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Bio Efficacy of Bio Pesticides against Spotted Pod Borer (*Maruca vitrata* Geyer) Infesting Black Gram

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study entitled "Bio-efficacy of bio-pesticides against spotted pod borer *(Maruca vitrata* Geyer) infesting black gram" at Organic Research Farm, Karguan Ji, Department of Entomology, Institute of Agricultural Sciences Bundelkhand University, Jhansi (U.P.) during *kharif* 2023 containing nine treatments *viz*, Neem oil 5%, Garlic bulb extract 5%, *Bacillus thuringiensis* 2.50 ml/l, *Verticillium lecanii* 5 ml/l, Panchagavya 10%, NSKE 5%, Castor oil 5%, *Beauveria bassiana* 5 ml/l and untreated control in RBD with three replications aiming to evaluate their efficacy of bio-pesticides

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against spotted pod borer. To evaluate the efficacy, two applications of treatments were carried out, and the spotted pod borer infestation on selected plants were evaluated after three, seven, and fourteen days after spraying. The outcomes showed that In the management of the spotted pod borer after the first and second spray, the *Beauveria bassiana* 5 ml/l (2.14) was superior and best effective in controlling larval population, followed by *Bacillus thuringiensis* 2.50 ml/l (2.34), and neem oil 5% (2.59), and the maximum yield 13.85 qt/ha and C: B ratio 1:1.71 was obtained from the *Beauveria bassiana* treated plot followed by *Bacillus thuringiensis* and neem oil by that obtained 12.89 qt/ha and 12.55 qt/ha yield, moreover 1:1.64 and 1:1.52 C: B ratio respectively.

Keywords: Spotted pod borer (Maruca vitrata Geyer); Beauveria bassiana; Bacillus thuringiensis; neem oil and black gram.

1. INTRODUCTION

Black gram is scientifically referred to as *Vigna mungo* L. Hepper and it belongs to the family Fabaceae, subfamily Papilionaceae. In India, black gram is commonly called as urd bean, mash Kalai, matimah, etc. Black gram is India's fourth most important short-duration pulse crop due to its nutrition and commercial values [1]. Black gram is a wealthy supply source of carbohydrates (63.4 g), protein (24 g), fiber (16.2%), fat (1.6 g) and energy (347 Kcal) [2]. The black gram crop production in India was 278 million tonnes from an area of 463 million hectares, with a productivity of 600 kg/ha. The black gram crop accounts for 11 per cent of India's total pulses production (25.46 million tons in 2020-21) [3]. At different stages of growth of black gram and under different Agro-climatic conditions, more than 200 insects from 48 families of the orders Lepidoptera, Coleoptera, Thysanoptera, Diptera, Hemiptera, Hymenoptera, Isoptera, and Orthoptera, as well as 7 species of mites from the order Acarina, have been reported to cause severe damage [4], of which spotted pod borer is the most important pest causing huge yield loss.

This legume and spotted pod borer are scientifically called *Maruca vitrata* Fabricius, although it is also called *Maruca testulalis* Geyer. It is a member of the Crambidae family and order Lepidoptera which is officially classified as Pyralidae [5]. Spotted pod borer is a serious pest of grain legumes in tropical and subtropical regions due to its wide host range, distribution, and destructiveness. In India, the spotted pod borer, *Maruca vitrata* (Geyer), is estimated to be responsible for yield losses of about 30 million dollars per year [6]. Spotted pod borer in Black gram causes an economic loss of 20-25% and yield loss of 2-84% [7]. Infestation by *Maruca vitrata* larvae begins at the vegetative stage of black gram, where the young larvae (first, second, & third instar) create webs in the growing points of the tender leaves and feed on the chlorophyll content and make small holes and subsequently older larvae (fourth & fifth instar) migrate to the inflorescence, pod and web the floral parts, pod and feed on them due to which the flower buds fail to bloom and fall from the inflorescence. It attacks the crops from the pre-flowering stage to the pod ripening stage. Farmers use various types of pesticides according to their experience and financial situation. Despite the high cost of chemical pesticides and other disadvantages, the indiscriminate use of these substances has caused many harmful side effects, affecting beneficial organisms such as parasites, predators, and pollinators [8]. Botanical and bio-pesticides, which are naturally occurring and often slow-acting, serve as crop protectants and secondary metabolites (phytochemicals) that can control and destroy without environmental side effects [9,10]. Therefore, the present study was conducted to evaluate some bio-pesticides for effective management of spotted pod borer on the black gram [11,8,4,12].

2. METHODS AND MATERIALS

A field experiment was conducted to evaluate the relative efficacy of different bio-pesticides against spotted pod borer on black gram at Organic Research Farm, Karguan Ji, Bundelkhand University Jhansi (U.P.) during the *Kharif* season of 2023. The black gram variety, PU-35 were sown in the plots of 1.8 × 2.10 m^2 with a spacing of 30 × 10 cm^2 in a Randomized Block Design (RBD) with 9 treatments, in 3 replications. Eight eco-friendly treatments were used in the experiment *Viz*., Neem oil @ 5%, Garlic bulb extract @ 5%, *Bacillus thuringiensis* var. kurstaki (5×10^8) CFU @ 2.50 ml/lit, *Verticillium lecanii* (2×10^8) CFU @ 5 ml/lit, Panchagavya @ 10%, NSKE @ 5%, Castor oil @ 5%, *Beauvaria*

bassiana (1×10^8) CFU @ 5 ml/lit and water control.

C: B = Gross return (production) / Cost of treatment (Total expenditure)

3. OBSERVATION

After sowing, five randomly selected plants were observed with the number of larvae per plant at weekly intervals starting from seven days after sowing (DAS). Two applications of treatment were done in the total crop period according to the economic threshold level (ETL) of 3 larvae/plant of the spotted pod borer. To assess bore holes in buds, flowers, and pods, five randomly tagged plants per plot were examined for infested parts with webbed shoots and pod damage caused by the larvae of the spotted pod borer. The larval population of *Maruca vitrata* was observed one day prior and at three, seven, and fourteen days after each spray application on five randomly selected plants in each plot.

4. RESULTS AND DISCUSSION

4.1 First Spray

The result of the decrease in spotted pod borer larval population three, seven, and fourteen days following the first spray showed that all treatments are considerably better than control. Among all the treatments the overall mean of the lowest larval population of spotted pod borer was noticed in the plot treated with *Beauveria bassiana* 5 ml/l (3.91), followed by *Bacillus thringiensis* var. kurstaki 2.50 ml/l (4.06), Neem oil 5% (4.30), *Verticillium lecanii* 5 ml/l (4.41), NSKE 5% (4.55), Castor oil 5% (4.72), Panchagavya 10% (4.94), and least effective treatment were Garlic bulb extract 5% (5.01) as compared to untreated plots (5.81).

4.2 Second Spray

The data on the number of larval populations of *Maruca vitrata* after the second spray revealed that all the treatments were significant. Among all the treatments, the lowest larval population of the spotted pod borer was recorded in *Beauveria bassiana* 5 ml/l the overall mean obtained in the second spray was (2.14), which was in line with Patil et al. [13] and Vineetha et al. [14], were found significantly superior among all the treatments. *Bacillus thuringiensis* var. kurstaki 2.50 ml/l (2.34) according to Vineetha et al. [14] was the next best treatment for reducing the larval population of the spotted pod borer. It was followed by Neem oil 5% (2.59), which was found to be the next best treatment which is in line with the findings of Kudililla, and Tayde [15] (4.15). *Verticillium lecanii* 5 ml/l (2.73) was effective in controlling *Maruca vitrata*. NSKE 5% was found to be the next most effective treatment, resulting in a minimum larval population (3.76) this finding is supported by Berani et al. [8] and Krishna et al. [11]. Castor oil 5% (3.26) and Panchagavya 10% (3.51) were found to be the most effective treatments against *Maruca vitrata*, while Garlic bulb extract 5% (3.74) was the least effective, compared to the water control (6.27).

Table 1. Bio-efficacy of different Bio-pesticides against spotted pod borer, *Maruca vitrata* in black gram

S. No.	Treatment	Doses	Number of larval population per 5 plants				
			First spray				
			Before	3 DAS	7 DAS	14 DAS	Over all mean
T_1	Neem oil	5 %	5.31	4.91	4.39	3.61	4.30
T_2	Garlic bulb extract	5 %	5.28	5.23	5.13	4.64	5.01
T_3	*Bacillus thuringiensis* var. kurstaki	2.50 ml/l	5.15	4.82	4.10	3.27	4.06
T_4	*Verticillium lecanii*	5 ml/l	5.32	5.00	4.51	3.73	4.41
T_5	Panchagavya	10 %	5.44	5.33	4.99	4.47	4.94
T_6	NSKE	5 %	5.33	5.11	4.63	3.92	4.55
T_7	Castor oil	5 %	5.25	5.21	4.74	4.23	4.72
T_8	*Beauveria bassiana*	5 ml/l	5.31	4.70	3.87	3.17	3.91
T_9	Water control	----------	5.10	5.60	5.72	6.12	5.81
	C.D. at 0.05%		N/A	N/A	0.52	0.54	0.56
	SE(m)		0.25	0.19	0.17	0.17	0.18
	SE(d)		0.36	0.28	0.24	0.25	0.26
	C.V.		8.37	6.76	6.43	7.51	7.02

**OPSTAT*

Table 2. Bio-efficacy of different Bio-pesticides against spotted pod borer, *Maruca vitrata* in black gram

S. No.	Treatment	Doses	Number of larval population per 5 plants				
			Second spray				
			Before	3 DAS	7 DAS	14 DAS	Over all mean
T_1	Neem oil	5 %	4.31	3.73	2.62	1.44	2.59
T_2	Garlic bulb extract	5 %	5.04	4.71	3.50	3.09	3.74
T_3	*Bacillus thuringiensis* var. kurstaki	2.50 ml/l	3.82	3.37	2.48	1.15	2.34
T_4	*Verticillium lecanii*	5 ml/l	3.73	3.91	2.75	1.54	2.73
T_5	Panchagavya	10 %	4.47	4.54	3.28	2.72	3.51
T_6	NSKE	5 %	3.92	4.03	3.10	1.82	2.98
T_7	Castor oil	5 %	4.23	4.30	3.27	2.24	3.26
T_8	*Beauveria bassiana*	5 ml/l	3.17	3.27	2.18	0.99	2.14
T_9	Water control	----------	6.12	6.45	6.48	7.25	6.72
	C.D. at 0.05%		0.62	0.47	0.53	0.43	0.90
	SE(m)		0.20	0.15	0.17	0.14	0.29
	SE(d)		0.29	0.22	0.24	0.20	0.42
	C.V.		8.30	6.38	9.20	10.10	15.49

**OPSTAT*

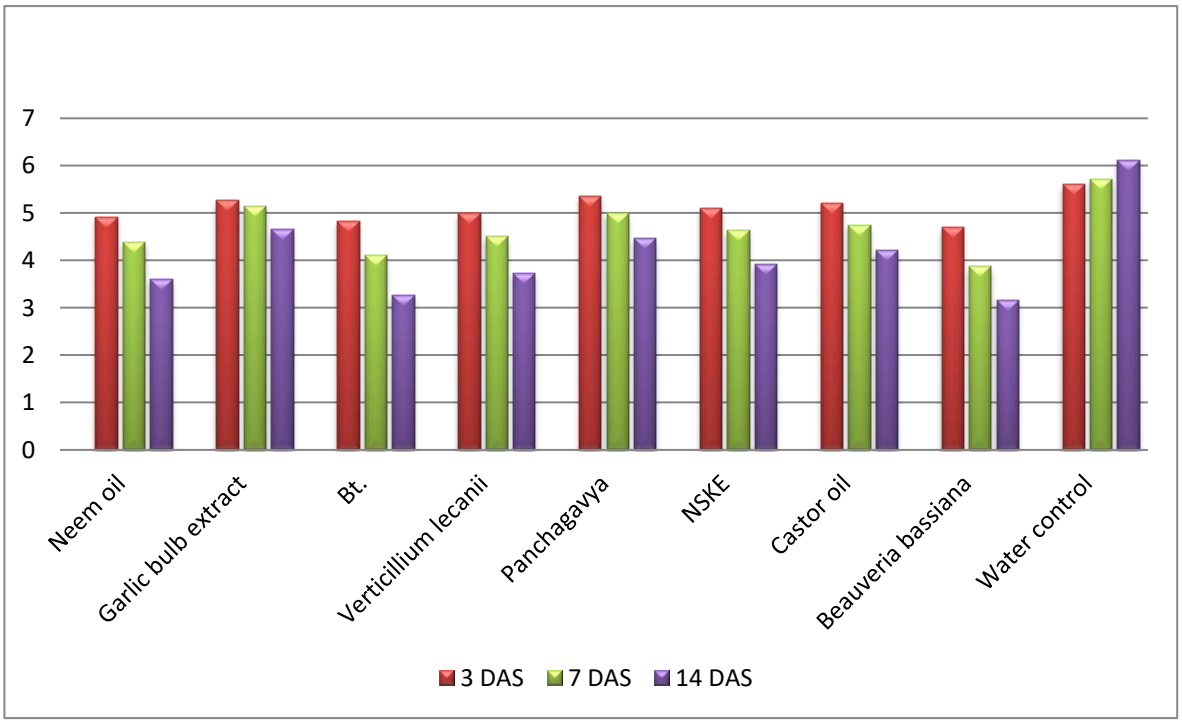

Fig. 1. Effect of bio-pesticides against the mean larval population of *Maruca vitrata* (Geyer) in black gram after the first spray of treatment

4.3 Cost-benefit Ratio and Yield

The yields among the different treatments were significant. The highest yield and C: B ratio of black gram was recorded in *Beauveria bassiana* 5 ml/l (13.85 q/ha), (1:1.71), followed by *Bacillus thuringiensis* var. kurstaki 2.50 ml/l (12.89 q/ha), (1:1.64), Neem oil @ 5 % (12.55 q/ha), (1:1.52), *Verticillium lecanii* 5 ml/l (12.05 q/ha), (1:1.57), NSKE 5 % (11.55 q/ha), (1:1.13), Castor oil 5 % (11.00 q/ha), (1:1.18), Panchagavya 10 % (9.54 q/ha), (1:1.02), Garlic bulb extract 5 % (7.30 q/ha), (1:0.57), as compared to untreated plots (5.49 q/ha), (1:0.18).

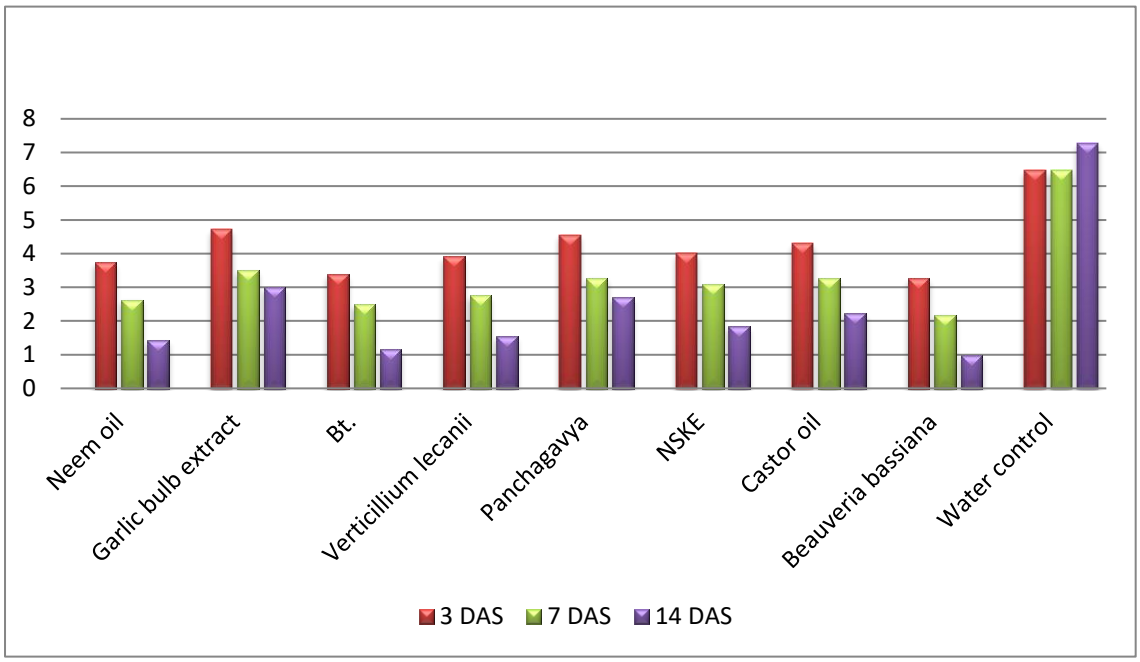

Fig. 2. Effect of bio-pesticides against the mean larval population of *Maruca vitrata* (Geyer) in black gram after the second spray of treatment

Table 3. Impact of different bio-pesticides on seed yield of black gram and C: B ratio

S. No.	Treatments	Dose	Yield (q/ha)	C: B Ratio
T_1	Neem oil	5 %	12.55	1:1.52
T_2	Garlic bulb extract	5 %	7.30	1:0.57
T_3	*Bacillus thuringiensis* var. kurstaki	2.50 ml/l	12.89	1:1.64
T_4	*Verticillium lecanii*	5 ml/l	12.05	1:1.57
T_5	Panchgavya	10 %	9.54	1:1.02
T_6	NSKE	5 %	11.55	1:1.13
T_7	Castor oil	5 %	11.00	1:1.18
T_8	*Beauveria bassiana*	5 ml/l	13.85	1:1.71
T_9	Water control	---------	5.40	1:0.18

5. CONCLUSION

The experimental result concluded that among different eco-friendly bio-pesticides and botanicals evaluated against *Maruca vitrata*, *Beauveria bassiana* 5 ml/l, *Bacillus thuringiensis* 2.50 ml/l, and Neem oil 5% were found effective treatments in preventing spotted pod borer infestation as well as controlling a smaller number of spotted pod borer larvae.

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DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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