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Mango Fruit Loss at Field by Major Pests in South-western Ethiopia

Sisay Kidanu*, Wakjira Getachew, Tamiru Shimales

Ethiopian Institute of Agricultural Research, Jimma Agricultural Research, P. O. Box 192, Jimma, Ethiopia

ABSTRACT

Mango production is facing many challenges of which pests are the major. A study was done in 2019/20 at the potential mango production areas of Southwestern Ethiopia to assess production experiences and magnitude of losses of mango fruits caused by mango pests at the farm level. A total of 80 mango producers farms were sampled and fruit damage symptom and sign determination was conducted at fields using hand magnifying lens and colored pictorial manual. Result revealed most farmers had knowledge about white mango scale, fruit fly and grivet monkey. About 90% of the respondents of Didessa and 80% of Metu and Gumay districts mentioned white mango scale as the dominant pest. In Nopha and Gomma, 60 and 80% ranked grivet monkey for their mango fruit loss. There was statistically significant ($\chi 2$ = 17.71) differences between districts for pest management training. Mango fruits losses was 1.67 to 50.76% by fruit fly (mean 13.5%), white mango scale caused null to 78.50% (mean 49.13%) and monkey, 4.22 to 19.64% (mean 10.7%). Due to the growth of supermarkets and the demands from consumers and buyers require giving more attention on reduction of losses, the need for pest management.

Keywords: Fruit fly; Fruits losses; Mango producers; Grivet monkey; White mango scale

INTRODUCTION

Mango (*Mangifera indica L.)* is the third most important fruit crop in the tropics after citrus *(Citrus spp.)* and banana *(Musa spp.)* [1]. It is consumed as a fresh fruit and as other kinds of preparations for its high contents of sugar, protein, fats, salts and most of the vitamin types, among others [2-4]. Mango is known as the king of the fruits due to its excellent flavor, delicious taste and high nutritive values [5] that makes the crop valued for both food and nutritional security especially for developing countries like Ethiopia where the realization of food and nutritional security is still a challenge.

Mango is one of the most widely grown among the fruit crops cultivated in Ethiopia preceded only by banana in terms of economic importance [6]. In Ethiopia, upper Awash, Assossa zone and South western parts are some of the areas where the bulk of this production comes from. A total of 69,743.39 tons of mango is produced from 12,799 ha of land [7].

Losses in quantity and quality or post-harvest losses occur after harvest at different points in the handling chain [8]. Yellowing and weight loss which represent loss in marketable weight are the othernature of losses. The high incidence of decay mainly in the form of anthracnose and pests can be attributed to the high level of pre-harvest infection due to improper pest management during production [8].

Mango tree is attacked by different insectsof whit mango scale and fruit fly is the serious. White mango scale insect is a serious pest that injures mangoes by feeding on the plant, branches and fruits, causing defoliation, drying up of young twigs, poor blossoming. These injures so affecting the commercial value of fruits and their export potential especially to late cultivars where it causes conspicuous pink blemishes around the feeding sites of the scales [9]. The build-up of the scale population coincides with the physiological maturity of mango fruit, both happening at the beginning of the rainy season which is the maturation and ripening of mango fruit begin during the first months of rainy season that is, in March to April and continues for few months [10]. Previous study indicated significant differences in infestations between ripe and green ripe fruits irrespective of the varieties [11]. Female fruit flies puncture the pericarp and lay their eggs under the skin of mango fruit. Then, the eggs hatch into larvae which feed on the decaying flesh of the fruit. Infested fruits rot quickly causing considerable losses [12] and causes up to 80 percent yield loss in mango production [13]. Grivet monkeys are extremely adaptable and can live in both rural and urban environments. They are persecuted as crop pests [14,15] and the expansion of agricultural activities has intensified the conflict between grivets and humans [16]. Crop loss due to wild mammals' in 2007/2008 harvest year was 26.78% and among the faecal samples of grivet monkeys, 34.28% had the seeds of citrus fruits [17]. The control of this pest

Correspondence to: Sisay Kidanu, Ethiopian Institute of Agricultural Research, Jimma Agricultural Research, P. O. Box 192, Jimma, Ethiopia, Tel: + 0913367466; E-mail: ksisay32@gmail.com

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at the destructive larval stage is difficult because insecticides in form of dust or sprays cannot reach them and the ways to deal with them is to target adult flies before they start laying eggs by trapping them [12]. In Ethiopia the efficacy of Success Bait (GF-120 Naturalyte Fruit Fly Bait) was reduced the population density of the adult fruit fly the first application reduced the catches from 18 to less than eight flies per trap whereas at the end of the fourth application only two flies were caught per trap on the average [18]. The integrated use of the systemic soil drenching insecticide and tree management can significantly reduce the white mango scale life stages on infested mango trees indicating that it is a promising approach to the control the scale [19].

One of the major constraints upon establishing effective pest management approaches for smallholder mango farmers is the lack of adequate information about farmers' knowledge, perceptions, practices in pest management and determination of yield losses. Assessing farmers knowledge and pest management strategies for the control of these pests is critically important for setting a research agenda, designing extension strategies, and formulating research that meets farmers demands. Unless these losses are minimized, the gains from production will be offset and potential income cannot be realized. Understanding farmers' socio economic factors, their knowledge and perceptions, their current management practices and potential constraints of the post harvest insect pest control are critical steps towards developing sustainable integrated management strategies. Therefore, the aim of this study was to understand farmers socio characteristics and assess the losses of matured mango fruits inthe farmers fields caused by white mango scale, fruit fly and grivet monkey.

MATERIALS AND METHODS

Description of the study areas

A survey of mango farms was conducted in the major mango producing areas of Southwestern Ethiopia to gather information on farmers' mango production experiences, mango fruits fallen and loss in the fields. The study districts agro-ecological characteristics were summarized in Table 1.

Sampling Procedures and data collections

A survey was conducted immediately after harvesting to asses mango fruits losses in Southwestern Ethiopia. A three stage purposive stratified technique was used for data collection. Maximum care was, therefore, taken to assess potential production areas, though we were constrained by time of the survey. The survey covered three major mango producing zones in Southwestern part of Ethiopia; namely, Jimma, Buno Bedelle and Ilu Ababora. In the next stage, sample districts were selected purposively based on mango production potentials. From Jimma zone (Gomma, Gumay and Seka Chokorsa districts), from Buno Bedelle (Gechi, Bedelle and Didessa districts) from Ilu Ababora zones (Nopha, Metu and Yayo districts) were selected. A total of 80 farmers were interviewed, for socioeconomic data, by considering slightly more representation for the Southwest part of mango producer farmers' fields, selection of peasant associations was made together with districts agricultural experts.

Sampling procedures for mango fruits loss due to pests

In each farm, five points were considered when sampling, one at each of the four corners under the tree and the centre near the base of the tree. Totally, 10-20 fallen fruits were sampled based on availability. Under the tree the sampled fruits were visually examined and the maggots start feeding inside the fruit pulp and causes internal discoloration emits off flavours, pulp rotting by fruit fly and severe decayed fruits due to white mango scale insect pests, fruits eaten by grivet monkey using magnifying lens. It was therefore possible to collect primary data on the amount of mangoes rejected by consumers/buyers in the farms due to invertebrates' and vertebrate pests' damage. The percentage of mango fruits losses were estimated by taking the ratio of the total quantity of fallen sampled fruits by white mango scale, fruit fly and monkey to the actual total number of fallen sampled fruits in the farm.

Mango fruits loss due to white mango scale insect pest (WMS) was calculated with the formula

$$\text{Percent of mango fruit loss(WMS)} = \frac{(\text{No of fruits damaged and fallen by WMS})}{\text{Total number of sampled fruits}} * 100$$

Mango fruits loss due to fruit fly insect pest (FF) was calculated with the formula

$$\text{Percent of mango fruit loss(FF)} = \frac{(\text{No of fruits damaged and fallen by fruit fly})}{\text{Total number of sampled fruits}} * 100$$

Percent of mango fruits loss due to grivet monkey was calculated as

$$\text{Percent of mango fruit loss monkey} = \frac{(\text{No of fruits damaged and fallen by Monkey})}{\text{Total number of sampled fruits}} * 100$$

Data analysis

The survey data were summarized and descriptive statistics (means and percentages) were calculated and analyzed using Statistical Package for Social Science (SPSS) version 20.0 software. Comparative statistical tools including chi square was used to compare the differences of demographic and socio-related data

Table 1: List of surveyed zones, districts, their coordinates and altitudes.

Zones	Districts	Latitude (N)	Longitudes (E)	Altitudes (m)
Jimma	Gomma	7°4937-7°5050	36°3537-36°3552	1596-1695
	Seka Chokorsa	7°2925-7°3183	36°2398-36°2909	1461-1790
	Gumay	8°0002	36°2936	1689
Buno Bedelle	Bedelle	8°82702-8°82704	36°2030-36°2031	1984 -1998
	Didessa	8°3943	36°2321	1454
	Gechi	8°1956-8°1960	36°457-36°5202	2036-2044
Ilu Ababora	Metu	7°5251-8°1923	35°2904-35°3525	1558-1780
	Nopha	8°2630 -8°2457	35°3716-35°3628	1492-1709
	Yayo	8°2134-8°2337	35°4742-35°5241	1350-1488

on mango fruits loss and pest management practices of producers among the surveyed districts.

RESULTS AND DISCUSSION

Demographic profile of surveyed mango producers

Among the interviewed farmers, the majorities were male (85.2%) in Jimma, this was also the case in both Buno Bedelle (78.3%) and Ilu Ababora (53.3%) zones (Figure 1A). This indicates that men dominated mango production activities in Southwestern Ethiopia and women run mango farming inherited, when their husband deceased as the farmers responded. This unequal representation could be explained due to the general view of mango is a man work and females are mainly engaged in food crops such as haricot beans, enset, maize and children care as interviewed farmers perceived. In the central and eastern Kenya, from the total number of participants intended to be interviewed (n=75), about 59% of mango producers were male [20].

Farmers had experienced mango production for a number of years in southwestern Ethiopia. In Jimma zone 66.7% of the respondents experienced for 10-30 years and about 22.2% for more than 30 years of mango production (Figure 1B). Similarly, in Ilu Ababora zone, 50% of the respondents experienced between 10-30 years and only 16.3% produced mango for more than 30 years. On the other hand, mango producers in Buno Bedelle zone, most of them (65.2%) experienced for less than ten years and only 13.1% produced for more than 30 years (Figure 1B).

Butynski TM, et al. [15] reported as information obtained from the respondents indicated that mango production was a common farming practice in Kiambu, Machakos and Murang'a countries in central and eastern Kenya. Sixteen percent of respondents responded that mango production started before 40 years, 20% said 31-40 years ago, and 19% responded between 21 and 30 years back. About 23% of the total respondents said they experienced mango production since the last 20 years, while about 22% claimed their experience in mango production was below 10 years.

Results showed that the respondents interviewed in the Southwestern mango growing region of Ethiopia possessed knowledge of the insect pests infesting their mango fruit, mentioning two insect pests, namely, the white mango scale and fruit fly and from vertebrate 'Grivet monkey'. Of these pests, the white mango scale and grivet monkey were the most commonly mentioned pests of mango fruitsin surveyed districts including personal observation. According to this survey most farmers in Southwestern of Ethiopia had knowledge about white mango scale, fruit fly and monkey; they could identify them mainly during the maturation of fruit and ready for harvest. A study revealed that about 90% of the respondents of Didessa and 80% of Metu and Gumay districts were mentioned white mango scale was the dominant pest respectively (Table 2). According to Butynski TM, et al. [15] reports from 20 localities of the 15 districts surveyed for white mango scale in western Ethiopia, 13 localities found in 11 districts were confirmed to have been infested by white mango scale. In Nopha and Gomma districts 60 and 80% ranked Monkey for their mango fruit loss respectively where as mango fruit fly was in Seka Chokorsa (Table 2). There was statistically significant ($\chi 2$ = 17.71) difference between districts in opportunity to mango fruit pest management training in Southwestern part of Ethiopia. Sofar, mango farmers had not access to mango fruit pest management

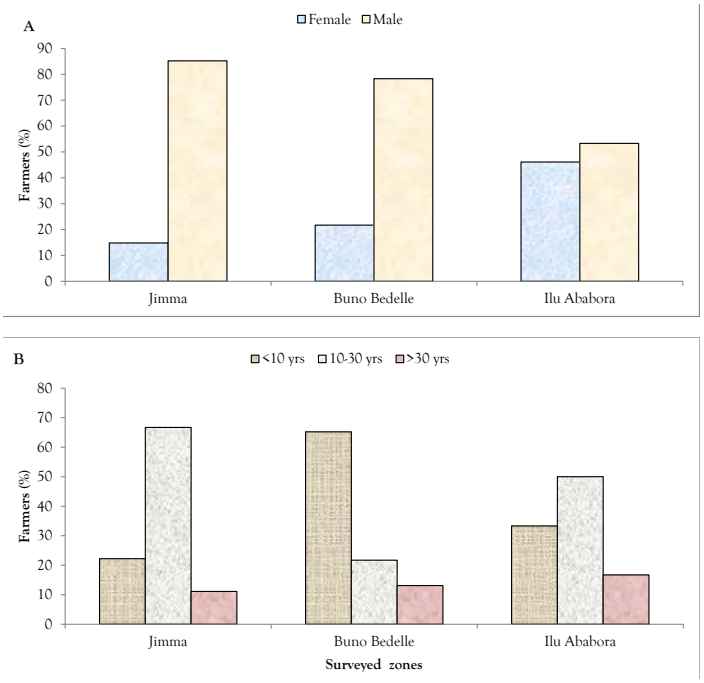

Figure 1: Sex status. A) Production experiences and B) interviewed farmers of mango.

trainingexcept 20% at Bedelle and Gomma and 25% at Gechi district (Table 2).

Mango fruits losses in the fields

Percent of mango fruits losses by pest in the field : A study conducted in 2019/20 showed, various percentage of damaged fruits were left in the field by pests. This was mainly in the form of decay or deteriorates which can be attributed to the high level of pre-harvest infestation due to improper pest management during production. White mango scale is one of the major insect pest which is responsible for mango yield loss. In this study it caused ranged of null (Seka Chokorsa) to 78.50% (Didessa) district with total mean of 49.13% (Table 3). In addition, during the assessment different percent of mango fruits losses caused by fruit fly was ranged from 1.67 (Gechi) to 50.76% (Seka Chokorsa) with a total mean of 13.5% (Table 3). A study in Kenya indicated that the average percentage loss of mango fruit due to fruit fly infestation via rejections at the farm was 24%, with some farmers reporting higher losses of up to 60% [12].

On the other hand, Monkey, a vertebrate pest caused about a range of 4.22 (Metu) to 19.64% (Nopha) district with an average of 10.7% at the surveyed districts of Southwestern Ethiopia (Table 3). At Nopha, mango trees were very huge and their branches were dense this might be suitable for monkey to feed fruits without seeing by the farm owner, as hiding purpose. Previous study showed, 90.2% respondents ranked Grivet monkey as one of the major and widely distributed pest mammals in the largest and mostly dense forest covered Peninsula of Zegie along lake Tana of Ethiopia [17]. In our study, the overall mean percent of damaged fruits and left in the field due to fruit fly, white mango scale and grivet monkey was between 16.76 to 31.61% (Table 3) (Figure 2).

According to Tesfaye H, et al. [9], farmers in east Wollega zone of Western Ethiopia were harvest up to 10 quintals of mango fruits per tree before the occurrence of white mango scale insect pest. However, in the current condition 2-3 quintals per single tree was obtained, due to the heavy infestation of this insect pest [9].

Table 2: Farmers response to dominant pests and access to mango pest control training.

Variables	Surveyed Locations									χ^2
	Nopha	Metu	Yayo	Bedele	Gechi	Didessa	Gumay	Goma	Seka	
Pests Mentioned as Dominant										218.8***
WMS	26.7	80	40	60	75	90	80	0	0	
Fruit fly	0	0	0	40	25	0	0	0	100	
Monkey	60	20	50	0	0	10	20	80	0	
WMS, Fruit fly	13.3	0	0	0	0	0	0	20	0	
Fruit fly, Monkey	0	0	10	0	0	0	0	0	0	
Pest Management Training										17.71*
Had access	0	0	0	20	25	0	0	20	0	
Not access	100	100	100	80	75	100	100	80	100	

Hint: WMS=White Mango Scale, statistically significant * at p<0.05, **p<0.01, ***p<0.001; NS = Not Significant

Table 3: Mango fruits fallen and left due to major pests in the field under the tree.

Districts	Mango Fruits Loss in the Farm			Mean
	Fruit Fly	White Mango Scale	Grivet Monkey	
Nopha	19.73	28.82	19.64	22.73
Metu	2.22	51.28	4.22	19.24
Yayo	3.33	35.83	11.11	16.76
Gechi	1.67	49.88	8.75	20.10
Bedelle	2.30	74.00	11.11	29.14
Didessa	2.50	78.50	6.50	29.17
Gumay	22.00	59.16	13.67	31.61
Gomma	17.03	64.68	10.83	30.85
Seka Chokorsa	50.76	0.00	10.49	20.42
Mean	13.50	49.13	10.70	24.45

Figure 2: Fallen mango fruits sampling during the study.

Fita T [6] reported that in Western Ethiopia; at Diga and Gimbi district mango fruit yield reduced from 2.88 and 2.57 to 0.56 and 0.49 quintals after infested by white mango scale respectively. Similarly at Guto Gida yields reduced from 2.96 to 1.84 due to this insect pest. Fruits harvested at ripe stages had higher levels of infestations compared to those harvested at green stage. The pest dispersed to old cultivar of the local farmers at an alarming rate and, a recent study by Fita T [6] and Tesfaye H, et al. [9] showed that mango white scale in Wollega area makes the whole mango farm out of production within short period of time. On the other hand, according to Tadesse F [21] based on interviews conducted in Ethiopia reported a very wide range of estimates of postharvest losses of mango is 26.3% in the country.

CONCLUSION

Pests are important biotic factors that cause significant damage on mango fruits which results yield losses. In the surveyed areas, white mango scale, fruit fly and monkey were regarded as the three important major pests of mango fruits in the farmers' fields. In

this study, it is possible see different level of mango fruit losses due to these pests in the farms of Southwestern Ethiopia. The increasing demand of consumers for mango initiates the need to reduce the high level of losses and so as the future direction the need for identifying the main factors that determine the buildup and peak season of these pests is very important and this will be assist in designing control strategy. Besides, it was understood that integration different pest management methods rather than unitary tactics could be used in the mango producers' farm to achieve better protection of fruits losses against pests.

DECLARATION

Declarations Author contribution statement

Sisay Kidanu: Conceived and designed the experiments; conducted the survey; analyzed and interpreted the data; wrote the paper.

Wakjira Getachew: Conceived and designed the experiments; conducted the survey; analyzed and interpreted the data; wrote the paper.

Tamiru Shimales: Conceived and designed the experiments; conducted the survey; analyzed and interpreted the data; wrote the paper.

Declaration of interest statement

The authors declare no conflict of interest.

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