

Integrated Approaches of Mechanical Barrier, Insecticide and Botanicals against Mango Mealybug (*Drosicha mangiferae*)

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Abstract

An experiment was conducted to test the efficacy of a mechanical barrier around the tree trunk with one spray of Cypermethrin @ 1 ml/l and turmeric powder extract @ 15 g/500ml of water applied in integrated approaches against mango mealybug on mango tree. There were 7 treatments including a control. The treatments were Mechanical barrier, Cypermethrin spray @ 1 ml/l, Turmeric powder spray @ 15 g/500ml of water, Cypermethrin spray + Turmeric spray, Cypermethrin spray + Mechanical barrier, Turmeric + Mechanical barrier and untreated control. Three-year-old mango plants grafted from a 5-year-old mango tree (Variety Amropali) and planted in pots were used in the experiment. The treatment, Cypermethrin spray + Mechanical barrier gave the highest reduction of mango mealybug population 87.06% to 93.90% followed by Turmeric spray + Mechanical barrier and showed 81.13% to 86.04% and Mechanical barrier alone showed 81.13% to 84.59% population reduction. Turmeric powder extract showed only (8.42% to 23.77%) population reduction of mango mealybug which was lowest compared to other treatments.

Keywords

Mango Mealybug, Integrated Management

1. Introduction

Mango (*Mangifera indica* L.) a member of family Anacardiaceae is known as king of fruits for its sweetness, excellent flavor, delicious taste and high nutritive

value [1] [2]. This important tropical fruit is being grown in more than 100 countries [3]. A number of insect pests are known to attack the mango trees, which have been studied in detail [4]-[7]). The nymphs and female bugs suck sap from inflorescence, tender leaves, shoots and fruit peduncles. As a result, the affected inflorescences are shriveled and get dried. Severe infestation affects the fruit set and causes fruit drop. They secrete honey dew over, which sooty mould develops [8]. Due to the growth of sooty mould on the leaves, photosynthetic activity is affected [9] [10] reported that mealybug (*Drosicha mangiferae* Green.) is the serious pest of mango in Pakistan and is growing as a threat to mango orchards. In Bangladesh mango mealybug population started to increase gradually from December and continued up to February when the ambient average temperature was 20.95°C, relative humidity 63% and rainfall was absent [11].

Mango mealybug (*D. mangiferae*) is difficult to control using single plant protection tactic. Use of only insecticides is not sufficient to control the pest [12]. Use of insecticides may cause environmental pollution and destruction of natural beneficial insects [13] [14]. Considerable efforts are being made in various parts of the world to minimize the overuse of insecticidal chemicals and increase the use of Integrated Pest Management techniques. Available reports reveal that botanicals are effective in controlling mealybugs [15]-[17]. Khan and Ashfaq [18] reported that Funnel Type trap is an effective barrier for mango mealybug nymphs and also worked for collecting the egg carrying female. Karar *et al.*, [19] tested nine tree bands to check the upward movement of mango mealybug (*D. mangiferae*) and found a new band named Haider's band (plastic sheeting having a layer of 3.8 cm of grease in the middle) is the most effective for preventing insects from reaching the tree canopies. In our previous studies, we found that foliar spray with insecticide Cypermethrin and botanical Turmeric powder extract are effective in controlling mango mealybug. Integrated use of the mechanical barrier, insecticide and botanical may give considerable control of the insect. Considering the above facts, an experiment was conducted to test the efficacy of integrated use of a mechanical barrier around the tree trunk, foliar spray with a chemical insecticide and a botanical against mango mealybug.

2. Materials and Methods

An experiment was conducted in an orchard of Sher-e-Bangla Agricultural University campus, Dhaka, Bangladesh from November to May to test the efficacy of integrated use of a mechanical barrier around the tree trunk, spray with a chemical insecticide and a botanical against mango mealybug. In mechanical barrier, tree trunk was tightly wrapped with a 30 cm wide white plastic sheet at 45 cm above the soil surface. The insecticide was Cypermethrin (@ 1 ml/l) and botanical was turmeric powder. Both Cypermethrin and turmeric powder extract were applied as spray on the mango tree. Mango plants of variety Amropali grafted from five-year-old trees were planted in earthen pots at one plant per pot. Three-year-old plants were collected from Green Orchid and Cactus Nursery, Agargaon, Dhaka. The experiment was laid out in randomized complete block

design (RCBD) with three replications (pot with mango plant). The treatments were as follows:

T₁. Mechanical barrier: Haider's band [20] was used as a mechanical barrier to stop the crawling of the nymphal stage of mango mealybug from the soil to the plant canopy. The plant was tightly wrapped with a 30 cm wide white plastic sheet 45 cm above the ground level. A thin layer of grease (7 cm) was applied surrounding the middle portion of plastic sheet from November to April. The barrier inhibits the crawling of nymphs to cross the band and reach the plant canopy. As a result, the nymphs gathered near the lower edge of the plastic barrier which was killed by spraying Cypermethrin @ 1 ml/l of water. Monitoring was done continuously and new grease was applied when the previous grease would dry.

T₂. Chemical spray: Mango plants were sprayed once with Cypermethrin @ 1 ml/l of water before crawling of nymphs of the insect.

T₃. Botanical spray: Mango plants were sprayed once with turmeric (Rhizome) powder extract @ 15 g/500ml of water before crawling off the 1st, 2nd and 3rd instar nymphs to the canopy.

T₄. Chemical + Botanical: Mango plants were sprayed once with Cypermethrin @ 1ml/l of water before crawling of nymphs of the insect. After 15 days of Cypermethrin application, the plants were again sprayed once with turmeric powder extract @ 15 g/500ml of water.

T₅. Mechanical + Chemical: Mechanical barrier (T₁) and Mango plants were sprayed with Cypermethrin @ 1ml/l of water (T₂).

T₆. Mechanical + Botanical: Mechanical barrier (T₁) and Mango plants were sprayed with turmeric powder extract @ 15g/500 ml of water (T₃).

T₇. Untreated control: Selected trees under untreated control were kept without any treatment application.

Preparation of turmeric (Rhizome) powder extract

Turmeric (Rhizome) powder was collected from Townhall Market, Mohammadpur, Dhaka. The requisite quantity of the materials was taken and 400 ml of water was added and ground well in a blender to make into a suspension. The mixture was kept undisturbed overnight, filtered through fine cloth and poured into a 500 ml volumetric flask. Fresh water was added to the flask to make the volume 500 ml.

Data collection

Number of 1st, 2nd and 3rd instars nymphs were counted separately from 2 cm² area of inflorescence of the treated and untreated mango trees. Percent reduction in insect population over control was calculated using the following formula:

$$\% \text{ Reduction} = \frac{\text{No. of insects in control} - \text{No. of insects in treatment}}{\text{No. of insects in control}} \times 100$$

3. Results

The effect of different IPM packages on the infestation of inflorescence and the

percent reduction of mango mealybug over control at different stages in various treatments are given in **Table 1**.

Application of mechanical barrier, Cypermethrin @ 1 ml/l and turmeric powder extract @ 15 g/500ml singly or combination with one another gave significant reduction in the population of mango mealybug at 1st, 2nd and 3rd instars nymphal stages. Higher reduction in their population was observed at 1st instar followed by 2nd and 3rd instar.

Population of 1st instar nymph: Among the treatment, T₅ (Cypermethrin @ 1 ml/l + Mechanical barrier) caused significantly highest reduction of 93.90% in population followed by T₆ (Turmeric + Mechanical) and T₁ (Only Mechanical) and showed 86.04% and 84.59% reduction in insect population compared to control. The efficacy of T₁ and T₆ was statistically similar and significantly higher than other treatments. The lowest reduction (18.31%) was recorded from T₃ (Turmeric spray)

Population of 2nd instar: Like 1st instar nymph, all treatments (T₁ - T₆) reduced population at 2nd instar nymphs significantly over control. The reduction ranged from 23.77% - 87.06%. Treatments T₅ (Cypermethrin @ 1 ml/l + Mechanical barrier) were reduced by 87.06%, T₆ (Turmeric + Mechanical) and T₁ (only Mechanical) and were reduced by 81.13%, in population of 2nd instar over control. Their efficacy was statistically similar but significantly higher compared to other treatments. Significantly lowest reduction of 23.77% was recorded from T₃ (only Turmeric), T₄ (Cypermethrin @ 1 ml/l + Turmeric powder extract @ 15 g/500ml) and T₂ (Cypermethrin @ 1 ml/l) showed 46.39% and 47.27% population reduction.

Table 1. Effect of mechanical, chemical and botanical measures applies in an integrated approach to control 1st, 2nd and 3rd instar nymphs of mango mealybug on mango under pot condition.

Treatment	Different nymphal stages					
	1 st instar nymph		2 nd instar		3 rd instar	
	No. of nymphs per 2 cm ²	Reduction over control (%)	No. of nymphs per 2 cm ²	Reduction over control (%)	No. of nymphs per 2 cm ²	Reduction over control (%)
T ₁ (Plastic sheet barrier)	03.33d	84.59b	03.33d	81.13a	03.33d	83.07b
T ₂ (Cypermethrin @ 1 ml/)	11.00c	49.12d	13.33c	47.27b	13.33c	32.19c
T ₃ (Turmeric powder @ 15 g/500ml)	17.67b	18.31e	20.33b	23.77C	18.00b	08.42d
T ₄ (T ₂ + T ₃)	10.00c	53.77c	13.67c	46.39b	12.67c	35.53c
T ₅ (T ₁ + T ₂)	01.33e	93.90a	01.67d	87.06a	02.00e	89.82a
T ₆ (T ₁ + T ₃)	03.00d	86.04b	03.33d	81.13a	03.33d	83.07b
T ₇ (Control)	21.67a	-	27.67a	-	19.67a	-
LSD (P = 0.05)	1.601	3.872	2.304	8.598		5.372
% CV	9.17	3.26	10.77	7.62		5.25

Population of 3rd instar nymph: At 3rd instar nymphal stage, the highest population (19.67 insects/2cm²) was found under control. All treatments significantly reduced their population over control within the range of 8.42% - 89.82%. Significantly highest population reduction over control was obtained with T₅ (89.82%) followed by T₆ (83.07%) and which was statistically similar with T₁ (83.07%). Treatment T₄ (Chemical + Botanical) showed 35.53% reduction in population over control, which was statistically similar to T₂ (**Table 1**).

4. Discussion

This experiment revealed that the highest reduction of mango mealybug population was observed at 1st instar followed by 2nd and 3rd instar. Among treatments, T₅ (Cypermethrin @ 1 ml/l + Mechanical barrier) caused significantly highest reduction of 93.90% in population followed by T₆ (Turmeric + Mechanical) and T₁ (Only Mechanical) and showed 86.04% and 84.59% reduction in insect population compared to control. The lowest reduction (18.31%) was recorded from T₃ (Turmeric powder extract spray). The results of this experiment were similar to the findings of other investigators. Atwal and Dhaliwal [21] reported that the mealybug could be controlled by destroying eggs laid under the infested trees; nymphs could be prevented from crawling up the trees by applying 8 cm wide sticky bands with grease material or slippery bands with alkathene or plastic sheets around the trunk. Moreover, Karar *et al.* [20] found that combined treatment with three measures (cultural, mechanical and chemical) showed the maximum effect in reducing the population of mealybug up to 98.46%. They were also concluded from the results that the measures in integrated form gave better results than the single treatment. Ishaq *et al.* [22] worked on the integrated management of mango mealybug and reported that the pest is difficult to control by water based insecticides. So for its management by using sticky bands along with burning and burying treatments significantly reduced the incidence of infestation. Gul *et al.* [23] also reported that integration of banding of tree trunks, destruction of eggs in the soil and application of insecticides was the most effective control strategy. Cypermethrin (CP) is a synthetic pyrethroid used as an insecticide in large-scale commercial agricultural applications as well as in consumer products for domestic purposes. It behaves as a fast-acting neurotoxin in insects. It is easily degraded on soil and plants but can be effective for weeks when applied to indoor inert surfaces. It is a non-systemic and non-volatile insecticide that acts by contact and ingestion, used in agriculture and in pest control products. Exposure to sunlight, water and oxygen will accelerate its decomposition. Cypermethrin is highly toxic to fish, bees, and aquatic insects, according to the National Pesticides Telecommunications Network (NPTN). It is found in many household ant and cockroach killers. In particular, pyrethroid are commonly used as insecticides and are recommended for insect control because they are considered to be relatively non-toxic to humans in all stages of life. However, recent data show that they are not completely harmless to human health as they may enter the body through skin contact, by inhalation and food

or water, and absorption level depending on the type of food. So, the insecticides must be used with great caution [24]. According to [25] to avoid resistance development of cypermethrin it has to be applied at the concentration recommended by WHO and by the manufacturers (label instructions), avoiding over-dosages which are costly and potentially hazardous, as well as under-dosages which are not effective enough and may accelerate the development of resistance. Insecticides of the same chemical group, acting on the same target site, should be considered as a single product as far as resistance is concerned.

5. Conclusion

Application of mechanical barrier, Cypermethrin @ 1 ml/l and turmeric powder extract @ 15 g/500ml singly or combination with one another gave a significant reduction in the population of mango mealybug at 1st, 2nd and 3rd instars nymphal stages. A higher reduction in their population was observed at 1st instar followed by 2nd and 3rd instar. T₅ (Cypermethrin @ 1 ml/l + Mechanical barrier) caused significantly the highest reduction of mango mealybug population followed by T₆ (Turmeric + Mechanical) and T₁ (Only Mechanical) in all stages.

Recommendations

- This study may be done further in different regions of the country to explore the results of the treatments in different climatic conditions.
- Different insecticides and different botanicals can be evaluated to select more options for combating mango mealybug.

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Authors' Contributions

This work was carried out in collaboration among all authors. Author NA conducted the research work. Author MZA designed and edited the manuscript. Author MAL designed and supervised the study, managed the literature searches and edited the manuscript. Author MAR managed the literature search. Author MRUM and IHM managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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