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Efficacy of Some Botanical Extracts for Eco-Friendly Control of Cucurbit Fruit Fly (*Bactrocera cucurbitae*) in Experimental Bitter Gourd Field

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Abstract

Two studies were carried out to evaluate the efficacy of some botanicals for the control of cucurbit fruit fly (*Bactrocera cucurbitae*) in experimental Bitter gourd field during April 2025 to November 2025. The botanicals were bulb of *Allium cepa* (Onion), rhizome of *Zingiber officinale* (Ginger), leaves of *Azadiracta indica* (Nim), leaves of *Lactuca sativa* (Lettuce), leaves of *Tamarindus indica* (Tamarind), leaves of *Trichosanthes dioica* (Pointed gourd), leaves of *Annona squamosa* (Custard Apple), leaves of *Elettaria cardamomum* (Cardamom), leaves and stems of clove of *Swertia chirayita* (Chirata), leaves of *Musa* spp. (Banana), seeds of *Swietenia macrophylla* (mahogany), seeds of *Piper nigrum* (Black Pepper) and seeds of *Corchorus capsularis* (Deshi Jute). In these two experiments, pesticide treatments were distinctly better than the botanical treatments in respect of controlling cucurbit fruit fly, fruit size and yield. A less number of cucurbit fruit fly attacks were found on Bitter gourd fruits in Ginger treatments in these two studies. In 1st experiment, 41.67% fruits were infested by cucurbit fruit fly in Ginger 10% solution. On the other hand, in 2nd experiment, 38.30% fruits were infested by cucurbit fruit fly in Ginger 20% solution. Cucurbit fruit fly infestations were 43.04% and 41.67% in *Annona squamosa* (Custard Apple) leaves 10% and 20% solution treatments in 1st and 2nd experiment respectively. *Annona squamosa* (Custard Apple) 20% solution treatment showed best performance on Bitter gourd yield (gm) among the botanicals. Therefore, Custard Apple (*Annona squamosa*) leaves solutions and Ginger (*Zingiber officinale*) extracts can be used as bio-pesticide for eco-friendly control of cucurbit fruit fly in Bitter gourd field.

Keywords

Botanicals, Bitter Gourd, Cucurbit Fruit Fly, Ginger, Custard Apple Leaves

1. Introduction

Bitter gourd (*Momordica charantia* L.) known also as bitter apple or Bitter melon or Balsam pear, is a tropical vine belonging to the order Cucurbitales, family Cucubitaceae and genus Momordica. The plant is cultivated as medicinal as well as vegetable crop widely in India, China and South East Asia (Behera et al., 2008). Even though whole plant is palatable in nature, Bitter gourd is mainly grown for its fruit part. Fruits, flowers and young shoots are used as flavouring agents in various Asian dishes. Fruits are cooked with other vegetables especially in soups for the slight bitter taste. However, in Indian cuisines, fruits are mainly used after blanching or par boiling or soaking in salt water to reduce bitterness (Saeed et al., 2018). Fruits can also be canned or pickled or dehydrated in addition to cooking or deep frying. It is considered widely as a folklore medicine against diabetes amongst the indigenous population of Asia, South America, India and East Africa (Joseph & Jini, 2013). Apart from fruits, the roots, leaves and vines are used as a suppressant for tooth ache, diarrhoea and furuncle. Various products of Bitter gourd like Bitter gourd tea, which is known as gohyah or herbal tea made from dried slices of bitter gourd, are gaining popularity as herbal medicine (Jia et al., 2017).

Researchers have proved that Bitter gourd contains an insulin like principle which is often being designated as plant insulin, which has positive effects in lowering the blood and urine glucose content (Janagal et al., 2018). It has also been shown to have anti-cholesterol (Saeed et al., 2018), anti-cancer (Bai et al., 2016), anti-dementia (Joshi et al., 2017), anti-bacterial & anti-fungal (Mahmood et al., 2019), antioxidant and anti-inflammatory (Bortolotti et al., 2019) activities. All part of the plants mainly the fruits and seeds, contain more than 60 phyto-medicines active against more than 30 diseases including cancer and diabetes (Kole et al., 2020).

Cucurbit fruit fly (*Bactrocera cucurbitae*) is one of the serious pests that limits the production of cucumber. It is also known as melon fly and melon fruit fly. The extents of damage due to cucurbit fruit fly vary between 30% to 100% depending upon the season and susceptibility of the crop's species and varieties (Dhillion et al., 2005).

When the temperatures fall below 32˚C, and the relative humidity ranges between 60% to 70%, Cucurbit fruit fly's (*Bactrocera cucurbitae*) abundance increases (Dhillion et al., 2005).

Chemical pesticides are generally used to control the cucurbit fruit fly. But chemical pesticides are very harmful to our environment as well as for living beings. Alternatively, bio-pesticides are plant extracts, which are less hazardous to

environment. On the other hand, one kind of botanical may be effective against only one kind of insect or pest, and combination of two or more botanicals may help to control all kinds of insect in crop field. Chemical pesticides are costly in the market but bio pesticides from plant extract are cheaper and even farmers may be able to make it at their home. Botanicals are easily prepared and their use in controlling cucurbit fruit fly from local plants is sustainable (Azad et al., 2012).

Therefore, the present study was conducted to examine some botanicals having insecticidal activity against cucurbit fruit fly and to identify the effect of botanical extracts on growth and yield of bitter gourd.

2. Materials and Methods

2.1. Study Location

These two studies were carried out in the Botanical Pesticide Experimental Field of Institute of Environmental Science, University of Rajshahi, Bangladesh. The experiment area is located at 24.37˚N latitude and 88.7˚E longitude at an altitude of 21 meters above sea level. The soil of the experimental site is Gangetic alluvial and climate is sub tropical.

2.2. Study Period

The first study was carried out during March 7, 2025 to May 30, 2025 and 2nd study was carried out during September 9, 2025 to November 29, 2025 (**Table 1**).

2.3. Land Preparation

The experimental land was first opened with a country plough. Ploughed soil is then brought into desirable final tilth condition by five operations of pouching followed by laddering. The grasses and weeds were removed from the field and the land was leveled properly. To support the plant growth, cow-dung, Triple Super Phosphate (TSP), Murate of Potash (MP) and Urea fertilizers were applied. The total amount of fertilizers was used as the basal dose during pit preparation. Then, the seeds were sown in the experimental plot. The plot was irrigated with pump-water when necessary.

2.4. Experimental Layout

In 1st experiment the experimental layout was in a Randomized Complete Block Design (RCBD) with fifteen treatments and each treatment had three replications. In this experiment total number of plants were (15 treatments × 3 replications) = 45. The plot size was 16 m × 4 m, line spacing and replication to replication distances were 1.0 m.

In second experiment the experimental layout was in a Randomized Complete Block Design (RCBD) with eight treatments and each treatment had three replications. In this experiment total number of plants were (8 treatments × 3 replications) = 24. The plot size was 9 m × 4 m. Line spacing and replication to replication distances were 1.0 m.

Table 1. Information about Bitter gourd cultivation (1st & 2nd Experiments).

Information	1st Experiment	2nd Experiment
Name of Crop	Bitter gourd	Bitter gourd
Variety	Local variety (Ranipukur)	Local variety (Ranipukur)
Scientific Name	*Momordica charantia*	*Momordica charantia*
Date of seed sown	March 7, 2025	September 9, 2025
Fruits harvest completed	May 30, 2025	November 29, 2025
No of Spray	17 times	16 times
Spray Started	01-04-2025	04-10-2025
Last Spray	27-05-2025	25-11-2025

2.5. Collection of Botanicals

Botanicals were screened considering the odor, anti-fungal activity and phyto-toxicity. Previous studies and ethno botanical knowledge were also considered to select the plants. Most of the plant materials were collected from Rajshahi University campus and some were purchased from local market. Thirteen plant materials are bulb of *Allium cepa* (Onion), rhizome of *Zingiber officinale* (Ginger), leaves of *Azadiracta indica* (Nim), leaves of *Lactuca sativa* (Lettuce), leaves of *Tamarindus indica* (Tamarind), leaves of *Trichosanthes dioica* (Pointed gourd), leaves of *Annona squamosa* (Custard Apple), leaves of *Elettaria cardamomum* (Cardamom), leaves and stems of clove of *Swertia chirayita* (Chirata) and leaves of *Musa* spp. (Banana), seeds of *Swietenia macrophylla* (mahogany), seeds of *Piper nigrum* (Black Pepper), seeds of *Corchorus capsularis* (Deshi Jute).

2.6. Preparation of Aqueous Botanical Extracts for Spray

After collection botanicals were washed in running tap water. For the preparation of 10% extract, 100 gm of grinding or cutting botanicals were dissolved in one liter of water and boiled for 30 minutes. Then the solutions were cool down and filtered with muslin cloth. The prepared aqueous extract was preserved in plastic bottles at room temperature. For 20% extract, 200 gm of grinding or cutting botanicals were taken in one liter of water. Rest of the procedure were same.

In the 1st experiment, 10% botanical extracts were used and chemical pesticide (malathion) concentration was 2 ml/L.

2.7. Spraying Method

Botanical extracts were sprayed in Bitter gourd plants under field conditions. Botanicals extracts were sprayed twice a week with the help of sprayer. There were two treatments devoid of botanical pesticides, one control treatment where only water was sprayed and one treatment where chemical pesticide was sprayed.

2.8. Fruits Infestation Monitoring

The Bitter gourd field was visited every day and Bitter gourd fruits were harvested

from each plant 2 times (every Tuesday and Friday in 1st experiment and every Tuesday and Saturday in 2nd experiment) in a week. Then total number of fruits harvested, infected fruits and fresh fruits from harvested fruits of each plant were counted. The weights of harvested fresh fruits from each plant were measured. Records of all data were kept. After final harvest the percent (%) of infested Bitter gourd fruits of each plant was calculated as per following formula:

$$\text{Infested Fruits } (\%) = \frac{\text{Number of all damaged bitter gourd fruits}}{\text{Total number of harvested fruits}} \times 100$$

After final harvest summation of all harvested fresh fruits weight of each plant was done to calculate the yield of each plant.

2.9. Statistical Analysis of Data

The data collected from all parameters were subjected to analysis of variance (ANOVA) using General Liner Model of SPSS software. The treatment means were separated using Duncan's Multiple Range Test (Duncan, 1951) at $P < 0.05$.

3. Results and Discussion

Botanicals are traditional and non-synthetic protectants derived from plants. Traditionally, different types of plant parts are used for the protection of agricultural produce; these plants are available in many developing countries and contain several active ingredients and act in different ways under different circumstances (Isman, 2006). Botanicals break down rapidly to harmless metabolites and appear less likely to build up genetic resistance to targeted species. They are also less harmful to mammals and other beneficial organisms (Rahman, 2009).

This experiment was carried out to evaluate the effects of 13 plant extracts on fruit fly infestation. Aqueous extracts of botanicals may act as effective insecticides against cucurbit fruit fly (*Bactrocera cucurbitae*) of Bitter gourd.

Table 2 shows the effect of botanicals on number of fruits per plant and fruit fly infestation in first experiment. The highest number of fruits per plant (30.67 ± 2.08a) was observed in pesticide treatment. The extract of 10% Custard apple leaves treatment showed 2nd highest (26.33 ± 4.16ab) number of fruits per plant. The 10% Custard apple leaves treatment kept about 2.26 times better performance than that of control treatment (**Table 2**).

The number of fruits infested by cucurbit fruit fly was regularly monitored during this study. **Table 2** shows the effect of botanicals on numbers of fruits infested by cucurbit fruit fly. The highest percentage (71.43%) of fruits infested (8.33 ± 4.16bcd) by cucurbit fruit fly was found in control treatment. The lowest percentage (14.13%) infestation (4.33 ± 1.53d) of cucurbit fruit fly was found in Pesticide treatment. Among the botanicals lowest percentage (41.67%) infestation (6.67 ± 0.58cd) of cucurbit fruit fly was found in 10% Ginger treatment. In 10% Custard apple leaves treatment the percentage of fruits infestation (11.33 ± 3.21abc) was 43.04%.

Table 2. Fruits per plant and fruits infested by cucurbit fruit fly (1st Experiment).

Treatment No.	Treatment Names	Fruits per Plant (Nos.)	Fruits Infested by Cucurbit Fruit Fly (Nos.)	Fruit Fly Infested Fruits (%)
T1	Control	11.67 ± 4.73e	8.33 ± 4.16bcd	71.43
T2	*Azadiracta indica* (Nim)	23.67 ± 2.52abc	14.33 ± 1.53a	60.56
T3	*Zingiber officinale* (Ginger)	16.00 ± 1.73cde	6.67 ± 0.58cd	41.67
T4	*Lactuca sativa* (Lettuce)	16.00 ± 3.61cde	9.00 ± 2.00bcd	56.25
T5	*Corchorus capsularis* (Deshi Jute)	13.00 ± 2.65e	7.33 ± 1.15bcd	56.41
T6	*Trichosanthes dioica* (Pointed gourd)	14.67 ± 4.93de	7.67 ± 3.21bcd	52.27
T7	*Tamarindus indica* (Tamarind)	15.67 ± 3.21de	8.33 ± 2.52bcd	53.19
T8	*Allium cepa* (Onion)	21.33 ± 4.16bcd	10.67 ± 2.08abc	50.00
T9	*Swertia chirayita* (Chirata)	21.67 ± 6.03bcd	11.67 ± 3.06abc	53.85
T10	*Annona squamosa* (Custard Apple)	26.33 ± 4.16ab	11.33 ± 3.21abc	43.04
T11	*Elettaria* cardamomum (Cardamom)	14.67 ± 4.51de	8.00 ± 3.00bcd	54.55
T12	*Musa* spp. (Banana)	16.67 ± 4.93cde	9.67 ± 2.31abc	58.00
T13	*Piper nigrum* (Black Pepper)	17.00 ± 5.57cde	9.67 ± 4.73abc	56.86
T14	*Swietenia macrophylla* (mahogany)	21.67 ± 3.21bcd	12.00 ± 2.00ab	55.38
T15	Pesticide (Malathion)	30.67 ± 2.08a	4.33 ± 1.53d	14.13

Sultana et al. (2020) found a less number of Cucurbit fruit fly attack on cucumber in 10% Ginger treatment. Only 7.06% fruits were infested by Cucurbit fruit fly. The Ginger treatment reduced 14.17 times Cucurbit fruit fly infestation compared to control.

Zingiberene, shogaol, and gingerol are the active components of ginger that give Ginger its potent biopescidal qualities (Sinha & Ray, 2024).

Custard apple extract with methanol solvent were found effective to toxic and residual effects against pulse beetle (Ahmed et al., 2020).

A laboratory study was conducted on the deterrent effect of different aqueous plant extracts against pulse beetle, *Callosobruchus maculatus* (Fabricius) (Coleoptera: Bruchidae) in stored seeds of cowpea, *Vigna unguiculata* (L.). Among different aqueous extracts of plants materials, maximum percentage of oviposition deterrence was observed in custard apple seed extract (67.19%), custard apple leaf extract (65.95%). The maximum adult emergence reduction was seen in custard apple seed extract (78.45%), custard apple leaf extract (77.14%) (Chudasama & Sagarka, 2015).

Custard apple extract showed the highest efficiency (80% and 76%) reduction against the aphid and the mite in hydroponic cucumber cultivated under greenhouse conditions (Saleem et al., 2019). The crude oils from seeds of custard apple at 2.5 and 5 percent concentrations significantly reduced leaf damage caused by *S. litura* larvae (Babu et al., 1998).

Kawazu et al. (1989) isolated two insecticidal compounds from the seeds of *An-*

nona squamosa. One was identified as annonin (squamocin) and the other was characterized as a novel dihydroxy-bistetrahydrofuran fatty acid lactone (acetogenin) with 35 carbons. These two compounds were toxic to eggs, larvae and adults of the fruit fly.

These observations are similar with the present findings.

Table 3 shows the effect of botanicals on average fruit size of Bitter gourd (cm). The Pesticide treatment showed the best performance on average fruit size (14.23 ± 0.95a) of Bitter gourd and the extract of Custard apple leaves treatment showed 2nd best fruit size (14.00 ± 0.61ab) whereas the lowest fruit size (9.53 ± 0.67g) was found in Banana leaves treatment.

Table 3 shows the effect of botanicals on total yield of Bitter gourd (gm). The Pesticide treatment showed the best performance on yield (2621.50 ± 130.37a) of Bitter gourd. The 2nd best yield (1472.33 ± 153.01b) was found in Custard Apple leaves treatment. The Custard Apple leaves treatment kept about 5.33 times better performance on Bitter gourd yield than that of control treatment (Table 3).

Table 3. Effect of botanicals on Bitter gourd fruit size and yield (1st Experiment).

Treatment No.	Treatment Names	Fruit Size (cm)	Fruit yield (gm)
T1	Control	11.80 ± 0.30def	276.03 ± 54.45f
T2	*Azadiracta indica* (Nim)	13.60 ± 0.72abc	885.73 ± 85.86cd
T3	*Zingiber officinale* (Ginger)	11.40 ± 0.95ef	738.03 ± 57.21de
T4	*Lactuca sativa* (Lettuce)	11.57 ± 0.91ef	571.43 ± 169.09e
T5	*Corchorus capsularis* (Deshi Jute)	12.97 ± 0.80abcd	512.87 ± 131.66ef
T6	*Trichosanthes dioica* (Pointed gourd)	12.57 ± 0.32cde	614.13 ± 144.56de
T7	*Tamarindus indica* (Tamarind)	13.37 ± 0.12abc	685.53 ± 138.58de
T8	*Allium cepa* (Onion)	13.93 ± 0.59ab	1035.77 ± 168.06c
T9	*Swertia chirayita* (Chirata)	12.53 ± 0.40cde	882.93 ± 290.50cd
T10	*Annona squamosa* (Custard Apple)	14.00 ± 0.61ab	1472.33 ± 153.01b
T11	*Elettaria cardamomum* (Cardamom)	10.60 ± 0.40fg	497.47 ± 130.89ef
T12	*Musa* spp (Banana)	9.53 ± 0.67g	459.20 ± 152.00ef
T13	*Piper nigrum* (Black Pepper)	12.87 ± 0.61bcd	658.00 ± 85.43de
T14	*Swietenia macrophylla* (mahogany)	10.80 ± 1.11f	741.53 ± 238.31de
T15	Pesticide (Malathion)	14.23 ± 0.95a	2621.50 ± 130.37a

Further 2nd experiment was carried out, which was dose dependent, (10% and 20%) of three best botanicals which ranked up to 2nd position among the botanicals in 1st experiment in respect of low fruit fly infestation (Ginger and Custard Apple) and higher fruit size (Custard Apple and onion) and yield (Custard Apple and onion) to confirm the efficacy of these botanicals (Table 4).

Table 4. Description of treatments of 2nd experiment.

Treatment No.	Treatment Names	Concentrations
T1	Control	
T2	*Zingiber officinale* (Ginger) extracts	10% (w/v)
T3	*Zingiber officinale* (Ginger) extracts	20% (w/v)
T4	*Annona squamosa* (Custard Apple) leaves extracts	10% (w/v)
T5	*Annona squamosa* (Custard Apple) leaves extracts	20% (w/v)
T6	*Allium cepa* (Onion) extracts	10% (w/v)
T7	*Allium cepa* (Onion) extracts	20% (w/v)
T8	Pesticide (Malathion)	2 ml/l

In second experiment highest number of fruits per plant (32.33 ± 2.08a) was observed in pesticide treatment. The extract of Custard apple leaves 20% solution treatment showed 2nd highest (28.00 ± 1.00b) number of fruits per plant. Here the Custard apple leaves treatment kept about 3.36 times better performance than that of control treatment (Table 5).

Table 5. Fruits per plant and fruits infested by cucurbit fruit fly (2nd Experiment).

Treatment No.	Treatment Names	Fruits per Plant (Nos.)	Fruits Infested by Cucurbit Fruit Fly (Nos.)	Fruit Fly Infested Fruits (%)
T1	Control	8.33 ± 1.53f	5.67 ± 2.08c	68.00
T2	*Zingiber officinale* (Ginger) 10% solution	16.67 ± 2.89e	7.00 ± 1.00bc	42.00
T3	*Zingiber officinale* (Ginger) 20% solution	15.67 ± 2.08e	6.00 ± 1.00c	38.30
T4	*Annona squamosa* (Custard Apple) 10% solution	25.33 ± 3.21bc	11.33 ± 2.31a	44.74
T5	*Annona squamosa* (Custard Apple) 20% solution	28.00 ± 1.00b	11.67 ± 2.08a	41.67
T6	*Allium cepa* (Onion) 10% solution	19.67 ± 3.06de	9.67 ± 1.15ab	49.15
T7	*Allium cepa* (Onion) 20% solution	22.33 ± 2.52cd	9.67 ± 1.53ab	43.28
T8	Pesticide (Malathion)	32.33 ± 2.08a	4.33 ± 1.53c	13.40

Table 6. Effect of botanicals on Bitter gourd fruit size and yield (2nd Experiment).

Treatment No.	Treatment Names	Fruit Size (cm)	Fruit Yield (g)
T1	Control	11.67 ± 0.76b	215.83 ± 35.75e
T2	*Zingiber officinale* (Ginger) 10% solution	11.37 ± 0.45b	765.8 ± 139.95d
T3	*Zingiber officinale* (Ginger) 20% solution	10.60 ± 1.41b	716.33 ± 114.59d
T4	*Annona squamosa* (Custard Apple) 10% solution	14.00 ± 0.26a	1371.07 ± 79.71bc
T5	*Annona squamosa* (Custard Apple) 20% solution	14.17 ± 0.58a	1618.17 ± 102.00b
T6	*Allium cepa* (Onion) 10% solution	13.90 ± 0.69a	973.30 ± 195.32d
T7	*Allium cepa* (Onion) 20% solution	14.33 ± 0.76a	1272.17 ± 144.24c
T8	Pesticide (Malathion)	14.50 ± 0.50a	2844.73 ± 261.91a

The highest percentage (68.00%) of fruits infested (5.67 ± 2.08c) by cucurbit fruit fly was found in control treatment. The lowest percentage (13.40%) infestation (4.33 ± 1.53c) of cucurbit fruit fly was in pesticide treatment. The 2nd lowest percentage (38.30%) of fruits infestation (6.00 ± 1.00c) was found in Ginger 20% solution. Custard apple leaves 20% solution treatment showed 41.67% fruits infestation (11.67 ± 2.08a) (Table 5).

Table 6 shows the effect of botanicals on average fruit size (cm) and yield (g) of Bitter gourd. The Pesticide treatment showed the best performance on average fruit size (14.50 ± 0.50a) of Bitter gourd and the extract of onion 20% solution treatment showed 2nd best fruit size (14.33 ± 0.76a).

Table 6 also shows the effect of botanicals on total yield of Bitter gourd (gm). The Pesticide treatment showed the best performance on yield (2844.73 ± 261.91a) of Bitter gourd. The 2nd best yield (1618.17 ± 102.00b) was found in 20% Custard Apple leaves solution treatment. The 20% Custard Apple leaves treatment kept about 7.50 times better performance on Bitter gourd yield than that of control treatment (Table 6). Rana and Azad (2025) found that the application 20% solution of *Annona squamosa* (Custard Apple) leaves enhance the growth, increased production and suppressed insect pest attack on jute in experimental field.

4. Conclusions

The present study revealed that Cucurbit fruit fly infestation was significantly reduced by some botanical extracts. Out of thirteen botanicals, Ginger (*Zingiber officinale*) 20% solution treatment showed best performance for the control of cucurbit fruit fly infestation in experimental Bitter gourd field.

A low fruit fly infestation was also found in the Custard apple (*Annona squamosa*) leaves 20% solution treatment. This treatment also produced the highest production of Bitter gourd among the tested botanicals.

Therefore, Ginger rhizome and Custard apple leaves 20% solution can be used as bio-pesticides in Bitter gourd field to manage the cucurbit fruit fly infestation in eco-friendly way.

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Authors' Contributions

Md. Kaysar Ikbal: carried out the field experiment, data collection, data analysis and writing; Tashfia Tashnim Dia: helped in monitoring pest infestation; Mst. Samia Sultana: helped in data analysis and Md. Abul Kalam Azad: conceptual design of research work, supervision and review and editing of manuscript.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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