Abundance and Diversity of Frugivorous Fruit Flies in Kandara, Murang'a County, Kenya

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Abstract

Fruits and vegetables are important source of livelihood to farmers and major horticulture sub sector with high contribution to agricultural GDP in Kenya. This study was conducted to determine diversity and abundance of frugivorous fruit flies in Kandara sub county, Murang'a County in 2018, at a place where first area of low pest population was created in Kenya for *Bactrocera dorsalis*. Three sets of pheromone traps (Methyl-Eugenol, Cuelure and Trimedlure) were set in six trap stations within farmers' orchards in four agro-ecological zones (LH1 (Lower Highland Zone), UM1 (Upper Mid-land Zone), UM2, and UM3). The trap catch data was collected fortnightly and data analyzed. Six fruit flies species namely; *Bactrocera dorsalis*, *Ceratitis cosyra*, *Ceratitis capitata, Zeugodacus cucurbitae, Dacus bivittatus* and *Perilampsis sp* were identified. *Bactrocera dorsalis* population was significantly (P<.001) different across the four agro-ecologies with lowest densities at LH1 and highest at UM3. Likewise, *C. capitata* recorded significant (P=0.042) difference densities across the agro-ecological zones, but no significant (P=0.386) difference was recorded for *C. cosyra* across the agro-ecological zones. Further, there was significant (P=0.012) difference in the number of *Perilampsis sp* across the agro-ecologies with the highest number recorded in UM1. Both *Z. cucurbitae* (P=0.061) and *D. bivittatus* (P=0.056) had low abundance across the agro-ecologies. The peak infestation period differed across the various fruit fly species, whereby *B. dorsalis* peaked in May, *C. capitata* in February and *C. cosyra* in January. The study shows that abundance for the fruit flies is probably related to their preferred hostplant and the weather patterns. We recommend continuous monitoring and intensifying trapping activities during peak periods in order to control the pest and protect fruits from damage. Farmers should be trained on the use of pheromone traps to reduce over-reliance on pesticides.

Key words: Agro-ecologies, *Bactrocera dorsalis, Ceratitis* sp, fruit fly density, Pheromone,

Introduction

Fruits are an important source of livelihood for farmers and they further contribute immensely to the agricultural GDP for the country. They also improve diet by providing nutrients and essential vitamins (Thomas, 2008). Majority of households living in Kandara is composed of farmers who grow mangoes, avocados, and guavas as commercial fruits which unfortunately are among the main host plants for fruit flies. Therefore, the productivity and quality of these fruit crops is highly affected by fruit flies (Tephritidae) which cause damage directly by puncturing the fruits to lay eggs, the hatched maggots feed on the fruit creating galleries that serve as entry points for pathogens, fruit decay occurs and then falls to the ground, which contribute to high farm losses. Exported fruit have been intercepted due to presence of fruit flies by the importing countries (Bissdorf & Weber, 2005; Follett & Neven, 2006). For example, since 2015 to date, 19 interceptions have been received from EU due to Tephritidae flies in Mango, Capsicum, Eryngium and Cucurbits (EC, 2020).

Pest management practices by farmers in Kandara include use of pesticides that has resulted in their over-reliance control, increased cost of production and economic losses due to rejection of fruits as a result of maximum residue levels, increased pollution, health problems, (USDA-APHIS, 2008).

Poor farmer knowledge on fruit fly development in relation to host development, possible practical pest management options have resulted into over-reliance on pesticides. Earlier studies indicate that lack of training and technical support to fruit farmers has contributed immensely to low adoption of Integrated Pest Management (IPM) technologies in developing countries (Parsa *et al*., 2014). The use of insect development and reproductive behaviour such as their activity density trends in the farmland is a major step towards their successful management. Earlier studies indicated that the activity density and distribution of Tephritid fruit flies is affected by biotic factors such as temperature and humidity (Vayssières *et al.,* 2008). For example, studies carried out in Thailand, indicated that the developmental time for the immature stages of *Bactrocera carambolae* and *Bactrocera papayae* increased with decrease in temperature (Danjuma *et al.,* 2014) whereas the optimum temperature for fruitflies development has been reported to lie between 20° and 30°C for *B. dorsalis* (Rwomushana *et al.,* 2008) and between 26 and 30°C for *B. cucurbitae,*.

The purpose of this study was to determine the diversity and activity density trends of fruit flies across the agro ecological zones in Kandara from January to May 2018.

MATERIALS AND METHODS

Study site

The study was carried out in Kandara sub-County in Murang'a County in 2018. Kandara Sub County covers an area of about 236 km^2 and is located at latitude 0° 53'59.99"N and longitude 37° 00'0.00"E and an altitude of between 1520-1880 m above sea level. Kandara is composed of four agro ecological zones; Lower Highland Zone (LH1) - Tea and dairy zone, First Upper Mid-land Zone (UM1) - Coffee and tea zone, Second Upper Mid-land Zone (UM2) - Main coffee zone, Third Upper Mid-land Zone (UM3) - Marginal coffee zone (Fig 1). The average annual rainfall of the area studied ranges between 1,400 to 2,000mm and the annual mean temperature is between 18°c to 21°c (Jaetzold *et al.,* 2006).

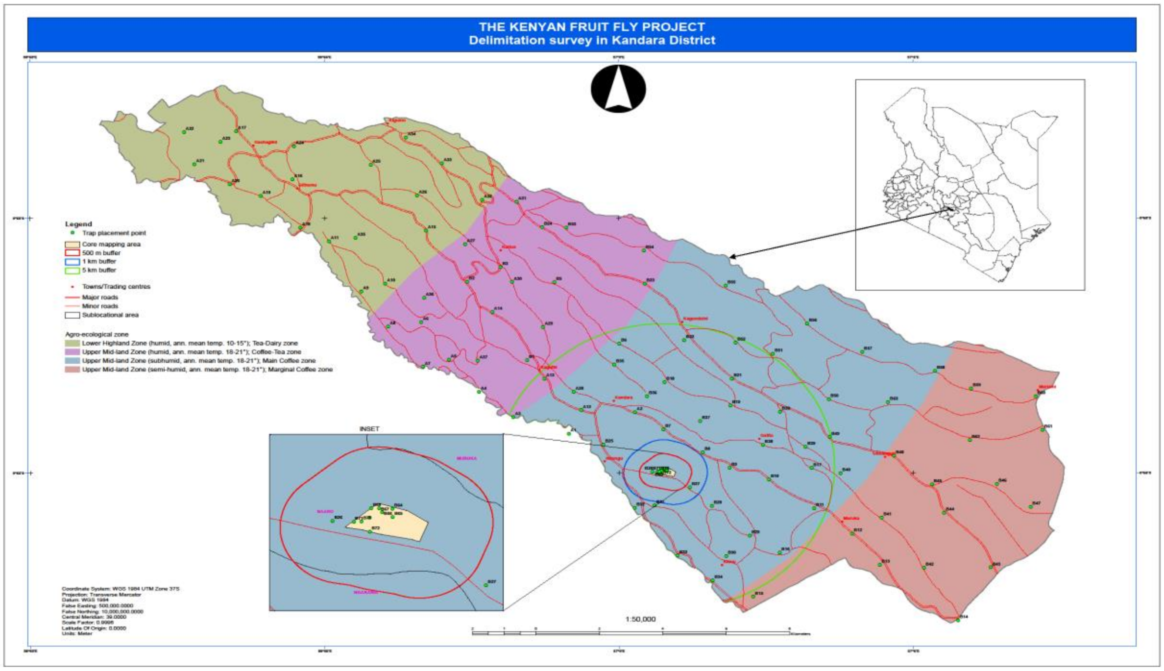

Figure 1. Map of the study sites

Data collection

Three sets of pheromone traps (Methyl-Eugenol, Cuelure and Trimedlure) were set in six trap stations within mango, avocado and guava farms in the four agro-ecological zones (LH1 (Lower Highland Zone), UM1 (Upper Mid-land Zone), UM2 (second Upper Midland Zone) and UM3 (third Upper Midland Zone) in the sub-county in 2018. Methyl –Eugenol was used to attract *Bactrocera dorsalis*, TrimediLure was used to attract *Ceratitis cosyra* and *Ceratitis capitata,* While Cuelure was used to attract both *Bactrocera cucurbitae* and *Dacus bivittatus.* Trap catch data was collected on a fortnight basis and servicing of the monitoring traps done every 6 weeks. Samples of collected trap catches were put in diffrent vials and taken to the laboratory at the Kenya Agricultural and Livestock Research Organization (KALRO) Sericulture, for further identification and counting. The ANOVA of the trap catch data was done using Genstat 17th edition*.* Significant means were separated using Fishers Protected

Least Significance Difference Test (LSD).

Results

Six species of fruit flies were identified across the four agro-ecological zones. These were *Bactrocera dorsalis Ceratitis cosyra*, *Ceratitis capitata, Bactrocera cucurbitae, Dacus bivittatus* and *Perilampsis sp.* (Table 1). A significant difference in the number *B. dorsalis* (P<0.001), *C. capitata* (P=0.042) and *Perilampsis* sp. (P=0.012) was recorded across the agro-ecological zones. However, there was no significant difference in the number of *C. cosyra* (P=0.386), *D. bivittatus* (P=0.056) and *B. cucurbitae* (P=0.061) across the agro ecologies. *Perilampsis sp* recorded the least activity density across all the agro ecologies, possibly due to low sensitivity of the lures towards this fruit fly. Generally, UM3 had the highest number of fruit flies (45.28%), followed by UM1 (24.77%), UM2 (22.40%) and the least was LH1 (7.55%). However, a significant number of *D. bivittatus* was recorded in LH1 (Table 1).

Table 1: Fruit fly densities across the agro-ecological zones.

Agro Ecology	*B. dorsalis*	*C. cosyra*	*C capitata*	*B. cucurbitae*	*D. bivittatus*	*Perilampsis sp*
LH1	3.64^{b}	17.7^{a}	27.21^{a}	4.267^{a}	7.752^{a}	0.2^{b}
UM1	65.69^{b}	41.25^{ab}	80.38^{b}	5.286^{a}	4.848^{b}	1.7905^{a}
UM2	106.9^{b}	25.54^{ab}	36.87^{c}	6.202^{a}	4.865^{b}	0.7212^{ab}
UM3	231.68^{a}	45.3^{b}	72.42^{b}	11.048^{b}	3.333^{b}	0.4762^{ab}
P value	<.001	0.386	0.042	0.061	0.056	0.012
s.e.	32.44	12.88	15.62	1.91	1.16	0.36

Abundance of *C. capitata* increased gradually from January peaking in February after which a gradual drop was recorded. In contrast, *C. cosyra* decreased gradually from January and almost flattened in April. A gradual increase in *B. dorsalis* was recorded from January to March and thereafter the population increased exponentially till the end of May (Fig 2).

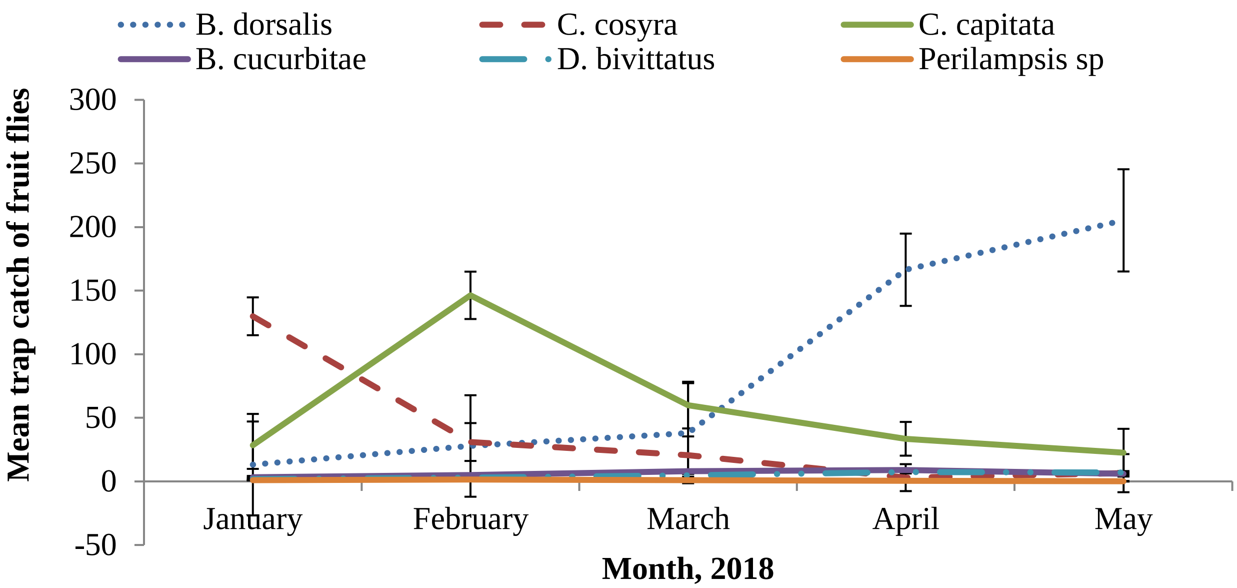

Figure 2: Fruit fly trap catch trend (Jan-May, 2018).

Discussion

Activity density of fruit flies differed across the four agro ecological zones probably due to variation in climatic conditions across the zones. The LH1, which is at a higher altitude and records lower temperatures explains why few fruit flies were recorded in this region. Further, fruit diversity is low in this zone. Temperature levels increase towards UM3 and this is likewise for fruit crop diversity and intensity of production. Previous studies on oriental fly (*B. dorsalis*) distribution in Kenya in the same area indicated that LH1 and UM1 had significantly lower pest population compared to UM2 due to cool weather LH1 (Kasina *et al.,* 2019). Earlier studies by Vayssières et al. (2008) indicated that Tephritid distribution and abundance depend on several abiotic factors (e.g., temperature, relative humidity, rainfall) and biotic factors (e.g., host plants, natural enemies). Low temperature was found to increase developmental time of immature stages of *Bactrocera carambolae* and *Bactrocera papaya* (Danjuma *et al.,* 2014) with the optimum temperature found to range between 25 and 30°C for *B. invadens* (Rwomushana *et al.,* 2008).

The difference in the level of infestation of fruit fly species across the months (January to May 2018) is associated to the availability of suitable fruits for egg laying and multiplication. In Kandara, mangoes matured between February and April while avocadoes matured from March. This ensured sufficient food supply for multiplication of the fruit flies, especially *B. dorsalis* throughout the study period. *B. dorsalis* is known to attack at least 46 host plants, including many commercially grown fruit crops such as mango, oranges, guava, cucurbit, papaya and avocado, as well as many other species indigenous to Africa (José *et al.,* 2013). Earlier studies on preferred hosts in Zimbabwe indicate that availability of cultivated and wild fruit varieties throughout the year results in increased population of fruit flies making it difficult to manage them (Musasa *et al.,* 2019). A previous review on status of data from Afrotropical countries indicated that host availability and ecological niches affected the occurrence and impact of *Z. cucurbitae* (De meyer *et al.,* 2015). Other fruit fly species are more host specific explaining why their numbers may have remained relatively low in absence of their hosts. Our results shows that abundance for the fruit flies is probably related to their preferred hostplant and the weather patterns.

Recommendations

There is need to carry out continuous monitoring of fruit flies in Kandara throughout the growing season for their timely management to reduce fruit damage and meet phytosanitary requirements. There is need to train farmers on how to use pheromone traps with specific lures to reduce the pest population. A year round fruit fly management in the farmland is the only assurance for long term reduction and control of the diverse fruit fly pest in the locality.

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