Original Research Article

Eco-friendly management of fruit fly (*Bactrocera cucurbitae) infesting* Bitter gourd

ABSTRACT

Aims: This study aimed to evaluate some Bio insecticides and bio-pesticides and management against fruit fly in bitter gourd.
Study Design: The experiment was laid out at a randomized complete block design with three replications.
Place and Duration of Study: Experimental farm of Sher-e-Bangla Agricultural University, Bangladesh during the period from February,2022 to july,2022.
Methodology: The experiment consisted of seven treatments viz. T_1(Lycomax 2g/lit of water+ Cutrac+ Yellow Sticky trap+ Sanitation), T_2(Lycomax 2g/lit of water+ Ceranock+ Yellow Sticky trap+ Cultural control), T_3 (Biomax M 1.2 EC+ Cuelure+ Yellow Sticky trap), T_4 (Lycomax 2g/ lit of water+ Yellow Sticky trap), T_5 (Biomax M 1.2 EC + Ceronock+ Cutrac), T_6 Sanitation+ Cultural control+ Cuelure), T_7 (Untreated Control) were used at 7 days interval.

Results: The degree of the fruit fly (*Bactrocera cucurbitae*) infestation at various phases of bitter gourd ripening was investigated in the field and in the lab, as well as the effectiveness of some bio-pesticides and other control methods used in combination. Among all treatments the highest number of fruit fly was captured in Lycomax 2g/lit of water+ Ceranock+ Yellow Sticky trap+ Cultural control treated plot.Healthy fruit per plant (9.50 fruit/plot) also found from T_2 treated plot. whereas the maximum amount of infested fruit number (12.21 fruit/plot), number of punctures per fruit (6.74 puncture/fruit) and infested fruit weight (77.13gm) was found from the control plot. The highest percentage reduction of puncture number over control resulted in treatment T_2 treated plot which was 92.58% which is near to treatment T_4 (85.16%) and also highest amount of healthy fruit weight (232.75 gm) came from T_2. In terms of maximum yield (2.54 kg/ plot) gained from Lycomax 2g/lit of water+ Ceranock+ Yellow Sticky trap+ Cultural control treated plot (T_2). From the study it was found that all the treatments except control (T_7) work effectively against fruit fly infestation.
Conclusion: It is concluded that T_2 treatment (Lycomax 2g/lit of water+ Ceranock+ Yellow Sticky trap+ Cultural control)

Keywords: Fruit fly; Bittergourd; Biomax ; Lycomax; Sticky trap; Ceronac; Cultural control

1. INTRODUCTION

"The Cucurbit fruit fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae), is one of the most serious polyphagous insect pests of cucurbits, representing 74.5% of the total number of flies infesting different vegetables growing in Bangladesh" [1]. "More than 125 host plants were reported worldwide, while 81 crop plants were reported from Bangladesh" [2]. "It is a major pest of cucurbitaceous vegetables, especially the bitter gourd, musk melon, snap melon, snake gourd, and ridge gourd, in Bangladesh" [3]. "As a result, the high prevalence of fruit fly infestation is a significant constraint on cucurbit yield and quality. The maggots of *B. cucurbitae* are responsible for causing damage by feeding internally on fruit pulp and making tunnels in fruits. The infested fruits become rotten and shed prematurely. If the fruits are not rotten, they become deformed and lose a significant portion of their market value. Sometimes, female adults make pseudo-punctures on the skin of the young fruits, which also reduce their market price adversely" [4]. "It is responsible for causing 30–100% yield losses depending on susceptible varieties, suitable weather conditions, and management practices" [5]. "Other than fruits, this pest also causes a loss of about 9.7% in female flowers" [6]. "Among different cucurbitaceous vegetables, bitter gourd (*Momordica charantia* L.) was reported as the most favorable host for *B. cucurbitae,* having the highest infestation rate (41–89%) and the shortest pre-mating, pre-oviposition, incubation, larval, and pupal periods" [7].
"Fruit fly management in the cucurbitaceous vegetable crops, including bitter gourd, is reasonably difficult because the maggot of *B. cucurbitae* is an internal feeder. Farmers in Bangladesh are exclusively relying on different kinds of broad-spectrum chemical insecticides of different groups like organophosphorous, organocarbamate, nicotinoids, older pyrethroids, etc. to control *B. cucurbitae"* [8]. "In some areas of Bangladesh, farmers spend about 25% of the cultivation cost on bitter gourd production only to buy toxic pesticides" [9]. "About 99 percent of farmers sprayed insecticides and fungicides in their fields to protect crops from different insect pests and diseases. Thirty-nine percent of farmers used pheromone traps for crop protection" [10]. "The majority of the farmers had a moderately favourable attitude towards IPM technology for producing bitter gourd, as shown by the farmers' attitude index" [11].

“However, the increasing use of synthetic chemical insecticides has led to a number of problems, such as the development of resistance to insecticides in insect pests, high insecticide residues in market produce, resurgence or increased infestation by some insect species due to the destruction of natural predators and parasitoids, changing the pest status of mites and other minor insect pests to major ones, ecological imbalance, and danger to the health of the pesticide applicator” [12]. “Because of their selective mode of action, low residual activity, and safety for farmer use, biopesticides and new types of short-duration insecticides against B*. cucurbitae* are urgently needed” [13]. Therefore, an attempt was made to evaluate the efficacy of biopesticides in combination with management practices against fruit fly in bitter gourd.

2. MATERIALS AND METHODS

2.1 Experimental site

The location of the present experimental field was at the central farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from February-2022 to july-2022. The soil in the experimental plot was a shallow reddish-brown terrace soil with a pH range of 5.8 to 6.5.

2.2 Experimental treatment and design

The test crop used in the experiment was the hybrid bitter gourd variety “BARI Hybrid Bitter gourd 2”. It is an imported high yielding variety with average yield 35-37 t/ha^{-1}. Seven treatments, viz. T_1(Lycomax 2g/lit of water+ Cutrac+ Yellow Sticky trap+ Sanitation), T_2(Lycomax 2g/lit of water+ Ceranock+ Yellow Sticky trap+ Cultural control), T_3 (Biomax M 1.2 EC+ Cuelure+ Yellow Sticky trap), T_4 (Lycomax 2g/ lit of water+ Yellow Sticky trap), T_5 (Biomax M 1.2 EC + Ceronock+ Cutrac), T_6 (Sanitation+ Cultural control + Cuelure), T_7 (Untreated Control) were used at seven days interval. Here, sanitation was maintained by removing the crop debris only and cultural control was performed by removing the debris, weeds and insect droppings. Loosening the soil to inhibit the pupation was also performed in cultural control. We laid out the experiment in a Randomized Complete Block Design (RCBD) with three replications. The area of a single plot of the experiment was 2m x 2 m, Inter plot distance 0.5m.

Table 1. Treatments, used in the experiment

Treatments	Active ingredients	Trade Name	Dose
T_1	2-3%*Metarhizium anisopliae* 2-3% *Trichoderma harzianum* 2-3% *Beauveria bassiana* 0.5-1% *Trichoderma viride*	Lycomax	3.46 gm/plot
	30% Culure+0.5% Abamectin	Cutrac	2 trap/plot
		Yellow Sticky trap	2 board/plot **Size:** 10 cm × 25 cm
		Sanitation	
T_2	2-3%*Metarhizium anisopliae* 2-3% *Trichoderma harzianum* 2-3% *Beauveria bassiana* 0.5-1% *Trichoderma viride*	Lycomax	3.46 gm/plot
	Protein Hydrolysate + Alpha cypermethrin 0.2%	Ceranock	2 trap/plot
		Yellow Sticky trap	2 board/plot **Size:** 10 cm × 25 cm
		Cultural control	
T_3	Abamectin 1.2%	Biomax M 1.2 EC	1 mL/L of water
		Cuelure	2 trap/plot
		Yellow Sticky trap	2 board/plot **Size:** 10 cm × 25 cm
T_4	2-3%*Metarhizium anisopliae* 2-3% *Trichoderma harzianum* 2-3% *Beauveria bassiana* 0.5-1% *Trichoderma viride*	Lycomax	3.46 gm/plot
		Yellow Sticky trap	2 board/plot **Size:** 10 cm × 25 cm
T_5	Abamectin 1.2%	Biomax M 1.2 EC	1 mL/L of water
	Protein Hydrolysate + Alpha	Ceronock	2 trap/plot

	cypermethrin 0.2%		
	30% Culure+0.5% Abamectin	Cutrac	2 trap/plot
T_6		Sanitation + Cultural control	
		Cuelure	2 trap/plot
T_7		Untreated	

2.3 Crop husbandry

The seeds were collected from the BARI (Bangladesh Agricultural Institute). The seedlings were raised on pots under special care on 24 February, 2022 and the germination of seedlings was started on 07 March, 2022. Before seed sowing, the seedbed was prepared well and made suitable for seedling production. Manures and fertilizers were applied according to the recommended fertilizer doses for bitter gourd production per hectare by [14]. Healthy and uniform seedlings were transplanting in the experimental plots on 18 March, 2022. The seedlings were transferred carefully from the seed bed to experimental plots to avoid damage to the root system. To minimize the damage to the roots of seedlings, the seed beds were watered one hour before uprooting the seedlings. a routine irrigation was given at 3 days' intervals. Before seed sowing, the seedbed was prepared well and made suitable for seedling production.

2.4 Data collection

Five plants were randomly selected from each unit plot for the recording of necessary data on different crop attributes. The data were recorded considering the following parameters: a) Number of captured insects per plot, b) Number of infested fruits per plot, c) Number of puncture per fruit, d) Number of healthy fruits per plot, e) Weight of healthy fruits, f) Weight of infested fruits, and g) Yield. Harvesting of the bitter gourd was not possible on a certain or particular date because the marketable size in different plants were not uniform.

2.5 Statistical package

The data obtained for different parameters will be statistically analyzed following computer based software Statistix-10 and mean separation will be done by LSD at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Captured Fruit fly in bitter gourd field

The experimental plots are treated with bio control agents on the infestation of Cucurbit fruit fly and the findings are presented in bar graph (Fig 1). This graph expresses that the highest number of captured fruit fly population was in the treatment T_2 treated plot and lowest number of captured fruit fly was at treatment T_6 treated plot. Treatment T_2 was comprised of Lycomax 2 g/lit of water, Ceranock, Yellow Sticky Trap, and Cultural Control. Female fruit fly larvae were attracted by the pheromone present in ceranock and died on exposure to the insecticide present in ceranock. Furthermore, the yellow sticky trap was appealing and sticky enough to catch the fruit fly. The similar result was also found after using combination of biopesticides and mechanical control [15] [16]. On the other hand Treatment T_7 was the control plot, no fruit fly was captured.

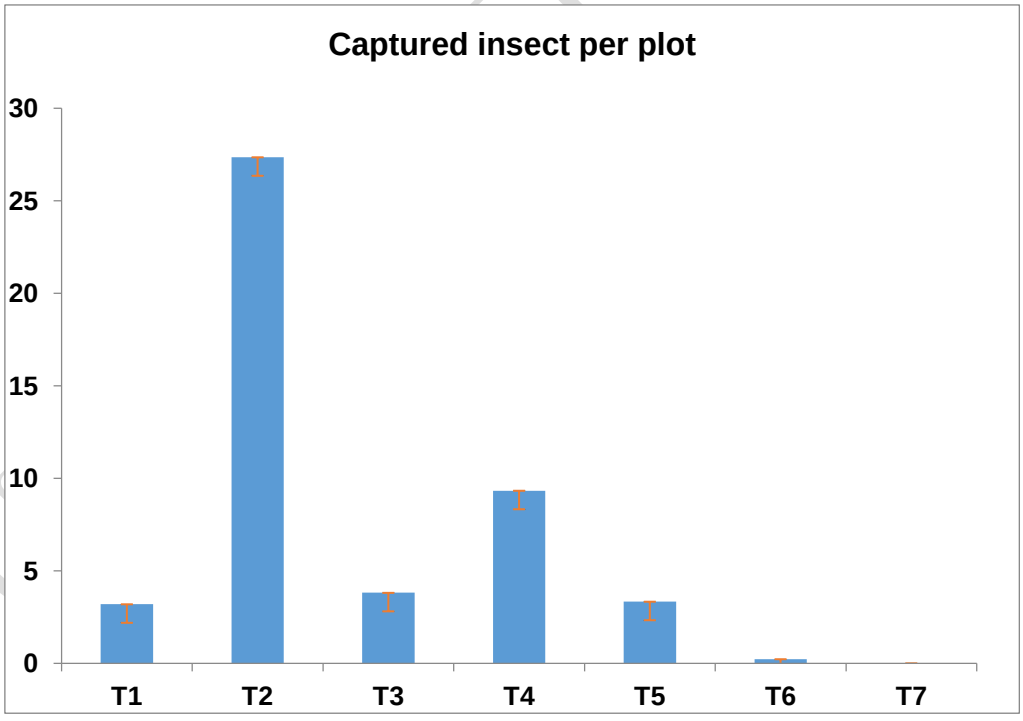

Fig 1. A bar graph showing the number of captured fruit fly in the experimental plot

3.2 Obtained healthy fruit and its weight in the experimental field

The setting up of different biocontrol agents showed effective results in the experimental field, and the result is presented in Table 2. Biocontrol agents were effective against the fruit fly, and after the infestation was controlled, the treatment T_2-treated plot produced the greatest number of healthy fruits. Other treatments are given with similar results.[17]. Whereas the minimum number of healthy fruits obtained from treatment T_7, the control plot, Furthermore, the results show that the control plot had the lowest weight of healthy fruit and the treatment T_2 plot had the highest weight of healthy fruit. In treatment, T_2, the active ingredient (protein hydrolysate and alpha-cypermethrin 0.2%) on ceranock, is highly effective, up to 97%, to attract the target pest fruit fly and kill it. Moreover, yellow sticky traps also work effectively with pheromone traps. The presence of 2-3% *Metarhizium anisopliae*, 2-3% *Trichoderma harzianum,* 2-3% *Beauveria bassiana,* and 0.5-1% *Trichoderma viride* inhibits the soil-borne diseases and destroys the pupae present on the soil. In cultural control, inhibition of pupation can be managed easily, and all that may be the reason for showing the best result from Treatmet, T_2.

Table 2. Effect of different bio control agents in healthy fruit and its weight during whole study period

Treatment	No of Healthy fruit per plot	Weight of healthy fruit per plot (gm)
T_1	4.72e	99.42 e
T_2	9.50 a	232.75 a
T_3	7.00 c	163.00 c
T_4	8.06 b	176.75 b
T_5	6.19 d	151.17 d
T_6	4.47 e	95.83 e
T_7	1.83 f	42.67 f
LSD	0.7920	11.337
CV%	7.46	4.64

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications.

3.3 Number of infested fruits under different bio control agents in the bitter gourd field

In terms of the number of infested fruits, there were significant differences between treatments. Table 3 shows that the highest number of infested fruits resulted in the treatment T_7-treated plot, which was the control plot. And the fruit fly infestation was checked effectively in the

treatment T_2 treated plot, and a minimum number of infested fruits resulted from it, which was statistically identical with the results from T_3 and T_4. Treatment T2 resulted in a significant percentage reduction (89.76%) of infested fruit over control [18]. A biopesticide-treated plot yielded a similar result.

Table 3. Effect of different bio control agents in fruit infestation during whole study period

Treatment	No of Infested fruit per plot	% Reduction of infested fruit over control
T_1	3.61 c	70.43
T_2	1.25 e	89.76
T_3	2.19 de	82.06
T_4	1.33 de	89.11
T_5	2.25 d	81.57
T_6	4.74 b	61.18
T_7	12.21 a	-
LSD	0.9465	
CV%	13.50	

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications.

3.4 Number of puncture in fruit under different bio control agents in the bitter gourd field

The significant variations were observed among the different treatments in terms of puncture number in fruit of bitter gourd.

Table 4 shows that the highest number of puncture in fruit resulted in treatment T_7 treated plot which was the control plot due to fruit fly infestation. And the fruit fly infestation was checked effectively in treatment T_2 that's why minimum number of puncture in fruit was resulted from treatment T_2 and it gave the highest percentage reduction of fruit puncture over control (92.58%). Kubar et al., 2021 found that combination of Tracer + Protein hydrolysate + Cuelure + T. daci gave minimum no of puncture on bitter gourd fruit [19] and Treatment, T_2 also containing Protein hydrolysate, 2-3% *Trichoderma harzianum,* 0.5-1% *Trichoderma viride* and other microorganism *(*2-3% *Metarhizium anisopliae &* 2-3% *Beauveria bassiana*) which enhanced the efficacy of the treatment.

Table 4. Effect of different bio control agents on puncture in fruit during whole study period

Treatment	No of Puncture per fruit	% Reduction of puncture over control
T_1	2.19 c	67.51
T_2	0.50 e	92.58
T_3	1.33 d	80.27
T_4	1.00 de	85.16
T_5	1.49 d	77.89
T_6	3.11 b	53.86
T_7	6.74 a	-
LSD	0.5406	
CV%	12.99	

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications.

3.5 Infested fruit weight under different bio control agents in the bitter gourd field

The significant variations were observed among the different treatments in terms of infested fruit weight of bitter gourd during the study period. Table 5 shows that the maximum amount of infested fruit weight resulted in treatment T_7 treated plot which was the control and this happened due to the fruit fly infestation. And the fruit fly infestation was checked effectively in treatment T_2 and T_4 that's why minimum amount of infested fruit weight was resulted from treatment T_2 and T_4. Highest percentage reduction of infested fruit weight over control was 68.99% at T_2. Kariyasa and Dewi also found the same trend of results during their study [20].

Table 5. Effect of different bio control agents on infested fruit weight during whole study period

Treatment	Weight of Infested fruit per plot (gm)	% Reduction of infested fruit weight over control
T_1	47.33 c	38.64
T_2	23.92 e	68.99
T_3	33.75 de	56.24
T_4	27.50 e	64.35
T_5	41.75 cd	45.87
T_6	62.00 b	19.62
T_7	77.13 a	-
LSD	10.345	
CV%	12.99	

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications.

3.6 Efficacy of different bio control agents on yield during study period

The significant variations were observed among the different treatments on yield of bitter gourd. Table 6 shows that the minimum amount of yield resulted in treatment T_7 treated plot which was the control and this happened due to the fruit fly infestation. And the fruit fly infestation was checked effectively in treatment T_2 for that maximum amount of yield was resulted from treatment T_2 (2.54 kg/ plot). Muritithi et al. and Alam & Khan found the similar result after using the IPM practice to control the fruit fly management in bitter gourd [21] [22].

Table 6. Effect of different bio agents on yield of bitter gourd during study period

Treatment	Yield per plot(gm)	Yield per plot (kg)
T_1	1838.3 e	1.84 e

T_2	2535.7 a	2.54 a
T_3	2332.3 c	2.33 c
T_4	2437.3 b	2.44 b
T_5	2152.3 d	2.15 d
T_6	1771 e	1.77 e
T_7	1199 f	1.20 f
LSD	97.415	
CV%	2.69	

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications.

CONCLUSION

Results showed that significant variations were observed among different bioagent-treated plots. The treated plot T2 (Lycomax containing 2-3% Metarhizium anisopliae, 2-3% Trichoderma harzianum, 2-3% Beauveria bassiana, and 0.5-1% Trichoderma viride with 2 g/lit of water + Ceranock containing protein hydrolysate and alpha-cypermethrin 0.2% + Yellow Sticky Trap + Cultural Control) had the most captured fruit flies, which explains why it produced the healthiest fruit (9.50 fruits/plant) and the healthy fruit weight (232.75 g). The control plot had the most infested fruit (12.21 fruits/plot) and the most punctures (6.74 punctures/fruit).

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