



## BIOLOGY OF MELON FRUIT FLY *BACTROCERA CUCURBITAE* (COQUILLET) ON CUCUMBER

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### ABSTRACT

The laboratory studies on the biology of melon fruit fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) on cucumber revealed that eggs were shiny white, nearly flat on the ventral surface and their length and breadth were  $1.29 \pm 0.05$  and  $0.27 \pm 0.02$  mm, respectively while, the incubation period was  $1.50 \pm 0.51$  days with  $81.41 \pm 3.61\%$  hatching. The apodous maggot was creamy-whitish and measured  $8.45 \pm 0.40$  and  $1.62 \pm 0.15$  mm in length and breadth, respectively while, the total maggot period was  $6.70 \pm 0.66$  days. The puparium measured  $5.70 \pm 0.47$  and  $2.39 \pm 0.22$  mm in length and breadth, respectively. The length and breadth with expanded wings of the male were  $6.42 \pm 0.55$  and  $13.50 \pm 0.66$  mm, respectively whereas, in the case of the female these were  $7.89 \pm 0.58$  and  $14.32 \pm 0.65$  mm, respectively. Moreover, the total life period of the female fly was recorded as  $38.23 \pm 2.80$  days, while for the male it was  $34.78 \pm 1.56$  days.

**Key words:** *Bactrocera cucurbitae*, tephritid fly, morphology, life stages, insect rearing, incubation, maggots, pupation, fecundity, behavior, morphometrics, trinocular microscope

Cucumber (*Cucumis sativus* L.) is a widely cultivated crop of the family Cucurbitaceae. It is attacked by several insect pests viz., red pumpkin beetle (*Aulacophora foveicollis* Lucas), leaf miner [*Liriomyza trifolii* (Burgess)] and cucurbit stink bug [*Cordius janus* (F)] at the seedling stage while by melon fruit flies at the fruiting stage (Ram et al., 2009; Gaddanakeri and Rolania, 2020). It has been reported that more than seventy species belonging to the genus *Bactrocera* are regarded as a primary pest of crops throughout the world (Saeed et al., 2022). Among them, *B. cucurbitae* is one of the most damaging species to cucumber. Moreover, a wide range of distribution, broad host range and long adult reproductive life are the main reasons for these serious causes and the decline in the production of cucumber (He et al., 2023). The mated gravid adult female fly causes oviposition injury to green mature fruits that are close to harvest and lays eggs under the tender skin of fruits. The puncture made by egg laying serves as a site of secondary infection by pathogens causing rotting, premature falling and decreased quality of fruits (Khan and Hugar, 2019; Subedi et al., 2021). The infested cucumber fruit looks deformed and loses nutritional quality which affects the quality and quantity of produce adversely. Also being a quarantine pest *B. cucurbitae* poses a serious threat to import and export opportunities. Therefore, the present study on

the biology of *B. cucurbitae* infesting cucumber was carried out to know the activities of various life stages and their significant effects on the cucumber.

### MATERIALS AND METHODS

The initial culture of *B. cucurbitae* was raised by collecting infested cucumber fruits from the local vegetable market. Infested cucumber fruits were kept in a plastic rearing tray on a 5.00 cm thick layer of sieved moist sand to obtain the puparium at the postgraduate research laboratory of the Department of Entomology, N M College of Agriculture, Navsari Agricultural University, Navsari between February and April 2022 ( $27 \pm 2^\circ\text{C}$ ,  $70 \pm 10\% \text{RH}$ ). The top of a plastic rearing tray was covered with a white muslin cloth to prevent the maggots from escaping. Sand in the plastic rearing tray was sieved after every six to seven days to collect the puparium. Thereafter, each puparium was transferred to a clean plastic Petri plate individually. Freshly emerged adult males and females were paired and confined into glass jars. The glass jar was covered with white muslin cloth tightened with a rubber band to prevent the adults from escaping. A cotton swab containing a 5% honey solution and semi-solid food of protein powder was suspended inside the glass jar as a food source for the adult flies. One physiologically mature cucumber

fruit was placed inside the glass jar for oviposition by a female. The cucumber fruit was replaced after observing the oviposition puncture. Twenty small cucumber fruit pieces having eggs were smoothly cut and transferred in a separate petri plate and observed twice a day (morning and evening) daily till hatching. Eggs were considered hatched when tiny maggots came out of them and observations about the hatching and the incubation period were taken. Twenty neonate maggots were gently transferred to a fresh fruit slice and reared till they undergo pupation. The observations regarding the total maggot period, pre-puparium and puparium period, pre-oviposition, oviposition and post-oviposition period, total longevity of male and female, sex ratio, fecundity and total life cycle were recorded. The morphological parameters like color and shape of twenty replicates of each stage viz., egg, maggot, pre-puparium, puparium and adult (male and female) were observed using binocular microscope Olympus SZ-61 while, the trinocular microscope (SZ-61; make: Olympus) attached to the software scope photo (Version 3.1) was used for measuring the length and breadth of egg, maggot, puparium and adult (male and female) stages. The data on temperature and relative humidity

were recorded daily during the entire investigation period by using a digital thermo-hygrometer. The data on different parameters were statically analyzed.

## RESULTS AND DISCUSSION

The gravid adult female fly made punctures on the skins of young, soft and tender cucumber fruits by her ovipositor and delivered eggs in clusters of five to nine. The newly laid eggs were shiny white, translucent, elongated elliptical, nearly flat on the ventral surface and slightly curved like a grain of rice. Morphometric studies revealed that the length and breadth of the egg varied from 1.22 to 1.34 mm and 0.23 to 0.29 mm, respectively. The duration of development between egg laying and hatching (incubation period) was very short and it varied from 1.00 to 2.00 days. Moreover, the average hatching ranged from 72.16 and 86.36% (Table 1). Present findings are in agreement with the report of Desai et al. (2018) who revealed that the average length and breadth of an egg of *B. cucurbitae* were  $1.30 \pm 0.08$  mm and  $0.25 \pm 0.05$  mm when reared on the pumpkin. The damaging stage, apodous maggot, passed through three distinct instars. The third instar maggot

Table 1. Biology and morphometrics of *B. cucurbitae* reared on cucumber

| Sl. No. | Life stage               | Particulars                    | Min.  | Max.  | Mean $\pm$ SD     |
|---------|--------------------------|--------------------------------|-------|-------|-------------------|
| 1.      | Egg                      | Incubation period (days)       | 1.00  | 2.00  | 1.50 $\pm$ 0.51   |
|         |                          | Hatching (%)                   | 72.16 | 86.36 | 81.41 $\pm$ 3.61  |
|         |                          | Length (mm)                    | 1.22  | 1.34  | 1.29 $\pm$ 0.05   |
|         |                          | Breadth (mm)                   | 0.23  | 0.29  | 0.27 $\pm$ 0.02   |
| 2.      | Maggot                   | Total period (days)            | 6.00  | 8.00  | 6.70 $\pm$ 0.66   |
|         |                          | Length (mm)                    | 7.73  | 9.16  | 8.45 $\pm$ 0.40   |
|         |                          | Breadth (mm)                   | 1.39  | 1.88  | 1.62 $\pm$ 0.15   |
| 3.      | Puparium                 | Total period (days)            | 6.00  | 9.00  | 6.95 $\pm$ 0.89   |
|         |                          | Length (mm)                    | 4.81  | 6.44  | 5.70 $\pm$ 0.47   |
|         |                          | Breadth (mm)                   | 2.02  | 2.72  | 2.39 $\pm$ 0.22   |
| 4.      | Adult male               | Longevity (days)               | 10.00 | 18.00 | 13.75 $\pm$ 2.40  |
|         |                          | Total life cycle (days)        | 32.00 | 38.00 | 34.78 $\pm$ 1.56  |
|         |                          | Length (mm)                    | 5.63  | 7.48  | 6.42 $\pm$ 0.55   |
|         |                          | Breadth (mm)                   | 12.34 | 14.56 | 13.50 $\pm$ 0.66  |
| 5.      | Adult female             | Pre-oviposition period (days)  | 8.00  | 13.00 | 10.30 $\pm$ 1.22  |
|         |                          | Oviposition period (days)      | 2.00  | 7.00  | 4.90 $\pm$ 1.33   |
|         |                          | Post-oviposition period (days) | 1.00  | 3.00  | 1.75 $\pm$ 0.79   |
|         |                          | Fecundity (No. of eggs/female) | 46.00 | 97.00 | 65.25 $\pm$ 11.88 |
|         |                          | Longevity (days)               | 13.00 | 20.00 | 17.00 $\pm$ 2.20  |
|         |                          | Total life cycle (days)        | 33.50 | 44.00 | 38.23 $\pm$ 2.80  |
|         |                          | Breadth (mm)                   | 7.53  | 8.54  | 7.89 $\pm$ 0.58   |
| 6.      | Sex ratio (male: female) |                                | 0.33  | 4.00  | 0.97 $\pm$ 0.85   |

All the values mean of twenty samples (n) except sex ratio, which is considered from five samples.

was creamy-whitish, and had a bilobed and eleven-segmented body. It possessed a pair of very distinct, black mandibles or mouth hooks that were retractile and extended outside the body at the time of feeding. It also exhibited a peculiar habit of curving and springing into the air by the sudden relaxation of certain muscles. The maggot continued to jump after leaving the host until they found a suitable place for pupation. Almost similar observations about colour and behaviour were made by Sohrab et al. (2018), Khan and Hugar (2019) and Pradhan et al. (2020). It was evident from the data (Table 1) that the length of mature maggot ranged from 7.73 to 9.16 mm while, breadth varied from 1.39 to 1.88 mm. Moreover, the duration of the maggot varied from 6.00 to 8.00 days. Present findings were nearly in conformation with the findings of Das et al. (2017), Sohrab et al. (2018), Gaddanakeri and Rolania (2020) who recorded that on bitter gourd total maggot period of *B. cucurbitae* ranged from five to seven days, with a mean of  $5.80 \pm 0.78$  days. The mature maggot formed a protective covering or circular case for pupa from third instar maggot skin so, that the markings of the maggot found on the puparium. Maggot was found pupating inside the sand layer of the rearing tray in the laboratory. Just after the formation of the puparium, the colour was pale brown that turned reddish brown to yellowish brown later on as the eclosion approached. It was elliptical, barrel, or cylindrical shaped and had eleven distinct segments, which were distinctly ringed by narrow yellow bands around each segment. The above findings were supported by Khan and Hugar (2019), and Gaddanakeri and Rolania (2020) who revealed that the puparium was barrel shaped with a black dot on the posterior portion and yellowish to deep brownish yellow when freshly formed and the color changed to a brownish grey as the eclosion approached. Looking at the data presented in Table 1 about morphometric studies it can be seen that the length of the puparium varied from 4.81 to 6.44 mm, while the breadth varied from 2.02 to 2.72 mm. Moreover, the duration of the puparial period varied from 6.00 to 9.00 days. Present data are corroborated by the findings of Gaddanakeri and Rolania (2020) who recorded that the length and breadth of puparium ranged from 5.30 to 6.45 mm ( $5.98 \pm 0.38$  mm) and 2.35 to 2.72 mm ( $2.54 \pm 0.14$  mm), respectively.

Adults emerged by breaking the puparium with the help of ptilinum. These were moderate in size, with three reddish brown or lemon-yellow curved markings (vittae) on the dorsal surface of the mesothorax and a distinctive black “T” shaped pattern at the base of the

abdomen of both sexes. The adult female was easily distinguishable by the presence of a tapering abdomen extending into a pseudo-ovipositor, while the adult male had a blunt abdomen due to the absence of a pseudo-ovipositor. The head was yellowish with black spots and compound eyes. The forewings of both sexes were membranous and the hindwings were modified into smaller halteres. On the apical margin (outer margin) of the forewing, greyish-brown patches, fuscous shading, and black bands on the radio-medial veins were observed. The mouth parts of adult fly were sponging type and it fed primarily upon the protein sources like juices of host plants, nectar and honeydew secreted by various kinds of insects. Adults had aristate antennae with a long third antennal segment bearing hair on it. Present findings are in complete agreement with the findings of Vigneswaran et al. (2016), Sohrab et al. (2018), Khan and Hugar (2019) and Pujar et al. (2024).

Data on morphometrics revealed that the female fly was bigger than her male counterparts because the length of the male fly varied from 5.63 to 7.48 mm and the breadth with expanded wings varied from 12.34 to 14.56 mm. Whereas in the case of females, length varied from 6.53 to 8.92 mm and breadth with expanded wings varied from 13.17 to 15.34 mm. The result of adult length and breadth with wing expanse is more or less similar to Mir et al. (2014) and Pradhan et al. (2020) who found that the male fly ranged between 7.22 and 7.66 mm and 11.36 and 11.82 mm in length and breadth (stretched wings), respectively while, female fly length ranged from 9.70 to 10.05 mm and breadth (stretched wings) ranged from 15.12 to 15.67 mm. After mating the adult female fly took 8.00 to 13.00 days for egg laying (pre-oviposition period). Moreover, the period in which adult females continued to lay eggs (oviposition period) varied from 2.00 to 7.00 days. After completion of egg laying female just lived about 1.00 to 3.00 days (post-oviposition period) (Table 1). The findings of the present investigation are in close confirmation with the findings of Sisodiya and Jhala (2009), Vigneswaran et al. (2016), Desai et al. (2018) and Patel and Patel (2018) who also recorded similar observations regarding above said periods. Based on morphological characters mentioned earlier the adults were differentiated into their respective sexes. The sex ratio (male: female) was found to be female biased that varied from 0.25 to 3.00 (1:1.27). However, previously Desai et al. (2018) and Gaddanakeri and Rolania (2020) stated that sex ratio was male oriented when *B. cucurbitae* reared on sponge gourd (1:0.93) and bitter gourd (1:0.93). Moreover, the fecundity i.e., egg laying

capacity of mated gravid females varied from 46.00 to 97.00 eggs/female. Pradhan et al. (2020) observed that *B. cucurbitae* laid a higher (77.50 eggs) number of eggs/ female on the bitter gourd and a lower (48.06 eggs) number of eggs/female on the bottle gourd. Adult females lived longer (13.00 to 20.00 days) than their male counterparts (10.00 to 18.00 days). Whereas, the total life cycle duration of males was shorter (32.00 to 38.00 days) than that of females (33.50 to 44.00 days) (Table 1). Past observations made by Desai et al. (2018), Khan and Hugar (2019) and Gaddanakeri and Rolania (2020) ascertained that the period from egg to death of the adult *B. cucurbitae* varied from male to female and also on the host on which it was reared.

From this study, it could be concluded that the biological and morphological description of *B. cucurbitae* will be useful for the identification of various life stages viz., egg, maggot, puparium, adult male and adult female under field conditions. Overall, it will be useful to distinguish *B. cucurbitae* from other species of fruit flies. Furthermore, the maggot and adult life span, nature of damage and damaging stages, and weak link/ target stage of *B. cucurbitae* will be useful for the planning of integrated management strategy under field conditions.

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#### AUTHOR CONTRIBUTION STATEMENT

CKV and AK conducted experiment and analyzed data. CKV wrote the manuscript. SRP Planned, designed and supervised the study. All authors read and approved the manuscript.

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#### CONFLICT OF INTEREST

No conflict of interest.

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