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Oviposition Tendency of *Bactrocera dorsalis* (Diptera: Tephritidae) Infesting Guava (*Psidium guajava* L.) in Relation to Fruit Ripening Stages

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ABSTRACT

Infestation Patterns of fruit fly was observed in fruits of different ripening stages of guava and also at different parts of the fruit (Top, middle and lower) under field conditions. The population of fruit fly was found in the orchard throughout the year with peak during the guava fruiting period. Fruit fly preference on green fruits did not show any pattern of incidence. However, fruit fly infestation increased slowly from July to reach its peak during third week of August in turning stage of fruits (38.89% infestation) and fourth week of August in ripe fruits (76.67 % infestation). Turning and ripe stages of fruit were most infested by B. dorsalis. In contrast, green fruits were less used by females for egg laying and also they preferred to oviposit on the top part followed by middle and the bottom part of turning and ripe guavas even though such preference did not exist in green fruits of guava

Key words: *Fruit fly, Ripening stages, Infestation, Fruit part, Guava*

INTRODUCTION

Guava is one of the hardiest fruits in productivity, adaptability with nutritional quality and hence aptly known as 'Poor man's apple' and 'Apple of tropics'. In India it is grown in an area of 246 thousand ha with an annual production of 3994 thousand MT [1]. It is the fifth most widely grown fruit crops in India and the major producing states are Bihar, Andhra Pradesh, Uttar Pradesh, Maharashtra, West Bengal, Karnataka, Gujarat and Madhya Pradesh. Though this fruit is attacked by many insects, fruit flies (*Bactrocera* spp.) have been a major restrictive factor in production of guava as female attacks the growing fruit by puncturing and lay eggs causing the economic damage. The tribe Dacini with genus *Bactrocera* is of importance in India and from economic point of view, Oriental fruit fly or mango fruit fly, *Bactrocera dorsalis* (Hendel), guava fruit fly, *Bactrocera correcta* (Bezzi) and peach fruit fly, *Bactrocera zonata* (Saunders) are very important pests of fruit crops and are recognized worldwide as the most important threat to horticulture[13, 11]. *B. dorsalis* is considered to be among the five most damaging and aggressive fruit flies in the world[7]. Fruit flies drop their eggs on host fruits when they are physiologically ripe. On hatching, maggots bore their way to the inner portion and feed on the fruit pulp.

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When the guava fruit is squeezed, the tiny punctures that leak juice from surface indicate the infestation of fruit flies. At first the oviposition marks are difficult to detect but as within one to two days the eggs hatch, oviposition marks appear as a distinct spot with a brownish patch around puncture site[10]. Area fed by the maggot is discolored due to rotting of the fruit and the fruit drops prematurely. It is well documented that the oviposition in fruit flies depends upon their decision to select the proper host which must support the activities of their off springs[5]. Other factors that may affect the oviposition preference in fruit flies include odour, colours and shape of host fruits[4].The oviposition preference levels vary spatially as a result of differences in fruiting phenology synchrony and fruit production among trees. Thus, in the present paper the preference of *fruit fly in relation to host ripening stages was planned to assess in* field conditions.

MATERIALS AND METHODS

The present study was conducted at Horticulture Research Station, Mandouri, BCKV, West Bengal, India during 2015 and to assess the preference of *B. dorsalis* females into fruits of different stages of ripening, 30 fruits of each stage (green, turning and ripe) were collected and fruit fly behaviour was recorded based on per cent infestation and egg puncture count at weekly intervals from June-October on guava cv. L-49. The same 30 fruits of each stages had been used to estimate the tendency of *B. dorsalis* females to oviposit at different parts/ portions (Top, middle and lower) of guava fruits at different ripening stages (green, turning and ripe) and counts of egg puncture had been taken.

Egg punctures of the fruit fly were counted by making visual observations on fruits of each stage sorted out based on the brownish pin hole size markings on fruit, i.e., oviposition puncture and pseudo-punctures (without eggs).The data obtained were subjected to statistical analysis after suitable transformation as per Gomez and Gomez and calculation was done in SPSS statistical package (20.0 version).

RESULTS AND DISCUSSION

Incidence of fruit fly, *B. dorsalis* on guava at different fruit ripening stages

Fruit fly, *Bactrocera dorsalis* oviposition activities under field conditions indicated that there were distinctive behavioural responses to guava fruit ripening stages under field conditions. There was a significant difference between stages of ripening with per cent infestation and the number of oviposition puncture. The adults were seen puncturing even on immature fruits. But most of the ovipositing punctures were made by the females when fruits started maturing or changed colour. Amongst the three fruit ripening stages *i.e*., green, turning and ripe, infestation of *B. dorsalis* was negligible on green colour stage fruits (Table 1). The pest infested fruits more at turning stage and maximum at ripe stage of fruits. Weekly observations indicated that ripe stage fruits were significantly more preferred than turning stage fruits. Fruit infestation remained nil during first week of June as only green fruits were available. Overall infestation was negligible in green stage fruits (0.32%), and this followed by turning stage fruits (19.44%) and significantly higher in ripe stage fruits (41.28%).Fruit fly preference on green fruits did not show any pattern of incidence. However, in turning and ripe stages, fruit fly infestation increased slowly from July to reach its peak during third week of August in turning stage of fruits (38.89%) and fourth week of August in ripe fruits (76.67%). Thereafter the trend of infestation showed increasing or decreasing depending on availability of fruits. Same trend was observed in egg puncture studies of fruit fly on different ripening stages of guava fruits (Table 2). Female flies made significantly more egg punctures into ripe fruits than turning or green fruits. Mean fruit infestation on green, turning and ripe stages were 0.32%, 19.44% and 41.28%, respectively, whereas mean egg puncture counts were observed to be 0.05, 8.03 and 12.84 numbers on green, turning and ripe fruits, respectively. However, fruit firmness act as limiting factor in egg laying by the females. In ripen fruits as decline in such fruit firmness takes place it enables the females to lay more eggs.Present results endorse the findings of [8] who observed that within the different stages of fruit maturity, the ripening stage was found to be highly infested and was the most susceptible stage for flies' infestation. This may be due to yellow color, strong aroma and high sugar content which might have an attractive effect on the flies. The percent fruit infestation was significantly higher in mature fruits than fruits at colour break stage and hard stage fruits of peach, pear and guava[12]. These results may be partially explained by fruit characteristics, as had been found in study on mango, infested by *B. dorsalis,* the fruit ripening process involves the conversion of acids and starch to free sugars, the development of pectinases which soften and ultimately break down the cell walls, and frequently the development of various pigments, usually anthocyanins, and the loss of chlorophyll[14]. Ripe and fully-ripe fruits, in comparison to unripe fruit, have a softer exopericarp and higher TSS as well as exhibiting different skin color and odours. Female tephritids have been found to show on several occasions to have an oviposition preference for ripe fruit or fruit with softer exopericarp, over unripe fruit or fruit with harder exopericarp[2].

Incidence of fruit fly, *B. dorsalis* on guava at different fruit parts at different ripening stages

So far as the number of egg punctures made by female flies into the three fruit portions between different ripening stages of guava (Table 3), it indicated a significant difference in their preference to different portions of the fruits. Female flies made very low numbers of egg punctures in all three fruit portions of the green guavas and the pattern of distribution of punctures was uneven with no differentiation between fruit parts. Oviposition counts on top, middle and lower parts of green fruit in these studies were found to be 0.27 ± 0.13, 0.29 ± 0.05 and 0.28 ± 0.11, respectively. In turning stage fruits, significantly more oviposition attempts were made into the top portion of fruits(8.07 ± 1.20 egg punctures) followed by middle (3.84 ± 0.82 egg punctures) and lower part of fruit with 1.71 ± 0.46 number of egg punctures. From the number of such punctures made on ripe fruits it could be observed that top and middle portion of the fruit almost had more number of oviposition marks with 14.37 ± 1.20 and 11.17 ± 1.61,respectively and significantly fewer into the bottom part of fruit with 4.58 ± 0.81numbers/fruit. The results indicated that female *B. dorsalis* preferred to oviposit on the top part followed by middle over the bottom part of ripe and turning guavas, even though such preference did not exist in green (unripe) fruits of guava.Pooled data regarding egg puncture counts into the three fruit portions across the three different ripening stages shown that female flies made more or less similar number of punctures into the top (7.57) and middle (5.10) part of fruits, but significantly fewer into the bottom part of fruits (2.19).

Present results are in support of views expressed by various authors that firmness is considered to be a limiting factor for oviposition of female fruit flies[2] and is possibly influencing adult preference. Ripe and fully-ripe mangoes may have more attractive characteristics to female *B. dorsalis* than unripe mangoes, for example yellow skin color[3] and stronger volatiles [6]. In contrast, ripe and fully-ripe fruits were more suitable for larval for development, with higher larval survival and shorter larval development times. Different fruit portions have different volatiles present in them. Identification of particular volatiles which attracts or repels is to be explored. How the females select the proper host for oviposition is quite a complex phenomenon. The oviposition preference of female flies for the top part of mango may be partially relate with the physiological changes of mango ripening. The top part of fruit ripens earlier than the middle and the bottom portions, and thus have a softer exopericarp and higher TSS, in comparison, to middle and bottom portions[9]. The results indicated that female *B. dorsalis* chosen to oviposit in the top part followed by middle over the bottom part of ripe and turning guavas, even though this preference did not exist in green (unripe) fruits. So far as the differential level of softening of the peel, as factors for differential preference of the fruit parts in guava doesn't hold good in logic. But ripening of pericarp certainly makes difference. The maggots of the pest as are provided only by a hook like mouth parts, the fruit parts with softer pericarp are preferred by the mothers to lay the eggs in convenience of the upcoming maggots emerging from those.

Table 1: Preference of *B. dorsalis* in relation to fruit ripening stages of guava cv. L-49 based on fruit infestation

Month	DOO	% fruit infestation at differing ripening stages			Mean
		Green	Turning	Ripe	
June	13.06.15	0.00 (0.00)	-	-	0.00 (0.00)
	20.06.15	0.00 (0.00)	2.22 (7.01)	5.56 (8.03)	2.59 (5.01)
	27.06.15	2.22 (7.01)	3.33 (8.49)	8.89 (17.28)	4.81 (10.93)
July	04.07.15	0.00 (0.00)	5.56 (13.48)	10.0 (18.01)	5.19 (10.50)
	11.07.15	0.00 (0.00)	11.11 (19.27)	14.44 (22.21)	8.52 (13.82)
	18.07.15	0.00 (0.00)	14.44 (22.14)	24.44 (29.41)	12.96 (17.18)
	25.07.15	0.00 (0.00)	18.89 (25.53)	35.56 (36.51)	18.15 (20.68)
August	01.08.15	0.00 (0.00)	26.67 (30.82)	47.78 (43.71)	24.81 (24.84)
	08.08.15	0.00 (0.00)	23.33 (28.85)	53.33 (46.92)	25.93 (26.43)
	15.08.15	1.11 (3.51)	30.00 (33.15)	64.44 (53.59)	31.85 (30.08)
	22.08.15	0.00 (0.00)	38.89 (38.55)	67.78 (55.85)	35.56 (31.47)
	29.08.15	0.00 (0.00)	36.67 (37.16)	76.67 (61.36)	37.78 (32.84)
September	05.09.15	1.11 (3.51)	25.56 (30.24)	70.00 (57.14)	32.22 (30.29)
	12.09.15	0.00 (0.00)	30.00 (33.12)	64.44 (53.57)	31.48 (28.90)
	19.09.15	0.00 (0.00)	22.22 (27.96)	55.56 (48.21)	25.93 (25.39)
	26.09.15	0.00 (0.00)	18.89 (25.53)	50.00 (45.00)	22.96 (23.51)
October	03.10.15	0.00 (0.00)	20.00 (26.57)	45.56 (42.39)	21.85 (22.99)
	10.10.15	2.22 (7.01)	22.22 (28.07)	44.44 (41.75)	22.96 (25.61)
	17.10.15	0.00 (0.00)	15.56 (23.03)	31.11 (33.71)	15.56 18.92)
	24.10.15	0.00 (0.00)	12.22 (20.42)	30.00 (33.19)	14.07 (17.87)
	31.10.15	0.00 (0.00)	11.11 (19.16)	25.56 (30.15)	12.22 (16.44)
	Mean	0.32 (1.00)	19.44 (24.93)	41.28 (38.90)	

Figures in parentheses are arc sin transformed values, DOO - Date of observation, - No fruits
CD (P=0.05)
Fruit ripening stages - 1.252
Time interval - 2.801
Fruit ripening stages x Time interval - 4.840

Table 2: Preference of *B. dorsalis* in relation to fruit ripening stages of guava cv. L-49 based on egg puncture counts

Month	DOO	Egg puncture count of *B. dorsalis* at differing ripening stages			Mean
		Green	Turning	Ripe	
June	13.06.15	0.00(0.71)	-	-	0.00 (0.71)
	20.06.15	0.00 (0.71)	1.20(1.30)	2.00 (1.58)	1.07 (1.42)
	27.06.15	0.27 (0.87)	3.03(1.86)	3.53 (2.00)	2.28 (2.95)
July	04.07.15	0.00(0.71)	2.73(1.77)	3.73 (2.05)	2.16 (2.87)
	11.07.15	0.00(0.71)	4.10(2.14)	4.77 (2.27)	2.96 (3.94)
	18.07.15	0.00(0.71)	5.70(2.47)	8.60 (3.01)	4.77 (6.36)
	25.07.15	0.00(0.71)	8.43(2.96)	11.00 (3.39)	6.48 (8.64)
August	01.08.15	0.00(0.71)	10.27(3.27)	14.13 (3.83)	8.13 (10.84)
	08.08.15	0.13(0.79)	12.93(3.66)	16.17 (4.08)	9.74(12.95)
	15.08.15	0.13(0.80)	12.27(3.56)	19.13 (4.42)	10.51(13.97)
	22.08.15	0.00(0.71)	15.70(4.02)	22.10 (4.75)	12.60(16.80)
	29.08.15	0.00(0.71)	13.03(3.67)	25.27 (5.07)	12.77(17.02)
September	05.09.15	0.23(0.86)	11.93(3.51)	23.60 (4.91)	11.92(15.82)
	12.09.15	0.00(0.71)	14.73(3.90)	19.07 (4.42)	11.27(15.02)
	19.09.15	0.00(0.71)	9.00 (3.07)	16.10 (4.07)	8.37(11.16)
	26.09.15	0.00(0.71)	9.17 (3.08)	14.47(3.87)	7.88(10.50)
October	03.10.15	0.00(0.71)	5.13 (2.37)	12.03(3.52)	5.72(7.63)
	10.10.15	0.23(0.85)	9.97 (3.20)	11.73(3.46)	7.31(9.67)
	17.10.15	0.00(0.71)	5.07 (2.32)	10.17(3.23)	5.08(6.77)
	24.10.15	0.00(0.71)	3.17 (1.87)	11.03(3.38)	4.73(6.31)
	31.10.15	0.00(0.71)	3.03 (1.83)	8.20(2.95)	3.74(4.99)
	Mean	0.05(0.74)	8.03 (2.79)	12.84(3.51)	

Figures in parentheses are square root transformed values, DOO - Date of observation, - No fruits

CD (P=0.05)

Fruit ripening stages - 1.353

Time interval - 0.271

Fruit ripening stages x Time interval - 0.541

Table 3: The mean (± SE) number of puncture counts made by *B. dorsalis* into three fruit parts of three different ripening stages of guava

Sr.no	Fruit portion	Egg puncture count at different ripening stage			Mean
		Green	Turning	Ripe	
1.	**Top**	0.27 ± 0.13 a	8.07 ± 1.20 a	14.37 ± 1.20 a	7.57
2.	**Middle**	0.29 ± 0.05 a	3.84 ± 0.82 b	11.17 ± 1.61 b	5.10
3.	**Lower**	0.28 ± 0.11 a	1.71 ± 0.46 c	4.58 ± 0.81 c	2.19

Means with the same letter are not significantly different

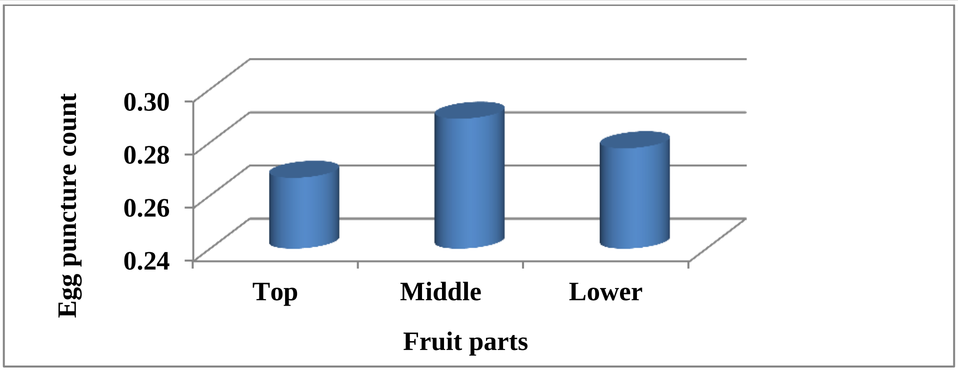

Fig. 1: Egg punctures in different fruit parts of green stage fruit

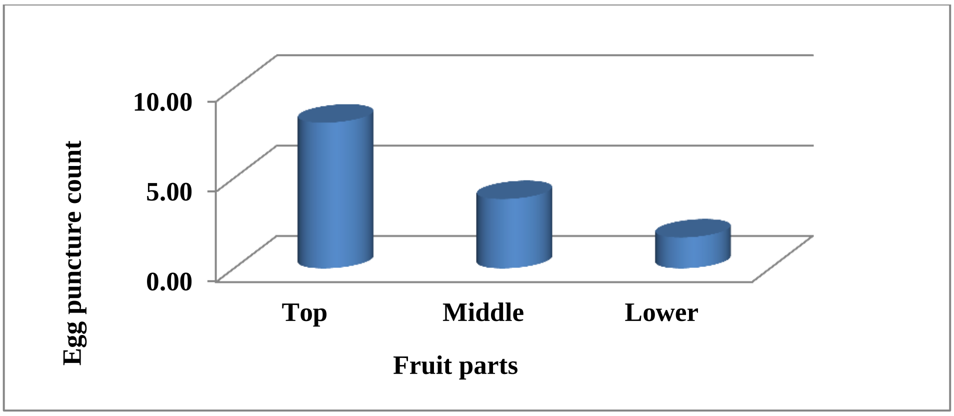

Fig. 2: Egg punctures in different fruit parts of turning fruit stage

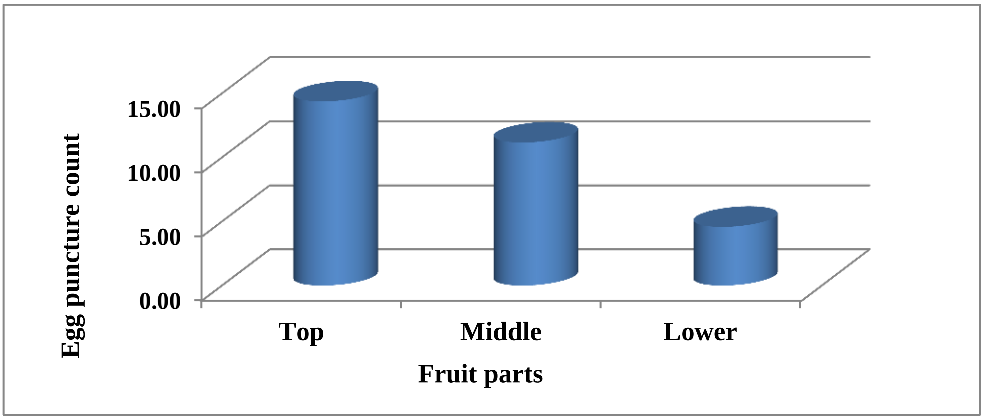

Fig 3: Egg punctures in different fruit parts of ripe stage fruit

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