# Life cycle, Mortality and Survival of Oriental Fruit Fly *Bactrocera dorsalis* (Hendel, 1912) on Mango in Meiktila

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**Abstract**

Life cycle, mortality and survival of Oriental Fruit Fly *Bactrocera dorsalis* were recorded during the study period from May to July 2014 (fruiting season). One complete generation had four stages (from egg, larva, pupa and adult) and took about lasted 22 to 24 days at 30°C -34°C. Incubation period lasted for two days, the entire larval stages lasted for (11) days, pupation period lasted 9-11days. Among the four stages, larval feeding damage in fruits was the most damaging. In this study the life cycle of Oriental Fruit Fly at high temperature was faster than the life cycle at low temperature. In five replications the highest percentage of mortality of *B. dorsalis* occurred in 1st larva stage, and the lowest percentage of mortality occurred in pupa.

**Key words:** mortality, survival, four stages

## Introduction

One of the important problems in agriculture is the loss of agricultural product due to attacking by insect pests. The insects are the dominant group of animals on the earth. Many insects are extremely valuable to man. However, a few insects are harmful and cause enormous losses to agricultural crops, stored products and the health of man and animals. Most types of plants are attacked and injured by insects. The injury is caused by insect feeding or oviposition on the plants or serving as agents in the transmission of plant diseases. Some insects damage crops by feeding on sap, leaves or fruits (Borror *et al*., 1992).

Oriental fruit flies are important agricultural pests, depositing their eggs into fruit and vegetables, the flesh of which is subsequently consumed by the developing larvae (White and Elson-Harris, 1992). Fruit fly females oviposit in ripening fruit, and larvae burrow into the pulp. Fully grown larvae exit the fruit, usually after it has fallen to the ground, and pupate in the soil (Dolinski & Lacey, 2007).

Fruit fly (*B. dorsalis*) is widely distributed in the oriental region from Australia and Hawaii to Pakistan; hence it is also called Oriental Fruit Fly (Jayanthi, 2002). It is widespread throughout much of Bangladesh, Pakistan, India, Srilanka, Myanmar and many countries (Narayana and Batra, 1960, Drew and Hancock 1994; IIE 1994, EPPO 1997; Stephers *et al*., 2007) cited by

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Nwe Nwe Yin (2009). The fruit fly plays an important role in fruit production for domestic consumption and export in Myanmar. It is the most destructive pest on mango and a key pest of mango (Orankanok *et al*., 2007).

The main hosts of *B. dorsalis* are guava, mango, citrus, banana, avocado, papaya, etc. It is a serious pest of all fleshy fruits and vegetables in the general S. E Asia region, Hawaii (Hill,1983). More than one hundred varieties of mango exist in Myanmar (Hirano *et al.,* 2008). The different varieties of mangoes are Sein-ta-lone, Aung-din, Pan-swe, Shwe-hin-tha, Ma-chit-su, Yin-kwe, Thone-lone-ta-taung, Mya-kyauk. Among these varieties of mango trees, Sein-ta-lone, Shwe-hin- thar, Ma-chit-su and Yin-kwe are the popular varieties in Myanmar. Sein-ta-lone is the most important fruits for local consumption as well as for export market, because it has high sweetness level and unique taste, fibre free and aroma.

The females insert eggs in small clusters inside the mesocarp of the fruits. Then, ovipunctures and oozing of fluid. After hatching larvae feeds on the pulp which appears normal from outside. Brownish rotten patches on fruits. Fruits, finally drops down. Thus, adults attack the fruits by ovipositing and larvae (maggots) pollute and destroy the fruits by feeding on the pulp. The larvae pupate in soil and flies start emerging from April onwards with maximum population during May to July which coincides with fruit maturity. *B. dorsalis* is a serious pest of mangoes and other soft fruits in Myanmar and in several parts of the world (Jayanthi and Verghese, 2002).

Infested fruits are unmarketable and sometimes it causes total losses if it is not controlled by suitable insecticide or the fruits are not bagged. Therefore, the fruit fly plays an important role in fruit production for domestic consumption and export as well. Insect species are capable of survival only within certain environmental limits and when possible, individual actively seek out preferred temperature, humidity and light intensities. Of the environmental factors, temperature probably has the effect on insect's development rates. Development rate increases with temperature (Pedigo, 2002). Although Oriental Fruit Fly has recently become an important insect pest of mango, the various factors affecting the survival of the developmental stages of *B. dorsalis* have not been extensively studied. So, mango cultivators need to know the most destructive stage of *B. dorsalis* on mango.

By taking above the consideration, the present study was conducted with the following objectives;

- to investigate the developmental stages of *B. dorsalis* during the study period
- to record mortality and survival of Oriental Fruit Fly *Bactrocera dorsalis*

## Materials and Methods

### Study area and study sites

The study site was chosen, at Pyithayar, Meiktila Township, Mandalay Region. The study area was situated between 20° 54' and 20° 55' N, and between 95° 49' and 95° 54' 2" E (Plate.1).

Site A was Agricultural Garden and it has a total area of 12.14 $km^2$. Among these, mango plantation covers 4.29 $km^2$ and consists of 1190 trees.

Site B was Win Win Mango Garden and it has a total area of 6.88 $km^2$ consisting 207 mango trees. The main variety of mango in these two orchards (Study Site A and B) are Sein-ta-lone (Plate.1 A, B).

### Study period

Study period lasted from May to July 2014.

### Sample collection

For life cycle of fruit fly, fallen fruits were collected during the fruit season from May to July 2014, at two study sites (Site A and Site B). Infested fruits (mangoes) were kept in screened container, under which kept the plastic basin to collect the liquid from oozing fruits. There are three larval stages (instars). Among the larvae (first, second, third) (maggot) from the infested fruit, the first larvae were taken out together with some pulp of the fruits and they were reared in cups. The second larvae were also reared as the first larvae. Then the third larvae were separately kept in the plastic containers (boxes) measuring (15x10x8) cm containing fine moist sawdust to pupate. Before using the sawdust, they were sieved to retain only fine particles for larvae to pupate.

The container was checked daily and recorded any sign of pupation. Larvae were not handled and disturbed if not necessary. After pupation period, pupae (dark-brown color pupae) were collected when at least a few days old by gently sieving the sawdust and were stored in the large screened cage (45x25x35) cm for pupae to emerge into adult. The large cage was layered with 1 cm moistened sawdust for eclosion. The room temperatures (30°C - 34°C) were placed in the cage for the adult survival. Then the individuals were counted and rate of survival and mortality were calculated in five replications (I, II, III, IV and V).

**Identification**

Identification and classification were followed by Borror *et al*., (1992), Hill (1983).

Site (A) Agricultural Garden

Site (B) Win Win Mango Garden

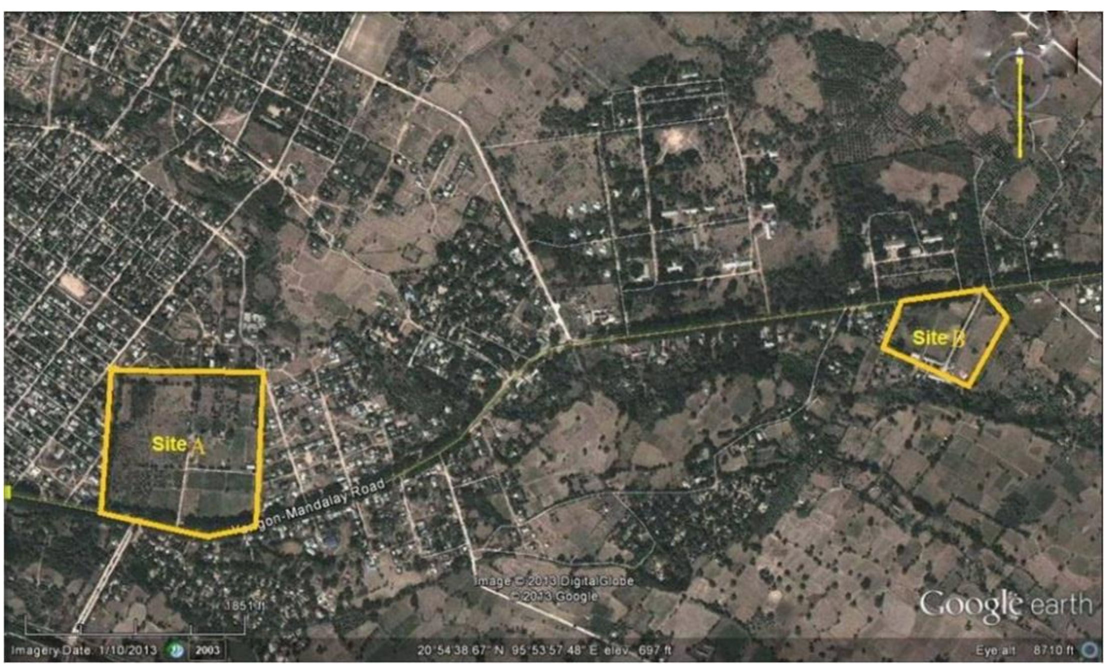



Plate. 1 Map of study area and study sites (Source: Google Earth, 2013)

## Results

Life cycle, mortality and survival of Oriental Fruit Fly *Bactrocera dorsalis* were recorded during the study period from May to July 2014 (fruiting season).

**The life cycle of Oriental Fruit Fly *Bactrocera dorsalis* (Hendel, 1912)**

### 1. Oviposition

During the fruiting season, female flies insert eggs in small cluster inside the mesocarp of the ripen fruits. Ripe fruits are preferred by females for egg laying (Plate 2. A, B).

### 2. Egg

The egg of *B. dorsalis* is white to creamy color, measure about 0.8 mm long and 0.2 mm wide. Eggs hatch within 2 days at room temperature and relative humidity. Brownish rotten patches on fruits were found. Fruit finally drops down (Plate 2.E).

### 3. Larva

After hatching larva feeds on the pulp which appears normal from outside. There are three larval stages (instars). The larva of fruit fly is elongated, legless, cylindrical- maggot shape, anterior end narrowed, flattened caudal end, and creamy white color. The mouth is at the pointed end of the body. In mangoes the maggots took longer duration for development before pupating. Larval feeding damage in fruits is the most damaging.

#### i. First instar

The larvae that hatch initially are small and delicate 1$^{st}$ instar (first larva). The body of the first instar is about 4 mm in length and 1 mm width. The anterior part of the body is white and is dull yellow. In this stage, the maggot is transparent in appearance.

Only the anterior part can move in this stage. The duration period of the first larva is three days (Plate 2.F).

#### ii. Second instar

They molt into slightly more robust second instar larvae. The 2$^{nd}$ instar is 5 mm in length and 1-1.5 mm width. The body changes into creamy color. The dark stripe occupies on the mid-ventral of the 2$^{nd}$ larva. In this stage, all segments become distinct. The caudal region is also clear in appearance. The body consists of 11 segments. The duration period of second instar is four days (Plate 2. G).

**iii. Third instar (Prepupa)**

These in turn molt into quite stout and tough third instar larvae. The body is 7 mm in length and 1.5-2 mm width. The only band of spinules encircling the body is found on the first segment. The first and the second larvae occurred in pulp of the rotten fruit. At the larva reached the third stage, it stopped feeding and comes out of the fruit to pupate. Because the 3$^{rd}$ stage of larvae has been finished the feeding stage.

After completing larval development, the larvae leave the host fruit, and entered into the sawdust. In this stage the larva is very jumpy it can jump away about 0.33 metre. The duration period of third instar is four days at room temperature and relative humidity. Thus, in this present study, the entire larval stages lasted for 11 days (Plate 2. H).

**4. Pupa**

After completing larval development, the mature larva emerges from the fruit, they were then put into the moistened and fine sawdust. After a short period larva burrowed into the sawdust, and then its body become shorten and ceases to move. The cuticle then transforms into which is initially soft and white but soon hardens, turning tan and eventually into brown and brittle, forms a tan to dark-brown pupa and they are seeds like 4-9 mm in length.

Each larva forms a hard, brown barrel-like shell from its skin. Inside this case the pupa develops into a fly. Among the pupae the tan-color of pupae are the immature and the dark-brown are mature stages that hatch into adult fly. In the present study, the pupation period lasted 9-11days (Plate 2.I).

**5. Adult**

Adult flies emerge from the puparium on to the sawdust surface. Development from egg to adult takes 22-24 days. Upon emergence the adult soon starts looking for the nourishment. It needs to reach sexual maturity, copulate and lay eggs.

The adult has a body length of about 6-8 mm, the wing is about 7.3 mm in length and is mostly hyaline. The upper margin of hyaline wing is blackish. The color of the fly is very variable, but there are prominent yellow and dark-brown to black markings on the thorax.

Generally, the abdomen has two horizontal black stripes and a longitudinal medium stripe extending from the base of the third segment to the apex of the abdomen. These markings may form a T-shaped and occupy in 3rd segment of abdomen. T-shaped pattern on the abdomen is the distinctive character of the oriental fruit fly. The female has a pointed slender ovipositor use to deposit eggs under the skin of host fruit (Plate 2. K&L).

The emergence of the fruit fly starts from April onwards and maximum population is reached in May to July.

Survival and mortality of Oriental Fruit Fly in five replications (I to V) were conducted in the laboratory of Department of Zoology, Meiktila University. Five replications were investigated from May to July, 2014.

The initial number of individuals were the same (20) individuals in the five replications, entering the early stages was summarized, the number of dead larvae, the percentage of mortality and the percentage of survival were shown in (Table.1-5). The stages observed in this study were the first instar or neonate, the second instar and third instar larval stages, pupal stages and adult stages.

The numbers of mortality were generally high between first instar and second instar in five replications of this investigation (Table 1-5). The mortality of first instar steadily increased from first to second instar stage. The mortality declined sharply from second to third instar stage. Mortality was found to be highest at first instar larvae and then, slowly decreased from second instar to adult stage. According to observation, the number of first larvae 20 was same in five replications. The highest mortality was observed in the first stage. The number of dead first instar larva ranged from 12-14 in the present study (Table 1-5).

According to the observation of present experiment, the results of present study revealed that percentage of high mortality was found the first instar larval stage (Table.6).Newly hatched larvae were difficult to find because of their small size and nature of living inside the fruit pulp. The survival was very low in this stage.

In five replications, the highest mortality percentage occurred in 1stinstar larva and the highest survival percentage occurred in pupa (Table. 6&7).

Table 1. Life cycle of Oriental Fruit Fly *Bactrocera dorsalis* in laboratory (Replication I)

| Stages | No. of individuals | No. of Dead individuals | % of Mortality | % of Survival |
|---|---|---|---|---|
| 1st instar larva | 20 | 13 | 65 | 35 |
| 2nd instar larva | 7 | 2 | 29 | 71 |
| 3rd instar larva | 5 | 1 | 20 | 80 |
| Pupa | 4 | 0 | 0 | 100 |
| Adult | 4 | 0 | 0 | 100 |

Table 2. Life cycles of Oriental Fruit Fly *Bactrocera dorsalis* in laboratory (Replication II)

| Stages | No. of individuals | No. of Dead individuals | % of Mortality | % of Survival |
|---|---|---|---|---|
| 1st instar larva | 20 | 12 | 60 | 40 |
| 2nd instar larva | 8 | 2 | 25 | 75 |
| 3rd instar larva | 6 | 1 | 17 | 83 |
| Pupa | 5 | 1 | 20 | 80 |
| Adult | 4 | 0 | 0 | 100 |

Table 3. Life cycles of Oriental Fruit Fly *Bactrocera dorsalis* in laboratory (Replication III)

| Stages | No. of individuals | No. of Dead individuals | % of Mortality | % of Survival |
|---|---|---|---|---|
| 1st instar larva | 20 | 13 | 65 | 35 |
| 2nd instar larva | 7 | 1 | 14 | 86 |
| 3rd instar larva | 6 | 1 | 17 | 83 |
| Pupa | 5 | 0 | 0 | 100 |
| Adult | 5 | 0 | 0 | 100 |

Table 4. Life cycles of Oriental Fruit Fly *Bactrocera dorsalis* in laboratory (Replication IV)

| Stages | No. of individuals | No. of Dead individuals | % of Mortality | % of Survival |
|---|---|---|---|---|
| 1st instar larva | 20 | 14 | 70 | 30 |
| 2nd instar larva | 6 | 1 | 17 | 83 |
| 3rd instar larva | 5 | 0 | 0 | 100 |
| Pupa | 5 | 0 | 0 | 100 |
| Adult | 5 | 0 | 0 | 100 |

Table 5. Life cycle of Oriental Fruit Fly *Bactrocera dorsalis* in laboratory (Replication V)

| Stages | No. of individuals | No. of Dead individuals | % of Mortality | % of Survival |
|---|---|---|---|---|
| 1st instar larva | 20 | 13 | 65 | 35 |
| 2nd instar larva | 7 | 2 | 29 | 71 |
| 3rd instar larva | 5 | 0 | 0 | 100 |
| Pupa | 5 | 1 | 20 | 80 |
| Adult | 4 | 0 | 0 | 0 |

Table 6. Percentage of mortality of *Bactrocera dorsalis* in five replications

| Stages | I | II | III | IV | V | Mean |
|---|---|---|---|---|---|---|
| 1st instar larva | 65 | 60 | 65 | 70 | 65 | 65 |
| 2nd instar larva | 29 | 25 | 14 | 17 | 59 | 23 |
| 3rd instar larva | 20 | 17 | 17 | 0 | 0 | 11 |
| Pupa | 0 | 20 | 0 | 0 | 20 | 8 |
| Adult | 0 | 0 | 0 | 0 | 0 | 0 |

Table 7. Percentage of survival of *Bactrocera dorsalis* in five replications

| Stages | I | II | III | IV | V | Mean |
|---|---|---|---|---|---|---|
| 1st instar larva | 35 | 40 | 35 | 30 | 35 | 35 |
| 2nd instar larva | 71 | 75 | 86 | 83 | 71 | 77 |
| 3rd instar larva | 80 | 80 | 83 | 100 | 100 | 89 |
| Pupa | 100 | 80 | 100 | 100 | 80 | 92 |
| Adult | 100 | 100 | 100 | 100 | 100 | 100 |

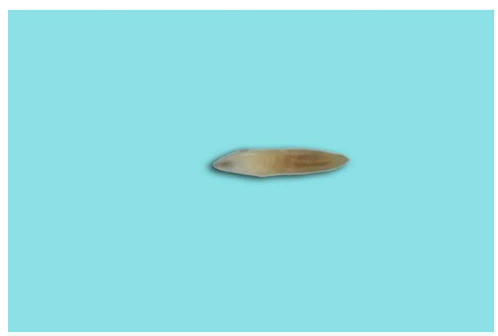
(A) Oviposition

(B) Ovipositing on damaged fruit

(C) Fallen fruits in screened container with plastic basin

(D) Rearing cage for adult

(E) Egg



(F) 1st instar larva

Plate 2. Rearing apparatus and life cycle of *Bactrocera dorsalis*

(G) 2nd instar larva

(H) 3rdinstar larva


(I) Pupa

(J) Mass of Pupae

(K) Adult (male)

(L) Adult (female)

Plate 2. Contd.

## Discussion

Life cycle, mortality and survival of Oriental Fruit Fly *Bactrocera dorsalis* was recorded during the study period from May to July 2014 (fruiting season).

Various scientists have reported the incubation period of Oriental Fruit Fly egg as 38 hr (Dekker and Messing 2008), 1-1.5 days (Mau and Matin 2007), and 1-2 days (Christenson and Foote 1960; Fletcher 1987). In the present study the incubation period lasted for two days. Therefore, it was relatively longer than that of the previous report by Mau and Matin,2007 and Dekker and Messing 2008. However, it was similar to report by Christenson and Foote 1960; Fletcher 1987.

The entire larval stages lasted (11-15) days (Christenson and Foote 1960; Ekesi *et al.*, 2006; Mau and Matin 2007). The findings of the present study indicated larval duration was similar to previous reports by (Christenson and Foote 1960; Ekesi *et al*., 2006 and Mau and Matin 2007). In the present study the entire larval stages lasted for (11) days, however, was much longer than the report by Dekker and Messing (2008) who observed that larvae develop in seven days.

Fletcher (1987) recorded that pupation period lasted 10-11 days at 25°C. Christenson and Foote (1960) found that pupation period lasted 1-2 weeks, but longer in cool conditions. In the present study, pupation period lasted 9-11days. So, the finding of present study was similar to the reports by Fletcher (1987) although shorter than the reports by Christenson and Foote (1960).

One complete generation takes about 37 days at 25°C (Saeki *et al*.1980). In the present study, the development from egg to adult lasted 22-24 days at 30°-34°C. Thus, the findings of present study are not similar to the above findings. Findings from the present study was similar to the report by Vargas *et al.*, (1991) and Cornelius *et al.*, (1999) who reported that ripe mangoes have more attractive characteristics to female *B. dorsalis* than unripe mangoes. The same kind of occurrence of fruit fly was also recorded in the present study.

## Conclusion

life cycle of fruit fly *Bactrocera dorsalis* at high temperature was faster than at low temperature. On the other hand, the life cycle of insect depends on the temperature. Above the consideration, the cultivators may notice the time that abundance of fruit flies. The findings from this study on the life cycle of Oriental Fruit Fly provide information to the important stages causing damage to mango. Thus, ability to predict the most injurious stages and times by Oriental Fruit Fly depends on the knowledge of its life cycle. Consequently, the cultivators may prevent from the destructive of pests on crops so that fruit production will be good for domestic consumption and marketable for export.

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