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Ashoka KS
Department of Agricultural Entomology, College of Agriculture, Dharwad, Karnataka, India

B Thirupum Reddy
Department of Agricultural Entomology, College of Agriculture, Dharwad, Karnataka, India

Bharathi MC
Department of Sericulture, University of Manasagangotri, Mysore, Karnataka, India

Abhishek BM
Department of Agricultural Entomology, S V Agricultural College, Tirupati, Andhra Pradesh, India

Corresponding Author:
Ashoka KS
Department of Agricultural Entomology, College of Agriculture, Dharwad, Karnataka, India

Biology and morphometry of different life stages of oriental fruit fly, *Bactrocera dorsalis* on custard apple reared under laboratory condition

Ashoka KS, B Thirupum Reddy, Bharathi MC and Abhishek BM

Abstract
The oriental fruit fly *Bactrocera dorsalis* (Hendel) is a very serious pest of fruit crop globally causing considerable economic losses. The present investigation on biology and biometrics of *B. dorsalis* was studied on custard apple under laboratory conditions at Department of Agricultural Entomology, University of Agricultural Sciences, Dharwad, Karnataka during 2018. During the period of investigation, the mean temperatures recorded was 25±2ºC with a relative humidity of 65-70 per cent. The experimental results revealed that average length and breadth of the egg was 1.19±0.08 mm and 0.21±0.03 mm, average length, breadth and weight of full-grown maggots and pupae were about 9.01±0.76, 1.76±0.13 mm and weight was 0.0176 mg. in case pupa 5.17±0.20 mm and 2.10±0.20 mm and weight was 0.0149 mg respectively, and length of adult flies measured about 5.90±0.28 and 6.18±0.29 mm in male and female respectively. The biological study revealed that developmental period from immature to adult stages is varied from 16 to 22 days with the mean fecundity of 276.6±43.6eggs/female.

Keywords: Biology and morphometry, oriental fruit fly and custard apple

Introduction
The oriental fruit fly *Bactrocera dorsalis* (Hendel), first reported in Taiwan Island at frist time, it is one of the most destructive pests of fruits and vegetables around the world, causing huge economic losses and serious pest on a wide range of fruit crops in the Indian subcontinent [5]. Fruit flies 325 species, of which 243 families and 79 genera are from India reported [1]. *B. dorsalis* is reported to cause 100.0, 87.0, 78.0 and 61.0% fruit damage in rainy season on guava, mango, peach and pear respectively[6], whereas [7] reported significant losses in Kinnow due to fruit flies. The damage on crops caused by oriental fruit flies resulted from oviposition in fruit, feeding by the maggots and decaying of tissue by invading secondary microorganisms that leads to fruit drop.

Custard apple, *Annona squamosa* L. (Family: Annonaceae), is a lowland or marginally subtropical crop being cultivated throughout the tropics and warmer subtropics for its edible fruit. This crop is being attacked by a number of pests that feed on its roots, stems, leaves and fruits. Presently fruit fly is attaining a considerable pest status and causing up to 25 per cent yield loss in the custard apple orchard and gaining the economic importance under commercial cultivation. Fruit fly menace is difficult to manage because of the fact that these are polyphagous, multivoltine, adults with high mobility, fecundity and all the developmental stages are unexposed [6]. Hence in order to prevent its spread and reduce damage, great efforts have been made to clarify its ecological and physiological adaptation and to develop control methods [9]. So to know the advancement of damage and distribution in the population of fruit fly on custard apple, there is enormous scope for gaining the knowledge of biology and biometrics of *B. dorsalis* on *Annona* species, which is being commercialized in the recent days so for better marketability there is essential in developing efficient management strategy which can prevent wasteful costly as well as hazardous insecticide usage. Keeping in view of the precedent perspectives, the present investigation on study of the biology and biometrics of *B. dorsalis* on custard apple under laboratory condition was undertaken with the precise experimental set up.

Materials and Methods

Experiment was conducted on custard apple under laboratory conditions at Department of Agricultural Entomology, college of Agriculture, Dharwad, Karnataka during 2018. The biology of *B. dorsalis* was studied under suitable laboratory conditions (temperatures was 25±2 ºC with relative humidity of 65-70 per cent). Ten infested custard apple fruits have been collected from the orchard. The fruits were kept individually rearing cages (35cm x 30cm x 35cm), provided with plastic tray containing 5 cm thick layer of sieved sand as source for pupation and covered with muslin cloth for the observation of developmental studies of fruit flies. Fruits were dissected few days after collection for counting the number of maggots present in each fruit and allowed for the pupation. Pupae were collected in the test tubes and kept in the separate cages for adult emergence and freshly emerged adults (males and females) were provided with protine powder, honey solution and water as adult diet and the fruit fly species emerged from infested custard apple fruits were identified from ICAR-NBAIR, Bangalore. 10 pairs of male and female flies were kept separately in the vials for mating process and further used to study the life cycle and morph metric studies of *B. dorsalis* on custard apple fruit.

Gravid females were kept in the cage provided with egg laying device (it is made with plastic bottle with small minute holes it is pasted with fine fruit pulp inside the bottle), water and honey solution for egg laying. The eggs were collected from egg laying device transfer on custard apple fruit by making small cavity with fifty eggs on each four individual fruits. Freshly hatched first instar maggots were take count and maggot duration was recorded for the same. Last instar maggots were transferred to the plastic tray containing the sand for pupation, same were collected in the test tubes and kept in the separate cages for adult emergence. The incubation, maggot, pupal period, adult male and female longevity, ovipositional period, fecundity and morph metric parameters were recorded and subjected to the statistical analysis.

Results and Discussion

Biology and morph metric of different life stages of oriental fruit fly, *B. dorsalis* on custard apple reared in laboratory during October to November, 2018.

Eggs

The eggs of *B. dorsalis* were elliptical, smooth, elongated, slightly curved and tapering at one end. The posterior end is broadly rounded and the anterior end was found to be pointed and shiny white in colour and turned dark brown colour as they nearer to the hatching. Morphometric observations revealed that the eggs measured about 1.19±0.08 mm in length and 0.21±0.03 mm in breadth. These findings are in close with the results of [7], who observed that the mean length and width of egg was 1.30±0.07 and 0.24±0.04mm, respectively (Table 1) and even the mean incubation period was 1.71±0.85days, which is in line with the [7], who observed an incubation period of 1.3±0.41 days (Table 2).

Maggots

The matured maggots were cylindrical, apodous, frugivorous with an elongated body, pointed anteriorly or cephalic end and blunt posteriorly. The black coloured mouth hooks were retractile and extended outside the body at the time of feeding. The mean maggot period was 7.24±0.90days (Table 2), the freshly hatched maggot was pale white in colour with translucent body and later instars are turn to brownish yellow in colour. All these findings are in line with reports of [3], who recorded the larval period of *B. dorsalis* as 7.5±0.16 and 8.4±0.33 days on mango and sapota, respectively.

The mean maggot length and breadth and also maggot weight of the full grown maggot was 9.01±0.76 and 1.76±0.13mm respectively, and also (0.0176 mg) (Table 1). The present observations are in corroborated with the earlier findings of [7], who reported 8.02±1.02 mm x 1.55±0.17 mm for full grown maggots respectively.

Pupa

The pupation of *B. dorsalis* occurs in the moist sand. The pupae were segmented, barrel shaped or cylindrical and yellowish white to deep brownish yellow when freshly formed. Later on, the colour changed into light brown to brownish grey with 11 distinct segments. Morphometric measurements of pupae recorded was about 5.17±0.20mm in length and 2.10±0.20mm in breadth with pupal weight 0.0149 mg (Table 1) and these results are in line with [8], who recorded 4.60mm length and 2.01mm width in *B. cucurbitae* under laboratory condition, when reared on gherkins and the pupal period lasted for 10.0±0.87days (Table 2). The present findings are in accordance with that of [3], who reported the mean pupal period of *B. dorsalis* as 10.4±0.30 and 11.7±0.15 days on papaya and banana respectively.

Total developmental period

The total life cycle from egg to adult emergence recorded 16 to 22 days, with a mean of 18.9±2.37days in the present study. These results are in confirmation with those of [3], who reported a total developmental period of 20.3±0.44 and 21.6±0.88 days on banana and sapota by *B. dorsalis* respectively.

Adult Longevity

Male

In adult male, the abdomen was blunt and smaller in size than that of the female. The mean length of the male adult was 5.90±0.28 mm. The longevity of male was 25.6±7.39days and all these findings are similar to that of [7] in case of *Bactrocera tau* on *Cucurbita maxima* and [4] in case of *B. cucurbitae* on pumpkin.

Female

Adult females were easily distinguishable by the presence of tapering abdomen extending into an ovipositor and comparatively larger than the males. The length of the female adult was 6.18±0.29 mm. The longevity of female was 31.2±7.73days. These findings were similar to that of reports of [7] in *B. tau* on *C. maxima* and [4] on *B. cucurbitae* on pumpkin.

Pre oviposition period

The freshly emerged adults were fed for few days with protein power mixture, water and honey as adult diet. The pre-oviposition period was observed between 9 to 12 days, with a mean duration of 10.3±1.11days. These findings are in agreement with the findings of [7].

Fecundity

It was recorded that each female laid a mean total fecundity of 276.6±43.6eggs/female during its life cycle. Contrary to the present studies, [7] reported that each female laid a mean

fecundity of 464.6±67.98 eggs/female when reared on *Cucurbita maxima*. These differences could be attributed to the difference in the season and geographical location involved in these two different studies

Table 1: Morphometri data of different life stages of *B. dorsalis* on custard apple reared in laboratory during October to November, 2018.

Parameters	Range (mm/mg)		Mean±S.D
	Minimum	Maximum	
Egg length (mm)	0.97	1.24	1.19±0.08
Egg breadth (mm)	0.16	0.25	0.21±0.03
Maggot length (mm)	7.86	9.71	9.01±0.76
Maggot breadth (mm)	1.49	1.92	1.76±0.13
Maggot weight (mg)	0.0156	0.0192	0.0176±0.00099
Pupal length (mm)	4.78	5.41	5.17±0.20
Pupal breadth (mm)	1.74	2.38	2.10±0.20
Pupal weight (mg)	0.0132	0.0169	0.0149±0.00087
Adult male length (mm)	5.35	6.29	5.90±0.28
Adult female length (mm)	5.74	6.63	6.18±0.29

Sample size (n) = 10, S. D= Standard deviation

Table 2: Duration of different life stages of *B. dorsalis* on custard apple reared in laboratory during October to November, 2018.

Parameters	Range (days)		Mean±S.D
	Minimum	Maximum	
Incubation period	1	3	1.71±0.85
Maggot period	6	8	7.24±0.90
Pupal period	9	11	10.0±0.87
Total developmental period	16	22	18.9±2.37
Adult longevity			
Male	16	36	25.6±7.39
Female	18	41	31.2±7.73
Pre-Ovipositional period	9	12	10.3±1.11
Fecundity	216	359	276.6±43.6

Sample size (n) = 10, S. D= Standard deviation

A) Eggs

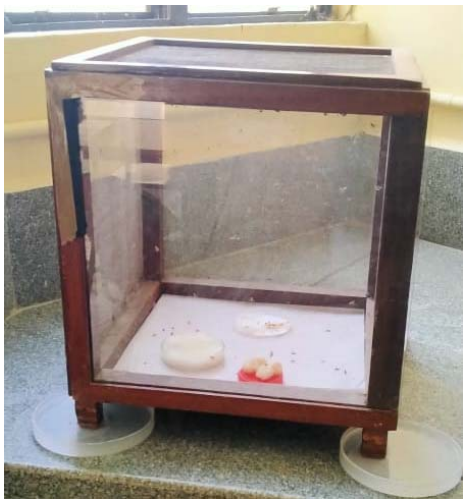
B) Maggot

C) Pupa

D) Adult male

E) Adult female

F) Egg laying device



G) Adults rearing cage with food

Conclusion

Custard apple is being commercializing in the subtropical and tropical climatic condition recently, there is a need for understanding the production and protection aspects of the crop. In India, the area and production of *Annona* species is considerably increasing in the recent years, although it is growing as a marginal crop, but due to its pharmaceutical significance recently gaining importance. So there is a need for accounting the plant protection measures to ensure the better production of the crop, hence as the fruit fly, *B. dorsalis* is being threats to the crop in the recent days, so to understand the biology of *B. dorsalis* on *A. squamosa* we undertaken the laboratory study and results revealed that the total developmental period was 16 to 22 days, with a mean of 18.9±2.37 days and other developmental parameters were presented in the results and discussion section and by knowing the life cycle of a pest we can exploit these findings in the better field management of an pest.

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