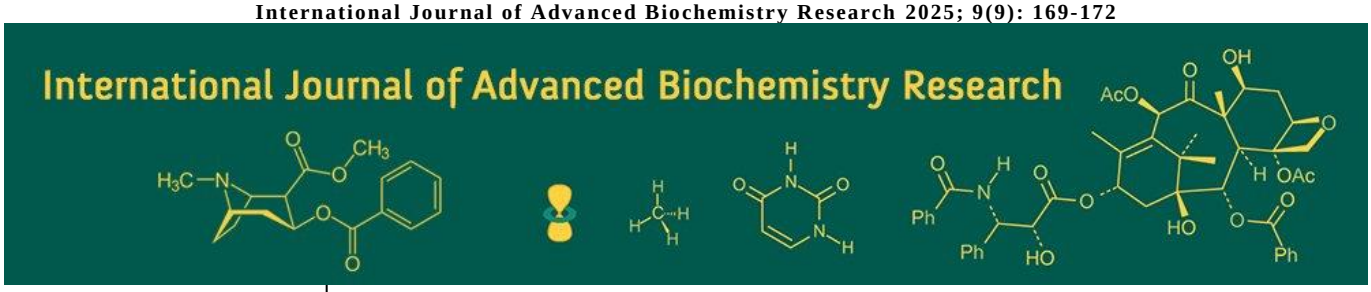

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Rohini Pundlik Borutkar
PG Scholar, Entomology Section, College of Agriculture, Nagpur, Maharashtra, India

HR Sawai
Assistant Professor, Entomology Section, College of Agriculture, Nagpur, Maharashtra, India

VJ Tambe
Professor, Entomology Section, College of Agriculture, Nagpur, Maharashtra, India

SL Borkar
Associate Professor, Entomology Section, College of Agriculture, Nagpur, Maharashtra, India

RI Khobragade
Assistant Professor, Horticulture Section, College of Agriculture, Nagpur, Maharashtra, India

Akanksha D Nakaskar
PG Scholar, Entomology Section, College of Agriculture, Nagpur, Maharashtra, India

Prajakta G Falke
PG Scholar, Agronomy Section, College of Agriculture, Nagpur, Maharashtra, India

Corresponding Author:
Rohini Pundlik Borutkar
PG Scholar, Entomology Section, College of Agriculture, Nagpur, Maharashtra, India

Relative performance of *Trichogramma chilonis*, chemical insecticides and botanicals against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen.

Rohini Pundlik Borutkar, HR Sawai, VJ Tambe, SL Borkar, RI Khobragade, Akanksha D Nakaskar and Prajakta G Falke

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Abstract
The field investigation was carried out in the Insectary and at the Field of Entomology Section, College of Agriculture, Nagpur during the kharif season of 2024-25. The experiment was carried out in Randomized Block Design (RBD) with seven treatments and three replications. Treatments were applied at 10 days interval. The fruit infestation ranged from (12.34 to 29.01%) in various treatments on weight basis. The results revealed that the treatments (T_2) Two release of *Trichogramma chilonis* @ 1.00 lakh/ha followed by spraying alternatively of Emamectin Benzoate 5 SG @ 0.4 g/l and Spinosad 45 SC @ 0.5 ml/l and (T_4) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l were superior to all other treatments and statistically at par with each other, wherein 12.34 and 13.14 percent fruit infestation recorded with 57.46 and 54.71 percent reduction over control respectively. However, the next effective treatments were observed (T_4) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l and (T_1) Release of *Trichogramma chilonis* @ 1.00 lakh/ha which were at par with each other and recorded 13.14 and 14.05 percent fruit infestation with 54.71 and 51.57 percent reduction over control respectively, on weight basis as compared to control (29.01%) against brinjal shoot and fruit borer *Leucinodes orbonalis*.

Keywords: Relative performance, brinjal shoot and fruit borer, *Leucinodes orbonalis*, *Trichogramma chilonis*, chemical insecticides, botanicals

Introduction
The brinjal (*Solanum melongena* L.) belonging to the family Solanaceae, often referred as an eggplant or an aubergine in other regions of the world and it is native of India. Brinjal is predominantly self-fertilized with diploid chromosome no. 2n=2x=24 and is recognized as "King of vegetables". India is one of the largest producer of brinjal in the world, ranking second after China. Brinjal is popular vegetable grown as "Poor man's crop" in India due to its affordability and availability. Nutritionally, it is low-calorie vegetable enriched with carbohydrates, essential minerals and dietary fiber and vitamins such as C, A and B-complex group, which play a vital role in enhancing immunity. Furthermore, the phenolic compounds and flavonoids present in brinjal contribute to reducing the risk of cardiovascular diseases and exhibit anti-inflammatory properties.

In India, during 2023-24, the area under brinjal cultivation increased by 0.29 percent to 6.81 lakh hectares, producing 128.10 lakh tonnes, compared to 129.72 lakh tonnes harvested from 6.79 lakh hectares in the previous year. (Anonymous, 2025) [1, 2]. In Maharashtra, brinjal production in 2025 was approximately 308.3 thousand tonnes, with cultivated area of 18.54 thousand hectares (Anonymous, 2025) [1, 2]. The brinjal crop is attacked by more than 70 species of insect pests, among which the shoot and fruit borer (*Leucinodes orbonalis* Guenee) is regarded as the most destructive (Sardana *et al*., 2004) [11]. Infestation during the reproductive stage causes severe losses, as larvae bore into fruits, and boreholes are plugged with frass and excreta which makes fruits unfit for consumption. Infested fruits also become misshapen, which decreases their market value. In case of severe infestation, multiple larvae can be observed within a single fruit (Dash *et al*., 2020) [5]. In India, yield reductions of up to 70-90 percent have been reported (Rosaiah, 2001) [10]. Prior studies (Sharma *et al*., 2023) [12] who have assessed the effectiveness of pesticide application, including biochemical

pesticides and botanical products, against *L. orbonalis* whereas, these alternative insecticides are currently being employed in addition to conventional ones.

Although several insecticides have been suggested, their extensive use has led to substantial problems and dangers (Das *et al*., 2024) [4]. Considering the issues associated with injudicious use of chemical insecticides by farmers in brinjal cultivation, the present experiment was undertaken to assess the relative performance of releases of bioagent *Trichogramma chilonis* with alternate application of chemical insecticides and botanicals for management of brinjal shoot and fruit borer *Leucinodes orbonalis*.

Materials and Methods

The field investigation was carried out during kharif season of 2024-25 in the Insectary and at Field of Entomology Section, College of Agriculture, Nagpur. Seeds of brinjal variety AKLB-9 were sown in a nursery and seedlings were transplanted in main field at a distance of 75 cm × 60 cm^2 in a plot of 3.75 × 3.00 m^2. The experiment was conducted in a Randomized Block Design with seven treatments each replicated three times. The treatments evaluated against brinjal shoot and fruit borer *Leucinodes orbonalis* were: (T_1) Release of *Trichogramma chilonis* @ 1.00 lakh/ha, (T_2) Two release of *Trichogramma chilonis* @ 1.00 lakh/ha followed by spraying alternatively of Emamectin Benzoate 5 SG @ 0.4 g/l and Spinosad 45 SC @ 0.5 ml/l, (T_3) Two release of *Trichogramma chilonis* @ 1.00 lakh/ha followed by spraying alternatively of Neem oil 2 percent @ 20 ml/l and Karanj oil 2 percent @ 20 ml/l, (T_4) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l, (T_5) Neem oil 2 percent @ 20 ml/l followed by Karanj oil 2 percent @ 20 ml/l, (T_6) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l followed by Neem oil 2 percent @ 20 ml/l followed by Karanj oil 2 percent @ 20 ml/l and (T_7) Control (Water spray). All treatments were applied at 10 days interval. The observations on healthy and damaged fruit from each treatment plot were recorded on five observational plants replication wise at each picking at 10 days interval on weight basis. The data recorded from various treatments were statistically analyzed after suitable transformation.

$$\text{Percent fruit infestation (Weight basis)} = \frac{\text{Weight of damaged fruits}}{\text{Weight of total fruits}} \times 100$$

Results and Discussion

Effect of various treatments against fruit infestation by Brinjal Shoot and Fruit Borer *Leucinodes orbonalis* in brinjal on weight basis:

During the kharif season 2024-25, harvesting of brinjal fruits was initiated at 65 days after transplanting at 10 days interval upto eight pickings. The fruit infestation, recorded on weight basis, ranged from 12.34 to 29.01 percent, as presented in Table 1 and illustrated in Fig.1. The results revealed that all the treatments were effective in suppressing fruit infestation caused by the brinjal shoot and fruit borer *Leucinodes orbonalis* as compared to the control.

The treatments (T_2) Two release of *Trichogramma chilonis* @ 1.00 lakh/ha followed by spraying alternatively of Emamectin Benzoate 5 SG @ 0.4 g/l and Spinosad 45 SC @ 0.5 ml/l and (T_4) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l were statistically superior to all other treatments and were at par with each other, wherein 12.34 and 13.14 percent fruit infestation with 57.46 and 54.71 percent reduction over control, respectively resulted on weight basis. These results coincide with the findings of Murali *et al*. (2017) [8], who recorded 8.97 percent fruit infestation with 83.32 percent reduction in fruit infestation over control using combination treatment (*T. chilonis* @ 100000 adults/ha + Cypermethrin 25 EC @ 0.4 ml/lit) on weight basis followed by chemical treatment (Cypermethrin 25 EC @ 0.4 ml/lit). Present findings corroborate the observations of Yawale *et al*. (2019), who reported the fruit infestation (9.63%) with (69.67% reduction) over control using Emamectin Benzoate 5 SG @ 0.4 gm/lit and (12.01%) fruit infestation with (62.17% reduction) over control using Spinosad 45 SC @ 0.32 ml/lit on weight basis.

However, the next best performance was observed in treatments (T_4) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l and (T_1) Release of *Trichogramma chilonis* @ 1.00 lakh/ha which recorded 13.14 and 14.05 percent fruit infestation with 54.71 and 51.57 percent reduction over control, respectively and were at par with each other. These results are comparable with the findings of Islam *et al*. (2019) [6], who reported effectiveness of Emamectin Benzoate 5 SG @ 1 ml/L and Spinosad 45 SC @ 0.4 ml/L and recorded fruit infestation 15.47 and 9.32 percent respectively on weight basis. Our findings are in line with Budhvat and Magar (2014) [3], who evaluated the performance of *T. chilonis* @ 5 cc eggs/ha and recorded 17.30 percent fruit infestation on weight basis. The results are consistent with the findings of Singh *et al*. (2019) [13], who reported that six and eight releases of *T. chilonis* @ 150,000/ha were most effective, with mean fruit damage of 11.59 and 9.90 percent on weight basis.

For the remaining treatments, the order of relative performance was (T_6) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l followed by Neem Oil 2 percent @ 20 ml/l followed by Karanj Oil 2 percent @ 20 ml/l > (T_3) Two release of *Trichogramma chilonis* @ 1.00 lakh/ha followed by spraying alternatively of Neem Oil 2 percent @ 20 ml/l and Karanj Oil 2 percent @ 20 ml/l > (T_5) Neem Oil 2 percent @ 20 ml/l followed by Karanj Oil 2 percent @ 20 ml/l which recorded 15.89, 17.19 and 18.91 percent fruit infestation and 45.23, 40.74 and 34.82 percent reduction over control respectively, on weight basis as compared to the maximum 29.01 percent fruit infestation in control. These results are in agreement with the findings of Mote and Bhavikatti (2003) [7], who observed performance of *T. chilonis* @ 60,000 eggs/ha and recorded 19.61 percent fruit damage with 37.26 percent reduction over control on weight basis. The results are in conformity with the findings of Tripura *et al*. (2017) [15], who recorded (14.49-10.77%) and (15.17-15.69%) fruit infestation on weight basis using Spinosad 45 SC (0.5 ml/l) and Neem Oil (5 ml/l) respectively. The work pertinent to Owen *et al*. (2023), who reported 17.07 and 25.60 percent fruit infestation on weight basis using Emamectin Benzoate (1.33 g/L) and Neem Oil (5% v/v) respectively. Similarly, Thakur *et al*. (2024) recorded 22.93 percent fruit infestation using Karanj oil (1%) on weight basis.

Table 1: Effect of various treatments against fruit infestation by Brinjal Shoot and Fruit Borer *Leucinodes orbonalis* in brinjal on weight basis

Tr. No.	Treatments	Fruit infestation (%) after different pickings at 10 days interval								Mean	Percent reduction over control
		I	II	III	IV	V	VI	VII	VIII		
T_1	Release of *Trichogramma chilonis* @ 1.00 lakh/ha	21.12 (27.35)	19.22 (26.00)	17.50 (24.73)	15.76 (23.39)	12.33 (20.56)	9.40 (17.85)	9.05 (17.50)	8.02 (16.45)	14.05 (22.01)	51.57
T_2	Two release of *Trichogramma chilonis* @ 1.00 lakh/ha followed by spraying alternatively of Emamectin Benzoate 5 SG @ 0.4 g/l and Spinosad 45 SC @ 0.5 ml/l	18.41 (25.40)	18.36 (25.37)	16.37 (23.86)	13.75 (21.77)	10.17 (18.60)	7.59 (15.99)	7.48 (15.87)	6.57 (14.85)	12.34 (20.57)	57.46
T_3	Two release of *Trichogramma chilonis* @ 1.00 lakh/ha followed by spraying alternatively of Neem Oil 2% @ 20 ml/l and Karanj Oil 2% @ 20 ml/l	23.32 (28.87)	23.41 (28.93)	22.87 (28.57)	18.39 (25.39)	15.17 (22.92)	12.40 (20.61)	12.02 (20.28)	9.91 (18.35)	17.19 (24.49)	40.74
T_4	Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l	19.34 (26.08)	19.18 (25.97)	16.78 (24.18)	14.90 (22.70)	11.19 (19.54)	8.15 (16.58)	8.14 (16.57)	7.43 (15.82)	13.14 (21.25)	54.71
T_5	Neem Oil 2% @ 20 ml/l followed by Karanj Oil 2% @ 20 ml/l	24.33 (29.55)	24.51 (29.67)	24.95 (29.97)	20.84 (27.16)	17.52 (24.74)	14.87 (22.68)	13.37 (21.45)	10.93 (19.30)	18.91 (25.78)	34.82
T_6	Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l followed by Neem Oil 2% @ 20 ml/l followed by Karanj Oil 2% @ 20 ml/l	22.09 (28.03)	22.10 (28.04)	19.84 (26.45)	16.87 (24.25)	13.51 (21.57)	11.51 (19.83)	11.62 (19.93)	9.51 (17.96)	15.89 (23.49)	45.23
T_7	Control (Water spray)	39.46 (38.91)	39.36 (38.85)	36.95 37.44)	31.21 (33.96)	26.05 (30.69)	20.59 (26.98)	20.57 (26.97)	17.87 (25.00)	29.01 (32.59)	-
	'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	-
	SE (m) ±	0.81	0.65	0.42	0.38	0.53	0.76	0.42	0.56	0.26	-
	C.D. (0.05)	2.50	1.99	1.28	1.17	1.65	2.35	1.30	1.71	0.82	-

(Figures in parenthesis are the arc sin transformations)

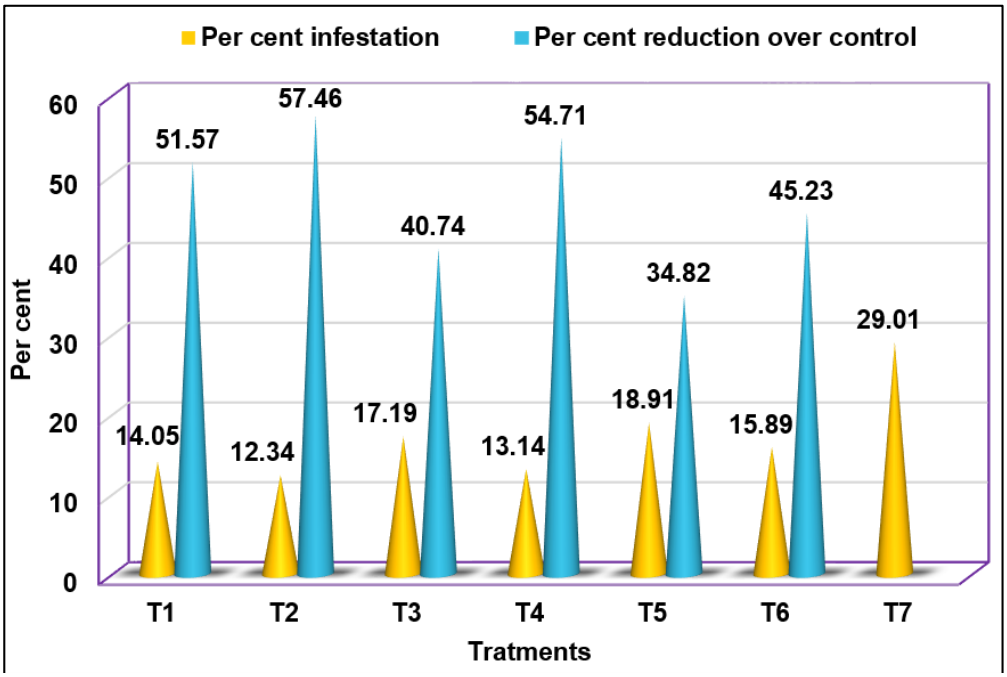

Fig 1: Effect of various treatments against fruit infestation by Brinjal Shoot and Fruit Borer *Leucinodes orbonalis* in brinjal on weight basis

Conclusion

On the basis of relative performance of *Trichogramma chilonis*, chemical insecticides and botanicals it can be concluded that, the treatments (T_2) Two release of *Trichogramma chilonis* followed by spraying alternatively of Emamectin Benzoate 5 SG @ 0.4 g/l and Spinosad 45 SC @ 0.5 ml/l and (T_4) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l were at par with each other and found most effective in minimizing the fruit infestation against brinjal shoot and fruit borer *Leucinodes orbonalis* on weight basis over the control. Hence, alternate application of *Trichogramma chilonis* and chemical insecticides such as Emamectin Benzoate 5 SG @ 0.4 g/l and Spinosad 45 SC @ 0.5 ml/l reduced the use of chemical insecticides by nearly 50 percent, indicating a promising substitute for indiscriminate use of chemical insecticides. However, treatments (T_4) Emamectin Benzoate 5 SG @ 0.4 g/l followed by Spinosad 45 SC @ 0.5 ml/l and (T_1) Release of *Trichogramma chilonis* @ 1.00 lakh/ha which were at par with each other. Thus, the release of *Trichogramma chilonis* proved a more cost-effective and environmentally sustainable approach, which is useful for reducing the residual effects of chemical insecticides on brinjal fruits.

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