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**Review Article**

# White Mango Scale, *Aulacaspis tubercularis* Newstead (Hemiptera: Diaspididae): A Challenging Mango Productions in Ethiopia: A Review

**Belay Abate*, Nagassa Dechassa**

Ethiopian Institute of Agricultural Research, Ambo Agricultural Research Centre, Ambo, Ethiopia

**Email address:**
abatebelay9@gmail.com (B. Abate)
*Corresponding author

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**Abstract:** Mango considered as a major fresh fruit used in the world and produced in several tropical and sub-tropical countries. The production of the crop has increased at alarming rate in the producing areas to feed its demands increments. It is a major fruit widely grown in Ethiopia and placed on second rank in terms of area coverage. Its production in Ethiopia is very low as compared to other countries production and potential of the crop. Even though, many factors reported by farmers, affordability agricultural inputs mainly fertilizers, pesticides and pests are the major challenges for the production of the crop. Recently, white mango scale, Aulacaspis tubercularis is the major problem affecting mango production in Ethiopia. This pest was first reported in Loko, Guto Gidda district, east Wollega zone of the Oromia region on August, 2010. The infestation of pest has been speeded at an alarming rate and recorded from almost all mango producing areas of the country. Its population dynamics is increased from October to March and reached the highest peak on April in Didesa and Green focus sites. While, at Bako areas, the population of the pest increased from October to April and reached the highest on May. Pruning supported with insecticides decreased the infestation of the pest. But natural enemies showed promised results in South Africa; as a result in Ethiopia it is on the process to introduce these bio-agents. Integrated approaches of biological control agents, cultural practices and insecticide for the sustainable and eco-friendly management option needs further study.

**Keywords:** Distribution, Damage, Pruning, Natural Enemy, IPM

## 1. Introduction

Mango (*Mangifera indica* L.) is classified under Anacardiaceae family. It is the most consumed and traded fruit which grown commercially and garden in tropical and subtropical regions of the world. Globally, the crop is produced in more than one hundred countries. In terms of production, a mango is considered the major tropical fruits [1]. It accounted more than half of the total production from the global production of the major tropical fruits, followed by pineapples, papayas, and avocados in 2012 [2].

The mango demand has increased significantly since the 1990s. the crop has an ability to grown under different climatic conditions, agro-ecologies. This made the fruit available year round, allows harvesting throughout the year, and improvements in transportation, market access, pre - harvest production practices, and postharvest treatment allow the crop to be shipped long distances [1]. These parameters lead the fruit into mainstream market outlets in most of the developed countries. Even though there is diverse and favorable agro-ecology of Ethiopia, the production of mango is very low in which its productivity is 6.44 ton/ha as while, the crop potential is about 20-30 ton/ha. Therefore this paper is initiated to review the mango production challenges, previous achievements and to identify gaps in the country.

## 2. Mango Productions as the Globe and Specifically in Ethiopia

Even though mango has high nutritional value, well known in developed nations and source of foreign currency for the many developing nations, relatively small portion of the produce enters into international trade. And the bulk of production is consumed in the producing country [1]. It is one of the most widely grown among the fruit crops cultivated in Ethiopia [3]. In Ethiopia, within the past 10 years (2003 to 2013), both area coverage and production of mango increased by 208.4 and 247%, respectively [4]. Mango is grown in several parts of the country where Oromia and South Nation, Nationalities and Peoples regions are major producing belt of the country [5].

In Ethiopia, 1,666,040 householders were participated mango productions on 16,363.48 hectares in 2019/20 cropping year which shared 12.49% of the fruit production of the country [5]. However, it was produced on 19,497.92 hectares in 2018/19 cropping year. The production and productivity of mango is reduced by 16.08% and 6.09%, respectively from 2018/19 to 2019/20 cropping year (Table 1). However, mango cultivation has increased at alarming rate in tropical America and other mango producing regions in response to increasing demand and which led export opportunities for mango producing countries [6].

***Table 1.*** *Mango productions across 2018/19 and 2019/20 cropping years in Ethiopia.*

| Productions | Production years | | % change |
|---|---|---|---|
| | 2018/2019 | 2019/20 | |
| Production area (Hectare) | 19,497.92 | 16,363.48 | -16.18 |
| Fruit Produced | 1,337,049.26 | 1,053,793.75 | -21.19 |
| Productivity (Quintal/hectare) | 68.57 | 64.40 | -6.09 |

Source: CSA, [5].

## 3. Mango Productions Challenges

Mango productions in Ethiopia is very low in which its productivity is 6.44 ton/ha, but the crop potential is about 20-30 ton/ha [7, 5]. As Tewodros *et al*. [8] reported among several factors reported by the farmers, accessibility to agricultural inputs mainly fertilizers, pesticides and pests and diseases are the major bottlenecks for the production of the crop in major mango production areas of Ethiopia. These authors indicated that, insecticides and pest problems accounts 69.9% and 66.4% growers, respectively. Additionally, half of the growers didn't prune their mangos while, the few who did it in an irregular and unprofessional manner. As a result, the trees didn't have the proper architecture that fit the required agronomic practices [8]. However, Griesbach [9] indicated that mango tree requires selective pruning of branches to encourage the growth of lateral branches and good tree architecture. This allows air and sunlight to penetrate, which reduces pests and diseases, and enhances yield and quality of the fruit [10, 11]. And similarly, it enhances pesticides applications and its effectiveness on target pest. Mango production in Ethiopia is currently highly affected and damaged by infestation of white mango scale, *Aulacaspis tubercularis* Newstead (Homoptera: Diaspididae).

### *3.1. Distribution, Population Dynamics and Host of White Mango Scale*

The white mango scale was believed to be first recorded in Asia and later distributed all over the globe. It is currently challenging the production and productivity of the crop globally. It reported as a major pest problem in South Africa [12, 13}, Australia, East and West Africa, North and South America and the Caribbean Islands [14]. This pest became an important insect pest in Egypt, after it was restricted in Minia Governorate under quarantine regulations then crept to Beni-Suif Governorate [15]. CABI distribution map of pests showed the pest occurred in several countries of West Africa and Sub-Saharan Africa [16].

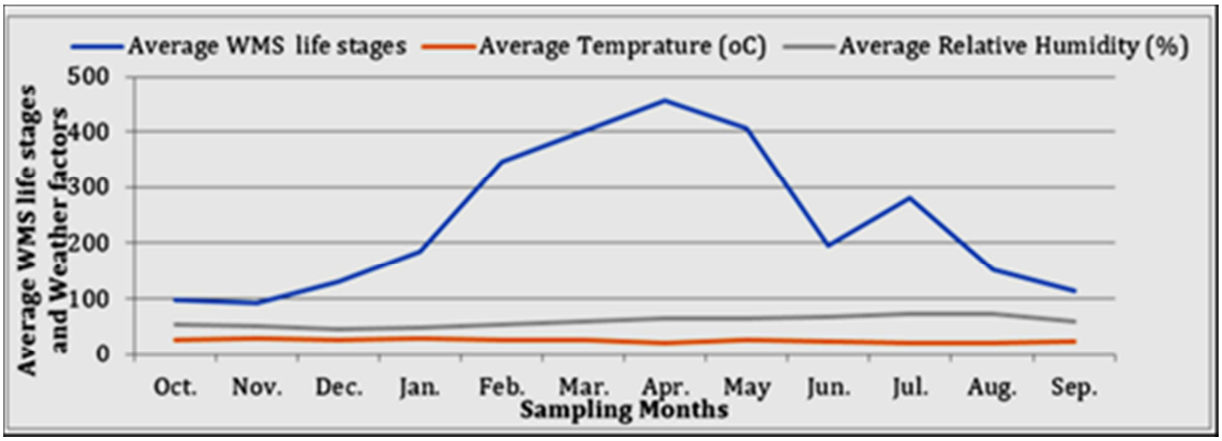
In Ethiopia, white mango scale was first recorded in Loko, Guto Gidda district, east Wollega zone of the Oromia region on August, 2010 at Green Focus Ethiopia Ltd [17]. The pest infested all stages of the crop at Green Focus Ethiopia. It caused yellowing and drying of leaves, leaf drop, die-back of twigs and ultimately killing of the crop. Heavy infestation killed leaves and branches. Additionally, the infested mango fruits showed conspicuous pink blemishes around the feeding sites of the scales, which affecting the commercial value of the fruits and export potential [18, 19] (Figure 1). The pest distributed immediately to the other adjacent administrative peasant associations of Guto Gida districts in the Anger Valleys [17]. At that time, farmers were uprooted mango trees from their farm because there were no available management options since the pest was new for them. And then, the infestation of pest has been speeded at an alarming rate and recorded at Gida Ayyana, Sassiga, Limu and Diga districts [17].

***Figure 1.*** *The infestation of white mango scales on leaves, fruit and mango tree.*

Ofgaa *et al.* [19] showed the distribution of white mango scale from its first observed, into four cardinal directions. The pest distributed over the air distances of 97, 98, 92 and 43 km to the east, south, west and north directions, respectively. Teshale *et al*. [21] study showed that white mango scale distribution is expanded to the southwestern part of Ethiopia and considerably affecting mango production and productivity. They recorded very low population density and the pest free areas at Sokoru, Saka, Shabe, Gumma, Gumayit districts of Jimma zone, Halu district of Ilu ababora zone and Mandi and

Nedjo districts of West Wollega zone.

Joubert *et al*. [13] indicated that white mango scale is available all year round with overlapping generations. However, Abo-Shanab [22] showed that weather factors related with white mango scale population density in Egypt. This author reported that daily mean temperature and relative humidity influenced population density positively, but wind speed and dew point influenced population density of the pest negatively. Teshale *et al*. [21] studied that the population dynamics of white mango scale increased from October to March and reached the highest peak on April in Didesa and Green focus sites. But, at Bako areas, the population of the pest increased from October to April and reached the peak on May [21] (Figure 2). On other hand in South Africa, Ascher *et al.* [23] reported that the population peaks of the pest occurred during different periods of the year, the population peak at Kaapmuiden occurred on August, much earlier than at Nelspruit, where it occurred in November.




Source: Teshale *et al*., [21]

***Figure 2.*** *White mango scale population dynamics at Didessa valley.*

Ofgaa *et al.* [20] reported that mango is the only host for white mango scale in western Ethiopia. They collected plant samples in fields and observed for white mango scale infestations. Then, they found no white mango scale infestation from any of the plants in the study areas (Table 2). From their study, mango is the only host plant for white mango scale in western Ethiopia. However, white mango scale was reported by infesting other plants in different countries [24, 25, and 26]. As an example, Hodges and Hamon [27] reported that plant species found under families Sapindaceae and Rutaceae served as host plants for white mango scale. However, *Casimiroa edulis* La Llave from Rutaceae and *Blighia unijugata* Bak from Sapindaceae were confirmed that not infested by the pest across the study area. Erichsen and Schoeman [24] listed avocado (*Persea americana* Mill.) among the fruits infested by white mango scalwe in South Africa. But, Ofgaa *et al.* [20] reported that avocado has not infested by white mango scale, even though found intercropped with mangos in the studied areas.

### *3.2. Management Options of White Mango Scale*

#### *3.2.1. Cultural Control Methods*

Cultural insect pest control is the manipulation of the crop production system or cultural practices to reduce or eliminate pest populations. Pruning is the most important cultural practice that contributes significantly in management of insect pests and it includes the removal of old dry branches, offshoots, and infested parts. It improves aeration around the tree and thus reduces humidity and discourages hiding and oviposition of the pest. Many authors [28, 29, and 30] indicated that pruning, smoking and area clearing, application of soaps and homemade oils, use of humus as supportive plant nutrient and among others reported for control of scale insect pests. Bautista-Rosales et al. [31] revealed that mango tree pruning significantly decreased the number of female white mango scale in Mexico. On the other hand, they showed that the use of humus in organically managed mango plantation encouraged the female pest to become abundant. It was implicated that increasing nutritional quality of plants favours reproduction and dispersal of insect pests. Fita [3] reported that farmers in Ethiopia practiced pruning, smoking and area clearing as cultural management practices to control white mango scale. Similarly, Ofgaa et al. [32] reported that in eastern Kenya, some mango growers reduced white mango scale infestation on mango through regular and cyclic pruning. Additionally, insecticides supported with pruning significantly reduced the infestation of the pest [33, 34].

#### *3.2.2. Chemical Control Methods*

Chemical control option is most used when crop are heavily infested with the pest [35]. Among evaluated insecticides, granular systemic insecticide Spark 250 WG, Spirotetramat has been reported with promising results for white mango scale control [36, 37] reported that higher population reduction was by Folimat and followed with Closer 240. However, some non-target insects were dead on trees treated with Folimat. As a result, Ofgaa [37] recommended incorporation of the less toxic insecticide, Closer 240 SC, in to Integrated Pest Management. Belay *et al*. [33] study showed that Thiamethoxam 25% WG at 12 g/tree + pruning resulted in the lowest number of the white mango scale after the second

treatment applications (43.5 per leaf) followed by thiamethoxam 25% WG at 18 g/tree + pruning at first the site of Tullu sengota areas. While, at second site they reported that imidacloprid 35% SC + thiamethoxam 25% WG at 18 g/tree + pruning, resulted in the lowest mean number of the pest (31.1 per leaf) followed by thiamethoxam 25% WG at 12 g/tree + pruning (61.4 per leaf). Their study showed that use of systemic insecticides and pruning are promising control tactics for the white mango scale.

However, Belay *et al*. [34] indicated that Thiamethoxam 25% WG at 18g/tree + pruning treated trees decreased the white mango scale life stages per leaf (42.23) and (27.83) followed by Thiamethoxam 25% WG at 12g/tree + pruning treated trees (86.83) and (61.0) in the first and second application seasons, respectively. While, the negative control trees showed highest (334.33) and (591.29) number of white mango scale life stages in the first and second application seasons, respectively at Uke areas (Table 2). Belay *et al.* [33, 34] study showed that the integrated use of the systemic soil drenching insecticide and tree management significantly reduced the white mango scale life stages on infested mango trees.

***Table 2.*** *Mean combined treatment effects on total number of life stages (crawlers, male and female) of the WMS over years (2018 & 2019) at Uke.*

| | **Mean number of white mango scale life stages per leaf** | | |
|---|---|---|---|
| | **Treatment application time** | | |
| | **Before** | **After 1st** | **After 2nd** |
| Year 1 (2018) | 323.00 | 178.71a | 200.41a |
| Year2 (2019) | 182.75 | 138.46b | 132.25b |
| LSD (5%) | - | 37.36 | 45.87 |
| Thiamethoxam 25% WG at 6g/tree | 233.00 | 276.08a | 236.83b |
| Thiamethoxam 25% WG at 12g/tree | 254.67 | 156.83b | 128.00c |
| Thiamethoxam 25% WG at 18g/tree | 256.83 | 136.00b | 90.17cd |
| Thiamethoxam 25% WG at 6g/tree + pruning | 291.50 | 124.33b | 107.50cd |
| Thiamethoxam 25% WG at 12g/tree + pruning | 242.17 | 86.83bc | 61.00cd |
| Thiamethoxam 25% WG at 18g/tree + pruning | 231.00 | 42.23c | 27.83d |
| Pruning only | 289.17 | 109.04bc | 88.00cd |
| Control | 215.67 | 334.33a | 591.29a |
| LSD (5%) | - | 74.72 | 91.74 |
| CV (%) | 32.53 | 39.96 | 46.78 |

Source: Belay *et al*., [34].

### *3.2.3. Biological Control Methods*

Biological control is relies on predation, parasitism, herbivory, or other natural mechanisms, but typically also involves an active human management role [38]. There are many natural enemies recorded from white mango scale. As an example, Nabil et al. [39] recorded Aphytis sp. and Encarsia sp. (Aphelinidae), Habrolepis diaspidi (Risbec) (Encyrtidae) as parasitoids and Cybocephalus micans Reitter as predator of white mango scale in Egypt. Similarly, Abo-Shanab [22] recorded natural enemies which included parasitoids such as Aphytis mytilaspidis (Le Baron) and Encarsia citrina (Craw), and a predatory beetle, Scymnus syriacus Marseul in the same country. On the other hand, the successful classical bio-control of white mango scale was implemented in South Africa using the Aphelinid ecto-parasitoid, *Aphytis chionaspis* Ren with parasitism level of over 50% and the predatory beetle *Cybocephalus binotatus*. As a result, white mango scale population reduced to 2-3% scale infestation has been reported [40] in South Africa. In Ethiopia, Chilocorus beetles spps (*Chilocorus spps*-1, 2, and 3) were identified feeding on all stages of white mango scale and highest population of *Chilocorus spps-1* were recorded in east Wollega (Teshale *et al*., in press). To realize the sustainable white mango scale management, currently Ethiopian Institute of Agricultural Research is working with South African scientists for the introduction of the effective exotic natural enemies, *A. chionaspis* and *C. binotatus.*

# 4. Summary and Conclusions

Mango productions in Ethiopia are very low as compared to the crop's potentials. As many authors suggested it related with poor agronomic practices, unavailability of agricultural inputs such as fertilizers, pesticides and insect pests. Among reported insect pests, white mango scale is the major insect pest affecting the production of the crop and distributed across the county. Different researchers tried to study on the identification of the pest and its natural enemies, distribution and infestation, population dynamics and efficacy of the management options against the pest since its introduction into the country.

White mango scale expanded to major producing areas of Ethiopia and considerably threatened mango production and productivity. Its population dynamics increased from October to March and reached the highest peak on April in Didesa and Green focus sites and the pest increased from October to April and reached the peak on May at Bako area. White mango scale infestations reduced by using Thiamethoxam 25% WG at 18g/tree + pruning, Closer 240 SC and Movento insecticides. While, in South Africa the pest was managed by introducing *A. chionaspis* and *C. binotatus* from Thailand.

Even though, white mango scale is distributed across the country and highly affecting the mango productions in Ethiopia the future study should focus on:

1) Population dynamics and its natural enemies along with

agro-ecology of the country

2) Developing rearing protocols and efficacy study of the native natural enemies (Chilocorus beetles spps,) an options for the management methods
3) Control level and economic implications of the cultural practices against the pest
4) Effects of the insecticides on the natural enemy complex and residual toxicity in fruits
5) Introduction of the promised exotic natural enemies
6) High quality production of mango fruits for exportation, demand an effective integrated control program against this pest as long as reduction in chemicals used
7) Integration of native and exotic natural enemies with compatible methods for the sustainable and eco-friendly management option

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