انخفاض نسبة التعذر بالمقارنة بالكنترول، و أدت المركبات المستخدمة إلى نقص فى وزن العذارى الناتجة و انخفاض فى نسبة ظهور الطور البالغ عند التركيزات 1000و2000 جزء فى المليون .كما أحدثت المركبات المستخدمة انخفاضاً معنويا فى متوسط عمر الطور البالغ لكلا الجنسين و نقص فى قدرة الإناث على وضع البيض و كذلك الخصوبة وأدت أيضاً الى زيادة نسبة العقم. و كان الأدميرال الأكثر تأثيرا فى ذلك.