

Effect of Parapheromones and Food baits on the Capture of Fruit Flies (Diptera: Tephritidae) in Ri-Bhoi district of Meghalaya

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ABSTRACT

With a view to generate a catalogue of the fruit fly fauna (Tephritidae: Diptera) found in the Ri-Bhoi district of Meghalaya, a study was conducted using three traps viz. parapheromones, food baits and infested fruit and vegetable samples to capture the adult fly. The traps containing methyl eugenol attracted 6 fruit fly species (*Bactrocera dorsalis*, *B. tuberculata*, *B. aethriobasis*, *B. zonata*, *Zeugodacus diversus* and *Z. scutellaris*). Whereas zingerone attracted 4 species viz. *B. dorsalis*, *B. tuberculata*, *B. abbreviata* and *Dacus maculipterus*. The food bait (Protein-x, soybean and fruit bait) attracted 3 species viz. *D. longicornis*, *Z. cucurbitae* and *Z. tau*. Two species were recorded for the first time in Meghalaya (*B. abbreviata* and *D. longicornis*), of which *B. abbreviata* is a new record for the country. Two fruit fly species (*Z. tau* and *B. dorsalis*) emerged from collected samples of fruits and vegetables (guava, mango, pumpkin, tomato, and ridge gourd). Methyl eugenol attracted more fruit flies from the *Bactrocera* genus, whereas food baits attracted more from the genus *Zeugodacus*. Thus, it is recommended that fruit flies should be monitored and managed using a combination of traps and baits.

1. Introduction

Meghalaya is a Northeastern land locked state of India. The variation of agro-climatic zones of Meghalaya, ranging from temperate to tropical offers excellent scope for the cultivation of temperate, subtropical and tropical fruits and vegetables. Besides the major food crops (rice and maize, Meghalaya is renowned for its oranges (Khasi Mandarin), pineapple, banana, jackfruits, temperate fruits like plum, pears and peaches. Fruit farming offers farmers with a source of income and employment. Fruit fly (Diptera: Tephritidae) is an important quarantine pest of horticultural crops and causes great loss to fruits and vegetables. Due to different climatic conditions, hill agriculture is relatively more vulnerable to pests. They cause serious problems and lead to low productivity of almost all crops (Thakur *et al.*, 2012). In addition, Northeast India, which has a huge natural forest ecosystem, borders five different countries, so migration of transboundary insects is also unavoidable. Fruit flies in wild host plant in forests play an important role in maintaining and carry over of fruit fly populations, mainly during periods

when fruit and vegetable crops are out of season. To handle the fruit fly damage, an ecologically based Integrated Pest Management (IPM) system for fruit flies is come, as such systems are commonly environmentally sustainable and economically feasible to small holding farmers (Vargas *et al.*, 2015). Fruit flies are commonly caught with parapheromones. However, the development of a cost-effective, plant-based insect attractant that is easily accessible to farmers is also essential. The goal of this study was to contribute to fruit fly species information through the installation of various parapheromone and food baits.

2. Materials And Methods

2.1 Research area

The observation was recorded from Ri-Bhoi district, Meghalaya (Fig. 1), located between 25°40'N latitude and 91°54'E longitude, 1000 m above mean sea level. The study was conducted from 2020 to 2021 at ICAR-NEH, NBPGR Research Farm, Umiam, Shillong (Meghalaya), Kyrdemkulai, Botanical Survey of India (BSI), Umiam, and the College of

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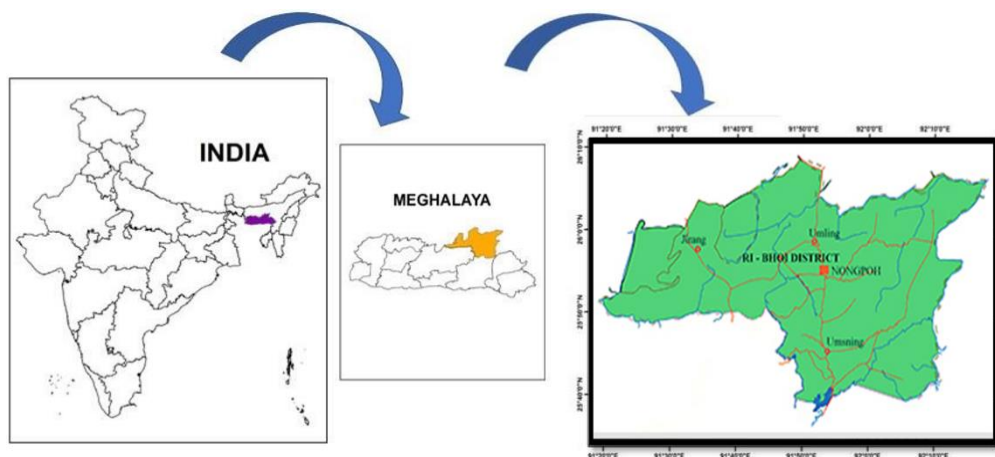


Figure 1. Map of Ri Bhoi District

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2.2 Collection of Fruit Flies

Two types of parafferomones were used, namely, methyl eugenol and zingerone. Methyl eugenol traps were made by mixing 60 ml ethyl alcohol and 40 ml methyl eugenol. Similarly, 5 mg of zingerone was combined with 50 ml of ethyl alcohol. Both male and female fruit flies of different species were collected by using food baits consisting of protein powder, soybean seed extract, and overripe fruits pulp. Protein-x, soybean, and fruit baits were made by mixing 5 g Protein-x in 100 ml water, 250 g soybean boiled in 500 ml water and 30 g fruit pulp (apple, pumpkin, banana) in 3 ml base bait (vinegar) respectively. The traps, which were spaced six metres apart, were emptied once a week and hung 1.5 metres above the ground on twigs. The flies captured were placed in sample jars with 70% ethyl alcohol and labelled with the sample site and date. Infested fruits and vegetables having puncture mark made by the female's ovipositor were collected and brought to the laboratory and kept in wire netting cages (20 cm × 20 cm × 26 cm) having a layer of sand at bottom for emerging larvae to pupate. Adult fruit flies upon emergence feed with sugar solution for few days for their survival and development of colour patterns was used for identification.

2.3 Identification of Species of Fruit Flies

Based on morphological characteristics provided by David and Ramani, 2011; fruit fly fauna collected at weekly intervals was identified using a stereozoom microscope. Cataloguing and documentation were done by using images and photographs.

3. Result

3.1 Species recorded from Parafferomone

Parafferomones (Methyl eugenol and Zingerone) were found to capture eight male species of Tephritidae (Table 1). Six species were attracted to methyl eugenol as *Bactrocera dorsalis*, *B. tuberculata*, *B. aethriobasis*, *B. zonata*, *Zeugodacus diversus*, and *Z. scutellaris*. Species namely *B. dorsalis*, *B. tuberculata*, *B. abbreviata*, and *Dacus maculipterus*, were found to be lured by zingerone.

3.2 Species recorded from Food baits

Z. cucurbitae and *Z. tau* were found to be attracted to all three forms of fruit baits (Protein-x, soybean extract, and fruit baits). Conversely, *Dacus longicornis* was captured only in fruit bait trap (Table 1).

3.3 Non target insects captured from Parafferomone traps and food baits

Insects from a total of five orders were captured as non-target insects in parafferomonic traps and food baits (Table. 2). Zingerone was found free of non-target insects; whereas, Methyl eugenol attracted insects from Blattodea and Hymenoptera (ants and parasitoids). Food baits captured non-target insects from Diptera, Lepidoptera and Coleoptera orders.

3.4 Species recorded from Infested fruits

It was observed that *Z. tau* and *B. dorsalis* were emerged from fruit fly infested fruits and vegetables. *Z. tau* emerged from pumpkin, tomato and ridge gourd. While *B. dorsalis* emerged from guava and mango (Table 3).

Table 1. Comparison on species captured in Parapheromonic traps and Food baits

Species	Parapheromone trap		Food baits		
	ME	ZN	Protein X bait	Soybean Bait	Fruit bait
<i>Bactrocera dorsalis</i> Hendel	+	+	-	-	-
<i>Bactrocera tuberculata</i> Bezzi	+	+	-	-	-
<i>Bactrocera aethriobasis</i> Hardy	+	-	-	-	-
<i>Bactrocera zonata</i> Saunders	+	-	-	-	-
<i>Bactrocera abbreviata</i> Hardy	-	+	-	-	-
<i>Dacus longicornis</i> Wiedemann	-	-	-	-	+
<i>Dacus maculipterus</i> Drew and Hancock	-	+	-	-	-
<i>Zeugodacus diversus</i> Coquillett	+	-	-	-	-
<i>Zeugodacus cucurbitae</i> Coquillett	-	-	+	+	+
<i>Zeugodacus tau</i> Walker	-	-	+	+	+
<i>Zeugodacus scutellaris</i> Bezzi	+	-	-	-	-
Total	6	4	2	2	3

+ (Present), - (Absent), ME- Methyl eugenol, ZN- Zingerone

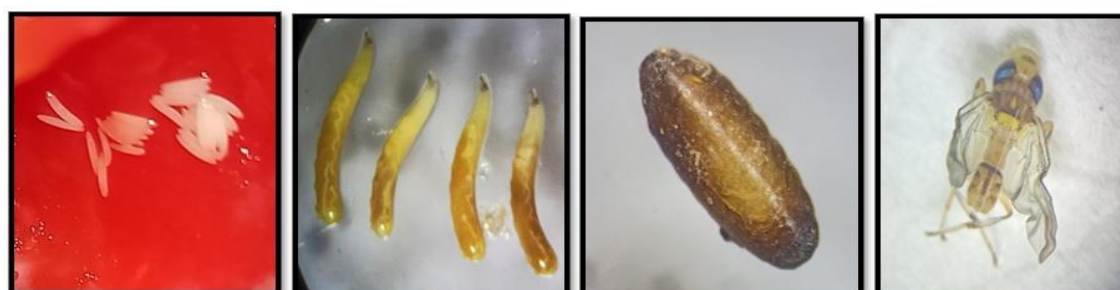
Table 2. Non-target insects captured from different traps

Order	Parapheromone trap		Food baits		
	ME	ZN	Protein X bait	Soybean Bait	Fruit bait
Diptera	-	-	+	+	+
Blatodea	+	-	-	-	-
Lepidoptera	-	-	+	-	+
Coleoptera	-	-	-	-	+
Hymenoptera (ants)	+	-	-	-	-
Hymenoptera (Parasitoids)	+	-	-	-	-

+ (Present), - (Absent), ME- Methyl eugenol, ZN- Zingerone

Table 3. Fruit fly species collected from infested Fruits and Vegetables

Sl.no	Common name	Scientific name	Fruit fly species
1.	Pumpkin	<i>Cucurbita moschata</i>	<i>Zeugodacus tau</i>
2.	Tomato	<i>Solanum lycopersicum</i>	<i>Zeugodacus tau</i>
3.	Ridge gourd	<i>Luffa acutangula</i>	<i>Zeugodacus tau</i>
4.	Guava	<i>Psidium guajava</i>	<i>Bactrocera dorsalis</i>
5.	Mango	<i>Mangifera indica</i>	<i>Bactrocera dorsalis</i>



Eggs

Maggots

Pupa

Adult

Figure 2. Different life stages of *Zeugodacus tau*

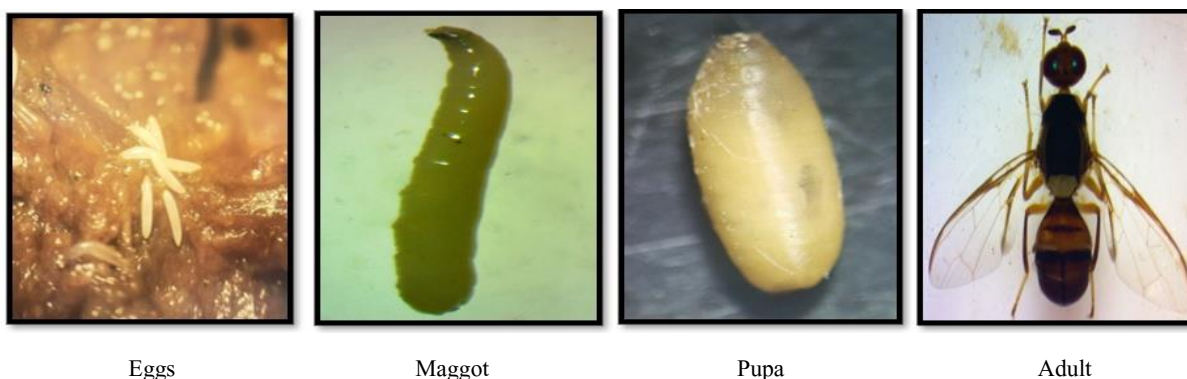


Figure 3. Different life stages of *Bactrocera dorsalis*

4. Discussion

Methyl eugenol (ME) (4-allyl-1, 2-dimethoxybenzene-carboxylate) and Zingerone [4-(4-hydroxy-3-methoxyphenyl)-2-butanone] are strong male-specific lures, and according to the findings of this study, parapheromone attracted all male flies of *B. dorsalis*, *B. tuberculata*, *B. aethriobasis*, *B. zonata*, *Zeugodacus diversus*, and *Z. scutellaris* were among the species attracted to Methyl eugenol traps. The results revealed that Methyl eugenol is more specific to genus *Bactrocera*. Similar finding was described by Deepa *et al.* (2009) who had reported methyl eugenol to be more effective for capturing *Bactrocera* complex. The result added to Chyne's (2011) findings that two fruit fly species were attracted to methyl eugenol, namely, *Bactrocera sp.* and *B. dorsalis* in Meghalaya's mid hills. In an attempt to identify the Tripura based Dacine fruit fly species by Nair *et al.* (2018), Several *Bactrocera* complexes, including, *B. tuberculata*, *B. dorsalis*, *B. zonata*, *B. diversa*, and *B. correcta* were observed to be attracted to methyl eugenol. Vargas *et al.* (2000) also reported that the strong olfactory attraction of methyl eugenol traps attracted numerous male fruit flies from a distance of 1000 meters.

Zingerone was found to attract *B. dorsalis*, *B. tuberculata*, *B. abbreviata*, and *D. maculipterus* in very small numbers. Zingerone's low stability in air, which makes it a poor attractant in comparison to the extremely strong methyl eugenol, may be the cause of its weak activity. However, *B. abbreviata*, a junior synonym of *B. bipustulata* and a new species for India, appears to be only zingerone responsive. The new compound Zingerone (ZN) can be tested in the field, especially in areas with a lot of different species, to learn more about how the lure works.

Fay (2012), Dominiak *et al.* (2015), Royer (2015), and Royer *et al.* (2018) also reported low stability zingerone in air. They reported that zingerone attracted a small number of unknown species tephritidae. Doorenweerd *et al.* (2018) and David *et al.* (2020) also reported that zingerone can attract *B. dorsalis*, *B. abbreviata* and *D. maculipterus* species respectively.

All the three types of food baits (Protein-x, soybean extract and fruit baits) were found to attract two species of fruit flies, *Z. tau* and *Z. cucurbitae*, most of them were female. The results of the study may explain that female fruit flies required extra nitrogen to develop their eggs and finish the egg laying, as evidenced by the increased female catch rate. These findings are in conformity with the work done by Maung *et al.* (2019), who cited a higher female captured percentage as evidence that female tephritidae required a greater quantity of protein to develop their eggs and complete egg cycle. Similarly, Epsky *et al.* (2014) reported that mature female tephritidae need sugar and protein to live and produce eggs, and the chemical compounds produced by these materials may serve as the reason for their attractancy to fruit flies. If unfertilized females were trapped before they had a chance to produce mature eggs and oviposit, it would increase the efficiency of attractants for the management of fruit fly populations. According to Bharathi *et al.* (2004) report, the rapid evaporation of the food baits, which results in a considerably reduced fermentation and limited production of volatile compounds, may be the cause of their weak performance. As a result, it attracted a smaller number of fruit flies. Fruit baits (seasonally available fruits and vegetables) are less expensive and easier to prepare than soybean bait, indicating that fruit baits are just as effective at attracting in fruit flies, particularly when combined with vinegar as a controlled releaser.

Additionally, *D. longicornis* was only captured in a fruit bait trap, which might have come from nearby cucurbit plants, as Allwood *et al.* (1999) have mentioned it as a host plant for *D. longicornis* species. Similar findings were reported by Doorenweerd *et al.* (2018).

5. Conclusion

According to the findings of this investigation, the Ri-Bhoi district of Meghalaya is a home to a diverse species of Tephritid fruit flies. All of the materials used to attract fruit flies were more or less efficient, but the Methyl eugenol

attracted maximum number of fruit flies as well as six different species of fruit flies. Food baits, on the other hand, attracted both male and female flies and Zingerone, which is known to attract non-responsive fruit flies. The findings of our research are extremely valuable in the capturing of fruit flies. Methyl eugenol attracted more fruit flies from the *Bactrocera* genus, whereas food baits attracted more fruit flies from the *Zeugodacus* genus. It may be recommended that fruit flies should be monitored and managed using a combination of traps and baits. Therefore, adequate knowledge of the different lures, traps and factors affecting their efficiency is important for successful use of lures and traps as a tool for IPM and ecological studies. This study gives basic information on fruit fly species as well as useful data for future comparisons of fruit fly capture methods.

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