

# **Evaluation of some bio-pesticides for eco-friendly management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) in the northwest region of Bangladesh**

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## **ABSTRACT**

It is extremely challenging to control the *Leucinodes orbonalis* Guenee, also known as the brinjal shoot and fruit borer (BSFB) in brinjal cultivation. Considering the prevailing dangerous effects of chemical pesticides on human health and ecology, biopesticides can be an effective weapon to sustain against BSFB. Among the different types of biopesticides, Spinosad was found to be more effective @0.4ml/L to recommend as it was elucidated the lowest shoot infestation (10.19%) and fruit infestation (25.53%) followed by Abamectin @1.2ml/L (12.82% and 30.71%). Furthermore, other biopesticides like Buprofezin, Abamectin, Neem oil, Mahogany oil, Neem leaf extract, and Garlic bulb extract are also used to finding out the best possible solution of existing threats from BSFB. Consequently, with the higher efficacy of Spinosad the economic point of view can be accentuated through the highest benefit-cost ratio (2.28) and quantity of marketable fruit yields (36.62 tons/ha) in the study area.

**Keywords:** Biopesticides, brinjal, eco-friendly management, *Leucinodes orbonalis*.

## **INTRODUCTION**

Brinjal (*Solanum melongena*) is a highly edible and demandable Solanaceous vegetable commercially grown in Southeast Asia (Thapa, 2010). It comprises around 15% of Bangladesh's total vegetable growing area, with more than 1,600,000 ha under cultivation globally and 50 million Mt of production (Rahman, 2005 and FAO, 2018). From seedling until senescence, numerous insects can harm brinjal. *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae), a brinjal shoot and fruit borer, is the most deleterious pest among these insects and is regarded as a limiting factor in both the quantity and quality of brinjal fruit harvest. The pest is very active during the rainy and summer season and may cause 85 to 90 % damage. The larvae bore into tender shoots at the vegetative stage causing withering and drooping of young shoots. A single larva can infest 4 to 7 fruits during its life

span (Jayaraj and Manisegaran, 2010). Therefore, about 70-92% yield loss is really obvious from this certain pest attack (Murugesan and Murugesu, 2009).

Chemical control is the most common practice in Bangladesh to control *Leucinodes orbonalis* as well as to produce blemish-free brinjal fruits. More precisely, 98% of brinjal-growers relied exclusively on the use of conventional pesticides and they used those pesticides 140 times or more in the 6-7 month cropping season. Being a vegetable crop, in brinjal the use of conventional chemical insecticide leaves shows considerable toxic residual effects on the fruits, and it also increases the 40-50% production cost in Bangladesh (SUSVEG-Asia, 2007). Consequently, the numerous and indiscriminate uses of insecticides against this pest cause substantial difficulties for plant survival viz., insecticide resistance, toxic residues in fruits, killing of natural enemies and ultimately pest resurgence. In addition to being expensive, it also harms the ecosystem's beneficial fauna as well as the environment, human consumption, and human health.

It is now a crucial need to use safe but effective, biodegradable insecticides with no or less toxic effects on non-target organisms. Uses of biopesticide products have many potentials to overcome these adversities. Biopesticides originated from natural materials (such as animals, plants, bacteria, and minerals) and have low toxicity on non-target organisms including humans, animals, natural enemies and the environment. Most Asian countries like China, Japan, and Korea are intensively using bio-pesticides, but there are very low uses in Bangladesh (Srinivasan and Ying, 2014). Considering the above points, the present research work has been planned to study the damage assessment and to develop a suitable eco-friendly management strategy using some biopesticides (Spinosad, Buprofezin, Abamectin, Neem oil, Mahogany oil, Neem leaf extract & Garlic bulb extract).

## **MATERIALS AND METHODS**

The experiments were carried out at Somaspur village in Godagari Upazila under the district Rajshahi from April to September 2021. Land preparation was done by breaking the clods through continuous ploughing. The prepared main field with weed-free and good tilth condition was divided into 3 distinct blocks comprised of 8 equal plots ( $1.5 \times 1.5 \text{ m}^2$ ) each. A distance of 60 cm between the plots and 80 cm between the blocks was maintained. Finally, the unit plots were prepared as 10 cm raised beds along with basal doses of recommended fertilizers maintaining a single pit in each bed.

### ***Materials used and experimental design***

This study was implemented with Singnath (Upshi) as the tested cultivar. Healthy and disease-free brinjal seedlings 30 days old were collected from the Chapainawabganj horticulture center, Chapainawabganj. The collected seedlings were transplanted in the experimental plots @4 seedlings/plot maintaining the spacing of 80 cm  $\times$  60 cm. Then, different cultural operations like weeding, irrigation, mulching, and top dressing of urea were done when necessary. A total of 24 plots were used for the efficacy of different types of biopesticides- i. T<sub>1</sub>= Spinosad @0.4ml/L, ii. T<sub>2</sub>= Buprofezin @1ml/L, iii. T<sub>3</sub>= Abamectin @1.2ml/L, iv., T<sub>4</sub>= Neem oil @3ml/L, v. T<sub>5</sub>= Mahogany oil @4ml/L, vi. T<sub>6</sub>= Mahogany leaf extract @50g/L, vii. T<sub>7</sub>= Garlic bulb extract @30g/L & viii. T<sub>8</sub>= Untreated Control. A total of three sprayings were given in the experimental field at 7 days intervals. Spraying was done from 9.00 to 11.00 AM to avoid bright sunshine and drift caused by the strong wind. Spinosad (Tracer 45 SC manufactured by Auto Crop Care Ltd), Abamectin (Ambush 1.8 EC manufactured by Haychem Bangladesh Ltd) and Buprofezin (Award 40 SC manufactured by Square Pharmaceuticals Ltd) were collected from the local market. Neem and Mahogany oil were collected from the local dealer of a company situated at Gazipur, Dhaka. Neem leaf extract and Garlic bulb extract were prepared by crushing the leaves & cloves using a hand

blender. The treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications.

Data were collected on shoot and fruit infestation & fruit yield in the quantitative means. In the case of shoot infestation, data were collected at 3 and 7 days after providing each spray. On the other hand, fruit infestation data was recorded after each harvest. After collection, shoot and fruit data were converted into a percentage using the following formulae used by Karmakar et al. (2018):

$$\text{Percent fruit infestation} = \frac{\text{Mean number of infested fruit}}{\text{Mean number of total fruit}} \times 100$$

$$\text{Percent shoot infestation} = \frac{\text{Mean number of infested shoot}}{\text{Mean number of infested fruit}} \times 100$$

$$\begin{aligned} &\text{\%increase or decrease over control} \\ &= \frac{\text{Mean value of the treated plot} - \text{Mean value of untreated plot}}{\text{Mean value of untreated plot}} \times 100 \end{aligned}$$

After harvesting successive grading was done based on their degrees of infestation and the weight of marketable and infested fruits was taken from the three replicated plots regarding the treatments and yield was converted into tones/hectare (t/ha). Finally, the total yield (t/ha) was calculated by adding marketable and infested yields from four pickings.

Brinjal fruits were harvested after 7 days of each spray and then marketable fruits were separated carefully from total fruits. The marketable brinjal fruits were defined as the visibility of no hole or even no deformation on the fruits. In contrast, infested fruits were defined as the visibility of clear holes or excreta on the fruits.

For statistical analysis, all the collected data were compiled and tabulated. The MSTAT program was used to analyze variance (ANOVA) (Nissen, 1990). Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) were used to determine treatment mean differences as needed.



Figure 1. Experimental plots and treatment application

## RESULTS AND DISCUSSIONS

It was observed that each of the treatments was significantly effective against brinjal shoot and fruit borer compared to control. The highest percentage of shoot infestation was observed in the case of untreated control, which ranged from 18.54% to 33.37% where the

cumulative mean of infestation was 29.51% (Table 1). Among individual treatments, the lowest percentage of shoot infestation was exhibited from Spinosad (10.19%) treated plots which were followed by Abamectin (12.82%), Buprofezin (14.53%), Neem oil (14.54%), Neem leaf extract (14.74%), Mahogany oil (15.03%) and Garlic bulb extract (16.68%) respectively.

Table 1. Mean percentage of shoot infestation caused by BSFB at different sprayings against different treatments

| Treatments                   | Mean percent of shoot infestation at different DAT |         |                       |         |                       |         |                            |
|------------------------------|----------------------------------------------------|---------|-----------------------|---------|-----------------------|---------|----------------------------|
|                              | 1 <sup>st</sup> spray                              |         | 2 <sup>nd</sup> spray |         | 3 <sup>rd</sup> spray |         | Cumulative mean Percentage |
|                              | 3 DAT                                              | 7 DAT   | 3 DAT                 | 7 DAT   | 3 DAT                 | 7 DAT   |                            |
| T1=Spinosad                  | 5.12e                                              | 8.130d  | 9.873d                | 11.29d  | 9.26c                 | 17.48c  | 10.19e                     |
| T2=Buprofezin                | 8.59cd                                             | 9.583d  | 13.92bc               | 15.26cd | 17.85b                | 21.94b  | 14.53cd                    |
| T3=Abamectin                 | 6.78de                                             | 8.370d  | 11.13cd               | 14.11cd | 17.48b                | 19.08bc | 12.82d                     |
| T4= Neem oil                 | 9.99bc                                             | 12.79bc | 12.84bcd              | 16.78bc | 16.31b                | 18.54bc | 14.54cd                    |
| T5=Mahogany oil              | 9.10cd                                             | 10.24cd | 13.68bc               | 17.07bc | 17.85b                | 22.22b  | 15.03bc                    |
| T6= Neem leaf extract        | 8.85cd                                             | 11.30cd | 13.68bc               | 17.07bc | 17.85b                | 19.68bc | 14.74c                     |
| T7= Garlic bulb extract      | 12.39b                                             | 15.26b  | 14.60b                | 20.26b  | 18.14b                | 19.41bc | 16.68b                     |
| T8= Control                  | 18.54<br>a                                         | 28.39a  | 33.37a                | 32.87a  | 31.98a                | 31.92a  | 29.51a                     |
| <i>LSD<sub>0.05</sub></i>    | 2.69                                               | 2.96    | 3.02                  | 4.00    | 3.91                  | 3.53    | 1.67                       |
| <i>SE (±)</i>                | 0.887                                              | 0.975   | 0.995                 | 1.32    | 1.29                  | 1.16    | 0.551                      |
| <i>Level of significance</i> | **                                                 | **      | **                    | **      | **                    | **      | **                         |
| <i>CV (%)</i>                | 15.50                                              | 12.97   | 11.19                 | 12.62   | 12.17                 | 9.47    | 5.96                       |

\*\* = Significant at 1% level of probability

On the other side, at maturity, the highest percentage of infested fruits from all 4 pickings was obtained when brinjal plants were left untreated where the cumulative mean was found at 71.39% (Table 2). Among individual treatments, the lowest percentage of fruit infestation was recorded from Spinosad (25.53%) treated plots which were followed by Abamectin (30.71%), Buprofezin (39.41%), Neem oil (41.48%), Neem leaf extract (43.93%), Mahogany oil (49.93%) and garlic bulb extract (51.16%) respectively. For the shoot and fruit protection, all the selected biopesticides significantly reduced percent fruit infestation in comparison to the control treatment (Figure 2 and Figure 3). More precisely, Spinosad showed both cases the most effective result in the case of protection i.e., 65.47% for shoot protection and T1=64.24% for fruit protection. However, T2=Buprofezin and T7= Garlic bulb extract was found less effective than the other treatments in both cases. The present findings conform with those of Sinha and Sharma (2008), and Mamun et al. (2014) who reported the effectiveness of Spinosad against brinjal shoot and fruit borer. Gayathri et al. (2019) also reported that Spinosad performed best among different rationales used to manage brinjal shoots and fruit borers. The present findings agree with the results of many researchers.

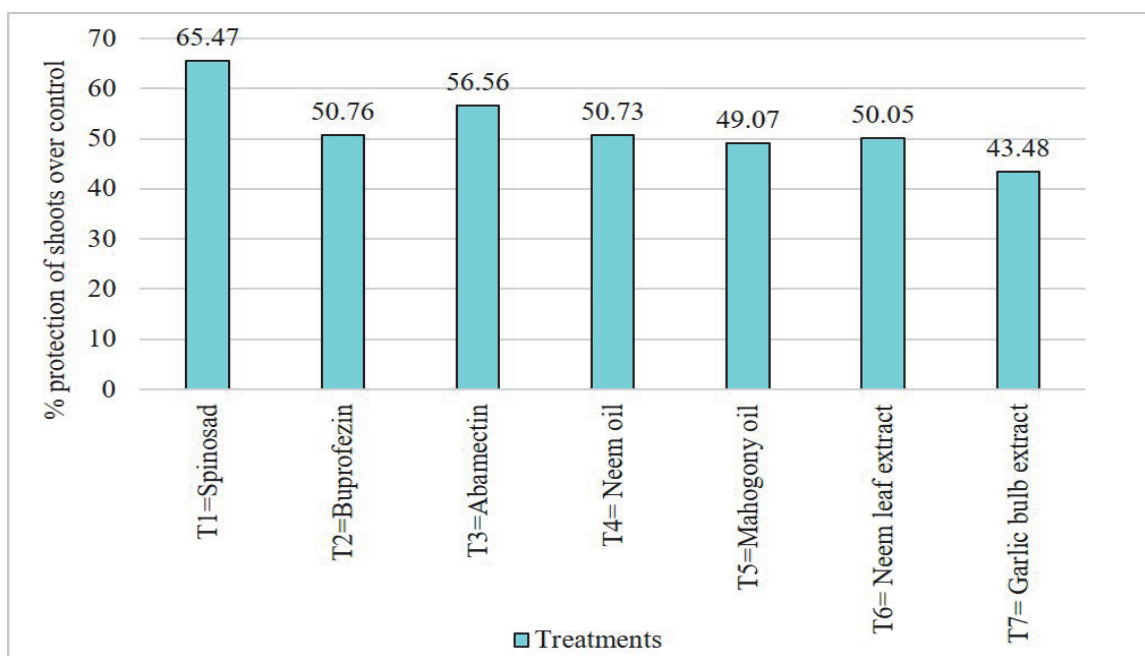


Figure 2. Percentage of protection shoots over control for different biopesticides

Table 2. Effect of treatments against BSFB on percent fruit infestation at different pickings

| Treatments                   | Mean percent fruit infestation at different pickings |                          |                          |                          |                            |
|------------------------------|------------------------------------------------------|--------------------------|--------------------------|--------------------------|----------------------------|
|                              | 1 <sup>st</sup> counting                             | 2 <sup>nd</sup> counting | 3 <sup>rd</sup> counting | 4 <sup>th</sup> counting | Cumulative mean percentage |
| T1= Spinosad                 | 20.06 e                                              | 26.78 c                  | 23.50 d                  | 31.78 c                  | 25.53 e                    |
| T2=Buprofezin                | 39.29 cd                                             | 37.14 bc                 | 41.07 bcd                | 40.12 bc                 | 39.41 cd                   |
| T3= Abamectin                | 30.36 de                                             | 26.19 c                  | 34.52 cd                 | 31.74 c                  | 30.71 de                   |
| T4= Neem oil                 | 43.39 bcd                                            | 34.72 bc                 | 46.29 bc                 | 41.11 bc                 | 41.38 bc                   |
| T5=Mahogany oil              | 46.67 bc                                             | 53.33 ab                 | 43.33 bcd                | 53.33 b                  | 49.17 bc                   |
| T6= Neem leaf extract        | 37.03 cd                                             | 45.83 abc                | 50.00 abc                | 42.86 bc                 | 43.93 bc                   |
| T7= Garlic bulb extract      | 54.17 b                                              | 43.33 abc                | 59.52 ab                 | 47.62 bc                 | 51.16 b                    |
| T8= Control                  | 68.33 a                                              | 62.22 a                  | 70.00 a                  | 85.00 a                  | 71.39 a                    |
| <i>LSD</i> <sub>0.05</sub>   | 13.31                                                | 18.23                    | 19.58                    | 17.39                    | 9.98                       |
| <i>SE</i> ( $\pm$ )          | 4.39                                                 | 6.01                     | 6.46                     | 5.73                     | 3.29                       |
| <i>Level of significance</i> | **                                                   | **                       | **                       | **                       | **                         |
| <i>CV</i> (%)                | 17.92                                                | 25.27                    | 24.29                    | 21.26                    | 12.92                      |

\*\* = Significant at 1% level of probability

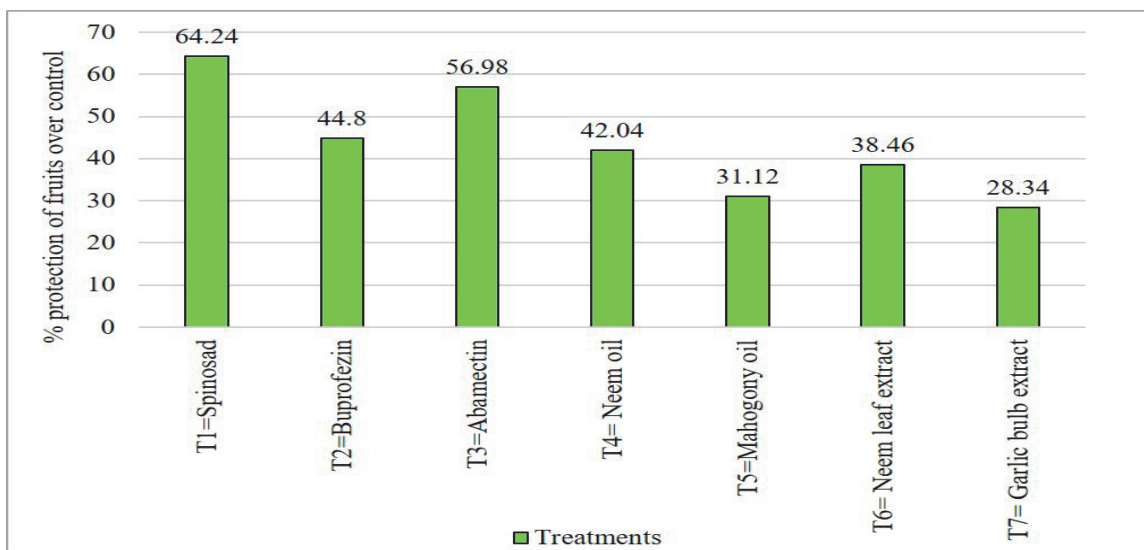


Figure 3. Percentage of protection fruits over control for different biopesticides

In the case of marketable fruit yield, the highest marketable fruit yield (ton/ha) was exhibited from Spinosad treated plots (36.62 ton/ha) which are followed by Abamectin (33.16 ton/ha), Buprofezin (29.51 ton/ha), Neem oil (28.53 ton/ha), Neem leaf extract (27.92 ton/ha), Mahogany oil (25.90 ton/ha) and Garlic bulb extract (25.49 ton/ha) respectively.

Table 3. Marketable fruit yield and Benefit Cost Ratio of brinjal production

| Treatments                   | Marketable fruit yield and Benefit Cost Ratio |                    |                                      |                          |
|------------------------------|-----------------------------------------------|--------------------|--------------------------------------|--------------------------|
|                              | Yield (ton/ha)                                | Net return (Tk/ha) | The total cost of production (Tk/ha) | Benefit-cost ratio (BCR) |
| T1= Spinosad                 | 36.62a                                        | 915500.00 a        | 401530.00 d                          | 2.28 a                   |
| T2= Buprofezin               | 29.51c                                        | 678730.00 b        | 429575.00 c                          | 1.58 c                   |
| T3= Abamectin                | 33.16b                                        | 829000.00 a        | 394760.00 d                          | 2.10 b                   |
| T4= Neem oil                 | 28.53cd                                       | 656190.00 b        | 449445.00 b                          | 1.46 d                   |
| T5=Mahogany oil              | 25.90e                                        | 569800.00 b        | 463250.00 b                          | 1.23 f                   |
| T6= Neem leaf extract        | 27.92d                                        | 614240.00 b        | 454990.00 b                          | 1.35 e                   |
| T7= Garlic bulb extract      | 25.49e                                        | 560780.00 b        | 505205.00 a                          | 1.11 g                   |
| T8= Control                  | 22.10f                                        | 298350.00 c        | 324295.00 e                          | 0.92 h                   |
| <i>LSD<sub>0.05</sub></i>    | 1.45                                          | 136707.44          | 17285.62                             | 0.096                    |
| <i>SE (±)</i>                | 0.477                                         | 45066.08           | 5698.26                              | 0.032                    |
| <i>Level of significance</i> | **                                            | **                 | **                                   | **                       |
| <i>CV (%)</i>                | 2.88                                          | 12.19              | 2.31                                 | 3.36                     |

\*\* = Significant at 1% level of probability

In the case of benefit-cost ratio, the highest benefit-cost ratio was observed from Spinosad treated plots (2.28) which are followed by Abamectin (2.10), Buprofezin (1.58), Neem oil (1.46), Neem leaf extract (1.35), Mahogany oil (1.23) and Garlic bulb extract (1.11) respectively. These significant results depict the effectiveness of Spinosad for ensuring economic sustainability in brinjal cultivation. Similar findings of Islam et al. (2019) support the Spinosad application benefits with higher BCR outcomes.

To ensure the quality of brinjal the infestation was morphologically detected by eye inspection. This may help to grade the infested plants and their fruits. Evident visibility of clear holes or excreta on the fruits spotted in the field throughout the cultivation season (Figure 4B). Meanwhile, the infested plants also show their infestation on their various nodes and shoots of the plant (Figure 4A). These might be useful for effective isolation of unaffected plants and for applying the aimed treatments which were used in this experiment.

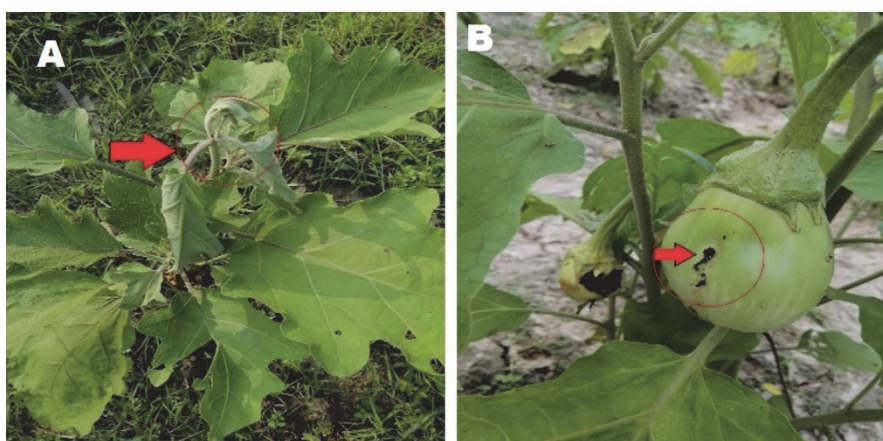


Figure 4. BSFB infestation throughout the season. (A) Shoot infestation and (B) Wounded fruit by BSFB

## CONCLUSIONS

Due to its availability and high nutritional value, brinjal is a very well-liked vegetable. However, the high levels of the brinjal shoot and fruit borer infestation are causing an alarming decline in brinjal productivity. Spinosad @0.4ml/L was the most effective biopesticide tested in this trial, followed by Abamectin and Buprofezin, according to the results of the current investigation. The results of the study can assist farmers in reducing the usage of synthetic chemical insecticides, which can ensure BSFB management practices in brinjal that are both environmentally and economically sound.

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