Screening of Some Botanicals for Eco-friendly Control of Cucurbit Fruit Fly (Bactrocera cucurbitae) Infestation in Experimental Cucumber Field

M. S. Sultana1, M. A. K. Azad1*, and M. S. Islam2

1Institute of Environmental Science, University of Rajshahi, Rajshahi 6205
2Department of Crop Science and Technology, University of Rajshahi, Rajshahi 6205
*Corresponding email: akazad_ies@yahoo.com

Abstract

Cucurbit fruit fly (Bactrocera cucurbitae) is the major pest of Cucumber (Cucumis sativus L.), which severely damage the cucumber production. This study was carried to evaluate the efficacy of fourteen botanicals such as Chili (Capsicum frutescens), Garlic (Allium sativum), Onion (Allium cepa), Ginger (Zingiber officinale), Carrot leaves (Daucus carota subsp. Sativus), Bitter gourd (Momordica charantia), young Tomato (Solanum lycopersicum), Mahogany seed (Swietenia macrophylla), Eucalyptus leaves (Eucalyptus globulus), Black plum leaves (Syzygium cumini), Jackfruit leaves (Artocarpus heterophyllus), Neem leaves (Azadirachta indica), Black pepper (Piper nigrum) and Garden croton leaves (Codiaeum variegatum) to control the cucurbit fruit fly infestation in experimental cucumber (Green Rohini F1 Hybrid Cucumber) field during March 15, 2021– May 14, 2021. This study observed a less number of cucurbit fruit fly attack on cucumber fruits in Ginger treatment. In this treatment, only 7.06% fruits were infested by cucurbit fruit fly. The Ginger treatment reduced 14.17 times fruit fly infestation compare to control. However, a high number of cucurbit fruit fly infestations were found in Bitter gourd, young Tomato, Mahogany and Garden croton treatments. Cucurbit fruit fly infestation was low (12.50%) in Neem treatment. This treatment showed best performance on cucumber size (cm) and yield (gm). The lowest yield was found in Bitter gourd treatment. The Neem treatment kept about 3.54 times better performance in respect to cucumber yield than that of control treatment. Therefore, Neem leaves (Azadirachta indica) and Ginger (Zingiber officinale) extracts can be used as bio-pesticide for eco-friendly control of cucurbit fruit fly infestation in cucumber field.

Keywords: Botanicals, Cucumber, Cucumber fruit fly, Ginger, Screening

Introduction

Cucumber (Cucumis sativus L.) is a creeping vine plant in the Cucurbitaceae family that bears usually cylindrical fruits and used as vegetables (Thoa, 1998). Cucumber is the main ingredient of salad. Besides being widely used for culinary purposes, cucumbers are also used in facial creams, lotions, and cleansers. This anti-inflammatory agent is known for its astringent and soothing properties (Azad et al., 2013 and Schieberle et al., 1990).

Cucurbit fruit fly (Bactrocera cucurbitae) is one of the serious pest 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 crops species and varieties (Dhillion et al., 2005). Pradhan (1976) reported that the degree of infestation varied from 19.4-22.1% in cucumber. It prefers to infest young fruits (Maharjan et al., 2015). When the humidity is high, intensity of cucurbit fruit fly damage becomes severe. Its abundance increases with increase in daily temperatures, however higher than 31°C is not ideal for its growth and reproduction (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, 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 is 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 screen some botanicals having insecticidal activity against cucurbit fruit fly and to identify the effect of botanical extracts on growth and yield of cucumber.

Materials and Methods

Experimental plot preparation for cucumber cultivation

This experiment was carried out in Kharif-1 season during March 15, 2020 to May 14, 2021 at Botanical Pesticides Research Field of Institute of Environmental Science of University of Rajshahi. The soil of the experimental site is Gangetic alluvial and climate is subtropical.
The experiment was laid out in a Randomized Complete Block Design (RCBD) with fourteen treatments. The plot size was 16 m x 4 m, line spacing and replication to replication distances were 1.0 m. 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 whole amount of fertilizers was used as the basal dose during pit preparation. Then, the seeds were sown in the experimental plot (Table 1). The plot was irrigated with pump-water when necessary.

**Table 1. Information about cucumber cultivation**

| Information                        | Variety and Cultivation Period |
|------------------------------------|--------------------------------|
| Name of Crop                       | Cucumber                       |
| Cucumber Variety                   | Green Rohini F1 Hybrid         |
| Scientific Name                    | *Cucumis sativus* L.           |
| Collection of seeds                | Katakhali Nursery, Rajshahi    |
| Date of seed sown                  | March 15, 2021                 |
| Fruits harvest completed           | May 14, 2021                   |
| No of Spray                        | 10 times                       |
| Spray Started                      | 01-04-2021                     |
| Last Spray                         | 07-05-2021                     |

**Preparation of aqueous botanical extracts for spray**

Botanicals like green Chili (*Capsicum frutescens*), Garlic (*Allium sativum*), Onion (*Allium cepa*), Ginger (*Zingiber officinale*), Carrot leaves (*Daucus carota subsp. Sativus*), Bitter gourd (*Momordica charantia*), young Tomato (*Solanum lycopersicum*), Mahogany seed (*Swietenia macrophylla*), Eucalyptus leaves (*Eucalyptus globulus*), Black plum leaves (*Syzygium cumini*), Jackfruit leaves (*Artocarpus heterophyllus*), Neem leaves (*Azadirachta indica*), Black pepper (*Piper nigrum*) and Garden croton leaves (*Codiaeum variegatum*) were collected from the campus of University of Rajshahi, Bangladesh. After collection, fruits, seeds and leaves were washed in running tap water. For the preparation of 10% extract, 100 gm of grinding or cutting fruits, seeds and leaves 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.

**Cucumber fruits infestation monitoring**

The cucumber field was visited every day and cucumber fruit infestation by fruit fly was counted every 3 days in a week. The percent (%) of infested cucumber fruits was calculated as per following formula:

\[
\text{Infested Fruits (%) = } \frac{\text{Number of damaged cucumber fruits}}{\text{Total number of harvested fruits}} \times 100
\]

**Statistical analysis of data**

The observed values were statistically analyzed by one way ANOVA and the significant levels were tested by Duncan’s Multiple Range Test (Duncan, 1951) (P < 0.05) using standard software.

**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 some plant extracts on fruit fly infestation. Aqueous extracts of botanicals may act as effective insecticides against cucurbit fruit fly (Bactrocera cucurbitae) which affect the cucumber cultivation throughout the world. Therefore, efficacy of fourteen plant extracts was evaluated in experimental cucumber field and the results are presented here with possible interpretations. Table 2 shows the effect of botanicals on plant growth (length) of cucumber. The Jackfruit leaves treatment showed best performance on plant length (242.67±34.35a) of cucumber. The extract of Garlic treatment showed moderate effect on plant length (239.67±15.60a), whereas the lowest plant length (cm) was found in Eucalyptus leaves treatment (119.00±4.58c). The Jackfruit treatment kept about 1.13 times better performance than that of control treatment (Table 2).

### Table 2. Effect of botanicals on cucumber plant growth

| Treatment                      | Plant length (cm) |
|--------------------------------|-------------------|
| Control                        | 214.00±13.28ab    |
| Green Chili 10%                | 170.67±29.45abc   |
| Garlic 10%                     | 239.67±15.60a     |
| Onion 10%                      | 153.33±34.44abc   |
| Ginger 10%                     | 176.33±26.21abc   |
| Carrot Leaves 10%              | 182.67±33.20abc   |
| Bitter Gourd 10%               | 129.67±24.97bc    |
| Young Tomato 10%               | 167.67±1.45abc    |
| Mahogany Seed 10%              | 167.67±16.68abc   |
| Eucalyptus Leaves 10%          | 119.00±4.58c      |
| Black Plum Leaves 10%          | 168.67±15.30abc   |
| Jackfruit Leaves 10%           | 242.67±34.35a     |
| Neem Leaves 10%                | 184.67±27.42abc   |
| Black Pepper 10%               | 210.67±52.21abc   |
| Garden Croton Leaves 10%       | 207.67±28.49abc   |

Table 3 shows the effect of botanicals on number of fruits per plant and fruit fly infestation. The highest number of fruits per plant (8.00±1.15a) was observed in Neem treatment. The extract of Garlic treatment showed moderate number of fruits per plant (7.67±2.19ab) and the lowest number of fruits per plant (1.00±0.00c) was found in Bitter gourd and young Tomato treatments. The Neem leaves treatment kept about 3 times better performance than that of control treatment (Table 3). This study also observed significant effect of other botanicals on number of fruits per plant of Cucumber.

### Table 3. Fruits per plant and fruits infested by cucurbit fruit fly

| Treatments               | Fruits per Plant (Nos.) | Fruits Infested by Cucurbit Fruit Fly (Nos.) | Fruit Fly Infested Fruits (%) |
|--------------------------|-------------------------|---------------------------------------------|-------------------------------|
| Control                  | 2.67±0.33abc           | 1.33±0.33a                                  | 49.81                         |
| Green Chili 10%          | 4.33±3.33abc           | 1.33±0.88a                                  | 30.71                         |
| Garlic 10%               | 7.67±2.19ab            | 2.00±0.58a                                  | 26.07                         |
| Onion 10%                | 3.67±1.20abc           | 0.67±0.33a                                  | 18.25                         |
| Ginger 10%               | 4.67±0.33abc           | 0.33±0.33a                                  | 7.06                          |
| Carrot Leaves 10%        | 4.00±1.73abc           | 1.67±0.67a                                  | 41.75                         |
| Bitter Gourd 10%         | 1.00±0.00c             | 1.00±0.00a                                  | 100.00                        |
| Young Tomato 10%         | 1.00±0.00c             | 1.00±0.00a                                  | 100.00                        |
| Mahogany Seed 10%        | 5.67±3.67abc           | 2.67±1.67a                                  | 47.08                         |
| Eucalyptus Leaves 10%    | 4.00±0.58abc           | 1.33±0.33a                                  | 33.25                         |
| Black Plum Leaves 10%    | 2.33±0.33abc           | 1.00±0.00a                                  | 42.91                         |
| Jackfruit Leaves 10%     | 7.33±1.20ab            | 1.67±0.33a                                  | 22.78                         |
| Neem Leaves 10%          | 8.00±1.15a             | 1.00±0.58a                                  | 12.50                         |
| Black Pepper 10%         | 3.67±1.20abc           | 1.67±1.20a                                  | 45.50                         |
| Garden Croton Leaves 10% | 6.33±1.20abc           | 2.67±1.67a                                  | 42.18                         |
The number of fruits infested by cucurbit fruit fly was regularly monitored during this study. Table 3 shows the effect of botanicals on numbers of fruits infested by cucurbit fruit fly. The highest number of fruits (2.67±1.67a) infested by cucurbit fruit fly was found in Mahogany seed and Garden croton treatments. The moderate infestation of cucurbit fruit fly (0.67±0.33a) was found in Onion treatment and the lowest number of infested fruits (0.33±0.33a) was found in Ginger treatment. In Ginger and Neem leaves treatments, 7.06% and 12.50% cucumber fruits were infested by cucurbit fruit fly, respectively. However, 100% fruits were infested in the Bitter gourd and Tomato treatments (Table 3). The Ginger treatment kept about 14.17 times better performance than that of control.

Agrawal and Dev (2013) observed that 5% aqueous neem seed kernel extract caused 66.3% pupae mortality of melon fruit fly (Bactrocera cucurbitae Coq.). According to Ranganath et al. (1997), neem oil (1.2%) was found most effective against the melon fruit fly infestation on cucumber and neem cake (4.0%) was found effective against pest attack on ridge gourd in south Andaman, India. These observations are similar with the present findings.

Table 4 shows the effect of botanicals on average fruit size of cucumber (cm). The Neem treatment showed the best performance on average fruit size (14.74±1.10a) of cucumber and the extract of Carrot leaves treatment showed moderate fruit size (13.43±0.16ab), whereas the lowest fruit size (11.90±0.58c) was found in Bitter gourd treatment. The Neem leaves treatment kept about 1.10 times better performance than that of control treatment (Table 4).

Table 4. Effect of botanicals on cucumber fruit size

| Treatments               | Fruit Size (cm) |
|--------------------------|-----------------|
| Control                  | 13.44±0.99ab    |
| Green Chili 10%          | 12.66±1.30abcd  |
| Garlic 10%               | 12.92±0.39abcd  |
| Onion 10%                | 11.39±1.24bcde  |
| Ginger 10%               | 11.27±0.79bcde  |
| Carrot Leaves 10%        | 13.43±0.16ab    |
| Bitter Gourd 10%         | 9.90±0.83e      |
| Young Tomato 10%         | 11.50±0.58bcde  |
| Mahogany Seed 10%        | 10.54±1.11cde   |
| Eucalyptus Leaves 10%    | 12.63±0.50abcde |
| Black Plum Leaves 10%    | 10.34±0.39cde   |
| Jackfruit Leaves 10%     | 13.07±0.08abc   |
| Neem Leaves 10%          | 14.74±1.10a     |
| Black Pepper 10%         | 12.27±0.24abcd  |
| Garden Croton Leaves 10% | 13.09±0.75abc   |

Table 5 shows the effect of botanicals on total yield of cucumber (gm). The Neem leaves treatment showed the best performance on yield (895.67±119.15a) of cucumber. The extract of Onion treatment showed moderate yield (260.00±83.52bc) and the lowest yield (56.33±7.06c) was found in Bitter gourd treatment. The Neem leaves treatment kept about 3.54 times better performance on cucumber yield than that of control treatment (Table 5).

Table 5. Total yield of cucumber

| Treatments         | Yield (gm) |
|--------------------|------------|
| Control            | 253.00±61.25bc |
| Green Chili 10%    | 497.00±428.10abc |
| Garlic 10%         | 760.67±213.12ab |
| Onion 10%          | 260.00±83.52bc |
| Ginger 10%         | 338.67±58.89abc |
| Carrot Leaves 10%  | 319.67±220.42abc |
| Bitter Gourd 10%   | 56.33±7.06c   |
| Young Tomato 10%   | 79.67±2.60c   |
| Mahogany Seed 10%  | 525.67±360.56abc |
| Eucalyptus Leaves 10% | 295.67±47.76abc |
| Black Plum Leaves 10% | 219.33±26.89bc |
| Jackfruit Leaves 10% | 606.33±155.45abc |
| Neem Leaves 10%    | 895.67±119.15a |
| Black Pepper 10%   | 398.00±169.82abc |
| Garden Croton Leaves 10% | 738.67±186.14ab |

The result showed that plant extracts not created any bad effect on cucumber production except Bitter gourd and young Tomato treatments. These observations are similar with the findings of Azad et al. (2013) and Maharjan et al. (2015). The present study revealed that cucurbit fruit fly infestation was significantly reduced by some botanical extracts that can be incorporated into IPM practice to reduce the synthetic pesticide application in cucumber field.

Conclusion

Out of fourteen botanicals, Ginger (Zingiber officinale) treatment showed best performance for the control of cucurbit fruit fly infestation in experimental cucumber field. A low fruit fly infestation (12.50%) was found in the Neem leaves (Azadirachta indica) treatment. This treatment also produced the highest production of cucumber. Therefore, Neem leaves and Ginger extracts can be used as bio-pesticides instead of toxic pesticides in cucumber field to manage the cucurbit fruit fly infestation in eco-friendly way.

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