

Bio Efficacy and Economics of Selected Biopesticides against Shoot and Fruit Borer [*Leucinodes orbonalis* (G.)] on Brinjal [*Solanum melongena* (L.)]

ABSTRACT

The present investigation was carried out in a Randomized Block Design having 3 replications and 8 treatments (seven insecticides and one control) during kharif season 2023 conducted at the Central Research Farm, NAINI, SHUATS, Prayagraj (U.P.). The order of effectiveness was observed in Chlorantraniliprole 18.5EC (11.79), (8.01) > Spinosad 45SC (13.52), (10.52) > Emamectin benzoate 5% SG (14.91), (11.41) > *Beauveria bassiana* 1% WP (16.00), (12.39) > *Metarhizium anisopliae* 1x10⁸ CFU/gm (16.71), (13.46) > Neem oil 0.4% + Pongamia oil 0.1% (17.84), (14.79) > Neem oil 2% (20.03), (17.77) > untreated control plot (27.22), (32.12) based on percentage shoot and fruit infestation. While highest yield and benefit cost ratio was obtained in Chlorantraniliprole 18.5EC (220.95 q/ha), (1:6.48) followed by Spinosad 45SC (198.20 q/ha), (1:5.68), Emamectin benzoate 5% SG (170.87 q/ha), (1:4.98), *Beauveria bassiana* 1% WP (160.00 q/ha), (1:4.75), *Metarhizium anisopliae* 1x10⁸ CFU/gm (140.69 q/ha), (1:4.13), Neem oil 0.4% + Pongamia oil 0.1% (125.50 q/ha), (1:3.68), Neem oil 2% (99.85 q/ha), (1:2.96). Least monetary returns was obtained with untreated control plot (55.16 q/ha), (1:1.70).

Keywords: *Leucinodes orbonalis*; bio-pesticides; chlorantraniliprole; spinosad; neem oil.

1. INTRODUCTION

“Brinjal or eggplant (*Solanum melongena* Linn.) is worldwide known as aubergine or guinea squash which is most popular and principal vegetable crop hence regarded as King of vegetables belonging to the family Solanaceae. It is an important vegetable grown in all these seasons. Due to its nutritive value, consisting of minerals like iron, phosphorous, calcium and vitamins like A, B and C, unripe fruits are used primarily as vegetable in the country”. (Danish and Alexander, 2022).

“Globally, India ranks second and China ranks first in the production of brinjal (57.9% of world output). In India, this crop occupies 71.13 lakh hectares area along with annual production of 135.57 (lakh tone) and productivity 19.1 MT per hectare. In Uttar Pradesh, the area under cultivation of brinjal is 3430 hectares producing 111.70 MT and the productivity is 8 MT/ha”. (Kolhe et al., 2017).

“A general view of the pest problem in brinjal in India reveals that this crop is attacked severely by number of pests, shoot and fruit borer (*Leucinodes orbonalis*), Epilachna beetle (*Epilachna vigintioctopunctata* Fab.), jassid (*Amrasca biguttulabiguttula* Shida), aphid, thrips and white flies (*Bemisia tabaci* Gennadius). Out of these pests, shoot and fruit borer, *Leucinodes orbonalis* G. is considered to be the most destructive. The infestation on brinjal can be as high as 75 to 92%. Brinjal crop is attacked regularly or sporadically by at least 50 insect pests and Aphid, Jassids, Whitefly and shoot and fruit borer are categorized as major pests of regular occurrence”. (Pooja and Kumar, 2022).

“Shoot and fruit borer, *Leucinodes orbonalis* Guenee of brinjal causing enormous damage in all brinjal growing areas. It is an internal borer which damages the tender shoots and fruits. The damaged shoots and the flowers droop down, and the damaged fruits get rotten from inside. This reduces plant growth, which in turn, reduces fruit number and size. The entry hole on the fruits is not visible as they

get smaller due to increase in size of fruits while a small depression can be often observed. Only the large and more round exit holes are visible on the fruits. Such fruits lose their market value". (Verma *et al.*, 2021).

"Bio-pesticides play an important role in insect pest management by their various inhibitory actions on insect physiology and behavior. They are the best alternative to chemical insecticides against *Leucinodes orbonalis* on brinjal. They are locally available, relatively cheap, biodegradable, and easy to handle. They are bringing about the balance back to the ecosystem. As agriculture shift toward organic farming, they have much better scope in the management tactics". (Warghat *et al.*, 2019).

2. MATERIALS AND METHODS

The present investigation was conducted at the experimental research plot of Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture Technology and Science, Prayagraj, during *Kharif* season 2023 in a Randomized Block Design (RBD) with 8 treatment and 3 replication using variety, Indam Supriya seeds in plot size of 2m X 1m at a spacing of 60 cm X 45 cm with a recommended package of practices excluding plant protection. The spraying was done after the population reached ETL.

The population of brinjal shoot and fruit borer was recorded 1 day before spraying and on 3rd, 7th day and 14th day after insecticidal application. The populations of brinjal shoot and fruit borer was recorded on 5 randomly selected and tagged plants from each plot and then it will be converted into percent of infestation by following formulas.

On Shoot:

Number Basis: The total number of shoots and number of shoots infested of five selected plants from each treatment replication wise was recorded.

$$\% \text{ shoot infestation} = \frac{\text{No. of shoot infestation}}{\text{Total no. of shoots}} \times 100$$

(Shyamrao *et al.*, 2018)

On Fruit:

Number Basis: At each picking the total number of fruit and number of fruits infestation five selected plants from each treatment replication wise was recorded.

$$\% \text{ fruit infestation} = \frac{\text{No. of fruit infestation}}{\text{Total no. of fruits}} \times 100$$

(Shyamrao *et al.*, 2018)

Based on the yield data, the gross returns and net returns were calculated for each treatment. Gross returns were calculated by multiplying total yield with the market price of the produce. The ratio of gross return and cost of cultivation will be work for each treatment and was used as benefit: cost ratio (BCR) to compare the performance of different treatments. Benefit cost ratio was calculated by using the following equation.

$$\text{Gross return} = \text{Total yield} \times \text{Market price}$$

$$BCR = \frac{\text{Gross returns}}{\text{Total cost}}$$

(Reddy and Yadav 2023)

3. RESULTS

3.1 First Spray-PerCentShoot Infestation

The data on the mean (3rd, 7th, and 14th DAS) of first spray for shoot infestation of *Leucinodes orbonalis* revealed that among all the treatments lowest percent shoot infestation was recorded in T₇ Chlorantraniliprole 18.5 SC (11.79), followed by T₆ Spinosad 45 SC (13.52), T₂ Emamectin benzoate 5% SG (14.91), T₃ *Beauveria bassiana* 1% WP (16.00), T₅ *Metarhizium anisopliae* 1x10⁸ CFU/gm (16.71), T₄ Neem oil 0.4% + Pongamia oil 0.1% (17.84) and T₁ Neem oil 2% (20.03) was least effective among all the treatments. Shoot infestation in Control plot T₀ was (27.22) recorded. (Table 1).

3.2 Second Spray-PerCentFruit Infestation

The data on the mean (3rd, 7th and 14th DAS) of second spray for fruit infestation of *Leucinodes orbonalis* revealed that among all the treatments lowest percent fruit infestation was recorded in T₇ Chlorantraniliprole 18.5 SC (8.01), followed by T₆ Spinosad 45 SC (10.52), T₂ Emamectin benzoate 5% SG (11.41), T₃ *Beauveria bassiana* 1% WP (12.39), T₅ *Metarhizium anisopliae* 1x10⁸ CFU/gm (13.46), T₄ Neem oil 0.4% + Pongamia oil 0.1% (14.79) and treatment T₁ Neem oil 2% (17.77) was least effective among all the treatments. Fruit infestation in Control plot T₀ was (32.12) recorded. (Table 1).

The yields among all the treatments was significant as compared to control. The highest yield was obtained in T₇ Chlorantraniliprole 18.5 SC (220.95 q/ha), followed by T₆ Spinosad 45 SC (198.20 q/ha), T₂ Emamectin benzoate 5% SG (170.87 q/ha), T₃ *Beauveria bassiana* 1% WP (160.00 q/ha), T₅ *Metarhizium anisopliae* 1x10⁸ CFU/gm (140.69 q/ha), T₄ Neem oil 0.4% + Pongamia oil 0.1% (125.50 q/ha) and treatment T₁ Neem oil 2% (99.85 q/ha). Control plot T₀ (55.16 q/ha). (Table 1).

When cost benefit ratio worked out, interesting result was achieved, among the treatments, the best and most economical treatment was found T₇ Chlorantraniliprole 18.5 SC (1:6.48), followed by T₆ Spinosad 45 SC (1:5.68), T₂ Emamectin benzoate 5% SG (1:4.98), T₃ *Beauveria bassiana* 1% WP (1:4.75), T₅ *Metarhizium anisopliae* 1x10⁸ CFU/gm (1:4.13), T₄ Neem oil 0.4% + Pongamia oil 0.1% (1:3.68) and T₁ Neem oil 2% (1:2.96) was found least effective among all the treatments. Control plot T₀ (1:1.70). (Table 1).

Table 1. Bioefficacy and economics of selected biopesticides against shoot and fruit borer [*Leucinodes orbonalis* (G.)] on brinjal

S. No.	Treatments	Doses	Percent shoot and fruit infestation of <i>Leucinodes orbonalis</i>										Yield (q/ha)	B:C ratio
			First spray (Shoot infestation)					Second spray (Fruit infestation)						
			1DBS	3DAS	7DAS	14DAS	Mean	1DBS	3DAS	7DAS	14DAS	Mean		
T ₁	Neem oil 2%	5ml/l	23.10	22.45	18.47	19.18	20.03	21.72	19.17	16.63	17.50	17.77	99.85	1:2.96
T ₂	Emamectin benzoate 5% SG	0.4gm/l	20.42	17.32	13.31	14.08	14.90	16.92	12.32	10.56	11.35	11.41	170.87	1:4.98
T ₃	<i>Beauveria bassiana</i> 1% WP	2.5gm/l	20.23	18.56	14.36	15.08	16.00	15.39	13.32	11.84	12.01	12.39	160.00	1:4.75
T ₄	Neem oil (0.4%) + Pongamia oil (0.1%)	2.5ml/l + 2.5ml/l	21.26	21.05	16.23	16.25	17.84	16.40	14.97	13.26	16.15	14.79	125.50	1:3.68
T ₅	<i>Metarhizium anisopliae</i> 1X10 ⁸ CFU/gm	4gm/l	21.51	19.60	15.04	15.49	16.71	18.73	14.15	12.39	13.83	13.46	140.69	1:4.13
T ₆	Spinosad 45% SC	0.5ml/l	21.07	16.16	11.41	12.99	13.52	16.43	11.39	9.35	10.82	10.52	198.20	1:5.68
T ₇	Chlorantraniliprole 18.5SC	0.4gm/l	20.01	14.65	9.77	10.95	11.79	15.95	9.30	6.89	7.83	8.01	220.95	1:6.48
T ₈	Control		21.69	25.51	26.57	29.58	27.22	27.59	31.31	32.60	32.45	32.12	55.16	1:1.70
	F-test		NS	S	S	S	S	NS	S	S	S	S		
	CD at 0.05%			1.14	1.52	1.19	2.54		1.67	1.82	2.70	1.35		
	S.Ed.(+)			0.53	0.71	0.56	1.18		0.78	0.85	1.26	0.63		

DBS- Day Before Spraying; DAS- Day After Spraying; BCR- Benefit Cost Ratio

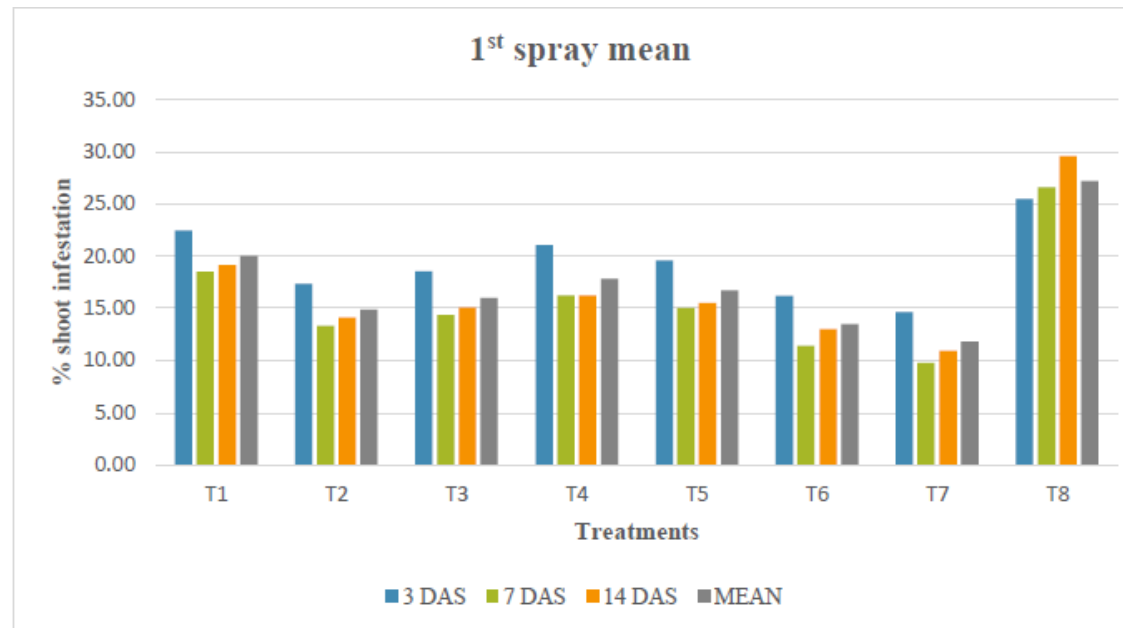


Fig.1.Effectofdifferenttreatmentsonbrinjalshootandfruitborerafter1stspray.(%shoot infestation)

UNDER REVIEW

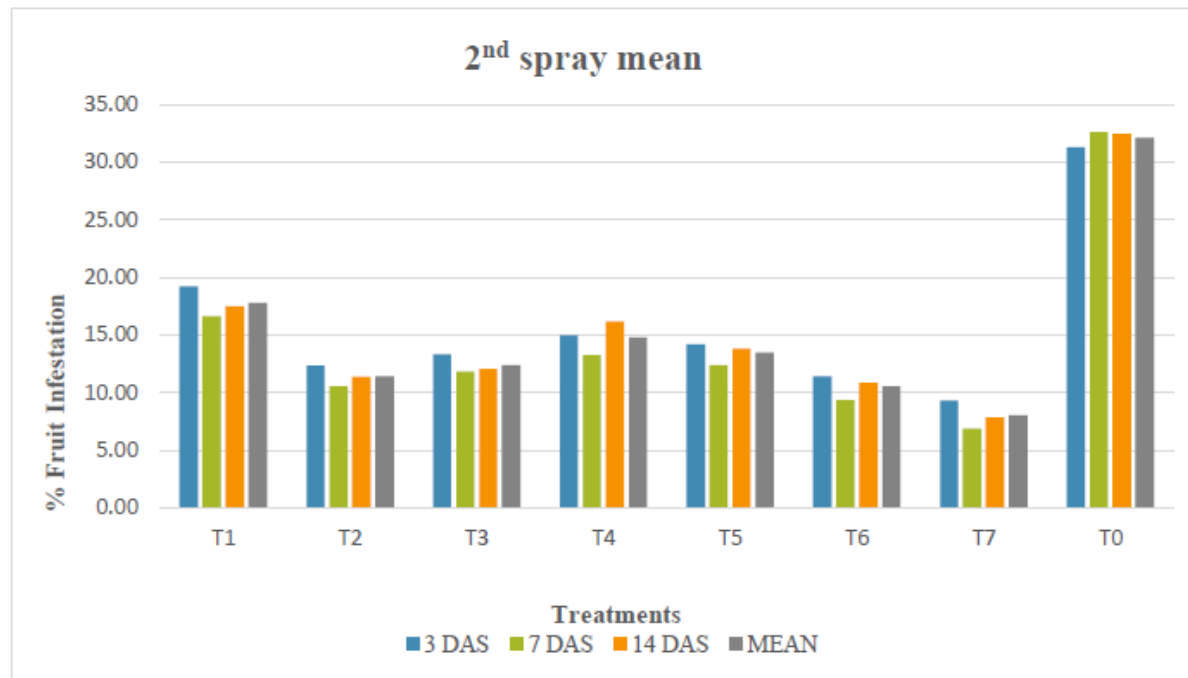


Fig.2.Effectofdifferenttreatmentsonbrinjalshootandfruitborerafter2ndspray(%fruit infestation)

4. DISCUSSION

In the present research work lowest percent shoot infestation was recorded in T₇ Chlorantraniliprole 18.5 SC treated plot (11.79%) as similar findings were also reported by Pooja and Kumar (2022) and Reddy and Yadav (2023). T₆ Spinosad 45 SC was found the next effective treatment with (13.52%) similar finding was reported by Shyamrao *et al.*, (2018). T₂ Emamectin benzoate 5% SG was found the next best effective treatment with (14.91%) similar finding was reported by Sharma and Tayde (2017). Mean percentage of shoot infestation of T₃ *Beauveria bassiana* 1% WP and T₅ *Metarhizium anisopliae* 1x10⁸ CFU/gm with treated plot was (16.00%) and (16.71%) respectively which is similar finding was reported by Naik and Kumar (2023). Mean percentage infestation of T₄ Neem oil (0.4%) + Pongamia oil (0.1%) treated plot was (17.84%) which is also similar reported by Kumar *et al.*, (2022). Mean percentage infestation of T₁ Neem oil 2% treated plot was (20.03%) which is similar reported by Chandar *et al.*, (2020) while shoot infestation in control plot T₀ was (27.22%) recorded.

In the present research work lowest percentage fruit infestation was recorded in T₇ Chlorantraniliprole 18.5 SC treated plot (8.01%) similar findings were also reported by Shirale *et al.*, (2012). T₆ Spinosad 45 SC (10.52%) is found next effective treatment which is similar reported by Verma *et al.*, (2021). T₂ Emamectin benzoate 5% SG treated plot showed (11.41%) percentage infestation similar findings were also reported by Jatand Shrivastva (2023). Mean percentage of fruit infestation in T₃ *Beauveria bassiana* 1% WP treated plot was (12.39%) and T₅ *Metarhizium anisopliae* 1x10⁸ CFU/gm (13.46%) which was similar to findings of Abirami *et al.*, (2023). Mean percentage fruit infestation in T₄ Neem oil (0.4%) + Pongamia oil (14.79%) which is similar findings were also reported by Kumar *et al.*, (2022). Mean percentage infestation of T₁ Neem oil 2% treated plot is (17.77%) which is similar findings were also reported by Mahajan *et al.*, (2020).

When the benefit cost ratio worked out, an interesting result was achieved. Among all the treatments the higher cost benefit ratio was obtained from T₇ Chlorantraniliprole 18.5 SC (1:6.48) as the similar findings was done Reddy and Yadav (2023), followed by, T₆ Spinosad 45 SC exhibited a cost benefit ratio of (1:5.68) as the similar finding was done Bhagwan and Kumar (2017), T₂ Emamectin benzoate 5% SG with a cost benefit ratio of (1:4.98), T₃ *Beauveria bassiana* 1% (1:4.75) and T₅ *Metarhizium anisopliae* 1x10⁸ CFU/gm exhibited cost benefit ratio of (1:4.13) as the similar finding was done by Sharma and Tayde (2017), T₄ Neem oil (0.4%) + Pongamia oil (0.1%) with a cost benefit ratio of (1:3.68) as the similar finding was done by Kumar *et al.*, (2022). T₁ Neem oil 2% was the least effective against *Leucinodes orbonalis* which obtained a cost benefit ratio of (1:2.96) which was supported by Sanjana and Tayde (2019). Cost benefit ratio of Control plot T₀ (1:1.70) obtained.

5. CONCLUSION

From the critical analysis it can be concluded that among biopesticides, combination and chemicals Chlorantraniliprole 18.5 SC was found to be most superior in managing brinjal shoot and fruit borer, as it recorded lowest percentage of shoot and fruit infestation (11.79%), (8.01%) respectively and highest marketable fruit yield (220.95q/ha) with B:Cratio (1:6.48). which was followed by Spinosad 45 SC, Emamectin benzoate 5% SG. Among biopesticides *Beauveria bassiana* 1% WP followed by *Metarhizium anisopliae* 1x10⁸ CFU/gm found effective against *Leucinodes orbonalis*. While Neem oil 2% was found to be the least effective in managing *Leucinodes orbonalis*. Bio-pesticides and combination of botanicals Neem oil + Pongamia oil can be a part of integrated pest management in order to avoid indiscriminate use of pesticides causing pollution in the environment and not harmful to beneficial insects and human beings. On the basis of reduced borer infestation and high yield, Chlorantraniliprole could be recommended in successful management of shoot and fruit borer.

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