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MANAGEMENT OF RED PUMPKIN BEETLE AND FRUIT FLY IN ASH GOURD USING BIORATIONAL INSECTICIDES

Rubina Parvin[1], Md Ruhul Amin[1], Mansura Afroz[1], Mohammad Zahangeer Alam[2] and Md Ramiz Uddin Miah[1*]

[1]Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh. [2]Department of Environmental Sciences, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.

Corresponding e-mail: ramizmiah@bsmrau.edu.bd

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ABSTRACT

Ash gourd *Benincasa hispida* Thumb., a cucurbit vegetable, faces frequent infestation of red pumpkin beetle and cucurbit fruit fly. Farmers in Bangladesh mainly apply conventional synthetic insecticides to protect crops from the attack of these pests. The current study was conducted in the experimental field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during March 2021 to July 2021 to know the effects of five biorational insecticides, namely Biotrin (matrine), Proclaim (emamectin benzoate), Sunmectin (abamectin), Mahogany oil and Neem oil on the abundance and infestation of red pumpkin beetle and fruit fly infesting ash gourd. The insecticides were applied 3 times maintaining 7 days interval. Results showed significant reduction of the insect population compared to untreated control. Sunmectin (1.55±0.34) treated plot showed the lowest abundance of red pumpkin beetle after the 3rd spray with 65% reduction of population compared to untreated control plot. Biotrin (8.59±1.00%) treated plot showed the lowest leaf and flower infestation by red pumpkin beetle after 3rd spray, with the reduction (69% in both) over control. The lowest fruit infestation was found in Sunmectin treated plot (23.01±8.05%). The highest yield of ash gourd (17.9 T/ha) was recorded from Sunmectin treated plot which showed statistical similarity to Proclaim (16.01 T/ha) and Biotrin (15.90 T/ha) treated plots with 3.5, 2.5 and 2.6 benefit cost ratio, respectively. Therefore, it could be concluded that Sunmectin, Proclaim and Biotrin were more effective to control the infestation of red pumpkin beetle and fruit fly of ash gourd than the other tested insecticides.

Keywords: *Aulacophora foveicollis, Bactrocera cucurbitae, Benincasa hispida,* biorational insecticides

Introduction

Ash gourd *Benincasa hispida* Thumb., is one of the most common summer vegetables grown in Bangladesh. In Bangladesh, total production of ash gourd is about 78845 metric tons from 25305 acres of land and the average yield is about 34 t/ha which is very low (BBS 2019). Different limiting factors are responsible for this low yield of ash gourd, among which the attack of red pumpkin beetle *Aulacophora foveicollis* Lucas and fruit fly *Bactrocera cucurbitae* Coquillett are the most common (Butani and Jotwani 1984). Beetle starts to attack the plant right after the germination and slows down the growth due to severe damage (Khan 2015). Losses by the attack of this pest are obvious which ranges from 35-75% at seedling stage and it declines as canopy increases (Saljoqi and Khan 2007). On the other hand, the extent of yield loss caused by the fruit fly to cucurbitaceous vegetables ranged from 30 to 100%, depending upon cucurbit species and the season (Nath and Bhusan 2006).

Biorational insecticides are composed of natural products likely animals, plants, microbes, and minerals, or are their derivates. They are synthetic or natural compounds that effectively control insect pests without affecting non-target organisms and environment (Hara, 2000). Botanical extracts or non-chemical materials (black pepper powder, neem oil, eucalyptus oil, mahogany oil, neem leaf extract, basil leaf extract, garlic extract, etc.) are cheap, safe to apply, unique in action and can easily be processed. In addition, they have little or no effect against beneficial spiders, ladybird beetles, parasitoid wasp and predatory mites and insects (Robinson and Decker-Walter 1999). As a result, these insecticides are becoming popular day by day and are being used against many insect pests of different crops now-a-days. Considering the above facts, the study was conducted to evaluate the effectiveness of some biorational insecticides for the management of red pumpkin beetle and fruit fly on ash gourd and to find out the benefit cost ratio of the insecticides.

Materials and Methods

Cultivation of ash gourd: The study was conducted with ash gourd in the experimental field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University during March 2021 to July 2021. The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. The experimental field was divided into 3 blocks and each block was again divided into 6 plots. So, the land was divided into 18 equal plots (3m × 2m) with plot-to-plot distance 1.0 m. Seeds of the ash gourd variety BARI chalkumra-1 were collected from Bangladesh Agricultural Research Institute, Gazipur and the seedlings were raised in polybags. Seedlings were transplanted in the experimental plots on 18 April 2021. Fertilizers were applied according to Fertilizer Recommendation Guide: N- 20 kg, P- 10 kg, K- 15 kg and S- 6 kg per hectare, cow dung 5 t ha^{-1} (FRG, 2018). Intercultural operations were done on necessity based.

Application of biorational insecticides: Feld inspection was done at weekly intervals and the biorational insecticides were applied at the advent of the infestation of red pumpkin beetle. Five biorational insecticides along with untreated control treatments were used in this study. The insecticide treatments were Biotrin (matrine) with concentration of 1.5 ml/1 of water, Proclaim (Emamectin Benzoate) with concentration of 1g /1 of water, Sunmectin (Abamectin) with concentration of 1ml /1 of water, Mahogany oil with concentration of 5 ml/1 of water, Neem oil with concentration of 5 ml/1 of water. The insecticide treatments were applied seven days interval at 44, 51 and 58 days after transplanting.

Data collection: Data on the abundance of red pumpkin beetle were counted from randomly selected three leaves of each of the three plants per plot at 7 days after every spray of the insecticides. On the other hand, total number of leaves and number of infested leaves within one meter length of a vine (from the apical portion) of the plants were counted. After 1st initiation of flower (42 days after transplant), careful observation was done. Total number of flowers and the number of red pumpkin beetle infested flowers from every plant were recorded. To collect data on the fruit fly infestation, the infested and healthy fruits were recorded at weekly intervals. From the collected data, the rates of leaf, flower and fruit infestations were calculated into percentage.

Yield and calculation of benefit-cost ratio: The mature healthy fruits of each plot were harvested and the yield of each plot was measured. Then the yield of each treatment was converted in to t ha^{-1}. The economic analysis and benefit-cost ratio (BCR) were calculated based on the total expenditure for each treatment (costs for labor and inputs) and the total return per hectare (total price obtained from total yield). The net return was calculated by subtracting the expenditure of a treatment from its gross return. The adjusted net return of each treatment was calculated by subtracting the net return of the control from the net return of the treatments. The BCR is the result of the adjusted net return of a treatment divided by the total expenditure of the same treatment.

Data analysis: One-way analysis of variance followed by Tukey HSD posthoc test (at 5% level of significance) was done to determine the efficacy of the insecticides against the abundance and infestation of red pumpkin beetle and fruit fly infesting pumpkin. The analyses were performed using IBM SPSS 20.0.

Results and Discussion

The abundance of red pumpkin beetle after using different biorational treatments is presented in Table 1. The results showed significant differences after 1st, 2nd and 3rd sprays of the insecticides and all the treatments revealed significantly lower abundance compared to control. Abundances after 1st, 2nd and 3rd sprays ranged from 3.1±0.2 to 4.7±0.3, 1.7±0.2 to 3.3±0.3 and 1.6±0.3 to 4.4±0.3, respectively. After 1st spray, the lowest abundance was found in Sunmectin (3.0±0.2) treated plot which was statistically similar to Biotrin (3.1±0.2) and Proclaim (3.4±0.2) treated plots. After 2nd spray, the lowest infestation was found in Sunmectin (1.7±0.3) treated plot which was statistically similar to Biotrin (1.8±0.2) treated plot. After 3rd spray, the lowest anundance was observed in Sunmectin (1.55±0.34) treated plot. In case of Mahogany oil (3.0±0.3), Biotrin (1.9±0.4), Proclaim (1.9±0.3) and Neem oil (2.7±0.2) treated plots, the abundance of red pumpkin beetle was statistically similar. After 3 consecutive sprays, the reduction in the number of red pumpkin beetle over untreated control was 30-65%.

Table 1. Abundance of red pumpkin beetle on ash gourd plant after spraying of biorational insecticides

Insecticide treatments	Abundance (number/3 plants) of red pumpkin beetle after			Reduction over control after 3rd spray (%)
	1st spray	2nd spray	3rd spray	
Biotrin	3.1±0.2c	1.8±0.2c	1.9±0.4bc	30
Proclaim	3.4±0.2c	2.3±0.4bc	1.9±0.3bc	58
Sunmectin	3.0±0.2c	1.7±0.3c	1.6±0.3c	65
Mahogony oil	3.9±0.3bc	2.7±0.2b	3.0±0.3b	32
Neem oil	3.9±0.1bc	2.3±0.3bc	2.7±0.2bc	40
Control	4.7±0.3a	3.3±0.3a	4.4±0.3a	-

Data expressed as mean±S.E. Means within a column followed by no common letter(s) are significantly different by Tukey posthoc statistic at $P \leq 0.05$.

The leaf infestation level after 1st, 2nd and 3rd sprays of the biorational insecticides is presented in Table 2. The leaf infestations after 1st, 2nd and 3rd sprays ranged from 20.4 ±0.2% to 31.9±1.8%, 11.8±0.8% to 30.2±1.5%. and 8.6 ±1.0% to 28.9±1.3%, respectively. All the treatments revealed significantly lower infestation rates compared to control. After first spray, Sunmectin (20.4±0.2%) and Biotrin (20.7±0.9%) treated plots had the lowest and statistically similar level of leaf infestation. After 2nd spray, the lowest leaf infestation was found in Biotrin (11.8±0.8%) treated plot which was statistically similar to Sunmectin (12.0±0.5%). After 3rd spray, Biotrin (8.6±1.0%), Sunmectin (8.7±1.2%) and Proclaim (12.8±0.8%) treated plots showed statistically similar and the lowest leaf infestation. The reduction percentage of leaf infestation ranged from 37 to 69% after the 3rd sprays and Biotrin and Sunmectin treated plants showed the highest and similar reduction percentage which was followed by Proclaim (56%) treated plant.

The flower infestation rates after 1st, 2nd and 3rd sprays varied from 14.9±2.3 to 36.7±0.6, 11.9±1.9 to 34.2±1.9 and 7.2±0.7 to 23.2±2.3%, respectively (Table 3). All the treatments revealed significantly lower infestation rates compared to control. After 1st spray, Proclaim treated plot showed the lowest flower infestation (14.9±2.3) which was statistically similar to Biotrin (15.1±3.9) and Sunmectin (15.6±3.8) treated plots. After 2nd spray, the lowest flower infestation (11.9±1.9) was found in Procliam treatment, which was statically similar to Sunmectin (13.5±1.6) and Biotrin (13.7±4.7) treated plots. After 3rd spray the lowest flower infestation (7.2±0.7) was found in Biotrin treated plants, which was statistically similar to Proclaim (9.3±1.3) and Sunmectin (10.3±4.9) treatments. The reduction percentage of flower infestation after 3rd sprays was 31% to 69% over untreated control.

Fruit infestation percentage showed statistically significant variations among the treatments (Fig. 1). Fruit infestation rates among the treatments varied from 23.1±8.5 to 62.5±3.6% and the lowest and statistically similar results were found in Biotrin and Sunmectin treated plots.

Table 2. Effects of different biorational insecticides on the leaf infestation (%) of ash gourd by red pumpkin beetle

Insecticide treatments	Leaf infestation (%) after			Reduction over control after 3rd spray (%)
	1st spray	2nd spray	3rd spray	
Biotrin	20.7±0.9b	11.8±0.5c	8.6±1.0c	69
Proclaim	25.2±1.3ab	13.2±0.4bc	12.8±0.8c	56
Sunmectin	20.4±0.2b	12.0±0.5c	8.7±1.2c	69
Mahogony oil	27.4±0.1ab	16.9±1.1b	17.91.1b	38
Neem oil	27.6±2.9ab	15.9±0.8bc	18.34±0.8b	37
Control	31.7±1.8a	30.2±1.5a	28.9±1.3a	-

Data expressed as mean± S.E. Means within a column followed by no common letter(s) are significantly different by Tukey posthoc statistic at $P \leq 0.05$.

Table 3. Effects of different biorational insecticides on the flower infestation (%) of ash gourd by red pumpkin beetle

Insecticide treatments	Flower infestation (%) after			Reduction over control after 3rd spray (%)
	1st spray	2nd spray	3rd spray	
Biotrin	15.1±3.9b	13.7±4.7b	7.2±0.7b	69
Proclaim	14.9±2.3b	11.9±1.8b	9.3±1.3b	60
Sunmectin	15.6±3.8b	13.5±1.6b	10.3±4.9b	56
Mahogony oil	24.5±7.1ab	18.7±2.0b	15.9±2.1ab	31
Neem oil	26.2±4.8ab	20.3±4.9ab	14.5±1.2ab	38
Control	36.7±0.6a	34.2±1.9a	23.2±2.3a	-

Data expressed as mean± S.E. Means within a column followed by no common letter(s) are significantly different by Tukey posthoc statistic at $P \leq 0.05$.

The yield of ash gourd among the treatments showed statistically significant variations and all the biorational treatments revealed statistically higher yield compared to control (Fig. 2). The yield ranged from 7.8 to 17.9 t/ha. The highest yield was recorded (17.9 Mt/ha) from Sunmectin treated plot which was statistical similarity to Proclaim (16.01 T/ha) and Biotrin (15.90 T/ha) treated plots. Nahar (2021) reported that Fytomax 3EC (containing the active ingredient of neem) reduced the fruit fly infestation upto 21.26 and 28.48% (n/n and w/w, respectively) at early fruiting stage of sweet gourd which was almost similar to the present findings.

Management costs and benefit-cost ratios under different biorational management practices are represented in Table 4. Results showed that the management cost, gross return, net return, adjusted net return and benefit-cost ratios among the treatments varied from Taka 29227.00 to 57520.00, 252445.00 to 400250.00, 194000.00 to 392980.00, 29227.00 to 198980.00 and 1.0 to 3.5, respectively. The highest management cost, gross return, net return, adjusted net return and benefit-cost ratios were found in the plots treated with Proclaim followed by Sunmectin, Biotrin, Neem oil and Mahogany oil.

The results obtained from this study clearly indicated that the abundance of red pumpkin beetle among the treatments varied, and the biorational insecticides significantly reduced the infestations on both leaves and flowers. The infestation of fruit by fruit fly among the

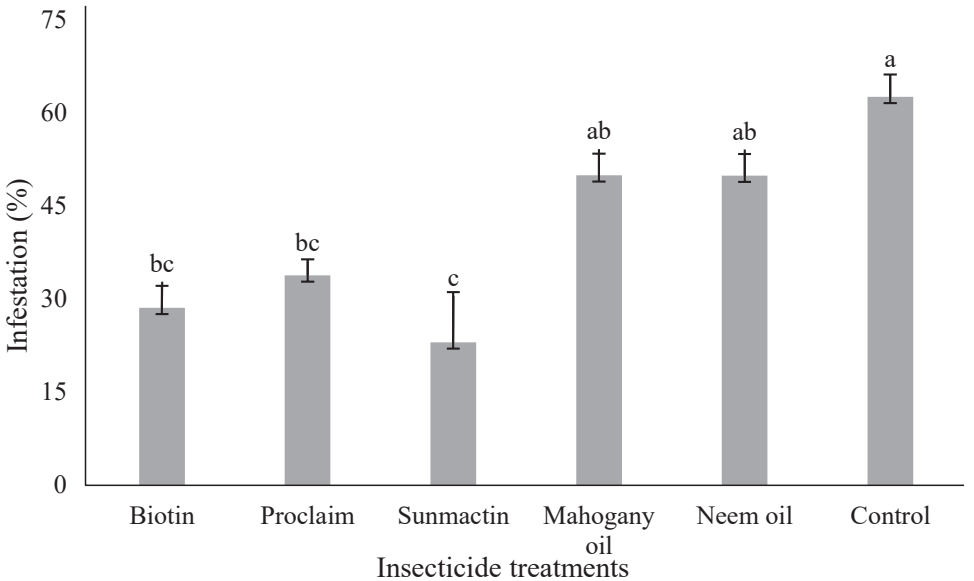


Figure 1. Effects of different biorational insecticides on fruit infestation of ash gourd by fruit fly. Data expressed as mean ± S.E. Bars with no common letter(s) are significantly different by Tukey posthoc statistic at $P \leq 0.05$.

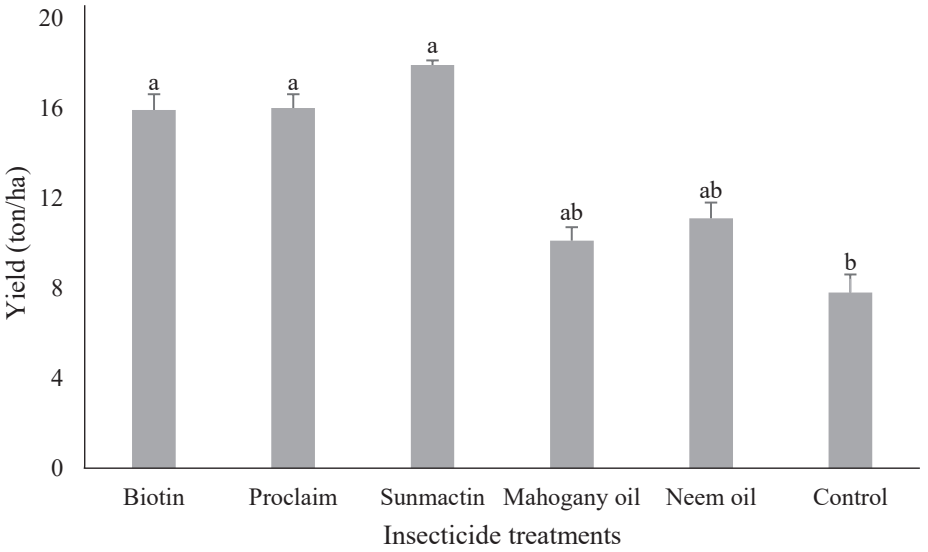


Figure 2. Effects of different biorational insecticides on the yield of ash gourd. Data expressed as mean ± S.E. Bars with no common letter(s) are significantly different by Tukey posthoc statistic at $P \leq 0.05$.

treatments was also significantly reduced. Sunmectin was the most effective in reducing the abundance of beetle on the plants. Plant derived biorational insecticides possess anthraquinones, monoterpenoids, naphthoquinones, phenols, and related alkaloids that affect the abundance and infestation of the insects (Bakkali *et al.* 2008, Kim *et al.* 2010). In this study, biorational insecticide treated plots revealed a higher yield compared to untreated control. The treatments reduced abundance and infestation of the insect pests and contributed to higher yields. The yield reduction in the control was attributed to the injury and damage caused by the beetle and fruit fly.

Many authors reported the efficiency of biorational insecticides against the abundance and infestation of different insect pests. Plant materials as biorational insecticides reduced abundance and infestation of fruit fly in ash gourd and biter gourd field (Amin *et al*. 2017a, Shafiullah *et al.* 2017). Amin *et al.* (2017b) found that sequential applications of bio-pesticide, botanical and chemical insecticide reduced the abundance and infestation of aphid in yard long bean field. Ahmed *et al.* (2019) reported that the Neem oil and Mahogany oil significantly reduced the abundance and infestation of aphid in country bean field and revealed higher yield and benefit cost ratio compared to untreated control. Biorational insecticides affect the metamorphosis, longevity and reproduction of the insect pests and suppress their population and infestation; however they do not have fatal effect on the growth and development of the predator and parasitoid insects, and entomopathogenic fungi.

Table 4. Benefit cost ratio calculation of different biorational insecticides used for management of red pumpkin beetle and fruit fly in the ash gourd field

Insecticide treatments	Management cost (Taka)	Gross return (Taka)	Net return (Taka)	Adjusted net return (Taka)	Benefit-cost ratio
Biotrin	56250.0	397500.0	3412250.0	147250.0	2.6
Proclaim	57520.0	400250.0	342730.0	148730.0	2.5
Sunmectin	56520.0	449500.0	392980.0	198980.0	3.5
Mahogany oil	29227.0	252445.0	223218.0	29227.0	1.0
Neem oil	33800.0	277475.0	243675.0	49675.0	1.4
Control	-	194000.0	194000.0	-	-

The findings of the study showed that the biorational insecticide Sunmectin and Biotrin was the most effective in reducing the infestation of red pumpkin beetle. Again, Sunmectin, Biotrin and Proclaim significantly reduced the fruit infestation by fruit fly. The highest benefit cost ratio was obtained in case of Sunmectin treated plots. So, Sunmectin, Biotrin and Proclaim can be incorporated in integrated pest management program for controlling red pumpkin beetle and cucurbit fruit fly in ash gourd.

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