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Morphometric study of melon fruit fly *Bactrocera cucurbitae* (Coq.) on host bitter gourd

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Abstract
Biological studies on melon fruit fly, *Bactrocera cucurbitae* were conducted at Department of Entomology laboratory, VNMKV Parbhani Maharashtra. To study the morpho metric features of melon fruit fly on host bitter gourd during *rainy* season 2021. The research revealed that the freshly laid eggs of melon fruit fly were pure white in color and elliptical in shape. The mean length and breadth of egg was 0.735±0.057 mm and 0.153±0.017 mm, respectively. Maggots passed through three instars to attain pupal stage. The first, second and third instar maggot measured on an average 1.44±0.03, 5.02±0.40 and 8.13±0.95 mm in length and 0.25±0.02, 0.47±0.09 and 1.41±0.20 mm in breadth, respectively. The average length and breadth of pupa was 4.81±0.84 mm and 2.19±0.13 mm, respectively. The average length and breadth of female was 8.54±0.43 mm and 2.49±0.11 mm, respectively, whereas, the male measured 7.07±0.55 mm in length and 2.42±0.16 mm in breadth indicating that females being larger in size than males.

Keywords: Melon fruit fly, Bitter gourd, *Bactrocera cucurbitae*, Biology, Morphometric etc.

Introduction
Bitter gourd is one of the important vegetable crops among cucurbits grown all over the world. Bitter gourd (*Momordica charantia* L.). It is well known for its medicinal values and good source of vitamins, minerals, fibers, carbohydrates, calcium, phosphorous and iron. It is bitter in taste due to presence of "Momordicin''. Bitter gourd is one of the important vegetable, it is high in demand due to its unique culinary taste, and it is also a good source of nutritional fiber (Gopalan *et al.* 2000) [6]. Cultivation of bitter gourd now a day´s becoming very problematic because of adverse climatic conditions and it´s been ravaged by many number of pests during different growth stages, among which melon fly, *Bactrocera cucurbitae* (Coquillett), that cause varying degrees of damage to the crop (Sunil *et al.* 2017) [9]. It may vary from 30 to 100 per cent damage based on crop and season (Dhillon *et al*. 2005) [4].

Fruit flies use a wide spectrum of hosts, from severe monophagy to extreme polyphagy. Some tephritid species, particularly those of the subfamilies Dacinae and Trypetinae, have frugivorous larvae that feed on the fruit pulp of both cultivated and wild plants, giving rise to their common name of "fruit flies." Larvae of remaining species feed on stems, shoots and flowers (Christenson and Foote, 1960) [3]. It infests more than 125 species of plants, including cucurbits, tomatoes, and many other vegetables, have been recorded as hosts of the melon fly. Preferred hosts include: cantaloupe, cowpea, cucumber, gourd, pumpkin, squash, string bean, tomato and watermelon. Occasional hosts include: eggplant, fig, mango, orange, papaya and peach. Wild hosts include: balsam apple; Chinese cucumber, *Momordica spp*.; colocynth; two genera of cucurbits-*Sicyos sp*.; *Cucumis trigonus*; *Diplocyclos palmatus*; and passion-flower, *Passiflora spp*. However, White and Elson-Harris (1994) [11] claim that a lot of these reports might have been based on haphazard observations of adults trapped in traps placed on non-host trees or resting on plants.

Controlling Tephritids were difficult since they are internal feeders. The adult female flies prefer young fresh fruits for laying egg while, people's demand also for the same stage fruit has been accompanying. The loss of the fruit has been starts from initial stage only because most of the time flies prefer to lay eggs in unopened flowers and the maggots develop successfully in the taproots, stems and leaf stalks. Sometimes pseudo punctures of melon fly on fruit skin lead to the discard of fruits occur and also which lowers the market value of the produce (Weems and Heppner 2001) [10].

A Profound study of this pest biology and its status at various periods, finding the weak point in an insect's life cycle, in particular, gives crucial background knowledge for designing tactics and bringing into practice efficient pest control strategies.

Materials and Method

Research on the biology of the melon fruit fly, *B. cucurbitae*, which infests bitter gourd, was conducted on a single host (Bitter gourd) crop. This work was done at PG Research laboratory, Department of Agricultural Entomology, College of Agriculture, Vasantarao Naik Marathawad Krishi Vidyapeetha, Parbhani Maharashtra.

Rearing Technique

Initial cultures of fruit flies raised by collecting infested fruits (Fig.1b) from the plots of bitter gourd crops from field of Department of Agricultural Entomology. The infested fruits were kept in plastic jars (diameter 15 cm and height 20 cm) containing 5 cm thick layer of sieved sand at bottom of jar to obtain pupae. The top of the jars were covered with clean white muslin cloth duly tightened with rubber band to prevent the maggots from escaping (Fig.1d).

Such jars were used for maintaining the culture of fruit fly, *B. cucurbitae* when all the full-grown maggots entered in the sand for pupation and the rotted fruits were removed from the container. After 4-5 days, the sand in the container was sieved to collect pupae. The collected pupae (Fig.1f) were transferred in a test tubes (1.5 cm diameter, 7.5 cm height), individually. The tubes were plugged with cotton plug (Fig.1g) to prevent the escaping of adult fruit flies when emerged. The emerged adult flies utilized for further studies of life history. The freshly emerged adults were paired and confined in the plastic jars (diameter 15 cm, height 20 cm) covered with a white muslin cloth bag. On end of the bag was kept open for introducing the adults into the jar. The open end of the bags were tightened with rubber band to prevent the adult from escaping. Such jars were kept in the wooden cages shown in Fig. 1h (68 x 53 x 37 cm) to prevent the damage from ants and rodents. A cotton swab was suspended with 5 per cent honey and yeast solution hanged inside the jar as food to the adult flies. Premature uninfected fruits were placed inside the jar for oviposition. The fruits were replaced after observing the punctures. The fruits punctured due to egg laying were cut open with a fine razor blade and egg laid if any, confirmed using magnifying lens. About 2 x 1 x 1 cm size piece of fruit having eggs were smoothly cut and transferred in a separate petri dish and observe twice a day for their hatching. Eggs were carefully transferred with a fine camel hair brush (No. 1) on a glass slide and observed under microscope to study their morpho-metric characters.

After hatching of eggs, the neonate maggots were gently transferred on a fresh fruit slice (2 x 2 x 1 cm), after that kept in petri dish for further rearing. The food (fruit slice) as well as petri dishes were changed every day to avoid microbial development on fruit slice. The maggots were reared by following this method until they full grown and transferred along with petri dish in a small plastic jar (diameter 15 cm, height 20 cm) filled with a layer of 5 cm sand. The jars were covered with muslin cloth and tightened with rubber bands for preventing the escaping of maggots Laskar (2013) [7].

Methods of recording observation

Egg: Eggs were observed under the microscope for studying their color, shape and size. Similarly, for measurement of the eggs were gently transferred under compound microscope with the help of moist camel hair brush. The microscope was calibrated with stage and ocular micrometer before measuring the eggs.

Maggot (larva): A thick (2 cm) slice of fruits were kept individually in a petri dish. It is slightly ruptured with the help of scalpel for easy entry of the maggot. The newly hatched maggots were transferred individually on fruit slice. The maggots were reared till they underwent for pupation. The food was changed every morning to maintain the sanitation in the petri dish. The first instar (newly hatched) and fully grown maggots were observed under microscope for studying the shape, size and color.

Pre-pupa: A stage, when full grown maggots ceased feeding and became inactive was considered as pre-pupal stage. Those 50 maggots were transferred with small amount of food to plastic jar (diameter 15 cm, height 20 cm) with 5 cm layer of sieved sand at the bottom for pupation. The observations on shape, size and colour of pre-pupal stage was recorded. The breadth and length of pre-pupal stage was measured under microscope.

Pupa: The 50 pupae were studied for their shape, size, color and period. The breadth and length also measured.

Adult: The newly emerged adults from pupae were critically observed under microscope for their size, shape, color and sex differences. The breadth and length of adults also measured.

Result and Discussion

Morphometric study of different life stages of melon fly like; egg, maggots, pupae and adults carried out by taking fifty replications and recorded data was analyzed and summarized in (Table:1)

Egg: The morphometric measurements of melon fruit fly life stage of egg, 50 eggs were taken and observed under microscope. From the study it was known that the freshly laid eggs were creamy white, slightly curved, elongated and tapering towards the end (Fig 2:a). The size of eggs with respect to length it varied from 0.55 to 0.82 mm with mean value 0.735±0.057 mm and width varies from 0.12 to 0.18mm with mean value 0.153 ± 0.017mm.

Current work in close related with others investigations results as Rahaman *et al.* (2015) [8] recorded mean length of egg was 0.78 mm whereas, width was 0.16 mm. Bhowmik *et al.* (2014) [1] experiment revealed that freshly laid egg were measured from 0.75 mm to 1.5 mm in length with an average of 1.06 ±0.25 mm and 0.1 mm to 0.3 mm in width with an average of 0.21±0.08mm. According to Barma and Jha (2011) freshly laid eggs length was varied from 0.76mm to 0.844 mm. and width 0.20 mm to 0.26 mm.

Maggots

Instar: As per the observations recorded (Table:1) first instar maggots length and width varied from 1.34 to 1.54 mm with

mean 1.446 ±0.039 mm. and 0.20 to 0.29 mm with mean 0.250 ± 0.025mm, respectively (Fig.2:b).
Present findings are accordance with of Gaddankeri and Rolania (2020) [5] reported that the length and breadth of first instar maggots 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.
According to Barma and Jha (2011) reported the first instar larvae were apodus, white translucent, a bit flattened dorsoventrally at both ends. The length and width varied 1.20 to 1.62 mm and 0.22 to 0.38 mm respectively.
Similarly, Bhowmik *et al.* (2014) [1] recorded the length of first instar larvae 1.1 mm to 1.92 mm with an average of 4.23 ±0.16 mm and the width ranged between 1.05 mm to 1.4 mm with an average of 1.22 ±0.12mm.

Instar
The data presented in (Table:1) observance the length of second instar maggots was varied from 4.35 to 5.86 mm with mean 5.020 ± 0.403 mm whereas, width varies from 0.32 to 0.69 mm with mean 0.476 ± 0.099 mm (Fig.2:c).
Present work in corroborative with some authors results like Rahaman *et al.* (2015) [8] also given statement that the second instar larvae were broad tapering at both ends. The average length of second instar larvae was 5.2 mm and width was 0.84 mm.
Bhowmik *et al.* (2014) [1] recorded the second instar larvae length measured between 4 mm to 4.52 mm with an average of 4.23±0.16 mm and the width ranged between 1.05 mm to 1.4 mm with an average of 1.22 ±0.12 mm.

Instar
The data recorded and analyzed in Table: 1 showed that the third instar maggots size varies with respect to length and width as 6.54 to 9.98 mm with mean 8.130 ±0.950 and 1.04 to 1.89 mm with mean 1.414 ± 0.201respectively (Fig.2: d).
Current experiments findings were closely related with previous experiments findings as Rolania and Gaddankeri (2020) [5] revealed that the length and width of the third instar larvae varies from 7.5 to 9.2 mm and 1.88 to 2.48 mm, respectively and Bhowmik *et al.* (2014) [1] reported that the length and width of third instar larvae varied from 7 mm to 11 mm with an average of 9.5 ±0.9 mm and 0.67 mm to 1.33 mm with an average of 1.31 ± 0.12 mm, respectively.
According to Barma and Jha (2013) said that the third instar larvae were yellowish in color due to reserved food materials within their stomach. The length and width of the larvae at the stage varied from 7.50 to 9.20 mm and 1.88 to 2.48 mm. respectively.

Pupae
The newly emerged pupae (Fig.2:c)were eleven segmented barrel-shaped. The length of pupae varied from 3.17 to 5.67 mm with mean 4.816 ± 0.840 mm and width was 2 to 2.56 mm with mean 2.198 ±0.134mm.
Similar findings recorded by some of authors like Rahaman *et al.* (2015) [8] recorded that the average length of the pupa was 4.22 mm and width was 1.76 mm and Bhowmik *et al.* (2014) [1] said that the pupa was barrel shaped and anterior was narrowed than posterior portion. Pupae were coarctate type and had hard wall which is known as puparium. There were eleven distinct segments and the last segment was somewhat more prominent. The length and width of pupae varied from 4.25 mm to 6.1 mm (average 5.22 ±0.52 mm) and 1.9 mm to 2.5 mm (average 2.1±0.12 mm).
The present findings are equal with Rolania and Gaddankeri (2020) [5] observed the pupae were measured within the range of 5.30 to 6.45 mm lengh (5.98 ±0.38 mm) and 2.35 to 2.72 mm width (2.54 ±0.14 mm).

Adult male
The recorded experiments results shows (Fig.2:g)that the length of adult male was varies from 6 to 8.35 mm with mean value 7.078 ± 0.553mm and width was 2.10 to 2.65 mm with mean values 2.42 ± 0.161 mm.
Similar readings were in conformity with Bhowmik *et al.* (2014) [1] reported that the lengths and width of the adult male varies from 5.5 mm to 9 mm with an average of 7.28 ± 0.9mm 7 mm to 10 mm with an average of 9.97±1.62 mm and Rolania and Gaddankeri (2020) [5] recorded that the average length and breadth (with expanded wings) of male fly was 8.41 ± 0.24 mm (8.05 to 8.74 mm) 11.35±0.90 mm (10.04 to 12.05 mm) respectively.

Adult female
The data recorded on the length of adult female varied from 7.46 to 9.01 mm with mean value 8.546 ±0.432 mm while, width varies from 2.30 to 2.67 mm with mean values 2.491±0.114 mm (Fig.2:f).
The present findings are accordance with of Bhowmik *et al.* (2014) [1] reported that the length and width of the adult female varies from 7mm to 10 mm with an average of 8.83±1.02 mm and 8mm to 16 mm with an average of 10.75 ±1.88 mm inclusive with wing expanse of 11 to 13 mm. Similarly, Rolania and Gaddankeri (2020) [5] recorded that the average length and breadth (with expanded wings) of female fly was 9.74 ±0.22mm (9.44 to 10.15mm) and 15.61 ± 0.75 mm (14.50 to 16.90 mm), respectively.

Summary and Conclusion
It was found that freshly laid eggs of melon fruit fly were pure white in colour and elliptical in shape. The mean length and breadth of egg was 0.735 ± 0.057 mm and 0.153 ± 0.017 mm, respectively. Maggots passed through three instars to attain pupal stage. First instar maggots were whitish in colour, somewhat oval in shape with translucent body. The second instar maggots were creamy white in colour and ellipsoidal in shape. The third instar maggots were creamy white to yellowish in colour with opaque body and exhibited a peculiar habit of hopping. The first, second and third instar maggot measured on an average 1.44±0.03, 5.02±0.40 and 8.13±0.95 mm in length and 0.25±0.02, 0.47±0.09 and 1.41±0.20 mm in breadth, respectively. The average duration of maggot period was found to be 6.21±0.83 days. The mature maggots contracted longitudinally to attain pre-pupal stages which were spiral in form.

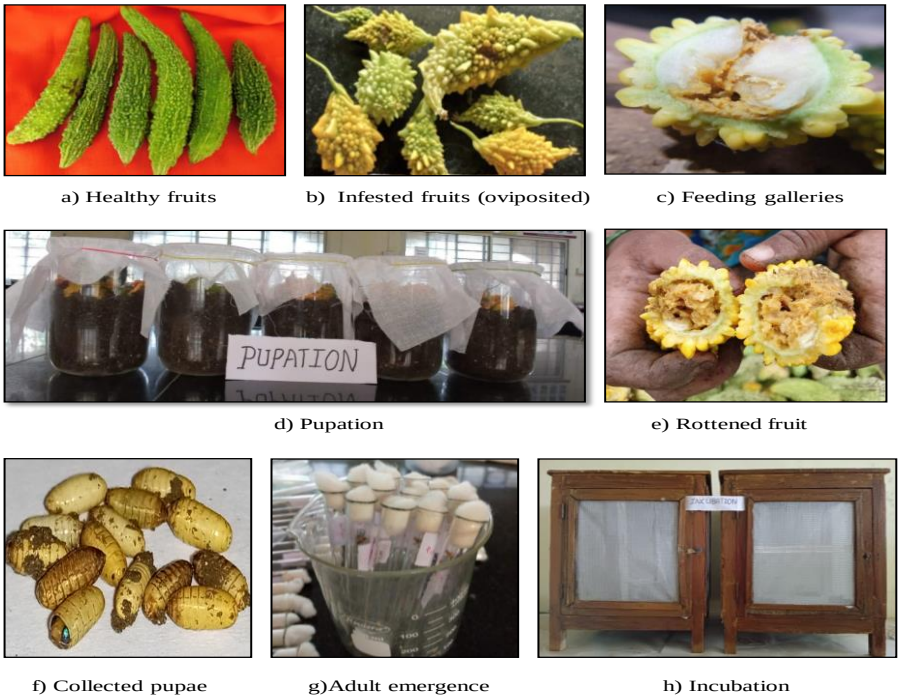

Fig 1: Materials used to study the biology of melon fruit fly on bitter gourd.

Table 1: Morphometric features of different stages of Melon fruit fly (*Bactrocera cucurbitae* Coq.) reared on bitter gourd

Life Stages	Minimum		Maximum		Mean ± S.D.		Range value	
	Length (mm)	Width (mm)	Length (mm)	Width (mm)	Length(mm)	Width (mm)	Length(mm)	Width(mm)
Egg	0.55	0.12	0.82	0.18	0.735±0.057	0.153±0.017	0.27	0.06
I instar	1.34	0.20	1.54	0.29	1.446±0.039	0.250±0.025	0.20	0.09
II instar	4.35	0.32	5.86	0.69	5.020±0.403	0.476±0.099	1.51	0.37
III instar	6.54	1.04	9.98	1.89	8.130±0.950	1.414±0.201	3.44	0.85
Pupae	3.17	2.00	5.67	2.56	4.816±0.840	2.198±0.134	2.50	0.56
Adult Male	6.00	2.10	8.35	2.65	7.078±0.553	2.424±0.161	2.35	0.55
Adult Female	7.46	2.30	9.01	2.67	8.546±0.432	2.491±0.114	1.55	0.37

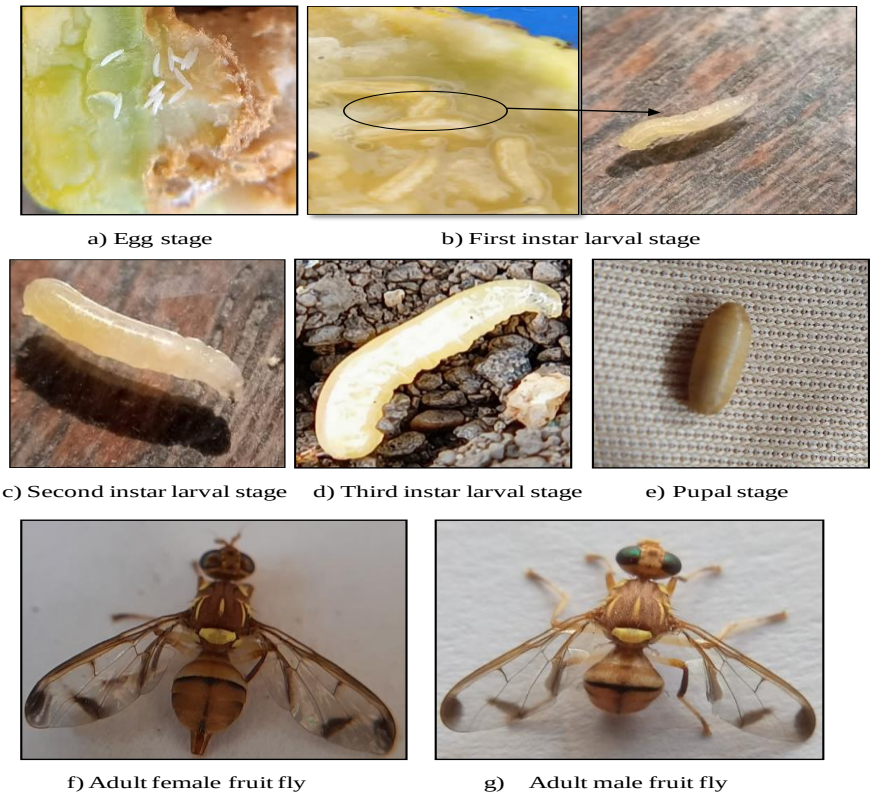

Fig 2: Different life stages of melon fruit fly recorded during experimental study on host bitter gourd during *Rainy* season 2021

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