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Efficacy of Methyl Eugenol and Food-Based Lures in Trapping Oriental Fruit Fly *Bactrocera dorsalis* (Diptera: Tephritidae) on Mango Homestead Trees

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Abstract**—**Trapping efficiency of methyl eugenol and three locally made food-based lures were evaluated in three locations for trapping of *B. dorsalis* on mango homestead trees in Ibadan South west Nigeria. The treatments were methyl eugenol, brewery waste, pineapple juice, orange juice, and control (water). The experiment was laid in a Complete Randomized Block Design (CRBD) and replicated three times in each location. Data collected were subjected to analysis of variance and significant means were separated by Turkey's test. The results showed that *B. dorsalis* was recorded in all locations of study. Methyl eugenol significantly ($P < 0.05$) trapped higher population of *B. dorsalis* in all the study area. The population density of *B. dorsalis* was highest during the ripening period of mango in all locations. The percentage trapped flies after 7 weeks were 77.85%-82.38% (methyl eugenol), 7.29%-8.64% (pineapple juice), 5.62-7.62% (brewery waste), 4.41%-5.95% (orange juice), and 0.24-0.47% (control). There were no significance differences ($p > 0.05$) on the population of *B. dorsalis* trapped in all locations. Similarly, there were no significant differences ($p > 0.05$) on the population of flies trapped among the food attractants. However, the three food attractants significantly ($p < 0.05$) trapped higher flies than control. Methyl eugenol trapped only male flies while brewery waste and other food based attractants trapped both male and female flies. The food baits tested were promising attractants for trapping *B. dorsalis* on mango homestead tress, hence increased dosage could be considered for monitoring and mass trapping as management strategies against fruit fly infestation

Keywords**—**Attractants, trapping, mango, *Bactrocera dorsalis.*

I. Introduction

THE oriental fruit fly, *Bactrocera dorsalis* Hendel (Diptera: Tephritidae) is a very vicious insect pest of many tropical and subtropical fruits and vegetables [1], [2]

The *Bactrocera dorsalis* complex comprises of more than 75 species, and is one of the most important pest complexes in global agriculture [3]. They are considered as a pest of major biosecurity concern [4], [5], due to their highly polyphagous and highly invasive species among them. In 2014, *B. papayae, B. philippinensis* and *B. invadens* were finally incorporated into *B. dorsalis* [6]. In 2003, *B. dorsalis* was recorded for the first time in Kenya and at that stage it was described as a new species, *Bactrocera invadens* [7], [8]. After its detection in Kenya, it spread rapidly throughout Africa and by 2005, it had been detected in Senegal, Ghana, Togo, Benin, Nigeria, Cameroon, Sudan, Uganda and Tanzania [8]. *Bactrocera dorsalis* is currently found in approximately 40 countries in Africa [9]. *Bactrocera dorsalis* is of huge economic significance to the fruit industry in Africa [10], [11].

Damage by *B. dorsalis* is caused by of punctures of the host tissue by adult females during oviposition and feeding by larvae on the fruit pulp. The feeding by the larvae inside the fruits leads to decay and prevalent crop losses [12]-[14]. *B. dorsalis* female adults trace their hosts through volatile compounds released by host plant species [15]. They lay their eggs under the skin of fruits. Females deposit batches of 120 eggs in many oviposition stings of a single fruit [16], [17], [1]. Larvae have three instars that feed on the fruit pulp, and this can result in complete destruction of the fruit. Mature larvae drop from the fruits onto the ground where they pupate in the soil at 25 cm depth. Adults emerge from the pupae and fly to the host plants to attain nutrition from nectar, dew and fruits [18]-[20], [1]. *Bactrocera dorsalis* causes direct damage ranging from 30 to 80 % of the crop depending on the cultivar, locality and season [21]- [23]. In West and Central Africa, *B. dorsalis* is highly polyphagous, infesting wild and cultivated fruits of about 46 species from 23 families with guava, mango and citrus being the preferred hosts [24].

The reported occurrence of *B. dorsalis* in parts of Africa has also caused major economic losses due to loss of market access through quarantine restrictions [25]. In Hawaii, fruit flies have been controlled traditionally in agricultural areas using protein bait sprays. Female fruit flies require sources of protein for egg production and growth; consequently they are easily attracted to baited protein food sources. The use of bait spray strategy has also reduced the amount of pesticide needed for fruit fly control and has been used successfully in eradication campaigns [26], [27].

In Nigeria, fruit fly managements are basically through cultural approach, mass trapping and food based lures. Mass trapping method represents preventive control measure, which is based on attraction and killing of fruit fly adults, before they infest the fruits. Mass trapping has proved to be very effective in fruit fly management and it has lesser cost of application [28]. The objectives of this study are to appraise the efficacies of three locally made food baits in trapping *B. dorsalis* and to compare their efficacy with methyl eugenol mango in homestead trees.

II. Materials and Methods

The study was carried out in Ibadan, South west Nigeria during the fruiting season of 2015. Ibadan is located within

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latitude 7º 22' 39.22"N and longitude 3º 54' 21.28"E of green meridian (GMT) with annual rainfall of about 1300 mm to 1500 mm and average relative humidity of about 80 to 85% [29].

Three local locations were selected for the study and they include; University of Ibadan, Federal College of Forestry and Elebu village. Lynfield traps with yellow screw top were used and four attractants were evaluated. The Lynfield trap consists of a transparent clear plastic cylindrical container measuring 115 m deep with 100 mm diameter base and 90 mm diameter screw top with four evenly spaced entry holes around the wall of the trap and four equidistant holes of 2 mm diameter positioned near the periphery of the trap base. The attractants comprise of methyl eugenol, pineapple juice, orange juice, hydrolyzed crud protein from brewery waste. The orange and pineapple juice baits were prepared by peeling 1 kg of each sample and blending them into smooth slurry paste. The juice was extracted with 500 ml of water and sieved with muslin cloths to obtain a homogenous solution [30]. Fresh brewery waste of 200 g was collected from Nigeria brewery at Alakia Ibadan and prepared for hydrolyzed crude protein by boiling for 15 hrs. 2 mls of cypermethrin was used to bait the prepared attractants to kill the flies when trapped. Three trees were selected from each location with each tree having 20 m distance apart to obtain three independent replicates within each location. 20 ml of prepared food baits were dispensed separately into the traps containing 0.5 g of cotton wool at bottom of the trap while 5 ml of methyl eugenol was used following the same procedure. Four traps were hung in each tree at 10 m above the ground within the tree and each treatment was replicated three times per location using each tree as a sampling unit. Catches of *B dorsalis* in each trap were counted every week and the attractants in each trap was replaced with new ones weekly for 7 weeks. Data collected were transformed using square root transformation ($X + 0.5$), then subjected to Analysis of Variance (ANOVA) and significant mean was separated at 5% level using the Turkey's Honestly Significant Difference (HSD).

III. Results

Effects of Treatments on the Population on B. dorsalis Trapped at Federal College of Forestry Ibadan

The population density on *B. dorsalis* trapped on mango at Federal College of Forestry Ibadan is shown in Table I. The densities of *B. dorsalis* trapped in this location significantly ($p < 0.05$) differed among the treatment from week one to seven. Methyl eugenol recorded the highest number of *B. dorsalis* with mean value of 110.8/trap/7 weeks, followed by brewery waste with the mean value of 12.09/trap/7weeks). The food based attractants showed no significant difference on the population of flies trapped when compared with control throughout the period of study. The highest population of *B. dorsalis* was trapped in week six (June) in this site during the study.

TABLE I
THE DENSITY OF *B. DORSALIS* TRAPPED AT FEDERAL COLLEGE OF FORESTRY IBADAN

Treatment	Week 1	2	3	4	5	6	7	Mean
Methyl eugenol	111.33a	105.67a	109.67a	126.67a	128.66a	22.33a	71.33a	118.80a
Brewery waste	39.33b	21.67b	4.67b	0.00b	8.00b	8.67b	2.33b	12.09b
Pineapple	37.67b	18.33b	8.33b	1.00b	0.00b	5.67b	1.33b	10.43b
Orange	33.67b	13.33b	3.00b	2.33b	1.66b	1.00b	067b	7.95bc
Water	4.33c	0.67c	1.67b	0.00b	0.33b	0.00b	0.33b	1.04c
Sig. level	*	*	*	*	*	*	*	*

Means with the same letter are not significantly different from each other within the column.
*= Significant at 5% level of probability

Effects of Treatments on the Density of B. dorsalis Trapped at University of Ibadan

The population of *B. dorsalis* trapped at the University of Ibadan is shown in Table II. All the attractants trapped *B. dorsalis* in this location. There were significant ($p < 0.05$) differences among the treatments from week one to week 7 at 5% level of probability. The efficacies of the attractants varied as in location one. Methyl eugenol significantly ($p < 0.05$) recorded the highest number of *B. dorsalis* with mean value of 114.62/trap/7week followed by pineapple bait with the mean value of 10.14/trap/7 weeks. Pineapple bait trapped highest number of *B. dorsalis* among the food based attractants.

TABLE II
THE DENSITY OF *B. DORSALIS* TRAPPED AT UNIVERSITY OF IBADAN

Treatment	1	2	3	4	5	6	7	Mean
Methyl eugenol	143.67a	137.33a	90.33a	144.00a	98.33a	117.67a	71.00a	114.62a
Brewery waste	18.67b	23.00b	1.67b	1.00b	8.33b	2.33b	0.33b	7.90b
Pineapple bait	26.00b	19.33bc	1.00b	9.00b	1.66b	11.00b	3.00	10.14b
Orange bait	26.00b	8.00bc	0.00b	0.00b	2.33b	5.00b	1.66b	6.14b
Water	0.67b	0.33c	0.00b	0.00b	0.33b	0.67b	0.67b	0.33b
Sig. level	*	*	*	*	*	*	*	*

Means with the same letter are not significantly different from each other within the column.
*= Significant at 5% level of probability

Effects of Treatments on the Density of B. dorsalis Trapped at Elebu Village

The population of *B. dorsalis* trapped at Elebu village is shown in Table III. The densities of flies trapped were significantly ($p < 0.05$) different among the treatments from first week to the end of the study. Methyl eugenol significantly ($p < 0.05$) recorded the highest number of *B. dorsalis* with the mean value of 109.76/trap/7weeks followed by pineapple bait with the mean value of 11.71/trap/7weeks.. All the food based attractants trapped higher numbers of *B. dorsalis* than control although there were no significant differences among them.

The Percentage Density of B. dorsalis Trapped by Different Treatments at the Study Sites

The percentage density of *B. dorsalis* trapped at the three study sites is shown in Fig. 1. All locations recorded incidences of *B. dorsalis* on mango during this study. Methyl eugenol trapped highest percent of flies at the three study sites

with the University of Ibadan having the highest density of trapped flies (82.32%), followed by Federal College of Forestry (FCF) (80.1%) and Elebu (77.85%). Brewery waste trapped higher flies at Elebu villange than other two villages while pineapple bait trapped highest at FCF and orange trapped highest at Elebu Village.

TABLE III
THE DENSITY OF *B. DORSALIS* TRAPPED AT ELEBU VILLAGE

Treatment	1	2	3	4	5	6	7	Mean
Methyl eugenol	130.67a	198.67a	117.67a	120.00a	121.33a	98.33a	71.67a	109.76a
Brewery waste	15.67b	5.00b	6.00b	0.00b	10.00b	13.00b	3.67b	7.62b
Pineapple bait	25.33b	16.66b	9.33b	10.00b	10.00b	7.67b	3.00b	11.71b
Orange bait	16.67b	11.00b	0.00b	6.33b	3.33b	0.00b	4.33b	5.95b
Water	0.33b	0.00b	0.33b	0.67b	0.67b	0.33b	0.67b	0.47b
Sig. level	*	*	*	*	*	*	*	*

Means with the same letter are not significantly different from each other within the column.
*= Significant at 5% level of probability

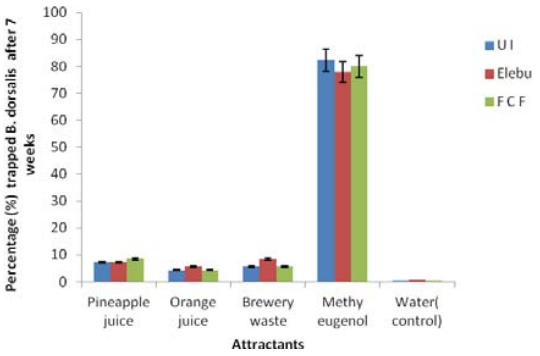

Fig. 1 Mean percentage density of *B. invadens* trapped at the study sites

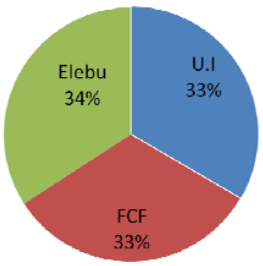

Fig. 2 Percentage (%) population of *B. dorsalis* trapped by all the treatments at the study sites

Total Percentage of B. dorsalis Trapped on Mango by All the Treatments during the Study

The overall population of *B. dorsalis* trapped at the study sites after 7 weeks is shown in Fig. 2. *Bactrocera dorsalis* was trapped by different attractants in all locations. There were no significant differences on the population of flies trapped by all the attractants at the study sites. However, highest density of flies were recorded at Elebu Village (34%) while University of Ibadan and Federal College of Forestry recorded equal densities of flies (33%) during the study.

Mean Density of Male and Female B. dorsalis Trapped on Guava Homestead

Trees at the Three Study Sites

Male and female *Bactrocera dorsalis* were trapped in all the study sites (Fig. 2) Methyl eugenol trapped only male *B. dorsalis* at the three study sites while food-based attractants trapped both male and female flies. The mean density of male *B. dorsalis* trapped by methyl eugenol was significantly ($p < 0.05$) higher than other treatments while pineapple bait trapped higher number of females than other food-based attractants.

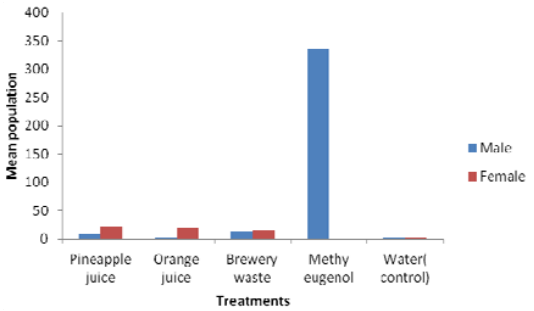

Fig. 3 Mean density of male and female *B. dorsalis* trapped at the three study sties

IV. DISCUSSION

Bactrocera dorsalis was trapped on mango tree in all locations by all the attractants with methyl eugenol recording highest densities of trapped flies. The results from this study were in line with the reports by other researchers that methyl eugenol is an effective and efficient lure for *B. dorsalis* [7], [10], [31], [8], [32]. The efficiency of the methyl eugenol in trapping *B. dorsalis* shows its importance in surveillance and monitoring of *B. dorsalis*. Correspondingly, methyl eugenol has been recommended for monitoring of male *Bactrocera dorsalis* and other invasive *Bactrocera* species such as *Bactrocera dorsalis* and *Bactrocera zonata* [33]. This study reveals that mango is major host of *B. dorsalis*. This study corroborates the report by Ekesi et al. [21] and Utomi [34] that mango is a major and preferred host of *B. dorsalis*. Umeh et al. [35] also reported incidences of *B. dorsalis* on mango and citrus in Nigeria. Adebayo and Akinbola [36] reported that highest number of *B. dorsalis* catches was recorded on mango host in Akure and its environs in Nigeria compared to other host plants evaluated indicating preference over other host plants. Similarly, Ugwu et al. [30] reported that *B. dorsalis* were trapped in high densities on mango using methyl eugenol in Ibadan, Nigeria. All the food based attractants caught both male and female adult *B. dorsalis* while methyl eugenol trapped only male flies. The result was in line with the earlier findings by Ekesi et al. [37] who reported that various food attractants tested in experiments were able to attract both sexes of *B. dorsalis* in mango but the level of attraction varied with the different protein baits. Protein source as an important constituent in the food baits and commercial lures has been

used to trap *B. cucurbitae* [38], [39] and *B. dorsalis* [40]-[42]. Similarly, Rajitha and Viraktamath [43] also reported attraction of female fruit flies to protein food baits in guava and mango orchards. Epsky et al. [44] reported that protein source has been exploited in developing attractant for female fruit flies. All the food based attractants trapped *B. dorsalis* on mango during this study which reveals their potentials in trapping fruit flies.

V. Conclusion

This study clearly revealed the presence of presence of *B. dorsalis* in Ibadan and its environs**.** *Bactrocera dorsalis* were trapped on mango in all study locations. Suitable choice of attractants enhances the trapping results. Food based attractants are promising attractants for trapping *B. dorsalis* on mango homestead trees in Southwest Nigeria, although further studies are required to establish its efficacy for mass trapping. Therefore, the strapping and selective response of *B. dorsalis* to methyl eugenol and food-based attractants and the suitability of mango fruits as major host of *B. dorsalis* were confirmed by this study

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