



Effectiveness of *Beauveria bassiana* and three selected botanicals on controlling *Idioscopus clypealis* and increasing mango fruit set and fruit retention

Md. Sohanur Rahman¹✉, Mahbuba Jahan², Md. Arifur Rahman³

¹Pest Management Division, Bangladesh Jute Research Institute, Manik Mia Avenue, Dhaka 1207, Bangladesh

²Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

³Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

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Correspondence:

Md. Sohanur Rahman

✉: sohanbau2010@gmail.com



ABSTRACT

This study was carried out to study the effects of a microbial pesticides (*Beauveria bassiana*) and three botanicals (*Neem*, *Mahogany* and *Karanja* oils) for the management of mango hopper (*Idioscopus clypealis*) to increase the fruit set and retention of mango. The experiment was conducted at Aqua, Mymensingh, Bangladesh following randomized complete block design (RCBD). Each of the botanicals and microbial pesticides was used with 3 different doses (1%, 2% and 3%). The observation on fruit set after pesticides application showed that the highest percentage of fruit setting was found in 1% *Beauveria bassiana* (8.33%) that was statistically similar to 2% *Beauveria bassiana* and the lowest number of fruit setting (3.6%) was found in 1% Mahogany oil. Among the botanicals, 3% neem oil (11.46%) had better performance on fruit setting. Observation on fruit retention after pesticides application showed that the percentage of fruit retention was maximum (10.50%) in 1% *Beauveria bassiana* and the lowest (4.86%) was found in 1% Mahogany oil. Among botanicals, 3% neem oil (8.07%) had better performance on fruit retention. Overall results suggested that *Beauveria bassiana* as a microbial pesticide performed better than botanicals for the mango fruit set and retention and it can be used as a promising microbial pesticide to ensure the quality mango production.

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Introduction

Mango is the most loved fruit in our country. So this fruit is regarded as the king of all the fruits by the people. Mango is a low-calorie fruit that is high in fibre, and is a great source of vitamins A and C. It also contains folate, B6, iron and a little calcium, zinc and vitamin E. Mangoes are a good source of antioxidant. Fruits are packed with major health protective nutrients providing energy which play an important role in balanced diet of human nutrition. The minimum dietary requirement of fruits per head per day is 85g; but 30-35g is presently available in Bangladesh (Anonymous, 2006). Mango belongs to the genus *Mangifera* and family Anacardiaceae (Kostermans and Bompard, 1993) and is known as the national tree of Bangladesh (Usman *et al.*, 2001). It is an important subtropical fruit with high commercial value in both national and export markets. United States Department of Agriculture provided that one cup of ripe mango pieces (165g) has 99 calories energy, small amount of fat (0.6g), and 25g of carbohydrates, 2.6g of fiber and 1.4g protein (Lehman, 2019). Mangoes also add high vitamins,

potassium, and folate (Lehman, 2019). Mango plants are grown in all homesteads, nurseries as well as most of the

orchards and now Bangladesh is ranking first in area and third in production (BBS, 2012). In a 1.53 lakh ha of land total mango production in the country is 2.99 lakh MT year⁻¹ with an average yield of 1.95 t ha⁻¹ (BBS, 2012).

Different insect pests play a significant role for the low yield and poor quality mango production in Bangladesh. Like other tree crops, several pests affect the mango production directly or indirectly and as many as 30 species of insect pests have been reported in the country (Alam, 1962). Among the pests, mango hoppers (*Idioscopus clypealis*) are considered to be the most destructive pests (Hossain, 1989a) and become a serious pest at flowering and fruiting stages (Kumari *et al.*, 2014) which can cause yield loss upto 80-100 percent (Rahman and Kuldeep, 2007). This hopper may cause a loss of 20 -100% of the inflorescence (Hossain, 1989b) and severely infested plants bear only a few fruits or no fruit at all. Mango hoppers (nymphs and adults) puncture

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and suck the sap from different growing parts of shoots, inflorescences and mango leaves which cause dropping of immature fruits (Adnan *et al.*, 2014). The lower amount of fruit set in mango can also be caused due to the self-incompatibility, predominance of male flowers, poor pollination, reduced pollen germination and pollen tube growth as well as unfavourable weather conditions prevailing at anthesis (Quintana *et al.*, 1984). Lower night temperatures during flowering reduced hermaphrodite flowers, fertile pollen and its germination, increased the proportion of abortive embryos and reduced fruit set (Dag *et al.*, 2000). The low fruit set and fruit retention resulted in the significant loss of fruit yield in mango (Singh, 1978). Extended damage of mango hopper is also an important reason of fruit setting and retention of mango by affect the pollinator (Hasan, 2003).

Use of pesticides has been the common practice to reduce hopper population in different mango-growing regions of the world. To control the pest, farmers use pesticides at improper doses and indiscriminately which not only disrupt the natural ecosystem but also causes the death of beneficial biocontrol agents and natural pollinators. However, considering the adverse effect of the chemicals, emphasis has been given on the application of botanical pesticides. The myco-pesticide based on *Beauveria bassiana* (Balsamo) has been used to control various insect pests like mango hopper (Babu *et al.*, 2001; Sharma, 2004). Scientific data on control of mango hopper and the use of pesticides in controlling it

in Bangladesh is very little in this promising commercial varieties of mango. Some field studies were also conducted by previous reporters (Hasan, 2003; Xie and Xie, 2000). This research work on mango hopper was attempted with the objectives to evaluate the efficacy of three botanical pesticides namely neem, karanja and mahogany oil and a microbial pesticide (*Beauveria bassiana*) in controlling mango hopper and on fruit setting and fruit retention of mango.

Materials and Methods

Geographically the experimental field was located at 24.75° N latitude and 90.50° E longitudes at an average height of 18 m above the mean of sea level. The experimental site belongs to the Old Brahmaputra Floodplain (AEZ-9). The region occupies a large area of Brahmaputra sediments, which are laid down before the river shifted into its present Jamuna channel 2 years ago (UNDP and FAO, 1988). Morphological characteristics of the soil of the experimental site have been presented in Table 1. Non-calcareous dark-grey, floodplain soils are generally predominant in the site. The land was medium high and the soil was silty-loam and well drained and its general fertility level was low. The soil of the experimental field was more or less neutral in nature, low in organic matter content (Table 1). The experimental area was characterized by moderately low temperature, low humidity and scanty rainfall during the February 2014 –April 2015.

Table 1. Morphological characteristics of soil of the experimental field

Morphology	Characteristics
Location	Aqua, Sadar, Mymensingh.
Agro-ecological zones (AEZ-9)	Old Brahmaputra Floodplain
General soil type	Non-calcareous Dark-grey floodplain
Soil series	<i>Sonatola</i>
Parent material	Brahmaputra river borne deposits
Land type	Medium high land
Topography	Fairly level
Flood level	Above flood level
Drainage system	Moderate
Textural class	Silty loam
Soil pH	6.82
Organic matter (%)	1.19
Vegetation	Cropped with rice, wheat, jute etc.

Botanical pesticides were collected from IPM Laboratory of Entomology Department, BAU, Mymensingh. A microbial pesticide (*Beauveria bassiana*) was collected from Ispahani Biotech. Company in Bolaspur, Mymensingh. Commercial formulation of *Beauveria bassiana* was used to conduct the experiment.

To conduct experiments six mango trees were selected in Aqua, Mymensingh. The variety of the mango was Amrapali which is a mango hybrid (Dashehari × Neelum) and gaining popularity for its dwarf stature and regular bearing in nature. The experiment was conducted in the Aqua, Mymensingh during February 2014– April 2015. Standing mango trees were selected to conduct

this experiment. The layout of experiment was designed in randomized complete block design (RCBD) with 3 replications (1 plant was used as a unit per replication),

where only two factors were considered the number of flowers and the number of fruit set. Three botanicals and one microbial pesticide each with 3 different doses were evaluated for their efficacy. The used botanical pesticides were neem oil, mahogoni oil and Karanja oil with the dose of 1%, 2% and 3% for each pesticide. The used microbial pesticide was *Beauveria bassiana* with the dose of 1%, 2% and 3%. Pesticides were sprayed two times: first spraying was done within 10 days of flowering when the flower buds were not opened and the second spraying was done after one month of the first

application when the mango fruit was as pea shaped. With the help of hand sprayer pesticides were sprayed to the selected inflorescence only and all the necessary precautionary measures were taken during the application of pesticides. The percent reduction of infestation over control was estimated with the following equation:

$$\% \text{ reduction of infestation} = \frac{\text{Difference of infestation of control and treatment}}{\text{Infestation in control}} \times 100$$

The percentage of fruit set was calculated from the number of bloomed flowers and number of fertilized flowers using the following formula:

$$\text{Percentage of fruit set} = \frac{\text{No. of fertilized flowers}}{\text{No. of bloomed flowers}} \times 100$$

The above observations were made on 7, 30 and 45 days after flowering. Obtained data were analyzed statistically after appropriate transformation using analytical computer software MSTAT and mean values were separated using DMRT.

Results and Discussion

Percentage of mango leaf hopper killed in lab condition

The data regarding comparative efficacy of pesticides at 6DAT on the basis of number of hoppers killed are presented in Fig. 1. The efficacy of the pesticides varied significantly according to their types and increasing dose. Among the treatments, *B. bassiana* (2 and 3% dose) showed highest efficacy (100%) to kill the mango hopper (both adult and nymph) at 6DAT. On the contrary, lowest pesticide efficacy was observed with control treatment. Among the botanicals, the highest efficacy was obtained from neem oil (3% dose) and the lowest was from Karanja oil (1% dose). Another study (Prabhakara et al., 2011) found similar results with the application of *B. bassiana* @ 6ml and reported maximum population reduction (82.29%) of mango hopper, whereas about 43.46 and 60.67% reduction was found with 2 ml and 4ml respectively. Annual Report Entomology Division of Bangladesh Agricultural

Research Institute (BARI, 2013) found satisfactory result with *B. bassiana* @ 5.0 g/litre to reduce the population of both nymph and adult mango hopper over control.

Reduction of mango hopper (%) over control

The percent reduction of infestation over control of the hopper at the flowering stage was maximum with the application of 3% *Karanja* oil (20.29) and lowest (1.04%) was found in 1% *Mahogany* oil (Table 2) which indicated the best efficacy of 3% *Karanja* oil than any other pesticide at this stage. But infestation reduction over control at pea-shaped after prior to second spray was highest (54.75) with 3% *B. bassiana* and the lowest (14.38%) was found in 1% *Mahogany* oil (Table 2). At fifteen (15) days after second spray, maximum reduction (100%) was found with all the three doses of *B. bassiana* as no hopper was found after treating with this dose (Table 3). Among the botanicals, the lowest percent of infestation reduction over control was found with 1% *Mahogany* oil (22.20%). Prabhakara et al. (2011) found that higher doses of *B. bassiana* are responsible for higher percent of hopper population mortality.

Effect of B. bassiana on fruit setting of mango

To determine the fruit setting data were recorded at flowering stage after prior to first spray and at pea shaped after prior to second spray that was given in Table 3. At flowering stage average number of flower was maximum in 1% *B. bassiana* (55.14%) that was statistically similar to 2%, 3% *B. bassiana*, 2%, 3% neem and 2%, 3% *Karanja* oil. On the other hand, the lowest no. of flower was found in 3% *Mahogany* oil (46.78%). The lowest no of flower 43.87% was recorded from control or untreated plant. In controlled plant, at flowering stage average no. of flower was 43.87% which was lower than lowest percentage. So, pesticides have effect on flowering. After application of pesticide prior to second spray, highest percentage of fruit setting was found in 1% *B. bassiana* (8.33%) that was statistically similar to 2% *B. bassiana* and the lowest no. of fruit setting was found in 1% *Mahogany* oil (3.6%).

Efficacy of microbial pesticide & botanicals on hopper

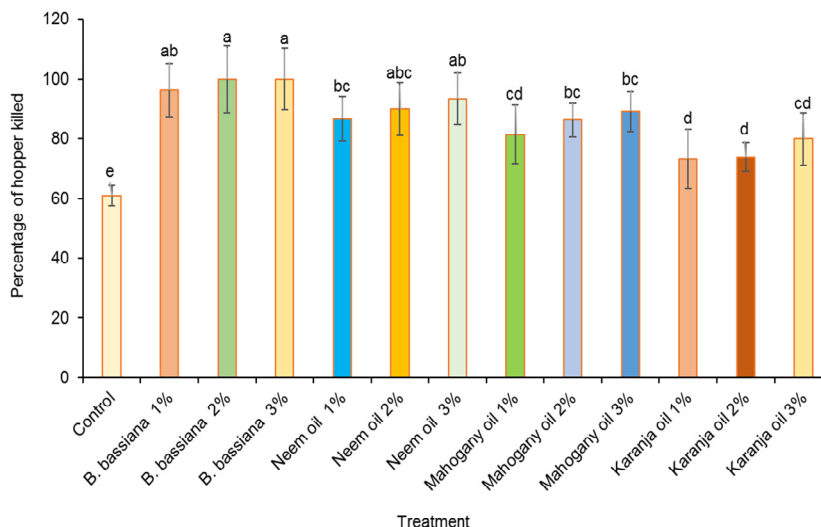


Fig. 1. Efficacy of a microbial pesticide (*Beauveria bassiana*) and botanicals based on percentage of mango hopper killed

Table 2. Efficacy of microbial pesticide (*B. bassiana*) and botanicals on the percent protection of infestation of mango hopper

Treatments	Percent protection over control		
	Before 1st spray at flowering (PFS) stage	After 1st spray at Fruit setting (when pea shaped/PSS) stage	After 2nd spray at Fruit setting (15 DASS/DAP) stage
<i>Beauveria bassiana</i> 1%	2.67a	39.51f	100.00e
<i>Beauveria bassiana</i> 2%	4.31a	46.48g	100.00e
<i>Beauveria bassiana</i> 3%	6.52ab	54.75h	100.00e
Neem oil 1%	7.96ab	30.06d	32.89bcd
Neem oil 2%	7.70ab	31.48de	41.07d
Neem oil 3%	9.52ab	35.68ef	42.33d
Mahogany oil 1%	1.04a	14.38a	22.20a
Mahogany oil 2%	4.11a	20.99b	26.92ab
Mahogany oil 3%	5.35a	22.41b	29.62abc
Karanja oil 1%	13.05ab	23.89bc	27.11ab
Karanja oil 1%	19.70b	27.96cd	33.27bcd
Karanja oil 3%	20.29b	28.64cd	37.92cd
LSD _{0.05}	1.86	0.837	1.39
CV (%)	7.85	4.34	9.63

Table 3. Effect of a microbial pesticide (*B. bassiana*) and some botanicals against on fruit setting of mango

Treatment	Average no. of flower (PFS)	Average no. of fruit set (when pea shaped/PSS)	% fruit set (when pea shaped/PSS)
<i>Beauveria bassiana</i> 1%	55.14 a	8.33 a	15.11 a
<i>Beauveria bassiana</i> 2%	53.50 ab	7.30 ab	13.64 b
<i>Beauveria bassiana</i> 3%	51.75 abc	6.62 bc	12.79 bc
Neem oil 1%	49.67 bcd	4.97 def	10.01 def
Neem oil 2%	52.75 ab	5.76 cdef	10.92 de
Neem oil 3%	53.67 ab	6.15 cd	11.46 cd
Mahogany oil 1%	48.33 cd	3.60 g	7.45 g
Mahogany oil 2%	50.71 bcd	4.80 ef	9.47 ef
Mahogany oil 3%	46.78 de	5.00 def	10.69 def
Karanja oil 1%	50.41 bcd	4.67 fg	9.26 f
Karanja oil 2%	51.80 abc	5.55 cdef	10.71 def
Karanja oil 3%	52.10 abc	5.93 cde	11.38 cd
Control	43.87 e	1.54 h	3.510 h
LSD _{0.05}	3.78	1.08	1.38
CV (%)	4.44	11.96	7.93

Means followed by different letters (using DMRT) in a column are significantly different; PFS = Prior to First Spray, PSS = Prior to Second Spray

Table 4. Effect of a microbial pesticide (*B. bassiana*) and some botanicals on fruit retention of mango

Treatment	Average no. of fruit retention (15 DASS/DAP)	% fruit retention (15 DASS/DAP)
<i>Beauveria bassiana</i> 1%	5.79a	10.50a
<i>Beauveria bassiana</i> 2%	5.33ab	9.96a
<i>Beauveria bassiana</i> 3%	4.81bc	9.29a
Neem oil 1%	3.33e	6.70cd
Neem oil 2%	3.96cde	7.51bcd
Neem oil 3%	4.33cd	8.07b
Mahogany oil 1%	2.35f	4.86e
Mahogany oil 2%	3.15ef	6.21d
Mahogany oil 3%	3.37e	7.20bcd
Karanja oil 1%	3.14ef	6.23d
Karanja oil 2%	3.67de	7.08bcd
Karanja oil 3%	4.01cde	7.70bc
Control	1.15g	2.62f
LSD _{0.05}	0.837	1.16
CV (%)	13.41	9.60

Means followed by different letters (using DMRT) in a column are significantly different; DAP = Days after Pea Shaped, PFS = Prior to First Spray, PSS = Prior to Second Spray, DASS = Days after Second Spray

Percentage of fruit set was maximum in 1% *Beauveria bassiana* (15.11%) and lowest percentage was found in 1% Mahogany oil (7.45%). The lowest no of fruit set 3.51% was recorded from control or untreated plant. Among the microbial and botanicals, microbial pesticide (*Beauveria bassiana*) had better performance on fruit setting than botanicals. Among botanicals, 3% neem oil (11.46%) had better performance on fruit setting that was statistically similar to 3% karanja oil (11.38%) and the lowest no. of fruit setting was found in 1% Mahogany oil (7.45%). In comparison to controlled plant pesticide had importance on fruit setting. In controlled plant fruit set was 3.51% where microbial pesticide 1% (*Beauveria bassiana*) had 15.11% fruit set and 1% Mahogany oil had 7.45%. This result was about to same to Prabhakara *et al.* (2011) study. They also said that fruit setting loss was minimum in case of microbial pesticide application. The present result clearly indicates that the application of fungus could improve the loss of fruit setting suppressing the hopper population significantly in field condition, though fungal infected hopper was few in field condition. The possible reason could be high migratory behavior of hopper which made them escaped from our observation. Other possibilities also could be some repellent action of the oil used as carrier in formulation. Further studies would be carried to device suitable method to establish the infection in field condition and also exploring the potential of fungus to include as an IMP input to manage mango hopper in mango ecosystems. Prabhakara *et al.* (2011) found that observation on fruit setting that all the treated dosage of Myco-jaal could reduce the loss in fruit setting significantly over control and the lowest reduction (13.33%) was recorded in 6m/L of Myco-jaal where as 34.78% and 45.45% was recorded in 2m/L and 4m/L of Myco-jaal, respectively.

Effect of B. bassiana and some botanicals on fruit retention of mango

Results revealed that average number of flowers was maximum in 1% *Beauveria bassiana* (55.14%) at flowering stage that was statistically similar to 2%, 3% *Beauveria bassiana*, 2%, 3% Neem, and 2%, 3%

Karanja oil. On the other hand, lowest no. of flower was found in 3% Mahogoni oil (46.78%). In controlled plant, at flowering stage, average number of flowers was 43.87% which was lower than lowest percentage (Table 3). After application of pesticide 15 days after second spray, highest percentage of fruit setting was found in 1% *Beauveria bassiana* (5.79%) that was statistically similar to 2% *Beauveria bassiana* and lowest number of fruit setting was found in 1% mahogoni oil (2.35%). Percentage of fruit retention was maximum in 1% *Beauveria bassiana* (10.50%) and lowest percentage was found in 1% mahogoni oil (4.86%). The lowest no of fruit retention 2.62 % was recorded from control or untreated plant. Among the microbial and botanicals, microbial pesticide (*Beauveria bassiana*) had better performance on fruit retention than botanicals. Among botanicals 3% neem oil (8.07%) had better performance on fruit retention that was statistically similar to 3% mahogoni oil and 3% Karanja oil. The lowest fruit retention was found in 1% mahogoni oil (4.86%) as presented in Table 4.

In comparison to controlled plant pesticide had importance on fruit retention. In controlled plant fruit retention was 2.62% where microbial pesticide 1% (*Beauveria bassiana*) had 10.50% (maximum) fruit retention and 1% Mahogany oil had 7.45% (minimum). Higher the percentage of fruit retention, higher is the yield. The present study indicates that microbial pesticide had positive effect on fruit retention. Side effect was less in microbial pesticide than chemical pesticide application. So microbial pesticide is worth mentioned to increase mango fruit. Similar trend was observed when cumulative hopper population caught in sticky trap was recorded and the lowest was found in the control and the lowest in neem treated plants followed by different doses of fungus with a clear indication that the dosage had a positive impact in reduction of hopper population. Previous report (BARI, 2013) showed that synthetic pesticide (Tido 20 SL @ 0.5 ml L⁻¹ of water) given the highest fruit retention over control although satisfactory result with *Beauveria bassiana* @ 5.0 g/litre was also obtained in that study.

Conclusion

This experiment revealed that microbial pesticide (*Beauveria bassiana*) had better performance on fruit setting than botanicals. Among botanicals 3% neem oil (11.46%) had better performance on fruit setting that was statistically similar to 3% Karanja oil (11.38%) and the lowest no. of fruit setting was found in 1% Mahogany oil (7.45%). Percentage of fruit retention was maximum in *Beauveria bassiana* 1% (10.50%) and lowest percentage was found in mahogoni oil 1% (4.86%). Among botanicals neem oil 3% (8.07%) had better performance on fruit retention that was statistically similar to Mahogany oil 3% and Karanja oil 3%. To tell in a nut shell, microbial pesticide (*Beauveria bassiana*) had better performance in controlling mango hopper, increasing fruit setting and ultimately resulting higher yield than botanicals.

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