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Research Paper

Evaluation of Some Insecticides against White Mango Scale, *Aulacaspis Tubercularis* Newstead (Hemiptera: Diaspididae) on Mango in Ethiopia

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Abstract

Mango (*Mangifera indica L.*) has been cultivated in Ethiopia at small scale level so far, but very few large scale farms have started to join the sector in recent days. Mango production in Ethiopia is currently constrained by white mango scale (*Aulacaspis tubercularis*). This study was performed to evaluate the efficacy of three formulations, i.e. Folimat, Closer 240 and D-C-Tron Plus, against white mango scale (WMS) on mango from mid-May 2016 to end of July 2016 in west Oromia. The experiment was laid in a Randomised Complete Block Design (RCBD) with three replications. Volume of water enough for complete coverage of a mango tree was calibrated and repetitive treatment and response recording were conducted. The insecticides were applied by manual Knapsack sprayer, every 14 days for a total of three times. A total of ten leaves were picked randomly from the treatments and the untreated control one day prior to each treatment and on the 5th and 10th days after each treatment. Live crawler; male and female WMSs were counted by the use of stereo microscope and recorded as number of live WMS. Folimat showed maximum pest population reduction followed with Closer 240. However, some non-target insects were found dead on trees treated with Folimat, an observation to be confirmed by further investigation. Incorporating the less toxic insecticide, Closer 240 SC which showed a certain degree of the pest population reduction, in to Integrated Pest Management to control the white mango scale infestation on big trees of mango landrace is recommended.

1. Introduction

Mango (*Mangifera indica* L.) is grown across the world in tropical and sub-tropical countries. It is the third most important fruit crop in the tropics next to citrus and banana (Louw et al., 2008). Mango is consumed as a fresh fruit and in different forms of beverages (Griesbach, 2003; Nabil et al., 2012). Mango possesses anti-oxidant, cardiotonic, hypotensive, anti-inflammatory and antispasmodic properties, and as a result plays vital role in Ethnopharmacology and various chemical industries (Wauthoz et al., 2007; Kayode and Sani, 2008; Masibo and He, 2008; Nwinuka et al., 2008; Shah et al., 2010). Moreover, mango is a significant foreign currency generating crop for many countries across the globe (UNCTAD, 2016). In Ethiopia mango is produced mainly at small scale level primarily for family consumption and local fresh fruit markets (Alemayehu Chala et al., 2014). However, large scale mango productions for juices and export markets are currently being introduced in to the sector (Wiersinga and Jager, 2009; Yilma Tewodros, 2009).

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Mango being a crop of such vital economic importance, its production is constrained by a variety of pests and pathogens. Medina and García (2002) depicted that over 492 species of insects, 17 species of mites and 26 species of nematodes were reported to have been damaging mango plantations. Mango pests include insects such as fruit fly complex, mango seed weevil, thrips, mealy bugs and scale insects; and non-insect pests such as mites, among others. Moreover, pathogenic fungi and bacteria cause diseases to the crop (USDA, 2006). Likewise, mango production in Ethiopia is challenged by a variety of pests and diseases (Alemayehu Chala et al., 2014, Ayantu Tucho et al., 2014). Tewodros Bezu et al. (2014) reported that, pertaining to poor management of mango production, thrips, fruit flies, termites, and various fungal diseases constrain the crop in Ethiopia. White mango scale is a noxious pest which has been reported to affect commercial values of mango in many countries (Labuschagne et al., 1995; Pena et al., 1998; Nabil et al., 2012; Mazzeo et al., 2014). In Ethiopia, white mango scale was reported to have posed severe threat to mango production since its first record in 2010 (Mohammed Dawd et al., 2012). White mango scale is a phytophagous insect. It inserts its stylets in leaf, fruit and other young mango parts and sucks the sap and results in discolouration of the leaves and the fruits, brings about dieback of the tree and in severe cases causes total death of young mango trees (Abo-Shanab, 2012; Juárez-Hernández et al., 2014).

Various methods, such as cultural method, biological control and chemical insecticide applications have been implemented to control the damages inflicted by white mango scale to mango in different mango growing countries. In line with this, pruning as a cultural method, was practiced and found to have considerably decreased population of white mango scale in Mexico (Bautista-Rosales et al., 2013). Regarding the possible role of bio agents in controlling the pest, Ofgaa Djirata et al. (2017) reported from a field experiment in Ethiopia that larvae of predatory ladybird beetle were found aggressively preying on it, even though whether they could control the pest or not has not been reported so far. Moreover, it was stated that ladybird beetles, and green lacewings and tiny parasitic wasps may be used to suppress scale insect populations (Muralidharan, 1994; Buss and Turner, 2006). Chemical insecticides and mineral oils such as deltametrine, pyrethrin, super masrona and Diver were also proposed for the control of mango scales in Egypt and Kenya (Findlay, 2003; Abo-Shanab, 2012). In Ethiopia, however, there has been no sufficient report regarding insecticide efficacy test for control of white mango scale, for which this study was conducted with the core objective of evaluating the most effective insecticides that could help control the pest.

2. Materials and Methods

2.1. Description of the study area

This study was performed at Arjo Gudetu mango orchard (09° 03´N and 036° 17´E) found in Diga District, East Wollega Administrative Zone of Oromia National Regional State at a distance of 370 km west of Addis Ababa, from mid-May to end of July 2016. The area receives a mean annual rainfall of 1649 mm and characterized by maximum and minimum monthly temperatures of 31°C and 16°C, respectively (Ethiomet, 2016).The orchard was found on a gentle slope with altitudes ranging between 1326 and 1379 m a.s.l. The study farm was entirely composed of local mango landraces grown by the orchard owner for the last 25 years. The plantation was spaced at an average distance of nine to ten metres away from each other. However, since no pruning has been practiced to the mango trees in the farm, most of the trees were tall and bushy, and moreover, their branches were highly interlocked in most instances. There has been no insecticide application to the mango farm for pest control so far (personal communication with Fayissa Dhuguma, owner of the orchard). The farming population of the study area grows mango as the major income generating crop next to maize and peanut. Cattle fattening is another source of income in the area.

2.2. The experimental design

The field experiment was laid in a Randomised Complete Block Design (RCBD) with three replications. Allocation of each treatment and the untreated control within each replication was done randomly. In the meantime, three mango trees were allocated for each insecticide and to the untreated control. After the allocations, each mango tree assigned to each treatment and that of the untreated control were tagged accordingly for repetitive spray and response record from the same tree. Before application of the formulations, the volume of water enough to completely cover a mango tree was calibrated. Mean volume of water enough per tree was found to be 20 litres.

The mango trees being tall and bushy, telescopic extension lance of 3.2 meters long was fixed to the sprayer knapsack. Spraying was effected with the spray man being supported by scaffold fixed on a tractor back for ease of accessing all parts of each mango tree. Treatments were applied every 14 days for a total of three times. A total of ten leaves were plucked from top, middle and lower canopies of each treatment tree and the untreated control, one day prior to each treatment and on the 5th and the 10th days after each treatment. The leaves from each tree were placed in a separate cloth bag, labelled, kept in a plastic bag and taken to a temporary laboratory established around the trial area. Live crawler, male and female white mango scales were counted by the use of stereo microscope and recorded as number of live white mango scale.

2.3. Insecticides evaluated

Field experiment was carried out to evaluate efficacy of three insecticides against white mango scale. These were Closer 240 SC (Sulfoxaflor), D-C-Tron (mineral oil) and Folimat 500SL. Closer 240 SC (Sulfoxaflor) was registered for the control of cabbage aphids on cabbage in Ethiopia (Federal Democratic Republic of Ethiopia Ministry of Agriculture and Natural Resources, 2016). It was obtained from Chemtex Plc, Addis Ababa, Ethiopia. Closer 240 SC was applied with the rate of six ml/tree in this study. The remaining two candidates, D-C-Tron (mineral oil) and Folimat 500SL (Omethoate 500g/L or 47.5% m/m) were registered in Kenya (Pest Control Product Board, 2016). D-C-Tron Plus was used for the control of leaf miners and scales in coffee, mites and aphids in flower and aphids in beans in Kenya. It was bought from Caltex Oil (K) ltd, Nairobi-Kenya and imported to Ethiopia for the purpose of this evaluation only. D-C-Tron Plus was applied with the rate of 100ml/tree in this study. Folimat 500SL was used for the control of aphids on coffee, citrus and flowers, and mealy bugs on coffee in Kenya. Like D-C-Tron Plus, Folimat 500SL was also bought from a legal company known as Arysta Lifescience Corporation (K) in Nairobi, Kenya, and imported to Ethiopia for the purpose of screening in this study. Folimat 500SL was applied at the rate of 25ml/tree in this study. Closer 240 is systemic in its action but Folimat serves as both systemic and contact insecticidal agent. D-C-Tron Plus is, however, suffocant oil.

2.4. Data analysis

Sum of live crawler, female and male white mango scale was taken as white mango scale count data and subjected to analysis. Proc ANOVA of SAS software v9 was applied for data analysis. Significant means were separated by Fisher's Least Significant Difference (LSD) at 5% error level. Percentage reduction in white mango scale population over control was worked out after each treatment using Henderson and Tilton (1955) formula of mortality correction.

$$\text{Mortality Correction} = \left(1 - \frac{N1 * N2}{N3 * N4}\right) * 100$$

where, N1, N2, N3 and N4 are white mango scale populations in control before treatment, in treated after treatment, in control after treatment and in treated before treatment, respectively.

3. Results

Mean numbers of white mango scale counts per 10 leaves just before the initial treatment and in the two successive records following the first treatment are shown in Table 1.

Table 1: White mango scale population counts before insecticide application and during the two successive recordings after initial application

Treatment/Control	Record before initial spray	First record after initial spray	Second record after initial spray
D-C-Tron	297	300	298
Closer	333	330	320
Folimat	1084	1070	1066
Control	155	157	158

Noticeable declines were observed in the counts of live white mango scale among the records starting from post second spray, mainly for Closer and Folimat, while population build up was recorded in cases of the untreated control. Mean numbers of live white mango scale per 10 leaves from pre-second spray onward are indicated by the following figures (Figures 1and 2).

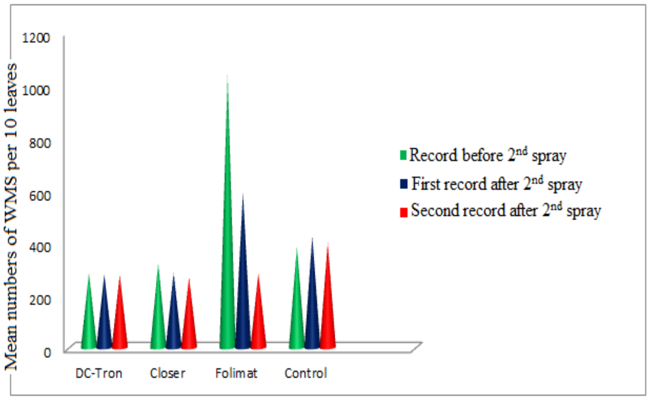

Figure1: White mango scale populations just before and after second round insecticide application

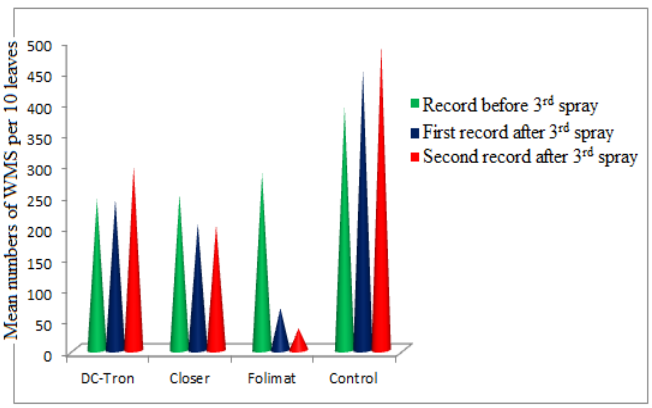

Figure 2: White mango scale population just before and after third round insecticide spray

The result of evaluating the three insecticides revealed that Folimat (49.52 ± 15.74) was found to be the most effective insecticide in reducing the population of white mango scale on mango with significant different (p<0.05) compared to Closer (18.72 ± 5.32) and D-C-Tron (5.90 ± 2.15) at 5% error level (LSD=29.15).

In the course of recording live white mango scales following each treatment, dead bodies of non-target insects, including *Chilocorus* sp. larvae (Coleopteran) were frequently encountered on mango leaves treated with Folimat, while no dead body of those insects was found on the leaves treated with the rest two insecticides, in most observed cases.

Percent corrected mortality showed marked progress from the first to the third application of the insecticides, mainly in Folimat and Closer. Reduction in white mango scale population in response to the insecticides applied during the three phases (A and B for first and second responses after initial spray, C and D for first and second responses after second round spray, and E and F denoting first and second responses after the third round (final) spray, respectively) is shown in Figure 3.

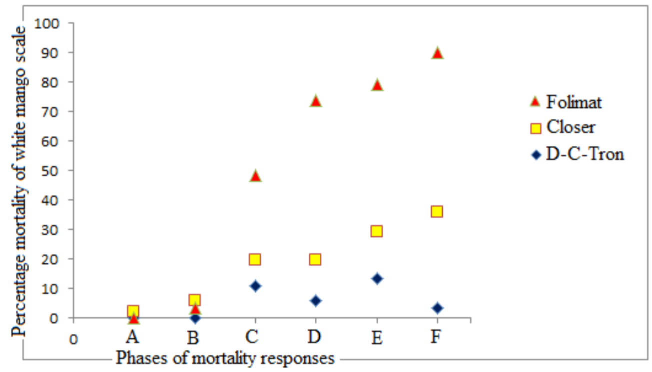

Figure 3. White mango scale percentage reduction in response to successive treatments

4. Discussion

Population count started to noticeably decrease only after the second round spray in Folimat and Closer treatments. This is probably because as the mango trees under the experiment were tall, bushy and characterized by dense foliage, there might be some probabilities of uncertainties to have fully addressed each mango scale through only one round spray. Chin et al. (2010) underlines that keeping mango tree sizes at a manageable stature through pruning is very essential for ease of insecticide spray for the desired response in the control of pests and diseases. Reddy et al. (2018) also states that pruning is an essential management practice in the control of scale insect infestation on mango. On the other hand, the apparent population decrease following repeated applications of the insecticides might account for cumulative effects of the successive sprays. The principle of applying systemic insecticide to control sucking insects arises from the fact that they diffuse through the soft parts of the host plant and reach the pest. Therefore, the rate at which it gets in contact with the pest may not be as fast as contact insecticides. Gashawbeza Ayalew et al. (2015) screened Methidathion and Movento on white mango scale on mango trees in Central Rift Valley, Ethiopia and found that population counts after the first treatment were similar between the treatments but differences were observed after the second spray, a report in agreement with the current trial. Population build-up was observed in the untreated control, indicating that the period of insecticide application in this trial took place during the period of continuous growth of white mango scale population. Ofgaa Djirata et al. (2018) stated that white mango scale population on mango began to build from February and attained its peak sometime before July.

Folimat 500SL was found to exhibit over 90% pest population reduction with marked difference from Closer 240, which also performed well. It was reported that mango farmers in central and eastern Kenya were using this product to have controlled white mango scale (Ofgaa Djirata, et al., 2016). Folimat is both systemic and contact insecticide. The white mango scale first instars are naked and as a result Folimat can exterminate them upon contact, which could probably increase its efficacy in addition to its indirect action on the armoured adult scales which are sap sucking. Non-target insects were found dead on leaves treated particularly with Folimat. This probably demonstrates its strong toxicity which renders it worrisome profile to be considered for white mango scale control in the context of this study. However, whether the death of the non-target insects was purely due to Folimat had not been evaluated in this study. It was indicated that Folimat serves as both systemic and contact insecticidal agent while Closer 240 works only by translaminar and systemic activity. Therefore, it is arguable that Closer 240 could cause similar deaths of non- target insects, which were particularly not sucking insects.

5. Conclusion

Folimat was found to exhibit considerable efficacy in reducing white mango scale population on mango. However, such highly toxic insecticides should not be used for white mango scale control purposes from ecological concern points of view. Complete coverage of the indigenous tall and bushy mango trees with insecticide during the spray was almost impossible. It is concluded, therefore, that controlling white mango scale on big mango trees by manual spraying, mainly at small scale farmer level after heavy infestation is highly challenging. As a result, it is advisable to practice consistent pruning and maintain general stature of the plantation at manageable size and make Integrated Pest Management an integral component in the control of white mango scale infestation on mango.

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