

Full Length Research Paper

Laboratory studies on ovipositional preference of the peach fruit fly *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) for different host fruits

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The peach fruit fly *Bactrocera zonata* (Saunders) is a serious pest of different fruits and vegetables in Pakistan inflicting economical damages. A laboratory experiment was conducted to determine the oviposition preference of the peach fruit fly for different fruits including guava, banana, citrus, ber, chikoo and apple under free or no choice conditions. Results showed that the guava was the most preferred host with mean pupal recovery of 318.00 ± 4.61 pupa/fruit (p/f) under free choice and 434 ± 2.64 p/f under no choice conditions, followed by banana (266.00 ± 4.5 p/f) in free choice and ber (177.00 ± 2.08 p/f) in no choice experiment. Whereas, apple and citrus were least preferred hosts.

Key words: *Bactrocera zonata*, host preference, oviposition.

INTRODUCTION

Fruit flies (Diptera: Tephritidae) cause most of the damage to fruits and vegetables in the Indo-Pak sub-continent. The members of the sub-family Dacinae infest almost all kinds of fleshy fruits, including solanaceous and cucurbitaceous plants. Many species are specialized, and host specific in their feeding habits, while others are generalists and attack a wide range of fruits and vegetables (Kapoor et al., 1980).

The peach fruit fly, *Bactrocera zonata* (Saunders), is a serious polyphagous pest originated in the South and South-East Asia where it attacks more than 50 host plants, including guava, mango, peach, apricot, fig and citrus (White and Elson-Harris, 1992; Ghanim, 2009). About 11 species of fruit flies have been documented so far from Pakistan and the most prominent among them are *B. zonata*, *Bactrocera cucurbitae*, *Bactrocera*

dorsalis, *Myiopardalis pardalina*, *Carpomiya incompleta*, *Carpomiya vesuviana*, *Dacus ferrugineus* and *Dacus diversus* (Abdullah and Latif, 2001; Abdullah et al., 2002; Stonehouse et al., 2002; Panhwar, 2005). The favorable hosts of these fruit flies species in Pakistan are guava (*Psidium guajava*), mango (*Mangifera indica*), apple (*Malus domestica*), ber (*Zizyphus jujube*), musk melon (*Cucumis melo*) and bitter gourd (*Momordica charantia*), (Khan and Musakhel, 1999; Sultan et al., 2000; Ahmad et al., 2005).

The scope of damage reported by the fruit flies species, *B. zonta* was 5 to 100% loss in Pakistan (Syed et al., 1970). Damage caused by fruit flies to fruit and vegetable growers in Pakistan is about 200 million US dollars annually at farm level with added losses to traders, retailers and exporters (Stonehouse et al., 1998).

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The greatest threat caused by the fruit flies is the rejection of fruit commodities especially mangoes due to the presence of its maggots and fruits becoming unfit for human consumption (Stonehouse et al., 2002).

The oviposition behavior in insects has been a widely studied theme in the insect-plant interaction context. This behavior is connected with the insect's specificity to determine the host plants, changes in host and insect-plant co-evolution (Thompson and Pellmyr, 1991). In holometabolous insects, the oviposition behavior is decisive in the choice of selecting a proper host plant for development of their immature, once they start moving they look for the nutritional resources selected by their adult females for their nourishment (Singer, 1986; Renwick, 1989). How the females select the proper host for oviposition is a quite complex phenomenon. The physical and chemical factors associated with plants influences the choice and the balance between positive and negative stimuli that determine the final selection of the proper host (Eisemann and Rice, 1985; McInnis, 1989; Oi and Mau, 1989; Messina, 1990; Kostal, 1993). Keeping in view the mode of damage and host range of *B. zonata*, the present study was designed to evaluate host preference of *B. zonata* under laboratory conditions.

MATERIALS AND METHODS

The study was conducted in the insectary of the fruit fly management unit at the Nuclear Institute of Agriculture, Tandojam, Pakistan. Six fruit hosts, viz. Banana (*Musa cavendish*), guava (*P. guajava*), apple (*M. domestica*), chikoo (*Manilkara zapota*), citrus (*Citrus reticulata*) and ber (*Z. jujube*), were selected. Banana, guava, chikoo and ber were collected from the Institute Orchards, whereas, apple and citrus were purchased from a local fruit market. The experiment was conducted in two phases, that is, six hosts (collectively) were offered as a free choice for oviposition, and secondly, each fruit was offered as separate treatment (no choice test).

Adult rearing cage

Peach fruit fly (*B. zonata*) used in this study were obtained from the culture maintained in the laboratory with $27 \pm 1^\circ\text{C}$, $60 \pm 5\%$ relative humidity and 14:10 light and dark. Two hundred (200) pairs of fruit flies from this stock culture were sexed and released into a cage (1 × 1 × 1 m). Flies were maintained in the room at $27 \pm 1^\circ\text{C}$, $60 \pm 5\%$ relative humidity, under the natural light phase. A mixture of sugar, yeast and water was placed in a Petri dish as a food supplement in the cage. Furthermore, regular changing of cotton swabs with water, in Petri dish was essential to avoid microbial contamination, especially mould development.

Choice and no choice tests

In the first phase, each fruit was offered as separate treatment for oviposition after determining the weight of each fruit (500 g). In the second phase, all fruits were collectively offered as free choice for oviposition. The fruits were exposed to the females for 2 h. The sexually mature female *B. zonata* successfully laid eggs on these fruits and then each fruit was kept separately in plastic jars

(5" × 12") containing fine sawdust at the bottom (for pupation) covered with blotting paper (to absorb excess moisture). The maggots, which developed in the fruits, exited to pupate in the sawdust. Puparia were collected and the number of puparia that emerged from each fruit was counted. These treatments were replicated three times. Observations were recorded fruit-wise on incubation, pupal weight, pupal recovery, deformity, adult emergence and sex ratio for each fruit. The data were tabulated and analyzed using analysis of variance, with *F*-tests as criteria with STATIX software.

RESULTS

Data presented in Table 1 show results of host preference under no choice conditions that is, each fruit was exposed separately. Statistical analysis showed that guava had the highest pupal recovery (434 pupa/fruit) and citrus had the least pupal recovery (5 p/f). Guava, ber and banana showed highly significant results as compared to other fruits. In the case of pupal weight, apple showed the maximum (13.42 mg) and citrus showed the least (4.27 mg). Generally, pupal weight of different fruits varied significantly. Adult emergence percentage was significantly higher in guava (90.98%) and apple (90.30%) compared to all other fruits. Data regarding sex ratio also varied significantly. Maximum population percentage of males was observed in ber (48.55%), while that of females in apple (54.59%). Deformity of emerging flies was significantly high in chikoo, apple and ber, where it recorded 8.93, 7.47 and 6.98%, respectively.

Table 2 shows results of oppositional response and other biological characters in response to opposition like pupal weight, sex ratio percentage adult emergence and deformity, when offered as free choice. Of all the fruits, *B. zonata* prefers laying eggs in guava fruit which showed maximum pupal recovery (318 p/f) followed by banana (266 p/f). The least pupal recovery was recorded from apple (0.00). In case of pupal weight, weigh of pupa resulted from guava and chikoo are 11.03 and 10.50 g, respectively. They were the highest significant as compared to other treatments. There was no significant difference observed in sex ratio among all treatments. Guava, ber, chikoo and citrus showed a non-significant difference of the percentage of emergence to each other but showed significant results against banana and apple. Maximum deformity was observed in banana (5.38%) followed by guava (2.95%) which was significantly higher than all other fruits.

DISCUSSION

It has been well documented that the oviposition in fruit flies depends upon their decision to select the proper host which must support the activities of their offsprings (Fontellas-Brandalha and Zucoloto, 2004; Joachim-Bravo et al., 2001). Other factors that may affect the oviposition preference in fruit flies include odor, color and shape of

Table 1. Some biological parameters of *B. zonata* resulted from infestation of different fruits under no choice test.

Fruit	No. recovered pupae/fruit	Pupal weight (mg)	Sex ratio (%)		Deformity (%)	Adult emergence (%)
			Male	Female		
Citrus	5.00 ± 1.15 ^e	4.27 ± 0.03 ^f	9.52 ± 9.5 ^d	11.43 ± 5.94 ^d	0.00 ± 0.00 ^b	20.95 ± 12.38 ^d
Chikoo	8.33 ± 0.88 ^{de}	8.77 ± 0.12 ^c	23.09 ± 4.63 ^{cd}	35.95 ± 5.53 ^{bc}	8.93 ± 4.49 ^a	67.97 ± 2.76 ^{bc}
Banana	120.67 ± 3.17 ^c	9.28 ± 0.01 ^b	27.84 ± 1.20 ^{bc}	20.62 ± 1.85 ^{cd}	5.23 ± 0.44 ^{ab}	53.69 ± 3.37 ^c
Ber	177.00 ± 2.08 ^b	7.77 ± 0.06 ^e	48.55 ± 1.40 ^a	21.82 ± 0.90 ^{cd}	6.98 ± 0.57 ^a	77.36 ± 1.73 ^{ab}
Apple	13.00 ± 1.15 ^d	13.42 ± 0.10 ^a	28.23 ± 1.27 ^{bc}	54.59 ± 8.43 ^a	7.47 ± 3.93 ^a	90.30 ± 5.78 ^a
Guava	434.00 ± 2.64 ^a	8.35 ± 0.27 ^d	41.14 ± 2.00 ^{ab}	46.54 ± 1.25 ^{ab}	3.30 ± 0.40 ^{ab}	90.98 ± 3.06 ^a

Means followed by the same letters, within a column, do not significantly differ at the 5% level according to the LSD test.

Table 2. Some biological parameters of *B. zonata* resulted from infestation of different fruits under free choice test.

Fruit	No. recovered pupae/fruit	Pupal weight (mg)	Sex ratio (%)		Deformity (%)	Adult emergence (%)
			Male	Female		
Citrus	38.66 ± 2.9 ^c	8.84 ± 0.30 ^b	47.50 ± 1.33 ^a	42.03 ± 1.77 ^a	0.00 ± 0.00 ^c	89.54 ± 0.77 ^a
Chikoo	9.00 ± 1.15 ^d	10.50 ± 0.98 ^a	54.69 ± 6.87 ^a	32.75 ± 2.26 ^b	0.00 ± 0.00 ^c	87.44 ± 8.42 ^a
Banana	266.00 ± 4.5 ^b	7.53 ± 0.03 ^b	11.51 ± 0.70 ^b	19.91 ± 0.64 ^c	5.38 ± 0.67 ^a	36.81 ± 1.27 ^b
Ber	29.66 ± 1.76 ^c	8.00 ± 0.21 ^b	48.58 ± 3.68 ^a	38.20 ± 1.90 ^a	1.01 ± 1.01 ^c	87.80 ± 1.49 ^a
Apple	0.00 ± 0.00 ^d	0.00 ± 0.00 ^c	0.00 ± 0.00 ^c	0.00 ± 0.00 ^d	0.00 ± 0.00 ^c	0.00 ± 0.00 ^c
Guava	318.00 ± 4.61 ^a	11.03 ± 0.04 ^a	46.89 ± 1.55 ^a	38.73 ± 1.69 ^a	2.95 ± 0.5 ^b	88.56 ± 3.34 ^a

Means followed by the same letters, within a column, do not significantly differ at the 5% level according to the LSD test.

host fruits (Li-Li et al., 2008).

In our study, the fruit flies showed maximum infestation on guava at free or no choice test as compared to other fruits. Different studies have reported guava as a most preferred host for the fruit flies (Mohammad and Abdel-Galil, 2008). According to the studies of Alies Van Sauers-Muller (2005), fruit flies infestation depends upon the size and shape of the fruit specially the guava. He also found that large sized fruit showed more susceptibility. The pupal recovery on guava in both the case free and forced choices was similar, however significant differences was observed in the pupal weight, deformity and half emergence which were comparatively high in free choice while there was a slight difference in emergence percentage in both the cases (White, 2000; Kapoor, 1989).

Results of the present study revealed that the pupal recovery in banana was the second after guava with less pupal weight and less emergence percentage in both free and no choice tests but the deformity and emergence was maximum in free choice in case of banana. This is because of the reason that delicate skin and particular aroma of banana make it a suitable host (Li-Li et al., 2008) to attract the fruit flies. Our results are in agreement with Li-Li et al. (2008) and Jayanthi and Abraham (2002). In case of citrus, we observed that there was a least fruit fly activity on no choice test but the maximum emergence was observed from the recovered pupae in case of free choice. Lies Van Sauers-Muller

(2005) reported that citrus was not found as an important host for fruit flies.

The fruit fly activities especially the pupal recovery, pupal weight and emergence in free and no choice tests on chikoo was at normal par, however, a significant variation was observed in case of deformity. This may be because the egg laying was done on chikoo but rests of the activities were not supported. The results of more pupal recovery on ber suggested the preference of fruit flies to use it as a favorite host because of the nutrient contents provided to the offsprings, while the other parameters studied on ber were at normal par for both free and no choices. Alies Van Sauers-Muller (2005) also observed that the sweet varieties of the certain fruits showed more infestation, while the sour varieties of these fruits were free of fruit fly infestation. Among all the fruit choices, apple was the least preferred host in free choice, however, maximum pupal weight was observed in case of no choice. According to the studies of Prokopy and Roitberg (1984) and Oi and Mau (1989), the oviposition of the fruit flies depends upon smell and visual signs to trace and identify the oviposition sites for egg laying on fruits. Similarly, Prokopy and Duan (1998) observed that the females of fruit flies use their previous experience to select a proper fruit for laying the eggs. The females also showed a learning ability to select the most appropriate host (Cooley and Prokopy, 1986).

According to the findings of Phillips (1977), Cassidy (1978), Cooley and Prokopy (1986), Prokopy and Papaj

(1988), and Hoffmann (1988), when there is no marked choice among the hosts for fruit flies there is always a definite liking for those fruits which have been previously visited and contacted by the females. In case of the choice of a host over another, the preference for the original host remains dominant but can decrease in terms of percent. Certain fruit characters specially the nutritional status of fruit also plays a vital role in supporting the larval activities. However, the biochemical analysis can further exploit this relationship.

Conclusion

Our investigation established that guava is the most preferable fruit for oviposition by peach fruit fly *B. zonata*. Banana and ber were also attracted when offered as free choice and no choice, respectively, whereas, apple showed least infestation.

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