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White Mango Scale (*Aulacaspis tubercularis*) Management approaches: A Review

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ABSTRACT: *There are different species of insects and diseases that contribute to low yield of mango tree throughout its stages of development. This review was intended to collect research works on white mango scale with special focus on research works done in Ethiopia. Different findings of research works on the insect were carefully studied. The white mango scale insect, Aulacaspis tubercularis (Hemiptera: Diaspididae) is a recent threat to mango production in Ethiopia which was introduced the first time in 2010 in western part of the country. It has spread to all mango producing areas of the country within a short period of time reducing the production and quality of mangos. Control measures taken against the white mango scale include use of chemical insecticides, quarantine, cultural practices, biological control using parasitoids and predators and integrated pest management. Quarantining the insect is the management method recommended in many cases. Generally, the current reports revealed that mango production in Ethiopia will be under serious threat which can even destroy total mango production in the future.*

KEYWORDSs: White Mango Scale, Aulacaspis tubercularis, Mango, Management

INTRODUCTION

There are different species of insects and diseases that contribute to low yield of mango tree throughout its stages of development. Fruit flies, red-banded thrips, mango tip borer, scales, seed weevil, anthracnose, bacterial black spot and powdery mildew are some of the biotic constraints of mango production [1-4]. Of these, insect pests such as fruit flies, mango seed weevils, mites, thrips, mealybugs, and scale insects are common in Ethiopia [5].

The scale insect, white mango scale Aulacaspis tubercularis, is agriculturally important scale insect of mango tree. Taxonomically, the insect is a sucking scale insect found in order Hemiptera [6]. The insect is a serious insect pest of mango across the mango producing parts of the world. A report in [7] indicates that the insect was a significant problem in Egypt. Reports indicate that white mango scale was a major problem in countries such as South Africa, Pakistan and Australia [8-10]. Until the first report of the insect in Ethiopia in 2010, it was not known as an insect pest of mango in the country [2, 11-13]. National sample survey reports indicate that there is a yield

reduction of mango in Ethiopia since the first occurrence of the insect, for instance, 87.39 Qt.h-1 could be harvested during the early occurrence of the insect [14] but currently 64.4 Qt.ha1 [15]. FAOSTAT [16] also indicates a general decline in mango yield since the occurrence of the white mango scale. This paper is therefore aimed at reviewing research works conducted so far on management options of the insect.

DISTRIBUTION, POPULATION DYNAMICS AND ECONOMIC IMPORTANCE

Local Distribution

White mango scale is a tropical insect species assumed to have originated in Asia [7]. The insect is reported distributing all over the world feeding on more than 40 plant species [17-22]. In Ethiopia, the insect white mango scale was reported in a private mango farm established in an area called 'Anger Gutin' where an Indian agro industry called 'Green Focus Ethiopia' grew mango plantations. It was since that the insect has spread to bordering districts of Diga, Ghimbi, Gobu Seyo, and Mana Sibu [2, 23, 24]. Reports showed that the private farm planted its own variety called 'Alphanso' which later on confirmed that the insect was from this introduced variety [6, 11]. The insect was then distributed to south-western, central, and northern parts of Ethiopia, far from its original report mainly through infested mango fruits [13, 25].

Population Dynamics and Economic Importance

A study conducted in western Ethiopia found that the population of white mango scale reaches a peak in April and May [26]. The same study also reported that there was a fluctuations in eggs numbers, crawlers and sessile stages across the study months (June 2013 to May 2014). Another survey conducted in southwest Ethiopia also indicates that the insect had distributed in the areas with its peak population density in April and May [27]. These studies also found that the prevailing weather conditions in the months significantly influenced the population density.

The damage of white mango scale is through chlorotic spots development which reduces the quality of the fruit for market; not direct damage to the internal part of the fruit; such quality reduction usually results in the rejection of the product in the market [20, 28, 29]. In a study conducted to investigate the infestation level of the insect during fruit development, highest level of infestation was at the yellow stage than the green and pre-yellow fruit development stage with a significantly higher number of the insects on the upper surface of the leaves [24, 26]. The authors also found that the female white mango scales infest more than the males and, the level of infestation by females was found to vary among the stages of fruit development. The same study found that male white mango scales infest the ripening fruits to green fruits. According to [30] as cited by Juárez-Hernández [31] reported that mango growth is severely affected by the insect in the nursery. A color change from pale green to yellow is a common characteristics of infested

leaves [18]. Bakry and Tolba [32] also reported significant yield loss from high population density and incidence of the insect in Egypt.

WHITE MANGO SCALE MANAGEMENT OPTIONS

The widespread and rapid establishments of the pests in orchards or gardens require immediate changes in integrated pest management (IPM) program as promising prospect. White mango scale can be managed by using quarantine, cultural, biological, chemical and integrated pest management methods [33].

Cultural control

The goal of cultural control is to make the environment less favorable to pest development and reproduction. Proper fertilization, pruning, and irrigation maintain plant vigor, promote plant tolerance to pest damage, and reduce sap-sucking insect population growth [34, 35].

Mulching is one of the controlling mechanisms of white mango scale especially in the young mango trees. Planting cover crops especially in mango orchards before fruit production starts can reduce population of white mango scale. Plugging of orchard after harvest to expose hibernating adults, reduce, infestation levels. Pruning is effective in removing infested plant tissues and reducing populations of scale [35].

Post-harvest pruning is an effective control measure and also helps the penetration of chemical sprays through the tree canopy [36]. The authors suggested other possible cultural control measures outlined such as: quarantine new plants and treat before placing them with established plants; spot treat with insecticidal soap if needed, taking care to cover all crack cervices and other possible hiding places: - water + oil treatments: Application of a garden hose with water in a hard spray and washing off white scales can be removed following the application of oil:- Wash plants with soapy water (2 teaspoons mild detergent per gal of Water) and a soft cloth. When plants are lightly infested, kill scales by rubbing then off with your fingers, if possible.

Biological control

Biological control is the utilization of natural enemies to reduce the damage caused by noxious organisms (pests) to tolerable level [37]. The most known natural enemies used as bio-control agents in frequency of their use include parasitoids (parasitic wasps and flies) predators (some insects, spiders and predatory mites) and pathogens (fungi, protozoa, bacteria and virus) [38]. There are a number of natural enemies that can manage scale insects including commercially available predatory insects and naturally occurring parasitoid wasps and predators. There are also a range of fungi and bacteria that may infect and kill scale insects, although these are less likely to substantially reduce populations unless they become very abundant. Almost all pesticides will

negatively impact beneficial insect populations (*i.e.* predators and parasitoids). It is recommended to seek advice from the biological control agent producer prior to releasing a predator for the first time so that their release is optimized. If pesticides have been applied, ensure that a sufficient time period elapses before releasing beneficial insects [39]. This pest *A. tubercularis* is under good biological control in most other mango producing countries and therefore it was decided to introduce an exotic biological control agent and try to establish it in different mango producing areas. Both the parasite and predators were successfully augmented, released in to mango orchards and became well established [40, 41].

The larvae of the ladybird beetle *Chilocorus sp*. (Coleoptera: Coccinellidae) infested with white mango scale and they were found feeding on both male and female white mango scales. When feeding, the larvae easily destructed coat of the male mango scale and reached it, whereas they forcefully pushed their heads inward and partly opened up cover of the female, captured and chewed it. In all instances of observations the presence of the larvae was associated with colony of white mango scales [37].

Chemical control

Scale insects are difficult to manage using pesticides alone. If pesticides are to be used to manage scale insects it is recommended to apply contact products only when there is a high proportion of crawlers present. Crawlers are very susceptible to many pesticides, including oil based products. If high populations are present a systemic product will probably be required [42]. Insecticides registered for soft scale management can be broadly categorized into contact and systemic insecticides. Systemic insecticides, which include members of organophosphates, neonicotinoids, tetramic acid derivatives, and diamides, function as contact insecticides when applied as topical sprays directly on the scale insects. When applied as soil drench, soil injection, basal trunk spray, trunk injection, granular broadcast, and pellet broadcast, systemic insecticides are absorbed by plant tissues and trans located to the canopy [43]. Typically, the application is made just before crawler emergence to ensure the highest concentration of active ingredients in the plant tissues. Although systemic insecticides have the benefits of greater flexibility and residual longevity, recent studies suggest that neonicotinoids should be used carefully because of their potential impact on pollinator health [44-46] and their implication in spider mite outbreaks [47-49].

According to Smith *et al*., [50], petroleum sprays at a rate of 1 % are recommended for the control of hard scales in Australia. Application of systemic or growth regulators helps to prevent population increase. Pre-harvest applications to prevent the scale insects build up during harvest. High volume (1200L/ha) cover sprays after pruning with mineral oils and methidathion depending on scale activity. Chloropyrifos, methidathion, Dimethoate 40%EC, [51], Diver and CAPL2 oils have been found successful in reducing the population of white mango scale [7, 36]. According to Manners [42], active ingredients registered against scale insects relevant to Australian mango

nurseries, include; Carbaryl, Chloropyrifos, Diazinon, Dimethoate, Methidathion, Imidaclopride, Pyriproxyfen, Buprofezin, Paraffinic oil and Sulfer.

The studies of Ayalew *et al*., [52] reported to the Movento was effective pesticides against white mango scale. According to Djirata *et al*., [37] Folimat 500SL was found to be the most effective of the three insecticides and the best period for application of insecticide for the control of white mango scale is from April to June, when white mango scale, in general and the crawlers in particular, are more abundant in western Ethiopia.

Quarantine

Conducting national delimiting surveys, establishing and strengthening quarantine facilities, enforcing laws prohibiting interstates movements of mango fruits and planting materials, building the capacity of plant health clinics, and applying bio rational and recommended soft insecticides are among the currently recommended management options [53].

Integrated pest management

An integrated pest management (IPM) alternative could be applied that would consist of a combination of pesticides, cultural practices and the use of biological control agents. And also pesticide application in mango orchards resulted in high mortality of endemic parasitoid [41]. IPM is a pest management philosophy that utilizes all suitable pest management techniques and methods to keep pest populations below economically injurious levels. IPM is a monitoring and decision making process for selecting the most appropriate, cost effective, compatible method of managing pests. It minimizes pest damage with minimal disturbance to the natural balance of the agro-ecosystem and minimal risk to human health. It does this by decreasing the net chemical pesticide inputs to agriculture. This eventually minimizes dependence on chemical pest control. For mango growers to adopt IPM strategies, they must be compatible and economically viable so that when properly implemented and precisely managed, they can jointly reinforce production goals of immediate economic gain and long-term sustainability. Conceptually, IPM falls between conventional and organic agriculture. The introduction of IPM presents a feasible and cost effective alternative to conventional agriculture by significantly lowering the costs of chemical pesticide use as well as an alternative to organic agriculture which in many cases, has been demonstrated not to substantially affect productivity [54]. In developing countries, IPM strategies are often the exception rather than the norm because of their higher labor demands and this is generally the reason why they are practiced on a small scale. Generally, IPM approaches are based on restoring the natural balance between pests and their predators in ecological systems. Where such IPM approaches are applied, it is possible to develop a profitable fruit industry because most of them are pest-specific and are influenced by host-plant relationships and the crop ecosystem.

According to Djirata *et al*., [37] integrated approaches to managing white mango scale was effective in Ethiopia and Kenya. The study was revealed that Cultural practices such as cyclic pruning and consistent scouting for white mango scale infestation and removal of infested parts are essential management practices. Some improved mango varieties like Apple mango was less susceptible to white mango scale infestation in central and eastern Kenya. Chilocorus sp. Was found preying ravenously on live white mango scale, signifying its association as a native predator with the exotic white mango scale. White mango scale has been introduced to Ethiopia, recently and its origin and related natural enemies should be conducted for the designing and implementation of classical biological control. The population of WMS is above the economic injury level insecticide should be implemented and Folimat 500SL was found to be the most effective insecticide against white mango scale.

CONCLUSION

The white mango scale, *A. tubercularis*, became a serious insect pest of mango in Ethiopia a decade ago. Mango producers have faced a big economic loss since the first report of the insect in Ethiopia. Mango growers are losing huge production. Mango farm in Ethiopia is almost out of production due to the newly introduced insect, the white mango scale. Biological, cultural and chemical management practices have been tested to manage/control white mango scale. However, there is no effective management practices in the country. White mango scale is highly spreading within the country through infested mango fruits and seedlings. So, unless an immediate solution will be given, the current reports indicate that mango production in Ethiopia will be under serious threat which can even destroy total mango production in the future.

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