Efficacy of cypermethrin, deltamethrin and nimbicidine on fecundity and egg viability of *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae)

R. Khatun, W. Islam and K.A.M.S.H. Mondal
Institute of Biological Sciences, University of Rajshahi, Rajshahi, Bangladesh

Abstract: Fecundity and egg viability of *Tribolium castaneum* (Herbst) females were significantly (P<0.01) reduced by synthetic pyrethroids and an alkaloid containing insecticide nimbicidine. In control, the average number of eggs laid by each female/day was 12.18. The lowest number of eggs laid by each female/day was noted as 4.38 when combining nimbicidine with two pyrethroids i.e., cypermethrin and deltamethrin. The percentage of egg hatching without insecticide treatment was 95%. The lowest percent of egg hatching was 63.95 when the adult female was fed on flour medium treated with combined doses of cypermethrin, deltamethrin and nimbicidine. Among the treated insecticides, nimbicidine (80.69%) proved effective in reducing the fertility than those of cypermethrin (86.05%) and deltamethrin (88.52%).

Key words: *Tribolium*, cypermethrin, deltamethrin, nimbicidine, fecundity, fertility

Introduction

Oviposition in *Tribolium* is influenced by different environmental factors including moisture, temperature (Park & Frank, 1948), relative humidity (Holdaway, 1932), flour medium (Khalequzzaman et al., 1994) and conditioning of the medium by the beetles living in it (Mondal & Port, 1985). A fertile female oviposits no eggs in the first 3 days but after that at an increasing rate upto 18 eggs per day (Ashford, 1970).


Viability of eggs also depends on different environmental factors such as temperature and relative humidity (Haque & Islam, 1978), food (Khan & Mazid, 1985; Khalequzzaman et al., 1994) and conditioning of food (Mondal, 1987).

Some conventional insecticides (Taher & Cutkomp, 1983; Amin, 2000; Hasnat, 2003), reduced the progeny production of *Tribolium* species.

Active ingredient, azadirachtin of neem plant exhibited profound effects on fertility of stored product insect pests including *Tribolium* spp. (Khanam, 2003).

However, there is meagre information on the effects of cypermethrin, deltamethrin and nimbicidine alone or in combinations on both fecundity and progeny production of *T. castaneum*. So, present study has been undertaken.

Materials and methods

**Fecundity**

*T. castaneum* adults were mass reared on fresh flour medium in a glass jar kept in an incubator at 30°C temperature without light and humidity control. After pupation, the pupae were collected by sieving the flour with a 500 micrometer sieve and sexed by microscopic examination of the exogenital process of the female pupae (Halstead, 1963). The male and female pupae were kept in the petri dish (9 cm diam.) and observed until the emergence of adults.

Ten days old adults of known sex were paired with one from each sex and twenty five such pairs were used for oviposition experiment. Each pair was kept in a glass vial (50×25 mm) containing 1g of food either treated or untreated (acetone only). The upper surface of vials were plugged with cotton wool. The vials were kept in an incubator at 30°C. Eggs were collected after every three days by sieving the flour media over a period of 45 days. The fresh food was supplied to each petri dish after every five days to avoid the conditioning of given food by the beetles themselves (Mondal & Port, 1985). The adults used in the experiments were all survivors - those adults which were alive and perfectly normal in external appearance on emergence from the pupae without any deformities (Ashford, 1970). The flour media treated with cypermethrin (0.5 ppm), deltamethrin (1ppm) and nimbicidine (6 ppm) individually and their different combinations were also used in the
The same procedure was maintained for each treatment.

Egg viability

The eggs laid by the first 15 pairs of *T. castaneum* from each treatment were selected for the source of eggs. Eggs were collected from 3rd to 45th days with equal interval of 3 days from introduction of each pair to the experimental tubes/vials. The collected eggs were then kept in separate petri dishes for each treatment and incubated at 30°C without light and humidity control.

Eggs were regularly observed with a microscope and hatched larvae were carefully separated using the method described by Mondal & Parween (1997). The percent of viability was calculated on the basis of the total number of first instar larvae that hatched from the number of eggs used (Mondal, 1987).

Results and Discussion

Fecundity

The results and statistical analyses are shown in Fig 1 and Table 1. The results were analyzed by Analysis of Variance and Duncan’s Multiple Range Test (DMRT).

Cypermethrin, deltamethrin and nimbicidine had significant (*P*<0.001) effects on reducing the fecundity of *T. castaneum* in comparison to that of the control.

The reduction of laying eggs in both cypermethrin and deltamethrin treatments is similar to the results of previous workers who reported that reduced fecundity in *Tribolium* was due to the effects of sub-lethal doses of DDT (Loschiavo, 1955; Taher & Cutkomp, 1983), pirimiphos-methyl (Mondal & Port, 1985; Rahman, 1992; Kamaruzzaman, 2000), lindane (Taher & Cutkomp, 1983) and deltamethrin (Hasnat, 2003).

![Fig 1. The average number of eggs laid by *T. castaneum* females at intervals of 3 days over a period of 45 days.](image)

Table 1. The average number of eggs laid by *T. castaneum* females reared on fresh medium (control) and medium treated with cypermethrin, deltamethrin and nimbicidine alone and their different combinations.

<table>
<thead>
<tr>
<th>Treatment (ppm)</th>
<th>Mean ± SE</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (untreated)</td>
<td>11.14 ± 0.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.38</td>
<td>12.98</td>
</tr>
<tr>
<td>Acetone (As solvent)</td>
<td>11.22 ± 0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.24</td>
<td>12.27</td>
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<tr>
<td>Cypermethrin (0.5ppm)</td>
<td>8.55 ± 0.09&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.80</td>
<td>9.27</td>
</tr>
<tr>
<td>Deltamethrin (1.0ppm)</td>
<td>8.64 ± 0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.91</td>
<td>9.02</td>
</tr>
<tr>
<td>Nimbicidine (6.0ppm)</td>
<td>8.24 ± 0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.58</td>
<td>8.62</td>
</tr>
<tr>
<td>Cypermethrin (0.5)+Deltamethrin (1.0)</td>
<td>7.03 ± 0.07&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.62</td>
<td>7.73</td>
</tr>
<tr>
<td>Cypermethrin (0.5)+Nimbicidine (6.0)</td>
<td>5.52 ± 0.07&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.18</td>
<td>6.27</td>
</tr>
<tr>
<td>Deltamethrin (1.0)+Nimbicidine (6.0)</td>
<td>7.24 ± 0.08&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.47</td>
<td>7.71</td>
</tr>
<tr>
<td>Cypermethrin (0.5) + Deltamethrin (1.0) + Nimbicidine (6.0)</td>
<td>4.71 ± 0.04&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4.33</td>
<td>5.02</td>
</tr>
</tbody>
</table>

Each experiment consists of 20 pairs (male: female = 1:1) and eggs collected at intervals of 3 days over a period of 45 days. Means followed by the same letters indicate no significant (*P*>0.05) difference in the number of eggs laid by female adults (Duncan, 1955).
It is evident that in both insecticides (synthetic pyrethroids) and nimbicidine (alkaloid) treatments, female laid few eggs at the beginning of the oviposition period and the numbers generally increased in course of time. But the rate of oviposition started to decrease after 30 days both in treatments and control (Fig 1). This might be due to prolonged period of feeding on treated medium affecting the metabolism of adult beetles which ultimately reduced the fecundity (Taher & Cutkomp, 1983).

**Egg viability**

The results and statistical analyses are presented in Table 2. All the treatments significantly (P<0.001) reduced the fertility of eggs laid by *T. castaneum* females in comparison to those of the control.

The reduced rate of hatching in *T. castaneum* in the present experiment due to the insecticides - cypermethrin and deltamethrin is similar to the findings of Mondal (1987). Rahman (1992) and Kamaruzzaman (2000) who reported significantly (P<0.05) reduced fertility of *Tribolium* due to the effect of organophosphorus insecticide, pirimiphos-methyl. Taher & Cutkomp (1983) also observed that both DDT and lindane significantly (P<0.05) reduced fertility of *T. confusum* in comparison to control.

<table>
<thead>
<tr>
<th>Table 2. The numbers and percentage to egg hatching in <em>T. castaneum</em> reared on fresh medium (control) and medium treated with cypermethrin, deltamethrin and nimbicidine alone and their different combinations.</th>
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<tr>
<td>Deltamethrin (1.0) + Nimbicidine (6.0)</td>
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<tr>
<td>Cypermethrin (0.5) + Deltamethrin (1.0) + Nimbicidine (6.0)</td>
</tr>
</tbody>
</table>

Each experiment consists of 20 pairs (male: female = 1:1) and eggs collected at intervals of 3 days over a period of 45 days. Figures followed by the same letters indicate no significant (P>0.05) difference in percentage of egg hatching (Duncan, 1955).

The reduced rate of egg hatching due to nimbicidine (azadirachtin) found in the present experiment is similar to the findings of Khanam & Talukder (1993) who reported the reduced fertility in *T. castaneum* and *T. confusum* due to botanicals like Bishkatali (*Polygonum hydropiper* L), Neem (*A. indica*), Nishinda (*Vitex negundo* L.) and Royna (*Aphanamixis polystachya* W. & A.). Both Neem leaf and seed extracts were also found to reduce the fertility of FSS-II and CTC-12 strains of *T. castaneum* significantly (P<0.05) in comparison to that of control (Khanom, 2004). Banu (2004) reported that azadirachtin declined the fertility of both *T. castaneum* and *T. confusum*. The fertility of *T. castaneum* was minimized due to Neem plant extract treatment (Mannan et al., 1993).

The present result confirms the assertion that the fertility of eggs in *Tribolium* depends on environmental factors including food media. In the present experiment, the fertility was found to decline after 24 days exposure of *T. castaneum* to the treated media (Table 2). This might be due to longer period of feeding on treated medium affecting the metabolism of adult beetles and creating bad odours which ultimately reduced the fertility (Taher & Cutkomp, 1983, Mondal, 1987). Depending on the stage of development oocytes develop abnormally and resorbed vitellogenesis is inhibited. Eggs laid by females fed on food medium treated with azadirachtin or neem extracts often have poorly formed chronic surfaces and may be more sensitive to timgal attack and are often less fertile (Schmutterer, 1987).
According to (Loschiavo, 1955) chemical treatments probably affect the physiological state of the female which possibly induce a reduction in both fecundity and fertility. The net reduction of both fecundity and viability of eggs clearly demonstrates the potential means of reducing the population of *T. castaneum*.

**Acknowledgement**

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**References**


