COMPARATIVE BIOLOGY OF GUAVA FRUIT FLY *BACTROCERA CORRECTA* (BEZZI)

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ABSTRACT

Fruit flies are polyphagous insect pests, infesting various fruits and vegetables. The host preference and biology of guava fruit fly *Bactrocera correcta* (Bezzi) were studied on 17 hosts. Biological parameters such as incubation period, maggot and pupal period, maggot and pupal weight, pupal recovery, adult emergence, total fecundity and adult longevity were studied. All biological parameters were significantly influenced by the host fruits. The results showed that the total developmental period was longer on pomegranate (26.7± 2.1 days), ber (26.1± 2.4 days) and custard apple (25.1± 1.5 days); while shorter period was observed on sweet banana (20.1± 1.6 days). Pupal recovery was maximum on sweet banana (93.33%) and lowest on mango (Totapuri) (42%). The adult emergence was also more on sweet banana (90%) and survived for longer period. Sweet banana was preferred for oviposition followed by guava, papaya, and sapota.

Key words: *Bactrocera correcta*, Tephritidae, fruits, host preference, adult longevity, larval weight, pupal weight, larval period, developmental biology, pupal recovery, oviposition, fecundity, incubation period

Guava fruit fly *Bactrocera correcta* (Bezzi) (Diptera: Tephritidae) is a serious pest in tropical and subtropical areas of Asia and was first recorded in Bihar, India (Ahmad et al., 2023). Adults of fruit fly feed on plant secretions, nectar, sap, honeydew, bird dropping and microorganisms (Campos et al., 2022) and lay the eggs on different parts of the plants. Hatched maggots feed on the nutritive pulp resulting in decay and are prone to secondary infection. Moreover, female fruit flies cause direct damage to fruits and vegetables by puncturing the fruits for oviposition (Reddy et al., 2020). *B. correcta* can infest more than 70 species of tropical and subtropical fruits, representing 35 plant families (Liu et al.,2019) resulting in losses up to 60-80%, depending on locality, variety, and season (Hasnain et al., 2022). The primary hosts of *B. correcta* are guava, mango, sapota, cashew nut, cherry, jujube, orange, banana, carambola and wax apple (Liu et al., 2019, Liu et al., 2013). The preference of dacine fruit flys host is greatly influenced by the availability of host, season and also depending upon the pre and post-alighting features (Saeed et al., 2022). Usually, *B. correcta* co-exists with other *Bactrocera* sp. particularly *B. dorsalis* and *B. zonata* and attracted strongly to methyl eugenol in the field condition and also share almost similar host range (Hadapad et al., 2017). While, the differences in morphological and chemical substance between host fruits are likely interfere in the biology and behavior of pest (Papadopoulos et al., 2023, Balagawi et al., 2005).

Bactrocera spp. generally prefer to oviposit on soft and juicy skin fruits but dislike hard skin and unripen fruits (Cunningham et al., 2016, Rattanapun et al., 2009). Female flies usually get attracted to the hosts based on the aroma emission rate, size, softness and sugar level (Rattanapun et al., 2009, Jaleel et al., 2021) and also physical characteristics of fruits for oviposition. The development and survival of *Bactrocera* spp. are different and depending on the stage of fruits, traits and nutrition level (Balagawi et al., 2005, Rattanapun et al., 2009). Some of host fruits will provide enough nutrition for larval development which is sufficient to complete biology. Therefore, it is necessary to understand the host preference available in that region and its biology. Selection of suitable natural hosts and improvement of mass rearing methods for fruit flies are prerequisites for a successful study of genetics or implementation of sterile insect technique (SIT). Response of *Bactrocera* spp. to different hosts and their oviposition preference of has been documented

(Jayanthi and Verghese, 2002;Castilho et al., 2019). However, few studies have been conducted to compare the biology of *B. correcta* on multiple hosts. The present study was conducted to investigate the host preference and compare the biology of *B. correcta* on different host fruits. The present study will help to understand the host range and rearing of *B. correcta* in the laboratory for area-wide pest management program.

MATERIALS AND METHODS

The fruit fly infested guava fruits were initially collected from the guava orchard at the Agricultural Research Station (ARS) farm of College of Agriculture, Bheemarayanagudi, University of Agriculture Sciences (UAS), Raichur, Karnataka, India. Upon the pupation in sterile sand, the pupae were kept in insect rearing cage (45 x 45 x 45 cm) with water and protein (1 g), yeast (0.5 g) and honey solution (10%) in petri dishes (5 cm dia) as adult diet. The emerged adults were identified based on the morphological features[19]. *B. correcta* culture was maintained and reared on sweet banana (cv. *Elakki*) in a control room (28± 2°C and 75% RH, natural photoperiod). When the adult flies reached the age of 12 days, cages were set up for egg collection by using egg-laying device. A laboratory experiment was conducted to study the host preference on 17 natural host fruits viz., sweet banana (cvs *elakki*) and banana (cvs *robosta*) (*Musa* sp. L. (Musaceae)), ber (*Ziziphus mauritiana* Larn. (Rhamnaceae)), malabar plum (Jamun) (*Syzygium cumini* L. (Myrtaceae)), custard apple (*Annona reticulate* L. (Annonaceae)), guava (*Psidium guajava* L. (Myrtaceae)), mango (cvs baneshan and totapuri) (*Mangifera indica* L. (Anacardiaceae)), muskmelon (*Cucumis melo* L. (Cucurbitaceae)), papaya (*Carica papaya* L. (Caricaceae)), pear (*Pyrus communis* L. (Rosaceae)), pineapple (*Ananas comosus*(L.)Merr. (Bromeliaceae)), pomegranate (*Punica granatum* L. (Lythraceae)), sapota (*Manilkara zapota* L. (Sapotaceae)), sweet orange (*Citrus* sp. L. (Rutaceae)), tomato (*Solanum lycopersicum* L. (Solanaceae)) and watermelon (*Citrullus lanatus* (Thunb.) Nakai (Cucurbitaceae)).

Fruits of mentioned species were obtained from orchards or local markets and ensured free from natural infestation. When the adult flies had reached the age of 12 days, the plastic egg laying device smeared with guava paste was placed in fruit fly-rearing cages in evening hours. Next day morning, eggs were collected, washed twice with water, transferred into petri dishes and allowed to settle for few minutes. Further, eggs were used to assess the biological parameters through non-choice method. Host fruits were collected as described above and same age 50 eggs were seeded on each fruit using fine paint brush. The individual fruit containing eggs were placed in clear plastic containers (3ℓ capacity) containing sterilized sand and covered with muslin cloth (28± 2°C and 75% RH, natural photoperiod). Each container was observed for various biological parameters. Each host fruit was examined (n=20) for incubation period (days), maggot and pupal period (days), maggot and pupal weight (mg), pupal recovery (%), adult emergence (%) and further total developmental period was calculated according to Collins et al. (2008). Development of *B. correcta* stages in malabar plum, muskmelon, watermelon and pineapple was not observed and hence excluded in. Ten pairs of emerged adults of *B. correcta* from each fruit were placed in fruit fly rearing cages (15 x 15 x 15 cm) with water and food as described above. As the adults matured (12 days), the egg laying device smeared with respective paste of the thirteen fruit hosts was placed in the cages. Rearing cages were monitored daily for total fecundity and longevity of males and females. All biological parameters were subjected to Kruskal-Wallis test ($p \leq 0.05$) and the Steel–Dwass pairwise comparisons test ($p \leq 0.05$) test (KyPlot 6.0 software, Kyens Lab, Inc., Tokyo, Japan) was used to compare the significant differences between the biological parameters of *B. correcta*.

RESULTS AND DISCUSSION

Seventeen host fruit species screened for the *B. correcta* preference showed significant difference in biology (Table 1). The maximum incubation period was recorded on pomegranate (2.6± 0.4 days) followed by ber (2.1± 0.2 days) and found significant differences among other fruits ($p<0.05$). Significantly lowest incubation period was observed on sweet banana (1.4± 0.4 days) followed by guava, mango and pear fruits (1.5 days). The duration of maggot development was significantly longer in ber (11.4± 1.1 days). There were significant differences in maggot weight ($p<0.05$). The mean pupal period of *B. correcta* was maximum on pomegranate (14.0±0.8 days) followed by custard apple (13.2± 0.8 days) and sweet orange (13.1± 1.0 days). It was significantly lower on papaya (10.2± 0.8 days) followed by sweet banana (10.4± 0.5 days) ($p<0.05$) and further reflected the significant difference in pupal weight ($p<0.05$). These biological parameters were influenced significantly by the total development period in pomegranate (26.7± 2.1 days) followed by ber (26.1± 2.4 days) ($p<0.05$). However, a shorter development period was recorded with sweet banana (20.1± 1.6 days)

Table 1. Comparative development and biological parameters of *B. correcta* reared on different host fruits

Host fruits	Incubation period (Days)*	Maggot period (Days)*	Maggot weight (mg)*	Pupal period (Days)*	Pupal weight (mg)*	Total developmental period (Days)*
Custard apple	1.7± 0.4a	10.1± 0.6b	12.9± 0.9b	13.2± 0.8c	11.5± 0.5c	25.1± 1.5cd
Sweet orange	1.6± 0.5a	9.2± 0.8a	14.1± 0.8c	13.1± 1.0c	11.7± 0.9c	23.9± 2.2b
Pomegranate	2.6± 0.7b	10.1± 0.7b	13.5± 0.9d	14.0± 0.8d	11.2± 0.7c	26.7± 2.1d
Sweet banana (Elakki)	1.4± 0.4a	8.3± 0.7a	11.7± 0.8cd	10.4± 0.5a	10.1± 1.4b	20.1± 1.6a
Banana (Robosta)	1.6± 0.2a	8.6± 1.04a	12.9± 1.1b	11.0± 0.9a	13.0± 1.2d	21.2± 2.1a
Sapota	1.8± 0.6a	9.9± 0.9ab	12.5± 0.7bc	10.9± 0.8a	10.2± 1.5b	22.7± 2.2b
Guava	1.5± 0.4a	8.7± 0.7a	12.2± 0.8b	10.7± 0.5a	10.0± 1.2b	20.9± 1.5a
Papaya	1.7± 0.2a	8.8± 1.0a	14.7± 0.1b	10.2± 0.8a	10.0± 1.2b	20.8± 1.9a
Tomato	1.6± 0.2a	8.2± 1.2a	14.8± 1.0d	11.1± 0.7a	11.7± 1.2c	20.9± 1.05a
Pear	1.5± 0.5a	10.5± 1.1b	13.3± 0.8d	11.6± 1.3b	11.2± 0.7c	23.7± 2.8b
Ber	2.1± 0.2b	11.4± 1.1c	13.4± 0.9c	12.6± 1.2bc	12.4± 0.6cd	26.1± 2.4d
Mango (Baneshan)	1.5± 0.5a	11.0± 1.7c	14.0± 0.2c	11.7± 1.4b	9.8± 0.1a	24.3± 3.5cd
Mango (Totapuri)	1.7± 0.8a	10.1± 0.7b	9.9± 0.2cd	10.6± 0.7a	8.4± 0.1a	22.4± 2.01b
χ^2	60.78	135.60	116.17	152.39	135.62	123.81

followed by papaya (20.8± 1.9 days), guava (20.9± 1.5 days) and tomato (20.9± 1.05 days). This indicates that the unusual nutrient quality of pomegranate and ber might require prolonged feeding of immature stages of *B. correcta* and may have influenced *B. correcta* biology as compared to other host fruits. The comparative biology of *B. dorsalis*, *B. correcta* and *B. zonata* was studied using sweet banana, mango, papaya, guava, peach, pear, orange, tomato, kinnow and carambola fruits, found that host fruits influence the growth and development (Jayanthi and Verghese, 2002; Liu et al., 2014). The development of *B. dorsalis* on different hosts such as banana, guava, mango and papaya were studied, it was found that host fruits were sufficient enough to support the maggots till the final instars, except papaya (Jayanthi and Verghese, 2002).

The pupal recovery of *B. correcta* was maximum on sweet banana (93.33%), followed by guava (90.00%), banana (robusta) (88.00%) and sapota (84.22%) (Table 2). It was found minimum in mango (totapuri) with 42.00%. Similarly, maximum adults have emerged

Table 2. Pupal, adult emergence, fecundity and adults longevity of *B.correcta* on different host fruits

Sl. No.	Different host fruits	Pupal recovery (%)	Adult emergence (%)	Fecundity (eggs/ female)	Adult longevity Mean± S.D (N=20)	
					Male	Female
1	Custard apple	72.22	72.00	123.0	32.6± 12.8	34.1± 11.7
2	Sweet orange	74.19	62.00	135.4	32.1± 10.5	33.6± 11.1
3	Pomegranate	72.41	58.00	126.8	31.1± 10.1	35.8± 10.1
4	Sweet banana (Elakki)	93.33	90.00	224.2	36.7± 13.2	39.2± 13.2
5	Banana (Robosta)	88.00	88.63	203.7	31.6± 9.50	35.0± 11.6
6	Sapota	84.22	76.00	172.4	33.4± 10.5	36.6± 10.8
7	Guava	90.00	84.00	203.3	34.2± 11.4	38.1± 12.6
8	Papaya	86.00	88.37	170.2	34.5± 9.84	38.0± 12.5
9	Tomato	76.00	68.42	100.0	24.0± 10.5	27.5± 13.4
10	Pear	74.00	83.78	163.9	34.2± 11.4	38.1± 12.6
11	Ber	72.00	86.11	85.88	29.8± 12.8	34.8± 12.4
12	Mango (Baneshan)	82.66	58.06	95.40	25.2± 11.47	26.94± 13.27
13	Mango (Totapuri)	42.00	58.73	56.47	19.75± 9.75	19.83± 9.22

from the pupae collected from sweet banana (90.0%) followed by banana robusta (88.63%). Whereas, it was lowest on pomegranate (58.00%), mango (baneshan) (58.06%) and mango (totapuri) (58.73%). These results are in accordance with earlier findings (Jaleel et al., 2021), who found that two banana cultivars like robusta and elakki recorded highest pupal recovery for *B. dorsalis* and were not significantly different. Lowest pupal recovery was recorded in guava, mango (totapuri), pomegranate, custard apple and papaya. In addition, lower adult emergence was also observed in pomegranate, mango cultivars, sweet orange and custard apple. The adults emerged from sweet banana survived significantly longer period (male 36.7; female 39.2 days) as compared to other fruits (Male: χ^2=39.21; p<0.05 and Female: χ^2= 47.70; p<0.05). The adults emerged from pupa collected from different hosts showed differences in fecundity. The highest fecundity was recorded on sweet banana (224.20 eggs/ female), guava (203.30 eggs/ female) and sapota (172.40 eggs/ female) and lowest fecundity was observed on mango (totapuri) (56.47 eggs/ female). It was found that, The male and female adults reared on sweet banana lived significantly longer with 36.70± 13.20 and 39.20± 13.20 days respectively. Significantly, shorter was in the adults reared on mango (totapuri). Banana and guava are the preferred hosts for oviposition (Jayanthi and Verghese 2002). However, banana is considered an unusual host for oriental fruit fly (Ian and Harris, 1992).

In the present study, fruits paste was used as ovipositional stimulant and found to show difference in fecundity. Certain host and their paste exert differential influence on tephritid fruit flies, and vary in terms of susceptibility and egging stimulant due to their nutritional and chemical composition (Khan et al., 2011). For example, *B. correcta* preferred guava fruits more for oviposition as compared to banana and mango (Jaleel et al., 2021). The ovipositional preference of fruit flies depends upon the type of host which must facilitate the growth and development of their offspring (Balagawi et al., 2005, Rattanapun et al., 2009, Brandalha and Zucoloto, 2004). Moreover, the selection of hosts for oviposition from tephritid fruit flies depend on volatiles emission, texture and skin toughness of fruits (Rattanapun et al., 2009, Jaleel et al., 2021).The major volatiles like butanoic acid-3-methylbutyl ester, α-caryophyllene, and 3-carene were the major compounds present in banana, guava and mango fruits, respectively (Jaleel et al., 2021); and strong attractant of female adults of *B. dorsalis* and *B. correcta* was recorded with 3-carene and the mixture of β-caryophyllene and α-humulene (Jaleel et al., 2019). Fruit flies are polyphagous, multivoltine; adults have high mobility, wider adaptability and fecundity. The present study showed the difference in the development of *B. correcta* on various host fruit species. Among them, sweet banana (elakki) was the most suitable host and media for the mass rearing of *B. correcta* under laboratory conditions.

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AUTHOR CONTRIBUTION STATEMENT

Dr Basavaraj Shivabasayya Kalmath was Principal Investigator, Dr Ashok Basappa Hadapad and Ramesh Subhash Hire were the project collaborators, who monitored and guided the project. Dr Rachappa Haveri was the CO-PI of the project and assisted in conducting the experiments. Srilekha Koduri helped in writing the manuscript. Ashoka Kurutahalli Srirama Reddy is a research fellow who assisted in conducting experiments.

CONFLICT OF INTEREST

No conflict of interest.

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