



Fruit Fly Damage on Orange (*Citrus* sp.) and Guava (*Psidium guajava* L) Fruits in Eastern Amhara, Ethiopia

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ABSTRACT

Fruit flies (Diptera: Tephritidae) are among the most important pests of fruits and vegetables in the world. In Ethiopia, orange (*Citrus* sp.) and guava (*Psidium guajava* L) production are highly impacted by fruit fly (Diptera: Tephritidae) infestation and endanger the contribution of these fruits to the national economy. This study was conducted in the orange and guava growing areas of South Wollo and Oromia administrative zone, Ethiopia. In these areas, little is known on fruit fly incidence and the extent of damage on orange and guava fruits. Therefore, the aim of this study was to assess fruit fly damage on orange and guava fruits. We measured fruit fly incidence and the extent of fruit damage in four districts of 20 fruit farms of two zones in 2016/17. Mean percent damage of orange fruits was significantly higher at Worebabo (44.4%) and Dawachefa (40.4%) than Tehulederi (34.4%) and Kalu (29.2%). Similarly, the mean number of fruit fly larvae per fruit was significantly higher at Worebabo (5.8%) and Dawachefa (5.8%) than at Tehulederi (3.5%) and Kalu (3.8%). Fruit fly caused higher guava fruit damage (33.3-66.7%) than sweet orange (29.2%-44.4%) of different districts. The severity of damage by fruit fly was high in all economically important fruits. The presence of one or more larvae in fruits results in 100% marketable losses. In conclusion the damage caused by fruit fly on both locations was significantly high and need due attention to reduce the direct losses on marketable fruits. Therefore, we recommend that timely monitoring and forecasting, as well as integrated fruit fly prevention methods should be in place.

Keywords: Diptera, fruit fly, Guava, Tephritidae and sweet orange.

INTRODUCTION

Fruit flies have become an increasingly prevalent insect in most African countries causing major losses on both domestic and export fruit consumptions (De Meyer et al., 2010). *Bactrocera invadens* was first reported in 2003 in east Africa in Kenya (Lux et al., 2003). Since 2003, the species has been rapidly spreading across tropical Africa and is now reported in Benin, Democratic Republic of Congo, Ghana, Uganda, Mali, Nigeria, Sudan, Tunisia, Togo, Guinea, and Equatorial Guinea and Comoros Island (Drew et al., 2005) and is causing severe damage in Kenya (Ekesi et al., 2006). In Central Africa (Ndzana et al., 2008) and in West Africa (Vayssières et al., 2009), this pest is also a serious threat for guava and mango production.

Lux (1999) reported that about 40% of fruits produced in Africa are lost due to fruit flies, however, infestation rates vary among countries and seasons, ranging from 5% to 100%. Different factors attribute for the level of infestation and damage by fruit flies. The ripening of fruits can

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influence the extent of damage by post-harvest diseases and insect pests (Litz, 1997). It is known that multiple fruit fly species might attack each species of fruit and the importance of the fruit fly species may differ according to the type of the fruit and the area (White & Elson-Harris, 1992). The species composition and relative abundance of fruit flies are also important factors of attacks.

In Ethiopia, fruits are mainly produced by small-scale farmers and to lesser extent by extensive state farms. Smallholders produce fruits mainly for home consumption and local markets. However, large state farms like Upper Awash Agro Industry Enterprise produce for both local and export markets. The National Horticultural Development strategies being developed have a focus on producing quality fruit for export but fruit flies are expected to be export impediments. Thus, several species of fruit plants are grown. However numerous fruit crop pests have been observed with the expansion of fruit and the status of most of these pests is not known.

The newly introduced fruit fly, *Bactrocera* spp., was reported in South Ethiopia (Azerefege et al.,

2007). In western Ethiopia, *Bactrocera invadens* was found to be the most abundant fruit fly species (67%) in the all areas followed by *Dacus bivittatus* (96%) and *Ceratitidis fasciventris* (7%) (Fikiru et al., 2018) and *B. invadens* was also predominate species (96%) on mango in Arba Minch, Southwestern Ethiopia. Fikiru et al. (2018) reported that *B. invadens*, *C. capitata* and *C. fasciventris* are the major fruit flies that cause in losses in citrus and guava in Ethiopia. Currently, fruit pests are the most important insect pests of fruit crops, mainly citrus and guava, in the enterprise and the surrounding areas (Bezawork, 2005).

Studies conducted at Upper Awash Agro Industry Enterprise showed that losses due to *Ceratitidis* spp. could reach up to 20% on mangoes (Birtukan, 2006). Massebo & Tefera (2015) reported that *B. invadens* is the predominant species (96%) at Arbaminch and southern Ethiopia and it is also the dominant species (97.5%) in North Mozambique (Jose et al., 2013).

Our Observation in fruit market and orchards showed that the major causes of postharvest loss of citrus and guava are pre-harvest infection and mechanical injury. Orange and guava fruits are important crops to eradicate poverty through income generation among rural subsistence smallholder farmers and contribute to increasing food security. However, the production of citrus and guava are affected by fruit flies. However, since it is the first study in the Northern region, there has been no assessment of citrus and guava levels of infestation and fruit damage. Therefore, the present study was conducted to assess the levels of fruit damage and infestation.

MATERIALS AND METHODS

Study area:

The study areas are located in the South Wollo and Oromia administrative zones of Amhara National Regional State, Ethiopia. The study was conducted on October, November and December of 2016/17. These two Administrative zones are the major sweet orange (*Citrus sinensis*) and guava (*Psidium guajava*) production areas in Ethiopia. Three districts from South Wollo administrative Zone (Kalu, Worebabo and Tehulderi) and one district from Oromia administrative zone (Dawachefa) were purposely selected based on orange and guava production and area coverage. The elevations of Kalu, Worebabo, Tehulderi and Dawachefa are 1442-1527 m, 1680-2512 m, 1680-2338 m and 1412-1669 m, respectively. Only one sweet orange variety, Washington navel, was found in all studied areas. However, a local guava variety was found only at Kalu district. These are zones characterized by a tropical weather with an annual mean temperature between 22° and 34°C. Papaya,

mango and banana are the common fruits in these study areas.

Fruit sampling:

Five private fruit farms were randomly selected from each district for a total of 20 fruit farms. From each fruit farm, five fruit trees were selected for a total of 100 orange trees. During the study periods, only 25 guava trees were visited because guava was found only at Kalu district. Ten ripe orange and guava fruits per tree were picked resulting in a total of 1000 and 250 sweet orange and guava fruits collected, respectively. Fruits were sorted based on whether they had visible fruit fly ovipuncture symptom on fruits.

Damaged fruits were dissected with a knife and the number of larvae was counted. Finally, undamaged fruits were taken to Wollo University plant science laboratory. The fruits were kept in an insect rearing cage and observed over a week to check the presence of larvae. A fruit was considered damaged when a fly ovipuncture was visible. For guava, the presence of larvae was checked by dissecting the fruits. Following this procedure, a fruit was considered damaged when at least one fruit fly larva was observed inside the fruit according to Vayssières et al. (2009).

The proportions of damaged fruits were calculated as follow as:

$$\text{Damaged fruits (\%)} = \frac{\text{No. of damaged fruits}}{\text{No. of damaged + undamaged fruits}} \times 100$$

Data analysis:

Data were subjected to ANOVA using 'R' soft ware.

RESULTS

Sweet orange fruit damage:

There were significant differences between districts in fruit fly damage level. Significantly higher orange fruit damage was recorded at Dawachefa district (40.3%) than Kalu district (29.2%). In Dawachefa district, orange fruit damage was recorded from five orchards. Fruit fly damage to oranges was not significantly differing between orchards. However, fruit fly caused 36-50% orange damage in all sampled orchards. Mean larval density of 3-6 per fruit was recorded (Fig. 1). In Worebabo district; the results revealed that orange fruits were substantially damaged by fruit fly (38-52%). In the same district, larval density of 3-5 per fruit was recorded. In this district, mean orange fruit damage varied from 38% (lowest) to 52% (highest) (Fig. 2). In this district, the highest orange damage (44.4%) by fruit fly was recorded as compared with other districts (Table 1).

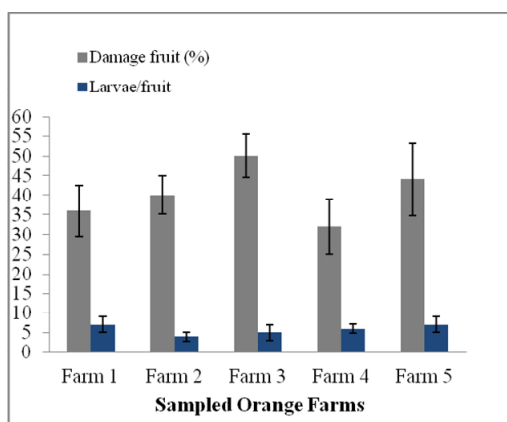


Fig. 1: Orange fruits damage (%) by fruit fly and larval density per fruit at Dawacheffa district in 2016/17

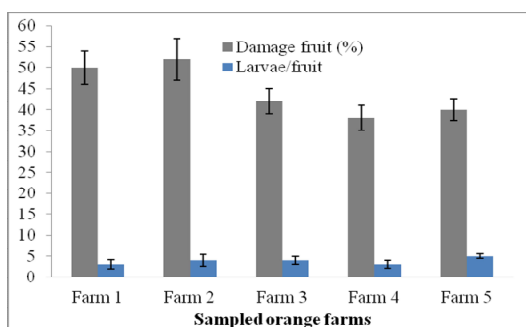


Fig. 2: Orange fruits damage (%) by fruit fly and larval density per fruit at Worebabo district in 2016/17

In Tehulderi district, similar orange fruit damage trends were recorded. Fruit fly caused orange fruit damage from 26 to 40% (Fig. 3). However, there were no significant difference to orange damage in Tehulderi (34.4%) and Kalu (29.2%) districts (Table 1).

In Kalu district, orange fruit damage of 20-38% was recorded. The highest and lowest orange fruit damage of 20% and 38% were recorded, respectively (Fig. 4). However, there were no significant orange damage differences in Tehulderi (34.4%) and Kalu (29.2%) districts (Table 1).

Guava fruit damage:

Ripe guava fruit was assessed only at Kalu during

Table 1: Mean damage orange fruit (%) and number of larvae per fruit of the four districts in 2016/17

Districts	Damage fruits (%)	Larvae/fruit
Dawacheffa	40.4±3.1a	5.8±1.3a
Worebabo	44.4±2.8a	5.8±1.3a
Kalu	29.2±3.0b	3.8±1.5ab
Tahuledri	34.4±1.9bc	3.5±1.7b

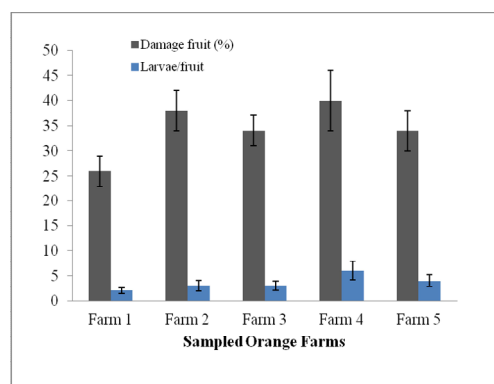


Fig. 3: Orange fruits damage (%) by fruit fly and larval density per fruit at Tehulderi district in 2016/17

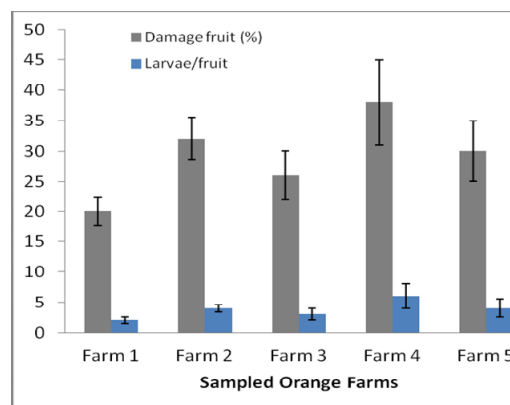


Fig. 4: Orange fruits damage (%) by fruit fly and larval density per fruit at Kalu district in 2016/17

The study period. The study showed that guava fruit damage of 33.3% - 66.6% and larval density of 4-9 per fruit were recorded (Fig. 5). In Kalu district, mean orange fruit damage of 20-38% and larval density of 2-6 larvae/fruit were recorded.

Fruit fly damage on the two fruit species significantly varied between locations. The study showed that there were significant differences

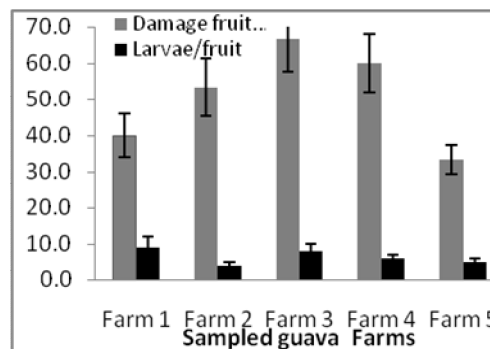


Fig. 5: Guava fruits damage (%) by fruit fly and larval density per fruit Kalu district in 2016/17

between locations in orange damages by fruit fly. Thus, high orange damage (44.4%) was recorded at Worebabo district and followed by Dawachefa district (40.4%). However, significantly low damage of orange due to fruit flies was recorded in Kalu (29.2%) and Tehulederi (34.4%) districts (Table 1). The level of infestation in Tehuledere (Jari) and Kalu (Harbu) were the low, however about 19.4% and 18.4% of the fruits were infested by larvae fruit flies, respectively (Fig. 1).

DISCUSSION

Generally, this study showed that fruit fly caused orange fruit damage of 29.2- 44.4% in all study districts of south Wollo. This study results are in agreement with Fikiru et al. (2018) that fruit flies caused high losses in citrus and guava in Ethiopia. However, the fruit types differ; Fikru et al. (2018) reported that fruit flies caused direct damage of 16.6-55.6% on mango. Adalton et al. (2004) reported that sweet oranges were the most susceptible to Tephritoidea infestations in Brazil. These results in concordance with Souza and Raga (1998) showed from unsprayed citrus orchards, the fruit dropping caused by fruit flies was estimated in 25-50%. In the central growing region of Brazil, early oranges are susceptible to tephritid infestation after they reach 50% of their full size (Souza & Raga, 1998). Currently, fruit pests are the most important insect pests of fruit crops, mainly citrus and guava, in the enterprise and the surrounding areas (Bezawork, 2005).

The damage level significantly varied between districts and the highest (44.4%) and the lowest (29.2%) damages at Worebabo and Kalu districts, respectively. Fikiru *et al.* (2018) reported that mango fruit damage varied among areas between 16.6-55.6%. Lux (1999) reported that of about 40% of fruits produced in Africa are lost due to fruit flies, however, infestation rates. Litz (1997) explained the different factors attribute for the level of infestation and damage by fruit flies. The ripening of fruits can influence the extent of damage by post-harvest diseases and insect pests (Litz, 1997). It is known that multiple fruit fly species might attack each species of fruit and the importance of the fruit fly species may differ according to the type of the fruit and the area (White & Elson-Harris, 1992). The species composition and relative abundance of fruit flies are also important factors of attacks.

In this study, guava fruits were more severely damaged (66.6%) by fruit fly at Kalu district than orange fruits (29.2-44.4%). A similar study in Mozambique showed that fruit fly caused higher damage on guava fruit (92.5%) than other fruits (Jose *et al.*, 2013). Moreover, a study in Pakistan showed that the highest level of guava fruit damage

of 92.5% were recorded due to the most abundant tephritid species (Muhammad et al., 2014).

In conclusion, the fruit fly caused 29-44% marketable losses on orange and guava fruits at South Wollo and Oromia administrative zones of Amhara Regional State. This implied that due attention should be focused timely monitoring and forecasting of fruit fly incidence, as well as integrated fruit fly prevention methods should be in place. Finally, the authors recommended that the fruit fly species complex should be identified in both locations and fruit types.

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