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Awareness of Mango Farmers at Southern Ethiopia on the Pest Status and Current Management Practices for the Control of the Fruit Flies (Diptera: Tephritidae)

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Abstract- Fruit flies generally considered as the most devastating pest of fruits and vegetables. The invasive fruit fly, Bacterocera dorsalis, expected to be introduced to Ethiopia in 2005. The awareness of mango farmers from Gamo and Wolaita districts in Ethiopia on the pest status and the current management options adopted for the control of this pest was followed by the use of a questionnaire. The survey results indicated that Ethiopian farmers rank fruit flies among the major pests of mango in Ethiopia. Farmers generally believed that it is more damaging than other insect pests of mango. Possible losses such as loss of market value and rejection of produce at the local market were also reported by the farmers. Several tactics are being adopted by farmers for the control of fruit flies in Ethiopia. These tactics include the use of insecticide, cultural control measure and, the use of trappings to manage fruit flies. Some of the respondents use a combination of insecticides and cultural practices to reduce the menace of fruit flies. It was evident that farmers adopt multiple tactics to minimize the losses due to fruit flies in an IPM fashion.

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I. Introduction

Fruit flies (Diptera: Tephritidae) are among the most important pests of fruit and vegetables worldwide. They constitute one of major threats to horticultural production, causing substantial produce losses in East, Central, and West Africa (White and Elson-Harris, 1992; Muhammad and Kiilu, 2004; ICIPE, 2007; Van Mellett *et al*., 2007). The family includes more than 5000 species worldwide, approximately 1400 species of which develop in fleshy fruits (Norrbom *et al.,* 1999). Sub-Saharan Africa is home to 915 fruit fly species from 148 genera, with 299 species evolving in either wild or cultivated hosts or in both (Ekesi, 2010). The common fruit fly species in Ethiopia are *Ceratitis fasciventries*, *Ceratitis cosyra,* and *Bactrocera invadens* (Dawit *et al.*, 2015). They cause enormous economic losses in every part of the world where fruits and vegetables are grown. Economically important tephritid fruit flies worldwide can be found in five genera: *Anestrepha, Bactrocera, Ceratiris, Rhagoletis, and Dacus (*White and Elson-Harris, 1992). The fruit fly *Ceratitis cosyra* has been long recognized as the most damaging tephritid fruit fly pest of mango (*Mangiferaindica*) in Africa, including Ghana (Lux *et al.,* 2003). However, in 2003, a new species *Bactrocera invadens* Drew *et al.* invaded Africa from the Indian subcontinent (Mwatawala *et al.,* 2004, Drew *et al.,* 2005). Within a span of few years, the species rapidly spread across Africa and was detected in Ghana in 2005 (Billah*et al.,* 2006). Mango is considered the primary host of *B. invadens* (Ekesi and Billah 2003*,* Mwatawala 2009). Yield loss of 15- 50% in mango was reported from some African countries, especially in West Africa (Vayssierres*et al.,* 2006).

Mango (*Mangiferaindica* L.) is the most widely cultivated fruit tree in the Sahel and one of the most important tree crops in the tropics (Deng and Janssen, 2004). It is a highly prized exotic fruit on the European market and one of the important fruit crops grown in tropical and sub-tropical regions (Nakasone and Paull, 1998; Nofal and Haggag, 2006). World production of mango in 2005 was estimated at 28.51 million tonnes (Mt) (Evans, 2008). Of this, Africa produced only 2.5 million tonnes, accounting for about 10 percent of fresh fruits and 11 percent of processed mango. The area coverage under mango in eastern Ethiopia has reached about 35% of the total acreage allotted for fruit production (Yeshitla, 2004). According to FAOSTAT (2010), the total cultivated area for mango in Ethiopia is not more than 12000 hectares. The highest annual production estimate in the past five years is 180,000 Mt, and more area coverage is expected in the south-western and other parts of the country due to more conducive climatic and edaphic factors.

The awareness of Ethiopian mango farmer son the pest status, and current management options for the control of this pest was studied in two districts in the Gamo and Wolaita district of Southern Ethiopia. The Objectives of this study were to assess the general awareness of mango farmers on the pest status of fruit flies and to study the management practices adopted by the farmers for the management of the pest.

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II. Materials and Methods

a) Field surveys

A field survey was conducted between October 2018 and January 2019 to establish the perception of mango farmers on the pest status and current management options for the control of *fruit flies* in Southern Ethiopia. Semi-structured questionnaires were administered to farmers selected at random, with the majority being members of the banana and mango producers. The study was conducted in two districts of Southern Ethiopia, namely the Gamo and the Wolaita, where fruit flies were previously reported as being prevalent by the Arbaminch plant protection laboratory, Ethiopia. In each district, a local Kebele was selected; Chano Mille and Chano Chalba in the Gamo and Bolloso Sore and Kindo Koyisha from Wolaita district. One hundred four (104) farmers were selected for the study, with each selected farmer having a farm size of at least 2 ha. The stratified random sampling procedure was adopted for the study so that each mango producing village in the selected local Kebele represented a stratum (sampling unit). Farmers were selected at random from each of the sampling units. Criteria for selection include the farmer being in production for at least four years. Where applicable, farmer registration to local Kebele was sought to confirm their status. This is because the level of awareness of members of the group is high due to their export disposition, which ensures the adoption of reasonably fair technologies that will guarantee the production of high-quality fruits. Local Kebele officials, therefore, assisted in the selection of most of the sampling units. Questions in the questionnaire were premised on finding information on pest problems commonly encountered by farmers in mango fruit production as well as finding the major and minor pests. Questions were also asked relating to the awareness of fruit flies, their species composition, and the nature of the damage caused by fruit flies.

Farmers were also asked to rate the effect of fruit fly on fruit production relative to other arthropod pests commonly encountered in the mango agro-ecosystem. Question relating to knowledge of the economic significance of the species with regards to it being a quarantine pest, and the losses it could cause in the mango industry were asked in the questionnaires. They were requested to indicate whether fruit flies were an exotic, endemic, and/ or occasional pest. The concluding aspect of the questionnaire dealt with matters relating to management options adopted by farmers.

b) Data analysis

All data generated from the field survey (questionnaire) were analyzed using descriptive statistics (percentages).

III. Results

a) Awareness of mango farmers on the pest status of fruit flies

Results from the survey questionnaire indicated that all the respondents (100%) have encountered some sort of pest problem at a point in their career as mango producers. Several insect pests were listed by the respondents as being pests in mango in Ethiopia. The insect pests mentioned by the farmers grouped under two set, namely major and minor pests (Table 1). Farmers categorized pests as being major mostly based on the length of time they spend dealing with them on their farms over the production period and the extent of intervention required in terms of monetary values. Few 8 (7.69%) of the farmers were thought that scale insects and thrips were of major concern in the mango plantation. The majority of the respondents 80 (76.9%) indicated that fruit flies were of major economic importance causing damage that can lead to the production of unmarketable fruits. The second in order of significance as a major pest to 78 respondents (75.0%) were the mealy bugs. This proportion of farmers believed that, mealy bags caused a lot of problems leading to yield reduction in the mango enterprise. They were fully aware of fruit flies being pest of economic significance. However, some farmers simply dismissed fruit flies as houseflies that are just opportunistic and taking advantage of the abundant food (rotting) found at the peak period of harvest. To this group, no harm was done to the fruit as the result of their presence. Similarly, 76 of the respondents (73%) also indicated mango stone weevils as being major pests that caused a significant reduction in fruit quality.

Table 1: Insect pests faced by farmers on mango farms

Name of insect (n=104)	Percentage (%)
Major	
Fruit flies	76.90
Mealy bugs	75.00
Stone weevil	36.50
Scale insects	7.69
Termites	2.80
Minor	
Fruit flies	3.80
Grasshopper	8.80
Mites	4.70
Ants	22.8

Few farmers cited termites (2.8%) and ants (27.2%) as pests of major economic importance that required some attention during and even after the production cycle. Insect pests indicated as minor pests by the respondents during the survey included fruit flies (3.8%), grasshoppers (8.8%), mites (4.7%) and ants (22.8%).

b) Fruit fly species are known to the farmers

Four fruit flies species were known to the farmers in the study area. These species were *Ceratitis cosyra, C. fasciventries, Bacterocera cucurbitae* and *B. invadens.* Forty-eight percent (68.1%) of the farmers indicated that they knew some species of fruit flies: of these, 39.2 % attested to knowing *C. cosyra* and 18.8% to *B. invadens*. This is an indication that a reasonable number of the farmers are already aware of the presence of the African invader fly relative to other species in spite of its recent introduction and establishment in Ethiopia.

In addition to insect pests, farmers mentioned some diseases which affect the productivity and quality of their mango product. The measure diseases they mentioned include anthracnose die back, and root rot are the measure one. They mentioned that anthracnose affects the leaf, flower, and the immature fruits, and the mature fruit loses quality.

c) Types of damage caused by fruit flies

The perceptions of farmers on the types of damage caused by fruit flies also vary significantly (Fig. 1). About 45.0% of them mentioned fruit destruction as one of the damage caused by the fruit flies. Some 27.4% of the farmers believed that, the fruit flies pierced the skin of the fruit and lay the egg and the egg changed in to larvae. Others (11.2%), indicated that the species caused fruit rottening, while 5.5% of the farmers indicated that a change in colour resulted from the attack by the fruit fly, and this led to premature ripening of the fruit. Total loss in yield is the direct effect of the presence of mango fruit fly in the mango production to some respondents (2.6 %), because the flies caused total destruction of the fruit leading to complete loss of yield in the absence of some intervention measures to control them.

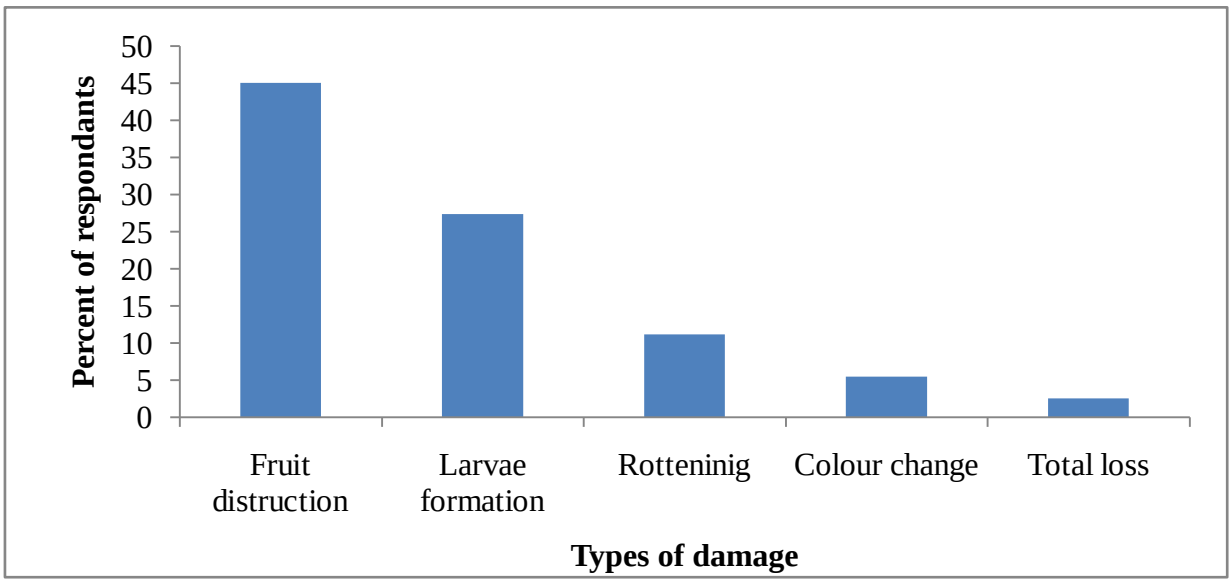

Figure 1: Percentage of respondents on types of damage on mango fruit due to fruit flies (n= 104).

d) Effects of fruit flies on fruit production

Generally, majority of the farmers (67.5%) are of the opinion that, the fruit flies caused very severe damage to the mango production. This implies that mango producers in Ethiopia are aware that, the fruit flies can cause serious damage to their crops with detrimental consequences to their incomes. On the rating of the mango fruit flies relative to other pests in the mango plantation, 70.0 % of the respondents indicated that the flies were more damaging to their fruit. Thus, mango farmers are aware of the threat posed by the fruit flies to the mango production.

e) Losses caused by the fruit flies

A greater number of the respondents (76.2%) revealed that, the presence of the fruit flies in Ethiopia causes some massive losses to farmers. These losses (fig. 2) ranged from a loss of market value (64.1%), loss in quality of the fruits (71.3%), rejection of fruits at local markets (49.1%), and increase in the cost of production (7.7%).

f) Pest status of fruit flies

Responding to the question on the pest status of the fruit flies, 28.4% of the respondents believed that the pest was a common one i.e., it has been in the system since they started the mango fruit production. On the other hand, 58.5% of the farmers said it was an unusual pest that found itself unto the country's landscape some ten years ago. Similarly, some 14.6% of the respondents firmly believed that it was an occasional pest occurring only when there was excess fruit in the area. About 36.9% of the farmers indicated that the pest was associated with newly introduced improved mango varieties.

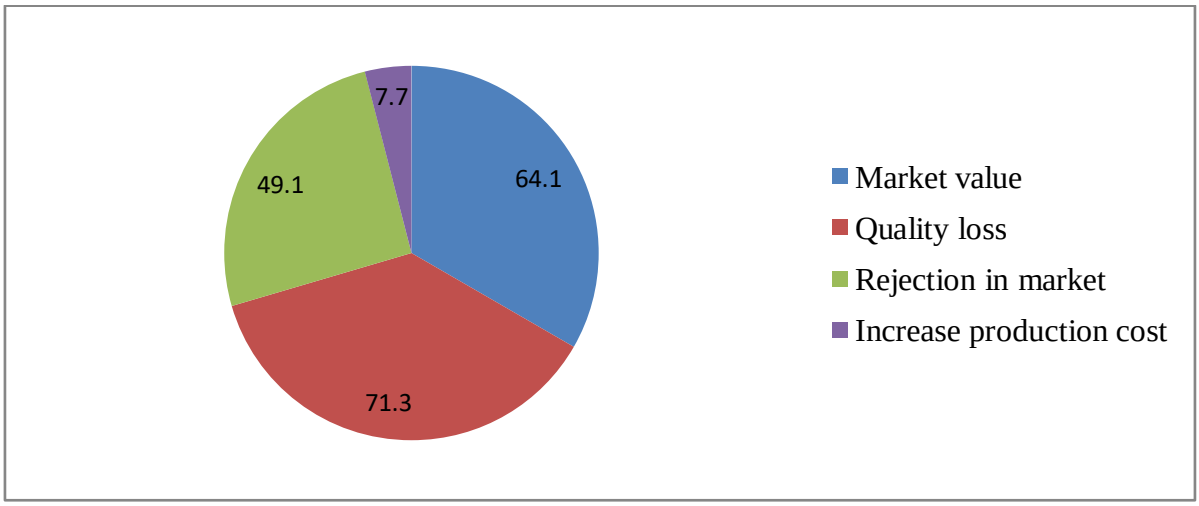

Figure 2: Response on nature of losses experienced by mango farmers (n=104)

g) Management strategies implementing by Ethiopian farmers to control fruit flies

Most of the respondents have used one control measure or the other to reduce the effects of fruit flies in their effort to produce fruit that will meet the needs of their customers. Two control methods, namely chemical and cultural, were dominant among all the respondents (fig. 3). Some 11.5% of the farmers apply chemicals as either a single control method or together with one or more other control measure(s). Similarly, (76.9%) of the farmers adopted cultural control measures e. g. fallen fruit destruction, branch pruning, and farm sanitation to control the fly. All the respondents were oblivious of any careful use of resistant varieties for the management of the fruit flies in Ethiopia. They generally believed that no variety of mango was in any way resistant to the attack of the pest and hence the use of host-plant resistance as means of controlling would be ineffective for all practical commercial purposes. Some 28.5% (from Gamo district) of the farmers showed to the use of trapping for the reduction of the male fruit flies numbers. Many NGO's and Arbaminch plant health clinics work on the management of fruit flies in the Gamo area, and they providing a lure trap to minimize the male population. A significant number (56.9%) used insecticides, and traps, in combination on their farms to combat the menace of fruit flies. Similarly (46.5%) used insecticides alongside cultural practices like collection and burial of fallen fruits to maintain better sanitary conditions on their farms. This in essence, has the advantage of reducing the source of the infestation. Some farmers (72.3%) used a combination of insecticides, traps and cultural methods for the fruit flies control (fig. 3).

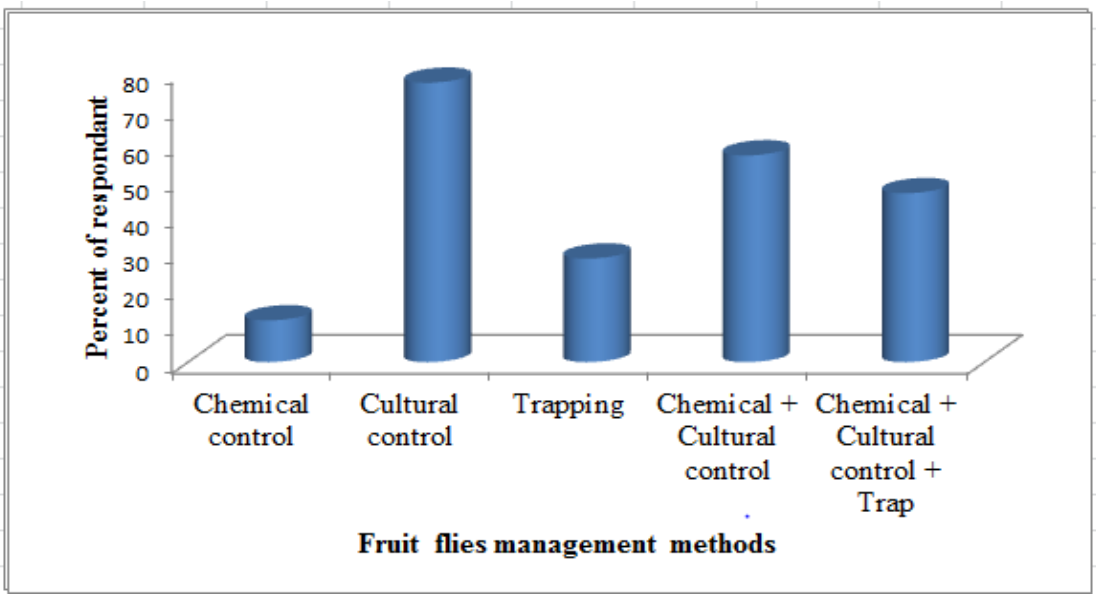

Figure 3: Percentage adoption of different management methods by farmers to control fruit flies in the study area (n=104).

IV. Discussion

Farmer Perceptions of pest status and Management option for fruit flies control

The results of the survey indicated that mango farmers rank fruit flies among the major pests of mango in Sothern Ethiopia (Table 1). This is an indication that Ethiopian mango farmers are already aware of the potential damage of the mango-infesting fruit flies. This confirms Vayssieres *et al*., (2005) observation that losses caused by fruit flies range from 12- 50% for mangos in Benin, depending on the season and management practices adopted. Thus, fruit flies inflict heavy losses on fruits and vegetable crops because of their phytophagous habits (Norrbom *et al*., 1999). Activities by different fruit fly species lead to these loses and vary between fruit fly species, fruit hosts involved, and between communities. Thus, they are accorded different economic statuses in different farming systems in the world (Mwatawala *et al*., 2009). This knowledge could have been gained as a result of curiosity on the part of the farmers trying to know the identity of flies they see most often or through contact with extension workers and some NGOs in their area. Several strategies are being adopted by farmers for the control of fruit flies in Ethiopia. These strategies include the use of insecticides (11.5%), cultural control measures (76.9%), and use of trappings (28.5%) as strategies to manage fruit flies. While46.5% of the respondents use a combination of insecticide, and cultural practices to reduce the threat of fruit flies. It was evident that farmers adopt multiple strategies to minimize the losses due to fruit flies in an IPM fashion outlined by Ekesi and Billah (2006) and Obeng-Ofori (2007). There is the need, therefore to carefully study how these practices are carried out by farmers and improvement made upon them where necessary to enhance their effectiveness in fruit fly suppression. Mango is one of the most important tropical fruit crops grown worldwide. Its demand and cultivation are also on the increase worldwide. In the Gamo district, it is the second income generation and providing employment opportunity to a large number of population to the banana. Mango production is also aimed at increasing the food security of the nation by providing suitable fruit that is rich in many of the nutrients required for the proper nourishment of the body. One of the major constraints to the production of this important crop is the attack by arthropod pests, among which the fruit flies and white mango scale are most destructive. Fruit flies generally believed to cause yield losses of up to 30-80% in East Africa and also ranks high among the quarantine pest of fruit and vegetable crops worldwide.

The awareness of Ethiopian farmers of the pest status and current management options for the control of this pest was studied in two districts in the Gamo and Wolaita of Southern Ethiopia. It was found that fruit flies are a major pest infesting mango in Ethiopia. The study also showed that farmers are already aware of the tremendous yield and other losses that can be incurred due to the activities of the pest. Their quarantine status was found to be clearly understood by some farmers. Management methods such as the use of insecticides, cultural control (e.g., destruction of fallen fruits), trapping alone or in various combinations in an IPM approach, are practiced against the pest by farmers in the study area.

V. Recommendations

The results of this survey indicate that there is an information gap between on mango producers in pest status and management strategies on mango insect pests and diseases. Some farmers have do not know fruit flies. Therefore, there are needs of aggressive public advocacy by extension workers, NGOs and other responsible organizations to increase farmer's awareness of fruit flies species and their effect on fruit production. There is the need to study the rate of infestation of fruit flies in farmers' field, to confirm whether there is a displacement of the indigenous species of fruit flies and to check the presence of natural enemies in the mango agro-ecosystem. This will curtail the development of new pest spectrum in other fruit and vegetable crops that may arise from host switching by those displaced species. This will also have implications for control strategies aimed at fruit fly management.

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