SHORT COMMUNICATION

Activity Pattern and Distribution of African Invader Fly, *Bactrocera invadens* (Drew, Tsuruta and White) [Diptera: Tephritidae] in Ondo State, Southwestern Nigeria

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ABSTRACT: African invader fly, *Bactrocera invadens*, is an invasive species and it has been reported as an economically important pest of fruits in Nigeria. The insect's pattern of activity was studied on mango (*Mangifera indica* Linn.) over a 2-week period in 2014 at the Federal University of Technology, Akure (FUTA) (5° 14" E and 7° 30" N), The population infesting three host plants, citrus (*Citrus sinensis* L.), mango, and pawpaw (*Carica papaya* Linn.) was assessed over 8-weeks at Adeyemi College of Education (ACE), Ondo, Rufus Giwa Polytechnic Owo (RUGIPO) (5° 35" E and 7° 11" N), and Adekunle Ajasin University, Akungba Akoko (AAUA) (5° 44" E and 7° 28" N). The flies were lured into locally-fabricated traps with methyleugenol pre-mixed with insecticide and catches were counted at 1100, 1500, and 1800 hours in the activity pattern study but at fortnightly intervals in infestation/distribution study. The experiments were laid in completely randomized design with three treatment replicates; trap catches were square root transformed before analysis of variance. Trap catches revealed that flies were prevalently active in the late morning and that location and host plant exerted significant influence. The highest trap catch was at AAUA (3866.67) followed by ACE (1726.99), and RUGIPO (1429.03). Mango was the most preferred host (4530.02), followed by citrus (1381.01), and pawpaw (1111.66). A total of seven thousand and twenty two (7022.69) flies were trapped at the three locations and on the hosts within the study period. It was concluded that *B. invadens* were most active in the late morning and were distributed in all the selected areas. Therefore, based on the results from the study, constant monitoring and trapping is recommended as a management option for the pestiferous *B. invadens*. Consequently, fly control strategy has to take cognisance of pest density variation by location, season, and host plant infested.

Keyword: *Bactrocera invadens*, activity pattern, distribution, trapping

INTRODUCTION

The production of fruits, particularly mango, citrus, pawpaw, apple, pineapple, and tomatoes, for local, urban and export markets is one of the fastest growing sector in African agriculture. However, access to international markets is hindered by infestation of tropical fruit flies. *Bactrocera invadens*, is an exotic tropical fruit fly

widely distributed in Africa and attacking diverse fruit and vegetable crops (Allwood and Drew, 1997; De Meyer *et al.*, 2007; De Meyer *et al.*, 2010; Drew *et al.*, 2005; Ekesi and Billah, 2007; Lux *et al.*, 2003; White and Elson-Harris, 1992). Characteristics that give it economic pest status include high mobility and dispersive powers, high reproductive rates, polyphagy, and top ranking on world list of insects of quarantine importance (Clarke *et al.*, 2005; White, 2006).

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Females lay their eggs under the skin of fruits and larval development is completed inside the fruits which quickly rot (Ekesi and Billah, 2007). Host species attacked exceed 46 although mango is the most preferred (Goergen *et al.*, 2011; Mwatawala *et al.*, 2009). About 40% of the mangoes produced in Africa is lost to fruit flies whose infestation varies among countries and seasons from 5 – 100 % (Drew *et al.*, 2005). In Kenya, direct damage to mango by *B. invadens* ranges from 30% to 80% of the crop depending on the cultivar, locality and season (Ekesi *et al.*, 2006).

Fruit production and export is one of the fastest growing agricultural sectors in Africa, providing income and employment. Mangoes, citrus, pawpaw, apple, pineapple and tomatoes are among the commonest ones grown both for domestic, urban markets and for exports that target large markets in Europe and the Middle East. Besides export, is the changing dietary patterns leading to increased consumption of fruits (Lux *et al.*, 2002). The presence of *B. invadens* has affected over twenty host plant which include tangelo, banana, plantain, strawberry guava, common guava, African peach, Ethiopian eggplant, apple, mango, avocado, tomato, African wild mango, bell pepper, chilli pepper, sour orange, sweet orange, grape, papaya, watermelon, lemon, tangerine etc. (De Meyer *et al.*, 2007). Tropical fruit flies are major pests of fruits common in most area of the world and many species can exist with different host plant preferences and geographical distributions. The *Bactrocera invadens*, a fruit fly in the family Tephritidae, is among the most economically important pests of fruits and vegetables worldwide (Allwood and Drew, 1997; Lux *et al.*, 2003). They constitute an important group of pest in many countries due to their potential to cause damage in fruits. They also restrict access to international markets of plant products that host them. Introduction of this new invasive fruit fly species, with high flying ability, high rate of reproduction and spread can establish easily in new environment or territories (Nwaneri, 2013). Since its first detection in 2003 on the East African Coastline (Drew *et al.*, 2005), *B. invadens* has spread to over 28 African countries including the Comoros Islands and

Cape Verde (Ekesi and Billah, 2007; De Meyer *et al.*, 2010). It has been recorded from 46 host plant species, although mango is the preferred host plant (Mwatawala *et al.*, 2009; Goergen *et al.*, 2011). *Bactrocera invadens* is thought to be responsible for causing extensive economic losses to horticultural crops throughout Africa since its first report in 2003 (Lux *et al.*, 2003). This is perhaps not surprising because, Asian fruit fly pests from the genus *Bactrocera* are regarded as among the most destructive insects of fruits and vegetables worldwide (White and Elson-Harris, 1992). With adult traits that can include high mobility and dispersive powers, high reproductive rates, and extreme polyphagy, *Bactrocera* species are well- documented invaders and rank high on quarantine lists world-wide (Clarke *et al.*, 2005). It is uncertain exactly when and how *B. invadens* was introduced into Africa (Copeland *et al.*, 2006). Females lay their eggs under the skin of fruit causing direct damage and the resulting larvae feed inside the fruit. Infested fruits quickly rot resulting in extensive losses (Ekesi and Billah, 2007).

An assessment reveals that of the 1.9 million metric ton of mangoes produced in Africa annually, about 40% is lost due to fruit flies. Fruit infestation rates vary among countries and seasons, ranging from 5% to 100% (Drew *et al.*, 2005). This pest has been reported to cause 15-50 % yield losses in mango and some other fruit crops in some African countries (Vayssieres *et al.*, 2005). In Kenya, direct damage to mango due to *B. invadens* ranged from 30% to 80% of the crop depending on the cultivar, locality and season (Ekesi *et al.*, 2006).

The biology of *Bactrocera* complexes vary from one species to another. They undergo complete metamorphosis. Temperature, humidity, rainfall and other eco-climate factors affect the life cycle of *B. invadens*. Females lay their eggs under the skin of fruit causing direct damage and the resulting larvae feed inside the fruit. Infested fruits quickly rot resulting in extensive losses (Ekesi and Billah, 2007). *Bactrocera invadens* is multivoltine and reproduce with an average life span of about three months (White, 2006). Infestation of *B. invadens* has been reported in Nigeria and the spread of the insect monitored in

Figure 1: Fabricated bottle traps

various parts of the country (Adebayo and Akinbola, 2014; Asawalam *et al.*, 2009; Umeh *et al.*, 2004; 2008). Fruit flies identified on citrus belonged to the genera *Bactrocera*, *Ceratitis*, *Dacus* and *Trirhithrum*. While higher fruit fly diversity was observed in Edo, Ogun and Oyo States in the rainforest ecological zone, relatively higher populations of major genera (*Bactrocera* and *Ceratitis*) were recorded in Benue and Kaduna States in the Guinea savanna ecological

zone (Umeh *et al.*, 2008). They also reported a 27% attack of fruits in Ondo State. However, only citrus was surveyed in their study. Observations have shown that, in most parts of Nigeria, fruit fly damage occurs at all times when fruits are set, whereas damage by the fruit piercing moths varies from one year to another (Umeh, unpublished data). Fruit fly populations can be said to have attained a numerical stability over a long period (Eguagie and Udensi, 1989) and are of economic significance at a particular phenological stage of the plant (usually during the fruiting season). In severe infestation, as high as 70% of set fruits may be lost with the combined attack of these insects (Babatola, 1985).

Therefore, the present study investigated the activity pattern and distribution of *B. invadens* in four Local Government Areas of Ondo State, South-western Nigeria, on mango, citrus and pawpaw.

MATERIALS AND METHODS

Study Sites

Figure 2 shows the sites used for the study. To investigate the activity pattern of the fly over a 2-week period in 2014, mango at the crop type museum, Obekekere, of the Federal University of Technology Akure (FUTA), Akure South Local Government Area was used. For the distribution of *B. invadens* in Ondo State, bi-weekly trapping of the fly on citrus, mango, and

Figure 2: The map of Ondo State showing Ondo West, Akure South, Owo and Akoko North East Local Government Areas as the study locations

pawpaw in the campuses of Adeyemi College of Education (ACE), Ondo-West Local Government Area; Rufus Giwa Polytechnic Owo (RUGIPO), Owo Local Government Area, and Adekunle Ajasin University Akungba (AAUA), Akoko North-East Local Government Area was carried out over a period of eight weeks.

At FUTA, treatment consisted of trap catches of fruit flies at 1100, 1500, and 1800 hours on mango trees spaced 50 m apart. Experimental set up at ACE, RUGIPO, and AAUA were similar but utilized three host crops and the trap catches were collected fortnightly. The plastic bottle traps used were fabricated according to the design of Billah *et al.*, (2005) [Fig. 1] and baited with methyl Eugenol (4-allyl-1, 2-dimethoxybenzen, Agri-Mat®, England) pre-mixed with insecticide Cypermethrin (Plan D[®] or Akape[®]) in ratio 4:1. Flies collected were identified using the morphological key of Billah *et al.*, (2005).

Data Analysis

Data on trapped flies were square root transformed and subjected to Analysis of Variance using Statistical Package for Social

Science (SPSS), version 16.0. Means were separated using Tukey's test at 95% probability.

RESULTS

Table 1 shows that *B. invadens* infestation occurred all-day long but activity was generally more prevalent in the late morning. Whereas in week 1 only, the late morning and evening collections differed significantly, in week 2, the differences of each of the afternoon and evening collection was significantly different from that of the late morning collection. *B. invadens* was found on all host plants examined and at all locations selected for the study of distribution. Across hosts and locations, 7,022 flies were trapped. Numbers trapped were preponderantly higher at AAUA (2.2- and 3.0-fold more than at ACE and RUGIPO, respectively) and on mango (3.6-and 3.9-fold more than on citrus and pawpaw, respectively) (Table 2). The preference for mango was consistently demonstrated by the significance of the weekly trap catches at AAUA (Table 3), and those of weeks 4 and 6 at ACE (Table 3). At RUGIPO, the weekly trap catch differences among hosts were due to random variation (Table 3).

Table 1: Comparison of trap catches on mango at different times of the day in FUT, Akure

Trap Collection Time	Number of Flies Trapped At Week *	
	1	2
Morning (11.00 am)	2.87a (8.95)	3.70a (14.10)
Afternoon (3.00pm)	2.34ab (6.24)	2.01b (4.43)
Evening (6.00pm)	2.22b (5.29)	2.30b (5.14)

*Means followed by the same letter within a column are not significantly different ($P>0.05$) using Tukey's test; untransformed data are presented in parentheses.

Table 2: Comparison of trap catches by location and host plant for 8 weeks

Location *	No of trapped flies			
	Citrus	Pawpaw	Mango	Total
AAUA	39.71b (472.34)	41.42b (439.66)	117.92a (2954.67)	(3866.67)
ACE	37.90b (372.33)	38.48b (438.66)	57.29a (916.00)	(1726.99)
RUGIPO	46.00a (536.34)	30.12b (233.34)	49.48b (659.35)	(1429.03)
Total	(1381.01)	(1111.66)	(4530.02)	(7022.69)

*Means followed by the same letter within a column were not significantly different ($P>0.05$) using Tukey's test; untransformed data were presented in parenthesis.

Table 3: Weekly trap catches on three host fruits at Adeyemi College of Education, Ondo (ACE), Rufus Giwa Polytechnic Owo (RUGIPO) and Adekunle Ajasin University, Akungba (AAUA)

No of flies at indicated Week				
ACE Host	2	4	5	8
Mango	11.66 (155.67)	9.94a (100.00)	19.17a (367.33)	16.52 (293.00)
Citrus	7.62 (58.67)	7.79ab (60.00)	11.10b (123.33)	11.39 (130.33)
Pawpaw	6.35 (39.33)	6.07b (38.00)	15.54ab (246.00)	10.52 (115.33)
	NS			NS
RUGIPO Host				
Mango	11.39 (130.33)	11.76 (159.69)	12.80 (181.33)	13.53 (188.00)
Citrus	11.52 (133.67)	11.18 (126.00)	11.49 (132.67)	11.81 (144.00)
Pawpaw	8.13 (67.33)	5.69 (31.67)	7.42 (54.67)	8.88 (79.67)
	NS*	NS	NS	NS
AAUA Host				
Mango	23.86a (569.67)	35.04a (629.00)	27.58a (764.00)	31.44a (992.00)
Citrus	9.03b (86.67)	10.44b (133.67)	10.84b (134.00)	9.40b (118.00)
Pawpaw	11.09b (123.33)	9.77b (95.00)	10.15b (113.33)	10.41b (108.00)

*Means followed by the same letter within a column in the same location are not significantly different ($P > 0.05$) using Tukey's test; untransformed data are presented in parenthesis.

DISCUSSION

B. invadens was detected and trapped at all study sites and on the three fruit hosts confirming the establishment of the species in Ondo State as previously reported by Adebayo and Akinbola (2014). The numbers trapped varied with location and host plant as a result of biotic and abiotic factors. Previous studies had shown the influence of predatory tailor ants, *Oecophylla* sp., noise pollution, moist humid environment on fly population (Aruna *et al.*, 2009; Adebayo and Akinbola, 2014). The preference of *B. invadens* for mango is in agreement with the findings of Adebayo and Akinbola (2014), Aruna *et al.* (2009), Ekesi *et al.* (2006), and Utomi (2006). Infestation of the other hosts confirmed the wide host range of this fly (Allwood and Drew, 1997; Lux *et al.*, 2003). The study substantiated the reliability of locally-fabricated, methyl eugenol-baited traps, previously used by Asawalam *et al.* (2009) and Adebayo and Akinbola (2014) as tool for surveillance of *B. invadens*. Though

Umeh *et al.* (2008) used different traps and bait, the flies were attracted and detected. The presence of the fly in all the locations further confirmed the works of Umeh *et al.* (2004; 2008). The present study however, showed that several factors were responsible for the presence of the fly in the locations. The nature of the location of the orchard and human disturbances seemed to greatly influence their presence. The highest fly population caught on mango in all the locations showed that it is the most parasitized by the fly.

CONCLUSION

Establishment of *B. invadens* in Ondo State has been affirmed using locally-constructed, methyl eugenol-baited traps. The fly's prevalent activity period is late morning. Mango was the most preferred of the host tested. The distribution of the fly in the locations at the Local Government Areas was influenced by the nature of the orchard and human disturbances.

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