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Biology of the cucurbit fruit fly, *Bactrocera cucurbitae* (Coq) on host bottle gourd, *Lagenaria siceraria*

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ABSTRACT

We investigated the biology of the cucurbit fruit fly, Bactrocera cucurbitae (coq) on bottle gourd, Lagenaria siceraria, using variety 'BARI-Lau 1'. The mean incubation period, larval (1st, 2nd and 3rd instars), pre-pupal, pupal and total developmental periods of B. cucurbitae were 1.69±0.28, (1.72±0.33, 1.41±0.31, 2.31±0.51), 0.74±0.28, 9.2±0.78 and 36±1.69 days, respectively. The mean adult longevity, with food and without food was 14.1±1.28 and 5.0±0.81 days, respectively. The lengths of all three larval instars were 1.1± 0.9, 3.03 ± 0.95 and 6.42 ± 0.90 mm, and the widths were 0.22 ±0.11, 1.12 ± 0.01 and 2.13 ± 0.20 mm, respectively. The length and width of the pre-pupa and the pupa were 5.86 ±0.48, 5.68± 0.26 mm and 1.94 ± 0.23, 2.39±0.20 mm respectively. The length of male and female were 6.61±0.59 and 8.28±0.52 mm. The widths of males and females with wingspan were 10.97 ± 0.43 and 13.02±1.28 mm respectively. The incidence of B. cucurbitae as maggot population in bottle gourd was higher in January during the study period from December 2018 to March 2019.

Key Words*: Biology, Cucurbit fruit fly, B. cucurbitae and Bottle gourd.*

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I. Introduction

Vegetables are accessible source of vitamins and minerals which are essential for maintaining sound health. Bangladesh has a serious deficiency in vegetables. The daily requirement of vegetables for a full grown person is 285 gm (Ramphall and Gill, 1990). But in Bangladesh, the percept consumption of vegetables is only 50 gm per day, which is the lowest among the countries of south and south East Asia (Rekhi, 1997). Cucurbitaceous vegetables play an important role to supplement this shortage during the lag period (Rashid, 1993). In Bangladesh, vegetables are grown in 2.63 percent of cultivable land (BBS, 2018). According to the Food and Agriculture Organization (FAO), Bangladesh holds the third position in the world for vegetable production (FAO, 2017).

Bangladesh produced 103 thousand tons of bottle gourds in the winter season and 77 thousand in the summer season of 2006-2007(BBS, 2010). Bottle gourd is primarily a winter vegetable but now a-

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days it is available also in summer. Now bottle gourd is grown round the year. Unfortunately, bottle gourds are infested by a number of insect pests, which are considered to be the significant obstacles for its economic production. Among them, cucurbit fruit fly and red pumpkin beetle are the major pests responsible for considerable damage of cucurbits (Butani and Jotwai, 1984).

The fruit fly, *Bactrocera cucurbitae* (Coq.) (Diptera: Tephritidae) is one of the most serious pests of cucurbits in Bangladesh (Alam, 1969; Akhtaruzzaman et al., 1999 and 2000). This pest is also known as melon fly and sometimes as a cucurbit fruit fly. The fruit fly attacks the ultimate economic part, i.e. fruits of the crop that alone can inflict yield loss in different cucurbitaceous vegetables ranging from 30-100% depending upon cucurbit species and the season (Dhillon et al., 2005). It also poses major a threat to global trade, since many countries have invoked restrictions to minimize the risk of establishment of exotic species. The damage caused by fruit fly is the most serious in melon and this may be up to 100 percent. Other cucurbitaceous fruits may also be infested upto 50 percent (Atwal, 1993). Yield losses due to fruit infestation vary from 19 to 70 percent in different cucurbits (Karim, 1995; Kabir et al., 1992). Shah et al. (1984) observed the symptom of infestation as the formation of brown resinous deposit on the attracted fruits. The female fly drums on the skins of young fruits by her oviposit and sometimes on the young leaves or stems of the host plants and make punctures for laying eggs (Chaudhary et al., 2007). Afterward, fruit juice oozes out which transforms into resinous brown deposit. After hatching in the fruit, the larvae feed into pulpy tissue and make tunnels in fruits and cause direct damage. They also damage the fruits indirectly by contaminating with frass and accelerated rotting of fruits by a pathogenic infection. Infested fruits if not rotten, become deformed and hardly which make it unfit for consumption. In Bangladesh where the production of vegetables is much below the requirements, the damage due to cucurbit fruit flies is undesirable. It is therefore, extremely important to devise means to reduce the extent of damage due to fruit flies without affecting the agroecosystem. Given the above facts, the main focus of this research work is lying in the following specific objectives: To study the different stages of cucurbits fruit fly, *B. cucurbitae* on host bottle gourd, *Lagenaria siceraria* which help to take an environmentally safe control measure in cucurbit crops.

II. Materials and Methods

The investigation was being undertaken in the laboratory at the Department of Entomology, Sher-e-Bangladesh Agricultural University, Dhaka-1207 after fruiting of the bottle gourd in the experimental plot from December 2018 to March 2019, on the biology of the cucurbit fruit fly, *B. cucurbitae*. The details of the experiment including the rearing of the test insects are furnished below:

Collection of eggs for the study of biology

The infested fruits of bottle gourd (Plate 01) just after egg deposited by cucurbit fruit fly collected from the field and marked egg deposited area on bottle gourd, then excavating the infested fruit below oviposition puncture from marked egg deposited area of bottle gourd and observed under a microscope for detected eggs of cucurbit fruit fly. After detection eggs were collected and transferred in the petridish (2 cm ht. × 10 cm dia.) for hatching and data were recorded. After hatching the newly hatched larvae were transferred in another Petri dishes containing pulp of the bottle gourd. At the time of intervals different instars of larva observed and data were recorded (Plate 02).

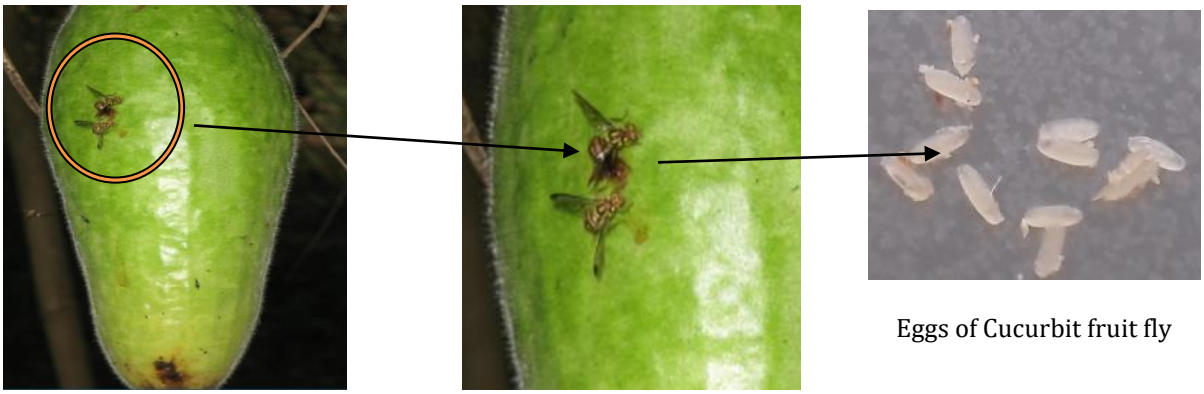

Plate 01. The infested fruits of bottle gourd (egg deposited by cucurbit fruit fly) in field

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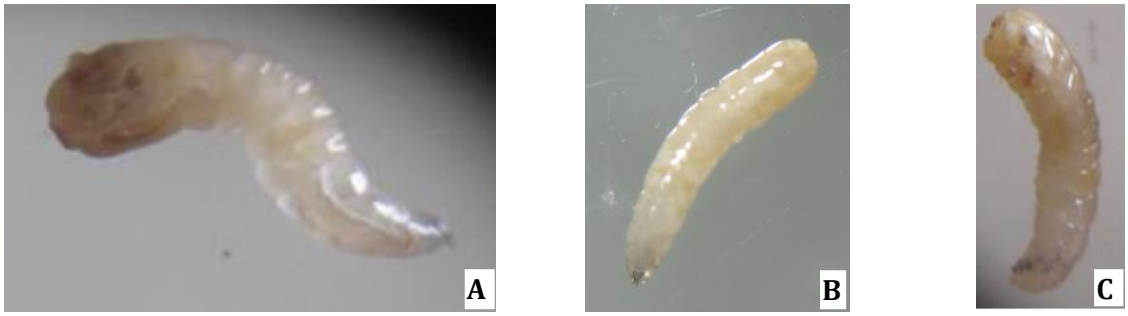

Plate 02. Different larval instars of Cucurbit fruit fly, *B. cucurbitae* (A-1st instar, B- 2nd inster and C- 3rd instar)

The morphological characteristics of the larvae/maggot and pupae were studied and recorded during the period of larval and pupal development, respectively. Different growth and development stages of cucurbit fruit fly such as incubation period, larval period, pupal period and adult longevity were recorded during the study. The incubation period was measured by the time interval between egg laying and larval hatching. The emerged adults of cucurbit fruit fly were kept in the rearing case with food (10% honey solution into watch glass) and without food till their death and the adult longevity were recorded. Total development period of both male and female were also recorded.

Length and width of different stages of the insect: The length and width of different stages of the insect were measured under a microscope and longer parts were measured with the help of slide calipers.

Larval and pupal mortality: The infested fruits of bottle gourd collected from the field kept in rearing case (1´×1´× 2´). Within the rearing case the infested fruits of bottle gourd were placed in a plastic tray. After ending of the larval period (when maggots come out from rotten fruit), the rotted fruits were removed. 50 maggots were kept in Petridis with soil and it replicated five times. After 5 days the soils were sieved to collect pupa and counted from each Petridis individually as well as larval mortality was recorded. For pupal mortality, 20 pupae were kept in a glass jar for adults emerged. After adults emerged data were recorded and determined pupal mortality. The incidence of cucurbit fruit fly: 10 (ten) infested fruits of bottle gourd were collected from the experimental field at the 5 days intervals. Numbers of maggots were counted from each infested fruits of bottle gourd. The incidence patterns of the cucurbit fruit fly as maggot population in bottle gourd were determined during the study period.

Design of the experiment: CRD (Completely randomized design) with 5 replications. Data were analyzed by MSTAT-C software for proper interpretation. Moreover, the graphical work was done using Microsoft Excel program.

III. Results and Discussion

Duration and morphometrics measurement of different life stages of the fruit fly, *Bactrocera cucurbitae* on Bottle gourd

Egg/oviposition period: The egg hatching period was 1.69±0.28 and the data range was 1.0-2.0 (Table 01).

Larvae/Maggot: The larvae/Maggots were apodus. The matured maggots were cylindrical, pointed anteriorly or cephalic end blunt posteriorly. The larvae develop through three instars presented below:

First instar: The newly hatched maggot was white. Total 1.72±0.33 days required for first instar larvae (Table 01) and the data range was 1.4-2.0. The length and width of first instar maggot when reared on bottle gourd ranged from 0.49-0.65 mm and 0.20-0.25mm; mean value being 1.1± 0.9 mm (Mean± S.D.) and 0.22 ±0.11mm (Mean± S.D.) respectively.

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Second instar: Total 1.41±0.31 days were required to complete second instar (Table 01). The length and width of second instar maggot when reared on bottle gourd data ranged from 3.0-4.0mm and 1.0-1.4mm; mean value being 3.03 ± 0.95 mm (Mean± S.D.) and 3.03 ± 0.95 mm (Mean± S.D.) respectively.

Third instar: Total 2.31±0.51 days were required to pass third instar maggot (Table 01). The maggot measured 6.42 ± 0.90 mm in length and 2.13 ± 0.20 mm in width when feeding on Bottle gourd fruit; the data range was 5.0-7.8 mm and 2.0-2.5 mm respectively (Table 02).

Table 01. Duration of different life stages of Cucurbit fruit fly, *B. cucurbitae* on Bottle gourd

Life stage		Duration in Days (Mean±S.D.)	Data range
Egg period		1.69±0.28	1.0–2.0
Larval longevity			
1st instar		1.72±0.33	1.4– 2.0
2nd instar		1.41±0.31	1.0–2.0
3rd instar		2.31±0.51	1.8– 2.7
Pre-pupal period		0.74±0.28	0.5–1.0
Pupal period		9.2±0.78	8.0–10
Adult longevity	Without Food	5.0±0.81	4.0–6.0
	With Food	14.1±1.28	12.0–15.0
Total developmental period (Egg to adult mortality)		36±1.69	33–37.7

Pre-Pupal duration and morphometrics measurement: 3rd instars of matured maggots try to leave the infested fruits and become quiescent before pupation. They become sluggish and stop feeding. At this stage the maggots contracted longitudinally and attained spiral form assuming pre-pupal stage. Total 0.74±0.17 days were required to pass pre-pupal period (Table 01). Length and width of the pre-pupa was varied from 5.3-6.7 mm and 1.7-2.5 mm; mean value being 5.86 ±0.48 mm (Mean± S.D.) and 1.94 ± 0.23mm (Mean± S.D.) respectively (Table 02).

Pupal duration and morphometrics measurement: Total 9.2±0.78 days were required to complete the pupal period (Table 01) and the data range was 8.0-10.0 mm. The pupa measured 5.68± 0.26 mm (Mean± S.D.) in length and 2.39±0.20 mm (Mean± S.D.) in width; the data range was 5.2-6.0mm for length and 2.1-2.8 mm in width respectively (Table 02). Depending on temperature and the host, the pupal period may vary from 7 to 13 days (Hollingsworth et al., 1997). (Gupta and Verma, 1995) recorded that the pupal period varied from 7.7 to 9.4 days on bitter gourd, cucumber, and sponge gourd whereas (Koul and Bhagat, 1994); Khan et al., 1993 observed 6.5 to 21.8 days pupal duration on bottle gourd.

Adult duration: The adult longevity was 5.0±0.81 days (Mean± S.D.) in case of supplying food (10% honey solution) and the data range was 4.0-6.0 mm (Table 01) and when rearing without food the adult longevity was 14.1±1.28 (Mean± S.D.) days and the data range was 12.0-15.0 mm (Table 01).

Morphometrics measurement of adult: In adult male fruit fly abdomen was blunt, ovipositor became absent. They were also smaller in size than that of the females. When reared in bottle gourd, the length of male fruit fly was 6.61±0.59 mm (Mean± S.D.) and the data range was 5.8-7.5mm. The width of male with the wing span was 10.97 ± 0.43 mm (Mean± S.D.) and the data range was 10.2-11.5 mm. (Table 02). In adult female fruit fly were easily detected by the presence of tapering abdomen extending into an ovipositor (Plate 03). They are comparatively larger than the males. The length and width with the wing expanse of the female adult were observed to vary from 11.5-15.0 mm; mean value being 8.28±0.52 mm (Mean± S.D.) and 13.02±1.28 (Mean± S.D.) respectively (Table 02).

The total development period (Egg to adult mortality) was 36±1.69 (Mean± S.D.) and the data range was 33.0 - 37.7mm (Table 01). The finding of the present study are in Corroboration with the earlier works of Lalla and Sinha (1959), Narayanan and Battra (1960), Patel (2007) and Laskar (2013). Minor deviations in Morphometrics may be attributed to the variations in host and environmental conditions.

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Table 02. Morphometrics measurement of different life stages of Cucurbit fruit fly, *B. cucurbitae* on Bottle gourd

Life Stage	Size (mm)			
	Length (mm) (Mean± Std)	Data range	Width (mm) (Mean± Std)	Data range
Larval Instars				
1st Instar	1.1± 0.9	1.0–1.2	0.22 ±0.11	0.20–0.25
2nd Instar	3.03 ± 0.95	3.0–4.0	1.12 ± 0.01	1.0–1.4
3rd Instar	6.42 ± 0.90	5.0–7.8	2.13 ± 0.20	2.0–2.5
Pre-pupal	5.86 ±0.48	5.3–6.7	1.94 ± 0.23	1.7–2.5
Pupal	5.68± 0.26	5.2–6.0	2.39±0.20	2.1–2.8
Adult			With wing span	
Male	6.61±0.59	5.8–7.5	10.97 ± 0.43	10.2–11.5
Female	8.28±0.52	8.0–9.0	13.02±1.28	11.5–15.0

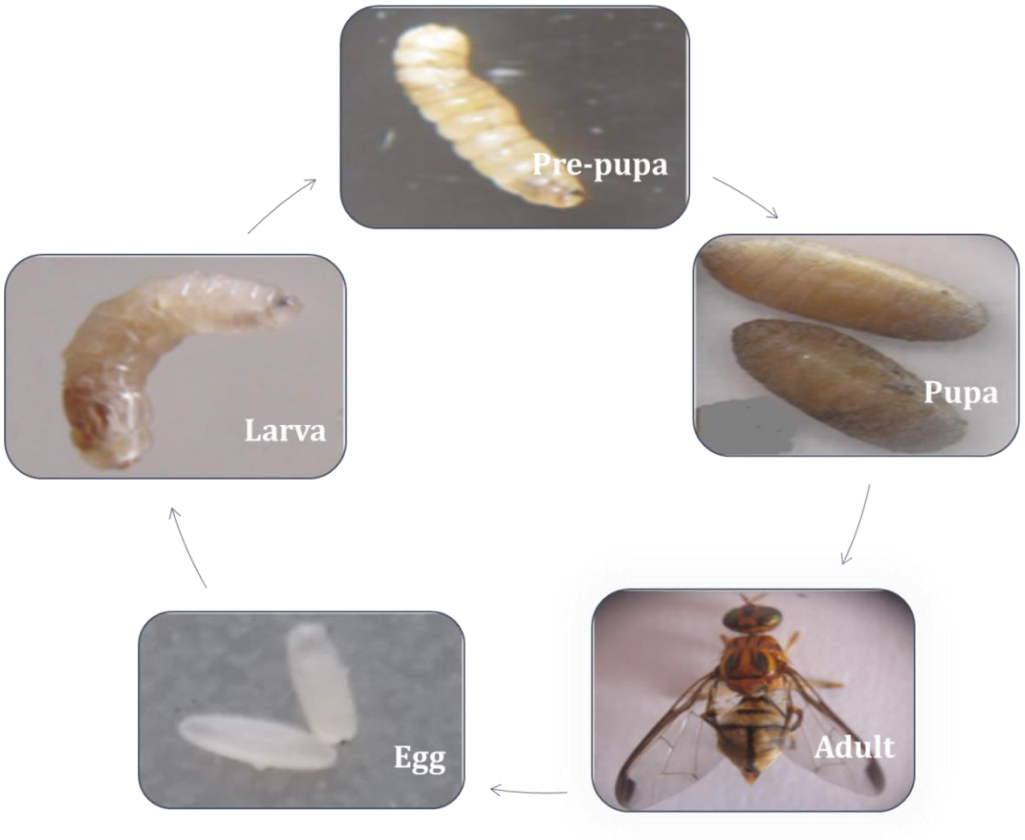

Plate 03. Life cycle of Cucurbit fruit fly (*B. cucurbitae*)

Larval mortality of Cucurbit fruit fly, *B. cucurbitae* during the study period: During the larval development some natural mortality was found to observe. The larval mortality was mainly due to environmental factors and percent of larval mortality was ranged from 20 to 40% during the study period.

Pupal mortality of Cucurbit fruit fly, *B. cucurbitae* during the study period: Pupal mortality was recorded lower than the larval mortality (Figure 01). Most of the healthy pupa formed able to enclose into adult. However, a few numbers not able to enclose into adult which was occurred failure to emerge. Mortality of pupa was noted lower in bottle gourd which was ranged from 10 to 20% during the study period (Figure 01).

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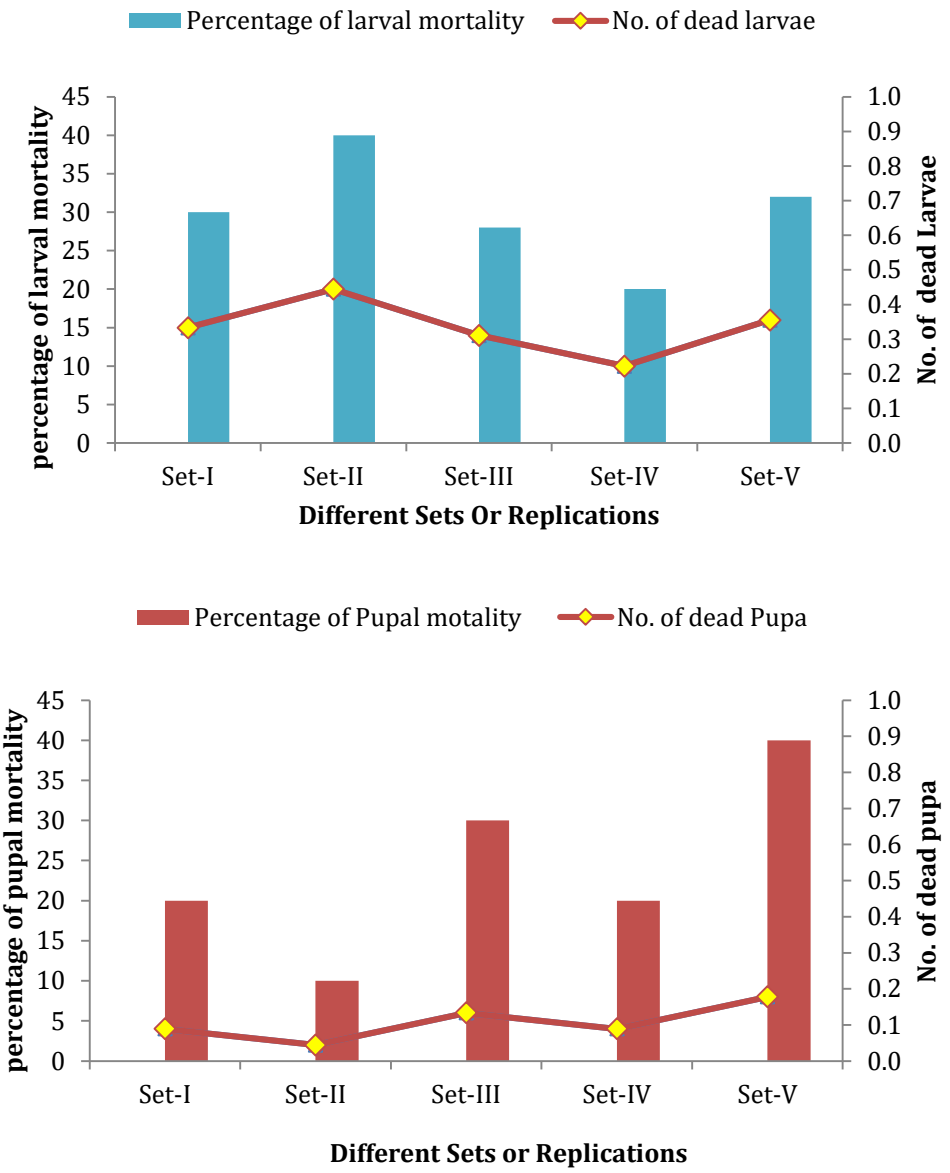

Figure 01. Larval and pupal mortality of *Bactrocera cucurbitae* during the study period

Incidence of cucurbit fruit fly as maggot population in bottle gourd at the different month during the study period

Cucurbit fruit fly, *B. cucurbitae* (Coq.), one of the most important pests of bottle gourd along with all members of family Cucurbitaceae occurred from of December 1st week to February last week during the study periods. Its infestation was recorded during first week of December and continued till the crop was finally harvested. High larval population (94.8 maggots/fruit) could be recorded from third observation (Each observation was done after 4- 5 days intervals) in January (Figure 02). Population of maggot was relatively low during the study period at the end of each month (December, January and February).

Among the different months, the highest maggot populations were observed from month of January, whereas the lowest maggot populations (43) were recorded from 4th observation in December. As a result, the order of incidence pattern of the cucurbit fruit fly as maggot population in bottle gourd at the different months during the study period in terms of number were January > February > December. However, population prevalence was of almost the same order as on each study month from different observations.

No such study was taken up from this region earlier. However, peak population of the pest had been reported to occur on bitter gourd from this region during summer followed by winter season (Banerji et al., 2005). Patnaik et al. (2004) showed that the peak population of the fly could be noted during

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April-May, i.e., around 18th to 20th standard weeks on bitter gourd. Such infestation on little gourd could be recorded throughout the year starting from the month of February reaching peak during third week of March and with negligible infestation during December-January (Patel and Patel, 1996).

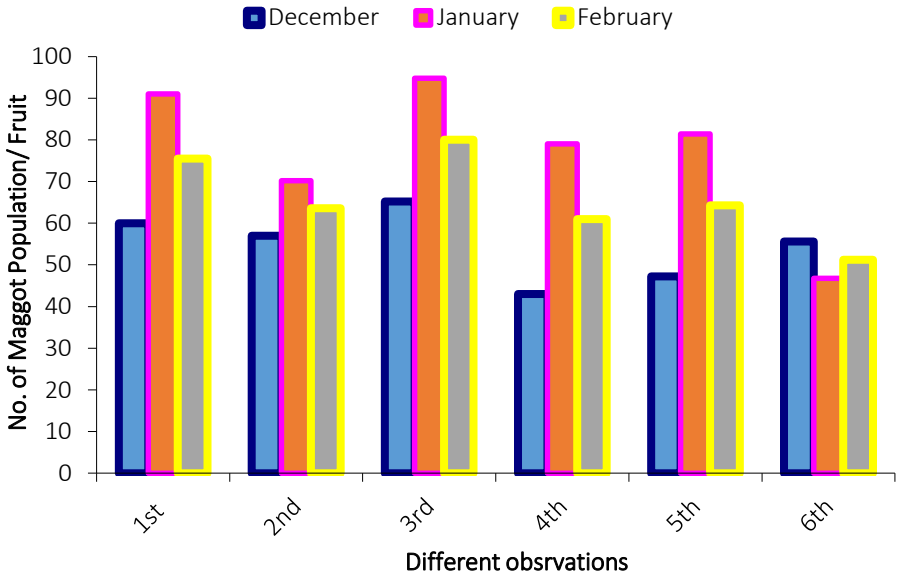

Figure 02. Incidence pattern of cucurbit fruit fly as maggot population in bottle gourd at the different months during the study period

IV. Conclusion

The cucurbit fruit fly, *Bactrocera cucurbitae* is one of the most serious insect pests of cucurbits vegetable. The fruit fly develops through egg, three instars, and pupa, pre-pupa and adult stages. The insect *B. cucurbitae* is more or less active throughout the study period but more active month of January. The present research work may be concluded that incidence of cucurbit fruit fly and infestation of bottle gourd by cucurbit fruit fly significantly varied among the months.

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