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Field Efficacy of Selected Chemicals and Biopesticides against Brinjal Shoot and Fruit Borer (*Leucinodes orbonalis*) on Brinjal (*Solanum melongena*) at Prayagraj

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

A field experiment was carried out at the Central research farm of Sam Higginbottom University of Agriculture, Technology, and Sciences, located in Prayagraj, Uttar Pradesh, during the *kharif* 2023-24. The experiment was designed following a randomized block design with three replications. It encompassed eight treatments: T1 - Neem oil 3%@ 30ml/lit, T2 - Metarhizium anisopliae @ 2.5ml/lit,T3 - Bacillus thuringiensis var. kurstaki @ 2gm/lit, T4 - Spinosad 45 SC @ 0.3 ml/lit, T5 - Emamectin benzoate @ 0.4 gm/lit, T6 - Chlorpyrifos 20 EC @ 2.5ml/lit, T7 - Chlorantraniliprole 18.5 SC @ 0.4ml/lit and T8 - untreated control. The objective was to assess the field efficacy of selected chemicals and biopesticides against *Leucinodes orbonalis* (Guenee)

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infestation on brinjal in Prayagraj. Two rounds of spraying was conducted at 15-days interval. Data on shoot and fruit infestation was recorded after each spraying and picking, including the percentage of shoot infestation. The results showed that the initial population of the pest before the spray exhibited a non-significant distribution. Following the spray, the findings demonstrated that T5 – Emamectin benzoate @ 0.4 gm/lit exhibited significant effectiveness against shoot and fruit borer, comparable to T7 – Chlorantraniliprole 18.5 SC, at 3, 7, and 14 days post-spraying. Following closely in efficacy were Spinosad 45 SC and Chlorpyrifos 20 EC. The highest cost benefit ratio was recorded- T5-Emamectin benzoate, followed by T7-Chlorantraniliprole 18.5 SC. The highest cost-benefit ratio was recorded in T5– Emamectin benzoate @ 0.4gm/lit followed by T7- Chlorantraniliprole 18.5 SC @ 0.4ml/lit and the lowest monetary return was observed with the control (T0).

Keywords: Bacillus thuringiensis var. kurstaki; R.B.D; Leucinodes orbonalis; brinjal shoot.

1. INTRODUCTION

Brinjal (*Solanum melongena* Linn.), with a chromosome count of 2n=24, stands as one of the most beloved vegetables, also recognized by names like eggplant, aubergine, or guinea squash. Belonging to the night shade family Solanaceae, it holds the prestigious title of "King of the Vegetables". Renowned for its high yielding capabilities, brinjal can thrive year-round across a variety of agro-climatic conditions, particularly in tropical and sub-tropical regions. The Indian sub-continent serves as the center of origin for this esteemed vegetable [1].

In India, brinjal cultivation spans approximately 0.743 million hectares of agricultural land, yielding a production of 12.77 million tonnes annually, and a productivity of nearly 17.17 MT/ha [2]. The primary brinjal cultivating states in India include Bihar, Odisha, Karnataka, Andhra Pradesh, Maharashtra, West Bengal, Uttar Pradesh, and states with climatic conditions conducive to tropical and subtropical cultivation. In Karnataka, brinjal cultivation covers an area of 1.58 lakh hectares, contributing to a production of 402.5 MT, accounting for a 3.13% share, with a productivity of 25.4 MT/ha [3]. Brinjal has been acknowledged in Ayurveda for its therapeutic potential in managing diabetes. Additionally, it is esteemed for its diverse medicinal properties, acting as a beneficial appetizer, aphrodisiac, cardiac tonic, laxative, and inflammation reliever. Moreover, it serves as an excellent remedy for liver-related health issues [4].

The year-round availability of brinjal exposes the crop to a spectrum of biotic and abiotic factors. Among these, insect pests emerge as crucial contributors to yield reduction, as they assail the crop from its nursery stage through harvesting. Brinjal faces attacks from approximately 142 species of insect pests, along with four species of mites and nematodes, across various regions worldwide [5]. Brinjal crops are susceptible to numerous insect pests, including aphids (*Aphis gossypii* Glover), whiteflies (*Bemisia tabaci* Lind.), jassids (*Amrasca biguttula biguttula* Ishida), spotted leaf beetles *(Epilachna vigintioctopunctata* Fab.), brinjal shoot and fruit borers (*Leucinodes orbonalis* Guenee), brinjal leaf beetles (*Psylliodes bali* Jacoby), and leaf folders (*Eublemma oleracea* Walk.) [6].

Among these pests, the brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guenee) (Lepidoptera: Crambidae), poses a significant and destructive threat to brinjal production [7]. During the early stages of crop growth, adult female moths predominantly lay eggs on the lower side of young leaves near the midrib, occasionally on tender shoots. Upon hatching, young larvae bore into the young leaves near the midrib or tender shoots, sealing the opening with frass and feeding within the shoot or midrib of the leaves. Symptoms such as drooping, wilting, or withering of shoots are commonly observed during the initial stages of crop growth, indicating shoot damage. As the crop matures and fruits begin to form, larvae typically penetrate through the underside of the calyx, bud, or fruit, sealing the entry point with frass. Infestation of buds often leads to flower drop, further exacerbating the impact of the pest on crop yield. The holes observed on the fruits are actually exit holes of the larvae. Such infested fruits are partially unfit for human consumption and fetch lower prices in the market [8]. This pest inflicts damage on brinjal crops, leading to yield losses ranging from 60-80 percent, or even causing complete damage if no control measures are implemented [9].

1.1 Justification

In recent years, a diverse array of insecticides from different chemical families have been employed to combat pests. However, overreliance on these chemicals has given rise to several issues including resistance, resurgence of pest populations, environmental contamination, and potential health risks for consumers. Consequently, there is an urgent need to judiciously administer insecticides at optimal dosages to mitigate environmental damage and safeguard human health. To address these challenges and minimize pest infestations, a combination of botanical extracts and insecticides from various chemical groups are recommended for managing the shoot and fruit borer (*Leucinodes orbonalis*). Continuous utilization of chemical pesticides poses significant threats to natural ecosystems, including environmental pollution, the development of pest resistance, and potential health hazards. To address these concerns, exploring the insecticidal properties of plant-derived products against the shoot and fruit borer (*Leucinodes orbonalis*) on brinjal is imperative. This study aims to elucidate the effectiveness of different insecticidal formulations, shedding light on their outcomes. Through rigorous analysis, the most effective treatments can be identified and implemented, offering sustainable solutions for pest management in brinjal cultivation.

2. MATERIALS AND METHODS

The investigation was conducted at the experimental field of Sam higginbottom university of agriculture, Technology and Sciences, Prayagraj, Uttarpradesh during the *kharif* 2023-24.

Experimental site: The present investigation was conduct at the Central research farm of “Sam Higginbottom University of Agriculture, Technology and Sciences” Prayagraj, Uttar Pradesh during *Kharif* season 2023-24. The research farm is situated on the right side of Rewa road at 25° 28' 22.9224'' North, 81° 52' 42.0852'' East longitude and is about 129.2 cm above sea level.

Sowing of seed on raised bed: The seeds of brinjal variety Supriya was used to raise seedling in nursery. Regular watering and weeding was done up to transplanting of seedling to the main field.

Application of fertilizers: Chemical fertilizers was applied @ NPK 50:25:25 kg/ha and 20 tonnes FYM per hectares. Full P, K, 33.3% N and FYM was applied as basal dose in the drills before sowing the seed and rest of the nitrogen was top dressed in two equal splits at 21 and 41 days after transplanting.

Intercultural operations: Weeding operations was carried out to conserve soil moisture and to keep the experimental field free from the weeds. Weeding done at 20 days, 40 days and 60 (DAT).

The data were subsequently converted into percentages of infestation utilizing specific formulas.

On Shoot:

Number basis: The total number of shoots and the number of infested shoots from five selected plants in each treatment replication was recorded [10].

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

On Fruit:

Number basis: During each picking, the total number of fruits and the number of infested fruits from five selected plants in each treatment replication was recorded [11].

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

Cost benefit ratio of treatments: Gross returns was calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments was deducted from the gross returns, to find out returns and cost benefit of ratio by following formula,

$$\text{BCR} = \frac{\text{Net returns}}{\text{Cost of treatment}}$$

Where,
BCR = Benefit Cost Ratio

Statistical analysis: The data averaged into respective parameter requisite was subjected to suitable transformation. After analysis, data was accommodated in the table as per the needs of objectives for interpretation of results. The standard procedures in agriculture statistics given by Gomez and Gomez (1976) were consulted throughout. The interpretation of data was done by using the critical difference value calculated at 0.05 probability level. The level of significance was expressed at 0.05 probability. The F-test were used to determine the significant difference.

List 1. Dates of spray application

Sr. No.	Spray application	Date of application
1	**Fist spray**	25/09/2023
2	**Second spray**	10/10/2023

3. RESULTS AND DISCUSSION

Field efficacy of selected chemicals and biopesticide against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee), infesting brinjal: The data concerning the percentage of infestation by shoot and fruit borers after the first and second spray indicated that all chemical treatments exhibited significant superiority over the control. Among all treatments, the lowest percentage of infestation by shoot and fruit borers was observed in Emamectin benzoate (T_5 - 7.94), followed by Chlorantraniliprole (T_7 - 8.93), Spinosad (T_4 - 10.12), Chlorpyrifos (T_6 - 10.82), *Metarhizium anisopliae* (T_2 - 11.57), Neem oil (T_1 - 12.46), *Bacillus thuringiensis* var. *Kurstaki* (T_3 - 11.57), and the control (T_0 - 26.90).A comprehensive analysis revealed that all the biopesticides were effective, with the following decreasing order of efficacy: Emamectin benzoate > Chlorantraniliprole 18.5 SC > Spinosad 45 SC > Chlorpyrifos 20 EC > *Metarhizium anisopliae* > Neem oil 3% > *Bacillus thuringiensis* var. *Kurstaki*. Their significant impact on reducing shoot infestation was evident when compared against the untreated control. These findings align closely with previous studies conducted by Mane and Kumar [12], Verma et al, [13] and Shyamrao et al, [14] which also highlighted the superiority of Emamectin benzoate in reducing the population of shoot and fruit borer.

Yield: The data revealed that the highest grain yield of 90 q/ha was attained with Emamectin benzoate (T_7) support by Prasad et al, [15], followed by Chlorantraniliprole 18.5 SC (T_7) with 87.5 q/ha support by Jalali et al. [16], Spinosad 45SC (T_4) with 85.12 q/ha support by Chakraborty et al. [17], Chlorpyrifos 20EC (T_6) with 79.4 q/ha support by Singh et al, [18], *Metarhizium anisopliae* (T_2) with 75 q/ha support by Kumar and Singh [19], Neem oil 3% (T_1) with 72.3 q/ha support by Anitha and Chakravarthy [20], and *Bacillus thuringiensis* var. *kurstaki* (T_3) with 69.5 q/ha support by Srinivas and Ramachandramurthy [21]. The untreated control plot (T_0) recorded the lowest yield of 44 q/ha.

In this study, Emamectin benzoate (T_5) exhibited the most promising results among all treatments, followed by Chlorantraniliprole (T_7), in reducing crop infestation. Spinosad 45 SC (T_4), Chlorpyrifos 20 EC (T_6), *Metarhizium anisopliae* (T_2), and Neem oil 3% (T_1) also demonstrated effectiveness against the Brinjal shoot and fruit borer [*Leucinodes orbonalis* (Guenee)].

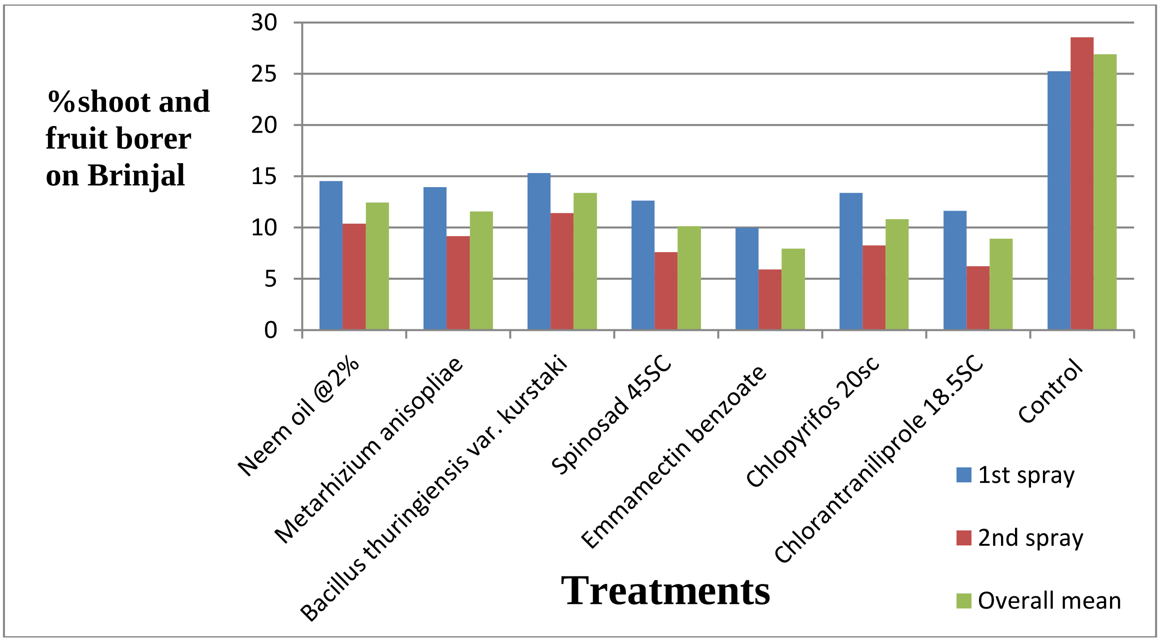

Fig. 1. Overall mean of brinjal shoot and fruit borer infestation at the 1st and 2nd spray

Table 1. Field efficacy of selected chemicals and bio-pesticides against *Leucinodes orbonalis* (Guenee) on brinjal.: (overall mean of 1st & 2nd spray, yield and B:C ratio)

Treatments				%Shoot infestation/5 plants										
		Dose (gm/ ml/L)	**1DBS**	**3DAS**	**7DAS**	**14DAS**	**Mean**	**3DAS**	**7DAS**	**14DAS**	**Mean**	**Overall mean**	**Yield (q/ha)**	**B:C Ratio**
T_1	Neem oil @ 3%	30ml	20.94	15.69	13.75	14.21	14.55	12.05	9.05	10.04	10.38	12.46	72.3	1:3.2
T_2	*Metarhizium anisoliae*	2.5ml	20.38	14.88	13.24	13.76	13.96	10.72	7.89	8.95	9.18	11.57	75	1:5.0
T_3	*Bacillus thuriensis* var.*kurstaki*	2gm	21.29	16.35	14.37	15.24	15.32	13.50	10.01	10.79	11.43	13.37	69.5	1:4.7
T_4	Spinosad 45% SC	0.3ml	21.35	13.55	11.82	12.56	12.64	9.15	6.61	7.01	7.60	10.12	85.12	1:5.3
T_5	Emmamectin benzoate 5% SG	0.4 gm	21.75	11.21	8.98	9.73	9.97	7.01	5.14	5.59	5.91	7.94	90	1:6.0
T_6	Chlopyrifos 20% EC	2.5ml	21.13	14.28	12.76	13.13	13.39	9.81	7.38	7.61	8.26	10.82	79.4	1:5.3
T_7	Chlorantraniliprole 18.5% SC	0.4ml	20.60	12.74	10.79	11.34	11.62	7.51	5.45	5.77	6.24	8.93	87.5	1:5.5
T_0	Controls	**-**	21.58	24.19	25.51	26.02	25.24	27.69	28.30	29.73	28.57	26.90	44	1:3.1
F-test			**NS**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	-	-
S. E(d) (±)			-	0.50	0.38	0.78	0.99	0.50	0.39	0.70	0.71	1.17	-	-
CD (5%)			-	1.29	0.78	1.42	1.14	1.07	0.77	0.85	1.41	2.42	-	-

**Figures in parentheses are arc sin transformation values, DAS - days after spray, NS - non significant, S - significant, CD 5% level – Critical differences at 5% level of significances*

Cost benefit ratio: The analysis of the Cost-Benefit Ratio for all treatments revealed that the highest monetary return was achieved with Emamectin benzoate (T_5) (1:6.0) support by Singh and Verma, [22], followed by Chlorantraniliprole 18.5 SC (T_7) (1:5.5) support by Sharma and Yadav, [23], Spinosad 45 SC (T_4) (1:5.3) support by Thakur and Kumar, [24], Chlorpyrifos 20 EC (T_6) (1:5.3) support by Gupta and Sharma, [25], *Metarhizium anisopliae* (T_2) (1:5.0) support by Singh and Singh, [26], Neem oil 3% (T_1) (1:3.2) support by Singh and Singh, [27], and *Bacillus thuringiensis* var. *kurstaki* (T_3) (1:5.0) support by Kumar and Jha, [28]. The lowest monetary return was observed with the control (T_0) (1:3.1) [29-33].

4. CONCLUSION

The data on the percent infestation of shoot and fruit borer after the first and second sprays revealed that all the chemical treatments were significantly superior to control. Among all the treatments, the lowest percent infestation of shoot and fruit borer was recorded in Emamectin benzoate (7.94) with highest yield 90q/ha and cost benefit ratio of (1:6.0). The highest infestation of in untreated control (26.90) with the lowest cost benefit ratio (1:3.1).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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