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Evaluation of Selected Biopesticides with Chlorantraniliprole against Chickpea Pod Borer [*Helicoverpa armigera* (Hubner)] at Prayagraj, India

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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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Original Research Article

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ABSTRACT

The research work entitled was undertaken at central research farm (CRF) SHUATS, Naini, Prayagraj consists of eight treatments viz, T_1- Spinosad 45% SC, T2- Chlorantraniliprole 18.5SC, T3- Half dose of Chlorantraniliprole + Nisco sixer plus, T4- Nisco sixer plus, T5- NSKE, T6- *Beauveria bassiana*,T7- Neem oil and T0- untreated control in RBD with three replications. The larval population of chickpea pod borer [*Helicoverpa armigera* (Hubner)]on third, seventh and fourteen days after spraying revealed that the treatment Chlorantraniliprole (2.41) found superior followed by Spinosad 45%SC (2.47), Half dose of Chlorantraniliprole 18.5 SC + Nisco sixer plus (2.61), Nisco sixer plus (2.67), Neem oil (2.72), NSKE (2.76) and *Beauveria bassiana* (3.60) as compared to control(4.67). Among the treatments studied, the best and most economical treatment was Chlorantraniliprole (1:3.0), followed by Spinosad 45%SC (1:2.6), Half dose of Chlorantraniliprole 18.5 SC + Nisco sixer plus (1:2.2), Nisco sixer plus (1:1.8), Neem oil (1:1.7), NSKE (1:1.5) and *Beauveria bassiana* (1:1.1) as compared to control (1:1.0).

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1. INTRODUCTION

"Chickpea, *Cicer arietinum* (L.) family Leguminaceae (Fabaceae) is originated in South eastern Turkey and spread to other parts of the world" [1]. According to De Candolle, the fact that gram has a Sanskrit Name "Chanaka" indicates that the crop was under cultivation in India longer than in any other country [1].

Gram commonly known as chickpea or Bengal gram is India's most important pulse crop. In India, it is also known as the 'King of pulses' India is the largest producer with 75% of world acreage and production of gram. India produces 5.3 MT of chickpeas from 6.67 million ha with an average productionof 844 kg per ha. "Chickpea is used for human consumption as well as for feeding animals. Its seeds are eaten as green vegetables, fried, roasted, as snack food, and ground to obtain flour and dhal" [2].

"Nutritional value per 100 g of chickpea contains carbohydrates (27.42 g), protein (8.86 g), total fat (2.59 g), dietary fiber (7.6 g), folates (172 mcg), niacin (0.526 mg), pantothenic acid (0.245 mg), pyridoxine (0.215 mg), riboflavin (0.063 mg), thiamin (0.200 mg), vitamin C (1.3 mg), vitamin A (27 IU),vitamin E (0.35 mg), vitamin K (4.0 mcg),sodium (7 mg), potassium (291 mg), calcium (49mg), iron(2.89 mg), magnesium (48 mg), phosphorus (168 mg), zinc (1.53 mg)" [3].

"The majority of the world's chickpeas is grown in South Asia, where India has the largest share in the world's chickpea area (8.39 MHA) and production (7.06 mt), respectively. In Haryana, the total area under chickpea cultivation was 42 thousand ha with a total production of 26 thousand tonnes and productivity of 619Kg /ha" [4].

"Madhya Pradesh ranked first contributing an area of 30.76 lakh ha, production 33.98 lakh tonnes, and productivity of 1105 kg/ha (34.46% and 40.62% of the total area and production of the country). Maharashtra is of second rank for an area of 15.41 lakh ha (17.26%) and third for production of 11.98 lakh tones (14.32%). Whereas, Rajasthan stood second in production (14.47%) and third in area (15.37%). The highest yield was recorded in the state of Telangana (1459 kg/ha) followed by Gujarat (1201 kg/ha) and West Bengal (1163 kg/ha). The lowest yield was recorded in Karnataka (578 kg/ha)" [5].

"The major insect pests attacking chickpea are pod borer *Helicoverpa armigera*, leaf feeding caterpillar *Spodoptera exigua*, black cutworm *Agrotis ipsilon*, aphid *Aphis craccivora* and semi-looper *Autographa nigrisigna*. *H.armigera* is the major damaging pest in areas where chickpea is grown. The attack of this pest begins right from the vegetative stage and continues up to maturity. Young larvae of *H. armigera* feeds on leaflets, buds, flowers, and pods of chickpea" [6].

"In India, Helicoverpa armigera has been recorded in 181 plant species from 45 families. The gram pod borer, Helicoverpa armigera is a potential and polyphagous pest, with various characteristic features like high fecundity, migratory behaviour, high adaptations to various agro climatic conditions and development of resistance to various insecticides, extensively damaging many crops including chickpea. The caterpillar not only defoliates the tender leaves but also makes holes in the pods and feed upon the developing seeds the anterior body portion of the caterpillar remains inside the pod and rest half or so hanging outside. When seeds of one pod are finished, it moves to the next" [7].

"The pest feeds voraciously from seedling stage to maturity and causes about 50 to 60 per cent damage to the chickpea pods" [8]. In India, losses caused by *H. armigera* on chickpea and pigeon pea fields exceeded Rs. 12,000 million per year as per survey carried out by ICRISAT.

In recent years, various types of insecticides belonging to different chemical group were used as spray to manage the pest complex. Sometimes users don't know suitable insecticide for pest control therefore, selected insecticides can be used for the management of Pod borer on Gram by potential evaluation of few selected insecticides through their comparative effectiveness.

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi* season 2022-2023 at Central Research Farm (CRF), SHUATS, Prayagraj (U.P). The study was set up in a Randomized Block Design (RBD) which was replicated thrice. Each main block was divided into 7 sub-plots of 2m x 1m size with maintaining 25cm borders as bunds and treatments were assigned randomly The spraying of botanical and conventional insecticides were applied at the initial incidence

of pod borer and two sprays were given. All the spraying was done by using a knapsack sprayer at 15 days intervals. The insecticide and bio pesticides include, T1- Spinosad 45% SC, T2- Chlorantraniliprole 18.5SC, T3- Half dose of Chlorantraniliprole + Nisco sixer plus, T4- Nisco sixer plus, T5- NSKE, T6- *Beauveria bassiana*,T7- Neem oil and T0- untreated control.

2.1 Observations

"Observation was recorded on the number of larvae per 5 plants in 2m row length at 5 different locations of all treatments were randomly selected and total number of larvae were recorded 1 day before application and 3rd, 7th and 14th days after application in each treatment. The result obtained was converted into percent larval population with following formula" [9].

$$\text{Larval population} = \frac{\text{No.of larvae}}{\text{Total no.of plants}}$$

2.1.1 Cost benefit ratio of treatments

Gross returns was calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments was deducted from the gross returns, to find out returns and cost benefit of ratio by following formula,

$$\text{BCR} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

Where,

BCR = Benefit Cost Ratio.

3. RESULTS AND DISCUSSION

The information on larval population of pod borer *Helicoverpa armigera* given in Table. 1 over manage at (3rd, 7th and 14th DAS) after first spraying, T2-Chlorantraniprole 18.5 SC (2.75%) proved to be best towards chickpea pod borer population. T1- Spinosad 45 SC changed into the subsequent nice treatment with (2.82%) accompanied with the T3- half dose chlorantraniliprole + Nisco sixer plus with (2.88%), T4 - Nisco sixer plus (2.95), T7 – Neem Oil 5% (3.02), T5- NSKE (3.04%), T6 – *Beauveria bassiana* (three.28%) and which become the least among all of the treatments.

After second spraying, the data on the the larval population of pod borer *Helicoverpa armigera* in Table 1 over control at (3rd, 7th, and 14th DAS) revealed that all the treatments were significantly superior over control. Among all the treatments used, T2-Chlorantraniprole 18.5 SC proved to be the most effective against *Helicoverpa armigera* with (2.067%) larval population as compared to the untreated control (T8 - Water spray (5.089%) followed by next effective treatments T1- Spinosad 45 SC with (2.133%), T3- Half dose chlorantraniliprole + Nisco sixer plus with (2.200%), T4 – Nisco sixer plus with (2.267%), T7 Neem Oil – with (2.333%), T5- NSKE (2.400%), T6 – *Beauveria bassiana* with (2.600) found to be the least.

Chitralekha et al., [4] and Akanksha and Singh [10] reported that "Chlorantraniliprole was superior in reducing the larval population of chickpea pod borer". Spinosad 45 SC is found to be the next best treatment which is in line with the findings of Vikrant et al., [6] and Lakshmikanth and Kumar [11] they reported that "Spinosad45 SC was found to most effective in reducing the larval population of Chickpea pod borer as well as increasing the yield". Half dose of Chlorantraniliprole 18.5SC + Nisco sixer plus was found to be the next best treatment which is in line with the findings of Tejeswari and Kumar [12]. Nisco sixer plus is found to be the next effective treatment which is in line with the findings of Barwa andKumar [7] and Lalhluzuala and Kumar [13]. Neem oil 5% is found to be the next effective treatment which isin line with the findings of Gautam et al., [14] and Bhati et al. [15]. NSKE is found to be the next effective treatment which is in line with the findings of Pachundkar et al., 2013. Beauveria bassiana was the least effective among all the treatments and these findings were supported by Anil and Kumar [5].

When the benefit-cost ratio was worked out, interesting results were achieved. Among the treatment studied the best and most economical treatment was Chlorantraniliprole 18.5SC (1:3.06), followed by Spinosad 45SC (1:2.6), Half dose of Chlorantraniliprole + Nisco sixer plus(1:2.2),Nisco sixer plus (1:1.8), Neem oil (1:1.78), NSKE (1:1.54), *Beauveria bassiana* (1:1.1) as compared to T0 control (1:1.0).

The yield among the treatments was significant. The highest yield was recorded in Chlorantraniliprole 18.5SC (29 q/ha) followed by Spinosad 45SC (26 q/ha), Half dose of Chlorantraniliprole + Nisco sixer plus (22 q/ha), Nisco sixer plus (20q/ha), Neem oil (19 q/ha),NSKE (16 q/ha), *Beauveria bassiana* (12q/ha) as compared to T0 control (8 q/ha).

Table 1. Comparative efficacy of selected bio pesticides with chlorantraniliprole against pod borer [*Helicoverpa armigera* (Hubner)] on chickpea

Treatments		First Spray					Second Spray				Overall Mean	Yield	C:BRatio
		1DBS	3 DAS	7 DAS	14DAS	Mean	3 DAS	7DAS	14DAS	Mean			
T1	Spinosad 45% SC	3.53(10.82)*	3.06(10.08)	2.80(9.62)	2.60(9.27)	2.40(9.66)	2.40(8.90)	2.13(8.38)	1.86(7.85)	2.13(8.38)	2.47(9.03)	26	1:2.60
T2	Chlorantraniliprole 18.5 SC	3.53(10.83)	3.00(9.97)	2.73(9.50)	2.53(9.14)	2.33(9.52)	2.33(8.77)	2.06(8.25)	1.80(7.70)	2.06(8.240	2.41(8.89)	29	1:3.06
T3	Half dose of Chlorantraniliprole18.5 SC + Nisco sixer plus	3.53(10.82)	3.13(10.19)	2.86(9.74)	2.66(9.39)	2.46(9.77)	2.46(9.03)	2.20(8.52)	1.93(7.99)	2.20(8.69)	2.54(9.15)	22	1:2.20
T4	Nisco sixer plus	3.60(10.93)	3.20(10.30)	2.93(9.85)	2.73(9.51)	2.53(9.89)	2.53(9.15)	2.267(8.65)	2.00(8.12)	2.26(8.81)	2.61(9.26)	20	1:1.80
T5	NSKE 5%	3.3310.51()	3.26(10.41)	3.00(9.97)	2.86(9.74)	2.66(10.03)	2.66(9.39)	2.40(8.90)	2.13(8.39)	2.40(9.07)	2.72(9.47)	16	1:1.54
T6	*Beauveria bassiana*	3.66(11.03)	3.53(10.83)	3.26(10.40)	3.06(10.08)	2.86(10.57)	2.86(9.74)	2.60(9.27)	2.33(8.78)	2.60(9.43)	2.94(9.85)	12	1:1.18
T7	Neem oil 5%	3.60(10.93)	3.26(10.40)	3.00(9.97)	2.80(9.62)	2.60(10.14)	2.60(9.27)	2.33(8.78)	2.06(8.26)	2.33(8.94)	2.67(9.39)	19	1:1.78
T0	Control	3.60(10.92)	3.93(11.43)	4.33(12.01)	4.53(12.28)	4.73(11.71)	4.73(12.56)	5.13(13.09)	5.40(13.43)	5.08(12.89)	4.67(12.46)	8	1:1.0
	F-test	NS	S	S	S	S	S	S	S	S	S	--	--
	C.D. at 5%		0.353	0.366	0.366	0.366	0.366	0.31	0.277	0.327	0.890	--	--
	C.V	7.312	0.353	6.697	7.016	7.389	7.389	6.711	6.476	8.067	13.059	--	--

**Figures in parentheses are arc sin transformed values*
DBS: Day before spraying
DAS: Day after spraying

The yield and benefit ratio of green gram shows the highest efficiency in Chlorantraniliprole 18.5SC was supported by Akhtar et al., [16] followed by Spinosad 45SC was supported by Shekhara et al., [17]. Nisco sixer plus was supported by Tejeswari andKumar [12]. and the results of Neem oil 5% and NSKE were supported by Reza et al., [18]. *Beauveria bassiana* was supported by Deepthi and Yadav [19].

4. CONCLUSION

From the analysis of present findings it is concluded that spraying insecticides significantly reduced the population of chickpea pod borer pests. The current discoveries reason that the new age insect sprays like Chlorantraniliprole 18.5SC, Spinosad, Half dose of Chlorantraniliprole 18.5SC+Nisco sixer plus besides, Nisco sixer plus, neem oil, NSKE, *Beauveria bassiana* were viewed as powerful against lepidopteran caterpillar Helicoverpa armigera and an unexpected yield level in Chickpea. Chlorantraniliprole 18.5SC and Spinosad also had a high cost-benefit ratio, according to the findings. Consequently, it is proposed that the compelling insect sprays might be substituted as one with the current Integrated pest management to keep away from the issues related to insecticidal obstruction, bother resurgence, and so forth.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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