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Comparative Efficacy of some Microbial Biopesticides against Gram Pod Borer, *Helicoverpa armigera* (Hubner), in Chickpea, *Cicer arietinum* (L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted at the research plot of the Department of Agricultural Entomology at the Central Research Field, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, India, during the *Rabi* season of 2022. The treatments selected for this experiment were Emamectin benzoate, *Beauveria bassiana*, Spinosad, *Heterorhabditis indica*, *Metarhizium anisopliae*, *HaNPV*, *Bacillus thuringiensis* and control to observe the efficacy of the treatments and the cost benefit ratio. The treatments were sprayed for two times to control the pod borers having crossed their ETL levels at an interval of 15 days. Observations i.e. the larval counts (5 random

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plants/plot) were taken in an order of day before spray, 3rd, 7th and 14th days after spray. The results revealed that the treatments were successful in bringing down the pest infestation and superior over control. Among all the treatments applied, lowest larval population of gram pod borer was observed in Spinosad 45 SC (1.09) showing a highest yield of 23.79 q/ha against the control yielding only upto 9.03 q/ha. At the same time, the benefit cost ratios of the treatments stands like Spinosad 45% SC (1:2.81) followed by Emamectin benzoate 5% SG (1:2.74), *HaNPV* 2x10^9 (POB's/ml) (1:2.56), *Beauveria bassiana* 1x10^8 (CFU/gram) (1:1.74), *Bacillus thuringiensis* 1x10^8 (CFU/ml) (1:1.54), *Metarhizium anisopliae* 1x10^8 (CFU/gram) (1:1.37), *Heterorhabditis indica* 5.0x10^9 IJ (1:1.30) as compared to control (1:0.69).

Keywords: Microbial biopesticides; efficacy; Helicoverpa armigera; chickpea.

1. INTRODUCTION

Chickpea [*Cicer arietinum* (L.)], also known as Chana, Bengal gram, or Gram, is a significant pulse crop grown in a lot of countries throughout the world and accounts for 20% of the world's supply of legumes. It is a member of the Leguminaceae family. South Western Asia is where the chickpea, known as the "King of Pulses," originated. The plant typically develops to a height of 20 to 50 cm during the *Rabi* season and has small, feathery leaves on either side of the stem [1]. It is typically grown under rainfed or residual soil moisture conditions. In addition to being a feed, chickpeas are utilized for human consumption. Its seed is used as a green vegetable, in dishes that are fried or roasted, as snacks, and in the production of flour and dhal [2].

With a total production of 162.25 lakh tonnes and an average productivity of 1252 kg/ha, it was cultivated on 149.66 lakh hectares of land worldwide [3]. In all regions of India, chickpea is primarily grown as a rainfed crop (68% of the total area) [4]. Chickpeas were grown in 2016–17 over an area of 99.27 lakh ha, producing 98.80 lakh tonnes at a productivity of 995 kg/ha. About 11.23 million tonnes of chickpeas were produced in 2017–18, accounting for 46% of India's total pulse production (23.95 mt) [5].

Chickpeas have a nutritional value (per 100 g) of 27.42 g of carbohydrates, 8.86 g of protein, 2.59 g of total fat, 7.6 g of dietary fibre, 172 µg of folates, 0.526 mg of niacin, 0.245 mg of pantothenic acid, 0.216 mg of pyridoxine, 0.063 mg of riboflavin, 0.200 mg of thiamine, 1.3 mg of vitamin C, 27 IU of vitamin A, 0.35 mg of vitamin E, 4.0 mcg of vitamin K, 7.0 mg of sodium, 291 mg of potassium, 49 mg of calcium, 2.89 mg of iron, 48 mg of magnesium, 168 mg of phosphorous, 1.53 mg of zinc [6].

From the time the crop is a seedling until it is fully grown, many different kinds of insects and pests attack it. *H. armigera*, *Spodoptera litura*, *Agrotis ipsilon*, *Plusia orichalchea*, and *Bemisia tabaci* are the main insect pests that target chickpea crops in the winter and summer [7]. A polyphagous insect of the Noctuidae family and Order-Lepidoptera, named gram pod borer. Its other names are cotton bollworm, corn earworm, tomato fruit borer, and false budworm. It targets more than 180 domesticated species, including those of cereals, legumes, fruits, vegetables, forage, and wild species. *H. armigera* has been found in 181 plant species across 45 families in India [8]. This pest attacks chickpea plants at every stage, from seedling to crop maturity, and its larvae may eat leaves, fragile twigs, flowers, and pods to survive. After the pods have formed, the larvae burrow into them, eat on the seeds within and significantly reduce seed production. Its caterpillars consume the developing seeds by creating holes in the young pods and placing half of their bodies inside the pod. Pod borer damage has the potential to lower chickpea yield by 20–30% [9].

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi* season 2022-23 at Central research field (CRF), SHUATS, Uttar Pradesh, India, in a Randomized Block Design (CRBD) with eight treatments replicated three times using PUSA-362 variety in a plot size of (2 m×1 m) at a spacing of (30×10 cm). Seven treatments of microbial biopesticides were evaluated against, *H. armigera* i.e., Emamectin benzoate 5SG, *B. bassiana* 1 x 10^8 (CFU/gram), Spinosad 45SC, *H. indica* 5.0 x 10^9 IJ, *M. anisopliae* 1 x 10^8 (CFU/gram), *HaNPV* 2 x 10^9 (POB's/ml), *B. thuringiensis* 1 x 10^8 (CFU/ml). The population of gram pod borer was recorded one day before spraying and after three, 7, 14 days post insecticidal application.

Table 1. Comparative effect and economics of different microbial biopesticides against gram pod borer, *Helicoverpa armigera* (Hubner) on chickpea, *Cicer arietinum* (L.) during *Rabi* season of 2022-23

S.No	Treatments	Larval population/ 5 plants										Yield (q/ha)	C: B Ratio
		First spray					Second spray						
		1DBS	3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean	Overall Mean		
T_1	**Emamectin benzoate 5SG**	3.13	2.13	1.13	1.66	1.64	1.40	0,80	1.06	1.08	1.36	20.67	1: 2.74
T_2	***Beauveria bassiana* 1×10^8 (CFU/gram)**	3.40	2.66	1.60	2.20	2.15	1.93	1.20	1.55	1.55	1.85	15.24	1: 1.74
T_3	**Spinosad 45SC**	3.20	1.73	0.86	1.40	1.33	1.13	0.60	0.86	0.86	1.09	23.79	1: 2.81
T_4	***Heterorhabditis indica* 5.0×10^9 IJ**	3.80	3.00	2.00	2.53	2.51	2.26	1.53	1.86	1.88	2.19	12.89	1: 1.30
T_5	***Metarhizium anisopliae* 1×10^8 (CFU/gram)**	3.66	2.80	1.86	2.46	2.37	2.13	1.40	1.73	1.75	2.06	13.36	1: 1.37
T_6	***HaNPV* 2×10^9 (POB's/ml)**	3.00	2.20	1.40	1.80	1.80	1.53	0.93	1.20	1.22	1.51	19.75	1: 2.56
T_7	***Bacillus thuringiensis* 1×10^8 (CFU/ml)**	3.06	2.73	1.80	2.26	2.26	2.00	1.33	1.60	1.64	1.95	14.42	1: 1.54
T_0	**Control Control**	4.0	4.26	4.46	4.66	4.46	4.73	4.93	5.06	4.90	4.68	9.03	1: 0.69
	F-test	NS	S	S	S	S	S	S	S	S	S	-----	-----
	S. Ed (±)	0.473	0.346	0.341	0.303	0.175	0.322	0.259	0.292	0.135	0.258	-----	-----
	C.D. (P = 0.5)	N/A	0.742	0.732	0.649	0.375	0.691	0.554	0.627	0.289	0.611	-----	-----

**DBS- Day Before Spray, **DAS=Day After Spray, ***NS- Non-Significant, ****S- Significant*

The populations of gram pod borer was recorded on 5 randomly selected and tagged plants from each plot for investigating larval population and cost benefit ratio by following formula:

$$\text{Larval population count} = \frac{\text{Total number of larva}}{\text{5 randomly selected plants}}$$

$$\text{C: B Ratio} = \frac{\text{Net returns}}{\text{Total cost incurred}}$$

3. RESULTS AND DISCUSSION

The data on the larval population of Chickpea pod borer; 3rd 7th and 14th day after first spray revealed that all the treatments were significantly superior over control. Among all the treatments lowest larval population was recorded in T_3 Spinosad 45 SC (1.33%) followed by T_1 Emamectin benzoate 5SG (1.64%), T_6 *HaNPV* 2×10^9 (POB's/ml) (1.80%), T_2 *B. bassiana* (1×10^8 CFU/ml) (2.15%), T_7 *B. thuringiensis* 1×10^8 (CFU/ml) (2.26%), T_5 *M. anisopliae* 1×10^8 (CFU/gram) (2.37%) and T_4 *H. indica* 5.0×10^9 IJ (2.51%). The treatments T_4 *H. indica* 5.0×10^9 IJ (2.51%) was found to be least effective among all the treatments, yet significantly superior over the control plot T_0 (4.46%).

The data on the larval population of Chickpea pod borer; 3rd 7th and 14th day after second spray revealed that all the treatments were significantly superior over control. Among all the treatments the lowest larval population was recorded in T_3 Spinosad 45 SC (0.86%) followed by T_1 Emamectin benzoate 5SG (1.08%), T_6 *HaNPV* 2×10^9 (POB's/ml) (1.22%), T_2 *B. bassiana* (1×10^8 CFU/ml) (1.55%), T_7 *B. thuringiensis* 1×10^8 (CFU/ml) (1.64%), T_5 *M. anisopliae* 1×10^8 (CFU/gram) (1.75%) and T_4 *H. indica* 5.0×10^9 IJ (1.88%). The treatments T_4 *H. indica* 5.0×10^9 IJ (1.88%) was found to be least effective among all the treatments, yet significantly superior over the control plot T_0 (4.90%).

The above results are similar to the findings of Mohanty and Tayde [10] where the lowest larval population of gram pod borer was recorded in Spinosad 45SC (2.11%). These results were also supported by Chandrasekhar [11] where the highest reduction in larval population of gram pod borer (72.12%) was observed with spinosad 45 SC @ 0.5 ml/1.

The results obtained from the experiment performed by Chaukikar et.al., [12] supports the data of the present experiment, where Emamectin benzoate 5% WG @ 9.4 and 8.1 g a.i. per ha were found to be most effective dose in reducing the *H. armigera* larval population followed by Emamectin benzoate 5% WG @ 6.9 and 5.6 g a.i. per ha.

The different yields among the treatments were significant. The highest marketable yield was recorded in Spinosad 45%SC (23.79 q/h), followed by Emamectin benzoate 5%SG (20.67 q/h), *HaNPV* 2×10^9 (POB's/ml) (19.75), *B. bassiana* 1×10^8 (CFU/gram) (15.24 q/h), *B. thuringiensis* 1×10^8 (CFU/ml) (14.42 q/h), *M. anisopliae* 1×10^8 (CFU/gram) (13.36 q/h), *H. indica* 5.0×10^9 IJ (12.89 q/h) and the lowest was recorded in control (9.03 q/ha) agreed with the findings of Reddy and Kumar (2022) who revealed that Spinosad 45%SC (21.66 q/ha) recorded the highest yield followed by Emamectin benzoate (18.33 q/ha).

The highest cost benefit ratio was recorded in Spinosad 45%SC (1:2.81) followed by Emamectin benzoate 5% SG (1:2.74), *HaNPV* 2x109 (POB's/ml) (1:2.56), *B. bassiana* 1×10^8 (CFU/gram) (1:1.74), *B. thuringiensis* 1×10^8 (CFU/ml) (1:1.54), *M. anisopliae* 1×10^8 (CFU/gram) (1:1.37), *H. indica* 5.0×10^9 IJ (1:1.30) as compared to control (1:0.69).

Maximum C:B ratio was obtained in the treatment Spinosad 45SC (1:2.81) followed by Emamectin benzoate 5SG (1:2.74) was reported by Mohanty and Tayde [10]. These findings were also supported by Dinesh et al., [13], Meena et al., [14] and Mohite and Khan [15].

4. CONCLUSION

The critical analysis of the present findings showed that, spinosad 45%SC was the most superior in managing chickpea pod borer. However, emamectin benzoate 5% SG, *HaNPV* 2×10^9 (POB's/ml), *Beauveria bassiana* 1×10^8 (CFU/gram), has shown average efficacy. Other biopesticides like *Bacillus thuringiensis* 1×10^8 (CFU/ml), *Metarhizium anisopliae* 1×10^8 (CFU/gram), *Heterorhabditis indica* 5.0×10^9 IJ found to be the least effective in managing *H. armigera*. Among the treatments studied Spinosad 45%SC gave the highest benefit / cost ratio (2.81) and marketing yield (23.79 q/ha) followed by Emamectin benzoate 5%SG (2.74 and 20.67 q/h), *HaNPV* 2×10^9 (POB's/ml) (2.56 and 19.75 q/ha), *B. bassiana* 1×10^8 (CFU/gram) (1.74 and 15.24 q/ha), *B. thuringiensis* 1×10^8 (CFU/ml) (1.54 and 14.42 q/ha), *M. anisopliae* 1×10^8 (CFU/gram) (1.37 and 13.36 q/ha) and *H. indica* 5.0×10^9 IJ (1.30 and 12.89 q/ha) under Prayagraj agroclimatic conditions more trials are recommended to verify this study findings.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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