

## “Comparative efficacy and economics of selected chemicals and biopesticides against pod borer [*Helicoverpa armigera* (Hubner)] on chickpea (*Cicer arietinum* L.)”

### ABSTRACT

The research work was undertaken at Central Research Farm (CRF) Sam Higginbottom University of Agriculture Technology ~~And~~ Sciences, SHUATS, Naini, Prayagraj during *rabi* season of 2023- 24. The treatments consists of eight ~~treatments~~ including control viz, T<sub>1</sub>- *Beauveria bassiana* 1.15 % WP, T<sub>2</sub> Chlorantraniliprole 18.5 SC, T<sub>3</sub>-Emamectin benzoate 5 SG, T<sub>4</sub>- *Bacillus thuringiensis* 1x10<sup>9</sup> CFU/ml, T<sub>5</sub> -Azadirachtin 00.03% ~~WSP~~, WSP, T<sub>6</sub> – NSKE 5% , T<sub>7</sub>- Spinosad 45 SC and T<sub>0</sub>-untreated control arranged in Randomized Block Design (RBD) with three replications targeting to evaluate the efficacy of selected insecticides on the larval population of *H. armigera* on Chickpea. Data was taken on larval population of chickpea pod borer. The larval population of chickpea pod borer , *Helicoverpa armigera* on third, seven and fourteen days after spray revealed that among all the treatment T<sub>2</sub> Chlorantraniliprole 18.5 SC found superior with larval population of (1.05) and with highest cost benefit ratio (1:3.78 ), followed by Emamectin benzoate 5 SG with a larval population of (1.17) and cost benefit ratio (1:3.53), Spinosad 45 SC with a larval population of (1.24) and cost benefit ratio (1:3.16), *Beauveria bassiana* 1.15 % WP with a larval population of (1.32) and cost benefit ratio (1:3.00 ), *Bacillus thuringiensis* 1x10<sup>9</sup> CFU/ml with a larval population(1.35) and cost benefit ratio ( 1:2.76 ), Azadirachtin 00.03% WSP with a larval population(1.42) and cost benefit ratio (3.49, 1:2.25), NSKE 5% with a larval population (1.47) and cost benefit ratio ( 1:1.77), NSKE 5% was least effective among the treatments and control plot T<sub>0</sub> with a larval population (2.07) and cost benefit ratio (1:1.51).

**Keywords:** Biopesticides, chemicals, chickpea, cost benefit ratio, efficacy, *Helicoverpa armigera*.

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## ~~INTRODUCTION~~ ~~INTRODUCTION~~:-

Gram commonly known as a 'chickpea' or chana is a self-pollinating diploid ( $2n=2x=16$ ) plant. It is originated in South-eastern Turkey and spread to other parts of the world. ~~It is a very important pulse crop that~~ A very important pulse crop grows as a seed of a plant named *Cicer arietinum* (L.) in the Leguminosae family. According to De Candolle, "Chanaka" which is the Sanskrit name of chickpea gives the indication of being cultivated in India from a very long duration compared to other countries in the world. **(Kumar and Yadav, 2023).**

India ranks first in the production and consumption of chickpea (*Cicer arietinum* L.) in the world. Chickpea is a most important pulse crop of ~~India which~~ India, which is mostly grown under dry land condition with heavy cloudy soil. It is a rich source of nutritional values in the diet of Indian people because of containing 21.5 per cent protein, 64.5 per cent carbohydrates and 4.5 per cent fat which is comparatively deficient in the cereals and oilseeds. ~~Its green leaves and pods are used as green vegetables and germinated grains for breakfast and other delicious dishes by the people in their daily meals~~ The people in their daily meals use its green leaves and pods as green vegetables and germinated grains for breakfast and other delicious dishes. **(Kumar et al., 2019).**

~~Chickpea is attacked by several pests, mainly insects~~ Several pests, mainly insects, attack chickpea. Sarwar, recorded "57 insect species, namely Lepidoptera as *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae), commonly known as gram pod borer is a major polyphagous and noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops". "In India, the extent of losses due to *H. armigera* in chickpea is up to 27.9 per cent in North West Plain Zone, 13.2 per cent in North East Plain Zone, 24.3 per cent in Central Zone and 36.4 per cent in South Zone. The crops have been noticed to suffer an avoidable loss of 9 to 60 per cent by this insect. In Uttar ~~Pradesh~~ Pradesh, alone 15.3 per cent of the chickpea crop worth ~~Rs.~~ 462.5 million is lost annually due to *H. armigera* attack, 17.2 per cent in Karnataka and 28.5 per cent in Delhi. **(Bhati et al., 2023).**

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## MATERIALS AND ~~METHODS~~:METHODS:-

The experiment was conducted at the experimental research plot of the Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture Technology ~~And~~ Sciences, during the *rabi* season of 2023-24. ~~The~~ Research field is situated at 25°27 North Latitude 80°50 East Longitudes and at an ~~Altitude~~ altitude of 98 meter above sea level. The climate is typically semi- arid and sub-tropical. The maximum temperature reaches up to 47°C in summer and drops down to

2.5°C in winter. The experimental design was Randomized Block Design with ~~8~~ eight treatments, each replicated thrice. The plot size was ( 2m × 1m) with a spacing of (30×10 cm). The treatments included - *Beauveria bassiana* 1.15 % WP (Bevroz) , Chlorantraniliprole 18.5 SC (Coragen) , Emamectin benzoate 5 SG (Proclaim), *Bacillus thuringiensis* 1×10<sup>9</sup> CFU/ml (Thuricide), Azadirachtin 00.03% WSP (Neemaura), NSKE 5% (Neemicide) , Spinosad 45 SC (Tracer), and a control.

The numbers of larva were counted on ~~5~~ five randomly selected plants in each plot. The pre-treatment count was made a day before the spray whereas, the post-treatment counts were made on ~~3<sup>rd</sup>, 3<sup>rd</sup>~~ 7<sup>th</sup> and 14<sup>th</sup> day after each spray. The larval population over control against gram pod borer was calculated by considering the mean of three observations recorded at ~~3<sup>rd</sup>, 3<sup>rd</sup>~~ 7<sup>th</sup>, ~~7<sup>th</sup>, 7<sup>th</sup>~~ and 14<sup>th</sup> day after spray

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## RESULT AND DISCUSSION

### 3.1 Efficacy of *Helicoverpa armigera* after first spray

#### Third days after spraying:

The data of gram pod borer after three spray days revealed that all treatments was significantly superior over the control. Among all the treatments, the lowest ~~Number-number~~ of larval populations was recorded in Chlorantraniliprole 18.5 SC (1.40) found superior over other treatments followed by Emamectin benzoate (1.53), Spinosad 45 SC (1.60), *Beauveria bassiana* (1.67), *Bacillus thuringiensis*  $1 \times 10^9$  CFU/ml (1.67), Azadirachtin 00.03% WSP (~~1.80~~→1.80) and Neem seed kernel extract 5% (1.80) is found to be least effective among all the treatments as compared to ~~control~~ control (2.00).

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#### Sevan days after spraying:

The data of gram pod borer after three spray days revealed that all treatments was significantly superior over the control. Among all the treatments, Chlorantraniliprole 18.5 SC (1.07) found superior over other treatments followed by Emamectin benzoate (1.13), Spinosad 45 SC (1.20), *Beauveria bassiana* (1.27), *Bacillus thuringiensis*  $1 \times 10^9$  CFU/ml (1.27), Azadirachtin 00.03% WSP (1.33 ) and Neem seed kernel extract 5% (1.40) is found to be least effective among all the treatments as compared to control (2.07).

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#### Fourteen days after spraying:

The data of gram pod borer after three spray days revealed that all treatments was significantly superior over the control. Among all the treatments, Chlorantraniliprole 18.5 SC (0.67) found superior over other treatments followed by Emamectin benzoate (0.87), Spinosad 45 SC (0.93), *Beauveria bassiana* (1.00), *Bacillus thuringiensis*  $1 \times 10^9$  CFU/ml (1.07), Azadirachtin 00.03% WSP (1.13), and ~~Neem-neem~~ seed kernel extract 5% (1.20) is found to be least effective among all the treatments as compared to the control (2.13).

**Overall mean of first spray:**

The data on the larval population of gram pod borer on mean (3<sup>rd</sup>, 7<sup>th</sup>, 14<sup>th</sup> DAS) days after spray revealed that all [the](#) treatments was significantly superior over control. Among all the [treatments](#)~~treatments~~. Chlorantraniliprole 18.5 SC (1.05) found superior over other treatments followed by Emamectin benzoate (1.17), Spinosad 45 SC (1.24), *Beauveria bassiana* (1.32), *Bacillus thuringiensis* 1×10<sup>9</sup> CFU/ml (1.35), Azadirachtin 00.03% WSP (1.42) and Neem seed kernel extract 5% (1.47) is found to be least effective among all the treatments as compared to control (2.07).

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**Table .1 Effect of certain insecticides and biopesticides on the larval population of *Helicoverpa armigera* on chickpea during rabi season 2023-24-24:**

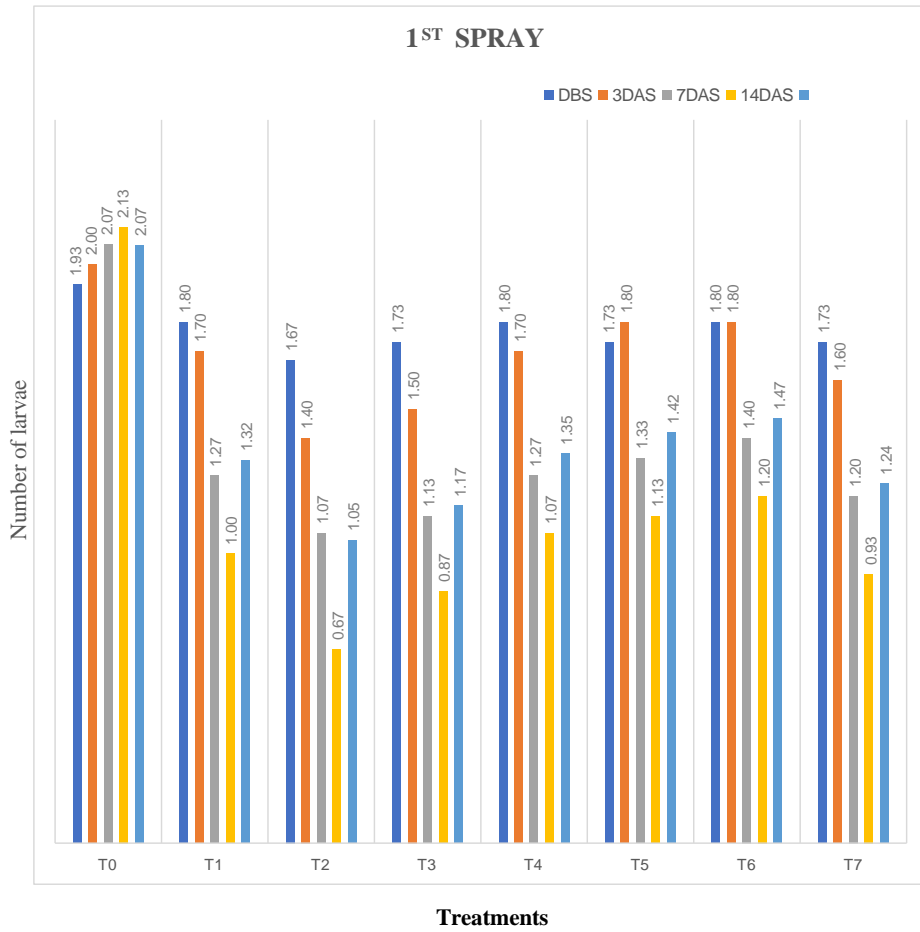
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Treatments		Number of larvae / 5 plants				
		IDBS	After spray			
			3 <sup>rd</sup> Day	7 <sup>th</sup> Day	14 <sup>th</sup> Day	Mean
T <sub>0</sub>	Control	1.93	2.00	2.07	2.13	2.07
T <sub>1</sub>	<i>Beauveria bassiana</i> 1.15 % WP	1.80	1.70	1.27	1.00	1.32
T <sub>2</sub>	Chlorantraniliprole 18.5 SC	1.67	1.40	1.07	0.67	1.05
T <sub>3</sub>	Emamectin benzoate 5 SG	1.73	1.50	1.13	0.87	1.17
T <sub>4</sub>	<i>Bacillus thuringiensis</i> 1x10 <sup>9</sup> CFU/ml	1.80	1.70	1.27	1.07	1.35
T <sub>5</sub>	Azadirachtin 00.03% WSP	1.73	1.80	1.33	1.13	1.42
T <sub>6</sub>	NSKE 5%	1.80	1.80	1.40	1.20	1.47
T <sub>7</sub>	Spinosad 45 SC	1.73	1.60	1.20	0.93	1.24
Overall Mean		1.77	1.69	1.34	1.13	1.39
F- test		NS	S	S	S	S
S. Ed. (±)			0.08	0.10	0.10	0.05
C. D. (P = 0.05)			0.185	0.228	0.224	0.255



**Figure 1.** Efficacy of selected chemicals and biopesticides against larval population of gram pod borer (*H. armigera*) on chickpea after first spray

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**Table .2 Economics of cultivation**

Sr. No:	Treatment	Yield of q/ha	Cost of yield(₹)	Total costof yield (₹) (Gross return)	Commo n cost (₹)	Treatmen tcost (₹)	Net Return (₹)	Total cost (₹)	B:C ratio
T <sub>0</sub>	Control	11.00	5500	60500	39940	–	21260	39940	1:1.51
T <sub>1</sub>	<i>Beauveria bassiana</i> 1.15 % WP	22.50	5500	123750	39940	1300	82510	41240	1:3.00
T <sub>2</sub>	Chlorantra niliprole 18.5 SC	29.10	5500	160050	39940	2290	117530	42230	1:3.78
T <sub>3</sub>	Emamectin benzoate 5 SG	26.65	5500	146575	39940	1550	105085	41490	1:3.53
T <sub>4</sub>	<i>Bacillus thuringiensis</i> 1x10 <sup>9</sup> CFU/ml	21.24	5500	116820	39940	2240	74640	42180	1:2.76
T <sub>5</sub>	Azadirachtin 00.03% WSP	17.08	5500	93940	39940	1700	52300	41640	1:2.25
T <sub>6</sub>	NSKE 5%	13.50	5500	74250	39940	1800	32510	41740	1:1.77
T <sub>7</sub>	Spinosad 45 SC	25.8	5500	141900	39940	4830	97130	44770	1:3.16

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## DISCUSSION

In the experiment eight different treatments were used viz, T<sub>1</sub>- *Beauveria bassiana* 1.15 % WP, T<sub>2</sub>- Chlorantraniliprole 18.5 SC, T<sub>3</sub> - Emamectin benzoate 5 SG, T<sub>4</sub> - *Bacillus thuringiensis* 1×10<sup>9</sup> CFU/ml, T<sub>5</sub>- Azadirachtin 00.03% WSP, T<sub>6</sub>- NSKE 5%, T<sub>7</sub>- Spinosad 45 SC and T<sub>0</sub>- untreated control, to tested to compare the efficacy against larval population of gram pod borer *Helicoverpa armigera* and their influences on yield of chickpea.

The data on the mean (3, 7, 14 DAS) of first spray for population of *Helicoverpa armigera*, revealed that all the treatments except untreated control which effective for controlling the larval population. Among all the treatments, lowest larval population was recorded in T<sub>2</sub>-Chlorantraniliprole 18.5 SC (1.05) followed by T<sub>3</sub>- Emamectin benzoate 5SG (1.17), T<sub>7</sub>-Spinosad 45 SC (1.24), T<sub>1</sub>- *Beauveria bassiana* 1.15 WP (1.32), T<sub>4</sub>-*Bacillus thuringiensis* 1×10<sup>9</sup> CFU/ml (1.35), T<sub>5</sub>- Azadirachtin 00.03% WSP (1.42), T<sub>6</sub>- Neem seed kernel extract 5% (1.47) is found to be least effective among all the treatments as compared to control (2.07).

The data on mean population after spray revealed that all the insecticides were found very effective and significantly superior over untreated control. Among all the treatments minimum number of larvae were found in T<sub>2</sub> Chlorantraniliprole 18.5 SC (1.05) as the similar findings was reported by Santosh and Kumar (2022), Jayanth and Kumar (2022), Barwa and Kumar (2022) and Bhati et al., (2023) to control *Helicoverpa armigera* larval population. T<sub>3</sub>- Emamectin benzoate 5SG (1.17) was found the next effective treatment with larval population (1.17). similar finding was reported by Abbas et al., (2021) Abbas et al., (2021), reported similar and Reddy finding, Reddy, and Tayde (2023) were found to be the next best treatment for reducing the larval population of *Helicoverpa armigera*. T<sub>7</sub>-Spinosad 45 SC (1.24) was found the next best effective treatments which was similarly found by Ravicharan and Tayde (2023) who reported Spinosad 45 SC to be the next best and effective treatment in controlling larval population , T<sub>1</sub>- *Beauveria bassiana* 1.15 WP (1.32) was found the next most effective treatment with the same findings was done by Sai et al.,(2021), Sireesha and Kumar (2022) T<sub>4</sub>-*Bacillus thuringiensis* 1×10<sup>9</sup>CFU/ml was found the next best effective treatment with a larval population of (1.35) as the same findings was done by Abbas et al., (2021) and Yerrabala et al., (2021), T<sub>2</sub> Azadirachtin 00.03% WSP was found the next effective treatment with a larval population of (1.42) as the same findings was done by Santosh and Kumar (2022) and Gautam et al.,(2018), T<sub>6</sub> NSKE 5% was found the least effective

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treatment with a larval population of (1.47) and the same findings was done by **Machindra and Kumar (2022)**.

When the cost benefit ratio worked out, interesting result was achieved. Among all the treatments the higher cost benefit ratio was obtained from T<sub>2</sub> Chlorantraniliprole 18.5 SC (1:3.78), as the similar findings was done by **Sireesha and Kumar (2022)**, **Barwa and Kumar (2022)**, **Bhati et al.,(2023)**, followed by the T<sub>3</sub> Emamectin benzoate 5SG exhibited a cost benefit ratio of (1:3.53) as the similar finding was done by **Bharti et al.,(2015)**, followed by T<sub>7</sub> Spinosad 45 SC with a cost benefit ratio of (1:3.16) as the similar finding was done by **Nitish et al.,(2015)**, **Keval et al., (2016)** **Choudhary et al.,(2017)** and **Chandra et al., (2017)** , which was followed by T<sub>1</sub> *Beauverria bassiana* which exhibited cost benefit ratio of (1:3.00) which was supported by the finding of by **Golvankar et al.,(2015)**, **Adsure et al.,(2015)**, followed by T<sub>4</sub> *Bacillus thuringiensis* exhibited cost benefit ratio of(1:2.76) it was supported by **Kumara et al., (2016)** and **Chitralkha et al.,(2018)**, which was followed by T<sub>5</sub> Azadirachtin 00.03% WSP with a cost benefit ratio of (1:2.25) as the similar finding was done by **Yerrabala et al.,(2021)**, **Santosh and Kumar (2022)**, Followed by T<sub>6</sub> NSKE 5% which obtained a cost benefit ratio of (1:1.77) which was supported by **Meena et al.,(2018)** and **Singh et al.,(2015)**.

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### CONCLUSION

From ~~the above discussion~~[the research](#) it was found that, spraying of insecticides significantly reduced the pod borer population in chickpea. The present findings conclude that the new generation insecticides like T<sub>1</sub> *Beauveria bassiana* 1.15 WP , T<sub>2</sub> Chlorantraniliprole 18.5% SC, T<sub>3</sub> Emamectin benzoate 5%SG, T<sub>4</sub> *Bacillus thuringiensis* 1×10<sup>9</sup> CFU/ml, T<sub>5</sub> Azadirachtin 00.03 WSP, T<sub>6</sub> NSKE 5%, T<sub>7</sub> Spinosad 45 SC. T<sub>2</sub> Chlorantraniliprole was found effective against lepidopteran caterpillar *Helicoverpa armigera* along with an additional yield level in chickpea. Further, it was observed that the cost benefit ratio was also high with Chlorantraniliprole 18.5% SC, Emamectin benzoate 5 SG and Spinosad 45% SC. Hence, it is suggested that the effective insecticides may be alternated in harmony with the existing ~~Integrated-integrated~~ pest management programs in order to avoid the problems associated with insecticidal resistance, pest resurgence ~~ete~~.

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UNDER PEER REVIEW

