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Biology and morphometry of melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) in different cucurbitaceous hosts

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Abstract

The melon fruit fly, *Zeugodacus cucurbitae* (Diptera: Tephritidae), is considered as catastrophic pest in most of the cucurbitaceous vegetable crops. It is denoted as an economic pest and yield misfortune up to 50-70% depends upon the host's environmental condition and its weakness. During their entire life period, major portion they live inside the host. Matured females lay eggs in the skin of the host, and the cycle is continued. Only after completion of maggot stage, the pupa comes out from fruit to become an adult. For the better management of fruit fly, an investigation related with habitat based variation in its biology is a need. For this reason, the laboratory experiment was conducted at Department of Plant Protection, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirappalli during November 2019 to January 2020. The biology and morphometry of different life stages of the melon fruit fly, *Zeugodacus cucurbitae* were carried out in snake gourd, bitter gourd, and ridge gourd host, at a temperature $25 \pm 2^\circ\text{C}$ and relative humidity $65 \pm 5\%$ to assess the variation in its life cycle. The results obtained in this laboratory experiment under a controlled atmosphere indicated that mean length and breadth of the egg (0.66 ± 0.08 mm, 0.13 ± 0.01 mm), first instar (1.10 ± 0.08 mm, 0.19 ± 0.01 mm), second instar (4.93 ± 0.09 mm, 0.79 ± 0.02 mm), third instar maggot (8.34 ± 0.14 mm, 1.51 ± 0.03 mm), prepupal (6.22 ± 0.11 mm, 1.83 ± 0.06 mm) and pupal period (5.69 ± 0.38 mm, 2.05 ± 0.08 mm) was maximum in bitter gourd host compared to snake gourd and ridge gourd. Similarly mean length and breadth of adult male (5.82 ± 0.07 mm, 10.43 ± 0.11 mm) and female (7.81 ± 0.11 mm, 12.34 ± 0.30 mm) was high in ridge gourd. On Comparing the other host, the egg period, first instar, second instar, third instar, prepupa, and pupal period was minimum in bitter gourd 1.45 ± 0.76 days, 0.70 ± 0.25 days, 2.85 ± 0.74 days, 4.3 ± 0.85 days, 0.80 ± 0.25 days, and 8.25 ± 0.82 days, respectively. The longevity of male and female flies was higher in ridge gourd host with 20.60 ± 4.35 days and 21.40 ± 3.20 days, respectively. The observation parameters registered on the biology of *Z. cucurbitae* in different cucurbitaceous hosts showed that the developmental duration was varied depends on host and adult longevity is maximum (20.60 ± 4.35 days in male, 21.40 ± 3.20 days in female) in ridge gourd.

Keywords: Snake gourd, bitter gourd, ridge gourd, *zeugodacus cucurbitae*, biology and morphometry

Introduction

Fruit flies (Tephritidae: Diptera) are one of the most fascinating gathering of creepy crawlers or crawlies called 'peacock flies' because of their propensity for swaggering and vibrating their wings and rank among the world most genuine nuisance in green harvests (Gopaul *et al.*, 2000; Kapoor, 1993)^[6,9]. The subgenus *Zeugodacus cucurbitae* is the economically important species in the genus *Bactrocera* (Biswas *et al.*, 2007; Dhillon *et al.*, 2005; Verghese *et al.*, 2006)^[2, 3, 17]. It infests nearly 70 host plants; among these, bitter gourd (*Momordica charantia* L.), snake gourd (*Trichosanthes angina* L. and *T. cucumerina* L.), muskmelon (*Cucumis melo* L.), and snap melon (*Cucumis melo* var. *momordica* Roxb.) are the most preferred host (Doharey, 1983)^[4]. Beating of posterior abdomen beating and wing vibration behavior in *Z. cucurbitae* were related to pheromone emission to attract virgin females (Kuba and Koyama, 1982)^[10]. Typically, females like to lay eggs underneath the epidermis in the green fruits up to 2 - 4 cm profound utilizing a sharp ovipositor. Sometimes pseudo punctures also seen in fruit without egg-laying. The eggs are additionally laid in unopened blossom buds, and maggots grew effectively in stems, taproots, and leafstalks (Weems and Heppner, 2001)^[20]. After hatching, maggots feed in the pulp portion by making galleries. Brown watery fluid exerts from a fruit surface, and logically, fruits become concave and rotten. The full-grown larva comes out by making exit holes and fall down into ground, pupate in the soil at a depth of 0.5 to 15 cm (Jackson *et al.*, 1998; Pandey and Mishra, 1999)^[8, 13].

This reduces the availability and marketing quality of the fruit. The management of fruit fly is troublesome because of its characteristics of polyphagous, multivoltine, adult with high mobility, fecundity, and unexposed developmental stages (Sharma *et al.*, 2011) ^[16]. In management aspects, the assessment and deriving of basic datas on its biology, development, morphometry, ecology and habitat oriented changes may highly useful to frame out and execute the proper management tactics in time. Hence, considering the importance of host factors on the biology of fruit flies, the morphometric studies were undertaken in varied cucurbitaceous hosts.

Materials and Methods

Fruit fly culture maintenance in laboratory

The initial cultures of *Z. cucurbitae* were gathered from field collected infested fruits of the different cucurbitaceous host in the weight of one Kg. The fruits were chosen depends on the ovipositional penetrates present on the host skin. The collected fruits were kept on the moist sand in medium-sized plastic trays (28 cm x 23 cm x 7 cm) to encourage the pupation. Following 5-6 days, the pupae were grouped from the sand and kept in 10 cm diameter Petri plates containing a moist filter paper. The petri plates were kept inside the rearing cage (35 cm x 30 cm x 35 cm) have shutter on three sides utilizing wire mesh, top portion comprised of glass and a solitary entryway is put on the front side for the utilization of assortment and giving food to adults. Developed adults from pupae were taken care of with 5% glucose solution. The glucose solution was inundated in the water absorbed cotton and kept inside the petri plates. The food source was changed at regular intervals to keep away from mold growth. The cultures were maintained in controlled atmosphere at $25 \pm 2^\circ$ C temperature and $65 \pm 5\%$ relative humidity.

Biology study

Tender fruits of snake gourd, bitter gourd, and ridge gourd were cut into slices and kept inside the rearing cage containing matured adults for oviposition. The eggs laid in the fruits were gathered day by day in the early daytime by using a needle and harmless feather hairbrush touch under the microscope. The eggs collected from the sample (50 eggs) were kept inside the 10 cm diameter petri plates containing a

moist filter paper (Mir *et al.*, 2014) ^[12]. Every 12 hours, the egg was monitored to record the incubation period. After hatching, the maggots were replaced in the petri plates containing fruit pulps of the host. The pulp in the petri plate was changed daily; at the same time, when maggots stop feeding, it changed in the plastic container filled with conditioned sand soil media to facilitate pupal formation. The sand was sieved daily to observe and record the pre-pupal and pupal period. After the fly emergence, the fruit flies were transferred to the rearing cage fed with 5% glucose solution. The observations on egg, maggot, and pre pupal, pupal and adult period were recorded in daily intervals.

Morphometry analysis

For the morphometric measurements, randomly selected ten replications from each host were utilized. The length and breadth of taken samples were measured using ocular and stage micrometer under the ocular microscope with 10x magnification. The length and breadth of egg, first instar, second instar, third instar, prepupal, pupa, adult male, and adult female were recorded. The observed and recorded parameters were analyzed statistically by using Microsoft excel software.

Results and Discussion

Biology

Egg

Z. cucurbitae eggs were elongated in shape with glistening white. The anterior portion of the egg is sharp, and the posterior end is blunt in appearance. The eggs were laid in batches contains 6-8 eggs in one laying. The egg incubation period was 2.90 ± 1.39 days in snake gourd, 1.45 ± 0.76 days in bitter gourd, and 2.30 ± 1.22 days in ridge gourd with the range of 0.5-4.5 days, 0.5-2.5 days, and 0.5-3.5 days, respectively (Table 1). The incubation period of egg in bitter gourd was differentiated with 0.6-0.7 days from the earlier finding of Gupta and Verma, (1995) ^[7], they reported that the egg period was 1.1-1.8 days in bitter gourd. According to Barma and Jha (2011) ^[11] egg duration in pointed gourd varied depending on the environment and extended up to 2-5 days in June to July and 4-6 days in August to October. In current study, the egg period in snake gourd was recorded as 0.5-4.5 days.

Table 1: Life stages and its duration of the fruit fly, *Z. cucurbitae* on different cucurbitaceous hosts

| Stage | Snake gourd | | Bitter gourd | | Ridge gourd | |
|-------------------------|---------------|------------------|---------------|------------------|---------------|------------------|
| | Period (days) | | Period (days) | | Period (days) | |
| | Range | Mean \pm SD | Range | Mean \pm SD | Range | Mean \pm SD |
| Egg (Incubation period) | 0.5-4.5 | 2.90 \pm 1.39 | 0.5-2.5 | 1.45 \pm 0.76 | 0.5-3.5 | 2.30 \pm 1.22 |
| Maggot | | | | | | |
| I Instar | 0.5-1.5 | 1.00 \pm 0.33 | 0.5-1 | 0.70 \pm 0.25 | 0.5-1 | 0.80 \pm 0.25 |
| II Instar | 2-4 | 2.95 \pm 0.59 | 1.5-4 | 2.85 \pm 0.74 | 1-3.5 | 2.25 \pm 0.71 |
| III Instar | 3-6 | 4.40 \pm 0.93 | 3-5.5 | 4.30 \pm 0.85 | 4-6 | 5.05 \pm 0.59 |
| Pre pupa | 0.5-1.5 | 0.75 \pm 0.35 | 0.5-1 | 0.80 \pm 0.25 | 0.5-1.5 | 1.05 \pm 0.36 |
| Pupa | 8-10.5 | 9.25 \pm 0.85 | 7-9.5 | 8.25 \pm 0.82 | 7.5-9.5 | 8.60 \pm 0.69 |
| Longevity | | | | | | |
| Male | 14-19 | 16.50 \pm 1.77 | 15-21 | 18.50 \pm 1.95 | 16-29 | 20.60 \pm 4.35 |
| Female | 15-25 | 20.70 \pm 3.88 | 16-27 | 21.10 \pm 3.28 | 17-27 | 21.40 \pm 3.20 |

*Mean of 10 replications

Maggot

First instar

Maggots came out from the anterior portion of the host with a slight cut opening. Newly emerged first instar maggot was translucent white in colour, elongated, and apodous. The first instar maggot duration was shorter in bitter gourd (0.7 ± 0.25

days) and ridge gourd (0.8 ± 0.25 days). In snake gourd, maggot duration is 1.0 ± 0.33 days higher when compared with other hosts. The first instar period in bitter gourd and ridge gourd was between 0.5-1 day, and it was in confirmity with the earlier report of Mir *et al.*, (2014)^[12] in cucumber crop during June month in Jammu and Kashmir, India.

Second instar

The second instar maggots were slightly elongated, ellipsoidal shape with creamy white. The second instar duration in snake gourd was 2.95 ± 0.59 days, it was considered higher than maggots reared on bitter gourd (2.85 ± 0.74 days) and ridge gourd (2.25 ± 0.71 days) with a range of 2-4 days, 1.5-4 days, and 1-3.5 days, respectively.

Third instar

Third instar maggots contains a dark line longitudinally from mouth to anus. The black coloured mouth hooks were moved

front and backside at the time of feeding. Final instars have the habit of jumping by curving the muscles. The maggot period was longer in ridge gourd 4-6 days (5.05 ± 0.59 days), the data was close conformity with Patel and Patel (2018)^[14], related third instar maggot in bottle gourd and ridge gourd were 4-6 days and 4-7 days respectively. The snake gourd and bitter gourd take 3-6 days (4.40 ± 0.93 days) and 3.5-5.5 days (4.30 ± 0.85 days) for a complete third instar period. The total maggot period was registered as high in snake gourd (8.35 days) and low (7.85 days) in bitter gourd host (Fig. 1).

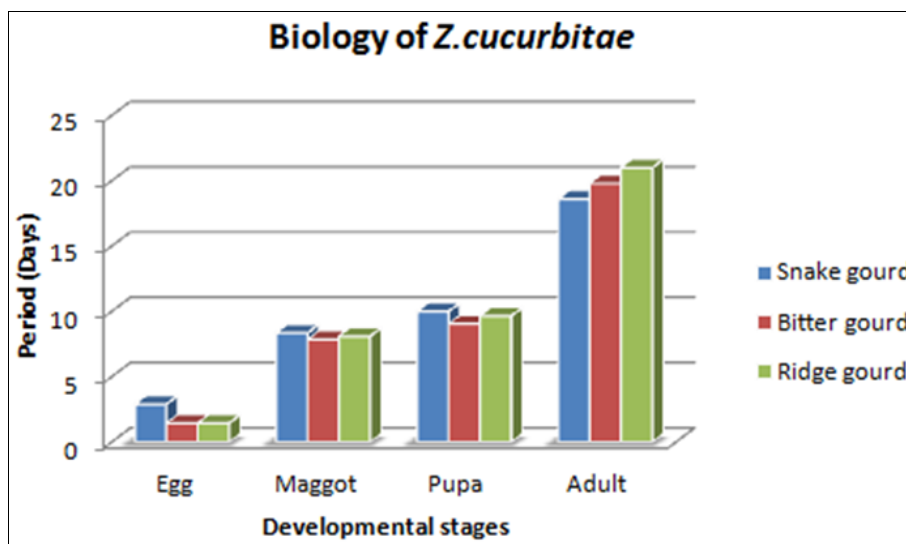


Fig 1. Biology of *Z. cucurbitae* in different cucurbitaceous hosts

Pre pupa and pupa

Fully matured final instar maggots stop feeding and become sluggish, slightly bent to form a prepupa. The prepupal stage of *Z. cucurbitae* in snake gourd, bitter gourd, and ridge gourd were 0.75 ± 0.35 days, 0.80 ± 0.25 days, and 1.05 ± 0.36 days with a range of 0.5-1 day, 0.5-1 day, and 0.5-1.5 days, respectively. Pre pupal period of melon fly in bitter gourd was slightly low compared to the earlier findings of Patel and Patel (2018)^[14] that the pre pupal duration in bitter gourd was 1.08 ± 0.277 days.

The pupation of fully grown maggots in the natural soil media conditioned plastic container was recorded at a depth of 2 to 12 cm, this observation is in accordance with the results of Pandey and Mishra, 1999^[13]. Pupa was 11 segmented, cylindrical shape with light yellow to dark brown in colour and small black dot present in the posterior portion. Pupal duration in snake gourd, bitter gourd, and ridge gourd were 9.25 ± 0.85 days, 8.25 ± 0.82 days and 8.60 ± 0.69 days, respectively. Pupal period of *Z. cucurbitae* in bitter gourd and ridge gourd ranged from 7-9.5 days and 7.5-9.5 days recorded in this study was in accordance with the reports of Gupta and Verma, (1995)^[7] in bitter gourd and sponge gourd with a slight variation that 7.7-9.4 days.

Adult

Newly emerged adults were observed less active and stuck their wings over the abdomen. It needs around 20-30 minutes to develop as a full adult. Normally, adult hatching was maximum in the morning time between 8-11 am. Fruit flies reddish-brown with lemon yellow marking in the vertical position in the mid dorsal line of the thoracic region. The fuscous shading in the outer margin of the wings of

Zeugodacus cucurbitae species is recorded and this taxonomical identical mark used to categorizes and differentiate the fly from other genus.

Male

The longevity of adult males in snake gourd was 16.50 ± 1.77 days, bitter gourd with 18.50 ± 1.95 days, and ridge gourd was 20.60 ± 4.35 days. In ridge gourd host, the male longevity (16-29 days) was higher, compared to bitter gourd (15-21 days) and snake gourd (14-19 days). The duration of male is lower compared to the findings of Gaddanakeri and Rolania (2020)^[5] that male longevity in bitter gourd was 23.7 ± 3.77 days.

Female

Female flies were slightly larger than the male with a sharp ovipositor in the posterior end. The longevity of females was longer in ridge gourd (21.40 ± 3.20 days) with the range between 16-29 days. In bitter gourd and snake gourd host, the longevity of females was almost similar with 21.10 ± 3.28 and 20.70 ± 3.88 days. The result was in conformity with the earlier reports of Gaddanakeri and Rolania, (2020)^[5] and Waseem *et al.*, (2012)^[19] on *Z. cucurbitae* female which have more longevity compared to male in bitter gourd and cucumber hosts.

Morphometry

Egg

The morphometric analysis of *Z. cucurbitae* eggs shown variation between hosts. Freshly laid eggs in snake gourd host measured from 0.42- 0.74 mm in length and 0.04-0.10 mm in breadth. The mean length and breadth of eggs were 0.53 ± 0.10 mm and 0.11 ± 0.01 mm. In the bitter gourd host, the

mean egg length (0.66 ± 0.08 mm) and breadth (0.13 ± 0.01 mm) were slightly higher than other hosts, with the average range of 0.53-0.79 mm and 0.12-0.16 mm. The finding of the present investigation was closely related with Rahaman *et al.* (2015) [15] finding that the mean length and width of egg in

bitter gourd were 0.78 mm and 0.16 mm. The egg laid in the ridge gourd host had a mean length and breadth of 0.53 ± 0.09 mm and 0.13 ± 0.01 mm, with a range between 0.46-0.74 mm and 0.10-0.16 mm (Table 2).

Table 2. Morphometrics of different life stages of *Z. cucurbitae* reared in cucurbitaceous hosts

| Stage | Snake Gourd | | | | Bitter gourd | | | | Ridge gourd | | | |
|--------------|-------------|----------------|--------------|-----------------|--------------|----------------|--------------|-----------------|-------------|----------------|--------------|-----------------|
| | Length (mm) | | Breadth (mm) | | Length (mm) | | Breadth (mm) | | Length (mm) | | Breadth (mm) | |
| | Range | Mean±SD | Range | Mean±SD | Range | Mean±SD | Range | Mean±SD | Range | Mean±SD | Range | Mean±SD |
| Egg | 0.42-0.74 | 0.53 ± 0.10 | 0.04-0.10 | 0.11 ± 0.01 | 0.53-0.79 | 0.66 ± 0.08 | 0.12-0.16 | 0.13 ± 0.01 | 0.46-0.74 | 0.53 ± 0.09 | 0.10-0.16 | 0.13 ± 0.01 |
| I Instar | 0.63-0.97 | 0.84 ± 0.11 | 0.16-0.21 | 0.17 ± 0.01 | 0.97-1.24 | 1.10 ± 0.08 | 0.18-0.24 | 0.19 ± 0.01 | 0.91-1.17 | 1.04 ± 0.09 | 0.16-0.24 | 0.19 ± 0.02 |
| II Instar | 4.32-4.95 | 4.71 ± 0.19 | 0.52-0.79 | 0.66 ± 0.09 | 4.85-5.10 | 4.93 ± 0.09 | 0.75-0.84 | 0.79 ± 0.02 | 4.95-5.19 | 5.07 ± 0.09 | 0.72-0.89 | 0.79 ± 0.06 |
| III Instar | 7.49-8.15 | 7.80 ± 0.21 | 1.27-1.35 | 1.29 ± 0.02 | 8.17-8.57 | 8.34 ± 0.14 | 1.46-1.57 | 1.51 ± 0.03 | 8.07-8.22 | 8.15 ± 0.05 | 1.37-1.46 | 1.41 ± 0.02 |
| Pre pupa | 5.52-6.13 | 5.79 ± 0.18 | 1.52-1.85 | 1.66 ± 0.11 | 6.12-6.42 | 6.22 ± 0.11 | 1.72-1.92 | 1.83 ± 0.06 | 6.05-6.27 | 6.16 ± 0.06 | 1.77-1.87 | 1.81 ± 0.03 |
| Pupa | 4.35-5.12 | 4.74 ± 0.29 | 1.71-1.97 | 1.83 ± 0.08 | 4.87-6.15 | 5.69 ± 0.38 | 1.92-2.15 | 2.05 ± 0.08 | 5.09-5.62 | 5.36 ± 0.21 | 1.82-1.92 | 1.87 ± 0.03 |
| Adult Male | 5.37-5.89 | 5.62 ± 0.17 | 10.09-10.52 | 10.32 ± 0.15 | 5.52-6.12 | 5.79 ± 0.18 | 10.02-11.15 | 10.45 ± 0.36 | 5.71-5.93 | 5.82 ± 0.07 | 10.21-10.57 | 10.43 ± 0.11 |
| Adult Female | 7.27-7.97 | 7.54 ± 0.21 | 11.79-12.79 | 12.32 ± 0.29 | 7.37-8.17 | 7.81 ± 0.27 | 11.95-12.97 | 12.65 ± 0.32 | 7.65-7.94 | 7.81 ± 0.11 | 11.95-12.31 | 12.14 ± 0.11 |

*Mean of 10 replications

Maggot

First instar

The mean length and breadth of the first instar maggot was maximum (1.10 ± 0.08 mm and 0.19 ± 0.01 mm) in bitter gourd host, with the range varied from 0.97-1.24 mm in length and 0.18-0.24 in breadth. In snake gourd, the range varied from 0.63-0.97 mm and 0.16-0.21 mm with a mean of 0.84 ± 0.11 mm in length and 0.17 ± 0.01 mm in breadth. Maggot hatched out from the ridge gourd host ranged 0.91 mm in length and 0.16-0.24 mm in breadth. The average mean length and breadth were 1.04 ± 0.09 mm and 0.19 ± 0.02 mm. The average length and breadth of first instar maggot was high in bitter gourd host and low in snake gourd.

Second instar

The second instar maggot measurement in snake gourd was 4.71 ± 0.19 mm in mean length and breadth of 0.66 ± 0.09 mm. The range lies between 4.32-4.95 mm and 0.52-0.79 mm in the second instar maggot. In bitter gourd, length (4.93 ± 0.09 mm) and breadth (0.79 ± 0.02) of maggot ranged from 4.85-5.10 mm and 0.75-0.84 mm. Maggot mean length in ridge gourd was 5.07 ± 0.09 mm with a range 4.95-5.19 mm and mean width 0.79 ± 0.06 mm with a range 0.72-0.89 mm. Comparing the second instar maggot, the maggot grown in ridge gourd has maximum length and breadth, whereas snake gourd has lower measurement.

Third instar

The mean length and breadth of the third instar maggot in snake gourd were 7.80 ± 0.21 mm and 1.29 ± 0.02 mm, with a data range of 7.49-8.15 mm and 1.27-1.35 mm. Maggots in bitter gourd had a mean length (8.34 ± 0.14 mm) and breadth (1.51 ± 0.03 mm) between the range of 8.17-8.57 mm and 1.46-1.57 mm. The mean length and breadth of maggot in ridge gourd host were 8.15 ± 0.05 mm and 1.41 ± 0.02 mm within a range of 8.07-8.22 mm and 1.37-1.46 mm. The total maggot length and breadth was maximum in bitter gourd and minimum in snake gourd host. From our finding, the length of third instar maggot in bitter gourd (8.34 ± 0.14 mm) was confirmity with the Barma and Jha (2011) [1] reports that the third instar larval length was 8.32 ± 0.66 mm in pointed gourd.

Pre pupa and Pupa

In bitter gourd, the mean length and breadth of the prepupal stage were maximum with 6.12-6.42 mm and 1.72-1.92 mm

within a mean of 6.22 ± 0.11 and 1.83 ± 0.06 mm. The pre pupal length and breadth is minimum in a snake gourd with a mean of 5.79 ± 0.18 mm and 1.66 ± 0.11 mm between the range of 5.52-6.13 mm in length and 1.52-1.85 mm in breadth. Mean length and breadth in ridge gourd were 6.16 ± 0.06 mm and 1.81 ± 0.03 mm within a range of 6.05-6.27 mm and 1.77-1.87 mm.

The mean length and breadth of pupa in snake gourd recorded is 4.74 ± 0.29 mm and 1.83 ± 0.08 mm, with the average variation of 4.35-5.12 mm and 1.71-1.97 mm. The mean length and breadth of pupa in bitter gourd was 5.69 ± 0.38 mm and 2.05 ± 0.08 mm between the range of 4.87-6.15 mm and 1.92-2.15 mm. In ridge gourd, maggot length and breadth varied between 5.09-5.62 mm and 1.82-1.92 mm with a mean of 5.36 ± 0.21 mm and 1.87 ± 0.03 mm. The pupal length and breadth observed in bitter gourd was higher than snake gourd host. Vigneswaran *et al.*, (2016) [18] observed and mentioned the mean length and breadth of pupal measurement of 4.97-5.83 mm length and 1.90-2.20 mm breadth in different cultivars of *Coccinia indica*, which is in tune with the observation recorded in this experiment.

Adult

Male

The length and breadth of adult males in the snake gourd host registered shown that 5.62 ± 0.17 mm and 10.32 ± 0.15 mm, with the range of 5.37-5.89 mm and 10.09-10.52 mm. In bitter gourd host, the mean length and breadth of maggot noticed was 5.79 ± 0.18 mm and 10.45 ± 0.36 mm in the data range of 5.52-6.12 mm and 10.02-11.15 mm. Adult males in the ridge gourd host had the mean length and breadth of 5.82 ± 0.07 mm and 10.43 ± 0.01 mm in a range of 5.71-5.93 mm and 10.21-10.57 mm. The average length and breadth registered in male (5.82 ± 0.07 mm, 10.43 ± 0.01 mm) was higher in ridge gourd followed by bitter gourd and snake gourd.

Female

The mean length and breadth of an adult female in a snake gourd host observed indicated that the range was 7.54 ± 0.21 mm, and 12.32 ± 0.29 mm lies between 7.27-7.97 mm and 11.79-12.79 mm. In bitter gourd host, the length and breadth varied from 7.37-8.17 mm and 11.95-12.97 mm with a mean of 7.81 ± 0.27 mm and 12.65 ± 0.32 mm. The length and breadth of adult males and females registered this findings are in accordance with the reports of Laskar, 2013 [11]. He denoted

the length and breadth of adult males and females with expanded wings were (5.5-7.0 cm, 10.10-12.65 cm) and (7.45-9.50 cm, 12.20-16.50 cm) in bitter gourd host. The Females in the ridge gourd host with a mean of 7.81 ± 0.11 mm in length and 12.34 ± 0.30 mm in breadth in a data range of 7.65-7.94 mm and 12.07-12.95 mm.

Conclusion

The variation in the biology of *Z. cucurbitae* studied in the varied cucurbitaceous hosts revealed that the average egg length and breadth were high (0.66 ± 0.08 mm and 0.13 ± 0.01 mm) in bitter gourd > ridge gourd > snake gourd. The mean length and breadth of maggot in bitter gourd and ridge gourd are almost similar. Pre pupa and pupal length and breadth were maximum in bitter gourd (6.22 ± 0.11 mm, 1.83 ± 0.06 mm) and (5.69 ± 0.38 mm, 2.05 ± 0.08 mm). The length and breadth of adult male and female was maximum in ridge gourd host with a mean range of 10.21-10.57 mm and 11.95-1.31 mm. In comparison with three hosts, all the developmental stages viz., egg (1.45 ± 0.76 days), first instar (0.70 ± 0.25 days), second in star (2.85 ± 0.74 days), third in star (4.3 ± 0.85 days), prepupal (0.80 ± 0.25 days) and pupal (8.25 ± 0.82 days) was shorter in bitter gourd host. The longevity of adult males and females was maximum in ridge gourd 20.60 ± 4.35 days and 20.70 ± 3.88 days, respectively.

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