

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(9): 312-314
www.biochemjournal.com
Received: 05-06-2024
Accepted: 11-07-2024

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Efficacy and economics of bio-pesticides against gram pod borer, *Helicoverpa armigera* (Hubner) on green gram under field condition

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DOI: <https://doi.org/10.33545/26174693.2024.v8.i9Sd.2117>

Abstract

The present investigation was conducted at the Central Research Farm Department of Entomology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj during the Kharif season of 2023. The experiment was conducted in Randomized Block Design (RBD) by using seven treatments viz., T₁ Neem oil 5% (0.4 ml/lit), T₂ Indoxacarb 14.5 SC (0.65 ml/lit), T₃ *Bacillus thuringiensis* (4%WSP), T₄ *Beauveria bassiana* (1.15%WP) (1 ml/lit), T₅ *Metarhizium anisopliae* (2 ml/lit), T₆ Spinosad (0.4g/lit), T₇ Chlorantraniliprole 18.5 SC (0.3 ml/lit) and untreated control T₀ are the treatments used in this experiment. Among the botanicals and insecticides evaluated, Chlorantraniliprole 18.5 SC (0.3 ml/lit) recorded low infestation of pod borer population i.e. (1.79) which was significantly superior over control followed by Indoxacarb 14.5 SC (2.02), Spinosad (2.23), Neem oil 5% (2.41), *Bacillus thuringiensis* (4%WSP) SC (2.61), *Beauveria bassiana* (1.15%WP) (1.86) and *Metarhizium anisopliae* (1.15%WP) (2.99) was least effective among all the treatments. Among the treatment studied the best and most economical treatment was T₇ Chlorantraniliprole 18.5SC (1:2.8) followed by T₂ Indoxacarb 14.5 SC (1:2.6), T₆ Spinosad (1:2.0), T₁ Neem oil 5% (1:1.6), T₃ *Bacillus thuringiensis* (4%WSP) (1:1.4), T₄ *Beauveria bassiana* (1:1.5), T₅ *Metarhizium anisopliae* (1:0.8) as compared to control T₀ (1:0.7).

Keywords: Bio-pesticides, B: C ratio, chemicals, efficacy, indoxacarb

Introduction

Pulses establish an excellent integrant of Indian agriculture as they are the paramount source of protein in predominantly vegetarian diet. They form almost an essential component of Indian diet as *dal-roti* denoting complete and satisfying food. Mung bean (*Vigna radiata*) is a plant species of Fabaceae which is also known as green gram. It is sometimes confused with black gram (*Vigna mungo*) for their similar morphology, though they are two different species. The green gram is an annual vine with yellow flowers and fuzzy brown pods. There are three subgroups of *Vigna radiata*, including one cultivated (*Vigna radiata* subsp. *radiata*) and two wild ones (*Vigna radiata* subsp. *sublobata* and *Vigna radiata* subsp. *glabra*). It has a height of about 15-125 cm. Mung bean has a well-developed root system. The lateral roots are many and slender, with root nodules grown. Stems are much branched, sometimes twining at the tips. Young stems are purple or green, and mature stems are greyish yellow or brown. Ambule *et al.* (2015) [2].

Mung beans are recognized for their high nutritive value. Mung beans contain about 55%-65% carbohydrate and are rich in protein, fat, vitamins and minerals. It is composed of about 20% to 50% protein of total dry weight, among which globulin (60%) and albumin (25%) are the primary storage proteins. Mung bean is considered to be a substantive source of dietary proteins. The proteolytic cleavage of these proteins are even higher during sprouting. Mung bean carbohydrates are easily digestible, which causes less flatulence in human compared to other forms of legumes. Both seeds and sprouts of mung bean produce lower calories compared to other cereals, which makes it more attractive to obese and diabetic individuals (Ali 2005) [1].

Helicoverpa armigera is a cosmopolitan and widely distributed insect pest in world. It is a serious pest of all the legumes. In India, it has been observed to feed on 181 cultivated and uncultivated species belonging to 45 families. *H. armigera* is found in the Palearctic,

Oriental, Ethiopian and Australian provinces, south of a line at approximately 52°N. This range occupied by the species includes tropical, dry and temperate climates. The currently reported global distribution of *H. armigera* suggests that the pest may be most closely associated with deserts and xeric shrub lands; Mediterranean scrub; temperate broadleaf and mixed forests and subtropical grasslands, savannas, and shrub lands; and tropical and subtropical moist broadleaf forest. Choudhary *et al.* (2017) [4].

Gram pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is the most important pest of chickpea. It is the major pest of gram. The pest starts its attack at early stage and become severe during maturity stage of the crop. The pest accounts for 90- 95% of total damage. A single larva of *H. armigera* can damage 25-30 pods of gram in its life time.

Infestation of this pest was found on 8-26% of plants and the number of larvae on infested plants varied from 1-4 (average 2.6) per plant. The extent of damage caused by *H. armigera* to chickpea depends on number of larval pests per plant and on its developmental stages.

Materials and Methods

The experiment was carried out at the Central Research Farm of Sam Higginbottom University of Agriculture, Technology, and Sciences in Prayagraj. The research field is located on the right side of Rewa Road at 25°27' North Latitude and 80°51' East Longitude, approximately 98m above mean sea level. Prayagraj has a typical subtropical climate, as does the eastern region of Uttar Pradesh. Summer and winter weather extremes can be found here. Summer maximum temperatures reached 49 °C, while winter minimums were 2.5 °C. The research trail was laid out in *rabi* 2023-2024 using a Randomised Block Design (RBD), with eight distinct treatments replicated three times. The plot measured 2 x 1 square meters. Green gram seeds of variety 'Samrat variety' were sown in plots with a row to row and plant to plant distance of 30 x 10 cm.

The treatments employed in the experiment were T₁ Neem oil 5% (0.4 ml/lit), T₂ Indoxacarb 14.5 SC (0.65 ml/lit), T₃ *Bacillus thuringiensis* (4%WSP), T₄ *Beauveria bassiana* (1.15% WP) 5% (1 ml/lit), T₅ *Metarhizium anisopliae* (1.15%WP) (2 ml/lit), T₆ Spinosad (0.4g/lit), T₇ Chlorantraniliprole 18.5 SC (0.3 ml/lit) and untreated control T₀. During the experiment, two sprays were performed at 15- day intervals to evaluate pesticide efficacy when the *Helicoverpa armigera* larval population reached the ETL threshold.

The insect population was counted from randomly selected plants in each plot, and the population per five plants was calculated. The mean of three replications was obtained for each treatment and compared to the untreated plot. The population of *Helicoverpa armigera* was counted before and after one day of spraying, as well as on the third, seventh-, and fourteenth-days following insecticide application. Healthy cobs were harvested, and their weight from each treatment was converted into marketable output in quintals per hectare. Finally, the cost benefit ratio was estimated using the current market prices of yield, pesticides, and spraying costs (Charitha and Kumar (2023) [3].

Charitha and Kumar (2023) [3].

Results and Discussion

The results (Table 1) after the first and second sprays demonstrated that all treatments were significantly superior to the control. The data on the mean larvae population of Chickpea podborer *Helicoverpa armigera* 3rd, 7th, and 14th day after the first spray revealed that all of the chemical treatments were considerably superior to the control. Among all the treatments lowest larval population of *Helicoverpa armigera* was recorded in Chlorantraniliprole 18.5SC (2.22) followed by Indoxacarb 45%SC (2.42), Spinosad (2.66), Neem oil 2% (2.86), *Bacillus thuringiensis* (4%WSP) (3.10), *Beauveria bassiana* (1.15% WP) (3.40) and *Metarhizium anisopliae* (1.15% WP) (3.53) was control (7.56).

The data on the mean larval population of Chickpea pod borer *Helicoverpa armigera* 3rd, 7th, and 14th days after the second spray showed that all treatments outperformed the control. Among all treatments, the lowest larval population of *Helicoverpa armigera* was reported in Chlorantraniliprole 18.5 SC (1.36) followed by Indoxacarb 45%SC (1.63), Spinosad (1.80), Neem oil 2% (1.96), *Bacillus thuringiensis* (4%WSP) (2.13), *Beauveria bassiana* (1.15% WP) (2.26) and *Metarhizium anisopliae* (1.15% WP) (2.46) and control (8.00).

The highest yield and cost benefit ratio was recorded in Chlorantraniliprole 18.5% SC (22.00 q/ha) and (1:2.8) followed by Indoxacarb 45%SC (18.80 q/ha and 1:2.6), Spinosad (15.50/ha and 1:2.0), Neem oil 2% (14.35 q/ha and 1:2.6), *Bacillus thuringiensis* (13.32 q/ha and 1:1.4), *Beauveria bassiana* (12.24 q/ha and 1:1.5), *Metarhizium anisopliae* (11.00 and 1:0.8) and control (8.56 q/ha and 1:0.07).

The data on the mean larval population in the first and second spray in Chlorantraniliprole 18.5 SC, the results were similar to be findings reported by Nitharwal *et al.* (2017) [10], Sushma *et al.* (2016) [15], Roopa and Kumar (2014) [13]. Indoxacarb 45% SC found to be next best. The results of Spinosad were supported by Pal *et al.* (2018) [12], Singh *et al.* (2017) [14] and Gautam *et al.* (2018) [7]. Neem oil 2% found to be next best effective treatment. These results were similar finding of Khademul *et al.* (2020) [9], Kumar and Sarda (2018). *Bacillus thuringiensis* (4%WSP) found to be next effective treatment and its results are supported by Jat *et al.* (2013) and Deshmukh *et al.* (2010) [5]. *Beauveria bassiana* are found to be effective treatments and the results were similar to findings reported by Ghosal *et al.* (2016) [6], Satish *et al.* (2018) [14] and Choudhary *et al.*, (2017) [4]. *Metarhizium anisopliae* found to be effective in reducing the larval population and the results were supported by Ojha *et al.* (2017) [11].

The cost benefit Higher yield (22.00 q/ha) and higher cost benefit ratio (1:2.8) was obtained from Chlorantraniliprole 18.5 Sc and lowest in control plot (100 q/ha). Similar findings made by Nitharwal *et al.* (2017) [10], recorded the highest cost benefit ratio. Pal *et al.* (2018) [12] who reported that the Indoxacarb 45%SC is the best and most economical treatment recorded (18.80 q/ha) and cost benefit ratio (1:2.6). Khademul *et al.* (2020) [9] reported cost highest grain yield was recorded in Spinosad and cost effectiveness of Spinosad was also very high and very favorable with incremental benefit ratio. Kumar and Sarada (2015) reported that cost effectiveness of Azadirachtin was high with cost benefit ratio. Recorded yield (14.35 q/ha) and cost benefit ratio (1:2.6).

$$\text{C: B Ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

Table 1: Efficacy of selected insecticides on the larval population of *Helicoverpa armigera* on chickpea after the 1st and 2nd spray:

S. No.	Treatments	Number of larval Population per 5 plants											Pooled mean	Yield (q/ha)	C: B Ratio
		Dosage	First spray					Second spray							
			1DBS	3DAS	7DAS	14DAS	MEAN	1DBA	3DAS	7DAS	14DAS	Mean			
T ₁	Neem oil 5%	5 ml/l	5.0	3.26	2.40	3.00	2.86	3.00	2.73	1.53	1.73	1.96	2.41	14.35	1:1.6
T ₂	Indoxacarb 14.5 SC	0.5 ml/l	5.4	3.00	1.93	2.66	2.42	2.66	2.26	1.26	1.53	1.63	2.02	18.80	1:2.6
T ₃	<i>Bacillus thuringiensis</i> 4%WSP	1.0 kg/ha	4.87	3.53	2.66	3.26	3.10	3.26	2.96	1.66	1.93	2.13	2.61	13.32	1:1.4
T ₄	<i>Beauveria bassiana</i> 1.15%WP	2.0 kg/ha	4.40	3.80	2.80	3.60	3.40	3.60	3.06	1.60	2.06	2.26	1.86	12.24	1:1.5
T ₅	<i>Metarhizium anisopliae</i> 1.15%WP	1 ml/l	4.0	3.93	2.93	3.66	3.53	3.66	3.26	1.86	2.40	2.46	2.99	11.00	1:0.8
T ₆	Spinosad 45% SC	0.5 ml/l	5.00	3.13	2.20	2.73	2.66	2.73	2.46	1.40	1.60	1.80	2.23	15.50	1:2.0
T ₇	Chlorantraniliprole 18.5 SC	1 ml/l	5.73	2.73	1.86	2.20	2.22	2.20	2.13	0.93	1.06	1.36	1.79	22.00	1:2.8
T ₈	Control	-	6.20	7.13	6.93	8.46	7.56	8.46	7.93	8.33	7.86	8.00	7.78	8.56	1:0.7
	F-test		NS	NS	S	S	S	S	S	S	S	S	S		
	S. ED (±)		1.469	0.76	0.93	0.81	0.51	0.81	0.93	0.40	0.65	0.53			
	C.D. (P = 0.5)		0.685	6.939	5.31	6.75	3.54	6.75	6.939	5.31	6.753	3.54			

Conclusion

From the critical analysis of the present findings, it can be concluded that, among all the treatments Chlorantraniliprole 18.5 SC is more effective in controlling larval population of *Helicoverpa armigera* followed by Indoxacarb 45% SC, Spinosad, Neem oil 2%, *Bacillus thuringiensis* (4%WSP), *Beauveria bassiana* (1.15% WP) and *Metarhizium anisopliae* (1.15% WP). Among the treatments studied, Chlorantraniliprole 18.5% SC (22.00 q/ha) and (1:2.8) followed by Indoxacarb 45%SC (18.80 q/ha and 1:2.6), Spinosad (15.50/ha and 1:2.0), Neem oil 2% (14.35 q/ha and 1:2.6), *Bacillus thuringiensis* (13.32 q/ha and 1:1.4), *Beauveria bassiana* (12.24 q/ha and 1:1.5), *Metarhizium anisopliae* (11.00 and 1:0.8) and control (8.56 q/ha and 1:0.07) respectively as such more trails are required in future to validate the finding.

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