

Full Length Research Paper

Survey on distribution and significance of White Mango scale (*Aulacaspis tubercularis*) in Bench-Maji Zone, Southwest Ethiopia

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This research was initiated following the outbreak of *Aulacaspis tubercularis* in bench Maji zone with the objective to assess information about occurrence and extent of pest infestation and distribution. Informal survey was conducted first to have a better insight and identify the major pest infested areas. Accordingly, three infested Kebeles namely, Otowa chole, Kuja and Berji in Guraferda woreda were purposefully selected. Among the three districts; only the farmers in Otowa Chole were interviewed about the case. A total of 45 respondents were interviewed using semi-structured questionnaires. For rating infestation level over season five mango trees were randomly selected and marked in the each Kebele. Ten leaves were randomly picked from each tree for counting the clusters of white scales formed on leaves using magnifying lens. The data collected on periodic field inspection and farmers interview were subjected to statistical analysis using SAS and SPSS software, respectively. The survey result indicated that the newly emerged pest was spread from its original infestation area to some mango growing neighboring districts and caused a significant yield reduction in mango plant. The survey also indicated that no significant control method was practiced by the farmers. Rate of infestation was influenced by interaction effect of Kebele and season. Status of pest infestation in each kebele over season showed that rate of pest infestation varied from moderate to severe. However, both the magnitude and pattern of pest infestations were not the same at all Kebeles and season. Due to poor quarantine system in the country the pest is aggressively invading the major mango producing areas of the Zone. Thus, identification of effective bio-control agents that is environmentally safe and cost effective method is highly recommended as sustainable solution to save the whole mango loss from the country.

Key words: Mango, *Aulacaspis tubercularis*, assessment, infestation.

INTRODUCTION

Mango (*Mangifera indica*) is a tropical evergreen tree native to the Indian subcontinent, more likely in the Burma-Malaysia region. The world production of mango is estimated at over 45.22 million tones, with a production

area of 5.64 million hectares. The average yield per hectare is 8 tones (FAOSTAT, 2014). In Ethiopia, upper Awash, Assossa zone and south western parts are some of the areas where the bulk of this production comes from.

Mango is the most popular fruit of tropical regions. Ripe fruits are eaten for dessert, candid or used for making juices, jams and other preserves. Nationally, the total cultivated area with mango is amounted by 15,691 ha, produced about 94,493 ton per annum and by average 6.02 ton per hectare (FAOSTAT, 2014). The yield reported at national level is far below the level realized at global level. Several factors are responsible for this; among which disease and pest problems are put in the top list. Beetles, Tephritid fruit flies and mango seed weevil are the major insect pests of mango recorded in Ethiopia until recently (Temesgen, 2014; Tsedeke; 1994, Ferdu et al., 2006).

White mango scale, *Aulacaspis tubercularis* is one of agriculturally important insect pest belongs to order Hemiptera and characterized by having a piercing and sucking mouth part and hence, it injures mango tree by feeding on the plant sap through leaves, branches and fruits. Recently, it became a serious pest on mango in all mango orchards in many countries. For instance, Abo-Shanab (2012) reported that this pest was a significant problem on mangoes in Egypt. Similar pest problems are evident in South Africa, Pakistan and Australia (Khan et al., 2016a, b; Pena et al., 1997; Joubert et al., 2000a). Previously it has not been recorded as pest of mango in Ethiopia; however, exact damage on mango tree by a new insect was observed in some part of western and Eastern Ethiopia (Mohammed et al., 2012; Temesgan, 2014; Tesfaye et al., 2014; Gashawbeza et al., 2015). Nationally, yields of mango since 2010 have showed a decreasing trend. For example, yield per hectare of mango in 2014 (6.02 t ha^{-1}) was decreased by 2.72 ton compared with the yield reported in 2010 (8.74 t ha^{-1}). This could be associated with the outbreak of white mango scale in Ethiopia in 2010.

In 2001 and 2002, a private farm called Green Focus Ethiopia Ltd introduced a new cultivar called Alphanso from India and was planted at Lako in Guto Gida Woreda of East Wollega zone of Oromia region, western Ethiopia. A study made in western Ethiopia confirmed that the variety introduced was highly infested with a new insect pest called white mango scale (Mohammed et al., 2012). Accordingly, Mizan plant protection laboratory has reported the occurrences of this pest in Bench-Maji in 2014. The pest was first observed in Gurafereda Woreda where commercial mango farm (Seka) is located. For the moment, destruction of infested seedlings and restriction in transfer of planting material had been taken to resolve the problem. However, such measures were unable to reduce the prevalence and in fact in some district the pest infestation even got worse and worse over time (Eyasu and Samael, Mizan plant protection laboratory,

personal comm. 5 October, 2014).

Now a day a country wide establishment of the pest was reported by more recent works. This is basically due to absence of strict internal quarantine system on the geographical exchange of planting material. In view of this, Gashawbeza et al. (2015) reported that several thousand seedlings suspected with the presence of white mango scale were purchased from Arbaminch area for plantation in Tigray. These seedlings were destroyed following proof of white mango scale presence in the seedling. It is essential that the concerned government offices have to come up with alternative measures such as establishing effective and sustainable solutions by undertaking a periodic survey on the occurrence and distribution of the pest. Such measures will also help in strengthening internal quarantine to limit the geographic expansion of the pest to newer area. Information on the association of cultural and environmental factors with pest occurrence are still lacking in the area. Therefore, collecting concrete information about *A. tubercularis* is very important for further control measures. Cognizant of the sparse information available on this economically important pest in the studied area; this research was designed with the main objective to assess information about pest occurrence, distribution and status of damage with the view to provide baseline information for further intervention measures.

RESEARCH METHODOLOGY

The research was carried out in local government areas of Bench-Maji zone which are selected by first informal survey. The infested Kebeles were selected on the basis infestations observed. The leaf infestation level of mango white scale was rated in three kebeles namely, Otowa chole, Berji and Kuja based on visual estimation of proportion of leaf infested. Among these districts, farmers in Otowa chole were used for interviewing about the case. Therefore, a total of 45 mango growing farmers were selected from Otowa chole kebele by employing proportional sampling methods (15% of households). During field inspection five mango trees were randomly selected and marked in the selected kebeles for rating the infestation level of mango white scale over each season (Plate 1). Ten leaves were randomly picked at the top, middle and bottom parts from each tree for counting the clusters of WMS formed on leaves. A pin was used to remove the scale cover and check a cluster of WMS in the field by using a magnifying lens. Males are clustered around a single female. Then a colony consisted of a female WMS surrounded by males was counted.

The infestation and the extent of damage were recorded by using a scoring method from 0 to 5 scale (Williams et al., 2009), who used rating scales of pest infestation on mango as; minimal damage = 5 to 24% of the panicle destroyed, moderate = 25 to 50% damage, severe = 51 to 70% damage and very severe = 71 to 100% damage. In this case the rating can be related to each other as: 1.0 to 1.99 = 5 to 24%, 2.0 to 3.99 = 25 to 50%, 4.0 to 5.0 = 51 to 70%

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Plate 1. Survey of infestation status in selected Kebeles.

and $>5 = 71$ to 100% of leaves damaged. Responses of the questionnaire were subjected to statistical analysis like; descriptive statistics using SPSS computer software. The data on the infestation and the extent of damage were analyzed by SAS computer software and LSD was used for mean separation at 0.05% significance level.

RESULTS AND DISCUSSION

Distribution or spread of WMS (white mango scale)

Initial survey from Bench-Maji zone indicated that the spread of mango white scale was limited to only Guraferda district of Bench-Maji Zone but later survey from other parts indicated that WMS was spreading from its original infestation area to other mango growing neighboring districts of the same zone such as Mizan and Tepi area. It has been forwarded by expertise team from Mizan plant protection laboratory that the natural outbreak and spread of most scale insects are very minimal. They had also listed specific cases about the outbreak and finally come to the conclusion that the introduction of the pest to the studied area is likely to be with planting materials that are hosts to this pest. Similar arguments were made by more recent works of Gashawbeza et al. (2015). Based on this premise, it was suspected that for the first time this pest was introduced to Guraferda area through Seka mango orchard. This farm is found at Kuja Kebele and Guraferda Woreda.

Five mango varieties namely, Apple, Tommy Atkins, Keitt, Kent and Alphanso are cultivated in Seka farm. After the outbreak of WMS Mizan plant protection laboratory undertook inspection on planting materials sourced from Seka farm. Inspection result indicated that white mango scale was observed from all seedlings obtained from Seka farm. Hence, several seedlings purchased from Seka farm for plantation in Sheko

Woreda and Mizan areas were destroyed by the scale and therefore, provided a proof of WMS presence in the seedling.

During field inspection, farmers in the selected kebeles witnessed that for the first time the pest was observed after the establishment of Seka farm in Kuja Kebele where the pest dispersed to old cultivar of the local farmers at an alarming rate. In same manner, recent study by Temesgen (2014) and Tesfaye et al. (2014) showed that mango white scale in Wollega area makes the whole mango farm out of production. Similarly, Gashawbeza et al. (2015) clearly indicated that white mango scale has now appeared in central rift valley area. The study clearly indicated that its spread is currently confined to pocket areas close to Melkasa agricultural research center.

Farmers' knowledge about WMS

The study indicated that more than half of the respondents had an information about this pest. Almost all farmers interviewed farmer in Otowa Chole Kebele were observed seasonal fluctuation on abundance of the pest prevalence. With regard to pest prevalence over season 62.2% of the respondents, participated in the study, said that high level of pest prevalence was occurred in winter. However, those farmers who said high level pest occurred during summer and spring make up 9 (20%) and 8(17.8%) farmers, respectively. About 30 (66.7%) farmers identified the pest by symptoms observed. From this, 15 (50%) of the farmers said white color on the leaf was symptoms of heavily infested trees (Figure 1).

Majority of the respondent indicated that the pest is new for the locality. Right from outbreak of this pest Mizan plant protection office gave awareness to farmers.

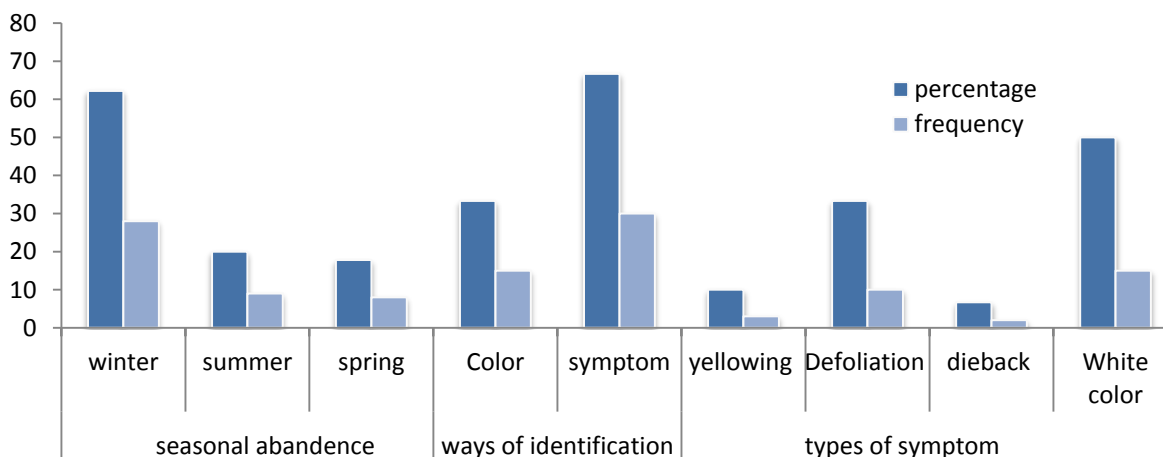


Figure 1. Assessment of farmers knowledge about mango white scale.

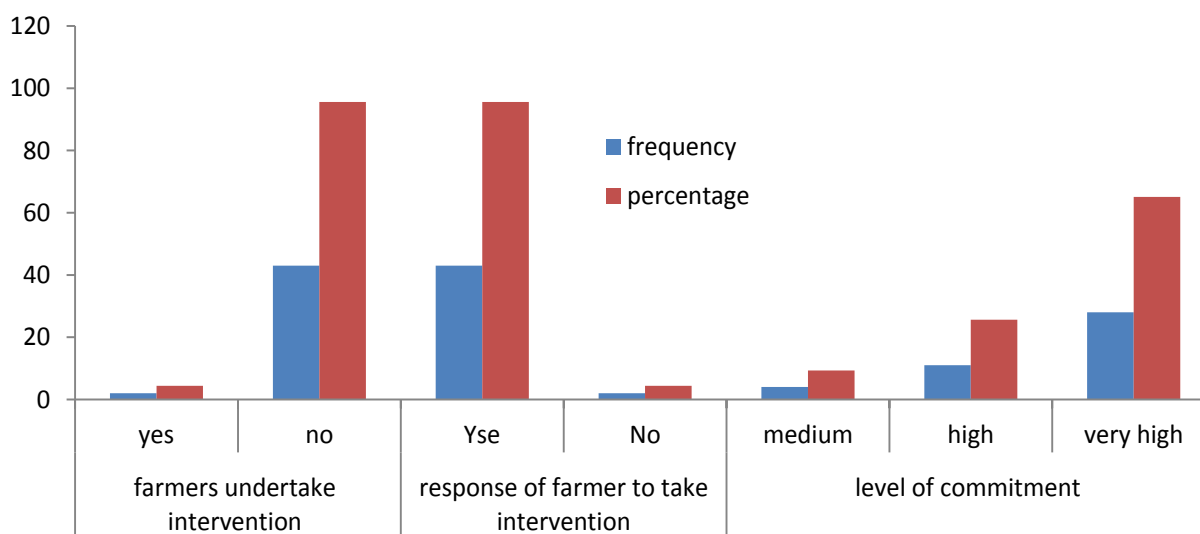


Figure 2. Assessing farmers management of mango white scale.

The finding of this research was supported by others such as Tesfaye et al. (2014) reported that farmers had never ever seen such kind of problem in their mango farm and considered it as new experience for the people of east Wollega. Temesgen (2014) also reported that majority of the respondents did not know the name and type of the mentioned insect pest.

Farmers' management of WMS

Off all the farmers answering the questioner, only 2 farmers (4.4%) had taken control measure. Both of them undertook pruning of heavily infested twigs and dense branches to eliminate infestations when infestations are on limited parts of the plant. However, 95.6% of the

farmers in the study area are still looking for possibilities to take intervention measure. When sample respondent farmers were asked about their commitment to experts order for any intervention measure, 95.6% of the farmer responded that they are committed for taking immediate measure. However; the level of their commitment varied from medium to very high (Figure 2). Among this 65.1% of the respondents have very high level of commitment for taking immediate intervention measures but only 9.3% respondents' fall on the range of medium level commitments (Figure 2). Therefore, farmers in study area are committed to undertake any intervention measures. Regardless of farmers commitment no significant control method was practiced by the nearby agricultural institutions. Farmers' management of MWS was reported by Temesgen (2014) and Tesfaye et al. (2014) that



Plate 2. Field inspection in Seka Farm by expertise team.

mango growers were undertaken cultural control methods like pruning, smoking and site clearing in wollega area.

Management of WMS in Seka farm

After the occurrence of mango white scale the farm sprays two broad spectrum synthetic chemicals such as Diaznon and Dimethoate to reduce pest damage. The farm also undertook cultural practice such as pruning of heavily infested branches and leaves. Meanwhile, field inspection made by the expertise team from Mizan-Tepi University had been realized that such managements were unable to avoid the pest in the entire farm and in fact in some tree the infestation even got worsen (Plate 2). It has been reported that commercial farms and government offices use a variety of broad spectrum insecticides to reduce the pest's damage in western Ethiopia (Mohammed et al., 2012; Temesgen, 2014). But, the use of old broad spectrum insecticides for controlling WMS should be discouraged as they are ineffective in most cases and negatively affect the natural enemy population that aid in the natural control of the pest (Gashawbeza et al., 2015). The same source also reported that bio-control agents such as Aphelinid parasitoid, *Aphytis chionaspis*, which successfully implemented in other country, need to be screened for effective control of the pest in the future. Under natural conditions; predators such as ladybird beetles and green lacewings can also suppress scale populations meaningfully, so that insecticide use is unnecessary.

Status of pest infestation over seasons within the selected kebeles

Status of pest infestation was studied in three districts of Bench-Maji zone; Otowa chole, Kuja and Berji kebeles of Guraferda wereda. Interaction effect of district and season on severity status of MWS was significant ($p < 0.05$) (Table 2). Except, in Otowa Chole kebele during winter status of pest infestation on other treatment combination was varied from 51 to 70%. However, both the pattern and rate of pest infestations were not the same at all districts and seasons. For instance, at Kuja kebele rate of pest infestation was sever in spring which however was not significantly different from the status of pest infection observed in Berji kebele at all seasons (Table 1 and 2).

From the preceding paragraph, it was observed that rate of pest infection is influenced by interaction effect of district and season. Severity status of the major white scale insect in each district over each season showed that rate of pest infestation varied from moderate to severe. The survey result also indicated that the majority of mango trees in the study area were severely damaged. The results are in contrary with Abo-Shanab (2012) who reported the lowest population density was observed in the beginning of spring season during the two studies years.

The interaction effect of district and season on rate of pest infestation can be explained by the fact that mango scale is present all year round, with overlapping generations throughout the year with peaks at flowering

Table 1. Mean squares of pest infestation as affected by district and season.

Source of variation	Degree of freedom	Status of pest infestation
Kebele (K)	2	2.58**
Season (S)	2	0.27*
Interaction (K*S)	4	0.22*
Error	81	0.09

Table 2. Status of *A. tubercularis* prevalence in three districts over three seasons.

Treatments Surveyed districts	Season of the year		
	Winter	Spring	Summer
Kuja	4.59 ^{bc}	4.89 ^a	4.58 ^{bc}
Otowa chole	3.99 ^e	4.34 ^{cd}	4.32 ^d
Berji	4.79 ^{ab}	4.7 ^{ab}	4.76 ^{ab}
	LSD _{0.05} = 0.26		CV% = 6.45

Means within a column and a row followed by the same letter (s) are not significantly different at $p \leq 0.05$ (LSD).

and harvest. Hence, monitoring monthly throughout the year helps to prevent severe problems from occurring

Conclusion

This research was initiated following the outbreak of the most important insect pest in Bench-Maji Zone with the objective to assess information about occurrence and extent of pest distribution. The outbreak of this economically important pest was first noticed at Kuja kebele in 2014 and it was spread from its original infestation area to some mango growing neighboring districts of the zone. It was revealed from the current study that newly emerged pest caused a significant yield reduction in mango plant, as there is no proper control method was practiced by the farmers. The main reason for this may be due to the unmanageable size of local cultivar. Most of the local cultivars are very long in height and this pose difficulty in undertaking control measures.

In view of this, we particularly recommend the following. First, the nearby agricultural office should help farmers by setting feasible goals to reduce the likelihood distribution of the pest. This could be achieved through strict inspection of planting material transfer and destroying any planting material after proof of MWS presence in the seedling. Second, Mizan-Tepi University should have to come up with alternative measures such as: (1) To provide farmers with high quality planting material. To realize this measure, first we have to maintain the desirable characters of landraces and then multiply the local cultivar in large number using grafting technique. Because the seedlings rose from grafting technique are shorter in height. This will facilitate in undertaking various cultural operations such as pruning and chemical spraying when such incidence happens in

the future. (2) To provide farmers with professional support. To this regard, cultural control method such as pruning of heavily infested branches and even eradication of some heavily infected trees may be the possible and immediate intervention measures to be taken right now in the studied area.

The current and previous studies in major mango growing areas of the country (Western Ethiopia and central rift valley) established that white mango scale is becoming the most important limiting factor for mango production in Ethiopia. Hence, due attention should be given to this pest, so that it is highly recommended to install a sustainable solution. Thus, identification and introduction of effective bio-control agents that is environmentally safe and cost effective method is highly recommended as sustainable solution.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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