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Species diversity and monitoring of population dynamics of two species of *Bactrocera* (*B. dorsalis, B. zonata*) through methyl eugenol traps at lower gangetic alluvium of West Bengal

Umesh Das, Supriya Okram, Sujit Kumar Karmakar and Santuno Jha

Abstract
Field experiments were conducted to study the species diversity and population dynamics of *B. dorsalis, B. zonata* in three orchards with different mango cultivars *Viz.*, Amrapali (1st orchard), Himsagar (2nd orchard) and Amrapali (3rd orchard) at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during April 2013- April 2014. Similarly screen out the mango cultivars namely Amrapali, Ratna, Himsagar and Fajli against mango fruit fly attack. Maximum population of fruit fly (*B. dorsalis, B. zonata*) in three orchards was observed in the months April - May 2013 when maximum temperature was 39.55°C. *B. dorsalis* showed a significant positive correlation coefficient with seasonal average maximum temperature (0.187) and negative correlation with minimum temperature (-0.087), morning relative humidity (-0.257), afternoon humidity (-.511**) and rainfall (-.329 *) while *B. zonata* showed a significant positive correlation with maximum temperature (0.543**), minimum temperature (0.192) and rainfall (0.017) and significant negative correlation with morning relative humidity (-0.241) and afternoon humidity (-0.215). The variety Amrapali, Himsagar showed a higher susceptibility to mango fruit flies followed by varieties Ratna and Fajli.

Keywords: Mango, fruit fly, population dynamics, species diversity

1. Introduction
India is the country of various tropical, subtropical and temperate fruits. India is the second largest producer of fruits in the world with an annual production of 43 million tonnes, from an area of four million hectares, and contributes to more than nine per cent of world's fruits production [1]. To date, with increasing globalization, it has become a challenge for this country not only to feed its own population but also to export fruits and vegetables to various developed countries. This requires strict quality control and restrictive quarantine measures. Mango (*Mangifera indica* L.) trees perform well both under tropical and subtropical climatic conditions but it faces major cultivation constraints due insect pest which include fruit flies [2]. Fruit flies belong to the family Tephritidae of the order Diptera. The family includes more than 4000 species in 500 genera. Of the 4000 speices known, 392 species have been recorded in India [3]. The major pest species belong to the genus *Bactrocera*: *B. cucurbitae, B. dorsalis* and *B. zonata,* while other species, such as *B. correcta, B. diversa* and *B. latifrons*, are still localized in their distribution [4]. The Oriental fruit fly, *Bactrocera dorsalis* is a direct pest on mango. In India, the loss in fruit yield ranges from 1 to 31% with a mean of 16% [5]. The Oriental fruit fly not only causes economic loss but is also of quarantine importance. The fly is distributed in the Oriental regions of Bhutan, China, Myanmar, Thailand, India and adults of the Oriental fruit fly are attracted to the para-pheromone, methyl eugenol and several studies have shown the efficacy of methyl eugenol in monitoring and management [6]. *Bactrocera zonata* is one of the most harmful species of Tephritidae. It causes extensive damage in Asia and many countries locate along or near the Mediterranean Sea, *B. zonata* occurs throughout much of the tropics and subtropics, including some parts of the USA, southern China, southeastern Australia and northern New Zealand [7]. A pest of peach (*Prunus persica*) and sugar apple in India [8], In Pakistan it has also been reared from the following hosts; guava, jujube and mango [9], Apple (*Malus domestica*), bitter gourd (*Momordica charantia*), date palm (*Phoenix datylifera*), Okra (*Abelmschus esulentum*), papaya (*Cerica papaya*), Paradise apple (*Malus pumla*) peach (*Prunus persica*), Phalsa (*Grencia asiatica*), pomegranat (*Punic*

granatum) and sweet orange (*Citrus sinensis*) [10]. Based on the surveys, [11] *B. correct, B. dorsalis* and *B. zonata* damaging guava and mango to an extent of 60 to 80%. The fruit fly activity varies a lot depending mostly on the prevailing climatic conditions. For this reason, it is imperative to study the influence of abiotic factors on fruit fly activity for development and proper implementation of fruit fly management programmes. The present experiment was undertaken to study the species diversity, incidence pattern of fruit flies and their relationship with different weather parameters with the use of methyl eugenol trap.

2. Materials and methods

Adult male fruit flies of different species were collected from three different mango orchards namely orchard-I (var. Amrapali) at Jaguli-instructional farm mango orchards, orchard-II (var. Himsagar) at Mohanpur Campus mango orchard and orchard-III (var. Amrapali) at NSS mango orchard of B.C.K.V. located at Mohanpur in the district of the Nadia (W.B.). The distances amongst the orchards were more than 800 m. Collection was made by trapping method. The trap (Patel's improved trap) used was a white coloured plastic trap of 15cm length, 10cm width and 10cm height with 0.5 ml methyl eugenol as attractant was used. Cotton plug injected with 0.5 ml methyl eugenol and placed inside the trap [12]. Observations were made on trapped flies at weekly intervals by changing the attractant once weekly. The adult fruit flies after narcotization were dried properly to preserve for proper identification. The diversity of the fruit flies was assessed in three Mango orchard through traps described as above. Trapped insects were sorted out weekly based on the species and species identification was done at the Zoological Survey of India, New Alipore Kolkata.

In order to screen the mango varieties *viz.,* (Amrapali, Ratna, Himsagar, Fajli) against the mango fruit fly maggot population study was conducted in the plant protection laboratory of B. C. K.V. during May-June 2013. Ten number of fruits were sampled from each variety *i.e.,* Amrapali, Ratna, Himsagar, Fajli. The infested fruits from the total sampled fruits were counted and the numbers of maggots per fruit were counted by splitting open the infested fruits. Later the maggot/fruit was calculated for each variety by the formulae [13].

$$\text{Maggot population /fruit} = \frac{\text{No. of infested fruits X Maggot per infested fruit}}{\text{Total number of fruits sampled}}$$

The meteorological data viz. Maximum temperature, Minimum temperature, Relative humidity I and II and rainfall were collected from the Department of Agrometeorology and Physics, B.C.K.V. from May 2013 to April 2014 and correlation was done with the incidence of fruit fly through statistical computer programme.

3. Results and Discussion

3.1. Species diversity

Studies on the species complex under mango ecosystems using methyl eugenol as attractant revealed the presence of two species *viz Bactrocera dorsalis* and *Bactrocera zonata* under the mango ecosystem. As an overall seasonal sum up, *B. dorsalis* had been found to be dominant one. In orchard-I, *B. dorsalis* was 86.25% and *B. zonata* was13.73%, in orchard-II *B. dorsalis* was 85.79% and *B. zonata* was 14.19%, and in orchard-III *B. dorsalis* was 87.32 % and *B. zonata* was 12.13 % (in 3rd orchard) respectively (Fig 1,2 and 3). However, some seasonal variations could be noted in the percentage share of the two species.

3.2. Incidence pattern of fruit flies with the use of methyl eugenol trap in three different orchard

3.2.1. Orchard -1 (var. Amrapali):- The population of *B. dorsalis* was found in the orchard throughout the year. The highest number of *B. dorsalis* was trapped in the second week of April 2013 with trap catches of 66 fruit flies/trap/weeks. The trap catches slightly declined during third week of April (49 fruit flies/trap week) and fourth week of April (35 fruit flies/trap/week). The population declined throughout the year, with lowest trap catches of 7 fruit flies/trap/weeks during first week of October. However in 2014 the maximum trap catch of *B. dorsalis* was recorded in second week of April (78 fruit fly/trap/week).

The population of *B. zonata* was nil throughout the study period except April to third week of June. Higher catches was recorded during second week of April (122 fruit fly/trap/weeks). The trap catches slightly declined during third week of April (96 fruit flies/trap/ week). The population declined to 0.00 fruit flies/trap/weeks by the fourth week of June. The incidence of *B. zonata* was observed again during April 2014 with trap catches of 7 fruit fly/trap/week and reached the peak by fourth week of April (17 fruit flies/trap/week).

3.2.2. Orchard -2 (var. Himsagar):- The population of *B. dorsalis* was found in the orchard throughout the year. The highest number of *B. dorsalis* was trapped in the first week of April 2013 with trap catches of 62 fruit flies/trap/weeks. The trap catches slightly declined during second week of April (61 fruit flies/trap week) and third week of April (37 fruit flies/trap/week). The population later declined to reach the lowest of 11 fruit flies/trap/weeks during first week of October.

The population of *B. zonata* was nil throughout the study period except April to fourth week of June. The higher trap catches was recorded during second week of April (81 fruit fly/trap/weeks). The trap catches slightly declined during third week of April (53 fruit flies/trap week). The population reach the level of 0.00 fruit flies/trap/weeks by fourth week of June. The incidence of *B. zonata* was again observed during first week of April in 2014 with trap catches of 3 fruit fly/trap/weeks and reached the peak by fourth week of April (32 fruit flies/trap/weeks).

3.2.3. Orchard -3 (var. Amrapali): The population of *B. dorsalis* was found in the orchard throughout the year. The highest number of *B. dorsalis* was trapped in the first week of April 2013 with trap catches of 73 fruit flies/trap/weeks. The trap catches slightly declined during second week of April (50 fruit flies/trap week) and third week of April (41 fruit flies/trap/week). The population declined to reach the lowest *i.e.*12 fruit flies/trap/week during 1st week of November.

The population of *B. zonata* was nil throughout the study period except April to fourth week of June. The higher trap catches was recorded second week of April (170 fruit fly/trap/weeks). The population declined to 0.00 fruit flies/trap/weeks by the fourth week of June. The incidence of *B. zonata* was again observed during first week of April in 2014 with trap catches of 6 fruit fly/trap/weeks and reached the peak by fourth week of April (21 fruit flies/trap/week). The more dominant species observed throughout the year

from April, 2013 till March, 2014 was *B. dorsalis* however the population *B. zonata* was most dominant in the month of April to May, 2013.

Findings of the present study are in agreement with the earlier works of [14] who reported the peak incidence of fruit fly from April-May in West Bengal. He also reported that *B. dorsalis* was the major fruit fly (60%) with presence of *B. zonata* (40%) in West Bengal. The population of *B. dorsalis* peaked during 2nd fortnight of April (453 fruit flies/trap) and May (483 fruit flies/trap) and thereafter the population declined gradually [15].

[16] reported from Bihar, India that average number of *B. dorsalis* and *B. zonata* in April and August in 1997 were 39.94 and 134.92 fruit flies per trap per week respectively. [17], [18] and [19] reported that the peak catch that was observed during the fruit maturity stage (April- May) through methyl eugenol trap.

3.3. Correlation between fruit fly population (*B. dorsalis* and *B. zonata*) and different weather parameters:

The data pertaining to relationship between fruit fly population and weather parameters is presented in the Table-1. The results indicated that trap catches of *B. dorsalis* showed a significant positive correlation with maximum temperature (0.187). Significant negative correlation with minimum temperature (-0.087), morning relative humidity (-0.257), highly significant negative correlation with afternoon humidity (-.511**) and significant negative correlation with rainfall (-.329 *). *B. zonata* showed a highly significant positive correlation with maximum temperature (0.543**), significant positive correlation with minimum temperature (0.192) and rainfall (0.017). Significant negative correlation with morning relative humidity (-0.241) and afternoon humidity (-0.215) (Table 1).

Findings of the present study are in corroboration with the earlier works of [20] who obtained a positive correlation between trap catches of *B. zonata* and maximum temperature, minimum temperature and rainfall and a negative correlation with relative humidity. [21] reported that peak incidence of fruit fly activity was observed during the last week of May (6.9 infested fruits per 20 fruits). Correlation studies between incidence and weather parameters showed positive relationship with maximum and minimum temperatures and negatively correlated with rainfall and relative humidity (morning and evening).

Table 1: Correlation studies between incidence of mango fruit flies (average of 3 traps data) and weather parameters during April 2013 to April 2014.

Fruit fly Species	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	Maximum	Minimum	Morning	Afternoon	
B. dorsalis	0.187	-0.087	-0.257	-.511**	-.329*
B. zonata	0.543**	0.192	-0.241	-0.215	0.017

** and *. Represent correlation is significant at the 0.01 and 0.05 level respectively

3.4. Screening of varieties against Fruit fly

The data collected on the density of mango fruit fly maggot population on four varieties of mango namely Amrapali, Ratna, Himsagar, Fajli, are presented in the Table-2. It is revealed that the density of mango fruit fly maggot population varied significantly among the four varieties. Maximum density of mango fruit fly maggot was recorded on Var-1 *i.e.* Amrapali (13.08 maggot/ fruit) fallowed by Var-3 *i.e.* Himsagar (8.16 maggot/ fruit), Var-2 *i.e*. Ratna (6.25 maggot/ fruit), var-4 *i.e*. Fajli (5.65 maggot/ fruit).

Table 2: Relative infestation incidence of mango fruit fly maggot on four different mango varieties.

Sl.No.	Varieties	Mean maggot population/ fruit
1.	Var-1 (Amrapali)	10.6
2.	Var-2 (Ratna)	6.25
3.	Var-3 (Himsagar)	8.16
4.	Var-4 (Fajli)	5.65

This is further to mention that the adult emerged from the collected fruit fly infected mangoes were always *Bactrocera dorsalis* without exception. Hence, it can be inferred that *Bactrocera zonata* population caught in the trap infect some other host then mango in this area.

4. Conclusion

Survey for the fruit fly species complex in the mango horticultural ecosystems observed species were *B. dorsalis* and *B. zonata*. In present investigation *B. dorsalis* was the major fruit fly in mango with presence of *B. zonata* but *B. zonata* was never found to lay egg in mango fruits during the stage. Studies undertaken on the incidence of mango fruit fly revealed that it was prevalent in the orchard throughout the year. Peak population density was recorded during April – May. *B. dorsalis* was found to be the dominant species in the mango ecosystem. *B. zonata* was very low throughout the year except April to June, 2013 when its percentage was more than 50% and the population of *B. dorsalis* was significantly correlated with seasonal maximum temperature and *B. zonata* high significantly correlated with maximum temperature. The present study revealed that amongst the four varieties screened the susceptibility of fruit fly was maximum in Amrapali sequentially followed by Himsagar, Ratna and fajli.

5. Acknowledgement

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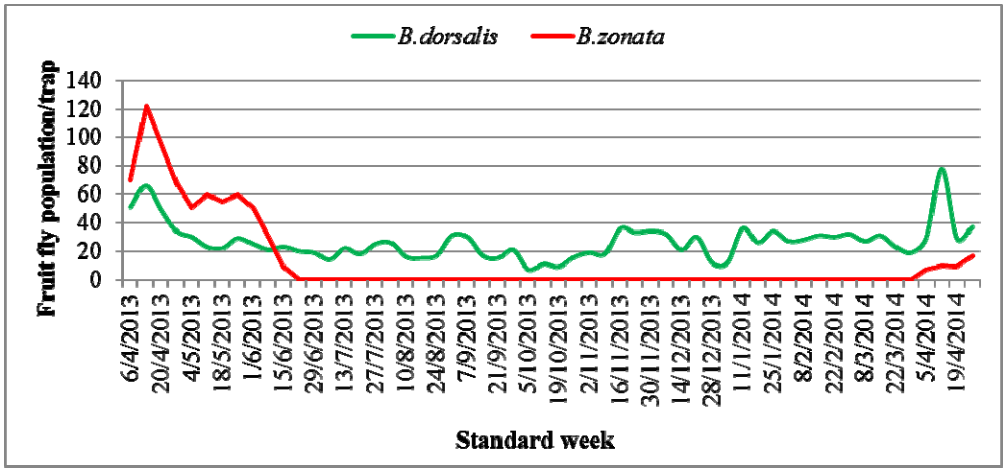

Fig 1: Incidence pattern of fruit flies (*B. dorsalis, B. zonata*) in orchard-1.

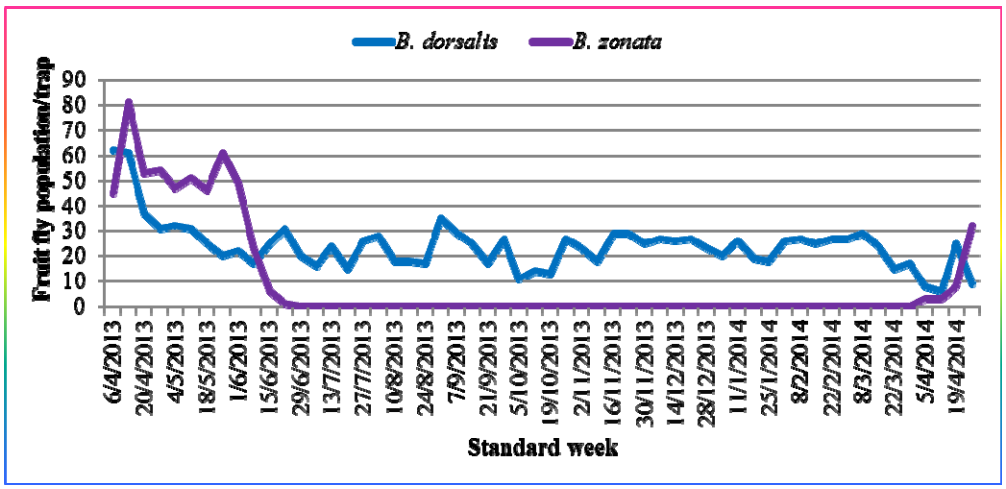

Fig 2: Incidence pattern of fruit flies (*B. dorsalis, B. zonata*) in orchard-2.

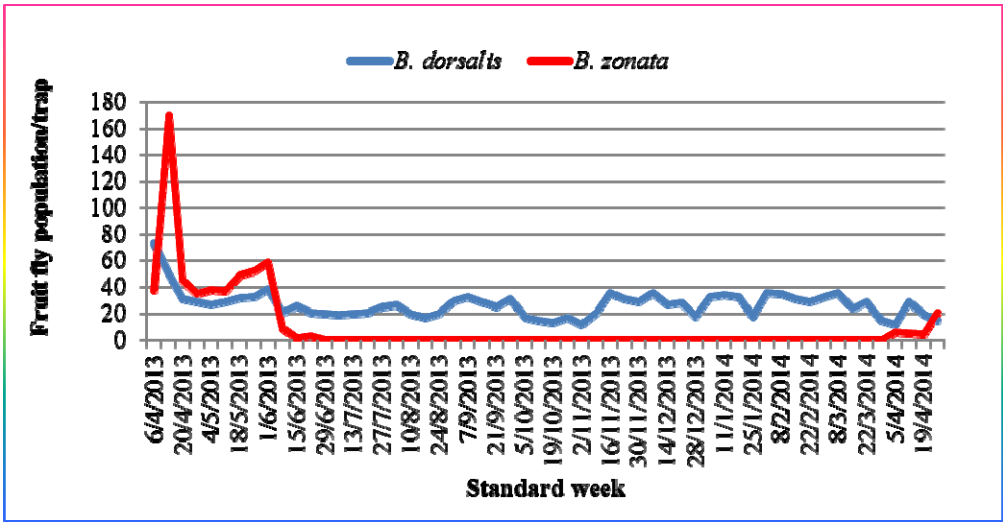

Fig 3: Incidence pattern of fruit flies (*B.dorsalis, B. zonata*) in orchard-3.

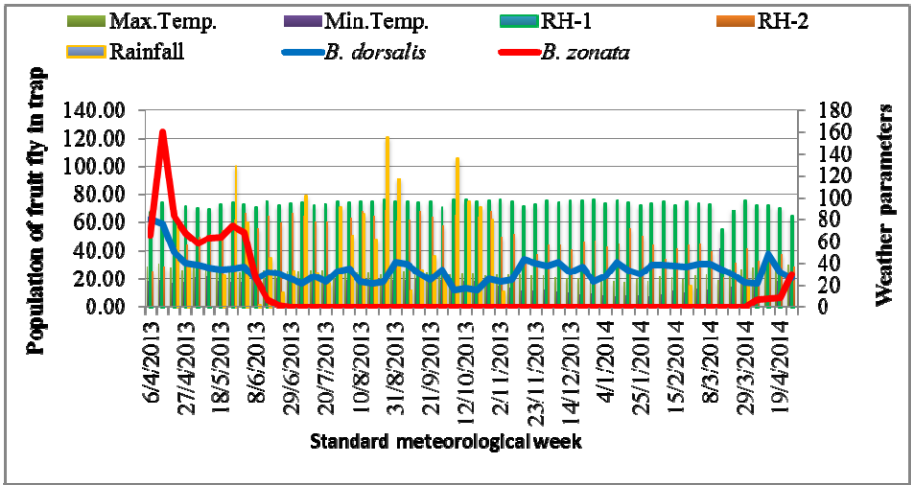

Fig 4: Correlation between fruit fly population (*B. dorsalis* and *B. zonata*) and different weather parameters.

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