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Field efficacy of Selected Insecticides against Pod Borer, *Helicoverpa armigera* (H.) in Chick Pea (*Cicer arietinum* Linnaeus)

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ABSTRACT: A field investigation was carried out in *rabi* season of 2022-2023 at Central Research Farm (CRF), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. The experiment was laid in Randomised Block Design with seven treatments each replicated thrice viz., Indoxacarb 14.5% SC, Chlorantraniliprole 18.5% SC, Lamda cyhalothrin 5% EC, *Bacillus thuringiensis* 1×10^8 CFU, Emamectin benzoate 5% SG, Spinosad 45% SC, *Metarhizium anisopliae* 1×10^8 CFU and control plot. The results on *Helicoverpa armigera* larvae population after the first and second sprays proved that all of the treatments insecticides and biopesticides were significantly superior to the control. Among all treatments, Indoxacarb 14.5% SC (1.20 & 0.86) recorded lowest larval population of *Helicoverpa armigera* after both sprays followed by Chlorantraniliprole 18.5% SC (1.51 & 1.08), Emamectin benzoate 5% SG (1.68 & 1.26), Spinosad 45% SC (1.91 & 1.55), Lamda cyhalothrin (2.22 & 1.80), *Bacillus thuringiensis* 1×10^8 CFU (2.17 & 2.47), *Metarhizium anisopliae* 1×10^8 CFU (2.24 & 2.62) was the least effective among all treatments respectively. While, the highest yield 22.76 q/ha was obtained from the treatment Indoxacarb 14.5% SC as well as C: B ratio (1:4.04) followed by Chlorantraniliprole 18.5% SC (20.55 and 1:3.52), Emamectin benzoate 5% SG (19.68 and 1:3.45), Spinosad 45% SC (18.68 and 1:3.18), Lamda cyhalothrin 5% EC (16.3 and 1:2.94), *Bacillus thuringiensis* 1×10^8 CFU (14.4 and 1:2.58) and *Metarhizium anisopliae* 1×10^8 CFU (12.5 and 1:2.54).

Keywords: *Bacillus thuringiensis* 1×10^8 CFU, Chickpea, Insecticides, *Helicoverpa armigera*, *Metarhizium anisopliae* 1×10^8 CFU.

INTRODUCTION

Chickpea is an important pulse crop cultivated and consumed across the world, especially in the Afro-Asian countries (Maurya and Kumar 2018). *Cicer arietinum* L., belongs to the "Fabaceae" (or Leguminosae) family of legumes, peas, or pulses and is farmed extensively for its generally yellow-brown, pea-like seeds. Within the *Cicer*, it is the sole crop that is grown. There are two varieties of chickpea cultivars that are known worldwide: kabuli and desi (Pundir and Mangesha 1985).

Due to its low cost of production, wide range of adaptability, capacity to fix atmospheric nitrogen, and flexibility to fit in different crop rotations, it is one of the most significant food legume plants in sustainable agricultural systems (Singh, 1997).

Because of its rich nutrient profile and affordable price, chickpea was investigated for this nutritional purpose. It is an excellent source of high-quality protein, carbs, vitamins (thiamine and niacin), minerals (calcium, phosphorus, iron, magnesium, and potassium), and its oil is a good source of the crucial fatty acid linoleic (Malunga *et al*., 2014). Some of the serious diseases that affect people, such type 2 diabetes, cardiovascular disease, digestive disorders, and some malignancies, could be therapeutic. In general, chickpeas are an essential pulse crop with a diverse array of potential nutritional and health advantages (Jukanti *et al*., 2012).

The second-most significant pulse crop in the world is chickpea. It ranks third in output and second in area (Verma *et al.*, 2021). In India, production of pulses during the year 2021-2022 about 273.02 lakh tonnes and during the year 2022-2023 is estimated at 278.10 lakh tonnes which is higher by 5.08 lakh tonnes. The production of chickpea during the year 2021-2022 is 135.44 lakh tonnes and during the year 2022-2023 is estimated about 136.32 lakh tonnes (Source: Ministry of Agriculture and Farmers Welfare Department 2022).

The chickpea is being attacked by seven different insect species. Three of these species, the white grub (*Holotrichia longipennis*), cutworm (*Agrotis ipsilon*), and wireworm (*Agriotes* spp.)—are soil-borne, and the gram pod borer (*H. armigera*), semilooper (*Thysanopulsia orichalcea*), and flea beetle (*Altica* *himensis*) are among the four foliage-feeding species (Rehman *et al*., 2021).

Among the insect-pests, pod borer is the most severe yield reducer throughout India (Kailas and Choudhary 2021). Gram Pod borer, *Helicoverpa armigera* (Hubner) is a pest with notable economic consequence, and it is the main constraint on the growth of chickpeas. In extreme situations, it reduces seed production by roughly 75% to 90% (Sarwar *et al.,* 2013).

MATERIALS AND METHODS

The experiment was conducted at the Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The research trail was laid out during *rabi* 2022-2023 in Randomized block design (RBD) with seven different treatments replicated thrice. The plot had a dimension of 2 ×1 m^2. The chickpea seeds of variety 'Shulabh- 45' were sown in plots keeping row to row and plant to plant distance of 30 × 10 cm.

All of the insecticides used in the study were sprayed as foliar application. The eight different treatments were used with dosage consisting of T_1 Indoxacarb 14.5% SC@ 1ml/L, T_2 Chlorantraniliprole 18.5%SC @ 0.5ml/L, T_3 Lamda cyhalothrin 5%EC @ 1ml/L, T_4 *Bacillus thuringinensis* 1×10^8 CFU@2ml/L, T_5 Emamectin benzoate 5% SG@ 0.4ml/L, T_6 Spinosad 45%SC@ 0.5ml/L, T_7 *Metarhizium anisopliae* 1×10^8 CFU@4g/L and T_8 control. Two sprays were carried out at intervals of 15 days during the experiment to assess the effectiveness of pesticides when the *Helicoverpa armigera* larval population reached the ETL threshold. On five randomly chosen and tagged plants in each plot, pre- and post-treatment observations on the larvae population were made shortly before 24 hours and 3^{rd}, 7^{th}, and 14^{th} days following application, respectively.

The spray solution of desired concentration should be prepared by adopting the following formula:

$$V = \frac{(C \times A)}{\%\ a.i.}$$

Where,
V=Volume of a formulated pesticide required.
C= Concentration required.
A= Volume of total solution to be prepared.
% a.i. = Percentage of active ingredient in commercial product

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

Kumar *et al.* (2018)

RESULTS AND DISCUSSION

The findings of the current investigation demonstrated that after insecticidal applications against pod borer *Helicoverpa armigera* were found significantly superior over control plot (Table 1). Indoxacarb 14.5% SC (1.20), Chlorantraniliprole 18.5% SC (1.51), Emamectin benzoate 5% SG (1.68), Spinosad 45% SC (1.91), Lamda cyhalothrin 5% EC (2.22), and *Bacillus thuringiensis* 1×10^8 CFU (2.77) were the treatments with the lowest larvae population after the initial spray. The maximum larval population in this investigation was obtained by *Metarhizium anisopliae* 1×10^8 CFU (3.00). After second spray lowest larval population with regards to all treatments was found in Indoxacarb 14.5% SC (0.86), followed by Chlorantraniliprole 18.5%SC (1.08), Emamectin benzoate 5% SG (1.26), Spinosad 45% SC (1.55), Lamda cyhalothrin 5% EC (1.80), and *Bacillus thuringiensis* 1×10^8 CFU (2.17). *Metarhizium anisopliae* 1×10^8 CFU (2.24) recorded the highest larval population in this study.

Among all treatments, the Indoxacarb 14.5% SC (1.03) was determined to have the lowest overall larval population, followed by Chlorantraniliprole 18.5%SC (1.30), Emamectin benzoate 5% SG (1.47), Spinosad 45%SC (1.73), Lamda cyhalothrin 5%EC (2.01), *Bacillus thuringiensis* 1×10^8 CFU (2.47) and *Metarhizium anisopliae* 1×10^8 CFU (2.62).

The yields among the treatments were significant. The highest yield was recorded in Indoxacarb 14.5% SC (22.76 q/ha) followed by chlorantraniliprole 18.5%SC (20.55 q/ha), Emamectin benzoate 5%SG (19.68 q/ha), Spinosad 45% SC (18.68 q/ha), Lamda cyhalothrin 5% EC (16.3 q/ha), *Bacillus thuringiensis* 1×10^8 CFU (14.4 q/ha), *Metarhizium anisopliae* 1×10^8 CFU (12.5q/ha) and untreated control plot (7.5 q/ha).

Among the treatments studied, the best and economical treatment was Indoxacarb 14.5% SC (1: 4.04) followed by chlorantraniliprole 18.5%SC (1: 3.52), Emamectin benzoate 5% SG (1: 3.45), Spinosad 45%SC (1: 3.18), Lamda cyhalothrin 5% EC (1: 2.94), *Bacillus thuringiensis* 1×10^8 CFU (1: 2.58), *Metarhizium anisopliae* 1×10^8 CFU (1: 2.54) and untreated control plot (1: 1.39). However, all the treatments controlled gram pod borer effectively compared to untreated plot.

Indoxacarb 14.5% SC (1.20 and 0.86) was most effective treatment reducing the pest population of *Helicoverpa armigera*, which was reported by Tripati *et al.* (2022); Meena *et al.* (2018) followed by Chlorantraniliprole 18.5 % SC (1.51 and 1.08) and the similar findings were given by Alok *et al*. (2022); Upadhaya *et al.* (2020), Emamectin benzoate 5%SG (1.68 and 1.26) these observations corroborates with Das *et al.* (2022); Sarnaik and Chiranjeevi (2017).

The yield and benefit cost ratio with the greatest value was found in Indoxacarb 14.5% SC (22.76q/ha and 1:4.04), findings were validated by Gautam *et al*., (2018); Yogeeswarudu and Krishna (2014), followed by Chlorantraniliprole 18.5% SC (20.55q/ha and 1: 3.52) and Emamectin benzoate 5% SG (19.68 and 1:3.45), the observations was supported by Antala *et al.* (2022); Kambrekar *et al*. (2012).

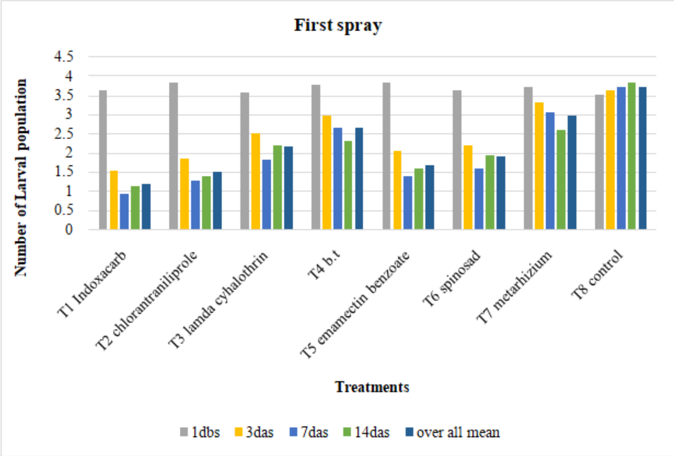

Fig. 1. Effect of Insecticides against larval population of *Helicoverpa armigera* on chickpea (1^{nd} spray).

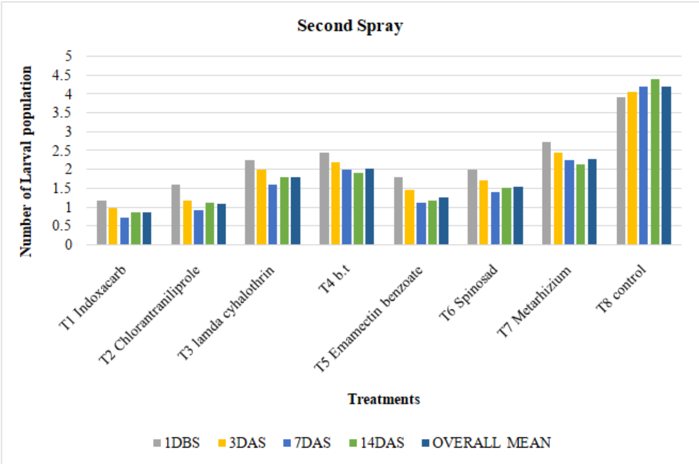

Fig. 2. Effect of Insecticides against larval population of *Helicoverpa armigera* on chickpea (2^{nd} spray).

Table 1: Effect of Insecticides against larval population of *Helicoverpa armigera* on chickpea ($1^{st}$and 2^{nd} spray).

Sr. No.	Treatments	Dosage	Number of larval population per 5 plants								Overall mean	Yield (q/ha)	B:C Ratio
			First spray				Second spray						
			1DBS	3DAS	7DAS	14DAS	1DBS	3DAS	7DAS	14DAS			
T_1	Indoxacarb 14.5% SC	1ml/L	3.66	1.53^{g}	0.93^{g}	1.13^{f}	1.26^{g}	1.00^{f}	0.73^{f}	0.86^{f}	1.03	22.76	1:4.04
T_2	Chlorantraniliprole 18.5%SC	0.5ml/L	3.86	1.86^{f}	1.26^{f}	1.40^{e}	1.60^{f}	1.20^{f}	0.93^{ef}	1.13^{ef}	1.30	20.55	1:3.52
T_3	Lamda cyhalothrin 5%EC	1ml/L	3.60	2.53^{d}	1.93^{d}	2.20^{c}	2.26^{cd}	2.00^{c}	1.60^{d}	1.80^{cd}	2.01	16.3	1:2.94
T_4	*Bacillus thuringiensis* 1×10^8 CFU	2ml/L	3.80	3.00^{c}	2.66^{c}	2.33^{c}	2.46^{bc}	2.20^{c}	2.00^{c}	1.93^{bc}	2.47	14.4	1:2.58
T_5	Emamectin benzoate 5%SG	0.4ml/L	3.86	2.06^{ef}	1.40^{ef}	1.60^{e}	1.80^{ef}	1.46^{e}	1.13^{e}	1.20^{e}	1.47	19.68	1:3.45
T_6	Spinosad 45%SC	0.5ml/L	3.66	2.20^{e}	1.60^{e}	1.93^{d}	2.00^{de}	1.73^{d}	1.40^{d}	1.53^{d}	1.73	18.68	1:3.18
T_7	*Metarhizium anisopliae* 1×10^8 CFU	4g/L	3.73	3.33^{b}	3.06^{b}	2.60^{b}	2.73^{b}	2.46^{b}	2.26^{b}	2.00^{b}	2.62	12.5	1:2.54
T_8	Control	….	3.53	3.66^{a}	3.73^{a}	3.86^{a}	3.53^{a}	4.06^{a}	4.20^{a}	4.40^{a}	3.99	7.5	1:1.39
F-test			NS	S	S	S	S	S	S	S	S	…..	…..
S. Ed (±)			0.18	0.09	0.09	0.09	0.10	0.08	0.07	0.07	0.18	…..	…..
C.D. (P = 0.5)			_	0.27	0.28	0.26	0.30	0.24	0.21	0.27	0.61	…..	…..

DBS** - Day Before Spray**, DAS**- Day After Spray***

CONCLUSIONS

From the critical analysis of the present findings, it can be concluded that, among all the treatments Indoxacarb 14.5%SC is more effective in controlling larval population of *Helicoverpa armigera* followed by chlorantraniliprole 18.5% SC, Emamectin benzoate 5% SG, Spinosad 45%SC, Lamda cyhalothrin 5%EC, *Bacillus thuringiensis* 1×10^8 CFU, and *Metarhizium anisopliae* 1×10^8 CFU. Among the treatments studied, Indoxacarb 14.5% SC gave the highest cost benefit ratio (1:4.04) and marketing yield (22.7q/ha) followed by chlorantraniliprole 18.5%SC (1: 3.52 and 20.55q/ha), Emamectin benzoate (1:3.45 and 19.68q/ha), Spinosad 45%SC(1:3.18 and 18.68q/ha), Lamda cyhalothrin 5% EC (1:2.94 and 16.3q/ha), *Bacillus thuringiensis* 1×10^8 CFU (1:2.58 and 14.4q/ha) and *Metarhizium anisopliae* 1×108 CFU (1:2.54 and 12.5q/ha) respectively as such more trails are required in future to validate the findings

FUTURE SCOPE

Conventionally farmers are using various types of synthetic chemical insecticides to control gram pod borer. But the unconscious and unjustified use of synthetic pesticides creates several problems in agro - ecosystem such as direct toxicity to beneficial insects, fishes and man. The repeated use of systemic insecticides alone has resulted in the development of resistance in the insect pest, and disturbance to the agro-ecosystem by affecting the non-target ones. Therefore, we need to use integrated approaches for the control of gram pod borer in order to avoid indiscriminate use of pesticides.

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Conflict of Interest. None.

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