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RESEARCH ARTICLE

# Effect of Juvenoid and Fenoxycarb on different Growth Stages of Sunn Pest under Laboratory Conditions

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**ABSTRACT**

Sunn pest (*Eurygaster integriceps* Put.) is one of the most important wheat pests that feed on the leaf, stem and seed of cereals and reduce the quantities and quality of crops. The aim of this study is using the nature based materials with minimum effect on non-target insects. In this study effects of Juvenoid, Fenoxycarb, were examined on third and fifth instar nymph, male and female adults and diapausing and out of diapausing adults of this pest. Meanwhile, different concentrations of Fenoxycarb examined as juvenoid to determine oviposition and creation of shriveled eggs of adult sunn pest. Fenoxycarb was diluted with acetone and control treated with acetone alone. $LC_{50}$ values of Fenoxycarb were found to be 33.10 and 37.16 ppm on third and fifth instars, 59.61 and 62.89 ppm on active male and female adults and 31.49 and 33.46 ppm on inactive male and female adults, respectively. Results showed that Fenoxycarb increase oviposition and creation of shriveled egg and also with increasing the concentration the rate of shriveled egg increased. For this purpose the number of adults exposed to different treatments of Fenoxycarb until the end of experiment. Concentrations were used 5000, 2700, 1500, 800 and 500 ppm and control (pure substance in water). Considering the mentioned lethal concentration and impacts of Fenoxycarb on oviposition of female insects we may be able to use this method for chemical control of sunn pest integrated with biologic control.

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## INTRODUCTION

Wheat as a main food of human societies and it's strategically roles is very important and obviously recognition of limiting factors in wheat production is needed to economic production of this crop. Sunn pest, *E. integriceps*, is the most important pest of wheat and barley in central and West Asia and also Eastern Europe countries. Sunn pest is an oligophagous insect that feeds on annually Gramineae plants but prefer wheat and barley to other grasses (Khodahemmati, 2011). Overwintering adults after establishing in the fields, mate and generate new individuals, that feeding on different phonological stages of wheat, reduce the quantity and quality of grains (Rajabi, 2000). Damage due to adults and new generation is estimated to be 20-30% in barley and by 50-90% in wheat (Malipatil, 2008) and sometimes the damage reach to 100 percent (Panov, 1970).

Therefore, low-risk control methods have to be used against sunn pest. One of the control methods which have been discussed in recent years is using the growth regulators. One of these growth regulators are juvenile hormone analogues (Zarnegar, 2006). Juvenile hormone in insects is produced by Corpora allata and its main function is controlling reproductive processes, molting and metamorphosis. Not only it is not toxic to insect in normal mode but in appropriate rate plays important role in the natural growth mechanism, metamorphosis and reproduction of insect.

Therefore, changes in hormone rate causes disorders in insect's physiology and behavior, which ultimately cause the death (Engelman, 2002). First Williams in 1956 examined the juvenoid effect and since then the other researchers used these compounds to control pests. In fact Juvenile hormone analogues act as insect juvenile hormone in the insect's body, and mimic all the activities of the juvenile hormone (Retnakaran *et al.*, 1985) and even some of these analogs are more active than natural juvenile hormone (Dhadialla, 2005). One juvenile hormone analogues is Fenoxycarb compound. Unusually

Fenoxycarb have the half-carbamate effect but not showing symptoms and toxicity of carbamates (Dhadialla, 2005). This compound is highly toxic to pests and affect through contact and ingestion. This compound has ovicidal and larvicidal effects for different species of insects. Having property of ovicidal prevent the metamorphosis and leads to morality of larvae and pupae in the last stage. Fenoxycarb is safe for beneficial insects in the field conditions (Talebi, 2007). Zarnegar (1995) reported that pyriproxyfen caused sterilize of adults out of diapause of Sunn pest. Based on the above research, the best time to use semi juvenile hormone on sunn pest is early fifth instar nymphal stage to complete stage (Zarnegar, 1995). The effect of pyriproxyfen on immature stage of Sunn pest showed that this compound is effective on sex ratio, survival and reaching to the nymph's maturity and can cause weight loss in their adults but is not effective on their growth (Mojaver, 2010). Rae Cho *et al*. (2005) reported that Fenoxycarb led to increases female ovulation in *Scotinophara luridas* but had no effect on the eggs developmental period.

Effects of Fenoxycarb on the different growth stage of sunn pest may be able to improve the control of this pest and enhance the efficiency coefficient of non-chemical control methods on this pest.

## MATERIALS AND METHODS

**Collecting and rearing of Sunn pest**

Adult sunn pests were collected from altitudes of Marvdasht-Shiraz (Green Mountain). Samples were collected in plastic sealed containers and stored in the laboratory. Adult sunn pests fed with Persian cultivar of wheat that had already been grown. The containers placed in an incubator with a temperature of 20°C until their oviposition and their eggs used for nymph rearing. Nymphs reared with dough stage wheat. Adult sunn pets and nymphs which used as treatments incubated at 25ºC, 60% relative humidity and 16 hours light and 8 h dark photoperiod.

**Bioassays**

**Lethal doses of fenoxycarb**

Since, according to the preliminary experiment, toxicity of Fenoxycarb against different stages of Sunn pest significantly differed, distinct concentrations were used. After preliminary tests high and low concentrations of Fenoxycarb determined and five concentrations were calculated for main experiments. The experiment was conducted with contact method and Fenoxycarb were used to ventral abdominal segments of different stages of Sunn pest. Adults and nymphs were treated individually with 2 µl concentrations of Fenoxycarb with a microapplicator. Amount of 2 µl acetone was applicated for the control treatment. Each treatment (dose) consisted of five replicates for adults and six replicate for nymphs at 20±2°C, 60±2% r.h and 16:8 LD photoperiods. Each replication consisted of 10 insect for different stage of nymphs and 18 insect for adults.

Determined concentrations in these experiments were: 100, 85, 65, 55 and 50 ppm against active females, 100, 75, 65, 50 and 40 ppm against active males, 22, 28, 37, 45 and 61 ppm against diapausing females and males and 100, 80, 50 and 30 ppm against third and fifth instars nymph. The number of dead insects was counted after 24 hrs of treatment. Insects were considered dead if couldn't move their appendages. Based on the mortality data obtained from different concentrations $LD_{50}$ were determined according to probit analysis using POLO-PC software.

**Sub lethal dose of fenoxycarb**

First of all Preliminary experiments conducted with the concentrations 5000, 500 and 50 ppm and considering to the amount of shriveled eggs for main experiment 5 concentrations estimated through fixed logarithmic formula betwean 5000 and 500 ppm because in concentrations of 50 ppm shriveled eggs were very low (5%). Main experiments conducted with immersing the green spike wheat for 5 minutes dipped into related solutions. Main experiment concentrations were 5000, 2700, 1500, 800, 500 and distilled water as control. Each treatment consisted of 10 insects (Male and Female). Each treatment replicated four times. The data were subjected to analysis of variance (Complete randomized design) and means compared with the Tukey test.

## RESULTS

The results of toxicity of Fenoxycarb against different stages of Sunn pest are presented in Table 1, 2 and 3. Results show that $LC_{50}$ values of Fenoxycarb were found to be 33.10 and 37.16 ppm on third and fifth instars, 59.61 and 62.89 ppm on active male and female adults and 31.49 and 33.46 ppm on inactive male and female adults of Sunn pest, respectively.

Sub lethal dose experiment conducted in a randomized complete design using granular formulation of Fenoxycarb. According to the Analysis of variance table the number of dead male and females and their mortality percent in different concentrations had no significant difference while the number eggs of female and Wrinkles eggs and mean number of Wrinkles eggs were significant at 1% level of probability which implies to the great impact of concentrations. According to the comparison of Fenoxycarb different concentrations table the highest average egg and the highest mean number of Wrinkles eggs were 71.31 and 61.51 respectively in a concentration of 5000 ppm and the number of dead in males and females at various concentrations had no significantly difference but male's mortality percent was higher than females. According to results the most sensitive developmental stage of sunn pests concerns to the male in diapause with $LD_{50}$=33.105 and the most resistant developmental stage of sunn pests concerns to active adult females with $LD_{50}$= 62.890.

## DISCUSSION

Applying insecticides such as Fenitrotion and Deltamethrine is the only control approach to prevent Sunn pest damages. Undoubtedly these broad spectrum Insecticides have deleterious and destructive effects on natural enemies and whole environment. Using bio-rational insecticides is a logical strategy to avoid such environmental interferences. Recently an attempt was

**Table 1:** Estimated $LD_{50}$ of Fenoxycarb against developmental stage of Sunn pest

| Developmental Stage | $LD_{50}$ (PPM) | Confidence limit 95% | | Slope ±SE | T ratio | Chi-square |
|---|---|---|---|---|---|---|
| | | Lower | Upper | | | |
| Active female | 62.89 | 56.16 | 69.16 | 6.731±0.65 | 10.24 | 2.74 |
| Active male | 59.61 | 52.53 | 66.65 | 2.205±0.36 | 6.04 | 3.84 |
| Third nymph | 33.10 | 12.61 | 37.92 | 2.205±0.36 | 6.04 | 3.84 |
| Fifth nymph | 37.16 | 19.67 | 58.01 | 2.059±0.27 | 7.55 | 2.70 |
| Inactive female | 33.46 | 31.33 | 35.56 | 5.251±0.51 | 10.14 | 2.94 |
| Inactive male | 31.49 | 27.36 | 35.24 | 5.098±0.50 | 10.11 | 2.91 |

**Table 2:** Analysis of variance for the effect of Fenoxycarb against developmental stages of Sunn pest

| Parameter | Variables | Df | Sum of Square | Mean of Square | F |
|---|---|---|---|---|---|
| Dead female (number) | concentration | 5 | 0.70 | 0.14 | 0.40ns |
| | error | 18 | 6.25 | 0.34 | |
| Dead male(number) | concentration | 5 | 3.00 | 0.60 | 0.982ns |
| | error | 18 | 11.00 | 0.61 | |
| Egg number | concentration | 5 | 74700.21 | 14940.01 | 25.76** |
| | error | 18 | 10437.82 | 579.93 | |
| Number of wrinkle eggs | concentration | 5 | 253650.31 | 50730.21 | 120.92** |
| | error | 18 | 7551.52 | 419.53 | |
| Mean number of eggs | concentration | 5 | 2988.04 | 597/66 | 25.764** |
| | error | 18 | 417.57 | 23.22 | |
| Mean wrinkle eggs number | Concentration | 5 | 10146.06 | 2029.27 | 120.92** |
| | error | 18 | 302.11 | 16.85 | |
| Female mortality (%) | concentration | 5 | 283/33 | 56.66 | 0.408 ns |
| | Error | 18 | 2500.00 | 138.88 | |
| Male mortality (%) | Concentration | 5 | 1200.00 | 240.00 | 0.982 ns |
| | Error | 18 | 4400.01 | 244.44 | |

ns not significantly different; ** Significantly different at 1%

**Table 3:** The effect of different concentrations of Fenoxycarb against adult of Sunn pest

| Concentration | Dead female number | Dead male number | Female egg number | Mean wrinkle eggs number | Mean number of eggs | Female mortality (%) | Male mortality (%) | Mean wrinkle eggs |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.51a | 1a | 243.53bc | 0e | 48.76bc | 10a | 20a | 0e |
| 500 | 0.75a | 0.75a | 190.51c | 78.25d | 38.12c | 15a | 15a | 15.65c |
| 800 | 1a | 0.75a | 228.75bc | 133.54c | 45.75bc | 20a | 15a | 26.71bc |
| 1500 | 0.75a | 1.75a | 260.51b | 174c | 52.13b | 15a | 35a | 34.87b |
| 2700 | 0.75a | 0.75a | 319.53a | 252.25b | 63.98a | 15a | 15a | 50.45a |
| 5000 | 0.52a | 1a | 356.51a | 307.53a | 71.31a | 10a | 20a | 61.51a |

done to substitute a more safe insecticide Pyriproxyfen (Zarnegar and Noori, 2005) but results show that it was expensive so the cost of pyriproxyfen per ha is 10 times of Deltamethrin. Also using this juvenoid against immature stages, leave Sunn pest nymphes alive and destructive until adult emergence. Our experiments suggest an alternative application of these juvenoids aiming on adult stage in spring.

Related to the acute toxicity of Fenoxycarb the results indicated that the most sensitive developmental stage of Sunn pest concerns to the males in diapause with LD50= 33.105 and the most resistant stage of Sunn pest concerns to the Sunn pests active adult females LD50= 62.890. According to (Khodahematy *et al.,* 2011), Fenoxycarb LD50 for inactive adult males and females (in diapause) of sunn pest was 29.626 and 31.634, respectively and also reported that this analogue cause the termination of diapause. Comparing these results with the results of our study indicate that the determined contact toxicity is very close together. Although fenoxycarb has leathal effects on the adults but in field conditions it seems that the needed dose to kill the pest may not to be economic. On the other hand the results of this study show that sub-lethal doses of granular Fenoxycarb (Insegar®) increases the egg number laid by adult sunn pest but majority of them desiccated before hatching with the highest mean wrinkled eggs was near to 61%. According to (Zarnegar and Noori, 2005) increasing the Pyriproxyfen dosage on the active sunn pests reduced oviposition rates of treated adults while increased oviposition rates of sunn pest in diapause. Furthermore the effect of this juvenile hormone analogue on fifth instar nymphs disrupts insect metamorphosis process causing abnormal adults which were not capable of flight and mating. (Mojaver *et al.,* 2010) reports that Pyriproxyfen had significant ovicidal effects on eggs so that hatchability percent in 1 to 3 days old eggs were significantly reduced. In our experiments adults were exposed to the treated surfaces only three days, whereas we expect in field conditions, exposure time might be extended thus lower doses can be effective. Thus it is apparent that applying Fenoxycarb against adults in spring is promising also some considerations must be noted. First the timing of application must be evaluated in the field because spraying the insecticide must be done before oviposition onset. Also before any recommendation the effect of fenoxycarb on natural enemies especially *Trisolcuss* spp. and other none target insects must be studied.

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