International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(8): 1051-1059
www.biochemjournal.com
Received: 04-06-2025
Accepted: 08-07-2025

Dhanshri Sinha
Department of Entomology, Indira Gandhi Krishi Vishwavidyalaya, Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

GP Painkra
Department of Entomology, Indira Gandhi Krishi Vishwavidyalaya, College of Agriculture and Research Station, Shankargarh, Balrampur, Chhattisgarh, India

KL Painkra
Department of Entomology Indira Gandhi Krishi Vishwavidyalaya Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

PK Bhagat
Department of Entomology Indira Gandhi Krishi Vishwavidyalaya Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

Corresponding Author:
GP Painkra
Department of Entomology, Indira Gandhi Krishi Vishwavidyalaya, College of Agriculture and Research Station, Shankargarh, Balrampur, Chhattisgarh, India

To study biorational approaches for the management of brinjal shoot and fruit borer

Dhanshri Sinha, GP Painkra, KL Painkra and PK Bhagat

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i8n.5414

Abstract
The present work entitled "Studies on insect-pests succession and biorational management with special reference to *Leucinodes orbonalis* (Guenee) on brinjal"was carried out at the Entomology Field, in RMD College of Agriculture & Research Station, Ambikapur, Chhattisgarh during the *Kharif* season of 2024-25 In this study, several biorational treatments was cmpared. Emamectin benzoate had the lowest rate of brinjal shoot and fruit infestation (3.26%), followed by *Bacillus thuringiensis* (3.78%), *Beauveria bassiana* (4.21%), *Metarhizium anisopliae* (4.84%), Nimbicidine (5.66%), and *Verticillium lecanii* (6.12%). Emamectin benzoate > *Bacillus thuringiensis* > *Beauveria bassiana* > *Metarhizium anisopliae* > Nimbicidine > *Verticillium lecanii* > Control plot was the order of the effective treatment. Some biopesticides, especially *Bacillus thuringiensis, Beauveria bassiana* and *Metarhizium anisopliae* showed comparable effectiveness over the long term.

Keywords: Biorational treatments, insecticides, emamectin benzoate, *Bacillus thuringiensis*

Introduction
In certain cultures, especially in India, brinjal (*Solanum melongena* L.) also called aubergine or eggplant, is frequently referred to as the "King of vegetables." It is thought to have come from the Indo-Burma region and India. From East to West and North to South, it is acclimated to a broad variety of climatic conditions, including high temperatures and rainfall. Although brinjal can be grown in a range of soil types, including sandy and clayey soil, it thrives in soils that are well-drained, fertile, and richin organic matter. The optimal pH range for brinjal cultivation is 6.5 to 7.5. In India and around the world, brinjal is a very popular and cosmopolitan vegetable because of its nutritional, medicinal, and commercial value. Abiotic and biotic factors cause a significant amount of brinjal yield loss, and insect pest attacks are one of the major factors from the nursery stage until harvest. At various stages of crop growth, 140 insect pest species have been reported to cause damage. The main pests of eggplant crops were BSFB (*L. orbonalis* Guen), leafhopper (*A. bigutulla bigutulla* Ishida), aphid (*A. gossypii* Glover), stem borer (*Euzophera perticella* Ragonotl), Epilachna beetle (*H. viginitoctopunctata* Fab.), lacewing bug (*Urantitus hystricellus* Distant), and non-insect pests, specifically red spider mite (*Teranychus macfurlanei* Baker).
The most disastrous and significant limiting factor in both the quantity and quality of brinjal fruit harvest is BFSB. During the early stages of crops, the borer larva only feeds on shoots; in the later stages, it feeds on fruits. The insect's damage causes the twigs to droop and the fruits to have holes in them, which are typically filled by the caterpillar's excrement. Depending on the yield and vitamin C content, the yield reduction can range from 20-30% (Bhargava *et al*., 2008) [1] to as much as 70% (Islam and Karim, 1991; Dhandapani *et al*., 2003) [5, 3] and possibly as much as 80% (Sharma, 2002). Because of this pest, many farmers opted not to grow eggplant.
The management of BSFB has become difficult due to a lack of knowledge about its unique feeding behaviour. Because *Leucinodes orbonalis* Guene feeds internally, insecticides are less effective against them. Farmers typically apply insecticides twice a week to address this issue, which causes the target insect to become resistant. According to Shanmugam *et al*., (2015) [11], biopesticides must be assessed for their ability to effectively control insect pests, which promotes sustainable environmental management and food quality maintenance. Other issues linked to the overuse of insecticides in brinjal include bioaccumulation,

biomagnifications, and disruptions in the ecological balance. In context with this, some of the most promising biopesticides with higher selectivity and significantly lower risk to humans, wildlife, and the environment are *Beauveria bassiana*, *Bacillus thuringienesis*, and *Metarhizium anisopliae*. Additionally, botanical-based pesticides have been shown to be successful in controlling lepidopteron pests (Mishra, 2008) [8]. The current situation involved evaluating biorational pesticides and insect-pest succession as separate approaches to managing fruit borer and brinjal shoots. The current study was carried out with the following goals in order to overcome the pest issue, taking into account the significance of the brinjal crop.

Methods and Material

The experiment was conducted at Raj Mohani Devi College of Agriculture and Research Station, Ajirma, Ambikapur, District Surguja (C.G.) during the September month of 2023-2024 year.

The pre-treatment observations were recorded from randomly selected ten plants at each treatment and the total number of fruit borer infected plants were counted by visual observation after application of the treatment. To determine brinjal fruit and shoot infestation the count was taken one day before the first spray and 3, 5 and 7 days after each spray, second application was applied at 15 days interval of first spray and so on. The treatments were sprayed four times in the same manner as mentioned earlier and data was be interpreted through Randomized block design.

Experimental details

Crop - Brinjal
Variety - Kiran
Plot size - 40×20 m^2
No. of treatments - 07
No. of replications - 03
Date of sowing - 24/08/2024
Date of transplanting - 09/09/2024
Design - Randomized Block Design (RBD)

Table 1.1: Treatment details are following:

S.no.	Treatments	Available concentration	Dose (gm or ml/L)
T_1	*Bacillus thuringiensis*	10^{10} CFU/gm	10 ml
T_2	*Beauveria bassiana*	10^9 CFU/gm	10 ml
T_3	*Metarhizium anisopliae*	10^7 CFU/gm	10 ml
T_4	*Verticillium lecanii*	10^7 CFU/gm	10 ml
T_5	Nimbicidine	0.3 % EC	3 ml
T_6	Emamectin benzoate	5 % SG	0.4 gm
T_7	Control (without treatment)	-	-

The observation at extent of damage was recorded at flowering and fruiting stage on the basis of damaged shoot and fruits. The per-centage of infestation were calculated according to Yadav *et al.*, 2015 [19] by the following formula:

$$\% \text{ Shoot damage} = \frac{\textbf{Number of infested shoots}}{\textbf{Total number of shoots}} \times 100$$

$$\% \text{ fruit damage} = \frac{\textbf{Number of infested fruits}}{\textbf{Total number of fruits}} \times 100$$

1.1 First spray against brinjal shoot and fruit borer

All the biopesticides were found significantly superior over untreated control in minimizing the incidence of brinjal shoot borer at all the days of observations after the first application of biopesticides.

Day before first spray

The data present in table 1.2 and Fig.1.1 revealed that pre-treatment population of *Leucinodes orbonalis* was found uniform in experimental area with of 6.83% to 7.42% infestation as the data are statistically non-significant.

Three days after first spraying

Third day after the first spray, T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded the minimum shoot infestation at 4.46%, statistically similar to T_1 (*Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L) with a shoot infestation of 5.12%. T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) showed a shoot infestation of 5.61%, T3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) recorded 6.42%, T_5 (Nimbicidine 0.3% EC @3ml /L) demonstrated 6.80% and T_4 (*Verticillium lecanii* 10^7 CFU/gm @10 ml/L) had 7.05%. In contrast, T_7 the untreated control plot recorded a higher shoot infestation at 7.21%.

Fifth day after the first spraying

Fifth day after first spray a consistent reduction in shoot infestation was observed across all treatments T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) demonstrated superior efficacy with the lowest shoot infestation at 4.29%, statistically comparable to T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) at 4.98%. The remaining treatments followed a sequential pattern, with T_2 (*Beauveria bassiana* (10^9CFU/gm) @ 10ml/L) at 5.37%, T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) at 6.04%, T5 (Nimbicidine 0.3% EC @3ml /L) at 6.76%, T_4 (*Verticillium lecanii* 10^7 CFU/gm @ 10 ml/L) at 6.99% and T_7 (Control) recorded the highest shoot infestation at 7.33%, significantly inferior to all tested biopesticide treatments.

Seven days after first spraying

Seven days after post first biopesticide spray T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) displayed the lowest shoot infestation at 4.16%, statistically comparable to T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) at 4.85%. The remaining treatments followed a sequential pattern with statistically comparable results. Specifically, T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) showed 5.24% shoot infestation, T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) recorded 5.82%, T5 (Nimbicidine 0.3% EC @3ml /L) demonstrated 6.71% and T_4 (*Verticillium lecanii* 10^7 CFU/gm @ 10 ml/L) 6.88%. These treatments were statistically comparable. The control group T_7 recorded the highest shoot infestation at 7.42%, significantly inferior to all tested biopesticide treatments.

1.2 Second spray against shoot borer infestation

The information regarding the infestation of *Leucinodes orbonalis* on shoots following the second spray was illustrated in Table No. 1.2 All the biorational treatments exhibited significant superiority over the untreated control in reducing the infestation of brinjal shoot and fruit borer. The shoot infestation caused by *L. orbonalis* decreased on the 3^{rd}, 5^{th} and 7^{th} days after spraying.

Day before Second spray

The data present in table 1.2 and Fig 1.2 revealed that pre-treatment population of *L. orbonalis* was found uniform in experimental area with of 6.04% to 7.55% infestation as the data are statistically non-significant.

Third days after second spraying

Third day after second spray T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) demonstrated the lowest shoot infestation at 4.04%, while T_1 (*Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L) showed 4.25%, both exhibiting superiority and statistical similarity. Other treatments followed a sequential pattern: T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) at 5.26% T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) at 5.97%, T_4 (*Verticillium lecanii* 10^7 CFU/gm @ 10 ml/L) at 6.51%, T_5 (Nimbicidine 0.3% EC @3ml /L) at 6.73%. In contrast, T_7, the untreated control plot recorded a significantly higher shoot infestation at 7.63%.

Fifth days after second spraying

Fifth day after second spray a consistent reduction in shoot infestation was observed across all treatments T_5 (Emamectin benzoate 5% SG @ 0.4 gm /L) resulted in the lowest shoot infestation at 4.20%, demonstrating significant superiority and statistical parity with T_1 (*Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L) at 4.21%. T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) showed a shoot infestation of 5.09%, T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 5.41%, T4 (*Verticillium lecanii* 10^7 CFU/gm @ 10 ml/L) demonstrated 6.30%, T5 (Nimbicidine 0.3% EC @3ml /L) had 6.49% following an increasing order of shoot infestation. All these treatments were significantly superior to T_7, the untreated control plot, which showed a shoot infestation of 7.73%.

Seventh days after second spraying

Seven days after post second biopesticide spray T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded the minimum shoot infestation at 3.60%, demonstrating superiority and statistical parity with T_1 (*Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L) at 4.18%, and T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) with a shoot infestation of 4.77%. T2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 5.28%, *Verticillium lecanii* 10^7 CFU/gm @ 10 ml/L) demonstrated 6.17%, and T_5 (Nimbicidine 0.3% EC @3ml /L) had 6.38%. These treatments effectively reduced shoot infestation compared to T_7 the untreated control plot which recorded 7.82% shoot infestation.

1.3 Third spray against shoot borer infestation

Information regarding the impact of various bio pesticides on shoot borer infestation in brinjal after the third spray is available in Table No. 1.3 The data indicates that all the bio pesticides were significantly more effective than the untreated control.

Day before third spray

The data present in table 1.3 and Fig 1.3 revealed that pre-treatment population of *L. orbonalis* was found uniform in experimental area with of 6.37% to 7.80% infestation as the data are statistically non-significant.

Third days after third spraying

Third day after the third spray T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded the minimum shoot infestation at 3.03%, statistically similar to T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) with a shoot infestation of 3.20%, T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) showed a shoot infestation of 3.57%, T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) recorded 5.02%, T_4 (*Verticillium lecanii* 10^7 CFU/gm @ 10ml/L) demonstrated 5.75% and T_5 (Nimbicidine 0.3% EC @3ml /L) had 5.92%. In contrast, T_7 the untreated control plot, recorded a higher shoot infestation at 7.82%.

Fifth days after third spraying

Fifth day after the third spray a consistent reduction in shoot infestation was observed across all treatments, T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded the minimum shoot infestation at 2.54%, statistically similar to T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) with a shoot infestation of 2.96%. T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) showed a shoot infestation of 3.13%, T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) recorded 4.44%, T_5 (Nimbicidine 0.3% EC @3ml /L) demonstrated 5.14% and T_4 (*Verticillium lecanii* (10^7 CFU/gm) @ 10ml/L) had 5.45%. In contrast, T_7 the untreated control plot, recorded a higher shoot infestation at 7.88%.

Seventh days after third spraying

Seven days after post third biopesticide spray T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded the minimum shoot infestation at 2.12%, statistically similar to T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) with a shoot infestation of 2.67%. Additionally, *Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) showed a shoot infestation of 2.79%, T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) recorded 4.16%, T_5 (Nimbicidine 0.3% EC @3ml /L) demonstrated 4.58%, T_4 (*Verticillium lecanii* 10^7 CFU/gm @ 10ml/L) had 5.01%. In contrast, T_7 the untreated control plot, recorded a higher shoot infestation at 7.91%.

1.4 Fourth spray against shoot borer infestation

Information regarding the impact of various biopesticides on shoot borer infestation in brinjal after the fourth spray is available in Table No.1.3 The data indicates that all the biorational treatments were significantly more effective than the untreated control.

Day before fourth spray

The data present in table 1.3 and Fig. 1.4 revealed that pre-treatment population of *L. orbonalis* was found uniform in experimental area with of 5.84% to 7.94% infestation as the data are statistically non-significant (N.S.).

Third days after Fourth spraying

Third day after fourth spray T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded the minimum shoot infestation at

1.98%, statistically similar to T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) with a shoot infestation 2.03%. T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) showed a shoot infestation of 2.24%, T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) recorded 3.95%, T_5 (Nimbicidine 0.3% EC @3ml/L) demonstrated 4.19%, and T_4 (*Verticillium lecanii* (10^7 CFU/gm) @ 10ml/L) had 5.88%. In contrast, T_7, the untreated control plot, recorded a higher shoot infestation at 8.05%.

Fifth days after Fourth spraying

Fifth day after fourth spray a consistent reduction in shoot infestation was observed across all treatments T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded the minimum shoot infestation at 1.85%, statistically similar to T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) with a shoot infestation 1.96% T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) showed a shoot infestation of 1.97%, T3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) recorded 3.54%, T_5 (Nimbicidine 0.3% EC @3ml /L) demonstrated 3.85% and T4 (*Verticillium lecanii* (10^7 CFU/gm) @ 10ml/L) had 5.22%. In contrast, T_7 the untreated control plot, recorded a higher shoot infestation at 8.09%.

Seventh days after Fourth spraying

Seven days after post fourth biopesticide spray, T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded the minimum shoot infestation at 1.41%, statistically similar to T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) with a shoot infestation 1.43%, T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) showed a shoot infestation of 1.47%, T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) recorded 2.89%, T_5 (Nimbicidine 0.3% EC @3ml /L) demonstrated 3.29% and T4 (*Verticillium lecanii* 10^7 CFU/gm @ 10ml/L) had 5.80%. In contrast, T_7 the untreated control plot, recorded a higher shoot infestation at 8.16%.

4.2.5 Overall mean of four sprays

Overall statistical analysis of all four spray observations first, second, third and fourth spray showed that all insecticidal treatment were found to be significantly effective compared to control (7.74%) in reducing the population. Emamectin benzoate 5% SG @ 0.4 gm /L was most effective against as it recorded the lowest population of (3.26%) followed by *Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L (3.78%), *Beauveria bassiana* 10^9CFU/gm @ 10ml/L also very effective in reducing larval population as recorded (4.21%) respectively and superior over other biorational treatment. The infestation of brinjal shoot and fruit borer in *Metarhizium anisopliae* 10^7CFU/gm @10ml/L recorded (4.84%), and Nimbicidine 0.3% EC @3ml /L (5.61%) respectively. Among the biorational treatment *Verticillium lecanii* 10^7 CFU/gm @ 10 ml/L. (6.12%) was comparatively least effective against fruit borer. Untreated control was recorded the highest Brinjal fruit and shoot borer. (Table 1.4 & Fig 1.5)

According to studies by Wankhede and Kaur (2010) [17] Kalwate (2012) [6], Kaur *et al.* (2014) [7], Warghat *et al.*, (2020) [18] and Goud *et al.*, (2019) [4] reported that Emamectin benzoate provided maximum protection and minimal damage to the shoots in brinjal. That is in fully supported with present finding. Tripura *et al.* (2017) [16] revealed that among biopesticides *Bacillus thuringiensis* and *Beauveria bassiana* were found superior treatment in reducing shoot and fruit infestation, the result were more or less similar to Sharma and tayde (2017) [13] Singh *et al.*, (2016) [14], while Rashid *et al.*, (2018) [10] found that *Bacillus thuringiensis* was effective in reducing the infestation of the shoot and fruit borer. The statement partially supported the present finding that *Bacillus thuringiensis* and *Beauveria bassiana* were effective in controlling brinjal shoot and fruit borer but not as much as effective like Emamectin benzoate. Singh (2010) [15] that *Bt* formulation Halt produced maximum fruit yield which was significantly higher than untreated control however, it was lower and at par with chemicals. The statement fully supports the current finding.

Table 1.2: Efficiency of biorational approaches for the management of brinjal shoot and fruit borer (First and Second spray)

S.no	Treatment	Dose (ml or gm/L)	Brinjal shoot and fruit borer infestation (%)									
			DBS	First spray			Mean	DBS	Second spray			Mean
				3 DAS	5DAS	7 DAS			3 DAS	5DAS	7 DAS	
1	*Bacillus thuringiensis* 10^{10} CFU/gm	10 ml	7.39 (15.77) *	5.12 (13.07)	4.98 (12.89)	4.85 (12.72)	5.59 (13.66)	6.91 (15.24)	4.25 (11.89)	4.21 (11.84)	4.18 (11.79)	4.21 (11.84)
2	*Beauveria bassiana* 10^9 CFU/gm	10 ml	6.83 (15.15)	5.61 (13.70)	5.37 (13.39)	5.24 (13.23)	5.76 (13.89)	6.04 (14.22)	5.97 (14.14)	5.41 (13.44)	5.28 (13.28)	5.55 (13.63)
3	*Metarhizium anisopliae* 10^7 CFU/gm	10 ml	7.01 (15.34)	6.42 14.67)	6.04 (14.22)	5.82 (13.96)	6.32 (14.56)	5.54 (13.61)	5.26 (13.25)	5.09 (13.03)	4.77 (12.61)	5.04 (12.97)
4	*Verticilium lecanii* 10^7 CFU/gm	10 ml	7.18 (15.54)	7.05 (15.39)	6.99 (15.33)	6.88 (15.33)	7.03 (15.37)	6.61 (14.89)	6.51 (14.78)	6.30 (14.53)	6.17 (14.38)	6.33 (14.56)
5	Nimbicidine 0.3% EC	3 ml	7.42 (15.80)	6.80 (15.11)	6.76 (15.06)	6.71 (15.01)	6.92 (14.56)	6.27 (14.50)	6.73 (15.03)	6.49 (14.75)	6.38 (14.63)	6.53 (6.53)
6	Emamectin benzoate 5% SG	0.4gm	7.25 (15.62)	4.46 (12.91)	4.29 (11.95)	4.16 (11.76)	5.04 (12.97)	5.44 (13.48)	4.04 (11.59)	4.20 (11.82)	3.60 (10.93)	3.95 (11.45)
7	Control		7.13 (15.49)	7.21 (15.57)	7.33 (15.71)	7.42 (15.80)	7.27 (15.64)	7.55 (15.94)	7.63 (16.03)	7.73 (16.14)	7.82 (16.23)	7.72 (16.13)
	S E (m) +			0.127	0.109	0.069	0.13	0.438	0.068	0.091	0.139	0.10
	CD at 5%		N. S	0.3924	0.3373	0.2112	0.41	N. S	0.2106	0.2793	0.428	0.31
	CV (%)			3.618	3.178	2.023	3.55	11.96	2.052	2.788	4.408	3.08

*Figures in the parenthesis are angular transformed values, $\theta = Arcsin\ (\sqrt{x}/100)$ DBS = Day before spray, DAS = Day after spray

Table 1.3: Efficiency of biorational approaches for the management of brinjal shoot and fruit borer (Third and Fourth spray)

S.no	Treatment	Dose (ml or gm/L)	Brinjal shoot and fruit borer infestation (%)									
			DBS	Third spray			Mean	DBS	Fourth spray			Mean
				3 DAS	5DAS	7 DAS			3 DAS	5DAS	7 DAS	
1	*Bacillus thuringiensis* 10^{10} CFU/gm	10 ml	4.95 (12.85)*	3.20 (10.30)	2.96 (9.90)	2.79 (9.61)	2.98 (9.98)	4.50 (12.24)	2.39 (8.89)	2.22 (8.56)	2.44 (8.98)	2.35 (8.81)
2	*Beauveria bassiana* 10^9 CFU/gm	10 ml	4.93 (12.82)	3.57 (10.89)	3.13 (10.19)	2.67 (9.50)	3.12 (10.17)	4.58 (12.35)	2.24 (8.60)	2.46 (8.60)	2.60 (9.27)	2.43 (8.97)
3	*Metarhizium anisopliae* 10^7 CFU/gm	10 ml	5.30 (13.30)	5.02 (12.94)	4.44 (12.16)	4.16 (11.76)	4.54 (12.30)	5.31 (13.32)	3.95 (11.46)	3.54 (10.84)	2.89 (9.78)	3.46 (10.72)
4	*Verticilium lecanii* 10^7 CFU/gm	10 ml	6.37 (14.61)	5.75 (13.87)	5.45 (13.50)	5.01 (12.94)	5.40 (13.44)	5.84 (13.98)	5.88 (14.03)	5.22 (13.20)	5.80 (13.93)	5.73 (13.72)
5	Nimbicidine 0.3% EC	3 ml	5.91 (14.06)	5.92 (14.08)	5.14 (13.10)	4.58 (12.35)	5.21 (13.19)	4.48 (12.21)	4.19 (11.81)	3.85 (11.31)	3.98 (11.50)	4.00 (11.54)
6	Emamectin benzoate 5% SG	0.4gm	4.68 (12.49)	3.03 (10.02)	2.54 (9.17)	2.12 (8.37)	2.56 (9.21)	3.97 (11.49)	1.73 (7.55)	1.45 (6.91)	1.34 (6.64)	1.50 (7.05)
	Control		7.80 (16.21)	7.82 (16.23)	7.88 (16.30)	7.91 (16.33)	7.87 (16.29)	7.94 (16.36)	8.05 (16.48)	8.09 (16.52)	8.16 (16.59)	8.10 (16.53)
	S E (m) +		0.642	0.178	0.212	0.173	0.20	0.781	0.08	0.07	0.06	0.07
	CD at 5%		N. S	0.55	0.6519	0.5346	0.59	N. S	0.25	0.24	0.20	0.23
	CV (%)		19.50	6.307	8.133	7.194	7.21	25.8	3.45	3.54	2.94	3.31

*Figures in the parenthesis are angular transformed values, $\theta = Arcsin\ (\sqrt{x}/100)$ DBS = Day before spray, DAS = Day after spray

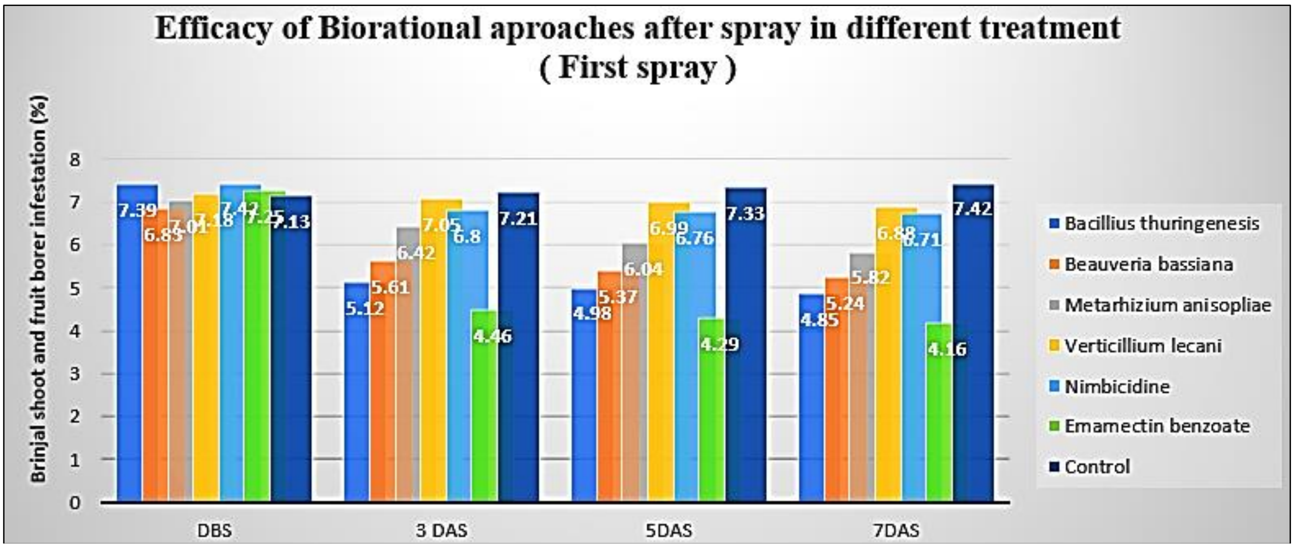

Fig 1.1: Brinjal shoot and fruit borer infestation (%) (First spray)

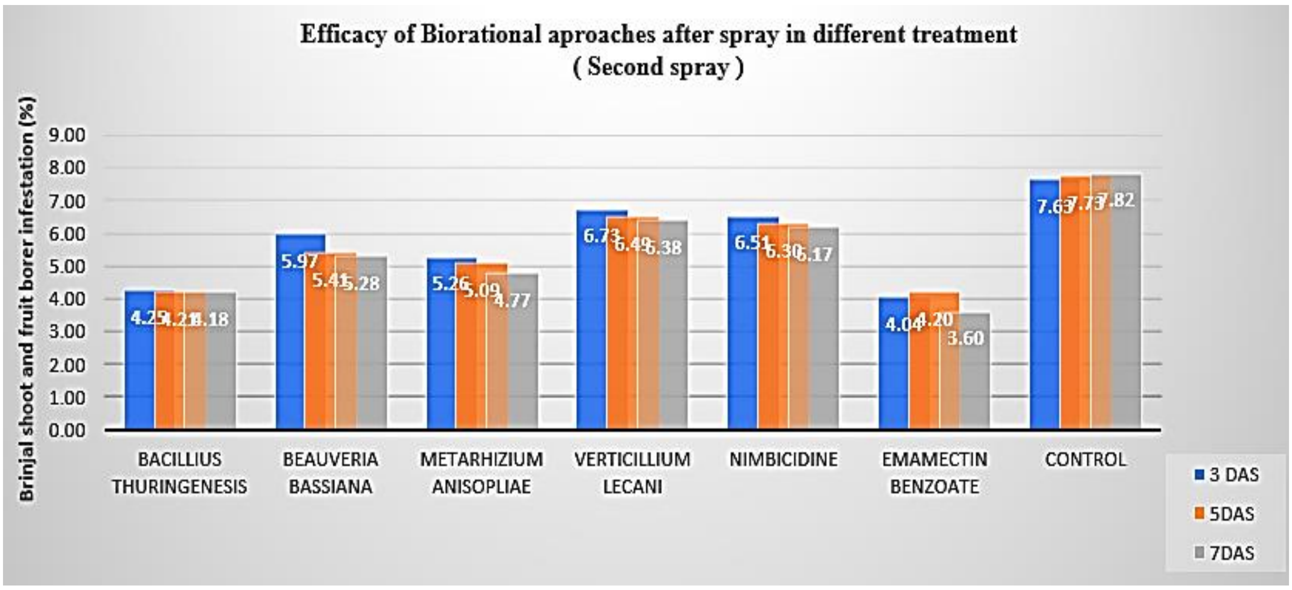

Fig 1.2: Brinjal shoot and fruit borer infestation (%) (Second spray)

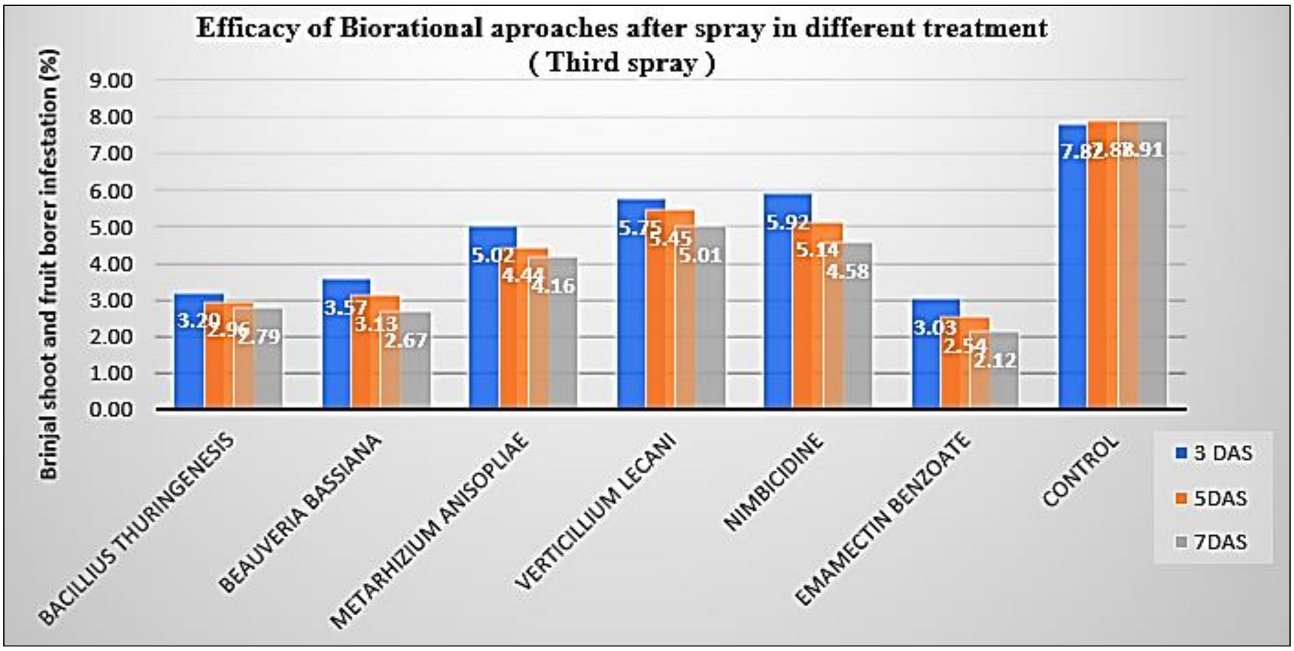

Fig 1.3: Brinjal shoot and fruit borer infestation (%) (Third spray)

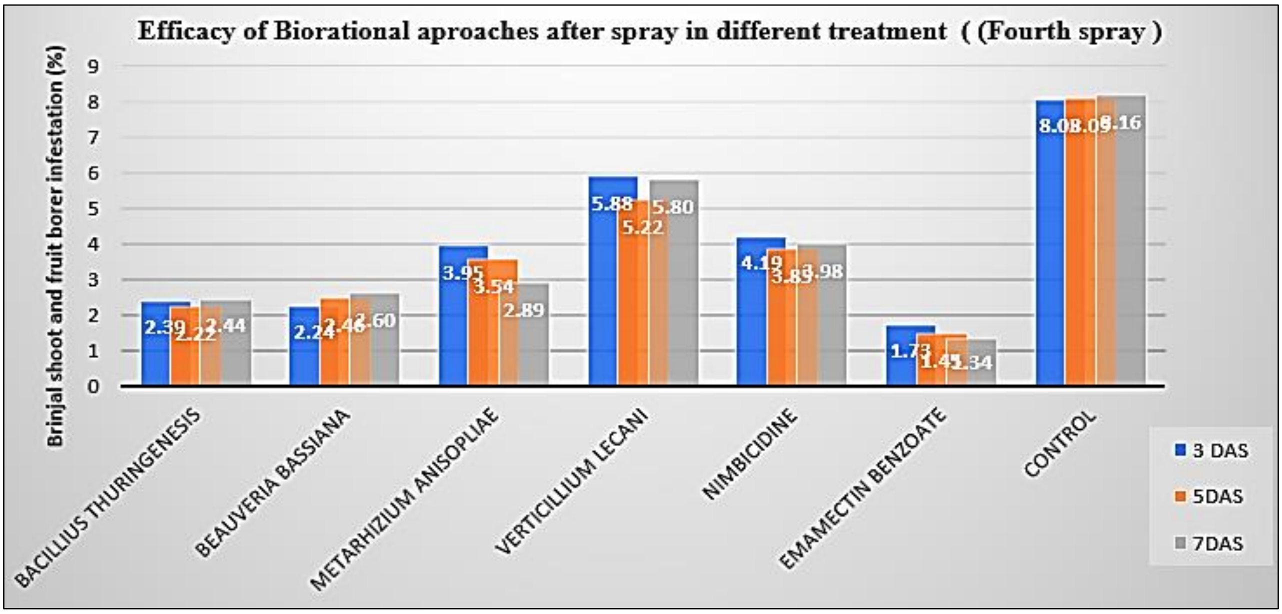

Fig 1.4: Brinjal shoot and fruit borer infestation (%) (Fourth spray)

Table 1.4: Overall effect of spray over brinjal shoot and fruit borer

S.no	Treatment	Dose ml or gm/L	Brinjal shoot and fruit borer infestation (%)				Overall mean of four spray
			First spray	Second spray	Third spray	Fourth spray	
1	*Bacillus thuringiensis* 10^{10} CFU/gm	10 ml	5.59(13.66) *	4.21 (11.84)	2.98 (9.98)	2.35 (11.21)	3.78 (11.21)
2	*Beauveria bassiana* 10^9 CFU/gm	10 ml	5.76 (13.89)	5.55 (13.63)	3.12 (10.17)	2.43 (11.84)	4.21 (11.84)
3	*Metarhizium anisopliae* 10^7 CFU/gm	10 ml	6.32 (14.56)	5.04 (12.97)	4.54 (12.30)	3.46 (10.72)	4.84 (12.70)
4	*Verticilium lecanii* 10^7 CFU/gm	10 ml	7.03 (15.37)	6.33 (14.56)	5.40 (13.44)	5.73 (13.72)	6.12 (14.32)
5	Nimbicidine 0.3% EC	3 ml	6.92 (14.56)	6.53 (6.53)	5.21 (13.19)	4.01 (13.77)	5.66 (13.77)
6	Emamectin benzoate 5% SG	0.4gm	5.04 (12.97)	3.95 (11.45)	2.56 (9.21)	1.50 (10.40)	3.26 (10.40)
	Control		7.27 (15.64)	7.72 (16.13)	7.87 (16.29)	8.10 (16.53)	7.74 (16.15)
	S E (m) +		0.13	0.10	0.20	0.07	0.12
	CD at 5%		0.41	0.31	0.59	0.23	0.38
	CV (%)		3.55	3.08	7.21	3.31	4.29

*Figures in the parenthesis are angular transformed values, $\theta = Arcsin\ (\sqrt{x}/100)$

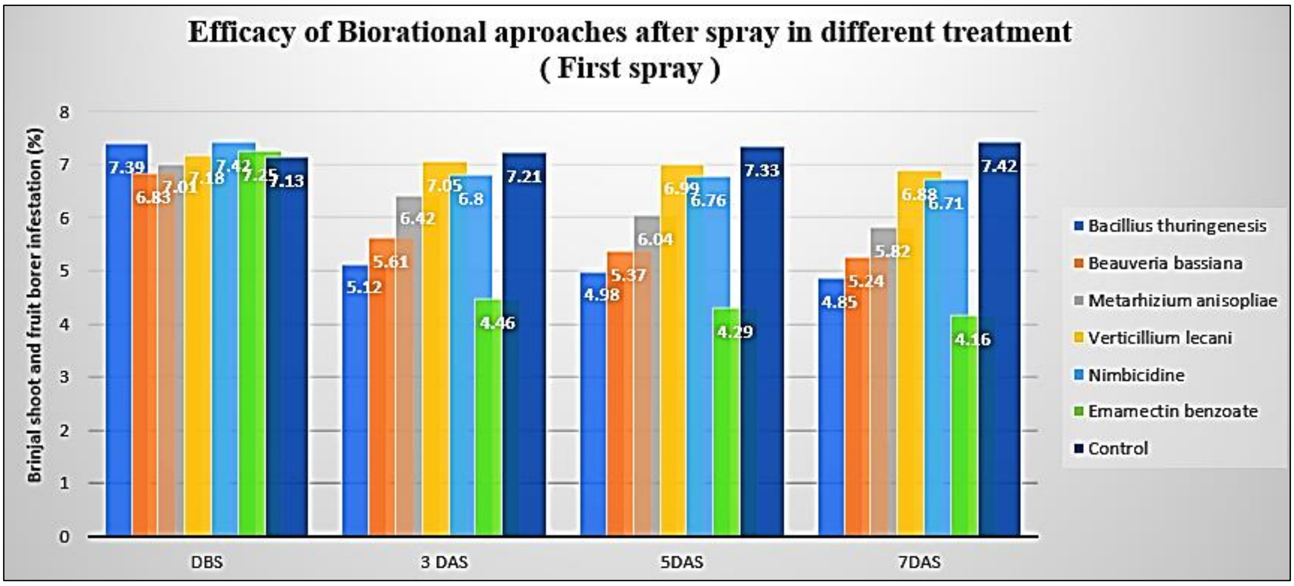

Fig 1.5: Overall mean data of all four spray

1.5 Effect of biorational approaches against fruit damage due to *Leucinodes orbonalis* in brinjal (Number basis)

Per-cent fruit damage

It was observed in table 1.5 and Fig 1.6 that all the biorational treatments recorded significantly lower infestation of fruit borer on number basis as compared of untreated control.

First picking infestation

From the first picking, it is revealed that lowest per cent fruit damage was observed in T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded 13.04% fruit damage which was found at par with T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) recorded 14.28% fruit damage followed by T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 17.07% fruit damage T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) 22.22%, T_5 (Nimbicidine 0.3% EC @3ml /L) recorded 22.72% and T_4(*Verticillium lecanii* 10^7CFUgm @10ml/L) recorded 23.33% fruit damage. The highest fruit damage was found in a T_7 untreated control plot recorded 29.87% fruit damage.

Second picking infestation

From the second picking, it is revealed that lowest per cent fruit damage was observed in T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded 9.8% fruit damage which was found at par with T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) recorded 12.01% fruit damage followed by T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 14.28% fruit damage T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) 19.58%, T_5 (Nimbicidine 0.3% EC @3ml /L) recorded 21.27% and T_4(*Verticillium lecanii* 10^7CFUgm @10ml/L) recorded 30.95% fruit damage. The highest fruit damage was found in a T_7 untreated control plot recorded 29.71% fruit damage.

Third picking infestation

From the third picking, it is revealed that lowest per cent fruit damage was observed in T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded 10.98% fruit damage which was found at par with T_1 (*Bacillus thuringiensis* 10^{10} CFU /gm @ 10ml/L) recorded 12.41% fruit damage followed by T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 13.63% fruit damage T_3 (*Metarhizium anisopliae10^7CFU/gm @10ml/L) 20.18%, T_5 (Nimbicidine 0.3% EC @3ml /L) recorded 20.68% and T_4(Verticillium lecanii 10^7CFUgm @10ml/L) recorded 29.62% fruit damage. The highest fruit damage was found in a T_7 untreated control plot recorded 32.5% fruit damage.*

Fourth picking infestation

From the fourth picking it is revealed that lowest per cent fruit damage was observed in T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded 8.03% fruit damage which was found at par with T_1 (*Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L) recorded 10.23% fruit damage followed by T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 10.81% fruit damage T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) 18.42%, T_5 (Nimbicidine 0.3% EC @3ml /L) recorded 20.93% and T4(*Verticillium lecanii* 10^7CFUgm @10ml/L) recorded 31.57% fruit damage. The highest fruit damage was found in a T_7 untreated control plot recorded 34.52% fruit damage.

Fifth picking infestation

From the fifth picking, it is revealed that lowest per cent fruit damage was observed in T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded 7.93% fruit damage which was found at par with T_1 (*Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L) recorded 9.66% fruit damage followed by T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 10.79% fruit damage T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) 17.74%, T_5 (Nimbicidine 0.3% EC @3ml /L) recorded 20% and T_4(*Verticillium lecanii* 10^7CFUgm @10ml/L) recorded 28.07% fruit damage. The highest fruit damage was found in a T_7 untreated control plot recorded 35.41% fruit damage.

Sixth picking infestation

From the first picking, it is revealed that lowest per cent fruit damage was observed in T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded 7.05% fruit damage which was found at par with T_1 (*Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L) recorded 9.05% fruit damage followed by T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 10.61% fruit damage T3 (*Metarhizium anisopliae*

10^7CFU/gm @10ml/L) 17.04%, T_5 (Nimbicidine 0.3% EC @3ml /L) recorded 19.62% and T_4(*Verticillium lecanii* 10^7CFUgm @10ml/L) recorded 29.87% fruit damage. The highest fruit damage was found in a T_7 untreated control plot recorded 36% fruit damage.

Seventh picking infestation

From the seventh picking, it is revealed that lowest per cent fruit damage was observed in T_6 (Emamectin benzoate 5% SG @ 0.4 gm /L) recorded 7.56% fruit damage which was found at par with T_1 (*Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L) recorded 9.23% fruit damage followed by T_2 (*Beauveria bassiana* 10^9CFU/gm @ 10ml/L) recorded 10.87% fruit damage. T_3 (*Metarhizium anisopliae* 10^7CFU/gm @10ml/L) 17.64%, T_5 (Nimbicidine 0.3% EC @3ml /L) recorded 20.19% and T_4 (*Verticillium lecanii* 10^7CFUgm @10ml/L) recorded 30.5% fruit damage. The highest fruit damage was found in a T_7 untreated control plot recorded 42.85% fruit damage.

Per-cent fruit damage by brinjal shoot and fruit borer

The data related to this aspect is presented in Table 1.5 and depicted by Fig 1.6 On the basis of overall mean fruit damage, all tested birational treatment recorded significantly less fruit damage as compared to untreated control (33.6% FD). Among the treatments Emamectin benzoate 5% SG @ 0.4 gm /L was found to be most effective treatment with are cord of minimum fruit damage (9.16% FD) *Bacillus thuringiensis* 10^{10} CFU /g @ 10ml/L followed by (10.98% FD) and *Beauveria bassiana* 10^9CFU/gm @ 10ml/L (12.58% FD) The next better treatments were *Metarhizium anisopliae* 10^7CFU/gm @10ml/L (18.97% FD) and Nimbicidine 0.3% EC @3ml /L (20.84% FD) and *Verticillium lecanii* 10^7CFUgm @10ml/L was found the least effective treatment with a percent infested fruit of (29.13% FD) but it was superior than untreated control.

Kaur *et al.*, (2014) [7] reported *Leucinodes orbonalis* (Guenee) to Emamectin benzoate higher toxic against brinjal shoot and fruit borer Patel *et al.*, (2015) [9] reported Emamectin benzoate the most effective insecticide in the brinjal crop with a higher yield. Deshmukh and Bhamare (2006) [2] reported that *Bacillus thuringiensis* has lower fruit infestation with higher marketable yield, which is in line with the reports of Singh *et al.*, (2010) [15] that *Bt* formulation Halt produced maximum fruit yield which was significantly higher than untreated control.

Table 1.5: Effect of biorational approaches over fruit infestation caused by of brinjal shoot and fruit borer during *Kharif* 2024-25

S.no	Treatment	Dose (ml or gm/L)	Fruit yield (q/ha)	Per-cent fruit infestation on number basis							Mean
				First Picking	Second Picking	Third Picking	Fourth Picking	Fifth Picking	Sixth Picking	Seventh Picking	
1	*Bacillus thuringiensis* 10^{10} CFU/gm	10 ml	361.25	14.28 (22.20) *	12.01 (20.27)	12.41 (20.62)	10.23 (18.65)	9.66 (18.10)	9.05 (17.50)	9.23 (17.68)	10.98 (19.35)
2	*Beauveria bassiana* 10^9 CFU/gm	10 ml	306.25	17.07 (24.40)	14.28 (22.20)	13.63 (21.66)	10.81 (19.19)	10.79 (19.17)	10.61 (19.00)	10.87 (19.25)	12.58 (20.77)
3	*Metarhizium anisopliae* 10^7 CFU/gm	10 ml	260.65	22.22 (28.12)	19.58 (26.26)	20.18 (26.69)	18.42 (25.41)	17.74 (24.90)	17.04 (24.28)	17.64 (24.83)	18.97 (25.82)
4	*Verticilium lecanii* 10^7 CFU/gm	10 ml	255.75	23.33 (28.88)	30.95 (33.80)	29.62 (32.97)	31.57 (34.18)	28.07 (31.99)	29.87 (33.12)	30.5 (33.52)	29.13 (32.66)
5	Nimbicidine 0.3% EC	3 ml	266.50	22.72 (28.46)	21.27 (27.46)	20.68 (27.04)	20.93 (27.22)	20 (26.56)	19.62 (26.29)	20.19 (26.70)	20.84 (26.96)
6	Emamectin benzoate 5% SG	0.4gm	376.1	13.04 (21.16)	9.8 (18.24)	10.98 (19.35)	8.03 (16.46)	7.93 (16.35)	7.05 (15.39)	7.56 (15.95)	9.19 (17.43)
7	Control	-	243.05	25.21 (30.13)	28.71 (32.29)	32.5 (34.75)	34.52 (35.98)	35.41 (36.86)	36 (36.86)	42.85 (40.88)	33.6 (35.42)
	S E (m)+			0.243	0.298	0.249	0.253	0.203	0.244	0.171	0.23729
	CD at 5%			0.7498	0.9178	0.7676	0.7808	0.6269	0.7526	0.5256	0.73159
	CV (%)			2.14	2.663	2.157	2.279	1.903	2.274	1.593	2.14414

*Figures in the parenthesis are angular transformed values, $\theta = Arcsin\ (\sqrt{x}/100)$

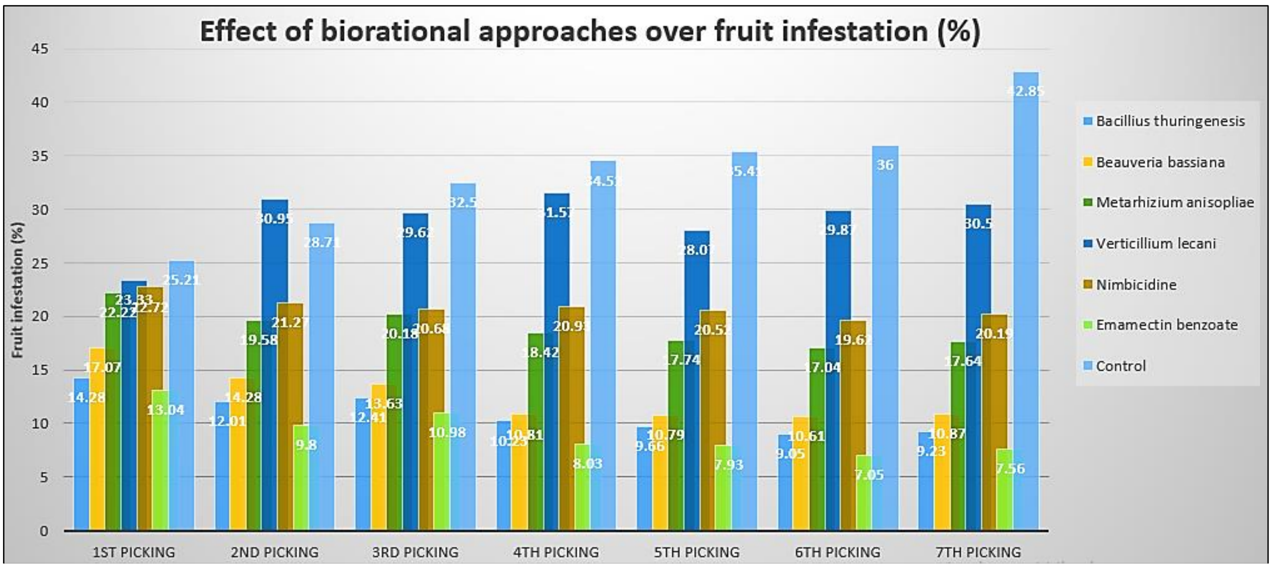

Fig 1.6: Per-cent Fruit infestation over different biorational approaches

Conclusion

In terms of pest management, the biorational strategy for lowering the brinjal fruit and shoot borer (Leucinodes orbonalis) produced favourable results. Among the tested treatments, *Bacillus thuringiensis*, *Beauveria bassiana*, *Metarhizium anisopliae*, and Nimbicidine proved to be the most effective. Both the number of fruit and shoot damage and the percentage of overall fruit infestation significantly decreased. It promotes the healthy microbial activity of the soil, which is essential for sustainable agriculture and long-term soil health. Emamectin benzoate offered the lowest infestation percentage which serves as a reference point for evaluating the efficacy of biorational treatments effectively.

Acknowledgements

The first author expresses her heartfelt gratitude to Major Advisor, Head of Section (Entomology), all the Advisory member, Staff members, Dean, RMD CARS Ambikapur and Head of Department (Entomology), COA Raipur for their excellent guidance, suggestions and regular encouragement during the course of investigation.

References

1. Bhargava MC, Choudhary RK, Jain PC. Genetic engineering of plants for insect resistance. In: Jain PC, Bhargava MC, editors. Novel approaches. New Delhi: New India Publishing; 2008. p. 133-44.
2. Deshmukh RM, Bhamare VK. Field evaluation of some insecticides against eggplant shoot and fruit borer, *Leucinodes orbonalis* Guenée. Int J Agric Res. 2006;2(1):247-9.
3. Dhandapani N, Shelkar UR, Murugan M. Bio-intensive pests management in major vegetable crops: An Indian perspective. J Food Agric Environ. 2003;1(2):330-9.
4. Goud GS, Bondre CM, Gawali KA. Efficacy of some chemical and botanical pesticides against brinjal shoot and fruit borer *Leucinodes orbonalis* (Guenée). J Pharmacogn Phytochem. 2019;8(4):2453-5.
5. Islam MN, Karim MA. Management of the brinjal fruit and shoot borer, *Leucinodes orbonalis* Guenée (Lepidoptera: Pyralidae) in field. In: Annual Research Report 1990-91. Joydebpur, Gazipur (Bangladesh): Bangladesh Agricultural Research Institute, Entomology Division; 1991. p. 44-6.
6. Kalawate A, Dethe MD. Bioefficacy study of biorational insecticide on brinjal. J Biopest. 2012;5(1):75-80.
7. Kaur P, Yadav GS, Wargantiwar RK, Burange PS. Population dynamics of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenée) (Lepidoptera: Crambidae) under agroclimatic conditions of Hisar, Haryana. Int J Environ Sci. 2014;8(1-2):1-5.
8. Mishra HP. New promising insecticides for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenée. Pest Manag Hortic Ecosyst. 2008;14(2):140-7.
9. Patel S, Mandloi R, Prajapati S, Saxena AK, Parmar R, Singh PO. Assessment of the efficacy and economics of insecticides and bio-pesticides against major insect-pests combination of brinjal (*Solanum melongena* Linn.) cv. JB-64. Plant Arch. 2015;15(2):923-30.
10. Rashid MA, Hasan MK, Matin MA. Socio-economic performance of Bt eggplant cultivation in Bangladesh. Bangladesh J Agric Res. 2018;43(2):187-203.
11. Shanmugam PS, Indhumathi K, Vennila MA, Tamilselvan N. Evaluation of bio-intensive pest management modules against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenée (Lepidoptera: Crambidae) under precision farming system. Pest Manag Hortic Ecosyst. 2015;21(2):154-8.
12. Sharma DR. Bioefficacy of certain insecticides and biopesticides against major pests of brinjal under field condition [MSc thesis]. New Delhi (India): Indian Agriculture Research Institute; 2002. 160 p.
13. Sharma JH, Tayde AR. Evaluation of bio-rational pesticides against brinjal fruit and shoot borer, *Leucinodes orbonalis* Guenée on brinjal at Allahabad agroclimatic region. Int J Curr Microbiol Appl Sci. 2017;6(6):2049-54.
14. Singh JP, Gupta PK, Chandra U, Singh VK. Bioefficacy of newer insecticides and biopesticides against brinjal shoot and fruit borer *Leucinodes orbonalis* (Guenée) (Lepidoptera: Pyralidae). Int J Plant Prot. 2016;9(1):1-7.
15. Singh N, Sharma US, Pareek A. Incidence of major sucking insect pests of brinjal. Indian J Appl Entomol. 2010;24(2):157-8.
16. Tripura A, Chatterjee ML, Pande R, Patra S. Biorational management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenée) in mid hills of Meghalaya. J Entomol Zool Stud. 2017;5(4):41-5.
17. Wankhede SM, Kale VD. Performance of some insecticides against *Leucinodes orbonalis* Guenée. Int J Plant Prot. 2010;3(2):257-9.
18. Warghat AN, Nimbalkar D, Tayde AR. Bio-efficiency of some insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guenée). J Entomol Zool Stud. 2020;8(1):932-6.
19. Yadav R, Lyall H, Kumar S, Kumar R. Efficacy of certain botanical insecticides against shoot and fruit borer, *Leucinodes orbonalis* (Guenée) on brinjal (*Solanum melongena* L.). Int Q J Environ Sci. 2015;10(3):987-99.