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MONITORING AND ECO-FRIENDLY MANAGEMENT OF CUCURBIT FRUIT FLY, *BACTROCERA CUCURBITAE* (COQUILLETT) ON BITTER GOURD

TONMOY MONDAL, MD. ADNAN AL BACHCHU*, ROUSHAN ARA, MD. NIZAM UDDIN, MOHAMMAD MOSHAROF HOSSAIN BHUYAIN AND REJVY SULTANA

Department of Entomology, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh

Abstract

An experiment was conducted to assess the adequacy of distinctive management practices, viz. yellow sticky trap set at 50, 100, and 150 cm height, fruit fly bait with a mashed sweet gourd (MSG), bagging, sanitation, and Ecomec 1.8 EC at the rate of 1mL per liter of water sprayed at 7 days interval. The experiment was carried out with a randomized complete block design (RCBD) with 8 treatments and 3 replications. All the treatments significantly differed from the control. The total highest number and weight of healthy fruits were recorded in bagging (41.33 and 6.08 kg) but the lowest in control (19.00 and 2.22 kg, respectively). No infested fruits were found in bagging, meanwhile, the highest number and weight of infested fruits were counted in control (13.00 and 1.27 kg). In addition, bagging appeared to have no percent of infestation by number and weight. The highest percent of fruit infestation was found in control (40.75% and 36.48%) treatments based on number and weight. No wet reduction was found in the bagging treatment and the highest percent weight reduction per fruit was recorded in Ecomec 1.8 EC (30.17%). The highest number of larval densities were found in fruit fly bait with MSG (15.83) and the lowest in a yellow sticky trap set at 150 cm height (6.7). The highest number of fruit flies in a yellow sticky trap set at 50 cm height was captured on 21 March 2021 (4.33) and the lowest was on 29 April 2021 (1.33). The highest number of fruit flies were captured in a yellow sticky trap set at 50 cm height (43/trap) and the lowest in a bait trap with MSG (9.70/bait). The highest yield and increase of yield over control were found in bagging (12.16 tons/ha and 176.10%).

Key words: Bagging, Cucurbit fruit fly, Fruit fly bait, Yellow sticky trap, Sanitation, and Ecomec 1.8 EC.

Introduction

The cucurbitaceous vegetables are one of the largest and major groups in vegetable kingdom with their wide adaptation from arid to humid tropic environments (Nasiruddin *et al.*, 2004). Bitter gourd (*Momordica charantia*) is one of the most important cucurbitaceous vegetables in Bangladesh for its excellent market value which encouraged

*Corresponding author: Email: adnan_hstu@yahoo.com, aabachchu1975@gmail.com

the farmers to cultivate on a large scale, while a total production of 54443 metric tons from 26491 acres of land (BBS 2020). The vegetable production in Bangladesh is very low in summer, while the major vegetables grown are cucurbits this season. Therefore, cucurbitaceous vegetables play an important role in supplementing their shortage during the lag period. But the production of bitter gourd is hindered due to several factors like disease and insect pests. The cucurbit fruit fly, *Bactrocera cucurbitae* (Coquillett), is a major pest causing yield loss in cucurbits, and infests about 15 kinds of cucurbit vegetables (Rakshit *et al.*, 2011).

It is reported that *B. cucurbitae* (Coquillett) is the most destructive pest causing yield loss ranging from 30-100% (Dhillon *et al.*, 2005) depending upon cucurbit species and the season. About 41-95% of fruit infestation by cucurbit fruit flies in bitter gourd crops has been recorded (Sapkota *et al.*, 2010). Hollingsworth *et al.* (1997) stated that cucurbit fruit fly has been reported to infest 95% of bitter gourd fruits in Papua New Guinea, 90% of snake gourd, and 60 to 87% of pumpkin fruits in the Solomon Islands. In another study, Singh *et al.* (2006) reported 31.27% damage on the bitter gourd and 28.55% on watermelon in India. The damage starts when the female fruit fly punctures the fruit with its long and sharp ovipositor. After egg hatching, the maggots feed inside the fruit (Nasiruddin *et al*., 2004; Dhillon *et al.*, 2005) and make fruits tunnels. The infested fruits become rotten, dry up and finally shed up prematurely. If not rotten, it becomes deformed and market value is severely reduced. The larvae of the pest remain inside the infested fruits, and the adults are free-living. They visit fruits only at the time of oviposition and leave immediately after egg deposition. So, the control of the pest can hardly be assured. Although several management options such as pheromone trap, different plant extracts, neem products, bagging of fruits, field sanitation, food baits, and a spray of chemical insecticides (Pawar *et al.*, 1991; Neupane, 2000; Satpathy and Rai, 2002; Dhillon *et al*., 2005; Jacob *et al.*, 2007; Mukherjee *et al.*, 2007; Islam *et al.*, 2015; Bachchu *et al.*, 2017; Siddique *et al.*, 2018, 2019) have been used for the management of cucurbit fruit fly, some of them either fail to control the pest and are uneconomic and hazardous to non-target organisms and the environment (Singh and Singh, 1998; Neupane, 2000, Dhillon *et al.*, 2005).

At present, farmers in Bangladesh solely rely on the use of toxic insecticides to control the pest in bitter gourd. Farmers spend about 25% of the cultivation cost in bitter gourd production in some areas only to buy toxic pesticides (Nasiruddin *et al.*, 2004). Moreover, repeated and long time uses of toxic insecticides have serious drawbacks such as pesticide resistance, toxic residues, increasing application costs, environmental pollution, and health hazards to human beings and domestic animals (Ahmed *et al.*, 1981;

Khanam *et al*., 1990). Therefore, it is desirable to explore alternative methods to control this pest. As a result of the recent efforts to reduce the application of harmful insecticides in vegetables, the trend has now shifted towards integrated pest management (IPM) for the control of tephritid fruit flies (Klungness *et al.,* 2005). However, information on the monitoring of insect pest species and its population is needed as a first step to address the integrated management of pests. Accurate methods for fruit fly population surveys are a prerequisite for effective decision-making in area-wide control programs aimed at pest suppression. A fruit fly species may have different preferences for trap color. The oriental fruit fly is most attracted to green, yellow, and orange colors in a laboratory experiment (Wu *et al.*, 2015).

Yellow sticky trap for field pest monitoring and control is, however, a recent approach, and it has drawn the special attention of researchers worldwide. Besides that, trap height from the ground can also affect the preference of particular species. For example, *Rhagotetis pomonella* prefers traps placed approximately 2.5m above the ground within the apple tree canopy (Reissig, 1975; Drummond *et al.*, 1984)

Islam *et al.* (2015) studied the evaluation of different management practices against cucurbit fruit fly (*B. cucurbitae* coquillett) in bitter gourd. They found that bagging of fruits showed the lowest percent infestation by number (19.49%, 7.48%, and 23.15%) and weight (11.79%, 7.18%, and 11.90%) at early mid and late fruiting stages, respectively, followed by pheromone trap treatment. To monitor the fruit fly, population pheromone trapping has been successfully used in different countries (Gillani *et al*., 2002), but, the lack of literate in regards monitoring and mass trapping of *B. cucurbitae* with yellow sticky traps. Despite this, a lot of knowledge is still lacking, and it is indispensable to understand those pests that this knowledge gap is filled. Considering the hazardous impact of chemicals on non-target organisms and the environment, it is urgent to develop a safer, cheaper, and eco-friendly management tool against the cucurbit fruit fly in bitter gourd. Therefore, the present study was undertaken for field monitoring of fruit flies by yellow sticky traps set at different heights and to investigate the effectiveness of different IPM tools for and eco-friendly management of cucurbit fruit flies on bitter gourd fields.

Materials and Methods

The present study was conducted to evaluate the monitoring and eco-friendly management of the cucurbit fruit fly, *B. cucurbitae*, on bitter gourd in the central research farm and the laboratory of Entomology Department, Hajee Mohammad Danesh Science

and Technology University (HSTU), Dinajpur during the period of October 2020 to May 2021.

Selection of treatments: Eight treatments (T), including an untreated control, were selected to monitor and manage the fruit fly infestation in bitter gourd. The treatments were T_1: Yellow sticky trap set at 50 cm height, T_2: Yellow sticky trap set at 100 cm height, T_3: Yellow sticky trap set at 150 cm height, T_4: Fruit fly bait with a mashed sweet gourd (MSG), T_5: Bagging, T_6: Sanitation, T_7: Ecomec 1.8 EC@1ml/L of water sprayed at 7 days interval, T_8: Control.

Land preparation and design of the field experiment: The tentative field was equipped with deep ploughing and harrowing followed by laddering for proper level. During land preparation, all weeds and stubbles were removed from the field. Finally, the unit plots were prepared as 10 cm raised beds and applied basal doses of Urea 1 kg, TSP 1 kg, MoP 1 kg, and cow dung 5 kg. As recommended by Rashid (1993), during land preparation, potash and other micronutrients were applied. The experiment was conducted in a randomized complete block design (RCBD) with 8 treatments and 3 replications. The whole experimental land was divided into 24 equal plots, and the size of each plot was 2.5 m × 2.0 m with an inter-plot distance of 0.50 m. Therefore, the whole experimental field was 20.0 m x 10.5 m, which was divided into 3 equal blocks. In the center of each plot, about 30 cm x 30 cm x 20 cm pits were dug for sowing seeds of bitter gourd. Each pit was considered as one replication.

Seed source, sowing, and intercultural operation: The seeds of bitter gourd (Tia) were collected from Lal Teer Seed Company, Dhaka. The seed was soaked in water for 24 hours in the Petri dishes prior to sowing to soften the seed coat for better and quick germination. Three seeds per pit were sown directly. Before sowing, the seeds were treated with Vitavax 200 @ 2 g per kg of seed. Regular irrigation was done after sowing. Finally, only one healthy plant was kept in each pit. A new one replaced damaged and virus-infected seedlings. The watering and other intercultural operations were done for each seedling in the field and a bamboo stick was used for each seedling for support.

Application of treatments

Yellow sticky trap: Yellow sticky traps were used to monitor insect populations in the bitter gourd field. The yellow sticky trap of 20×15 cm sized was hung and was adjusted vertically with the help of a wooden stick/pole. The traps were hung at three different heights (50, 100, and 150 cm) for the respective treatments of the plot. The yellow traps were replaced by fresh ones at an interval of 3 days. Each yellow trap was placed in the

middle of the randomly selected plots. Three replications were maintained for each treatment. The traps were checked regularly, and were counted the number of fruit flies captured every 3 days interval. The traps were maintained in the field from the flower initiation stage to the last harvest covering the entire reproductive stage of bitter gourd.

Fruit fly bait with a mashed sweet gourd (MSG): As standard practices, a bait trap was considered a treatment for its effectiveness with bait sprays. The trap consisted of 0.5 ml (10-15 drops) of Dynamic 40 EC (SAM Agro chemical) (Dimethoate group – systemic and contact insecticide**)** mixed with 100 g of sweet gourd mash and 100 ml of water. The bait was kept in a small earthen pot placed within three split bamboo sticks, 50 cm above the ground. Fresh ones replaced the old bait materials at 2 to 3 days. Each set of bait traps was placed in the middle of the randomly selected plots. Three replications were maintained. Bait traps were checked regularly, and the number of fruit flies captured in each 3 days interval was counted. The traps were maintained in the field from the flower initiation stage to the last harvest covering the entire reproductive stage of bitter gourd.

Bagging: The bagging of fruits was applied using a transparent polythene bag with a few holes made by an ordinary pin. These tiny holes provided for aeration. The size of the perforated polythene bag was large (30 cm × 20 cm) enough for normal growth and provide a sufficient aeration. All the full-bloomed female flowers of the plant under treatment were visually checked every day and tagged. In the morning hours (8.00 AM to 9.30 AM) before the beginning of frequent visits of fruit flies, the tagged female flowers were bagged individually with perforated polythene bags at 3 days after anthesis (DAA) and were left for five days. The open mouth of the bags was wrapped and closed by thread near the fruit peduncle. After 5 days, the polythene bags were removed. Regular observation was done to check the fruit fly infestation on these tagged fruits, and the operations were continued till the last harvesting.

Sanitation: For sanitation treatment, fallen and rotten fruits were removed and disposed of every 3 days interval. This sanitation was done from flower initiation to the final harvest.

Ecomec 1.8 EC: Ecomec 1.8 EC (Neem-based biopesticide from Ispahani Agro Limited) was applied at the rate of 1ml/L of water sprayed at 7 days intervals starting from the flower initiation stage of bitter gourd. The application of Ecomec 1.8 EC was continued till the late fruiting stage. This was uniformly sprayed to ensure complete coverage of the plants.

Control treatment: Three plots were selected as control. No other control measures were taken in these plots. All other intercultural operations were similar to those done for other treatment.

Data collection: Data was recorded on the number of healthy fruit, the number of infested fruit**,** the weight of healthy fruit, and the weight of infested fruit harvested at different fruiting stages. The numbers of fruit fly trapped in different traps (Yellow sticky and bait trap) at different fruiting stages of the crop were also counted. After harvesting, the weight of healthy and infested fruit was separately recorded. The laboratory also measured and recorded the larval density of infested fruits. The total production of each treatment was calculated, and determined the yield (t/ha).

Percent fruit infestation as a number: After harvesting, the healthy fruit (HF) and the infested fruit (IF) were separated by visual observation. The percent fruit infestation for each treatment was calculated by using the following formula:

% Fruit infestation by number = Number of IF/ (Number of HF + Number of IF) × 100

Percent fruit infestation as weight: After sorting of the healthy and the infested fruit, the weight was taken for healthy, infested and total ones separately. The percent infested fruit as weight for each treatment was calculated by using the following formula:

% Fruit infestation by weight = Weight of IF / (Weight of HF + Weight of IF) × 100

Percent weight reduction per fruit: Fruit infestation by number and weight for each treatment of reproductive stages was used to determine the average weight of single healthy and infested fruits. The percent weight reduction per fruit for each treatment was then calculated using the following formula:

% weight reduction per fruit= (Weight of single HF - Weight of single IF) / Weight of single HF × 100

Percent yield increase over control: After harvesting, the weights of healthy and infested fruit were separately recorded. The total production of each treatment was calculated and was determined the yield (t/ha). The percent yield increase over control was computed by using the following formula:

% Increase of yield over control = (Yield of treated plot – yield of control plot) / Yield of control plot × 100

Statistical analysis: All the collected data were analyzed following the analysis of variance (ANOVA) technique with the help of the MSTAT-C Computer Package. The mean differences were adjusted by Duncan's Multiple Range Test (DMRT) techniques.

Results and Discussion

The results of the experiment are presented and discussed under the following subheadings:

Effect of different management practices on the fruit infestation (by number) of bitter gourd: Number of healthy fruit per plot, number of infested fruit, and percent fruit infestation are shown in Table 1. The result indicated that the number of healthy fruit were significantly different (p>0.001, F=20.36, df=7) among the treatments. The highest number of healthy fruits per plot was recorded in bagging (41.33), followed by a yellow sticky trap set at 150 cm height (39.00), bait trap with a mashed sweet gourd (38.00), Ecomec 1.8 EC (38.00) and yellow sticky trap set at 100cm height (37.33) which were statistically identical. But the lowest number of healthy fruits per plot (19.00) was recorded in the control treatment. On the other hand, the highest infested fruit was recorded in the control (13.00) treatment. However, no fruit infestation occurred in bagging. The percent infestation was found 9.48, 15.69, 18.24, 18.49, 18.84, and 21.36% in bait trap with mashed sweet gourd, Ecomec 1.8EC, yellow sticky trap set at 100cm height, sanitation, yellow sticky trap set at 50cm height, and yellow sticky trap set at 150cm height, respectively. On the other hand, the highest fruit infestation by number was recorded in the control (40.75%) treatment.

From the above findings, it was revealed that the lowest fruit infestation by number was recorded in bagging in the field, whereas the highest fruit infestation (40.75%) by number was recorded in the control treatment. The present study agrees with those of Islam *et al.* (2015). They studied the evaluation of different management practices against cucurbit fruit flies (*B. cucurbitae* coquillett) in bitter gourd. They found that bagging of fruits showed the lowest percent infestation by number (19.49%, 7.48%, and 23.15%) at the early mid and late fruiting stages, respectively.

Effect of different management practices on the fruit infestation (by weight) of bitter gourd: The effects of different management practices on fruit infestation by weight are displayed in Table 2. Significant variations (p>0.001, F=37.19, df=7) were found among the treatments regarding of fruit fly infestation on bitter gourd. The weight of healthy fruits ranged from 2.22 to 6.08 kg/plot. The highest weight of healthy fruit per plot was recorded in bagging (6.08), followed by Ecomec 1.8 EC (5.94), which is statistically similar. But the lowest weight of healthy fruit per plot was recorded in control (2.22). The highest weight of infested fruit per plot (1.27) was recorded in control followed by a yellow sticky trap set at 150cm height (1.12) which was statistically similar. Considering the percent fruit infestation by weight, no percent fruit infestation by weight was recorded

in bagging. On the other hand, the highest percent fruit infestation by weight was recorded in the control (36.48%), which is statistically different from all other treatment applied in this study.

Table 1. Percent fruit infestation by a number of bitter gourd fruit affected by different treatments.

Treatments	Number of healthy fruit	Number of infested fruit	% infestation
Yellow sticky trap set at 50 cm height	30.33^{b}	7.00^{c}	18.84^{bc}
Yellow sticky trap set at 100 cm height	37.33^{a}	8.33^{c}	18.24^{bc}
Yellow sticky trap set at 150 cm height	39.00^{a}	10.67^{b}	21.36^{b}
Bait trap with mashed sweet gourd	38.00^{a}	4.00^{d}	9.48^{d}
Bagging	41.33^{a}	0.00^{e}	0.00^{e}
Sanitation	28.00^{b}	6.33^{c}	18.49^{bc}
Ecomec 1.8 EC	38.00^{a}	7.00^{c}	15.69^{c}
Control	19.00^{c}	13.00^{a}	40.75^{a}
LSD	5.06	1.91	4.22
CV %	8.52	15.49	13.51

In a column, means followed by the same letter(s) are not significantly different at a 5% probability level by DMRT.

It is clear from the study that in the bagging treatment, no infestation was found; accordingly, bagging was very effective to control fruit flies. The present study is supported by Islam *et al.* (2015). They found that bagging of fruits showed the lowest percent infestation by weight (11.79%, 7.18%and 11.90%) at early mid and late fruiting stages, respectively. Amin (1995) found lowest infestation significantly (4.61%) in bagged cucumbers compared to other chemical and botanical control treatment. Bagging of cucumbers with perforated polythene bags at the immature stage significantly reduced the fruit fly infestation (Akhtaruzzaman *et al*., 1999).

Weight reduction: The weight of single healthy fruit, single infested fruit, and the percent weight reduction per fruit are presented in Figure 1. The result specified that the weight of single healthy fruit among the treatment was significantly different (p>0.001, F=68.97, df=7). The percent weight reduction per fruit ranged from 0.0 to 30.17%. Results also revealed that there were no wet reduction was found in the bagging treatment, and the highest percent weight reduction per fruit was recorded in Ecomec 1.8 EC (30.17%),

followed by a yellow sticky trap set at 100 cm height (26.69%), control (16.51%), yellow sticky trap set at 150 cm height (15.76), fruit fly bait with MSG (13.02%). The present study was similar to the study of Amin (1995). He significantly obtained the lowest weight reduction (24.45 %) when the fruits were bagged at fruit initiation stage.

Table 2. Percent fruit infestation by weight (Kg) of bitter gourd fruit affected by different treatments.

Treatments	Weight of healthy fruit (Kg)	Weight of infested fruit (Kg)	% infestation
Yellow sticky trap set at 50 cm height	3.66^{c}	0.73^{b}	16.71^{bc}
Yellow sticky trap set at 100 cm height	5.17^{b}	0.83^{b}	13.86^{cd}
Yellow sticky trap set at 150 cm height	4.86^{b}	1.12^{a}	18.64^{b}
Bait trap with mashed sweet gourd	4.96^{b}	0.45^{c}	8.34^{e}
Bagging	6.08^{a}	0.00^{d}	0.00^{f}
Sanitation	3.37^{c}	0.68^{b}	16.94^{bc}
Ecomec 1.8 EC	5.94^{a}	0.77^{b}	11.52^{de}
Control	2.22^{d}	1.27^{a}	36.48^{a}
LSD	0.67	0.19	3.77
CV %	8.39	15.00	14.07

In a column, means followed by the same letter(s) are not significantly different at a 5% probability level by DMRT.

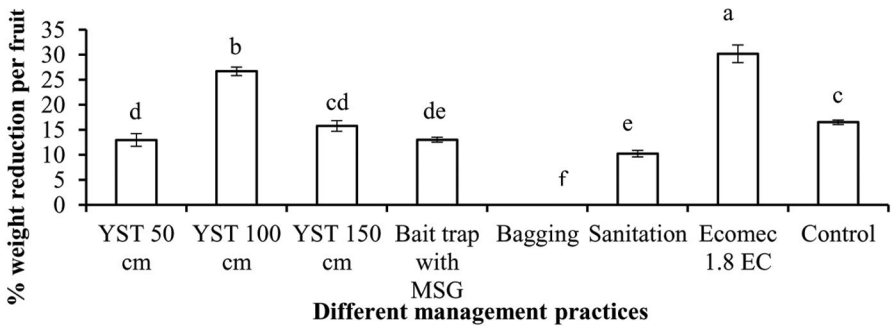

Fig 1. Effect of weight reduction per fruit on different management practices. Where, YST 50 cm=Yellow Sticky Trap set at 50 cm height, YST 100 cm=Yellow Sticky Trap set at 100 cm height, YST 150 cm=Yellow Sticky Trap set at 150 cm height, MSG=Mashed Sweet Gourd.

Larval density: Figure 2 represent the number of larvae per infested fruit in different management practices. Among the treatments, the number of larvae per infested fruit was significantly different (p>0.001, F=13.80, df=7). The highest number of larval density were found in fruit fly bait with MSG (15.83) followed by sanitation (10.60), yellow sticky trap set at 50 cm height(10.48), Ecomec 1.8 EC (10.60), control (8.85), yellow sticky trap set at 100 cm height (7.70). But the lowest number of larval densities was found in a yellow sticky trap set at 150 cm height (6.7).

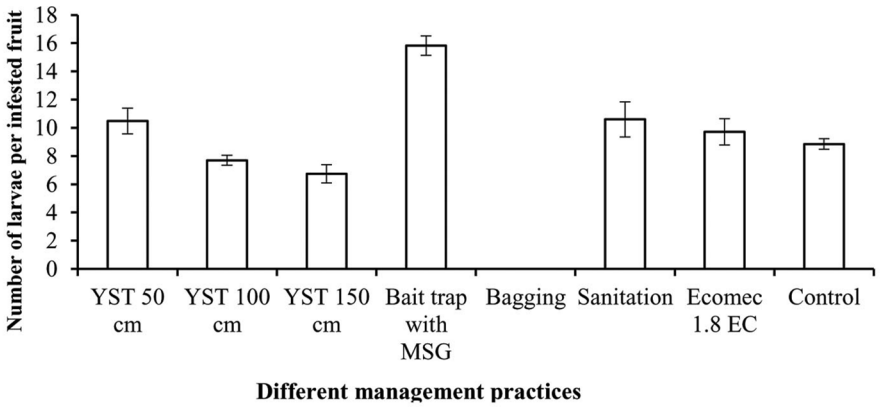

Fig 2. Larval density in infested fruit in different management practices. Where, YST 50 cm= Yellow Sticky Trap set at 50 cm height, YST 100 cm=Yellow Sticky Trap set at 100 cm height, YST 150 cm=Yellow Sticky Trap set at 150 cm height, MSG=Mashed Sweet Gourd.

Monitoring of fruit flies by yellow sticky traps and poison bait traps: To monitor fruit fly abundance at the different dates of the study period, four type of traps viz yellow sticky trap set at 50 cm, 100 cm, 150 cm height and bait trap with mashed sweet gourd was used to capture fruit fly which is shown in Figure 3. The highest number of fruit flies in a yellow sticky trap set at 50 cm height was captured on 21 March 2021 (4.33) and the lowest on 29 April 2021 (1.33). The highest number of fruit flies in a yellow sticky trap set at 100 cm height was captured on 14 February 2021 (2.00) and the lowest on 05 April 2021 (1.00). Consequently, the highest number of fruit flies in a yellow sticky trap set at 150 cm height were captured on 4 March 2021 (2.00) and the lowest on 29 April 2021 (0.67). The highest number of fruit flies in the bait trap with mashed sweet gourd was captured on 4 February 2021 (1.00), but no fruit flies were captured on 29 April 2021.

The present results showed that the yellow sticky trap set at 50 cm height performed the best among the traps studied. Figure 3 revealed that the fruit fly abundance was higher on

early February 2021. After that decreased to 21.03.2021 and again increased for a week, followed by a decreased in population found with slight increase at the end of April 2021. Other than a yellow sticky trap set at 50 cm height, it showed a steady increase and decrease due to weather parameters and various biotic and abiotic factors.

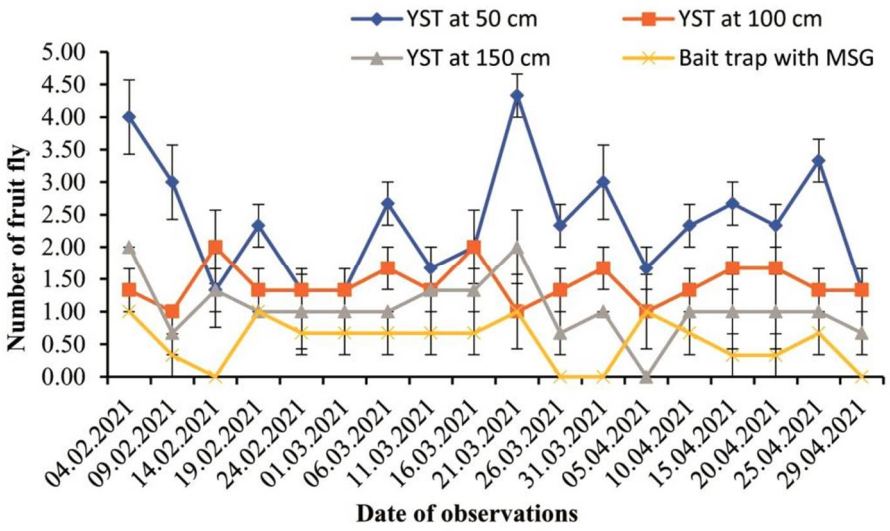

Fig 3. Fruit flies were captured in different yellow sticky traps and poison bait of various dates in the experiment. Where, YST 50 cm=Yellow Sticky Trap set at 50 cm height, YST 100 cm=Yellow Sticky Trap set at 100 cm height, YST 150 cm=Yellow Sticky Trap set at 150 cm height, MSG=Mashed Sweet Gourd.

Performance of yellow sticky trap and poison bait in capturing fruit flies during the study period: Total numbers of fruit flies captured in the study period in four types of traps are represented in Figure 4. The highest number of fruit flies were captured in a yellow sticky trap set at 50 cm height (43/trap) followed by a yellow sticky trap set at 100 cm height (26/trap) and a yellow sticky trap set at 150 cm height (19.70/trap) which are gradually decreased. Consequently, the lowest numbers of fruit flies were found in a bait trap with a mashed sweet gourd (9.70/bait).

The present results agreed with those of Said *et al.* (2016), who studied the effect of sticky trap color and height on the capture of adult oriental fruit fly, *B. dorsalis* (Hendel) (Diptera: Tephritidae) on chili pepper in Indonesia and found that yellow trap was consistently the most attractive trap amongst the other trap colors tested with an overall average of 62.6 adults per trap during the study where the second most attractive trap

were white and green traps with overall averages of 45.2 and 40 adults per traps respectively. Besides that, trap height from the ground can also affect the preference of particular species. In addition, traps set up at 25 and 50 cm above the ground captured significantly more adults (187.8 and 171.9 per trap, respectively) compared to those set up at 75 and 100 cm above the ground (60.8 and 37.1 per trap, respectively).

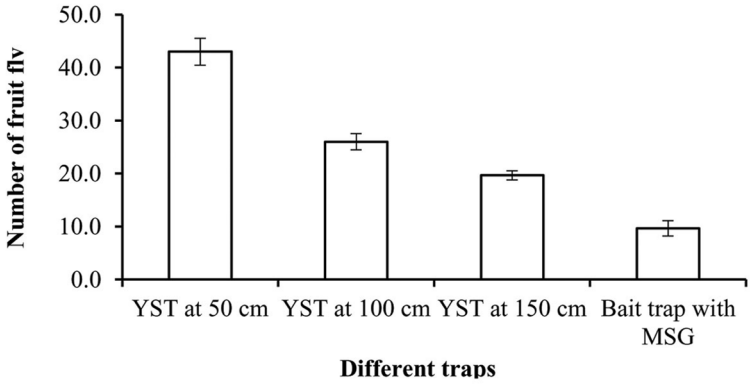

Fig 4. The number of captured fruit fly at the yellow sticky trap and poison bait. Where, YST 50 cm= Yellow Sticky Trap set at 50 cm height, YST 100 cm=Yellow Sticky Trap set at 100 cm height, YST 100 cm=Yellow Sticky Trap set at 100 cm height, MSG=Mashed Sweet Gourd.

The relationship between the number of captured fruit flies per trap and the percent fruit infestation by number is shown in Figure 5(a). The highest percent fruit infestation by number was found in a yellow sticky trap set at the height of 150 cm (21.36%), and the lowest number of fruit flies were captured in a bait trap with a mashed sweet gourd (9.70/bait). On the other hand, the lowest percent fruit infestation by number was found in a bait trap with a mashed sweet gourd (9.48%), and the highest number of fruit flies were captured in a yellow sticky trap height at 50 cm (43/trap). Percent fruit infestation by weight and the number of captured fruit flies per trap is presented in Figure 5(b). The highest percent of fruit infestation by weight and captured fruit flies were found in yellow sticky trap height at 150cm (18.64%) and yellow sticky trap height at 50cm (43/trap), respectively. But the lowest percent fruit infestation by weight and the number of captured fruit flies was found in bait traps with MSG (8.34%, 9.70/bait, respectively).

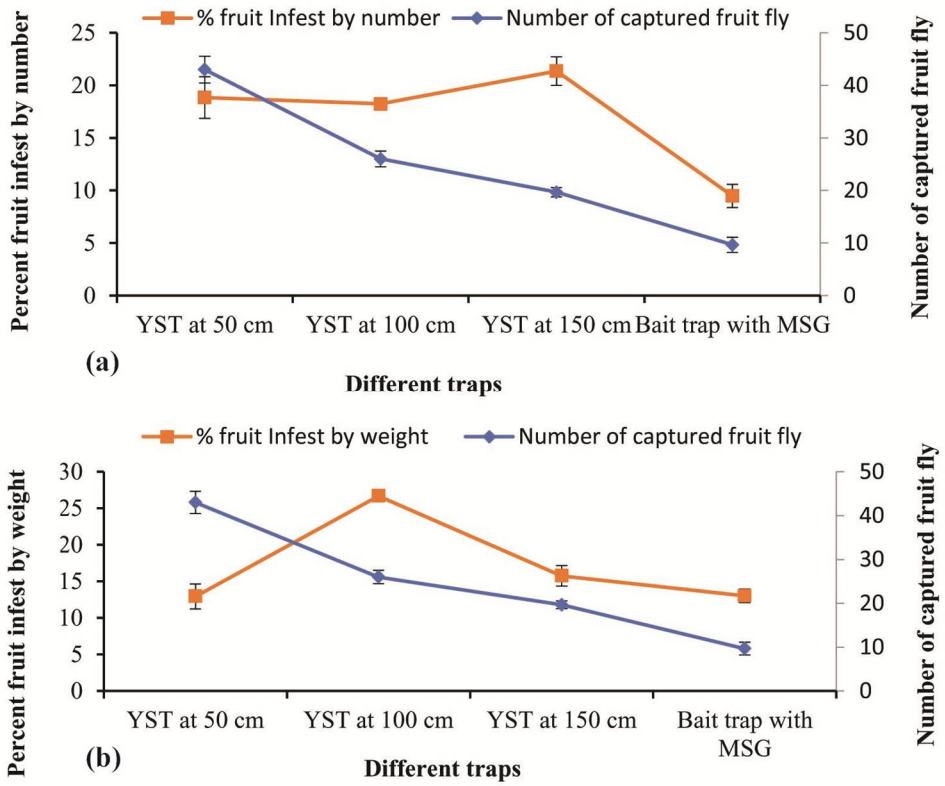

Fig 5 (a) Relationship between percent fruit infestation by number and number of captured fruit flies (up) (b) Relationship between percent fruit infestation by weight and number of captured fruit flies (down). Where, YST 50 cm=Yellow Sticky Trap set at 50 cm height, YST 100 cm=Yellow Sticky Trap set at 100 cm height, YST 150 cm=Yellow Sticky Trap set at 150 cm height, MSG=Mashed Sweet Gourd.

Effect on yield of bitter gourd: The effect of different management practices such as yellow sticky trap set at 50 cm height, yellow sticky trap set at 100 cm height, yellow sticky trap set at 150 cm height, fruit fly bait with mashed sweet gourd, bagging, sanitation, Ecomec 1.8 EC and control on the yield and percent increase of yield over control are shown in Table 3. Significant variations (p>0.001, F=37.21, df=7) of bitter gourd yield were observed among the treatments. The highest yield per plot was recorded in bagging (12.16 ton/ha), followed by Ecomec 1.8 EC (11.89 ton/ha), which was statistically similar. But the lowest yield per plot was recorded in control (4.43 ton/ha). On the other hand, the highest increased yield over control was recorded in bagging (2.75

times) followed by Ecomec 1.8 EC (2.68 times). In contrast, the minimum yield increase over control was recorded in sanitation (1.52 times).

Table 3. Percent increase of yield over control (ton/ha).

Treatments	Yield of treated plot	Yield increased in times
Yellow sticky trap set at 50 cm height	7.32[c]	1.65
Yellow sticky trap set at 100 cm height	10.36[b]	2.33
Yellow sticky trap set at 150 cm height	9.72[b]	2.19
Fruit fly bait with mashed sweet gourd	9.92[b]	2.24
Bagging	12.16[a]	2.75
Sanitation	6.75[c]	1.52
Ecomec 1.8 EC	11.89[a]	2.68
Control	4.43[d]	-
LSD	1.33	-

In a column, means followed by the same letter(s) are not significantly different at a 5% probability level by Duncan's Multiple Range Test (DMRT).

Conclusion

It is concluded that bagging, fruit fly bait with mashed sweet gourd and yellow sticky trap set at 50 cm height may be used for monitoring and eco-friendly management of cucurbit fruit fly for the cultivation of bitter gourd in Bangladesh.

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