

Original Research Article

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Preference of Fruit Flies, *Bactrocera* spp. in Relation to Size and Ripeness of Intact and Fallen Guava Fruits

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ABSTRACT

The productivity of the guava fruit is mainly ravaged by the fruit flies, *Bactrocera* spp. and found to be the major devastating insect pest that causes extensive damage. Fruit flies cause direct damage to fruit by oviposition punctures followed with the feeding of maggots. The greatest threat influenced by the fruit flies is the rejection of harvested fruits in markets and exporters especially in case of guava due to the presence of maggots, it leads fruit becoming unfit for marketing and consumption. To overcome this problem basic knowledge on the scientific reasons behind the preference towards the guava fruits exerted by the fruit flies to be ascertained. The ovipositional preference of the fruit flies may vary depends upon the fruit phenology viz., size, ripeness, odor and thickness of pericarp etc., Thus, the present investigation on preference of fruit flies in relation to fruit size and ripeness in guava was carried out by sampling and assessment of maggot population, pupal percentage, adult emergence and sex ratio in intact and fallen fruits. The overall sampling study revealed that the maggot population was more in large sized fruits i.e., 30 – 50 per fruit in fallen condition and 20 – 30 in intact fruits and the adult emergence was also more in the large sized fruits (> 70%) when compared with the small and medium sized fruits. Comparing the intact and fallen fruits, the fallen fruit shows the higher population (41.67/fruit) and intact fruits shown comparatively less population (24.75/fruit). The infestation of *B. caryeae* was higher than the *B.dorsalis* and sex ratio recorded shows the male population is more in *B.dorsalis* whereas the male and female seems to be present in equal ratio in case of *B. caryeae*.

Keywords

Guava, Fruit fly, *Bactrocera* spp., Feeding preference, Fruit size and fruit ripeness

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Introduction

Guava (*Psidium guajava* Linn.) is one of the most important fruit crop belonging to the family Myrtaceae and popularly it is known

as “Poor man’s apple” or “Apple of tropics”. It is native to Central America and introduced into India by Portuguese during the 17th century (Baloda *et al.*, 2018). It is rich in protein, vitamin C, ascorbic acid, calcium,

iron and phosphorus. The guava fruit is normally used in table purpose as well as in preservation industry for making jam, jelly and other value added products. Guava tree is well suited for cultivation under tropical and subtropical climatic conditions. It is capable of withstanding adverse situation in various types of soil (Gurjar *et al.*, 2018). In India, the total area under guava is 2.6 lakhs ha with the annual production of 3.9 million tons and contributes about 4.0 percent of total fruit production. While comparing the productivity of guava with other nations, our country is poor in productivity due to the several insect pest problems (Jalaluddin, 2001). Guava crop is attacked by nearly 80 species of insect and mite pests, however only few of them have been noted as regular pest and causing serious damage. The most severe insect pest which attacking guava is fruit flies, *Bactrocera* spp., and potent enough to cause 60 to 80% damage (Jalaluddin *et al.*, 1999). Fruit flies are polyphagous insect pest and strong fliers which is capable of flight up to two kilometers for searching food (Butani, 1974). Fruit flies cause direct damage to fruit by oviposition punctures on the fruit skin, through which saprophytic microbes invade into the fruit, resulting in rotting of the fleshy tissues. After the hatching of eggs, the maggots start feeding on the flesh, which hasten the fruit decay, resulting in unsuitability of fruits for human consumption. Severely infested fruits fall on the ground just prior to the pupation of maggots. Besides the direct damage, it will also cause indirect damage by affecting the export of fruit and brings a drastic loss in the country's economy (Heather and Hallman, 2008). India has been shortlisted in the countries from where import of fruits to developed countries is banned (Stone House *et al.*, 2002). Fruit fly is a potential threat in successive production and marketing of guava, so it is mandatory to take necessary investigations on its preference in relation to size and ripeness of guava fruits to

plan and frame out the timely management strategies in orchards for maximizing the profit.

Materials and Methods

The current investigation on the preference of fruit flies, *Bactrocera* spp. in relation to size and ripeness of intact and fallen guava fruits was carried out in the entomology laboratory of Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli under normal room temperature $27 \pm 1^{\circ}\text{C}$ by keeping the small, medium and large sized infested intact and fallen fruits separately in rearing cages to access the population built up in each categories of fruits.

Fruit flies lay their eggs on guava fruits in partially ripened stage. On hatching, the maggots enter into endocarp portion and start to feed fruit pulp. In the intact and fallen fruits presence of tiny punctures on the surface indicates the infestation of fruit flies. To understand the prevalence of fruit flies in the confined ecosystem the infested fruits were collected both from tree and ground based on the ovipositional puncture marks and brought into the laboratory and incubated at ambient temperature condition for adult emergence.

For the experiment, four guava trees enriched with blossoms and bearings were selected and tagged, from these trees both the intact and fallen infested fruits of three types *viz.*, Small (≤ 20 cm diameter), Medium (≤ 25 cm diameter) and Large fruits (≥ 30 cm diameter) were taken and placed in a plastic container of dimension 10 X 8 X 15 cm (lbh), covered with the net by following the procedure of Jadhav and Patil (2013).

The plastic container is filled with the sterilized sand up to a depth of 3cm which

serves as the media for pupation, the container with infested fruit is incubated at $27 \pm 1^{\circ}\text{C}$ and $75 \pm 2\%$ RH for the period of 21 days. The pupae in the sand were sieved and collected carefully, the pupae collected from the sand were transferred into a rearing cage of dimension 35 X 35 X 30cm (lbh) and kept undisturbed for the adult emergence.

The emerged young ones were fed with yeast, sugar and honey solution on a cotton swab, additionally water is provided for the adult development (Kamala *et al.*, 2017).

During the study, number of puparia collected from the fruit, percentage of adult emergence, sex ratio, parasitoid emergence were recorded and the species of emerged fruit flies were taxonomically identified by running the keys of David and Ramani (2011). The observed parameters on the number of maggots, per cent pupation, adult emergence and sex ratio were taken to assess its preference towards size and ripeness in fallen and intact guava fruits.

Results and Discussion

The previous reports on the seasonal occurrence and the activity of fruit flies indicated that, the prevalence of *Bactrocera* spp. in guava orchards was peak in abundance during the months of March and April; moreover the population abundance was also positively correlated with the maximum temperature (Das *et al.*, 2017).

The flowering to fruiting stage of guava was also coincides in this period with the availability of intact and fallen fruits in tropical regions. Keeping this in mind, the present study on the assessment of the preference of intact and fallen guava fruits to the fruit fly, *Bactrocera* spp. was carried out from January to May month.

Preference exerted by the fruit fly species *Bactrocera* spp.

The assessment on the preference of fruit fly species complex in guava ecosystem showed the presence and spread of *Bactrocera* spp. in guava orchards during the experimental period. The identification of trapped fruit flies at species level by using taxonomic keys clearly indicated that the population of *B.dorsalis* and *B.correcta* were more prevalent both in intact and fallen guava fruits, the occurrence and preference of these two species in mixed fruit ecosystem is also reported by Taylor *et al.*, (2005) in Tamil Nadu, Bheemanna and Prabhuraj (2017) in Karnataka and David *et al.*, (2016) in Andaman Nicobar islands. The record on the presence of these two species and its high preference of guava fruits is accordance with the results on the high response of these two species towards guava orchards of Punjab region (Balaji and Singh, 2018).

The ovipositional preference of fruit flies in different sized fruits were examined by sampling infested guava fruits both in intact and fallen condition, the results shows that more number of maggots were recorded in the large sized fruits (30.50 – 41.67/fruit) and maximum adult emergence (62.25 – 91.99 %) was also noted in the large sized fruits when compared with the medium and small sized fruits. The influence of large sized fruits with increased oviposition was found to be in consonance with the findings of Malheiro *et al.*, (2015), who stated that bigger sized fruits were preferred by olive fruit flies than the smaller fruits at Mexico and Kamala Jayanthi *et al.*, (2017) in oriental fruit fly. The combining effect of visual and olfactory stimuli will enhance the fruit fly catch in guava orchards; this concept is in tune with the reports of Alyokhin *et al.*, (2000) in oriental fruit flies.

Maggot population

The observations illustrated in Table 1 and 2, clearly depicts the range of *Bactrocera* spp. infestation that the maggot population was more in the large sized fruits both in intact and fallen condition and it was followed by the medium and small sized fruits. The high preference of fallen guava fruits by *Bactrocera* spp. was proved with the registered maggot's population that the number of maggots was more in fallen fruits (18.75 – 41.67), when compared with the intact fruits (6.75 – 24.75). The maximum number of maggots of *B. correcta* (41.67) and *B. dorsalis* (39.00) was noted in the month of January in fallen guava fruits, it was 24.75 and 22.75 in intact fruits in the month of April. The population trend of maggots and adult emergence pattern of *B. dorsalis* and *B. correcta* were represented in Fig.1 and Fig.2 respectively. Irrespective of species, the incidence and multiplication of fruit flies was more in fallen fruits than in intact fruits, moreover the maximum incidence (up to 50%) and population was started in the month of January itself in fallen fruits but it was comparatively less (< 25 %) in intact fruits. The larval survival is highly favoured by the ripen fruits and confirms the firmness of fruit is the major factor that influences the infestation. Díaz-fleischer and Aluja (2003) also opinioned that the soft and ripen fruits were highly preferred by *Anastrepha ludens* in a confined mango ecosystem. Considering the impact of size, the small size intact fruit the maggot population was very minimum (< 10 per fruit) but it was > 20 per fruit in fallen fruits. The preference was logically increased towards the medium and large sized fruits. In case of medium sized fruits the maximum of 18.25 maggots were recorded in intact, but it was 25.75 per fruit in fallen fruits. The proneness of large size fruits was strengthened by the data registered with more than 30 maggots per fallen fruit and the maximum of 24.75 maggots per intact fruit

was observed throughout the experimental period. The thickness of the rind, gradual increase in ripeness and the changing of the color from green to yellow during ripening might be the possible reasons for the exertion of preference towards ripened large sized fallen fruits than the intact fruits. The role and response of visual stimuli towards the attraction and preference of fruit flies to the yellow color observed in this study is well strengthened by the findings of Cornelius *et al.*, (1999) in female oriental fruit flies to fruit-mimicking traps.

Fruit fly Pupation and Adult emergence

The results obtained on the per cent pupation and adult emergence of *Bactrocera* spp. both in fallen and intact fruits conveyed that the size and ripeness of the fruits were almost non significant in registering the variation both in fallen and intact fruits. The intactness of the fruit in tree and the fallen fruits in the ground canopy of the tree both are registered the per cent pupation (64.91 - 91.86) and the adult emergence (61.88 - 92.28) of fruit flies, irrespective of species. These results obtained on the per cent pupation and adult emergence clearly indicated that the size, stage (intact and fallen) and ripeness of guava fruits were does not show any influence on pupation of fruit fly maggots.

The overall observation parameters concluded that though there is non significance in the variation, the maximum per cent in pupation and adult emergence was noticed in fallen fruits when compared with the intact fruits. These findings concluded that semi to full ripeness, partial decaying and delayed rottenness of the fallen fruits may provide a congenial condition for the better pupation and adult emergence. Considering the sex ratio, the overall observation shows the male population of *B.dorsalis* was more when compared with the females, whereas male and female seems to be equal in *B. caryeae*.

Table.1 Preference of *B. dorsalis* in relation to fruit size and ripeness of intact and fallen guava fruits

Fallen fruits*												
2018	Small				Medium				Large			
	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F
Jan	20.67	85.26	72.65	0.9:1.0	25.33	77.56	83.87	1.0:1.0	39.00	75.36	73.58	0.9:1.0
Feb	20.33	74.71	75.14	1.0:0.9	24.25	82.11	90.97	1.0:0.9	31.25	78.10	76.35	1.0:1.0
Mar	22.00	75.42	77.60	1.0:1.0	25.25	73.82	74.42	1.0:0.8	36.25	72.63	74.09	1.0:0.7
April	18.75	65.81	76.67	1.0:0.9	30.75	73.82	73.20	1.0:0.9	30.75	71.31	73.91	1.0:1.0
Intact fruits*												
2018	Small				Medium				Large			
	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F
Jan	7.00	90.80	79.76	0.7:1.0	14.67	90.00	72.20	1.0:0.9	22.33	79.53	83.29	1.0:1.0
Feb	15.67	83.89	71.04	1.0:0.9	17.25	81.15	77.68	1.0:0.9	21.50	76.68	91.99	1.0:0.9
Mar	6.75	81.01	57.71	1.0:1.0	14.75	69.49	79.17	0.9:1.0	22.25	79.46	82.35	1.0:0.9
April	9.25	86.01	67.63	0.7:1.0	15.75	76.19	68.39	0.8:1.0	22.75	79.04	81.74	1.0:0.9

*Mean value of four replications

Table.2 Preference of *B. correcta* in relation to fruit size and ripeness of intact and fallen guava fruits

Fallen fruits*												
2018	Small				Medium				Large			
	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F
Jan	21.00	81.51	75.63	0.9:1.0	23.67	85.03	82.29	1.0:0.6	41.67	76.90	72.53	0.9:1.0
Feb	21.67	75.07	81.83	1.0:0.8	25.75	91.86	75.71	1.0:0.8	30.50	86.74	69.99	0.9:1.0
Mar	20.50	72.57	92.28	1.0:0.9	24.00	86.94	70.63	1.0:0.8	34.50	79.06	71.06	0.9:1.0
April	19.75	82.90	59.16	0.8:1.0	29.50	86.94	64.52	1.0:0.9	34.75	75.16	62.25	1.0:0.6
Intact fruits*												
2018	Small				Medium				Large			
	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F	No. of Maggots	Pupation (%)	Adult emergence (%)	Sex ratio M:F
Jan	9.33	63.88	85.32	1.0:1.0	15.33	75.00	75.27	1.0:1.0	23.67	81.40	85.97	1.0:1.0
Feb	17.33	82.58	73.82	0.7:1.0	18.25	86.30	80.60	0.7:1.0	22.75	84.93	77.50	1.0:1.0
Mar	8.50	64.91	61.88	0.9:1.0	15.75	71.42	81.38	1.0:0.9	24.50	86.46	89.19	1.0:1.0
April	10.25	79.20	73.88	1.0:0.7	16.50	78.78	84.02	1.0:1.0	24.75	84.38	85.49	0.9:1.0

*Mean value of four replications

Fig.1 Preference of *Bactrocera dorsalis* in intact and fallen guava fruits

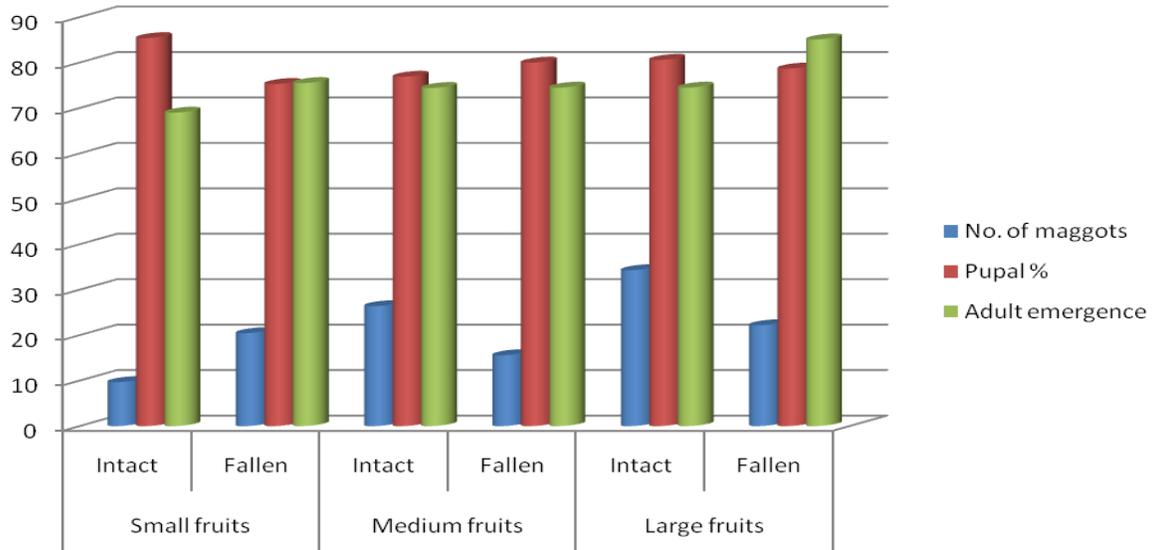
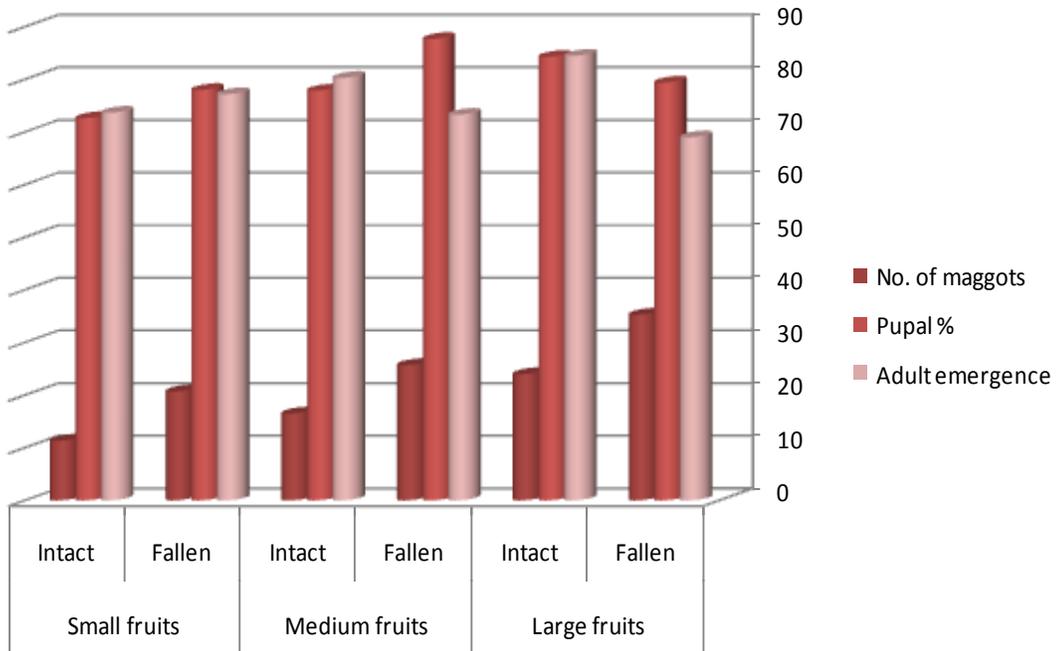


Fig.2 Preference of *Bactrocera correcta* in intact and fallen guava fruits



The present findings of the proneness of large sized fallen guava fruits to the attack of fruit flies was well strengthened by the reports of Rizzo and Caleca (2006), according to their results the correlation shown that the response of maximum population of fruit flies with increased fruit size. The findings of Migani (2013) shown that the physiological stage of the mango and its clutch size determines the fecundity of fruit flies, the fully ripened and semi ripened fruits shown the more probability for oviposition. It was in accordance with the current result, that the maximum load of fruit fly maggot in the large sized fruits. The influence of fruit stage in ovipositional preference was also strengthened by the findings of Rattanapun *et al.*, (2009), in which he states that the pericarp toughness and total soluble sugars present in the different phenological stage of the fruit act as cues in attracting fruit flies. The influence of physico-chemical properties of various stages of fruits might be the major reason for the variation on its preference, it was in tune with the findings of Dhillion *et al.*, (2005) in bitter melon on larval density and resistance to melon fruit fly, *B. cucurbitae* (Coquillett).

The intact fruit was mostly in green and turning stage whereas the fallen fruits were mostly in turning yellow and ripe stage, the preference of fruit flies towards the large sized ripened fallen fruit sample conveys that the thinness of the fruit rind might be the reason to influence the oviposition. This experimental result was supported by the preference of fruit flies towards ripe stage of tomato and guava as reported by Balagawi *et al.*, (2005) and Devi and Jha (2017), respectively.

The fruit in green stage *i.e.*, before July shows the less pattern of incidence and from July onwards the fruits in green stage changes into turning stage were the incidence tends to be increased, this opinion and less preference of

intact quality fruits than fallen semi-ripened fruits by *Bactrocera* spp. was also documented by Jadhav and Patil (2013) with their fruit quality management system based on image processing technologies.

In conclusion, the egg laying and feeding injury of fruit flies in guava is highly influenced by the size and ripeness of the intact and fallen fruits. Evidencing the preference of fruit flies towards various fruit size in intact and fallen condition may act as a valid tool in population assessment, distribution and per cent infestation.

The present finding revealed that the large sized fruits are more preferable than the medium and small sized fruits, whereas the fallen fruits recorded the maximum maggots built up when compared with intact fruits. So, hereby we conclude that picking up of intact medium sized guava fruits before falling over the ground due to over size and ripeness for marketing is better to escape from the loss inflicted by fruit flies. This valid information will be useful to the farmers to avoid the infestation of fruit flies by timely harvest of marketable fruits.

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