



E-ISSN: 2320-7078

P-ISSN: 2349-6800

www.entomoljournal.com

JEZS 2020; 8(5): 994-998

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Received: 14-07-2020

Accepted: 20-08-2020

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Biology and morphometrics of melon fruit fly, *Bactrocera cucurbitae* Coquillett on bitter gourd (*Momordica charantia* L.)

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Abstract

Biology and morphometrics of Melon fruit fly (*Bactrocera cucurbitae* Coquillett) on Bitter gourd was carried out during 2018-19 at Department of Entomology, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The mean incubation period of eggs of *B. cucurbitae* was 18.0 ± 6.32 hours. The total maggot period ranged from 5 to 7 days with a mean period of 5.8 ± 0.78 days. Pupation took place inside the soil (5 to 6 cm thick) provided in cylindrical glass jar. Mean pupal duration was 6.9 ± 0.87 days having a length and breadth of 5.98 ± 0.38 mm and 2.54 ± 0.14 mm, respectively. Total life period of male fruit fly ranged from 30 to 46 days with a mean of 36.2 ± 5.77 days. In case of female fruit fly total life period was slightly longer ranging from 32 to 50 days with a mean of 40.4 ± 6.24 days. Sex ratio in *B. cucurbitae* was recorded as 1:0.84 (male:female).

Keywords: *Bactrocera cucurbitae*, biology, morphometrics, longevity, sex-ratio

Introduction

Bitter gourd (*Momordica charantia* L.) is one of the important and widely cultivated vegetable crop in India. Fruits of bitter gourd are good source of carbohydrates, vitamins, minerals and proteins and have the richest nutritive value among cucurbits^[1]. It is cultivated under an area of 93.00 thousand hectares with a production of 1046 thousand metric tonnes^[2].

Bitter gourd is attacked by a number of insect pests during different stages of crop growth. Among these, melon fruit fly, *Bactrocera cucurbitae* has been observed as a serious pest infesting on the most economic part of bitter gourd crop. It causes losses up to the extent of 30 to 100 per cent in cucurbits depending on the season^[3].

Generally, the female fruit flies lay the eggs under fruit tissues by puncturing the soft and tender fruits by their sharp ovipositor and watery fluid oozes from the puncture, which reduces the market value of the produce^[4]. Soon after hatching, the maggots by making galleries feed on the pulp of the fruits and simultaneously lead to the secondary infection, resulting in rotting of fruits. Thus *B. cucurbitae* is the most noxious pest of bitter gourd. By looking into its economic importance, the laboratory studies were carried out to know the biology of this pest, as it provides the growth rate statistics, which can be used as a predictive basis of pest control. The biological studies of this pest were carried out in the laboratory conditions at $25 \pm 3.5^\circ\text{C}$ temperature and 69 ± 3 per cent relative humidity, during 2018-19.

Materials and Methods

Infested bitter gourd fruits were collected from the field. These infested fruits were kept in a tray consisting 5-6 cm thick layer of sieved soil, in insect rearing cages. The rotted fruits were removed after 6-7 days subsequently, the soil was sieved to collect pupa. The individual pupae were placed in glass tube. Freshly emerged adults were paired (female and male) and kept in rearing jars having a piece of sponge dipped in 5 per cent honey solution. The rearing jars were covered with muslin cloth. Fresh and tender fruits of bitter gourd were kept in the cages for egg laying. The eggs were identified by excavating the fruit below the ovipositional puncture under simple microscope. The eggs were then transferred into the glass tubes containing bitter gourd pulp. After 5 days, the maggots were provided with slices of fresh bitter gourd fruits. This culture was utilized in carrying out biological studies in which, incubation period, maggot period, pre-pupal period, pupal period and adult longevity were recorded. Oviposition period, fecundity and sex ratio were also recorded.

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By using calibrated vernier callipers, ocular and stage micrometer the morphometric observations of different life stages of *B. cucurbitae* were recorded. Fifteen replicates of each stage viz. egg, full grown maggot, pupae and adult were maintained for linear measurements. In addition to the above parameters shape, colour and period interval for each life stage were also recorded.

Results and Discussion

Biology and morphometrics of different life stages of *B. cucurbitae*

Egg

The freshly laid eggs were pure white in colour, elliptical, nearly flat on the ventral surface and slightly curved on other side (Plate-I). The surface of eggs was carved with grooves and ridges (Plate-II). Morphometric studies revealed that the length and breadth of egg varied from 1.12-1.34 mm (mean±S.D.=1.22±0.07 mm) and 0.16-0.28 mm (mean±S.D.=0.23±0.04 mm), respectively. These findings are in accordance with Desai *et al.* [5] who recorded mean length and breadth of egg, which varied from 1.26±0.03 mm and 0.26±0.02 mm, respectively on sponge gourd. Das *et al.* [6] revealed that average length of egg was 1.30±0.08 mm and breadth was 0.25±0.05 mm in pumpkin.

The time span between laying and hatching i.e. incubation period ranged from 12 to 24 hours with a mean of 18.0±6.32 hours. The present findings are in agreement with the reports of Langar *et al.* [7] and Mir *et al.* [8] who also recorded incubation period of the melon fruit fly to be ranging from 12-24 hours in musk melon and cucumber, respectively.

Maggots

The first instar maggots were elongated, transparent with pointed head consisting of small mandibular hook. Morphometric observations revealed that the length and breadth of first instar maggot ranged from 1.16 to 1.84 mm (mean±S.D.=1.54±0.28 mm) and 0.20 to 0.36 mm (mean±S.D.=0.29±0.07 mm), respectively. The second instar

maggots were creamish-white with translucent body and ellipsoidal in shape (Plate-III). The length and breadth of second instar ranged from 4.90 to 7.15 mm (mean±S.D.=6.10±0.82 mm) and 1.06 to 1.32 mm (mean±S.D.=1.19±0.11 mm), respectively. The third instar maggots were more yellowish in colour and had more opaque body compared to first and second instar maggots. They exhibited a peculiar habit of springing into the air by sudden relaxation of certain muscles as a defence mechanism to avoid soil dwelling insect predators. The length and breadth of third instar maggot ranged from 8.25 to 10.75 mm (mean±S.D.=9.29±0.80 mm) and 1.75 to 2.35 mm (mean±S.D.=2.04±0.23 mm), respectively. These observations are more or less similar with the findings of Laskar [9], Mir *et al.* [8] and Desai *et al.* [5].

In the present investigation total maggot period ranged from 5-7 (mean±S.D.=5.80 ± 0.78) days with the average duration of first, second and third instars ranging from 0.5-1 (mean±S.D.=0.8 ± 0.26), 1.5-3 (mean±S.D.=2.0 ± 0.53) and 2-3 (mean±S.D.=2.55 ± 0.44) days, respectively (Table-3). The present readings are consistent with the readings of Patel and Patel [10] and Laskar [9] who also reported that total maggot period varied from 5-7 and 5-6.5 days on little gourd and bitter gourd, respectively.

Pre-pupa

Matured third instar maggots became sluggish, stopped feeding and contracted longitudinally to attain pre-pupal stages which were spiral in form. The duration of this stage was very short and not even lasted a day. The present findings revealed that, the duration of pre-pupal period ranged from 0.5 – 1.0 day with average duration of 0.7±0.20 days. The length and breadth of pre-pupa varied from 6.25 to 6.54 mm (mean±S.D.=6.41±0.15 mm) and 1.98 to 2.08 mm (mean±S.D.=2.03±0.04 mm), respectively. The results are in conformity with the results recorded by Waseem *et al.* [11] and Laskar [9] who also found pre-pupal duration to be 0.5-1 days on cucumber and bitter gourd, respectively





Plate I-IX: Life stages of *Bactrocera cucurbitae*. I. Eggs on bitter gourd pulp, II. Individual egg, III. Second instar maggot, IV. Pupae, V. Emergence of adult from pupa (Ecllosion), VI. Teneral adult, VII. Wing showing venation, VIII. Adult male, and IX. Adult female fly with prominent ovipositor.

Table 1: Durations of life stages of *B. cucurbitae* reared on bitter gourd

Stage	Range	Mean±SD
Incubation period of egg (in hours)	12 – 24	18.0 ± 6.32
Maggot period (in days)		
First instar	0.5 – 1	0.8 ± 0.26
Second instar	1.5-3	2.0 ±0.53
Third instar	2-3	2.55 ± 0.44
Total maggot period (in days)	5-7	5.80 ± 0.78
Pre-pupal period (in days)	0.5-1	0.70 ± 0.20
Pupal period (in days)	6-8	6.90 ± 0.87
Adult period (in days)		
Male	18-31	23.7 ± 3.77
Female	20-33	25.9 ± 4.15
Oviposition period (in days)	10 – 24	16.3 ± 4.85
Fecundity (in no.)	80 – 108	87.8 ± 8.61
Sex ratio (M:F)		1:0.84
Total life period (in days)		
Male	30-46	36.2 ± 5.77
Female	32-50	40.4 ± 6.24

*Each data is the mean of 15 observations

Table 2: Morphometrics of life stages of *B. cucurbitae* reared on bitter gourd

Stage	Length (mm)		Breadth (mm)	
	Range	Mean±SD	Range	Mean±SD
Egg	1.12-1.34	1.22 ± 0.07	0.16 – 0.28	0.23 ± 0.04
Maggot				
First instar	1.16-1.84	1.54 ± 0.28	0.20 – 0.36	0.29 ± 0.07
Second instar	4.90-7.15	6.10 ± 0.82	1.06 – 1.32	1.19 ± 0.11
Third instar	8.25-10.75	9.29 ± 0.80	1.75 – 2.35	2.04 ± 0.23
Pre-pupa	6.25-6.54	6.41 ± 0.15	1.98 – 2.08	2.03 ± 0.04
Pupa	5.30-6.45	5.98 ± 0.38	2.35 – 2.72	2.54 ± 0.14
Adult (with expanded wings)				
Male	8.05-8.74	8.41 ± 0.24	10.04 – 12.05	11.35 ± 0.90
Female	9.44-10.15	9.74 ± 0.22	14.50 – 16.90	15.61 ± 0.75

*All measurements are the means of 15 observations.

Pupa

The laboratory studies revealed that the pupae were eleven segmented, barrel shaped with a black dot on posterior portion and yellowish to deep brownish yellow when freshly formed. As the eclosion neared, the colour changed into brownish grey (Plate-IV). The duration of pupal period ranged from 6.0 – 8.0 days with average duration of 6.9±0.87 days. The length and breadth of pupa ranged from 5.30 to 6.45 mm (mean±S.D.=5.98±0.38 mm) and 2.35 to 2.72 mm (mean±S.D.=2.54±0.14 mm), respectively. The results obtained during the investigation are in confirmation with Laskar^[9] and Desai *et al.*^[5] who recorded pupal period of 6-8

days on bitter gourd and sponge gourd, respectively. However Hollingsworth *et al.*^[12] reported pupal period to last for 6.5-21.8 days. The morphometrical readings are in conformity with the findings of Laskar^[9], Mir *et al.*^[8] and Das *et al.*^[6] who recorded similar readings in various cucurbitaceous crops.

Adult

Soon after the emergence, the teneral adults were less active, pale yellow in colour with wings attached to body and took nearly thirty minutes to gain a fly look (Plate-V and VI). The exoskeleton of teneral adults is later hardened by the process

of sclerotization and melanisation. Adults were moderate in size, reddish brown with lemon yellow markings on thorax with spotted wings. Wing margin had a large apical spot which is formed by the expansion of posterior cross vein. Adult males were smaller in size than that of the females (Plate-VIII). They were easily distinguished from female adults by the absence of ovipositor and presence of blunt abdomen (Plate-IX). The average length and breadth (with expanded wings) of male fruit fly was 8.41 ± 0.24 mm (8.05 to 8.74 mm) and 11.35 ± 0.90 mm (10.04 to 12.05 mm), respectively, whereas, the average length and breadth (with expanded wings) of female was 9.74 ± 0.22 mm (9.44 to 10.15 mm) and 15.61 ± 0.75 mm (14.50 to 16.90 mm), respectively. These morphometrical observations are more or less similar with the findings of Laskar^[9] Mir *et al.*^[8] and Desai *et al.*^[5]. Adult flies were provided with 5% honey solution during their life period. The longevity of adults varied from male to female. Female adult longevity varied from 20.00 to 33.00 days, the average being 25.9 ± 4.15 days. Longevity of male adult ranged from 18 to 31 days, the average being 23.7 ± 3.77 days. The findings are in consistent with the findings of Das *et al.*^[6] and Desai *et al.*^[5] who reported that female flies lived comparatively longer than the males.

Total life period

Total life period, right from egg to death of the adult of fruit fly varied from male to female. The present study revealed that the total life period of male fruit fly ranged from 30 to 46 days with a mean of 36.2 ± 5.77 days. In case of female fruit fly it was slightly longer where it ranged from 32 to 50 days with a mean of 40.4 ± 6.24 days (Table-3). The findings are in accordance with those of Laskar^[9] who reported that the total life period of male and female ranged from 31-57 and 38.5-56.5 days respectively on bitter gourd. Das *et al.*^[6] and Desai *et al.*^[5] also reported that the total life period of male ranged from 25-65 and 29.5-48 days, whereas total life period of female ranged from 42.5-75 and 31.5-53 days, respectively when reared on pumpkin and sponge gourd.

Oviposition period

Oviposition period, *i.e.* the duration from initiation of egg laying till its termination by gravid adult female was computed as oviposition period. Oviposition period of female melon fruit fly ranged from 10 to 24 days in the present study with a mean of 16.3 ± 4.85 days (Table-3). The results are almost in consistent with the findings of Koul and Bhagat^[13] and Langar *et al.*^[7] who reported it to vary between 12-28 days on Indian squash and cucumber, respectively. However, the oviposition period is contradictory with the readings of Waseem *et al.*^[11] who reported that the oviposition period of melon fly varied from 5-44 days which was even longer in winter while rearing on cucumber.

Fecundity

Fecundity, *i.e.* the total number of eggs laid by a single mated female throughout its oviposition period. In the present investigation, female on an average laid 87.8 ± 8.61 eggs (5-15 in cluster) with a range of 80-108 eggs under laboratory conditions. The results obtained during the investigation are in confirmation with the readings of Langar *et al.*^[7] and Mir *et al.*^[8] who recorded it varying from 50-91 and 58-92 eggs, respectively during entire life span of female fruit fly. However, Koul and Bhagat^[13] and Laskar^[9] recorded fecundity of melon fruit fly ranging 120-250 eggs and 90-197

eggs on bottle gourd and bitter gourd, respectively, which differed with the findings of the present study.

Sex ratio

Sex ratio constituted the ratio between the total number of female and male fruit flies emerged out from the same lot of pupae. The differentiation of sexes of adult flies was made on the basis of presence or absence of ovipositor, their abdominal breadth and general size. Sex ratio of melon fruit fly was male oriented in the present study *i.e.* 1:0.84 (male: female) The findings are in consistent with the readings of Patel^[14] and Patel and Patel^[16] who also reported it to be of male biased *i.e.* 1:0.89 and 1:0.67, respectively, on bitter gourd. However, Sisodiya^[15] reported that sex ratio was female biased *i.e.* 1:1.28 on bitter gourd which differs with the results of the present investigation. Seasonal fluctuation and type of food material available decide the sex ratio of melon fruit fly^[8].

Conclusion

From the present biological and morphometrical studies on *B. cucurbitae* it can be concluded that, the mean length and breadth of egg of was 1.22 ± 0.07 mm and 0.23 ± 0.04 mm, respectively with an incubation period of 18.0 ± 6.32 hours. The first, second and third instar maggot measured on an average 1.54 ± 0.28 , 6.10 ± 0.82 and 9.29 ± 0.80 mm in length and 0.29 ± 0.07 , 1.19 ± 0.11 and 2.04 0.23 mm in breadth, respectively. The average duration of maggot period was found to be 5.80 ± 0.78 days. The pre-pupal period lasted for 0.5 to 1 day, while the pupal period ranged from 6 to 8 days. The longevity of male and female flies was found to be 23.7 ± 3.77 and 25.9 ± 4.15 days, respectively when supplied with 5% honey solution.

Acknowledgement

The first author is honestly thankful to Major advisor, Dr. Krishna Rolania and other advisory committee members, Department of Entomology, College of Agriculture, CCS Haryana Agricultural University, Hisar for their guidance and valuable suggestions and also for providing necessary facilities to carry out the research work. The author also acknowledges all technical staff who assisted their help in successful completion of work.

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