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RESEARCH ARTICLE

# Evaluation of Post Embryonic Development in *Antigastra catalaunalis* Duponchel under Stress of Insect Growth regulators

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## ABSTRACT

*A perusal of the literature shows that the efficacy of the fourth generation insecticides depends upon the mode of their entry, and stage of the life-cycle to which these are applied. Some are more effective when applied to adults or larvae by feeding method than when applied to adults or larvae by residue film method.*
***Key words**: Novaluron, Chlorfluazuron, Post embryonic development*

## INTRODUCTION

The insect growth regulators induce variable biological effects: these are not equally or identically effective, some are more effective than others in the same species and their influence may be sex oriented. Different species exhibit different response to the same fourth generation insecticides. When these chemicals applied carelessly, they damage ecological conditions. These chemical insecticides may result in acute and long terms effects including sickness and death of people, useful animals and destruction of crops. Even when properly used, they may cause harmful effects on man's health and well beings. Such problems forced the economic entomologists to proceed further in search of safer insecticides to control the different crop pests.

Economic entomologists continued their efforts to control this pest. They discover some new range of chemicals as alternative control measures. They used chemosterilants, juvenile hormones, pheromones, etc. as well as their analogs and repellents. Pandy (1976); Dhawan (1991) found chemostgerilants (Tepa, Metepa, Thiotepa etc.) were effective to control this polyphagous pest. According to findings of these workers, chemosterilants fit well in decreasing the population of *P. ricini* below the economic threshold by reducing their birth rates than by increasing their death rates. But they involved very much cost as compared to other insecticides and desired success could not be achieved.

## MATERIALS AND METHODS

**Test Insect:** *Antigartra catalaunalis* Duponchel

**Systematic Position:**

- Phylum-Arthropoda
- Class-Insecta
- Order-Lepidoptera
- Family-Pyralidae
- Genus-*Antigastra*

**SOURCES:**

Male and Female, *Antigastra catalaunalis* Dup. were collected in second week of July, 2009 from sesame field. Their large population and swarms may be seen during rainy season (July-September). To collect the larvae the sesame crop was inspected time to time.

**LABORATORY STOCK OF THE INSECT:**

The insect was reared and maintained in the laboratory in order to ensure regular supply of the insect and its developmental stages during whole tenure of the present investigation as described below. To begin with, the stock was established with the help of field collected moths. These moths were maintained on 10 per cent sugar solution in glass chimneys with tender sesame leaves (*Sesamum indicum*). Eggs obtained from them were kept as such for hatching. Larvae hatched from eggs were transferred on tender sesame leaves in petridishes (15 cm dia) and reared on them till pupation. The food supply to larvae was renewed twice a day in view of evaporation of water, which proceeds fast when leaves are detached from plants. The sesame leaves were treated with $KM_nO_4$ solution for five minutes followed by washing in running water. These leaves were dried under shade and provided to the experimental larvae. The larval period lasted for about 15.25 days. All possible precautions were taken to save larvae from bacterial and fungal infections. The first and second instars were reared in pertidishes but from third instar to pupations they were reared in pneumatic troughs (25 cm dia.) in small groups. When larvae acquired full growth and stopped feeding, they were transferred in separate pneumatic troughs having 6 inches thick moist soil layer on their bottoms. The larvae pupated in leaves made coverings. Pupae, thus obtained were kept as such for eclosion. Moths emerged from pupae were reared in pneumatic troughs as described above. In this way the progeny of moths of succeeding generations were reared generation after generation continuously till the tenure of the investigation. The laboratory reared insects and larvae were maintained throughout the tenure of investigation into the Department of Zoology, D.V. (P.G.) College, Orai, Jalaun by the technique described above with slight modifications as when found necessary.

**INSECT GROWTH REGULATORS USED AND APPLICATION:**

The following fourth generation insecticides whose efficacy as insecticides has already been proved in different crop pests employed against *Antigastra catalaunalis* in this investigation- Novaluron and Chlorfluazuron

The different concentrations of insect growth regulators mentioned above were applied against *A. catalaunalis*. The concentrations considered in this work included 0.0001, 0.001, 0.01, 0.10, 0.50 and 1.00 per cent. These concentrations were obtained by dissolving the desired quantity of insect growth regulator in acetone or methanol.

The insect was treated with different concentrations of insect growth regulators used in this investigation by two methods namely- Adult feeding method and Residue film method. Details of both methods are mentioned below:

**(I) RESIDUE FILM METHOD (RFM):**

In this method of treatment 1 to 2hr old adults were exposes to a thin film of residue of a concentration of a particular insect growth regulator. For obtaining the thin film of the chemical as residue, about 10 ml of a concentration of a chemical was poured in a petridish (10 cm dia.) and the petridish was tilted in different ways to spread the chemical on the whole floor area of the petridish and its raised periphery. Thereafter, the petridish was kept in the air for the evaporation of the solvent. This led to the formation of a thin film of a concentration of a insect growth regulator in the petridish as residue. Adults were left in petridishes having thin film of the insect growth regulator for 24 hours. The petridishes were covered by thin muslin cloth to prevent the escape of the adults. Such treated adults were employed in the different experiments as described later on. This method of treatment will be designated as RFM in the text from here onwards.

**(II) ADULT FEEDING METHOD (AFM):**

In this method of treatment a concentration of a particular insect growth regulator was mixed in 20 per cent sugar solution which was supplied to adults for feeding. From here onwards this method of treatment will be referred as AFM in the text.

The embryonic develpoment is determined as per standard laboratory methods and guidelines. The data obtained from the studies were subjected to statistical analysis. Various statistical techniques mentioned below have been applied to study the nature and relationship between

variables to know the reliability and precision test the significant difference between the observed and corresponding expected values and to predict the estimated values of effectiveness for a given value of concentration.

## RESULTS AND DISCUSSION

**Effect of Novaluron on Post-Embryonic Development of *Antigastra catalaunalis* under A.F.M.:**

The larvae of the adults of the untreated parents had considerably more survival (82.36%) as compared those of the adults treated earlier with any concentration of the novaluron (P<.01). In response to treatment of parent moths by feeding method, the survival of the larvae varied from 30.33 to 66.66 per cent decreasing with the increasing concentrations of the insecticide. But according to the statistical analysis, the percentage of the survival depended on the strength of the insecticide from 0.0001 to 0.50 per cent and the effect of the 1.00 per cent concentration was not statistically different from that of the 0.50 per cent (P<0.5). Further, the duration of the larvae in response to non- treatment of their adults was just 15 days, whereas this duration varied from 18.24 to 36.72 days in response to the earlier treated adults (parents) with different concentrations of this insecticide, appearing to increase with the increasing concentration. However, as per statistical analysis, concentration from 0.0001% to 0.10% did not influence the larval period differently (P<.05) but 0.50% and 1.00% concentration delayed the larval development considerably as compared any concentration from 0.001% to 0.10% and the latter of the two caused more delay (P<0.01).

The moths, not treated earlier exhibited 100 per cent emergence, whereas that treated at the same stage with any strength of the novaluron had far reduced emergence (P<0.01). In response to parent moth's treatment by feeding method with the different concentrations of this insect growth regulator, the emergence, varying from 16.66 to 60 per cent, tending to decrease with increasing concentration of used insect growth regulator, differed significantly with the strength of this fourth generation insecticide (P<0.01). Further, the duration of the pupa of the untreated parent moths (11.65 days) was considerably shorter than that of the pupa of the earlier treated parent moth's with any concentration of the novaluron (12.25 days to 29.68 days) (P<0.01).

The net mortality under the adult feeding treatment varied from 52 to 94 per cent increasing with the advancing concentration and the $x^2$ test detected it to depend on the concentration (P<0.05).

The male adults obtained from the untreated parent moths had life-span more as compared the male adult obtained from the treated parent moths with any concentration of the novaluron and this fact was applicable to the female adult also (P<0.05). The longevity of the male adult, varying from 3.44 to 9.48 days and that of the female adult, varying from 4.38 to 12.48 days, tended to decrease with the increase in the concentration of the insecticide. However, the statistical analysis revealed that 0.0001% and 0.001% concentrations, inducing more longevity in the both sexes as compared any of the remaining concentrations, behaved identically in affecting the life of either sex differed with the concentrations from 0.01% to 1.00% (P<0.05).

**Effect of Novaluron on Post-Embryonic Development of *Antigastra catalaunalis* under R.F.M.**:

The larva of the parents treated with residue film of any strength of the novaluron acquired lesser survival than the larva whose parents remained untreated (P<.05). In response to parents' treatment with the residue films of this insecticide, the percentage of pupation, varying from 33.33 to 70.00 per cent and decreasing with the advancing concentration depended on the concentration (P<0.005) and the duration of the larva, being prolonged with the residue film of any concentration of this insect growth regulator as compared the non-treatment condition (Anova, P<0.05), varying from 18.44 to 36.34 days in response to residue films of different strengths and prolonging with the rise in the strength level, also differ with the concentration level of the novaluron (Anova, P<0.05). Further, the parents' treatment with the residue film of any concentration of this insecticide affected the percentage of the emergence (P<0.05) which

varying from 20 to 66.67 per cent among residue film of different concentrations and tending to fall with the rise in the strength of the residue film, was found to depend on the concentration of the residue film applied to the parents (Anova, P<0.05). The pupal duration with the 0.0001 per cent concentration was not more as compared that under the non-treatment condition (P>0.05) but the residue film of any other concentration prolonged this condition (P<0.05). As regards the influence of the residue film of different concentrations (0.001% to 1.00%) on the pupal period, it varying from 13.50 to 27.05 days and increasing with the rising concentration level, differed significantly from concentration to concentration (P<0.05).

The adult male progeny of the untreated parents had more longevity as compared that of the parents treated with the residue film of any concentration of the novaluron (Anova, P<0.05). The longevity of the adult male progeny, in response to treatment of its progenitor adults with the residue films of different concentrations of this insecticide varying from 5 to 9.76 days and declining with the advancing concentration, depended on the concentration of the novaluron (P<0.05). In case of female adult's longevity barring 0.0001% the remaining residue films of different concentrations caused reduction in the longevity (P<0.05) and it was affected differently by the residue films of different strengths (Anova, P<0.05), decreasing with the increase in the strength of the residue film of this insect growth regulator.

**Effect of Chlorfluazuron on Post-Embryonic Development of *Antigastra catalaunalis* under A.F.M.**:

Any concentration of the Chlorfluazuron except 0.0001 per cent applied earlier to the parent moths by feeding method reduced the larval survival and delayed the pupation as compared the untreated condition of parent moths (P<0.05). The larval survival, varying from 45.00 to 72.66 per cent among different concentrations from 0.001% to 1.00 per cent and appearing to be indirectly proportional to them, was affected differently by different concentrations of chlorfluazuron (P<0.05). Further, the larval period, varying from 16.56 to 23.56 days and prolonging with the advancing concentration of the chlorfluazuron, differed from concentration to concentrations applied earlier to the parent moths (P<0.05).

Under A.F.M., the emergence was curtailed significantly by any concentration of the chlorfluazuron (P<0.05) and the pupal period was also prolonged significantly by any concentration of this insecticide other than 0.0001 per cent (Anova, P<0.05). In the concentration range of 0.001% to 1.00 per cent chlorfluazuron, the emergence, varying from 30.76 to 66.00 per cent and tending to decrease with the increasing concentration, differed from concentration to concentration significantly and like wise, the pupal period varying from 12.20 to 20.66 days among concentrations from 0.0001% to 1.00 per cent also depended on these concentrations but it exhibited the direct proportionality to the concentration of the chlorfluazuron under adult feeding treatment.

In response to the different concentrations of the chlorfluazuron applied earlier to parent moths, the net mortality varying from 34.00 to 84.00 per cent and increasing with the advancing concentration, differed significantly from concentration to concentration (P<0.05).

The treatment of the parent moths with any concentration of the chlorfluazuron curtailed the longevity of progeny male adults (P<0.05). The concentrations from 0.0001% and 0.001% affected the life-span of male but other concentrations of the chlorfluazuron among which the longevity of the male varied from 5.46 to 9.78 days, affected it differently (P<0.05), causing progressive reduction. Barring the concentrations 0.0001% and 0.001% any other concentration of the chlorfluazuron applied to parent pupae reduced the longevity of the progeny female adults (P<0.05) which exhibited indirect proportionality to the concentration of the chlorfluazuron.

**Effect of Chlorfluazuron on Post-Embryonic Development of *Antigastra catalaunalis* under R.F.M.**:

Except 0.0001% residue film, the residue films of other strengths of the chlorfluazuron reduced larval survival significantly (P<0.05). As regards the influence of residue films of the effective concentrations of this insect growth regulator on the pupation, these concentrations affected

the larval survival differently (P<0.05) and the pupation declined with the advancing concentrations of the residue film of chlorfluazuron. The residue film of any concentration of the chlorfluazuron prolonged the larval stage. The larval period, varying from 16.28 to 24.00 days and prolonging with the increasing concentration of the residue film depended significantly on the residue film of different concentrations of the chlorfluazuron (P<0.05).

**Table 1:** Effect of Novaluron on post-embryonic development in *Antigastra catalaunalis* Dup. at different concentrations under different modes of treatment

| (Values are means ± S.E.) | | | | | |
|---|---|---|---|---|---|
| **Mode of treatment** | **Concentration %** | **Pupation (%)** | **Larval Pd. (days)** | **Emergence (%)** | **Pupal pd. (days)** |
| | .0001 | 66.66 | 18.24±0.82 | 60.00 | 12.25±0.36 |
| | .001 | 56.56 | 18.92±0.45 | 32.35 | 13.93±0.42 |
| **AFM** | .01 | 45.00 | 19.23±0.84 | 29.63 | 1578±028 |
| | .10 | 36.36 | 19.42±0.43 | 27.27 | 19.46±0.32 |
| | .50 | 31.36 | 28.42±0.73 | 21.05 | 24.60±0.60 |
| | 1.00 | 30.33 | 36.72±1.44 | 16.66 | 29.72±0.88 |
| | .0001 | 70.00 | 18.44±0.25 | 66.67 | 12.00±0.18 |
| | .001 | 58.33 | 19.14±0.24 | 34.29 | 13.50±0.26 |
| | .01 | 48.33 | 20.25±0.24 | 34.48 | 14.66±0.31 |
| **RFM** | .10 | 40.00 | 21.32.0.15 | 29.17 | 18.72±0.36 |
| | .50 | 36.36 | 28.56±0.45 | 27.27 | 23.46±0.32 |
| | 1.00 | 33.33 | 36.34±0.32 | 20.00 | 27.05±0.21 |
| | Control | 82.36 | 15.00±0.34 | 100.00 | 11.65±0.24 |

**Table 2:** Effect of Chlorfluazuron on post-embroyonic development in *Antigastra catalaunalis* Dup. at different concentrations under different modes of treatment

| (Values are means ± S.E.) | | | | | |
|---|---|---|---|---|---|
| **Mode of treatment** | **Concentration %** | **Pupa (%)** | **Larval Pd. (days)** | **Emergence (%)** | **Pupal pd. (days)** |
| | .0001 | 82.33 | 16.56±0.24 | 66.00 | 12.20±012 |
| | .001 | 72.66 | 17.30±0.28 | 62.79 | 12.36±016 |
| **AFM** | .01 | 65.00 | 18.42±0.16 | 56.41 | 13.38±0.10 |
| | .10 | 58.33 | 20.00±0.34 | 45.71 | 14.66±0.26 |
| | .50 | 50.00 | 21.20±0.24 | 40.00 | 17.66±0.32 |
| | 1.00 | 45.00 | 23.65±0.28 | 30.76 | 20.66±0.44 |
| | .0001 | 81.34 | 16.28±0.28 | 68.00 | 11.66±0.10 |
| | .001 | 76.66 | 17.10±0.22 | 63.33 | 12.33±0.30 |
| | .01 | 65.00 | 17.90±0.26 | 53.33 | 13.00±0.30 |
| **RFM** | .10 | 58.33 | 17.90±0.26 | 48.57 | 14.24±0.18 |
| | .50 | 56.66 | 20.80±0.36 | 41.18 | 17.33±0.32 |
| | 1.00 | 46.00 | 24.00±0.42 | 33.33 | 19.27±0.42 |
| | Control | 82.36 | 15.00±0.34 | 100.00 | 11.65±0.21 |

Barring 0.0001 per cent concentration, the residue film of any of the other concentrations prolonged the duration of the pupa (P<0.05). Among the residue films of different effective concentrations, the pupal period, varying from 12.33 to 19.27 days and prolonging with the increasing strength, differed significantly with these concentrations (P<0.05). The residue film

of every concentration reduced the emergence (P<0.05) which varying from 33.33 to 68.00% among different strengths and prolonging with the advancing concentration was detected to differ with residue films of different concentrations of the chlorfluazuron (P<0.05) (Table-8).
The net mortality, varying from 32.00 to 82.00 per cent, among residue films of different concentrations of the chlorfluazuron and decreasing with the increasing concentration, was found to be dependent on the concentration of the residue film as per chi-square test (P<0.05).
Every concentration of the chlorfluazuron applied as residue film to the adult reduced the life-span of both male and female adults (P<0.05). As regards the influence of different concentrations of the chlorfluazuron as residue films on the longevity of adults, it varying from 6.66 to 10.43 days in male and from 6.94 to 13.82 days in female and declining with the advancing concentration, differently with the concentration of the residue film (P<0.05).

**Fig.1:** Effect of Novaluron on post-embroyonic development in *Antigastra catalaunalis* Dup. at different concentrations under both modes of treatment

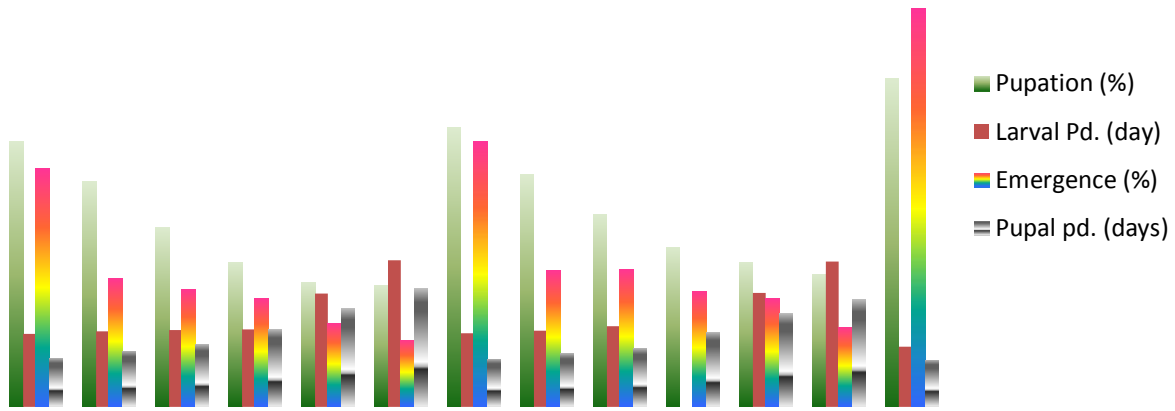
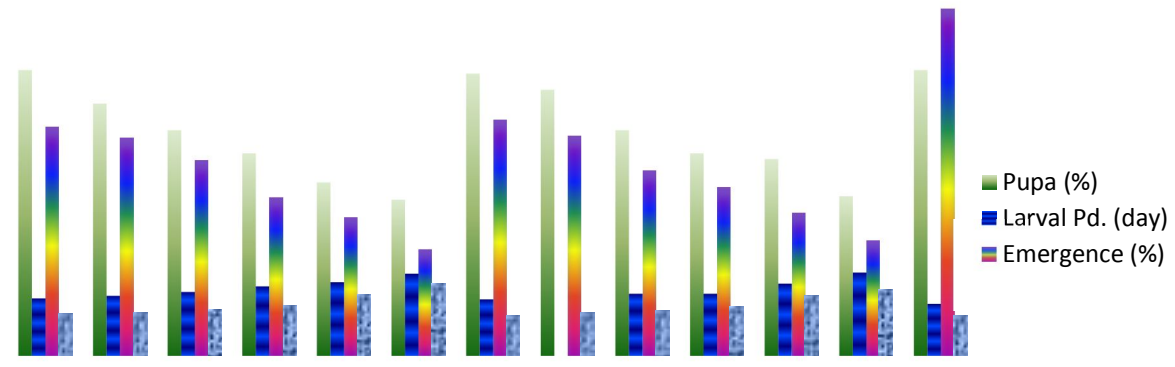



**Fig. 2:** Effect of Chlorfluazuron on post-embroyonic development in *Antigastra catalaunalis* Dup.at different concentrations under both modes of treatment




Both fourth generation insecticides, screened against *Antigastra catalaunalis* when applied to young stage are effective in causing sterility even at their lowest concentration in this insect. These induce sterility by reducing the fecundity by decreasing the viability of eggs laid by a female. The related results in the context of novaluron reveal that the fecundity decreases with

increase in the concentration; however, concentrations from 0.0001 to 0.01 per cent reduce the fecundity identically. The results also show that under the influence of novaluron, fertility decreases distinctly with the advancing concentration and the data pertaining to the per cent reduction in fecundity and per cent net sterility confirm the above facts. Under adult feeding method of application, in case of the chlorfluazuron, reduction in the number of eggs laid by a female and the hatchability of laid eggs are distinctly concentrations dependent; these decrease with the increasing concentrations of insect growth regulators. This trend is clearly witnessed by the data on per cent reduction in fecundity and the percent net sterility. Under the adult feeding method at one per cent concentration novaluron induce about more than 29-33 per cent net sterility whereas at one per cent concentration, the chlorfluazuron induce about 45 to 46 per cent net sterility. On the basis of their sterility inducing efficiency under the adult feeding method, the both insect growth regulators screened against *Antigastra catalaunalis* may be arranged as novaluron and (63.41%), Chlorfluazuron (57.25%) in descending order. Both insect growth regulators are found more effective under the adult feeding method of treatment. However, contrary to our findings, Knapp and Herald (1983) reported that the pupal stage is not a suitable stage in fruit flies for successful sterilization because a very high concentration of the insect growth regulator (up to 40% or more) is required for complete sterilization of the female flies. Reports are also available in the literature that the lepidopterous insects, in general, respond poorly to sterilizing action of the insect growth regulators (Hull and Biddinger, 1997; Cloyd, 2003). Contrary to this, as per results of this investigation, *Antigastra catalaunalis*, a lepidopterous insect, responds fairly well at one per cent concentration of the insect growth regulator applied as adult feeding treatment. At one per cent concentration the used insecticides induce more than 50 per cent sterility.

Besides, the above mentioned aspects of the reproduction in *Antigastra catalaunalis* the insect growth regulators applied through the adult feeding method also effect the preoviposition and ovi-position period. The preoviposition period prolong even with 0.0001 per cent concentration of both used fourth generation insecticides. This fact suggests that a fourth generation insecticide delays the sexual maturity in *Antigastra catalaunalis*. In this insect the delay in sexual maturity increases with increasing concentrations of the both fourth generation insecticides. In context of the delay in sexual maturity, considering influence of one per cent concentration, the both fourth generation insecticides may be arranged as novaluron, and chlorfluazuron in descending sequence. Like the preoviposition period, when applied through adult feeding method both insecticides even at its lowest concentration (0.0001%) affects the oviposition period too and this period decreases with the increasing concentration. Since the decreased ovipoisition period is associated with decreased fecundity, this fact suggests that both insecticides retard or inhibit the oviposition in this investigation.

Under the above mentioned methods of treatment, both of the screened insect growth regulators have potential to increase the incubation period but in this respect, the effective concentration is dependent on the kind of the insecticide. In case of chlorfluazuron, the concentrations from 0.0001 to 1.00 per cent do not exert influence on the incubation period. In case of both fourth generation insecticides the concentrations above the effective concentration cause proportionate increase in the incubation period depending on their strength. The above facts suggest that the insect growth regulators lower the speed of the embryonic development which becomes more and slower with the progressive increase in the strength of the insecticide.

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