Efficacy of Two Food-based Attractants and Methyl eugenol for Mass trapping of African invader fly, Bactrocera invadens (Diptera: Tephritidae) on Bush mango in Ibadan, Southwest Nigeria

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Abstract

The African invader fly, Bactrocera invadens Drew, Tsuruta and White is a quarantine pest of Asian origin infesting various commercial fruit crops in tropical Africa. Mass trapping has proven to be a potent tool in its management. This study evaluated the effectiveness of two food attractants (orange juice, pineapple juice) and methyl eugenol for mass trapping of B. invadens on bush mango (Irvingia gabonensis) in Ibadan, Southwest Nigeria during the 2015 fruiting season. The treatments were orange juice (20 ml/trap), pineapple juice 20ml/trap), Methyl eugenol (5ml/trap) and control (water) using Lynfield traps. The traps were hung on Irvingia trees at height of between 4-5 m from the ground level (within the tree canopies). Using three sites, the distance between each tree was 20 m and traps were replicated three times in each site. Incidences of B. invadens on Irvingia were observed in all the sites. Methyl eugenol significantly (P<0.05) trapped higher B. invadens than other attractants. The percentage trapped flies after 12 weeks range from 81.06%-82.97% (Methyl eugenol), 9.48%-10.17% (orange juice), 6.60%-8.48% (pineapple juice) and 0.24-0.39% (control) on the sites. There was no significant difference (P>0.05) between the populations of flies trapped on the food attractants, although orange juice trapped more flies than pineapple juice. However, the two food attractants significantly (P<0.05) trapped higher flies than the control. Orange juice and pineapple juice are promising attractants for trapping B. invadens on Irvingia in Nigeria, hence increased dosage could be considered for mass trapping.

Keywords: Trapping, Irvingia gabonensis, food lures, fruit fly, Methyl eugenol

INTRODUCTION

The African invader fly, Bactrocera invadens Drew, Tsuruta and White (Diptera: Tephritidae) is a quarantine pest of Asian origin infesting various commercial fruit crops (Drew et al., 2005). In a current revision of the Bactrocera dorsalis (Hendel) complex, B. invadens was incorporated into the species B. dorsalis (De Villiers et al., 2016). The Bactrocera dorsalis complex consists of more than 75 species, and...
is one of the most important pest complexes in agriculture worldwide (Clarke et al., 2005). There has been argument for many years regarding some species of the *B. dorsalis* complex, in fussy the status of *Bactrocera papayae* Drew & Hancock, *Bactrocera philippinensis* Drew & Hancock, *Bactrocera invadens* Drew, Tsuruta and White and *B. dorsalis*, with various authors suggesting that these species should be considered as one (Tan et al., 2011; Krosch et al., 2013; San Jose et al., 2013). In 2014, *B. papayae, B. philippinensis* and *B. invadens* were finally incorporated into *B. dorsalis* (Schutze et al., 2015a, b).

*B. dorsalis* is one of the most destructive insects of fruits and vegetables in the world (Lux et al., 2003). *B. dorsalis* was first reported in Kenya in 2003 and was described as a new species, *Bactrocera invadens* (Lux et al., 2003; Drew et al., 2005). 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 (Drew et al., 2005). *Bactrocera dorsalis* is currently found in approximately 40 countries in Africa, including the islands of Madagascar, Cape Verde, Comoros and Mayotte, having spread as far north as Southern Mauritania, Southern Mali, Southern Niger, Southern Chad and Central Sudan, and as far south as Northern Namibia, Northern Botswana, Northern Zimbabwe and Mozambique (De Meyer et al., 2012, CABl, 2015; EPPO, 2015). Furthermore, it was recently confirmed present in the Vhembe district in the Limpopo province of South Africa (IPPC, 2013b; Manrakhan et al., 2015), and it has been reported in Swaziland (IPPC, 2013a; CABl, 2015).

*Breccera dorsalis* causes direct damage ranging from 30 to 80% of the crop depending on the cultivar, locality and season (Ekesi et al., 2006; Rwomushana et al., 2008; Vayssieres et al., 2009). *Bactrocera invadens* seem to have displaced the previously prevalent indigenous fruit flies, *Ceratitis* spp. (Vayssières et al., 2005 and Ekesi et al., 2009). According to Umeh et al. (1998) more than 70% of fruit set can be lost due to fruit fly infestation in Nigeria.

The host range of *B. invadens* in Africa consists of 72 plant species spread across 28 families (Ekesi et al., 2006; Vayssieres et al., 2009; Goergen et al., 2011). In West and Central Africa, *B. invadens* is highly polyphagous, infesting wild and cultivated fruits of about 46 species from 23 families with guava, mango and citrus being the preferred hosts while *Terminalia catappa* (Tropical almond), *Irvingia gabonensis* (African bush mango) and *Vitellaria paradoxa* (Sheanut) are main wild hosts with high infestation incidence (Goergen et al., 2011). The extremely polyphagous nature of the species facilitates their attack of wide range of fruits (Goergen et al., 2011).

African bush mango, *Irvingia gabonensis* is among the indigenous fruit trees widely cultivated in West Africa. *Irvingia* species are valuable source of income for West and Central African farmers. The fruits of *I. gabonensis* are edible and highly relished by rural women and children. The most important product is the kernels which fetch higher prices than the fruits. *Irvingia* kernels not only provide income locally to the rural women but also a source of foreign trade for many underdeveloped and developing countries in Africa with export worth US$ 50 million (Ladipo, 1997).

Production of healthy and saleable bush mango fruits has been constrained severely in Nigeria since the arrival of African invader fly *Bactrocera invadens*. In Nigeria, farmers suffer great losses, more than 50% yield loss annually due to fruitfly infestation (Umeh et al., 1998). Damage is done when female flies lay egg under the skin of fruit; afterward the larvae feed inside the fruit, leading to decay and extensive
crop losses (Ekesi and Billah, 2007; James and Schießers, 2007; Vayssières et al., 2008).

In Nigeria, fruit fly control approach by farmers has mainly focused on the use of synthetic chemical insecticides. (Umeh, 2008). The extensive use of chemical pesticides poses adverse effect on the activities and survival of natural enemies in the treated orchards (Ehler, and Endicott, 1984; Hoelmer and Dahlsten, 1993; Purcell et al., 1994). Due to adverse effects of chemical pesticides emphasis has been focused on implementing environmental safe measures of control, monitoring and detection of fruit flies pest in order to reduce the application of synthetic pesticides and substitute them with new environment friendly methods. The environment friendly measures for fruit fly control include the use of traps baited with the female targeted and male-targeted lures (Broughton et al., 2002; Toth et al., 2004; Heath et al., 2004). The use of the mass trapping technique through female-targeted and male-targeted lures can be included as a component of an Integrated Pest Management (IPM) program (Mediouni-Ben et al., 2010).

Nagaraj et al. (2014) reported that sanitation combined with the use of traps and lures and synthetic protein food baits has proved to be one of the best alternatives for the control of fruit flies. Bjelis (2006) earlier reported that Mass trapping of fruit flies show better efficacy over bait sprays and has lower cost of application especially human labour. The objectives of this study are to appraise the efficacies of two locally made food baits in mass trapping B. invadens and to compare their efficacy with Methyl eugenol in mass trapping of B. invadens on bush mango in homestead trees.

**MATERIALS AND METHODS**

**Experimental site**

The study was carried out in Ibadan, Oyo State south west Nigeria during the year 2015 fruiting season. Ibadan is located within latitude 7° 22′ N and longitude 3° 54’ E of Greenwich Meridian Time (GMT) with annual rainfall of about 1300 mm to 1500mm and average relative humidity of about 80 to 85% (FRIN, 2015). Ibadan has 11 Local Governments Areas (LGAs) of which three namely; Ibadan North West, Akinyele Local and Lagelu Local were selected for the study. Three locations/villages were selected from each local government which are Idishin (Ibadan North west LGA), Sangoro (Akinyeie LGA and Eniosa (Lagelu LGA) villages. The areas selected were known for bush mango production.

**Preparation of food bait**

The orange and pineapple baits were prepared by peeling 1kg of each sample and grinding them into smooth slurry paste using electric blender. The juice was extracted with 1 litre of water and sieved with muslin cloths to obtain a homogenous solution. The samples were refrigerated at 1.6°C until when used.

**Experimental set up**

Lynfield trap (LT) was used in this study. Lynfield trap is a bucket type trap composed of a cylindrical plastic container with four equidistant holes on the upper third and the lid of the trap contains a hook to which an ME (Methyl Eugenol) dispenser such as Invader Lure must be fitted (Copeland, 2012). The attractants used were Methyl Eugenol, Pineapple juice bait and orange juice bait. Cypermethrin (2 mls) was added to each attractant to knock down the trapped flies. Three trees were selected from each location and a distance of 20m separates each tree to obtain three independent replicates within each location. Four traps were hung on each tree at 10m above the ground within the tree canopy. Ten (10) mls of prepared food baits were taken with aid of 10 mls injection syringe and
carefully dropped on a 0.5 gm of absorbent cotton wool and placed at bottom of the trap. 5mls of Methyl eugenol was used following the same procedure and each treatment was replicated three times per location using each tree as a sampling unit.

Data Collection and Analysis
Catches of B invadens in each trap were counted every week and the attractants in each trap was replaced with new ones weekly for 12 weeks consecutively.

Data collected were transformed using square root transformation \( \sqrt{(X+0.5)} \) and then subjected to Analysis of Variance (ANOVA). Significant means were separated at 5% level using Tukey’s Honestly Significant Difference (HSD). Analysis was done with ASSISTAT version 7.6 beta 2011 software.

RESULTS
Effects of attractants on the number of Bactrocera invadens trapped in Idishin Village
The result showed that Methyl eugenol was the most effective attractant in trapping B. invadens at Idishin Village (Fig. 1). It recorded mean population of 92.94 (80.89%) adult B. invadens per trap after 12 weeks. This was followed by Orange juice bait with mean population of 11.66 (10.15% ) per trap over 12 weeks. The weekly catches of flies by the attractants per trap revealed that Methyl eugenol significantly (p<0.05) trapped the highest number of flies throughout the period of the study. The population of the B. invadens trapped declined as the fruiting season lapsed. The highest populations of flies were recorded at the peak of fruit ripening from 5th-7th week (June).

Effects of treatments on the number of Bactrocera invadens trapped in Sogunro village
The population density of B. invadens recorded at Sogunro Village followed similar trend with that of Idishin Village. Highest population of B. invadens were trapped on Methyl eugenol with mean density of 91.11 (82.69 % ) per trap in 12 weeks,(Fig. 2). It was followed by Orange bait with mean density of 10.44 (9.48%) per trap in 12 weeks. Methyl eugenol significantly (p<0.05) caught higher B. invadens flies from 1st week to the 12th week. There were no significant difference (P>0.05) between the population of flies caught by orange juice bait

Fig. 1: Effects of attractants on the population of Bactrocera invadens trapped on bush mango in Idishin Village (Standard error of the mean (SME) as error bar)

Fig. 2. Effects of treatments on the population of Bactrocera invadens trapped on bush mango in Sogunro Village (Standard error of the mean (SME) as error bar)
and pineapple bait. The control trapped least number of *B. invadens* throughout the period of this experiment. The peak density of flies were also recorded at the high point of fruit ripening from 5th-7th week (June) during the study.

**Effects of attractants the number of *Bactrocera invadens* trapped in Eniosa village**

The population of *B. invadens* tapped by the different attractants at Eniosa village was shown in Fig. 3. Methyl eugenol significantly (p<0.05) recorded highest catches of the *B. invadens* flies throughout the study period. It gave mean density of 86.44 (82.98%) per trap in 12 weeks, followed by Orange bait with mean value of 10.44(10.02%). There were no significant differences (p>0.05) between the density of flies caught on orange juice and pineapple juice baited trap. Control also trapped few flies in this Village *B. invadens* density were similarly more from 5th-7th week (June) during the study in this location.

There were no significant differences (p<0.05) in the population density of *B. invadens* trapped in all the locations. However, highest percentage of *B. invadens* was trapped at Idishin village followed by Sogunro while the the least population density of *B. invadens* was trapped at Eniosa Village.

![Fig. 3: Effects of attractant on the population of *Bactrocera invadens* trapped on bush mango in Eniosa Village (Standard error of the mean (SME) as error bar)](image)

**DISCUSSION**

The study revealed that all the food attractants tested attracted adult *B. invadens*, however, the level of attraction varied with the different food baits evaluated. This corroborates the earlier report by Vargas *et al.* (2003) who reported that the type of protein in food-based bait can influence the attractiveness of the bait to fruit flies. The orange and pineapple trapped both male and female adult *B. invadens* while Methyl eugenol trapped only male flies. This corroborates the earlier study by Ekesi *et al.* (2014) who reported that various food attractants tested in his experiment were able to attract both sexes of *B. invadens* in mango but the level of attraction varied with the different protein baits.

Methyl eugenol a para-pheromone out-performed the food attractants evaluated in terms of attractiveness to *B. invadens* while orange food baits were moderately effective and pineapple baits was the least effective. Methyl

**Percentage population of *B. invadens* trapped on Bush mango in the three villages**

*Bacterocera invadens* were trapped in all the three Villages selected for the study (Fig. 4).

![Fig. 4: Percentage population of *B. invadens* trapped on Bush mango in the three villages during the study (Standard error of the mean (SME) as error bar)](image)
eugenol trapped only male \textit{B. invadens} flies while food baits trapped both male and female adult \textit{B. invadens} as well as \textit{Drosophila} species. This confirms the report that Methyl eugenol is a male annihilation lure for \textit{B. invadens} and it attract only males (Ekesi et al., 2014). Male lures are specific to different kinds of fruit flies. For instance Methyl eugenol is a powerful male lure for \textit{Bactrocera invadens} Terpinyl acetate is effective for \textit{Ceratitis cosyra} and Cuelure is practically effective for \textit{Bactrocera cucurbitae} (Ekesi and Billah, 2007).

\textit{Bactrocera invadens} were trapped on homestead Bush mango trees in all the locations during the study which implies that Bush mango is appropriate host for \textit{B. invadens}. This confirms the earlier report by Goergen et al. (2011) that African bush mango is one of the major hosts of \textit{B. invadens} in the wild. However, it has been reported that \textit{B.invadens} has been reared from over 30 host plant species; although, mango is clearly the preferred host plants (Goergen et al., 2011). Similarly, Adebayo and Akinbola (2014) reported that highest number of \textit{B. invadens} catches was recorded on mango host in Akure and its environs in Nigeria compared to other hosts plants indicating preference over other host plants.

**CONCLUSION**

\textit{Bactrocera invadens} was trapped on homestead \textit{Irvingia gabonensis} trees during the fruiting season at the study sites. Suitable choice of attractants enhances the mass trapping results. Methyl eugenol was the most effective lure in trapping \textit{B. invadens} in all the locations. Orange juice and Pineapple juice baits showed potential results in trapping \textit{B. invadens}. Therefore, food baits are promising attractants for trapping \textit{B. invadens} in fruits orchards as an environment-friendly fruit fly control option, although more studies are required to ascertain their efficacy for mass trapping.

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