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Cost benefit analysis and management of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guene) using bio-pesticides in Bundelkhand region, Uttar Pradesh

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Abstract

The field experiment was conducted to observe the Brinjal shoot and fruit borer (*Leucinodes orbonalis* Guene) Cost benefit analysis of different bio-pesticides use in Bundelkhand region at Organic Research Farm Kargua ji, Department of Entomology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (Uttar Pradesh) during *kharif* season of 2023. Result disclose that the all treatments were significantly superior over control. The economics effective bio-pesticides *Bacillus thuringiensis*. 2.0 kg/ha, followed by *Beauveria bassiana* 2.0 lit/ha, NSKE 5%, Neem oil 5%, *Metarizium anisoplae* 1.5 lit/ha, *Verticillium lecanii* 2.0 kg/ha. The highest effective treatment *Bacillus thuringiensis* (Bt.) highest net income was 98,350 Rs/ha⁻¹ with cost benefit ratio of 3.21 with yield 243.60 q/ha⁻¹. It can be concluded that maximum control of brinjal shoot and fruit borer, provided through the bio-pesticides followed by two sprays at recommended interval and doses of *Bacillus thuringiensis* (Bt.) 2.0 kg/ha. The brinjal shoot and fruit borer was recorded as major insect pest of brinjal crop. *Bacillus thuringiensis* was significantly superior over all the bio-pesticides in reducing the BSFB infestation, producing significantly higher yield. Resulting in more net profit and higher cost benefit ratio.

Keywords: Bio-pesticides, management, brinjal, yield, *Bacillus thuringiensis*

Introduction

Brinjal (*Solanum melongena* L.) is one of the most important vegetables in South Asia which accounts for almost fifty percent of the world's area under cultivation and also popular in some parts of Africa and Central America (Harish *et al.*, 2011) [3]. In 2023, India is estimated to have raised 12.61 million metric tons of brinjal from more than 760,000 hectares of agricultural land. This represented a minor decline from the previous year. India is the second-biggest producer of brinjal in the world, after China. The average yield of brinjal in India is 20–30 tons per hectare for a particular season and variety. Brinjal being a hardy crop, grows well in dry areas with limited irrigation and during the off-season. It's also a moderate source of vitamins and minerals. (NHB 2023). Unripe fruits are used primarily as vegetable in the country due to its nutritive value, as fruits are consisting of minerals like iron, phosphorous, calcium and vitamins like A, B and C, (Singh *et al.*, 1963) [7]. It has been reported as Ayurvedic medicine for curing te diabetes. In addition it is used as a good appetizer, good aphrodisiac, cardi tonic, laxative and reliever of inflammation. Brinjal plants are very much susceptible to insect pests attack right from seedling stage to final harvesting stage. Brinjal is attacked by 53 species of insect pests of which 8 are considered as major pests causing enormous damage to crop in every season in every year (Chakraborti and Sarkar, 2011) [1]. In brinjal cultivation, there are several constraints, which are responsible for reduction in yield amongst them, insect pests are one of the most important factor. It has been reported that this crop is damaged by one hundred forty (140) species of insect pests at different stages of the crop growth. Among the insect-pests infesting brinjal, the major ones are brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.), whitefly, *Bemisia tabaci* (Genn.), leafhopper, *Amrasca biguttula biguttula* (Ishida), *Epilachna* beetle, *Henosepilachna vigintioctopunctata* (Fab.) and red spider mite, *Tetranychus macfurlanei* (Baker and Pritchard) of these, *L. orbonalis* is considered the main constraint as it damages the crop throughout the year.

It is known to damage shoot and fruit of brinjal in all stages of its growth. The yield loss due to the insect-pests is to the extent of 70-92 percent (Eswara Reddy and Srinivas, 2004) [2]. The shoot and fruit borer, *Leucinodes orbonalis* Guenee is the most destructive pest of brinjal at both vegetative and reproductive stages of almost all regions of India causing significant reduction in the yield by 40-80 percent. After hatching, the young larvae bore into the petioles/growing shoots/flower buds/fruits and close the bore holes with frass, after entering in them. The larvae feed inside the midrib/flowers and in the pulp of fruit. The damaged shoots and flowers drop down. The large one or more round exit holes are visible on the fruits. Affected fruits get rotten from inside and such fruits lose their market value (Jyoti Raina and Yadhav, 2018) [4]. Brinjal contains potassium, an important mineral, which plays a key role in maintaining electrolyte balance in the body. Thus help in neutralizing the effects of sodium in the entire human body and thus aiding in blood pressure control. Brinjal shoot and fruit borer is regarded as one of the most destructive pest attacking brinjal at every stage of its development (Sangma CD, Simon S, 2019) [6]. The purpose of this experiment was to identify the best course of action of selected bio-pesticides application on the evident of recommended doses. Hence the study of evaluation of cost benefit analysis was planned, on brinjal (*Leucinodes orbonalis* Guenee). During *Kharif* season which will derive out a conclusion and certainly be helpful for progressive brinjal cultivation in Bundelkhand region. (Vishal Sarsaiya, 2020) [8]

Material and Methods

The present field experiment was conducted at Organic Research Farm Kargua ji, Department of Entomology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P) during *kharif* season of 2023. It is situated at 78° 36'47" E Longitude and 25° 27'2"N Latitude and is about 178.36 m above mean sea level. Transplanting of brinjal variety DEV- KIRAN (614) was done in well prepared experimental field in the first week of July, plots size 1.80 × 2.40 m² keeping row to row and plant to plant distance of 60 cm and 45 cm, respectively. The details of material used and methodology adopted during the present investigation are given below:

Net plot size - 1.8 × 2.40 m²

Gross plot size - 2 × 2.60 m²

Field size - 19 × 9.2 m²

Season - *Kharif* (2023)

Method of recording observation

Brinjal crop was monitored regularly for recording occurrence of shoot and fruit borer, *Leucinodes orbonalis* (Guenee), on five randomly selected plants per plot and thereby for management of pest on ETL basis. Pre-treatment observation was taken one day before treatment and post treatment observations were taken on 3rd, 7th and 14th days after each treatment. The incidence of shoot and fruit borer was recorded on regular basis to know the ETL. Spray of bio-pesticides was done when the shoot/fruit damage reached/ crossed 5% in any one of treatments. Percent shoot and fruit infestation was worked out by using following formula.

$$\text{Percent shoot Infestation (\%)} = \frac{\text{Number of infested shoots}}{\text{Number of total Shoot}} \times 100$$

$$\text{Percent fruit Infestation (\%)} = \frac{\text{Number of infested fruits}}{\text{Number of total fruits}} \times 100$$

The cost benefit ratio was determined for each treatment by using the following formula.

$$\text{Cost: benefit ratio} = \frac{\text{Value of saved yield over control (Rs/ha)}}{\text{Total cost of plant protection (Rs/ha)}}$$

Total cost of protection included cost of test materials and chemicals + labour charge + sprayer charge.

Results and Discussion

The data presented in table-01. All treatments were significantly superior over control. The data on the percent of infestation in the series of shoot infestation, the efficacy of treatments on first spray showed that the minimum shoot infestation mean was 7.47, 6.20, and 5.50 percent was recorded in *Bt.* @ 2 kg/ha treated plot at 3rd, 7th and 14th days after spraying respectively followed by *Beauveria bassiana* 2.0 kg/ha (8.37, 6.53 and 5.87) < NSKE 5% (8.53, 6.93 and 6.10) < Neem oil 5% (10.30, 7.50 and 6.80) < *Metarizium anisoplae* 10% (10.97, 9.30 and 8.57) < *Verticillium lecanii* 2.0 kg/ha (11.90, 10.53 and 9.77) < Castor oil 5% (12.13, 10.60 and 9.83) < Karanj oil 10% (14.87, 13.07 and 12.30) compared to control (16.83, 17.80 and 20.60), all the treatments were found effective and significantly superior over the control.

In the series of fruit infestation, the efficacy of treatments on second spray showed that the minimum fruit infestation after spray was recorded in *Bt.* 2 kg/ha treated plot i.e. 10.73, 6.27 and 4.87 percent fruit infestation followed by *Beauveria bassiana* 2.0 kg/ha (11.30, 7.37 and 5.77) < NSKE 5% (11.70, 8.23 and 6.13) < Neem oil 5% (13.37, 8.57 and 6.30) < *Metarizium anisoplae* 10% (14.20, 9.67 and 7.77) < *Verticillium lecanii* 2.0 kg/ha (14.47, 10.93 and 9.70) < Castor oil 5% (15.37, 12.87 and 11.60) < Karanj oil 10% (17.33, 14.87 and 13.53) compared to control (24.13, 24.53 and 25.67), all the treatments were found effective and significantly superior over the control at 3rd, 7th, and 14th days after spraying respectively.

In the series of fruit infestation, the efficacy of treatments on third spray showed that the minimum fruit infestation after spray was recorded in *Bt.* 2 kg/ha treated plot i.e. 8.43, 5.97 and 5.33 percent fruit infestation followed by *Beauveria bassiana* 2.0 kg/ha (9.03, 6.73 and 6.00) < NSKE 5% (9.43, 7.77 and 7.03) < Neem oil 5% (11.00, 8.53 and 7.70) < *Metarizium anisoplae* 10% (11.97, 8.70 and 7.77) < *Verticillium lecanii* 2.0 kg/ha (12.17, 9.40 and 8.27) < Castor oil 5% (13.00, 10.53 and 9.63) < Karanj oil 10% (14.90, 12.77 and 11.80) compared to control (27.19, 28.33 and 30.23), all the treatments were found effective and significantly superior over the control at 3rd, 7th, and 14th days after spraying respectively.

The data on yield amongst the treatment were significant as depicted in table - 02. The yields among the treatment were significant. The highest yield was recorded in T₄ *Bacillus thuringiensis* (243.60 q/ha) which followed by T₈ *Beauveria bassiana* (233.15 q/ha), T₇ NSKE (217.43 q/ha), T₁ Neem oil (207.40 q/ha), T₂ *Metarrhizium anisoplae*. (202.50 q/ha), T₃ *Verticillium lecanii* (192.30 q/ha), T₅ Castor oil (186.50 q/ha), and T₆ Karanj oil (173.65 q/ha) as compare to T₉ (110

q/ha). When cost benefit ratio was worked out, good result was achieved. Among the treatment studied, the best and most economical treatment was T₄ *Bacillus thuringiensis*

(1:3.21), followed by T₂ (1:3.12), T₇ (1:2.77), T₁ (1:2.77), T₈ (1:2.69), T₃ (1:2.59), T₅ (1:2.49), T₆ (1:2.29), as compared to control T₉ (1:1.06).

Table 1: Efficacy of bio- pesticides against brinjal shoot and fruit borer (*Leucinodes orbonalis*).

S. No	Treatment	Concentration Dose/a.i./ha (g/lit/kg)	Percent Shoot and Fruit damage								
			First spray			Second spray			Third spray		
			3 das	7 das	14 das	3 das	7 das	14 das	3 das	7 das	14 das
T ₁	Neem oil	5%	10.30	7.50	6.80	13.37	8.57	6.30	11.00	8.53	7.70
T ₂	<i>Metarhizium anisopliae</i>	10%	10.97	9.30	8.57	14.20	9.67	7.77	11.97	8.70	7.77
T ₃	<i>Verticillium lecanii</i>	2.0 kg/ha	11.90	10.53	9.77	14.47	10.93	9.70	12.17	9.40	8.27
T ₄	<i>Bacillus thuringiensis</i>	2.0 kg/ha	7.47	6.20	5.50	10.73	6.27	4.87	8.43	5.97	5.33
T ₅	Castor oil	5%	12.13	10.60	9.83	15.37	12.87	11.60	13.00	10.53	9.63
T ₆	Karanj oil	10%	14.87	13.07	12.30	17.33	14.87	13.53	14.90	12.77	11.80
T ₇	NSKE	5%	8.53	6.93	6.10	11.70	8.23	6.13	9.43	7.77	7.03
T ₈	<i>Beauveria bassiana</i> .	2.0 kg/ha	8.37	6.53	5.87	11.30	7.37	5.77	9.03	6.73	6.00
T ₉	Water control		16.83	17.80	20.60	24.13	24.53	25.67	27.19	28.33	30.23
CD			0.971	0.793	1.777	0.674	0.847	1.419	1.532	0.902	1.548
SE(m)			0.321	0.262	0.588	0.223	0.280	0.469	0.507	0.298	0.512

Significant at 5 percent level of significance

NSKE – Neem seed kernel extract

Table 2: Economics of treatments.

S. No.	Treatment	Yield q/ha	Total cost of yield	Treatment cost	Total cost	C:B ratio
T ₁	Neem oil	207.40	269620	4020	97120	2.77
T ₂	<i>Metarhizium anisopliae</i>	202.50	262600	3900	97000	2.70
T ₃	<i>Verticillium lecanii</i>	192.30	249990	3100	96200	2.59
T ₄	<i>Bacillus thuringiensis</i>	243.60	316680	5250	98350	3.21
T ₅	Castor oil	186.50	242450	4200	97300	2.49
T ₆	Karanj oil	173.65	225745	5400	98500	2.29
T ₇	NSKE	217.43	282659	8700	101800	2.77
T ₈	<i>Beauveria bassiana</i>	233.15	303095	4575	97675	3.10
T ₉	Water control	110	99000		93100	1.06

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Author Contributions

Shiv Shankar Kumawat: Investigation, formal analysis, writing—original draft, Prof. B. Gangwar and Dr. Pradeep Kumar Validation, methodology, writing—reviewing Formal analysis, and Investigation, Mukesh Haritwal and Ankit Yadav: writing—reviewing. and editing

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