Field efficacy of selected chemicals and biopesticide against brinjal shoot and fruit borer(*Leucinodesorbonalis*) on Brinjal (*Solanum melongena*)

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 (Pin: 211007), during the *Kharif* season of 2023–24. The experiment was designed following a randomized block design with three replications. It encompassed eight treatments: T_1- Neem oil 3%@ 30ml/lit, T_2- *Metarhizium anisopliae* 2.5ml/lit,T_3 – B. *thuringiensis*2gm/lit, T_4- Spinosad 45SC @ 0.3 ml/lit, T_5 –Emamectin benzoate @ 0.4 gm/lit, T_6-Chlopyeifos 20EC 2.5ml/lit, T_7-Chlorantraniliprole 18.5 SC @ 0.4ml/lit and T_8 -untreated control. The objective was to assess the field efficacy of selected chemicals and biopesticides against*Leucinodesorbonalis*Guenee infestation on Brinjal in Prayagraj. Two rounds of spraying were conducted at 15-day intervals. Data on shoot and fruit infestation were 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 at 0.4 ml/L 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 45SC and Chlorpyrifos 20EC. The highest cost benefit ratio was recorded- T_5-Emamectin benzoate at@ 0.4 ml/L, followed by T_7-Chlorantraniliprole 18.5SC. The highest cost-benefit ratio were recorded- T_5 –Emamectin benzoate@2ml/L followed by T_7-Chlorantraniliprole at 18.5SC i.eEmamectin benzoate > Chlorantraniliprole > Spinosad > Chlorpyrifos >*Metarhizium anisopliae* > Neem oil >*Bacillus thuringiensis* var. *krustaki*> Untreated control.

Keywords:*Metarhizium anisopliae*, *Bacillus thuringiensis* var. *kurstaki*,*Leucinodesorbonalis*

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 nightshade family Solanaceae, it holds the prestigious

Comment [HG1]: Check the spelling of pesticide.
It should be Emamectin benzoate.
Please check and correct it in the whole manuscript

Comment [HG2]: Check the spelling
It should be Chlorpyrifos

Comment [HG3]: Follow the correct way of writing the abstract.
1)Aims
2)Study design
3)Place and duration of the study
4)Methodology
5)Results
6)Conclusion

Comment [HG4]: Could you please use same style of writing throughout the manuscript?
You could use ml/lit or ml/L. Not both

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Comment [HG5]: Conclusion???

Based on these results, the treatment or the treatments were promising to control brinjal shoot and stem borer with highest CBR

Comment [HG6]: Add 3 more keywords: Suggestions are given below;

Field efficacy, Brinjal shoot and fruit borer

Comment [HG7]: The introduction part lacks a major literature review, justification for the research, and scope.

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 centere of origin for this esteemed vegetable**(Omprakash and Raju 2014)**.

In India, brinjal cultivation spans across approximately 0.743 million hectares of agricultural land, yielding a production of 12.77 million tonnesannually, and with a productivity of nearly 17.17 MT/ha(**Anonymous,.2022**).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**(Anonymous., 2016**). 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**(Lalita and Kashyp, ;2020).**

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**(Jat and Shrivastva,; 2023).** Brinjal crops are susceptible to numerous insect pests, including aphids (*Aphis gossypi*i Glover), whiteflies (*Bemisiatabaci* Lind.), jassids (*Amrascabiguttulabiguttula* Ishida), spotted leaf beetles *(Epilachnavigintioctopunctata*Fab.), brinjal shoot and fruit borers (*Leucinodesorbonalis*Guenee), brinjal leaf beetles (*Psylliodesbal*i Jacoby), and leaf folders (*Eublemma oleracea* Walk.)(**Patra *et al*.,2016**).

Among these pests, the brinjal shoot and fruit borer, *Leucinodesorbonalis* (Guenée) (Lepidoptera: Crambidae), poses a significant and destructive threat to brinjal production( ). 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. Drooping, wilting, or withering of shoots are typical symptoms of shoot damage during the early stages of crop growth. After fruit formation, larvae generally enter from the underside of the calyx, bud, or fruit, closing the entry hole with frass. Infestation of in the buds results in a flower drop. The holes observed on the fruits are actually exit holes of the larvae. Such infested fruits are partially unfit for human consumption

Comment [HG8]: Check before you cite any document.
Did "Omprakash and Raju 2014" really state "The Indian sub-continent serves as the centre of origin for this esteemed vegetable"??

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and fetch lower prices in the market(**Shigaonkar*et al*.,2022**). 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(**Thakare et al., 2021**).

2. MATERIALS AND METHODS –

The investigation on the **''Field efficacy of selected chemicals and biopesticide against brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee) on Brinjal (*Solanum melongena* L.) at Prayagraj''**was conducted at the experimental field of Sam higginbottom university of agriculture, Technology and Sciences, Prayagraj-211007 Uttarpradesh during the *Kharif* season of 2023-24.

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 were recorded**(Soulakhe*et al*, 2021).**

$$\%\text{Shootinfestation} = \frac{\text{No.ofshoot infested}}{\text{Totalno.ofshoot}} \times 100$$

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 were recorded (**Gowrish et al, 2015**).

$$\text{Fruitinfestation} = \frac{\text{No.offruitinfested}}{\text{Totalno.offruit}} \times 100$$

2.1 Cost-Benefit Ratio (ICBR) and statistical analysis –

The Cost-Benefit Ratio was calculated by dividing the net monetary return (B) by the total additional cost incurred due to treatments (C). For statistical analysis, the percentage of fruit damage caused by borers was subjected to angular transformation using the ARCSIN method. The data were then analyzed using standard analysis of variance as suggested by **Panse and Sukhatame (1985).**

Comment [HG11]: A short paragraph on the objective of this research is missing.
Write a paragraph covering the significance of this study and mention the objectives of the study.

Comment [HG12]: Materials and methods for this research should be clearly re written

Comment [HG13]: Could you please rewrite the paragraph comprising the experimental location, brinjal cultivar, treatment combinations, number of replications, sample collection, spray frequency, experimental design, and statistical analysis?

Net returns

BCR=----------

Costoftreatment

Where,

BCR=Benefit Cost Ratio

3. Results andDiscussions-

3.1 ~~To study the~~ F~~f~~ield efficacy of selected chemicals and biopesticide against brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee), i~~I~~nfesting ~~brinjal~~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 Em~~m~~amectin 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: E~~m~~mamectin benzoate > Chlorantraniliprole 18.5SC > Spinosad 45SC > Chlorpyrifos 20EC >*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 (2020),Verma *et al.*,(2021)** and**Shyamrao*et al.*,(2018)**which also highlighted the superiority of E~~m~~mamectin benzoate in reducing the population of shoot and fruit borers.

Comment [HG14]: Why the citations are highlighted in the text ?

Table.1 Fieldefficacyofselectedchemicalsandbio-pesticideagainst*Leucinodesorbonalis*(Guenee)onbrinjal.:(1st and 2nd spray)

TREATMENTS		Dose (gm/ml/L)	%Shootinfestation/5plants									Overall mean	Yield (q/ha)	B:C Ra
			1DBS	3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean			
T_1	Neemoil@ 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:
T_2	*Metarhiziumanisoliae*	2.5ml	20.38	14.88	13.24	13.76	13.96	10.72	7.89	8.95	9.18	11.57	75	1:
T_3	*Bacillusthuriensis*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:
T_4	Spinosad45SC	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 benzoate5%	0.4gm	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	Chlorpyrifos 20EC	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	Chlorantranilinprole18.5SC	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- ???, S-???.

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Comment [HG17]: Provide data for cost per pesticide application, labour cost, profit, and finally derive the cost-benefit ratio and compare it with the control for the economics of the selected insecticide application for the study.

Comment [HG16]: Is yield from a single data form one treatment?
Is the yield among different treatment significantly differ from each other ???

Comment [HG18]: Check the spelling
It should be *Bacillus thuringiensis*

Comment [HG19]: What does NS stands for ?

Comment [HG20]: What does S stands for?

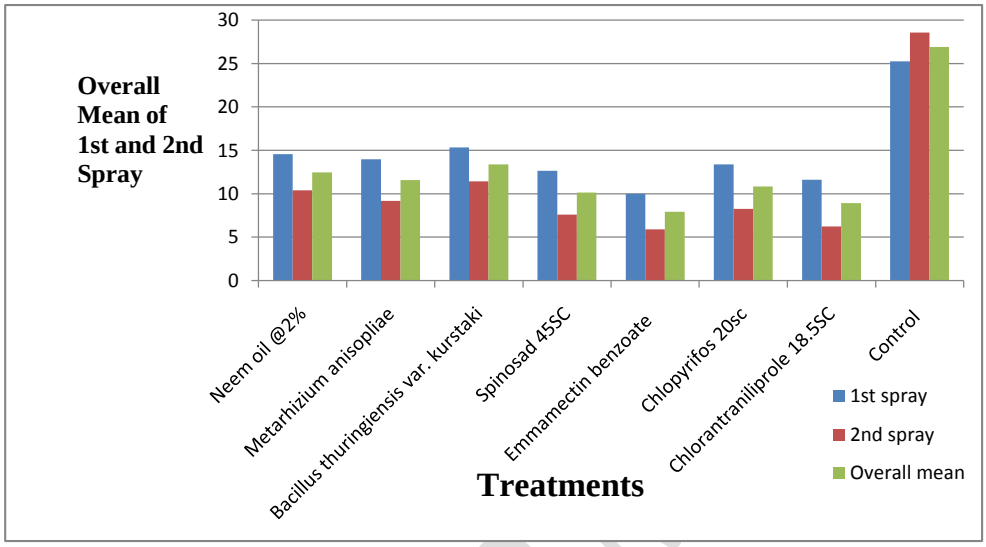

Fig 1- Overall mean of brinjal shoot and fruit borer infestation at the 1st and 2nd spray

3.2. Yield-

The data revealed that the highest grain yield of 90 q/ha was attained with Emmamectin benzoate (T_7), followed by Chlorantraniliprole 18.5 SC (T_7) with 87.5 q/ha, Spinosad 45SC (T_4) with 85.12 q/ha, Chlorpyrifos 20EC (T_6) with 79.4 q/ha, *Metarhizium anisopliae* (T_2) with 75 q/ha, Neem oil 3% (T_1) with 72.3 q/ha, and *Bacillus thuringiensis* var.*kurstaki* (T_3) with 69.5 q/ha. The untreated control plot (T_0) recorded the lowest yield of 44 q/ha.

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

Comment [HG21]: Support your findings with the other recent studies

3.3. Cost Benefit Ratio –

The analysis of the Cost-Benefit Ratio for all treatments revealed that the highest monetary return was achieved with Emmamectin benzoate (T_5) (1:6.0), followed by Chlorantraniliprole

18.5SC (T_7) (1:5.5), Spinosad 45SC (T_4) (1:5.3), Chlorpyrifos 20EC (T_6) (1:5.3), *Metarhizium anisopliae* (T_2) (1:5.0), Neem oil 3% (T_1) (1:3.2), and *Bacillus thuringiensis* var.*kurstaki*(T_3) (1:5.0). The lowest monetary return was observed with the control (T_0) (1:3.1).

Comment [HG22]: Discuss the cost benefit related results with other related studies

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 ~~over~~ control. Among all the treatments, the lowest percent infestation of shoot and fruit borer was recorded in E~~m~~mamectin benzoate(7.94) with highest yield 90q/hac and cost benefit ratio of ~~recorded~~ 1:6.0.The highest infestation recorded in untreated control(26.90) with the lowest cost benefit ratio (1:3.1).

Comment [HG23]: Re write the sentence as it showed similarities in the ithenticate report

5. Reference –

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Patra S, Thakur NS and Firake DM. Evaluation of bio-pesticides and insecticides against brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee) in Meghalaya of North-Eastern India. *International Journal of Bio-resource and Stress Management*, 2016;7(5): 1032-1036.

Comment [HG24]:
Give the correct abbreviation for the journal title

Follow the below given style for referencing as indicated in the author guidelines for this journal.

Hilly M, Adams ML, Nelson SC. A study of digit fusion in the mouse embryo. Clin Exp Allergy. 2002;32(4):489-98.

Comment [HG25]: Give the proper web link and accessed information for this reference

Comment [HG26]: Give the web link and accessed information for this reference

Comment [HG27]: Write the abbreviation of the journal

Shigaonkar RS, Shinde BD, Shelke SB, Chopkar PS, Durge SM, Choudhari RJ. To screen some brinjal cultivars against shoot and fruit borer, *Leucinodesorbonalis*. *Journal of Pharmaceutical Innovation*, 2022;11(1):1337-1341.

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Comment [HG28]: Follow the correct referencing style according to the journal

Comment [HG29]: Follow the correct referencing style according to the journal preference.

Follow this style:

Hilly M, Adams ML, Nelson SC. A study of digit fusion in the mouse embryo. Clin Exp Allergy. 2002;32(4):489-98.