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EVALUATION OF TRAPS AND ATTRACTANTS FOR MASS TRAPPING OF AFRICAN INVADER FLY, *Bactrocera invadens* ON MANGO IN SOUTH WEST NIGERIA

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ABSTRACT

Mass trapping has demonstrated to be a powerful tool in the control of fruit flies, its use in African countries has currently increased remarkably as a control method. This study evaluated the efficacy of two traps; Lynfield Trap (LT) and Modified Lynfield Trap(MLT) and two lures (Methyl Eugenol (ME) and Protein Bait from Brewery Waste (PBBW)) for mass trapping of Bactrocera invadens Drew, Tsuruta, & White (Diptera: Tephritidae) on mango during 2014 and 2015 fruiting seasons. Traps containing attractants were randomly set on mango homestead trees in three replicates at three selected locations in Ibadan Southwest Nigeria. Results showed no significant difference ($p > 0.01$) between the trap types baited with ME attractant, although the MLT recorded higher catches of B. invadens during the two seasons. Methyl eugenol was significantly ($p < 0.01$) more effective than hydrolyzed protein bait from brewery waste in mass trapping B. invadens in the three locations of study. However, ME trapped only male B invadens while PBBW trapped both male and female. B. invadens population was highest at the peak of mango ripening (June) and the density of flies trapped in 2015 was significantly ($p < 0.05$) higher than 2014 in all the locations. Suitable choice of traps, lures and season enhances the mass trapping results. The use of Protein bait from brewery waste and modified lynfield trap for monitoring B. invadens and population suppression is promising and should be encouraged since they attract both sexes and less cost effective.

Key words: trapping, mango, lures, fruit fly, control

INTRODUCTION

The African invader fly, *Bactrocera invadens,* Drew, Tsuruta, & White (Diptera: Tephritidae) is a quarantine pest of Asian origin infesting several commercial fruit crops (Drew *et al.,* 2005). *Bactrocera invadens* was first discovered in Kenya in 2003 and later spread to other African countries. In Africa it has been reported from Benin, Cameroun, Democratic Republic of Congo, Ethiopia, Gabon, Ghana, Guinea, Kenya, Togo, Mali, Nigeria, Senegal, Sudan, and Uganda (Drew *et al*., 2005; Ekesi and Billah, 2007). *Bactrocera invadens* was first reported in Nigeria in 2005 (CABI/EPPO, 2008; Umeh *et al.*, 2008; Vayssières *et al.*, 2008; Asawalam and Nwachukwu, 2011; EPPO, 2014).

Since the introduction of *B. invadens* into Africa, they have been ravaging many fruits and vegetables that have led to increase in yield losses. *B. invadens* is highly polyphagous and have been confirmed to have a broad host range. It has been reared from mango, lemon, orange, tomato, banana, guava, marula, custard apple, Indian almond, and papaya, among other hosts (Ekesi and Billah, 2007; Rwomushana *et al.,* 2008). Ekesi *et al*. (2006) reported that mango appears to be the primary host plant. According to report by ICIPE (2007) mango is the second most important tropical fruit traded internationally across the globe. World production of mango in 2005 was estimated at 28.51 million tonnes (Mt) (Evans, 2008). Of this, Africa produced only 2.5 million tones, accounting for about 10% of fresh fruits and 11% of processed mango.

Nigeria ranks the 9th position among the ten leading mango producing countries of the world, but does not feature among the ten leading mango fruit exporters due to quarantine restriction (FAOSTAT, 2007). Most of the mango fruits produced in Nigeria are consumed locally as fresh

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fruit and the bulk of fruits marketed in Nigeria are produced by smallholder farmers (Aiyelaagbe *et al.,* 1999; Umeh *et al.,* 2002). The majority of these farmers are not acquainted with efficient fruit fly control options, hence, mango production in Nigeria is currently being constrained by the attack of *B. invadens.*

Current control measures against fruit flies mainly incorporate the use of insecticides as a cover spray or bait and targeting the adult flies (Raga and Sato, 2006). The use of insecticide is not a suitable control measure once the female fly has deposited egg inside the fruit meso carp, because the chances of affecting the larvae inside the fruits is very slim (Moreno *et al.,* 1994). Mass trapping method represents a preventive control measure, which is based on attracting and killing of fruit fly adults, before they get to the fruit to make infestation. The key advantage of mass trapping method is exclusion of fruits and whole canopy contamination by insecticides. The mass trapping methods can be applied by traps of different constructions, which have to be set on the tree canopy. The traps are filled with different types of attractants and treated by insecticide, or they could be filled with attractant-insecticide water solution (Haniotakis *et al*., 1983; Barcley and Haniotakis, 1991; Bjeliš, 2006). Mass trapping has been reported to show better efficacy over bait sprays and it has lower cost of application especially human labour (Brumas and Haniotakis, 1987; Bumas *et al*., 1998; Delrio and Lentini, 1993; Bjeliš, 2006.)

Traps designs, including different colors and shapes, are essential to obtain a high efficacy in fruit fly catches (Epsky *et al.* 1995, Vargas *et a*l. 1997). Therefore, the objectives of this study were to assess and compare the efficacies of two trap types and two attractants in mass trapping *Bactrocera invadens* on Mango homestead trees in Ibadan south west Nigeria.

MATERIALS AND METHODS

Experimental Site

The study was carried out in Ibadan, Oyo state South west Nigeria during the mango maturity periods of May- July 2014 and 2015. Ibadan is located within latitude 7^0 and 9^0 N longitude 3^0 and 58^0E of green meridian (GMT) with annual rainfall of about 1300 mm to 1500 mm and average relative humidity of about 80 to 85 % (FRIN, 2014).

Ibadan has eleven local governments and three local governments were selected as experimental site for the study. They include; Ibadan North – West, Iddo, and Akinyele local government areas. Three locations were selected from each local government. The areas selected were known for mango production. Three mango trees were selected in each location with a distance of 10 m apart.

Collection and Preparation of Brewery Waste

The brewery waste was collected early in the morning from Nigerian brewery Alakia, Ibadan Oyo state, Nigeria when fresh. Twenty kilogram of fresh brewery waste was poured inside an aluminum pot and placed inside another pot contain water. The setup was placed on a gas cooker and boil at for 15 hrs consecutively. It was observe for colour change, when the colour changes from light brown to deep brown the heating was stop, it was allow to cool for 2 hrs and later served with the aid of muslin cloth to collect the solution is known as hydrolyzed crude protein.

Experimental Set-Up

Two types of Lynfield traps were used; a conventional Lynfield trap (LT) (Figure A) and Modified Lynfield Trap (MLT) (Figure B) made from a recycled transparent 500-ml cylindrical plastic bottle (Eva Water, Nigeria) with two equidistant holes created opposite each other in the uppermost part, a lid and a small metal string which was used as a hanger for one of the attractants. The attractants used were Methyl Eugenol (ME) and Protein bait from Brewery Waste (PBBW). Three trees were selected from each location, the tree within each location were separated by 10 m to obtain three independent replications within each location. Six traps were randomly hung on each tree. Two hundred and fifty (250) mls of prepared crude protein and 250 mls methyl eugenol was each baited with 2 mls of cypermethr in (insecticide). The solution was then used to set the trap. Ten (10) mls of baited crude Protein was taken with aid of syringe and carefully dropped on a 0.5 gm of cotton wool and placed at bottom of the trap, the trap was later hung at 1.8m above ground level and within the tree canopy. The same procedure was repeated for methyl eugenol. However, 5 mls of methyl eugenol was used while water treatment was used as control. Each treatment was replicated three times per each location. The experiment was set up during the Maturity to ripening stage of mango during the two years when the environmental temperature varied within 27-30°C until the fruits were all harvested from the tree.

Catches of *B invadens* in each trap were counted every week and the attractants in each trap was replaced with new ones weekly for 9 weeks. Data collected were analyzed using ANOVA and the significant means were separated using Turkey's tests.

RESULTS

Effects of Treatments on Number of B. *invadens* Trapped on Mango in Ibadan North West (Idishin)

The mean density of *B. invadens* flies trapped during the study on mango homestead trees at Ibadan North Local Government is shown in Table 3. The

results showed significant differences among the treatments during the two seasons of the study. Modified Lynfield trap baited with Methyl eugenol (MLT+ ME) recorded highest population of fruit fly with mean value of 17.63/trap/week, followed by lynfield trap with methyl eugenol (LT+ME) with mean value of 17.41 /trap/ week in 2014. It followed the same trend in 2015 where MLT+ ME recorded highest population of *B. invadens* fly with mean value of110.80/trap/week, followed by LT+ ME with mean value of 110.58/trap/week. There were no significant differences between the trap types baited with methyl eugnol on the fruit fly density trapped for the two years. The density of *B. invadens* caught in 2015 was significantly ($p < 0.05$) higher than that of 2014 in all the trap types and attractants. This indicates population increase with time and suitability of the host plant for their survival and spread. Similarly, there was no significant difference on the density of *B. invadens* caught on Lynfield trap with protein bait from brewery waste (LT + PBBW)) and Modified lynfield trap with protein bait from brewery waste (MLT + PBBW) for the two years. However, Lynfield tap with protein bait from brewery waste had higher catches of *B. invadens* than modified lynfield trap with protein bait from brewery waste during the two seasons. In 2014, control traps recorded no *B invadens* in this location while in 2015, 0.42 % of *B.invadens* was trapped.

Effects of Treatments on the Population of B. *invadens* Trapped on Mango in Iddo

The mean population of *B. invadens* flies captured during the study on mango homestead trees at Iddo is shown in Table 3. The results showed that there were significant differences($p < 0.05$) among the trap types and attractants on the density of *B. invadens* trapped during the two seasons Modified lynfield trap baited with methyl eugenol (MLT + ME) recorded highest catches of *B. invadens* with mean values of 18.41 and 114.62 per trap/week in 2014 and 2015 respectively. This was followed by lynfield trap with methyl eugenol (LT+ME) with mean values of 17.89 and 112..10 in 2014 and 2015 respectively There was no significant difference ($p > 0.05$) between the two trap types for the two seasons Similarly, there was no significant difference on the density of *B. invadens* caught on Lynfield trap with protein bait from brewery waste (LT + PBBW) and Modified lynfield trap with protein bait from brewery waste (MLT + PBBW) for the two years. However, LT + PBBW recorded higher catches of *B. invadens* both in 2014 and2015. The population of *B. invadens* trapped in 2015 was significantly higher than 2014 in all the trap types and attractants.

Effects of Treatments on the Population *B. invadens* Trapped on Mango in Akinyele Local Government

The mean numbers of *B. invadens* flies caught during the study on mango homestead trees at Akinyele Local areas is shown in Table 3. The results also showed significant difference ($p < 0.05$) among the treatments in both seasons. The densities of *B. invadens* trapped in this location followed the same trend with the other locations. Lynfield trap baited with methyl eugenol (LT+ME) recorded highest population of fruit fly with mean values of 18.19 and 115.55 in 2014 and 2015 respectively. There was significant difference on the densities of flies trapped by the Modified lynfield trap and Lynfield trap with methyl eugenol in 2014 while in 2015 there was no significant difference between the two traps with methyl, however LT + ME caught higher flies. Similarly, there was no significant difference ($p > 0.05$) on population density of fruit fly caught on Lynfield trap baited with Protein bait from brewery waste (LT+ PBBW) and Modified lynfield trap with Protein bait from brewery waste (MLT + PBBW) during the two seasons However, lynfield trap with Protein bait from brewery waste recorded higher *B. invadens* catch than Modified lynfield trap with Protein baith from brewery waste in both seasons.

Fig. 1: Lynfield Traps: A - Modified Lynfield Trap (MLT); B - *Lynfield* trap (LT)

Table 1: Mean population of *B. invadens* trapped in Ibadan North – West(Idishin)

Treatments	Mean population/trap/week in 2014	Mean population/trap/week in 2015	Percentage population/trap/week in 2014	Percentage population/trap/week in 2015
LT+ME	17.41a	110.58a	45.89	44.63
LT+PBBW	1.52b	12.23b	4.01	4.94
MLT+ME	17.63a	110.80a	46.47	44.72
MLT+PBBW	1.38b	12.09b	3.64	4.88
LT+Water	0.00b	0.33b	0.00	0.13
MLT+Water	0.00b	1.04b	0.00	0.42

Means followed by the same letter within the column are not significantly different. LT - Lynfield trap , ME - Methyl eugenol; PBBW - Protein bait from Brewery Waste; MLT - Modified Lynfield trap

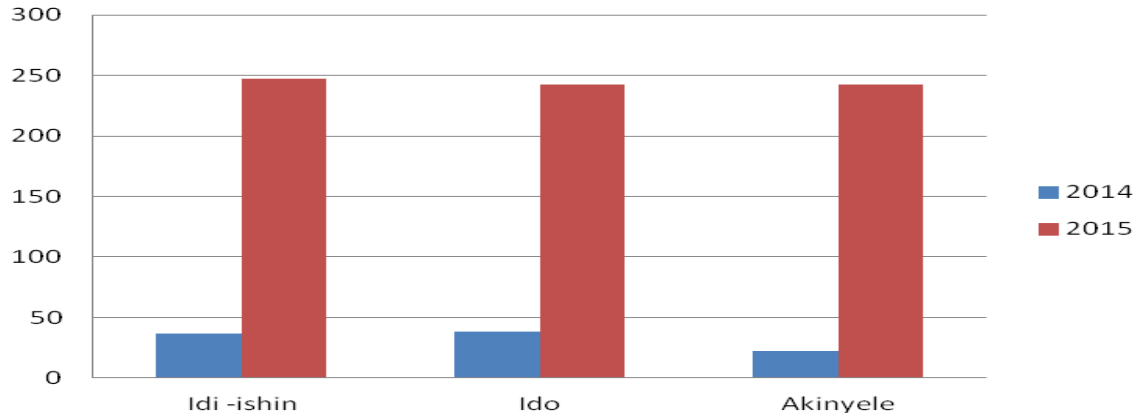

Fig. 2: Mean population of *B. invadens* trapped on mango in the three villages during the two seasons

Table 2: Mean population of *B. invadens* trapped in Iddo

Treatments	Mean population/trap/week in 2014	Mean population/trap/week in 2015	Percentage population/trap/week in 2014	Percentage population/trap/week in 2015
LT+ME	17.89a	112.10a	45.64	46.25
LT+PBBW	1.08b	7.16b	2.76	2.95
MLT+ME	18.41a	114.62a	46.96	47.29
MLT+PBBW	1.08b	7.90b	4.64	3.26
LT+Water	0.00b	0.27c	0.00	0.11
MLT+Water	0.00b	0.33c	0.00	0.13

Means followed by the same letter within the column are not significantly different. LT - Lynfield trap , ME - Methyl eugenol; PBBW - Protein bait from Brewery Waste; MLT - Modified Lynfield trap

Table 3: Mean population of *B. invadens* trapped in Akinyele

Treatments	Mean population/trap/week in 2014	Mean population/trap/week in 2015	Percentage population/trap/week in 2014	Percentage population/trap/week in 2015
LT+ME	18.19a	115.55a	52.63	47.65
LT+PBBW	2.52c	8.69b	7.29c	3.38
MLT+ME	12.4b	109.76a	35.87	45.26
MLT+PBBW	1.45c	7.62b	4.20	3.14
LT+Water	0.00c	0.41c	0.00	0.17
MLT+Water	0.00c	0.47c	0.00	0.19

Means followed by the same letter within the column are not significantly different. LT - Lynfield trap , ME - Methyl eugenol; PBB - Protein bait from Brewery Waste; MLT - Modified Lynfield trap

The control trapped no fly in 2014 but caught the lowest density of *B. invadens* in 2015 with 0.17% and 0.19% for Lynfield trap and Modified Lynfield trap respectively.

Mean Population of *B. invadens* Trapped on Mango in the Three Villages in the Two Seasons

Bacterocera invadens were trapped in all the three villages selected for the study (Fig. 2). There were no significant differences ($p < 0.05$) on the population density of *B. invadens* trapped in all the location during each season; however, the population of flies trapped in 2015 were significantly higher than 2014 in all the location. The highest number of flies was trapped in Ido in 2014 while in 2015 highest catch of *B. invadens* was in Idi-ishin while the least population were recorded in Akinyele both in 2014 and 2015.

DISCUSSION

Traps and attractants evaluated demonstrated their potentials in trapping *B. invadens* on mango homested trees in Ibadan south west Nigeria. Methyl eigenol showed a very high efficacy in masstraping *B. invadens* with different trap types on mango in all the locations of the study. This report corroborates the earlier report that the para-pheromone methyl eugenol (ME) captures a large number of *Bactrocera* species including: Oriental fruit fly (*B. dorsalis),* peach fruit fly (*B. zonata)*, carambola fruit fly (*B. carambolae*), Philippine fruit fly (*B. philippinensis*), and banana fruit fly (*B. musae*) (IAEA, 2003). Furthermore the findings by Ishaq *et al.* (2004), Stonehouse *et al.* (2005) and Jiji *et al.* (2009) revealed that Methy eugenol is very effective in mass trapping Bactrocera species in mango, stating that that among the various fruit fly management strategies tested ME trap + Bait was the most effective technique. Similarly AFF (2012) stated that Methyl eugenol is the attractant recommended for survey of male *Bactrocera invadens* and other invasive *Bactrocera* species such as *Bactrocera dorsalis* and *Bactrocera zonata*. Methyl eugenol attracted only male *B. invadens* in all the locations of the study. This report corroborates the earlier report by Russell (1999) that *Parapheromone lures* (methyl) eugenol, cue-lure, ceralure, trimed lure and latilure attract only males and every fruit fly species in Hawaii is attracted to a different kind.

Correspondingly, Ekesi *et al.* (2014) reported that Methyl eugenol is a male annihilation lure for *B. invadens* and it attract only males Protein bait of brewery waste trapped both male and female *B. invadens* and other insect species in all the location of the study. This confirms report by Sabine (1992) who reported that Protein baits attract both male and female fruit flies, making them more effective than the male attractant method for field pest management. There were no significant differences ($p < 0.05$) on the density of flies trapped using the same attractant with same trap type in all the locations of the study, although Modified Lynfied trap with same attractants trapped higher flies in two locations than the Lynfield traps. This implies that trap types is a determinant factors of fruit fly trapping efficiency for control programme. This assumption supports Epsky *et al*. (1995) and Vargas *et al.* (1997) who reported that traps designs, including different colours and shapes, are essential to obtain a high efficacy in fruit fly catches. Likewise several authors have reported that Tephritid traps vary in effectiveness depending on their size, color, shape and the particular olfactory attractant used (Prokopy, 1969; Prokopy and Bush, 1973; Moericke, 1976; Prokopy and Economopoulos, 1976; Aliniazee and Brown, 1977; Prokopy, 1977; Cytrynowicz *et al*., 1982; Robacker *et al*., 1990; Sivinski, 1990). The highest/peak population of *B. invadens* flies were trapped during the fruit ripening period which was in the month of May - June in all the locations of the study during the two seasons. The study by Lutap *et al*. (2009) also revealed a peak population of fruit flies during May - June, when monitored using ME trap in mango orchard.

CONCLUSION

All the location recorded incidence of *Bactrocera invadens* on mango homestead tree in Ibadan south west Nigeria. .Modified lynfield trap with Methyl eugenol was effective in trapping *B. invadens* in the study sites and the highest density of flies were trapped during the peak of mango ripening for the two seasons of the study. Suitable choice of trap and attractants enhances the mass trapping results. The use of locally made Protein bait from brewery waste shows great promise in trapping *B. invadens* on mango. Hence fruit fly traps can be easily improvised and adopted by farmers for fruit fly control while further studies are required on the protein bait brewery waste to enhance their efficacy in mass trapping since they attract both sexes, readily available and less cost effective than paraperomones which attracts only male flies.

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