Zagazig Journal of Agricultural Research
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# EFFECT OF FENOXYCARB ON SOME BIOLOGICAL ASPECTS OF THE BERSEEM *GRASSHOPPER, Euprepocnemis plorans plorans* (CHARP.)

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## ABSTRACT

The effects of Juvenile hormone analogue, fenoxycarb on some biological aspects of the berseem grasshopper, *Euprepocnemis plorans plorans* (Charp.) were studied. Three doses of 25, 50 and 100 µl per 3rd instar nymph were applied. The resulting adults were mated with each other in two different sets. First, the adult males and females from the treated 3rd instar nymphs were mated with untreated adults. Second, the adult males and females emerging from the 3rd instar nymphs treated with different doses were mated with each other. The low dose (25 µl/nymph) was the most effective one against the early nymphal instars. This dose prolonged the duration of resulting 3rd, 4th and 5th instars nymphs as well as the pre-oviposition period of adult stage. Mating between the treated males and females reduced the producing numbers of egg pods, laid eggs, hatched eggs and reproductive potential. There were unobvious differences between all doses. This compound can be considered as a promising control agent from the practical point of view.

**Keywords:** Fenoxycarb, *Euprepocnemis plorans plorans,* biological aspects, effects, duration.

## INTRODUCTION

Grasshoppers have become a serious pest in Egypt especially in the newly reclaimed areas (El-Garhy *et al.*, 1988). The most economic species that caused a serious damage is the berseem grasshopper, *E. plorans plorans* (Charp.). This species caused 95% damage to planted crops of the Nile Delta in 1942 (Nakhla, 1957) and (Abdel-Fattah, 2002). Existing control strategies depend on chemical insecticides to prevent damage to vegetation and these methods, though often effective, are not always appropriate effective alternatives that offer improved safety could have repaid as favorable environmental and economic impact. Juvenile hormone analogues are acceptable alternative chemicals for grasshoppers control. The high susceptibility of last instar of *Locusta migratoria migratorioides* nymphs to topically applied R70-1 is promising from the practical standpoint. Extremely effective application of fenoxycarb to these nymphs lead to death in the next moult, less effective treatment resulted in imperfect adults with curled wings (Pener *et al.*, 1997; Ortega and Bowers, 1995; Saiful-Islam and Islam, 1995).

The Juvenoid fenoxycarb is unrelated in structure to Juvenile hormone (JH), but the membrane receptor for it suggesting that fenoxycarb is a JH agonist (Davey and Grodan, 1996). JH and JH analogues inhibited fat body development in locust and suppressed the adipokinetic reaction leading to the suppression of migratory flight (Schneider *et al.*, 1995). The pattern of metabolic behaviour of fenoxycarb in *Schistocerca gregaria* confirmed that this compound has a pronounced juvenilizing activity (El-Gammal *et al.*, 1989). Also, it was observed that the morphogenetic deformations in *L. migratoria migratorioides* were dose dependent and increased with higher doses (Othman and Schmidt, 1998). Fenoxycarb and

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thyroxin mimics caused reduction in the volume of follicle cells of *L. migratoria migratorioides* (Davey *et al.*, 2000). Fenoxycarb caused decrease in reproductive potential for *S. gregaria* (Abdel-Fattah *et al.*, 2003). The present study deals with the early and latent effects of Juvenile hormone analogue, fenoxycarb on *E. plorans plorans* (Charp.). Reproductive potential, number of egg pods and hatched eggs were determined. Such mating, are similar to what could happen in the field after spraying, indicating that Juvenile hormone analogue can be applied as a promising controlling tool.

## MATERIALS AD METHODS

### Experimental Insect

Newly hatched nymphs were segregated from the stock colony of *E. plorans plorans* (Charp.) which had been maintained under the crowded conditions according to the method of Nakhla (1957) and Hunter-Jones (1961) for several years in the Locust Research Section, Plant Protection Research Institute, Dokki. Giza, Egypt.

### Chemical Tested

Fenoxycarb is the common name of one of the most known insect growth regulators was used in the present study. Tourus 2E, EC 240 g/l is the trade name of this compound. Sample of the trade formula was supplied by MAAG Agrochemicals Inc., Vero Beach, Fl 32961.

Three doses of fenoxycarb (0.03, 0.06 and 0.12 mg/µl) dissolved in acetone solution and topically applied at the rates of 25, 50 and 100 µl per 3rd instar nymph using a Hamilton microsyring (type 701-NCH).The untreated control nymphs were topically applied by using acetone alone. The treated and untreated control nymphs were replicated five times, each replicate contained 30 individuals. The treated and untreated control nymphs were kept in wooden cages (50×50×50 cm) and incubated at 32±2°C and 70±5% R.H.

### Biological Observations

The treated 3rd instar nymphs were examined daily to record changes in their biological aspects such as durations of the successive nymphal instars, and mortality percentages, especially during metamorphosis. Moreover, during the adult stage fifteen pairs of adults of both sexes were introduced to the tubes separately (one pair for each tube) for egg laying for each treated and untreated. Both nymphs and adults were fed on branches of the berseem *Trifolium alexandrinum*. Preoviposition, oviposition and post oviposition periods were calculated. Also, the adult life span, adult mortality and total life span of the treated insects were recorded. The durations of the successive nymphal instars were calculated using Dembester (1957) equation.

### Adult Mating System

The treated adult females were mated with untreated adult males, in another set the treated adult males and females were mated with each other in different combinations. The second set of mating was similar to what could happen in nature after fenoxycarb spraying in the field. This system may be explain the usefulness of the application of this juvenoid against the grasshoppers in the field. The numbers of egg pods, hatched eggs and the productive potential were calculated according to Toppozada *et al.* (1966).

## RESULTS AND DISCUSSION

### Early Effects of Fenoxycarb

To show the early effects of the juvenile hormone analogue, fenoxycarb, the newly moulted 3rd instar nymphs were treated topically with 25, 50 and 100 µl/ nymph. Durations and mortality percentages of the successive instars (3rd, 4th and 5th instars) were calculated.

Table 1 shows that the durations of the 3rd, 4th and 5th instars were prolonged and the prolongation was more pronounced with the low dose (25 µl/ nymph) while mortality percentages were high with the highest dose, (100 µl/ nymph) in the three instars. Mortality occurred during metamorphosis from an instar to another as well as to the adult stage. The durations of the 3rd instar were 12.7, 11.8 and 10.5 days for the three doses 25, 50 ad 100 µl respectively compared to 9.0 days for the untreated control. The 4th instar durations were 10.0 , 15.1 , 14.3

**Table 1. Biological response of *E. plorans plorans* to treatment with juvenile hormone analogue, fenoxycarb, during the first day of the 3rd instar nymphs under constant conditions of 32 ± 2°C and 70 ± 5% R.H**

| Treatments | Nymphal instars | | | | | | Adult stage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3rd instar | | 4th instar | | 5th instar | | Pre-oviposition period in days | oviposition period in days | Post-oviposition period in days | Adult life span in days | Adult mortality % |
| | Duration in days | Mortality % | Duration in days | Mortality % | Duration in days | Mortality % | | | | | |
| Control | 9.0 | 0.0 | 10.0 | 0.0 | 10.6 | 4.0 | 16.9 | 23.6 | 6.0 | 48.7 | 4.0 |
| 25 µl/nymph | 12.7 | 1.3 | 15.1 | 5.0 | 18.9 | 6.5 | 21.6 | 18.7 | 4.8 | 45.1 | 5.1 |
| 50 µl/nymph | 11.8 | 4.2 | 14.3 | 11.0 | 16.5 | 12.3 | 22.1 | 16.6 | 4.3 | 43.2 | 7.2 |
| 100 µl/nymph | 10.5 | 10.0 | 11.1 | 15.8 | 14.6 | 19.7 | 18.5 | 16.1 | 3.1 | 38.1 | 8.3 |

** Durations of the indicated nymphal instars were calculated by Dembester's equation (1957).
** The criteria studied were collected from the treated adult females which were mated with untreated adult males.

**Table 2. Effects of juvenile hormone analogue, fenoxycarb on the reproductive potential of adults resulting from the treated 3rd instar nymphs of *E. plorans plorans* when copulated with untreated ones under constant conditions of 32 ± 2°C and 70 ± 5% R.H**

| Treatments | Average no. of egg pods / female | % reduction in egg pods/ female | Average no. of eggs / pod | % reduction in eggs /pod | Average no. of laid eggs per female | % reduction in laid eggs / female | Average no. of hatched eggs / female | % reduction in hatched eggs / female | % hatching | % reduction in reproductive potential |
|---|---|---|---|---|---|---|---|---|---|---|
| Control | 3.6 | 0.0 | 45.7 | 0.0 | 164.56 | 0.0 | 160.2 | 0.0 | 97.0 | 0.0 |
| 25 µl/ female | 2.7 | 25.0 | 37.3 | 18.4 | 69.7 | 57.6 | 60.1 | 62.5 | 86.2 | 62.5 |
| 25 µl/ male | 2.9 | 19.4 | 38.1 | 16.6 | 68.9 | 58.1 | 61.1 | 61.9 | 88.7 | 61.9 |
| 50 µl/female | 2.0 | 44.4 | 30.2 | 33.9 | 60.2 | 63.4 | 52.1 | 67.5 | 86.5 | 67.5 |
| 50 µl/ male | 2.1 | 41.7 | 31.1 | 31.9 | 61.7 | 62.5 | 53.2 | 66.8 | 86.2 | 66.8 |
| 100 µl/female | 1.9 | 47.2 | 26.6 | 41.8 | 56.7 | 65.5 | 45.8 | 71.4 | 80.8 | 71.41 |
| 100 µl/male | 1.7 | 52.8 | 24.8 | 45.7 | 51.8 | 68.5 | 47.2 | 70.5 | 91.1 | 70.55 |

Each treated sex was mated with untreated one

and 11.06 days for untreated control, 25, 50 and 100 µl/nymph, respectively. These durations were 10.6, 18.9, 16.5 and 14.6 days for the untreated control, 25, 50 and 100 µl/nymph, respectively for the 5th instar. Mortality percentages during 3rd instar were 0.0, 1.3, 4.2 and 10.0 for control, 25, 50 and 100 µl/nymph, respectively. During the 4th instar these percentages were 0.0, 5.0, 11.0 and 15.8 for control, 25, 50 and 100 µl/ nymph, respectively. Mortality percentages during the 5th instar were 4.0, 6.5, 12.3 and 19.7 for control, 25, 50 and 100 µl/ nymph, respectively. These results are in accordance with those of Abd El-Fattah *et al.* (2003) and El-Gammal *et al.* (2008).

## Latent Effects of Fenoxycarb

### Some biological aspects

Table 1 revealed that the pre-oviposition period, which extended from the eclosion of the adult female to the first egg laying, was 16.9, 21.6, 22.1 and 18.5 days for control, 25, 50 and 100 µl/nymph, respectively. The oviposition period, which extended from the first egg pod to the last one was 23.6, 18.7, 16.6 and 16.1 days for control, 25, 50 and 100 µl/nymph, respectively. The post-oviposition period, this extended from the last egg pod to adult death, was 6.0, 4.8, 4.3 and 3.1 days for control, 25, 50 and 100 µl/nymph, respectively. It was observed that the pre-oviposition period was prolonged with fenoxycarb application to 3rd instar nymphs. On the other hand, the oviposition and post-oviposition periods were shortened compared to the untreated control adult females. Also, the adult life span was also shortened by the application of fenoxycarb to 3rd instar nymphs, showing 48.7, 45.1, 43.2 and 38.1 days for control, 25, 50 and 100µl/nymph, respectively. Mortality percentages during the adult stage were 4.0, 5.1, 7.2 and 8.3 for control, 25, 50 and 100 µl/nymph, respectively.

### Reproductive potential of the copulated treated adults with the untreated ones

The treated adult females were mated with untreated adult males and the treated adult males were mated with untreated adult females. The numbers of egg pods, eggs per pod, eggs laid per female and hatched eggs were recorded. The reduction percentages in egg pods, eggs per pod, laid eggs and hatching percent and percent of reproductive potential were calculated.

Generally, Table 2 shows that the mating between the adult males resulting from the previously treated 3rd instar nymphs and untreated females decreased the numbers of the egg pods, eggs per pod, eggs laid per female and hatched eggs per female, compared to those produced when the treated adult females were mated with the untreated adult males.

These results indicated that fenoxycarb was effective against the adult females and males. The reduction percentages supported this observation. These reduction percentages for egg pods, eggs per pod, laid eggs and hatched eggs per female were high in the case of mating between the treated adult males with the untreated adult females compared to those in the case of mating between the treated adult females with the untreated adult males. Also, the reproductive potential after mating between the treated males and untreated females was low in comparison with the reproductive potential of the treated females mated with the untreated adult males (Table 2).

In conclusion, the effects of fenoxycarb on the reproductive potential of *E. plorans plorans* adults were high pronounced in the adult females than males, and with the high dose 100 µl/nymph than low dose 25 µl/nymph, if this juvenoid was applied to the 3rd instar nymphs. These results are in agreement with those of Abd El-Fattah *et al.* (2003) and Tail *et al.* (2010).

### Reproductive potential of the treated male and female adults

The adult males and females from the 3rd instar nymphs treated with 25, 50 and 100 µl/nymph fenoxycarb, were mated with each other. The first set was between the treated males and females with 25, 50 and 100 µl/ nymph, the second one was between the males treated with 25, 50 and 100 µl and females with the same doses, respectively (Table 3).

The numbers and the reduction percentages of egg pods, eggs per pod, laid eggs, and hatched eggs per female were calculated. Also, the reduction percent in hatchability and that in the reproductive potential of the adult females were recorded.

**Table 3. Effects of juvenile hormone analogue, fenoxycarb applied to the 3rd instar nymphs of *E. plorans plorans* on the reproductive potential of the resulting adult females when copulated with treated males**

| Treatments | Average no. of egg pods / female | % reduction in egg pod / female | Average no. of eggs /pod | % reduction in eggs / egg pod | Average no. of laid eggs per female | % reduction in laid eggs / female | average no. of hatched eggs / female | % reduction in hatched eggs / female | % hatching | % reduction in reproductive potential |
|---|---|---|---|---|---|---|---|---|---|---|
| **Control** | 3.1 | 0.0 | 45.7 | 0.0 | 164.5 | 0.0 | 160.2 | 0.0 | 97.4 | 0.0 |
| **25 µl (m+f)** | 1.4 | 61.1 | 30.1 | 34.1 | 58.2 | 64.6 | 40.2 | 74.9 | 69.1 | 74..9 |
| **50 µl (m+f)** | 1.1 | 69.4 | 28.2 | 38.3 | 48.7 | 70.4 | 37.8 | 76.4 | 77.6 | 76.4 |
| **50 µl (m) + 25 µl (f)** | 1.4 | 61.1 | 27.7 | 39.4 | 44..9 | 72.7 | 34.9 | 78.2 | 77.7 | 78.4 |
| **50 µl (f) + 25 µl (m)** | 1.3 | 63.7 | 25.9 | 43.3 | 45.2 | 72.5 | 38.1 | 76.2 | 84.3 | 76.2 |
| **100 µl (m +f)** | 1.1 | 69.4 | 25.1 | 42.9 | 45.6 | 72.3 | 35.7 | 77.7 | 78.3 | 77.7 |
| **100 µl (m) + 50 µl (f)** | 1.2 | 66.7 | 24.7 | 45.9 | 46.8 | 71.6 | 36.6 | 77.1 | 78.2 | 77.2 |
| **100 µl (m) + 25 µl (f)** | 1.3 | 63.9 | 26.5 | 42.1 | 49.1 | 70.2 | 34.9 | 78.2 | 71.1 | 78.2 |
| **100 µl (f) + 50 µl (m)** | 1.3 | 63.9 | 23.9 | 47.7 | 45.2 | 72.5 | 38.1 | 76.2 | 84.3 | 76.2 |
| **100 µl (f)+ 25 µl (m)** | 1.2 | 66.7 | 26.2 | 42.7 | 47.3 | 71.3 | 36.2 | 77.4 | 76.5 | 77.4 |

Treated males ad females were mated with each other as indicated in the table.
m = male f = female

Table 3 shows that the numbers of egg pods, eggs per pod, laid eggs and hatched eggs per female were reduced after mating between the adult males and females treated with 25, 50 and 100 µl/nymph compared to control treatment. This reduction was high pronounced in all cases of the adult males mated with adult females treated with 25, 50 and 100 µl/nymph. Also, the hatching percentages and the reduction in the reproductive potential of the same mating set were high in the applied doses. There were unclear differences between all doses irrespective of the treatments. These observations concluded that the mating between treated male and female adults was similar to what happens in nature after spraying of any effective agent against the nymphal instars. Moreover, the early and adult latent effects of fenoxycarb supported this conclusion because the low dose 25µl resulted in the most pronounced biological effects in the resulting adult males and females.

The previous results of the juvenile hormone analogue, fenoxycarb, in the early nymphal instars and the adult stage of *E. plorans plorans* revealed its juvenilizing actions in this insect. The results obtained in the present study are in line with those obtained by some authors (El-Gammal *et al.,* 1989; Ortega and Bowers, 1995; Pener *et al.*, 1997) who stated that high doses of fenoxycarb on grasshopper nymphs lead to death in the next moult, and the less effective application resulted in imperfect adults with curled wings. Also, it was observed that the morphogenetic deformations in *L. migratoria migratorioides* were dose dependent and increased with higher doses (Othman and Schmidt, 1998).

The suppression of the reproductive potential of the resulting adult females in the present study is in concert with those of Abdel-Fattah *et al.* (2003) and El-Dydamony (2011). This suppression, can be due to the negative effect of fenoxycarb on haemolymph protein contents in the adult female of *S. gregaria* (El-Gammal *et al.,* 1989). Moreover, it is well established that fenoxycarb causes a reduction in volume of the follicle cells of *L. migratoria*. It may be happened in the resulting adult females of the present study. The early and latent effects of fenoxycarb in the present study confirmed that this juvenile hormone analogue can be recommended as a promising control tool against the nymphal instars of *E. plorans plorans* under field conditions.

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## تأثير مشابه هرمون الحداثة فينوكسىكارب على بعض المظاهر البيولوجية لنطاط البرسيم العادى

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تم دراسة تأثيرات مشابه هرمون الحداثة فينوكسىكارب على بعض المظاهر البيولوجية لحشرة نطاط البرسيم العادى حيث أنه تم معاملة حوريات العمر الثالث بثلاث جرعات ٢٥، ٥٠ و ١٠٠ ميكروليتر/حورية وتم إجراء عمليات التزاوج بين الحشرات الكاملة الناتجة من هذه المعاملات بطريقتين. الطريقة الأولى فيها تم تزاوج بين الذكور والإناث الناتجة من حوريات معاملة بالجرعات الثلاث مع حشرات كاملة ناتجة من حوريات غير معاملة سواء ذكور أو إناث. فى الطريقة الثانية تم التزاوج بين الذكور والإناث المعاملة بالجرعات الثلاث مع بعضهم. أوضحت النتائج أن الجرعة المنخفضة ٢٥ ميكروجرام/ حوريه كانت أكثر تأثيراً من الجرعة العالية ضد الأعمار الحورية التالية للعمر الثالث، حيث أطالت هذه الجرعة فترات حياه الحوريات للأعمار الثالث والرابع والخامس، كما أطالت فترة وضع البيض للحشرات الكاملة الناتجة، إتضح أن عملية التزاوج بين الذكور والاناث المعاملة قد خفضت من الأعداد الناتجة لكل من كتل البيض وعدد البيض الذى تضعه الأنثى وعدد البيض الفاقس من كل كتلة والكفاءة التناسلية لهذه الإناث. لا توجد فروق واضحة بين تلك الجرعات المختلفة فى خفض الكفاءة التناسلية. يعتبر استخدام هذا المركب حقلياً كطريقة واعدة لمكافحة هذه الآفة من وجهة النظر العملية.