Chapter 4 (A)

Life Cycle of Bagarda cruciferarum (Kirk)
Life Cycle of
Bagrada cruciferarum
(Kirk)
The life cycle of *Bagrada cruciferarum* (Kirk) was studied on the several important aspects as follows:

1. **MATING PERIOD AND COPULATION**

   Mating was observed in 3 to 5 days old adult insects in different combination in laboratory. These insects were usually very active from morning till evening.

   The insects copulated freely in the cages. The male attracted by female insects pheromones and moved very fast to attain the phenomenon of mating. The male insects were smaller than female and were very active in breeding season.

   It twisted its abdomen and tired to bring its posterior part nearer to the corresponding region of the female. The male then protrudes and insects its aedeagus into the vagina of the female and gets locked immediately. Now the male turns back so that the two insects have their heads pointed in opposite directions as shown in photograph 8.

   Sometimes on a mating couple 1-2 male culmed up and tried to perform mating. During the process of copulation both the individuals continue to feed and move. The female, which was larger and stronger determines direction of movement and practically drags the male along with her.

   The duration of copulation usually varies from 4 to 6 days in normal insects. Generally copulation occurs only once but in some cases its starts again after oviposition. The normal mating combination survived upto IInd oviposition and male was mare weaker than female and did not survive upto F-2 generation.

   The second copulation attempts might be resulted into oviposition again in copulation. It was not necessary that the same pair might be resume
the process again 1st was observe with treated of *Cerbera thevetia* seed kernel treatment and 1Ind was not seen with *Cerbera thevetia* seed kernel treatment. No oviposition seed in *Abrus precatoriosus* seed extract treatment.

100% mortality was observed after 1Ind oviposition with glycosides cerberin treated male. No oviposition was observed with glycosides abrin treated mates.

**EGG LAYING**

After copulation the female searched for a suitable place for oviposition in glass cages. After oviposition a normal female laid eggs insides the net cover of glass cages. The eggs are generally laid in one cluster at one place, but in some cases when the insects were disturbed during oviposition, they might be laid in two cluster at different places.

The process of oviposition generally took about 10-12 hrs. In exceptional cases it might be lost longer upto 15 hrs. after oviposition. It passed some time in a state of restlessness.

The total number of eggs laid by a mated female insect varies between 55-60, while about 20 eggs laid by cerberin treated female and no egg laid by abrin treated female insect.

**THE EGGS**

Freshly laid eggs were oval and pinkish in colour. The maximum average weight of single egg was about 0.49 mg in normal insect and 0.40 mg in cerberin treated insect and nil in abrin treated insect.

**1st NYMPHAL INSTAR STAGES**

When the eggs hatched out into very delicate nympha1 instars. It was somewhat oval in shape measuring approximately 0.80 mm in length and 0.50 mm and pinkish-red in colour.
Ist nymphal period was about 6 days in normal. There was no clear distinction between the thorax and the abdomen in 1st nymphal instar stage. The antennae are four jointed and 0.3 mm in length.

Ist nymphal instar stage only 3 days in cerberin treated insects and not survived due to high percentage of mortality in abrin treated 1st nymphal instar stages at the time of moult.

IIInd NYMPHAL INSTAR STAGE

The second instar nymphal stage hatched out from the first moult, measuring about 0.9 mm. The most prominent features of the second nymph is the presence of three median black spots between 3/4, 4/5 and 5/6 intertergal membranes of the abdomen, which are the opening of the stink glands, these prominent spots are retained throughout the nymphal life.

It has 3 pair walking legs and they are smaller in size and red-black in colour, length of antennae is about 0.9 mm in IIInd nymphal instar stage; the duration of the second nymphal instar stages in about 4 days in the case of normal insects, 2 days in cerberin treated insects and not survived due to high percentage of mortality in abrin treated IIInd nymphal instar stages at the time of moult.

IIIIrd NYMPHAL INSTAR STAGE

The second ecdysis takes place on the fourth day of the 1st moult and the third nymphal instars were emerged out soon after the moult measured about 1-2 mm to 2 mm in length.

The length of antennae were about 0.6 mm in normal IIIrd nymphal instar stage. There was a clear distinction start between the thorax and abdomen from IIIrd nymphal instar and the eyes possess a mixed colouration of black and red pigmentation. IIIrd nymphal instar stage lasts from 6 days in normal insects. 3 days in cerberin treated insects and not
survived due to high percentage of mortality in abrin treated IIIrd nymphal instar stages at the time of moulting.

**IVth NYMPHAL INSTAR STAGE**

The third moult occurred on 6 days after the second, leads to the fourth nymphal instar, which measures about 3.0 mm, but gradually grown in the size to attain a length of about 4.5 mm and antennae were measured about 0.5 mm in length.

This nymph possessed larger mesothoracic wing pads measuring about 0.2 mm. The size of wing pads gradually increased and its colour was black in normal insects. The duration of the IVth nymphal instar was ranged from 6 days to 8 days in normal insects. 5 days in cerberin treated insects and not survived due to high percentage of mortality in abrin treated IVth nymphal instar stages at the time of moulting.

**Vth NYMPHAL INSTAR STAGES**

The fourth ecdysis, usually occurred some 8 to 10 days after the third moult leads to the fifth nymphal instars, which was characterized by the presence of long prominent black mesothoracic wing pads measuring from 0.5 to 0.7 mm.

The newly moulted nymphs with flat abdomen increased in size from 0.5 mm to 0.6 mm. The females were larger in size as compared to the same age male. The proboscis measuring 0.4 mm to 0.6 mm extends upto the second abdominal segment. This stage generally lasts from 9 to 10 days but the period may vary from 10 to 12 days in normal insects, 7 days in cerberin treated insects and not survived due to high percentage of mortality in abrin treated Vth nymphal instar stage at the time of moulting.
THE ADULT

The fifth and final moult takes place some 8 to 10 days after the fourth moult when a fully grown adult emerged out. The newly moulted adult possessed deep black legs, antennae and light black coloured wing without spots. On the time of the moult the wings, legs and antennae assume the typical adult colouration. 80% mortality was observed in nymphal development of Cerbera thevetia seed extract treated mates. About 20% adult emerged from F₁ generation nymphs were not survived up to F₂ generation and no oviposition in Abrus precatorious seed extract treated mates has bee observed in the present investigation.
Chapter 4

Mortality and Reproductive Performance of
Bagarda cruciferarum (Kirk)
Studies on the reproductive performance of experimental insect *Bagrada cruciferarum* was done on the significant aspects as follows:

1. Breeding season
2. Life span and Mortality
3. Mating Behaviour
4. Copulation and oviposition
5. Fecundity
6. Embryonic development period
7. Nymphal development period
8. Viability
9. Ratio of male and female

1. Breeding Season:

The *Bagrada cruciferarum* (Krik) generally appears during the flowering season of the plants of Cruciferae family, specially on Cauliflower and Mustard plants. Both the nymphs and adults suck up the plant sap from steam and fruits.

Its breeding season starts from February to May, but sometimes it also appears on Gazar grass plants up to first week of July.

These insects are usually very active from morning till evening and shelter themselves on plants during the hot time of the day.

These insects multiply very rapidly in favorable environmental conditions but high rate of mortality was observed in treated groups.

2. Life span and mortality:

The maximum life span of *Bagrada cruciferarum* (Krik) is about 50-60 days. The adult male and female insects emerged from last nymphal instars survive up to 10-12 days after 1st oviposition but male dies 6-8 days after 1st
mating. The adults emerged from F₁ generation nymphs did not survive up to F₂ generation through they we're kept in normal laboratory conditions.

Life span is totally dependent on the adverse laboratory and environmental conditions e.g. temperature, food, moisture and extracts intoxication of natural product like seeds of Abrus precatorius and Cerbera thevetia etc. It effects in various ways on the nymphaal development. Under suitable conditions these bugs multiply very rapidly.

Generally 50-60% mortality was observed in normal earlier nymphaal development at the time of molting. The main cause of mortality in normal insect was food and adverse laboratory conditions, which were not as good as the normal environmental conditions, 100% mortality after IIIrd oviposition in normal mates but 100% mortality after IIrd oviposition was also observed in treated mates as shown in table 4, 5 and 6.

The mortality could be effected on the type and concentration of natural products like Abrus precatorius and Cerbera thevetia seeds extracts.

The mortality with respect to LC₁₀₀, LC₅₀, LC₀ and sub lethal concentration etc. with different doses of natural products is summarized in table 2 and 3.

3. Mating Behaviour

Mating was observed in 3-5 days old adults in different combinations in the laboratory. Male insects were attracted by female insect pheromones moved very fast to attain the phenomenon of mating. The male insects are smaller than female and were very active in breeding season. Sometime on a mating couples 1-2 males culmed up and tried to perform mating. The males moved towards the female and tired to held the female with the help of their fore legs. After adjusting itself male insects brought the posterior parts of the abdomen towards the corresponding region of female. Male protruded its aedeagus and inserted in to the vagina of female and thus mating was done.
The mating period was about 4-6 days in normal mates while it varies in different treated mates. It was noticed that 2-3 days male do mate with newly emerged females were unable to perform ovulation till they attained maturity. Mating was normally done 3-4 times at an interval of 2 days after oviposition by the same or other mate.

4. Copulation and Oviposition

_Bagrada cruciferarum_ (Krik) is an unisexual insects pest and the copulation takes place in 3-4 days old mates. Before oviposition copulation period varies in different mating combinations treated with glycosides extracted as natural products as shown in table 2.10.

The normal mating combinations survived up to III^rd_ oviposition, but treated mating combinations survived up to II^nd_ oviposition only as shown in table 8, 9 and 10.

5. Fecundity

In natural conditions a single normal female of _Bagrada cruciferarum_ (Krik) laid about 60-65 eggs. The eggs are small rounded in shape and pale yellow in colour, but before hatching they become pinkish.

The maximum average weight of single egg is about 0.49 mg.

The insects treated with different glycosides showed decline in fecundity, which was dose and duration of treatment dependent. Intoxication of natural products showed decline in fecundity due to high percentage of mortality not only in number but also in their color (Table 8, 9 and 10).

6. Embryonic Development

The number of days required for normal embryonic development in _Bagrada cruciferarum_ (Krik) is about 6-8 days but this period varies and may be prolonged in treated insects. The fertilized eggs require natural conditions for their progressive development in laboratory, but sometimes the embryonic development was arrested due to certain adverse conditions and in present
investigation natural products intoxication was the most potent cause as exhibited in table 11, 12 and 13.

7. Nymphal Development

The newly emerged nymphs showed negative phototropism.

Generally five nymphal instar stages were seen in *Bagrada cruciferarum* (Krik). Newly emerged nymphs start feeding on the juice of cauliflower, radish, bean and steam. In normal development the total nymphal period was about 30-35 days, but it was found to be variable and prolonged in the nymphs of treated insects. The nymphs were very similar to adult in having same type of mouth parts, feeding habits and lived in the same habitat but they were smaller in size and wingless. Newly hatched nymphs are pinkish in color and suck the sap of steam, leaves and fruits of the host plants of Cruciferae.

Generally male is weaker then female and did not survive up to F₂ generation in natural product treated insects. In development of normal insects their life history recycles and is similar to F₁ generation.

The last nymphal period is about 8-12 days in normal insects, which is variable in natural product treated insects as recorded in table 11, 12 and 13.

8. Viability :

100% viability was observed in normal and control *Bagrada cruciferarum* (Krik), but it was variable and lesser in treated insects. Nil viability was noticed in abrin treated insects as exhibited in table 8, 9 and 10.

9. Ratio of male and female :

The adults emerged from the same lot of eggs of any normal or treated female of *Bagrada cruciferarum* (Krik) insects did not show any particular ratio of male and female of vice-versa. It was never observed that either only males or females emerged from the same lot of the eggs.

The male and female ratio was variable in normal as well as in treated insects (Table 11, 12 and 13).
Table 4: Percent Mortality in Normal Male X Normal Female Mating combination of *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Mating Combination</th>
<th>Numbers of Pairs</th>
<th>Kind of glycosides or solvents</th>
<th>Number of eggs laid/female</th>
<th>Percent mortality and Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NM x NF</td>
<td>10 Pairs</td>
<td>Neither treated with glycosides nor their solvents</td>
<td>60-65 eggs/female</td>
<td>The maximum life span observed was about 50-60 days. The embryonic developmental period was about 6-8 days. The nymphs were progressively developed on normal Laboratory conditions. 100% mortality was observed in mates after III&lt;sup&gt;o&lt;/sup&gt; oviposition.</td>
</tr>
</tbody>
</table>

**Key to Abbreviations:**
- NM=Normal male
- NF=Normal female
- TM=Treated male
- TF=Treated female
- UF=Untreated female
- UM=Untreated male
Table 5: Percent Mortality in Untreated Male X Untreated Female Mating combination of *Bagrada cruciferarum* (Kirk) treated a with distilled water.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Mating Combination</th>
<th>Numbers of Pairs</th>
<th>Kind of glycosides or solvents</th>
<th>Number of eggs laid/female</th>
<th>Percent mortality and Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>UM x UF</td>
<td>10</td>
<td>Distilled water</td>
<td>60-65 eggs/female</td>
<td>10% mortality in mates after IIIrd oviposition was recorded.</td>
</tr>
</tbody>
</table>
Table 6: Percent Mortality in Untreated Male X Untreated Female Mating combination of *Bagrada cruciferarum* (Kirk) treated a with Solvents of the extract.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Mating Combination</th>
<th>Numbers of Pairs</th>
<th>Kind of glycosides or solvents</th>
<th>Number of eggs laid/female</th>
<th>Percent mortality and Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>UM x UF</td>
<td>10</td>
<td>Ethyl ether</td>
<td>60 eggs/female</td>
<td>100% mortality was observed in mates after IIIrd oviposition.</td>
</tr>
</tbody>
</table>

**Note:** Untreated male and Untreated female (treated only with solvents used for dissolving natural products) mating combination was used as control throughout the experiments.
Table 7: Results of Reproductive Behaviour in Treated Male and Treated Female Mating combinations of *Bagrada cruciferarum* (Kirk) treated with different types of glycosides.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Mating Combination</th>
<th>Numbers of Pairs</th>
<th>Name of plant</th>
<th>Part of plant</th>
<th>Type of glycosides</th>
<th>Con. of glycosides</th>
<th>Number eggs laid/female</th>
<th>Percent mortality and Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>TM x TF</td>
<td>10</td>
<td><em>Abrus precatorius</em></td>
<td>Seed</td>
<td>Abrin</td>
<td>0.09%</td>
<td>Nil</td>
<td>No. Oviposition was observed with glycoside Abrin treated mates.</td>
</tr>
<tr>
<td>2.</td>
<td>TM x TF</td>
<td>10</td>
<td><em>Cerbera thevetia</em></td>
<td>Seed Kernel</td>
<td>Cerberin</td>
<td>0.1%</td>
<td>20 eggs/female</td>
<td>100% mortality was observed after II&lt;sup&gt;nd&lt;/sup&gt; oviposition with glycosides Cerberin tearted mates.</td>
</tr>
</tbody>
</table>

Note: The natural plant product intoxication was observed in order *Abrus precatorius* > *Cerbera thevetia*. 
Table 8: Results of Reproductive Behaviour in Normal male X Normal female mating combinations of *Bagrada cruciferarum* (Kirk).

<table>
<thead>
<tr>
<th>Mating Combination</th>
<th>Number of Pairs</th>
<th>Kinds of glycosides or solvents</th>
<th>Pre-mating period</th>
<th>Mating period</th>
<th>I&lt;sup&gt;st&lt;/sup&gt; Oviposition period</th>
<th>II&lt;sup&gt;nd&lt;/sup&gt; Oviposition period</th>
<th>III&lt;sup&gt;rd&lt;/sup&gt; Oviposition period</th>
<th>Fecundity</th>
<th>Viability</th>
</tr>
</thead>
<tbody>
<tr>
<td>NM × NF</td>
<td>10</td>
<td>Neither treated with natural plant extract nor their solvent.</td>
<td>3 days</td>
<td>4 days</td>
<td>1 days</td>
<td>2 days</td>
<td>2 days</td>
<td>60 eggs / female</td>
<td>60 nymphs / female</td>
</tr>
</tbody>
</table>

**Note:** The data is recorded on the mean basis.
- **Pre-mating period**: The duration intervening between emergence of adults and commencement of the mating.
- **Mating period**: The duration of copulation.
- **I<sup>st</sup> Oviposition period**: The period between the end of mating and the oviposition of I<sup>st</sup> lot of eggs laid down.
- **II<sup>nd</sup>, III<sup>rd</sup>, IV<sup>th</sup> Oviposition period**: The period between two successive oviposition period.
- **Fecundity**: Number of eggs laid/female under different combinations of mating.
- **Viability**: Number of nymphs emerged/female.
Table 9: The results of Reproductive Behaviour in Untreated male X Untreated female mating combinations of *Bagrada cruciferarum* (Kirk) treated with solvent of the extract.

<table>
<thead>
<tr>
<th>Mating Combination</th>
<th>Numbers of Pairs</th>
<th>Kinds of solvents</th>
<th>Pre mating period</th>
<th>Mating period</th>
<th>1st oviposition period</th>
<th>2nd oviposition period</th>
<th>3rd oviposition period</th>
<th>Fecundity</th>
<th>Viability</th>
</tr>
</thead>
<tbody>
<tr>
<td>UM x UF</td>
<td>10 Pairs</td>
<td>Ethyl ether</td>
<td>4 days</td>
<td>4 days</td>
<td>28 hrs</td>
<td>2 days</td>
<td>2 days</td>
<td>60 eggs/Female</td>
<td>58 nymphs/female</td>
</tr>
</tbody>
</table>

**Note:** Untreated male X Untreated female (treated only with ethyl ether used for dissolving Natural products) mating combination was used as control throughout the experiments.
Table 10: Results of Reproductive Behaviour in Treated Male and Treated Female Mating combinations of *Bagrada cruciferaum* (Kirk) treated with different types of glycosides.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Mating Combination</th>
<th>Nos. of Pairs</th>
<th>Kinds of plant extract</th>
<th>Conc. of glycoside</th>
<th>Pre mating period</th>
<th>Mating period</th>
<th>I&lt;sup&gt;st&lt;/sup&gt; oviposition period</th>
<th>II&lt;sup&gt;nd&lt;/sup&gt; oviposition period</th>
<th>III&lt;sup&gt;rd&lt;/sup&gt; oviposition period</th>
<th>Fecundity</th>
<th>Viability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>TM x TF</td>
<td>10</td>
<td>Seed</td>
<td>0.09% Abnin</td>
<td>2 days</td>
<td>2 days</td>
<td>13 hrs</td>
<td>1 days</td>
<td>1 days</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2.</td>
<td>TM x TF</td>
<td>10</td>
<td>Cerbera thevetia Seed</td>
<td>0.1% Cerberin</td>
<td>3 days</td>
<td>21/2 days</td>
<td>15 hrs</td>
<td>11/2 days</td>
<td>1 days</td>
<td>25 eggs/ female</td>
<td>15-20 nymphs/ female</td>
</tr>
</tbody>
</table>

Result: The natural product glycosides intoxication was observed in order *Abrus precatorius* > *Cerbera thevetia*. 
Table 11: The results showing embryonic and nymphal development period in Normal male x Normal female mating combinations of *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Mating combination</th>
<th>Kind of glycoside or solvent</th>
<th>No. Of eggs laid/female</th>
<th>Average weight of one egg</th>
<th>Embryonic development period</th>
<th>Nymphal Development Period</th>
<th>Total period of nymphal development</th>
<th>Ratio of male and female</th>
<th>Percent mortality and results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NM x NF</td>
<td>Neither treated with natural product nor their solvent</td>
<td>60 eggs /female</td>
<td>0.49 mg</td>
<td>6 days</td>
<td>I-III IV-V V-Adult</td>
<td>33 days</td>
<td>28 male 32 female</td>
<td>No mortality was observed in nymphs, the five nymphal instars were emerged into adults, in F1 generation, which were survived upt to F2 generation and repeated their reproductive cycle in the same way as in F1 generation.</td>
</tr>
</tbody>
</table>

**Note:** Result based on average basis.
Table 12: The results showing embryonic and nymphal development period in untreated male and untreated female mating combinations of *Bagrada cruciferarum* (Kirk) treated with solvent of the extract.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Mating combination</th>
<th>Kind of solvent</th>
<th>No. Of eggs laid/ female</th>
<th>Average weight of one egg</th>
<th>Embryonic development period</th>
<th>Nymphal Development Period</th>
<th>Total period of nymphal development</th>
<th>Ratio of male and female</th>
<th>Percent mortality and results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>UM × UF</td>
<td>Ethyl ether</td>
<td>60 eggs/ female</td>
<td>0.48 mg</td>
<td>7 days</td>
<td>I-II 6 days</td>
<td>II-III 4 1/2 days</td>
<td>III-IV 6 days</td>
<td>IV-V 9 days</td>
</tr>
</tbody>
</table>

**Note:** Result based on average basis.
Table 13: The results showing embryonic and nymphal development period in treated male and treated female mating combinations of Bagrada cruciferarum (Kirk) treated with different types of glycosides.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Mating combination</th>
<th>Kind of natural product</th>
<th>Part of plant extracted</th>
<th>No. of eggs laid/ female</th>
<th>Average weight of one egg</th>
<th>Embryonic development period</th>
<th>Nymphal Development Period</th>
<th>Total period of nymphal development</th>
<th>Ratio of male and female</th>
<th>Percent mortality and results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>TM x TF Abrus precatorious</td>
<td>Seeds</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>Not survived due to high percentage of mortality in abrin treated nymphal instar stages at the time of molting.</td>
<td>Nil</td>
<td>Nil</td>
<td>No oviposition in Abrus precatorious seed extract treated mates.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>TM x TF Cerbera thevelia</td>
<td>Seed kernel</td>
<td>20 eggs</td>
<td>0.4 mg</td>
<td>5 days</td>
<td>3 days</td>
<td>2 days</td>
<td>3 days</td>
<td>5 days</td>
<td>7 days</td>
</tr>
</tbody>
</table>

Note: Results based on average basis.
DISCUSSION

The breeding season is specific and variable in different insects as reported by Rakshpal (1958), Guthrie and Tindal (1970) in *Periplaneta americana* from March to September, Khanna (1983) reported the breeding in *Aleurolobus borodensis* from August to September, in *Nephotettix apicalis* from August to October, in *Lipaphis erysimi* from end of November to February, in *Leptocorisa varicornis* (Squash bug) from middle of August to middle of November, in *Bagrada cruciferarum* from February to April and *Dysdercus cingulatus* from August to September, Jain (1991, a) observed in *Poekilocerus pictus* from mid rainy season to early summer and in *Periplaneta americana* from March to September, but in the present investigation in *Bagrada cruciferarum* (Kirk) breeding season was started from February to May.

In some species breeding is seasonal and in others it is performed at random and depends on the maturity of gonads, availability of food and favourable conditions.

The maximum life span has been observed by Sahai *et al.* (1981) in normal *Poekilocerus pictus* which is about 7-10 months, Khanna (1983) has observed in *Leptocorisa varicornis* about 20-30 days, in *Pyrilloperpusilla*, walk about 40-60 days during the rainy season and in *Earia fabia*, Stoll it is about 4-6 weeks, Jain (1991a) has observed in *Poekilocerus pictus* about 7-10 months and in *Periplaneta americana* about 16-1/2 – 25 months, but in the present investigation in *Bagrada cruciferarum* the life span is about 55-60 days.

Narayan (1954) mentioned in *Bagrada cruciferarum* that the males lived longer than the females, the mean being 18 days in male and 16 days in female on mustard, Mukerji (1958) and Batra and Sarup (1962) reported
the average longevity in *Bagrada cruciferarum* in male and female is about 4.11-8.14 days and 4.11-9.33 days on soaked mustard seeds and 13-40 days and 12.3-23 days on cabbage leaves respectively. That means the female lived longer than male. Sahai (1979) observed in *Sarcophaga lineatocollis* that male insects survived about 6-7 days and female for about 15-16 days, while Sahai and Sahai (1981-1984) have reported in *Bagrada cruciferarum* that the females lived longer than males and longevity of mated individuals are much reduced as compared to unmated individuals and unmated male and female survived for 35 days and 46 days respectively, but in the present investigation normal male and female *Bagrada cruciferarum* survived as long as 12-15 days and 18-20 days respectively.

The life span and longevity of male and females were affected by natural plant product in toxication and adverse environmental conditions.

Jain (1991a, b) reported in *Periplaneta americana* 100% mortality after IIInd to IIIrd oviposition and in *Poekilocerus pictus* after lst oviposition but in *Bagrada cruciferarum* 100% mortality after IIIrd to IVth oviposition, while abrin treated mates did not show oviposition in the present investigation.

Jain (1991a, b) reported in *Periplaneta americana* about 4-5% mortality was observed in earlier nymphal stages and 6-8% mortality in later nymphal stages, while 5-10% mortality in nymphs were reported by Klein (1993) in the same insect, but in the present investigation in *Bagrada cruciferarum* about 10-20% mortality was observed in normal lst nymphal instar and 30-40% mortality in IIIrd to IVth nymphal instars at the time of moultng.

The mortality is dependent on the concentration of pesticides and the number of dose injected as also reported by Bhide (1986a, b and 1989) in *Periplaneta americana* is used to control rate of fertility, while increasing the
rate of mortality in order eggs > nymphs > adults of *Bagarada cruciferarum* was observed by Bhide and Rai (2005) as observed in *Bagrada cruciferarum* after treatment with sub-lethal concentration of abrin and cerberin in present investigation.

Cent percent mortality was observed in 11nd instar larvae of *Heliothis armigera* after treatment with Boaa extract as reported by Pophaly (1991), while Singh and Rani (1994) reported that nymphal population of *Dysdercus koeniggi* was controlled by different concentration of neem product.

Tripathi *et al.* (1994) reported in *Antheraea mylitta* that 30°C temperature and 75.80 Rh humidity was found to be the most suitable condition for minimum mortality of larvae, pupae, male and female adults.

Low temperature and higher concentration of malathion resulted in death of the experimental *Sphaerodema rusticum* as observed by Thomas and Sahai (1989). The mortality rate was 54-85% to 84-95% in *Callosobruchus chinensis* after treatment with neem flower extract as observed by Dixit *et al.* (1990), while 9-60% mortality after cythion treatment in *Spodoptera littoralis* as observed by Jamal and Khan (1990). Mortality in insect treated with pesticides was also observed by Nigam *et al.* (1990) in *Bagrada cruciferarum* after 24 hrs. of treatment and showing toxicity of pesticides in order Dichlorvos > Phosphomidon > Fenthrotate > Endosulfan > Dimethoate > Diazinon > Malathion, but in the present investigation in *Bagrada cruciferarum* showed increase in the rate of mortality in nymphs as well as in male and female adults after treatment with abrin and cerberin and toxicity of both natural products in order abrin > cerberin.

The premating and mating periods were species specific and might be varied in different species e.g. the premating period was 7-8 days in normal *Poekilocerus pictus* as observed by Sahai *et al.* (1981), while 2-4 days in *Bagrada cruciferarum* as observed by Sahai and Sahai (1981-1984) 4-5
days in normal *Periplaneta americana* as also reported by Jain and Bhide (1988 and 1989). 7-8 days in *Poekilocerus pictus* and 3 days in *Periplaneta americana* as also observed by Jain (1991, a, b), but the premating period is about 3 days in normal *Bagrada cruciferarum* (Kirk) that period is longer and variable in control and treated insects in the present investigation.

The mating period was about 3-4 hrs. in *Sarcophaga lineatocollis* was observed by Sahai (1979), about 4-9 days in *Dysdercus similis* by Sahai and Devi (1980), that mating period lasts from 10 min. – 20 hrs. in *Bagrada cruciferarum* was reported by Sahai and Sahai (1981-1984), about 4-5 days in *Nesconia bihumpii* by Patel (1990), 1-12 hrs. in *Antheraea mylitta* by Dash *et al.* (1990), about 56 min. in *Poekilocerus pictus* and in 60 min. in *Periplaneta americana* by Jain (1991, a, b), but in the present investigation the mating period was about 4 days in normal *Bagrada cruciferarum* (Kirk) and that period is longer and variable in treated insects. The pre-oviposition and oviposition periods are variable in different insects, it was reported by Rakshpal (1949) in *Bagrada cruciferarum* the pre-oviposition period was upto one week and oviposition period till death, Guthrie and Tindall (1970) observed in *Periplaneta americana* that the pre-oviposition period was about 5 days, while 1st oviposition period was about 6-7 days and IIInd oviposition period was about 8-9 days in *Sarcophaga lineatocollis* as observed by Sahai (1979), about 4 days and 10 hrs. 11 days in *Dysdercus similis* by Sahai and Devi (1980), about 23-27 days in *Poekilocerus pictus* by Sahai *et al.* (1981), about 15-25 days in *Dysdercus koenigii* by Gupta and Sehgal (1990), but in the present investigation in *Bagrada cruciferarum* the pre-oviposition period was about 12-18 hrs. IIInd oviposition period was about 24 hrs. and IIIrd oviposition period was about 18 hrs.
The mated females complete 6 egg laying cycles over a period of 30 + 3 days, whereas virgins took 90+5 days to complete 3-4 egg cycles as also observed by Tiwari and Gupta (1990) in Dysdercus koenigii.

The oviposition was totally arrested in abrin treated mates of Bagrada cruciferarum in the present investigation as also observed in Musca domestica by Khan et al. (1974) after treatment with thiotepa, while Sahai and Sahai (1981-1984) observed in Bagrada cruciferarum that the pre-oviposition was significantly reduced on mustard and radish followed by cauliflower whereas it is significantly prolonged in Candytuft, Methi and Turnip. Turnip was significantly the least suitable food plant for oviposition in Bagrada cruciferarum.

Single female of Bagrada cruciferarum laid an average of 15-20 eggs per day and maximum of 230 eggs on mustard in her life time was observed by Batra (1958), while Mukerji (1958) reported upto 130 eggs laid on cabbage by a single female in the same insects.

The average number of eggs laid were about 100-140 eggs/female in Dysdercus similes was observed by Sahai and Devi (1980), while sahai and Sahai (1981-1984) reported in Bagrada cruciferarum laid about 100 eggs/female, but in the present investigation in normal Bagrada cruciferarum laid about 60 eggs/female and average weight of single egg was about 0.49 mg. The number of eggs was varied in control and treated mates.

The embryonic development was also observed by Khanna (1983) in Leptocorisa varicaris i.e. about a week Nephotettix apicaulis egg hatched within 6-7 days in Bagrada cruciferarum about 7 days, in Dysdercus cingulatus about 7-8 days and 55 days in Periplaneta americana, but in the present investigation in Bagrada cruciferarum the embryonic period was about 6-8 days in warm and moist weather. This period was variable and was prolong in treated insects. The period of embryonic development was
more probably dependent upon the physical condition of eggs and also on the environmental and laboratory conditions.

The nymphal period was species specific and variable in different insects as observed by Khanna (1983) in Drosicha managiferae about 3 months or little or more in Nephotettx apicalis it was about 23 days, in Helopeltis theivora about 2 weeks, but in winter the nymphal period was prolonged to 8 weeks or more, while in Dysdercus cingulatus, it was about 49-89 days. Sahai and Sahai (1981-1984) reported that mustard plant showed significant nutritive properties, which enabling the nymphs of Bagrada cruciferarum to became adult in 20.5 days, while 28.5 days on Candytuft and the results revealed that mustard is the most nutritious of all the food plants and next in order of food value are Radish, Cabbage and Cauliflower. Nymphal growth on mustard ranks at the top, the next comes cabbage then radish and cauliflower and 300 days in normal nymphal development in Periplaneta americana observed by Jain (1991, a, b) and moult inhibiting in Cleodendron inermis observed by Yankanchi et al. (2003), but in the present investigation in Bagrada cruciferarum the newly emerged nymphs show negative phototropism and their nymphs passes through five moults in normal development. The total nymphal period was about 30-35 days in Bagrada cruciferarum. Male nymphs are smaller than female nymphs. The average nymphal period was prolonged and variable due to natural product intoxication in treated insects.

The female of Periplaneta americana have decreased longevity with number of oothecae production as observed by Guthrie and Tindall (1970), while Bentur et al. (1974) observed that the longevity was not affected by the egg production and sperm maturation in Plebeiogyllus guttiventris and about 5 g thiotepa was able to reduce fecundity and fertility rate of fecundity, viability and longevity was reduced in Cimex hemipterus as observed by
Adhami (1974) after treated with hempa, in Dysdercus cingulatus as also observed by Ahmad (1976) after treated with hempa, Rao and Shetty (1991) how observed in Anophelese stephensis, the decrease in egg production, sex ratio and longevity after treatment with natural insecticides as observed in Bagrada cruciferarum after treatment with sub-lethal concentration of abrin and cerberin.

Dash et al. (1990) in Antheraea mylitta showed normal fecundity and poor hatchability when mated for 1, 2, 3 hrs. However if mated for 4 hrs, the average fecundity and hatchability was similar to that of control insects during three season while Tripathi and Lalita (1990) observed in Antheraea mylitta the great fecundity showed without loss of hatchability after fed with various nutrient and Arjuna leaves extract. Ahmad (1990) observed in Dysdercus cingulatus that the fecundity and longevity of male and female insects fed on Gossypium hirsktum was mare than fed on Thespiesia populnea host plant. Dixit and Saxena (1990) reported in Callosobruchus chinensis the adverse effect of antifeedent Permana intrigrifolia, which inhibited the oviposition hence indirectly hinder the rate of viability and fecundity, while Kumar and Sharma (1993) in Antheraea mylitta showed no variation in relation to sex within mutant strains for diapausing performance. Jamal et al. (1994) observed in Dysdercus cingulatus the increase in the longevity in order. 5th nymphal instar > male > female adults, but fecundity and fertility of female declined after treatment with sub-lethal concentration of monocrontophos, but in the present investigation about 40% fecundity in normal Bagrada cruciferarum was observed, while intoxication of natural product in different mating combinations resulted into decrease rate of viability and fecundity in order NM x NF > UM x UF > TM x TF, respectively. The probability of natural intoxication in different treated mating combinations showed that Abrus precatorious seed extract is more toxic
than *Cerbera thevetia* seed kernel extract. The probability of natural product intoxication in *Bagrada cruciferarum* is in order abrin > cerberin. This investigation has suggested that the natural pesticide should be used to control the progeny and population rate of pathogenic insects and should not be used against the insect having economic importance to human being.
REFERENCES

Adhami, N. (1974) : Laboratory studies on effectiveness of hempa as sterilant for 
no. 90, 185.

Ahmad, J. (1976) : The effect of hempa on the sterility and longevity of *Dysdercus 
cingulatus*, *Botyaagaka*, 41, 83-86.

Ahmad, J. (1990) : Fecundity viability of eggs, longevity of adults of *Dysdercus 
cingulatus* (Fabr.) fed on different host plants under laboratory conditions. 

Batra, H.N. (1958) : Bionomics of *Bagrada cruciferarum* (Kirk.) (Heteroptera : 
Pentatomidae) and its occurrence as a pest of mustard seeds, *Ind. J. Ent.*, 
20, 1-140.

Batra, H.N. and Sarup, Shanti (1962) : Technique of mass breeding of painted bug 
*Bagrada cruciferarum* Kirk. (Heteroptera : Pentatomidae), *Indian Oil 
Seeds J.*, 6(2), 135.

Behura, B.K., Dash, B.K. and Dash, A.P. (1974) : On the anatomy and histology of 
the reproductive organ of *Aspongopus janus* Fabr. (Hemiptera : 
Calcutta, Abs no. 103, 191.

Bhide (1986a) : Effect of DDT on mortality, behaviour, metamorphosis and on the 
histopathological changes in developing ovary of *Periplaneta americana*. 
*Environ and Ecotoxicology*, 267-276.

Bhide, M. (1986b) : Histochemical and cytological studies on the corpus luteum and 
resorptive bodies of *Dysdercus similis*, *Folia Morphologia*, 34(3), 
291-300.

Bhide, M. (1989) : Pyridine as xenobiotic showing adverse effect on the mortality, 
metamorphosis, mating behaviour and on the histopathological changes in 
the developing ovaries of *Periplaneta americana* (Orthoptera), *10th AEB 


Chapter

Knock Down (KD) Toxicity for 1st to 5th Nymphal Instar Stages of *Bagarda cruciferarum* (Kirk)
The experiments were done separately for each nymphal instar stages for the KD toxicity of glycosides abrin and cerberin and the data for KD$_{100}$, KD$_{50}$, KD$_{0}$ and experimental concentration was recorded and summarized in table 14-23 and graphs 2-11.
Table 14: KD toxicity of *Abrus precatorius* seed extract in 1st nymphal instar stages in

*Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Abrus precatorius</em></td>
<td>0.09% seed extract</td>
<td>40</td>
<td>100%</td>
<td>KD$_{100}$</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>Abrus precatorius</em></td>
<td>0.09% seed extract</td>
<td>12</td>
<td>50%</td>
<td>KD$_{50}$</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td><em>Abrus precatorius</em></td>
<td>0.09% seed extract</td>
<td>9</td>
<td>Nil</td>
<td>KD$_{0}$</td>
<td>Mortality rate in 1st nymphal instar was increased with respect to the dose application time</td>
</tr>
<tr>
<td>4.</td>
<td><em>Abrus precatorius</em></td>
<td>0.09% seed extract</td>
<td>7</td>
<td>Nil</td>
<td>Experimental concentration</td>
<td></td>
</tr>
</tbody>
</table>
Graph 2: Showing KD toxicity of *Abrus precatorious* seed extract in 1st nymphal instar stages in *Bagrada cruciferarum* (Kirk)
Table 15: KD toxicity of *Abrus precatorius* seed extract in 11nd nymphal instar stages in *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>0.09% seed extract</td>
<td>48</td>
<td>100%</td>
<td>$KD_{100}$</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>Abrus precatorius</em></td>
<td></td>
<td>14</td>
<td>50%</td>
<td>$KD_{50}$</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>10</td>
<td>Nii</td>
<td>$KD_{0}$</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>7</td>
<td>Nii</td>
<td>Experimental concentration</td>
<td></td>
</tr>
</tbody>
</table>

Mortality rate in 11nd nymphal instar was increased with respect to the dose application time.
Graph 3: Showing KD toxicity ofAbrus precatorious seed extract in IInd nymphal instar stages inBagrada cruciferarum (Kirk)
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>50</td>
<td>100%</td>
<td>KD&lt;sub&gt;100&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Abrus precatorius</td>
<td>0.09% seed extract</td>
<td>25</td>
<td>50%</td>
<td>KD&lt;sub&gt;50&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Abrus precatorius</td>
<td></td>
<td>15</td>
<td>Nil</td>
<td>KD&lt;sub&gt;0&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>14</td>
<td>Nil</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 16: KD toxicity of *Abrus precatorius* seed extract in IIIrd nymphal instar stages in *Bagrada cruciferarum* (Kirk)

Mortality rate in IIIrd nymphal instar was increased with respect to the dose application time.
Graph 4: Showing KD toxicity of *Abrus precatorius* seed extract in IIIrd nymphal instar stages in *Bagrada cruciferarum* (Kirk)
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>55</td>
<td>100%</td>
<td>$\text{KD}_{100}$</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>Abrus precatorius</em></td>
<td>0.09% seed extract</td>
<td>27</td>
<td>50%</td>
<td>$\text{KD}_{50}$</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>17</td>
<td>Nil</td>
<td>$\text{KD}_{0}$</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>15</td>
<td>Nil</td>
<td>Experimental concentration</td>
<td></td>
</tr>
</tbody>
</table>

Table 17: KD toxicity of *Abrus precatorius* seed extract in IVth nymphal instar stages in *Bagrada cruciferarum* (Kirk)

Mortality rate in IVth nymphal instar was increased with respect to the dose application time.
Graph 5: Showing KD toxicity of *Abrus precatorius* seed extract in IVth nymphal instar stages in *Bagrada cruciferarum* (Kirk)
Table 18: KD toxicity of *Abrus precatorius* seed extract in Vth nymphal instar stages in *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Abrus precatorius</em></td>
<td>0.09% seed extract</td>
<td>60</td>
<td>100%</td>
<td>$KD_{100}$</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>Abrus precatorius</em></td>
<td></td>
<td>30</td>
<td>50%</td>
<td>$KD_{50}$</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>20</td>
<td>Nil</td>
<td>$KD_{0}$</td>
<td>Mortality rate in Vth nymphal instar was increased with respect to the dose application time</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>18</td>
<td>Nil</td>
<td></td>
<td>Experimental concentration</td>
</tr>
</tbody>
</table>
Graph 6: Showing KD toxicity of *Abrus precatorious* seed extract in Vth nymphal instar stages in *Bagrada cruciferarum* (Kirk)

- **% Mortality**
- **Time (hrs.)**

Levels:
- Sublethal
- KD0
- KD50
- KD100
Table 19: KD toxicity of *Cerbera thevetia* seed kernel extract in 1st nymphal instar stages in *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Cerbera thevetia</em></td>
<td>0.1% seed kernel extract</td>
<td>48</td>
<td>100%</td>
<td>KD(_{100})</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>Cerbera thevetia</em></td>
<td>0.1% seed kernel extract</td>
<td>35</td>
<td>50%</td>
<td>KD(_{50})</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td><em>Cerbera thevetia</em></td>
<td>0.1% seed kernel extract</td>
<td>24</td>
<td>Nil</td>
<td>KD(_{0})</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td><em>Cerbera thevetia</em></td>
<td>0.1% seed kernel extract</td>
<td>20</td>
<td>Nil</td>
<td>Experimental concentration</td>
<td>Mortality rate in 1st nymphal instar was increased with respect to the dose application time</td>
</tr>
</tbody>
</table>
Graph 7: Showing KD toxicity of *Cerbera thevetia* seed kernel extract in 1st nymphal instar stages in *Bagrada cruciferarum* (Kirk)
Table 20: KD toxicity of *Cerbera thevetia* seed kernel extract in 1Ind nympha l instar stages in *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>51</td>
<td>100%</td>
<td>KD&lt;sub&gt;100&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Cerbera thevetia</td>
<td>0.1% seed kernel extract</td>
<td>36</td>
<td>50%</td>
<td>KD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>Mortality rate in 1Ind nympha l instar was increased with respect to the dose application time</td>
</tr>
<tr>
<td>3.</td>
<td>Cerbera thevetia</td>
<td></td>
<td>30</td>
<td>Nil</td>
<td>KD&lt;sub&gt;0&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>28</td>
<td>Nil</td>
<td></td>
<td>Experimental concentration</td>
</tr>
</tbody>
</table>
Graph 8: Showing KD toxicity of *Cerbera thevetia* seed kernel extract in 11nd nymphal instar stages in *Bagrada cruciferarum* (Kirk)
Table 21: KD toxicity of *Cerbera thevetia* seed kernel extract in IIIrd nymphal instar stages in *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>55</td>
<td>100%</td>
<td>(KD_{100})</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>Cerbera thevetia</em></td>
<td>0.1% seed kernel extract</td>
<td>35</td>
<td>50%</td>
<td>(KD_{50})</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>20</td>
<td>Nil</td>
<td>(KD_{0})</td>
<td>Mortality rate in IIIrd nymphal instar was increased with respect to the dose application time</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>15</td>
<td>Nil</td>
<td></td>
<td>Experimental concentration</td>
</tr>
</tbody>
</table>
Graph 9: Showing KD toxicity of *Cerbera thevetia* seed kernel extract in IIIrd nymphal instar stages in *Bagrada cruciferarum* (Kirk)
Table 22: KD toxicity of *Cerbera thevetia* seed kernel extract in IVth nympha1 instar stages in *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>60</td>
<td>100%</td>
<td>KD&lt;sub&gt;100&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>Cerbera thevetia</em></td>
<td>0.1% seed kernel extract</td>
<td>38</td>
<td>50%</td>
<td>KD&lt;sub&gt;50&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>20</td>
<td>Nil</td>
<td>KD&lt;sub&gt;0&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>16</td>
<td>Nil</td>
<td>Experimental concentration</td>
<td>Mortality rate in IVth nympha1 instar was increased with respect to the dose application time</td>
</tr>
</tbody>
</table>
Graph 10: Showing KD toxicity of *Cerbera thevetia* seed kernel extract in IVth nymphal instar stages in *Bagrada cruciferarum* (Kirk)
Table 23: KD toxicity of *Cerbera thevetia* seed kernel extract in Vth nymphal instar stages in *Bagrada cruciferarum* (Kirk)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Plant</th>
<th>Concentration of Seed Extract</th>
<th>Duration in Hrs.</th>
<th>Mortality</th>
<th>KD Toxicity Values</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>65</td>
<td>100%</td>
<td>KD$_{100}$</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>Cerbera thevetia</em></td>
<td>0.1% seed kernel extract</td>
<td>39</td>
<td>50%</td>
<td>KD$_{50}$</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>35</td>
<td>Nil</td>
<td>KD$_{0}$</td>
<td>Mortality rate in Vth nymphal instar was increased with respect to the dose application time</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>29</td>
<td>Nil</td>
<td></td>
<td>Experimental concentration</td>
</tr>
</tbody>
</table>
Graph 11: Showing KD toxicity of *Cerbera thevetia* seed kernel extract in Vth nymphal instar stages in *Bagrada cruciferarum* (Kirk)
RESULTS

Table 14-23 summarized the data on KD toxicity on 1st to Vth nymphal instar stages of *Bagrada cruciferarum* (Kirk). The experimental groups were treated with glycoside extracted from seeds of *Abrus precatorious* and seed kernel of *Cerbera thevetia*.

The 1st to Vth nymphal instar stages of normal and control groups did not show significant mortality percentage because they have provided because they have provided all normal environmental conditions with food and water ad libitum in the laboratory.

The glycosides abrin treatment showed nymphicidal activity at 0.09% concentration and the KD$_{50}$ was detected.

12 hrs. in 1st nymphal instar
14 hrs. in 2nd nymphal instar
25 hrs. in 3rd nymphal instar
27 hrs. in 4th nymphal instar
30 hrs. in 5th nymphal instar respectively.

While, KD$_{50}$ toxicity time became gradually increased. The data was recorded in table 14-18 and graphs 2-6 by the method adopted after Finney (1971).

The glycoside cerberin treatment showed nymphicidal activity at 0.1% concentration and the KD$_{50}$ was detected.

35 hrs. in 1st nymphal instar
36 hrs. in 2nd nymphal instar
35 hrs. in 3rd nymphal instar
38 hrs. in 4th nymphal instar
39 hrs. in 5th nymphal instar respectively.

While KD$_{50}$ toxicity time became gradually increased. The data recorded in table 19-23 and graph 7-11.
The experimental finding proved the efficacy of both the glycosides, while control groups showed the high viability rate of nymphs in all stages of Bagrada cruciferarum (Kirk), but experimental groups showed the decline in viability percentage and last nymphal instar stages never hatched into healthy adults and most of the nymphs were emerged into malformed adults with less developed gonads and the oocytes never attain such maturity, which is required for oviposition, so in the present investigation the glycosides abrin and cerberin were proved to be antiovipositional agent and abrin was more toxic in nature than cerberin.

DISCUSSION

In the present investigation 0.09% and 0.1% solution of glycosides abrin (extracted from seeds of Abrus precatorious) and cerberin (extracted from seeds kernel of Cerbera thevetia) were tested for KD toxicity in all nymphal instar stages and adult female insects emerged from the treated Vth nymphal instar exhibited the high degree of mortality in nymphs at the time of molting and 1st nymphal instars were more susceptible to the the test concentration in comparison to other nymphal instar stages as reported by Atal et al. (1978) in Tribolium castaneum, Mellini et al. (1994) in Exorister larvarum, Patil et al. (1997) in Dactynotus carthamii and Kumar et al. (1999) in Perigea capensis after the application of some plant extracts.

The extract of Abrus precatorious and Cerbera thevetia being a contact poison for insects, which penetrate the body wall and tracheal system resulted into death probably due to the nymphicidal activity against Bagrada cruciferarum in the present investigation.

The ethyl ether extract of Abrus precatorious and Cerbera thevetia contain glycosides, which acts as nymphicidal agent in the present investigation as reported by Kumar and Bhide (2001); Kumar (2003); Bhide et al. (2003 a, b; 2004) in Musca domestic after Cassia fistula and Delonix regia seed extract treatment and Bhide and Rai (2005) in Bagrada cruciferarum (Kirk).
The *Abrus precatorius* seed extract is more toxic than *Cerbera thevetia* seed kernel extract, suggesting the nymphicidal action in treated 1st to 5th nympha linstar stages of *Bagarada cruciferarum* (Kirk) (Table 14-18) and the toxicity of abrin was greater than cerberin in the present investigation. So the glycosides extracted from *Abrus precatorius* was more effective in present investigation due to creating some obstructions in hatching or moulting the nymphs into next conseqeuating stages in treated groups. The nympha linstar stages also showed morphological anomalies e.g. in size, colour, wings, legs, etc.

The KD toxicity was correlated with the duration of glycoside treatment.

The *Abrus precatorius* showed prominent adverse effect on KD toxicity as evident by table 14 to 18 graphs 2 to 6.

The results exhibited that these natural insecticides were of great economic importance from the agronomic point of view. The reason for using new natural pesticides is that, these are active at highly acceptable level as well as these plant products are non persistent type, biodegradable and their residues not accumulated in the food chains, non toxic to higher animals and showed significant toxic effects on small pest insects and it could be quite significant after formulation in large scale to use these natural insecticides of plant origin to control the fertility of pests of other crops and to increase the productivity of the developing country like India.
REFERENCES


