***Original Research Article***

**Comparative efficacy of selected chemicals and bio-pesticides against shoot and fruit borer, *Leucinodes orbonalis* (Guenee) on brinjal, *Solanum melongena* (L.)**

**ABSTRACT**

The present study was carried out during the *Kharif* season of 2024 at the research plot of the Department of Entomology, Central Research Farm (CRF), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment followed a Randomized Block Design (RBD) with three replications and included eight treatments aimed at managing the brinjal shoot and fruit borer (Leucinodes orbonalis Guenée). Data were collected on the 3, 7 and 14 days following the application of the treatments. The cumulative mean data revealed that all chemical treatments were significantly more effective than the untreated control in reducing infestation. Among the tested treatments, **Chlorantraniliprole** recorded the lowest percentage of shoot infestation, followed closely by ***Emamectin* *benzoate* 5% SG** and **Spinosad 45% SC**. **Cypermethrin 25% EC** and ***Beauveria* *bassiana*** showed similar levels of efficacy and were statistically at par. Meanwhile, **NSKE 5%** and **Neem oil 2%** were the least effective among the treatments but still performed significantly better than the control. In terms of economic analysis, **Chlorantraniliprole** also provided the highest benefit-cost ratio (B:C Ratio) of **1:8.89**, followed by ***Emamectin* *benzoate* 5% SG (1:7.81)** and **Spinosad 45% SC (1:7.80)**. **Cypermethrin 25% EC (1:6.49)** and ***Beauveria* *bassiana* (1:5.89)** again showed similar performance, while **NSKE 5% (1:4.89)** and **Neem oil 2% (1:4.45)** were lower, but still outperformed the control (**1:3.86**).

**Keywords:** Brinjal crop, *Leucinodes orbonalis*, chemical control, cypermethrin 25% EC, neem oil, chlorantraniprole

1. **INTRODUCTION**

Brinjal, commonly referred to as eggplant or aubergine, is a vegetable crop classified under the Solanaceae family and scientifically known as Solanum melongena L. It is believed to have originated in the Indo-Burma region and has been cultivated in India since ancient times. Among the various solanaceous vegetables, brinjal is one of the most widely grown and popular crops. It is a major annual vegetable cultivated across all three growing seasons and holds significant economic importance, particularly for small-scale and resource-poor farmers, as it serves as a valuable source of income. Brinjal is widely grown across several Indian states, with major cultivation taking place in Andhra Pradesh, Karnataka, West Bengal, Tamil Nadu, Maharashtra, Odisha, Uttar Pradesh, Bihar, and Rajasthan. Among these, **West Bengal** leads in both area and production, with approximately **181.5 thousand hectares** undercultivation and a total production of around **2.88 million tonnes. Karnataka** records the highest productivity, averaging **25.4 tonnes per hectare.** In **Uttar Pradesh,** brinjal is cultivated over an area of about **3,430 hectares,** producing around **111.70 thousand tonnes**, with an average productivity of **8 tonnes per hectare** (Sanjana *et al.,* 2019).

Brinjal, a member of the Solanaceae family and the Solanum genus, produces a fruit commonly used as a vegetable and is available year-round. The plant is an erect annual, often with spiny stems and large, coarsely lobed, fuzzy leaves measuring 10–20 cm in length and 5–10 cm in width. It typically grows to a height of 45 to 60 cm and bears fruits that vary in shape from long to oval, and in color from purple to green. The flowers are white to purple, featuring a five-lobed corolla and prominent yellow stamens. The fruit is a fleshy berry filled with numerous small, soft seeds. Brinjal is highly vulnerable to insect pests throughout its growth, from the nursery stage until harvest. It is known to be attacked by around 140 different insect species, with the **brinjal shoot and fruit borer** (Leucinodes orbonalis Guen.) being the most damaging. Other major pests include the **leaf hopper** (Amrasca biguttula biguttula), **whitefly** (Bemisia tabaci), and **aphid** (Aphis gossypii). However, the shoot and fruit borer remains the most destructive, causing significant losses due to its high reproductive rate, rapid life cycle, and the year-round, intensive cultivation of brinjal (Thakur *et al*., 2017). This pest bores into tender shoots and fruits, creating zigzag tunnels that severely damage the plant. It is considered the most serious insect pest of brinjal across Asia—particularly in India, Pakistan, Sri Lanka, Nepal, Bangladesh—as well as in parts of Africa and Southeast Asia. In India, fruit damage due to this pest has been reported to range from **3.3% to 68.9%,** while in Odisha, fruit damage can reach up to **85.8%,** with overall crop losses estimated between **70% and 92%** (Chakraborti and Sarkar, 2011).

Brinjal is considered one of the most important vegetables in South and Southeast Asia, where hot and humid climates are common (Thapa, 2010; Hanson *et al*., 2006). It belongs to the Solanaceae family and is among the most widely cultivated vegetables within this group. The Indo-Pak Subcontinent is reported to be the native land of brinjal (Dunlop, 2006). Its worldwide cultivation is more than 1,600,000 ha and production is 50 million Mt (FAO, 2012). In Pakistan it is cultivated in 9,000 ha and production is 87,000 tons per annum (FAO 2014), (Aslam *et al.,* 2015).

Annual production of eggplants in China is first ranked the country accounts for 64.41% of total world eggplant production, cultivated over 781,695 hectares, producing 454,852 hg/ha. Followed by India which accounts for 22.97% of total world eggplant production cultivated over 727,000 hectares with a yield of 174,415 hg/ha and Egypt which accounts for 2.14% of total world eggplant production, cultivated over 43,818 hectares with a yield of 269,350 hg/ha.

The brinjal shoot and fruit borer (BSFB), Leucinodes orbonalis Guenée (Lepidoptera: Pyralidae), is one of the most destructive pests affecting brinjal crops. It is a chewing insect that can cause significant losses, damaging up to 50–70% of the fruits. This pest attacks the plant at nearly every growth stage, targeting both the shoots and fruits. The most severe damage is caused during its larval stage, as the larvae bore inside the tender shoots and fruits, making control difficult and often leading to major yield losses. Adult moth having dirty whitish wings and speckled markings lays eggs on young leaves/ flowers/ calyx of the fruits. After hatching the larvae starts boring into the petiole/ midrib of the leaves/ growing shoots/ flower buds/ fruits and closes the bore hole with frays. Growth, yield and fruit quality of crop and thus make it unfit for feeding purpose (Kolhe *et al.,* 2017).

2. **MATERIALS AND METHODS**

The experiment was carried out during the *Kharif* season of 2024 at the Central Research Farm in Naini, Prayagraj, Uttar Pradesh, India. It was set up using a randomized block design with eight different treatments, each replicated three times. The brinjal variety used was Banaras Purple Round, planted in plots measuring 3 meters by 2 meters, with spacing of 60 cm between rows and 45 cm between plants. Recommended agronomic practices were followed throughout the trial, except for plant protection measures. In the experiment, eight different treatments used *viz*. (T1) Cypermethrin 25% EC, (T2) Neem oil 2%, (T3) Spinosad 45% SC, (T4) NSKE 5%, (T5) *Beauveria* *bassiana*, (T6) *Emamectin* *benzoate* 5% SG, (T7) Chlorantraniliprole, (T0) Control were tested to compare the efficac**y** against shoot and fruit borer (*Leucinodes orbonalis* Guenee) their influences on yield of brinjal.Spraying was carried out once the population of the borer reached the economic threshold level. This was assessed by examining the presence of the pest on shoots and fruits of five plants chosen at random. Observations were taken one day before spraying, and then again at 3, 7, and 14 days after the treatment. To assess shoot damage, the number of damaged and healthy shoots was counted on these five plants per plot, and the damage was expressed as a percentage. Brinjal fruits were harvested at weekly intervals. The percent fruit damage was total number of affected fruits from each plot. The total yield of marketable fruits from each treatment was calculated, taking into account the additional costs such as insecticides and labor. The benefits were then evaluated by comparing these yields to the untreated control. The percentage of shoot and fruit infestation was determined using the following equations.

 No. of shoot infested

% Shoot infestation = ---------------------------------------------- x 100 (Yadav *et al*., 2015)

 Total no. of shoot

 No. of fruit infested

%Fruit infestation = ----------------------------------------- x 100 (Yadav *et al*., 2015)

(Number Basis) Total no. of fruit

**Cost benefit ratio:**

Total income was calculated by multiplying the yield per hectare by the current market price. The net benefit was then determined by deducting the total plant protection costs from the total income. To find the benefit over the control, the income from the control treatment was subtracted from the income of each treated plot. The B: C ratio was calculated by following formula:

|  |
| --- |
| Gross return = Marketable yield × Market price |

|  |
| --- |
| Net return = Gross return – Total cost |

|  |
| --- |
| Benefit: Cost Ratio =$\frac{Gross return}{Total Cost of cultivation }$  |

(Naik and Kumar 2023)

1. **RESULT AND DISCUSSION**

The observations of shoot borer infestation on brinjal at 3, 7, and 14 days after spraying showed that all chemical treatments performed significantly better than the untreated control. Among these, the lowest percentage of shoot infestation was recorded in Chlorantraniliprole (3.64) followed by *Emamectin* *benzoate* 5% SG (3.95) and Spinosad 45% SC (4.34). Treatment Cypermethrin 25% EC (4.62), *Beauveria* *bassiana* (5.14) were statistically at par with each other and treatments NSKE 5% (5.62), Neem oil 2% (5.99) were found be least effective but significantly superior over the control.

The percentage of shoot borer infestation on brinjal recorded on the 3, 7 and 14 days after spraying showed that all chemical treatments were significantly more effective than the control. Among these treatments, the lowest shoot infestation was observed in Chlorantraniliprole (3.91) followed by *Emamectin* *benzoate* 5% SG (4.35) and Spinosad 45% SC (4.61). The treatments Cypermethrin 25% EC (5.13) and *Beauveria bassiana* (5.31) showed similar effectiveness, with no significant difference between them. Meanwhile, NSKE 5% (5.57) and Neem oil 2% (5.99) were the least effective treatments but still performed significantly better than the untreated control.

These findings align with previous studies such as Bhagwan *et al.* (2017), Kumar *et al.* (2017), Tripura *et al.* (2017), Palika *et al.* (2019), and Reddy *et al.* (2022), who reported that Chlorantraniliprole was highly effective in reducing the population of the shoot and fruit borer. Similarly, research by Bhagwan *et al.* (2017), Lekha *et al.* (2018), and Verma *et al.* (2023) indicated that *Emamectin benzoate* was among the best options for controlling this pest. Studies by Devi *et al.* (2015), Marmat *et al.* (2017), and Nail and Kumar (2023) found Spinosad to be particularly effective against the shoot and fruit borer. According to Yadav *et al.* (2015), Dongarajal *et al.* (2017), Thakur *et al.* (2017), and Sahu et al. (2017), Cypermethrin showed strong control over the pest population. *Beauveria bassiana* also proved to be an effective treatment, consistent with the results of Sanjana *et al.* (2019). NSKE was found to be a reasonably good treatment as well, which is supported by Shyamrao *et al.* (2018) and Mourya *et al.* (2023). On the other hand, Neem oil was the least effective in managing shoot and fruit borer infestations and was also more costly, as reported by Maru *et al*. (2018) and Ghosh *et al.* (2022).

The percentage of fruit borer infestation on brinjal was recorded on the 3rd, 7th, and 14th days after spraying, showing that all chemical treatments performed significantly better than the untreated control. Among these, Chlorantraniliprole recorded the lowest infestation at 3.91%, followed by *Emamectin benzoate* 5% SG at 4.35% and Spinosad 45% SC at 4.61%. Cypermethrin 25% EC (5.13%) and *Beauveria bassiana* (5.31%) showed similar levels of control. The treatments NSKE 5% (5.57%) and Neem oil 2% (5.99%) were the least effective but still offered better control compared to the control group.

There were significant differences in yields among the treatments. The highest yield was obtained with treatment T7 Chlorantraniliprole (220q/ha) followed by T6 *Emamectin* *benzoate* 5% SG (205 q/ha), T3 Spinosad 45% SC (190 q/ha), T1 Cypermethrin 25% EC (160 q/ha), T5 *Beauveria bassiana* (140q/ha), T4 NSKE 5% (120q/ha) and the treatment T2 Neem oil 2% (112.5 q/ha) was least effective among all the treatments. Control plot T0 (90.00 q/ha) yield.

When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was T7 Chlorantraniliprole (1:8.89) followed by T6 *Emamectin* *benzoate* 5% SG (1:7.89), T3 Spinosad 45% SC (1:7.80), T1 Cypermethrin 25% EC (1:6.49), T5 *Beauveria bassiana* (1:5.81), T4 NSKE 5% (1:4.89) and the treatment T2 Neem oil 2% (1:4.45) as compared to Control T0 (1:3.86) .

Maximum cost benefit ratio (1:8.89) was obtained in Chlorantraniliprole which was supported by Reddy *et al.,* (2022) who reported that the Chlorantraniliprole recorded the high yield followed by *Emamectin* *benzoate* 5% SG findings were supported by Paneru *et al.,* (2020). Spinosad 45% SC findings reported by Warghat *et al.,* (2020) Cypermethrin 25% EC was supported by Sharma *et* *al*., (2017). *Beauveria bassiana* was supported by Sarsaiya *et al.,* (2020).NSKE5% was supported by Singh *et al.,* (2020). At least the cost benefit Neem oil 2% which were supported by Naik and Kumar(2023)

**Table1: To evaluate the efficacy of chemical insecticides and bio-pesticides on infestation of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on Brinjal.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  **Sr. No.** | **Treatments** |  **Percent shoot and fruit infestation of Leucinodes orbonalis** | **YIELD q/ha** |  **B:C RATIO** |
|   **FIRST SPRAY** |  **SECOND SPRAY** |
|   1st DBS |  3rd  DAS |  7th DAS | 14th DAS |  MEAN | 3rd DAS |  7th DAS | 14th DAS |  MEAN |
| **T0** |  Control |  6.53 |  7.02 |  7.42 |  7.51 |  7.32 |  7.54 |  7.89 |  7.90 |  7.76 |  90 |  1:3.86 |
| **T1** | Cypermethrin25EC |  5.82 |  5.39 |  3.78 |  4.68 |  4.62 |  5.22 |  5.00 |  5.16 |  5.13 |  160 |  1:6.49 |
| **T2** |  Neem oil 2% |  6.03 |  6.08 |  5.86 |  6.03 |  5.99 |  6.03 |  5.92 |  6.01 |  5.99 |  112.5 |  1:4.47 |
| **T3** |  Spinosad45%SC |  7.06 |  4.74 |  3.63 |  4.66 |  4.34 |  4.66 |  4.52 |  4.64 |  4.61 |  190 |  1:7.80 |
| **T4** |  NSKE 2% |  6.18 |  6.03 |  5.42 |  5.41 |  5.62 |  5.93 |  5.32 |  5.46 |  5.57 |  120 |  1:4.89 |
| **T5** |  Beauveria bassiana |  6.52 |  5.46 |  4.72 |  5.24 |  5.14 |  5.42 |  5.16 |  5.36 |  5.31 |  140 |  1:5.81 |
| **T6** |  Emamectin benzoate 5SG |  6.44 |  4.57 |  3.43 |  3.95 |  3.95 |  4.52 |  4.16 |  4.37 |  4.35 |  205 |  1:7.85 |
| **T7** |  Chlorantraniprole |  5.46 |  4.00 |  3.27 |  3.66 |  3.64 |  3.95 |  3.89 |  3.89 |  3.91 |  220 |  1:8.52 |
| Overall Mean |  6.25 |  5.41 |  4.69 |  5.13 |  5.08 |  5.41 |  5.23 |  5.35 |  5.33 |  ----- |  ---- |
|  F-test |  NS |  S |  S |  S |  S |  S |  S |  S |  S |  ---- |  ----- |
| S. Ed. (±) |  0.59 |  0.34 |  0.34 |  0.21 |  0.28 |  0.42 |  0.40 |  0.41 |  0.12 |  ---- |  ----- |
| C.D.(P=0.05) |  1.27 |  0.72 |  0.74 |  0.62 |  0.59 |  0.89 |  0.86 |  0.88 |  0.25 |  ---- |  ---- |

DAS- Days after Sowing

DBS- Days before Sowing

 NS= Non-significant, S= Significant

1st Spray (% Shoot Infestation)

**Fig 1: To evaluate the efficacy of chemical insecticides and bio-pesticides on infestation of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on Brinjal. (First Spray)**

2nd Spray (%Fruit Infestation)

**Fig2:To evaluate the efficacy of chemical insecticides and bio-pesticides on infestation of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on Brinjal. (Second Spray)**

**CONCLUSION**

Based on the analysis, selected insecticides and bio-pesticides such as Chlorantraniliprole, *Emamectin benzoate* 5% SG, Spinosad 45% SC, Cypermethrin 25% EC, Beauveria bassiana, NSKE 5%, and Neem have shown promising results against Leucinodes orbonalis. These can be effectively integrated into pest management strategies to reduce the excessive use of chemical pesticides, which contribute to environmental pollution. Additionally, these treatments are less harmful to beneficial insects and help improve cost efficiency.

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