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# Bioefficacy of Certain Chemicals and Biopesticides against Pod Borer [*Helicoverpa armigera* (Hubner)] on 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 research work was undertaken at Central Research Farm (CRF) Sam Higginbottom University of Agriculture Technology and Sciences SHUATS, Naini, Prayagraj during *rabi* season in 2022 -23 consists of eight treatments including control *viz*, $T_1$- NSKE 5% @ , $T_2$- Neem Oil 5%, $T_3$-*Bacillus thuringiensis*@ 5mg/ml, $T_4$-*Beauveria bassiana*@ 1×1010 conidia/ml, $T_5$-Profenofos 40% + Cypermethrin 4% EC, $T_6$ – Spinosad 45 SC, $T_7$- Emamectin benzoate 5% SG and $T_0$- untreated control in Randomized Block Design (RBD) with three replications. The mean larval population of chickpea pod borer *Helicoverpa armigera* after two spraying revealed that Emamectin benzoate 5% SG @1 gm/lit was found the most efficient among all treatments with larval population of (2.32 larvae/5 plants), highest cost benefit ratio (1:3.87) and marketable yield (29.16q/ha), followed by Spinosad 45 SC @ 0.5 ml/lit with a larval population of (2.60), cost benefit ratio and yield (1:3.27 and 26.66 q/ha), Profenofos 40%+Cypermethrin 4% EC @ 3 ml/lit with a larval population, cost

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benefit ratio and yield (2.77, 1:3.42 and 25.83 q/ha), *Bacillus thuringiensis* @ 5mg/ml with a larval population, cost benefit ratio and yield (3.01, 1:2.93 and 22.5 q/ha*), Beauveria bassiana* @ $1\times10^{10}$ conidia/ml with a larval population, cost benefit ratio and yield(3.24, 1:2.83 and 21.25 q/ha), Neem oil 5% with a larval population, cost benefit ratio and yield(3.49, 1:2.25), NSKE 5% with a larval population, cost benefit ratio and yield(3.77, 1:1.75 and 13.33 q/ha). NSKE 5% is least effective among the treatments and control plot T0 with a larval population, cost benefit ratio and yield (5.84, 1:1.54 and 11 q/ha).

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

## 1. INTRODUCTION

"Gram (*Cicer arietinum*), commonly known as 'chickpea' or chana, is a very important pulse crop in the Leguminosae family. Chickpea is the world's third most important legume crop produced by India, Turkey, Pakistan, Iran, Mexico, Australia, Ethiopia, Myanmar, and Canada with an average annual production of about 9 million tons with 95 % cultivation and consumption occurring in developing countries" [1]. "Currently, chickpea is grown on about 11 million hectares worldwide with 65 % belonging to India and 8 % to Pakistan. In addition to its importance in human food and animal feed, chickpea plays an important role in improving soil fertility by fixing the atmospheric nitrogen. It can fix up to 140kg N per ha from air and meet most of its nitrogen requirement" [1].

"India is the largest chickpea producer as well as consumer in the world with 7.37 million hectares of 5.89 million tons and productivity of 799 kg/ha. The chickpea crop area covered mainly in Madhya Pradesh (32.97%), Maharashtra (18.36%), Rajasthan (16.70%), Andhra Pradesh (8.55%), Karnataka (8.21%), Uttar Pradesh (6.85%) and Gujarat (2.92%). In Karnataka, the crop is grown in an area of 6.05 lakh hectares with a productivity of 937 kg/ha" [2]. The Desi type chickpea contribute to around 80% and the Kabuli type around 20% of the total production. India is the largest producer of this pulse contributing to around 70% of the world's total production. Desi type chickpeas largely dominate the ratio of production in India.

Nevertheless chickpea is attacked by several pests, mainly insects. Sarwar, [3] recorded 57 insect species, namely Lepidoptera as *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae), commonly known as cotton bollworm or American bollworm, is a major noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops [4].

"In India, the extent of losses due to *H. armigera* in chickpea is up to 25%. The crops have been noticed to suffer an avoidable loss of 9 to 60 % by this insect. In Uttar Pradesh alone 15.3% of the chickpea crop worth Rs. 462.5 million is lost annually due to *H. armigera* attack, 17.2% in Karnataka and 28.5 % in Delhi reported that the yield losses of chickpea grain due to *H. armigera* were 75-90 % and in some places the losses were up to 100 %" [5].

The Chemicals and Biopesticides used for spraying are NSKE 5% , Neem Oil 5%, *Bacillus thuringiensis* @ 5mg/ml, *Beauveria bassiana @* $1\times10^{10}$, Profenofos 40% + Cypermethrin 4% EC, Spinosad 45 SC, Emamectin benzoate 5% SG.

The aim of the study was to record and check the efficacy of different chemicals and biopesticides against gram pd borer (*Helicoverpa armigera*) on chickpea.

## 2. MATERIALS AND METHODS

**Study area:** The study was conducted at the experimental research plot of the Department of Entomology, Central Research Farm (lat. 25°27 N; long. 80°50 E; alt. 98m) in Sam Higginbottom University of Agriculture Technology and Sciences, during the *Rabi* season of 2022-23. 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.

**Experiment:** The experiment was conducted in randomized complete block design (RBD) with eight treatments (including control), each with three replications. The plot size taken was $2m^2$ (2m×1m) The crops of chickpea were used for sowing. by maintaining 30 cm inter-row and 10 cm intra-row distance with the seed rate of 60 kg/ha. The spray solution was applied with the help of a hand compression sprayer. Spraying was done at dawn and desk time and there must not be much wind currents.

**Treatments/I:** The Chemicals and Biopesticides used for spraying are NSKE 5% , Neem Oil 5%, *Bacillus thuringiensis* @ 5mg/ml, *Beauveria bassiana* @ 1×1010, Profenofos 40% + Cypermethrin 4% EC, Spinosad 45 SC, Emamectin benzoate 5% SG and untreated control. The insecticidal spray solution of desired concentration as per treatments was freshly prepared every time at the site of experiment just before the start of spraying operations. The quantity of spray materials required for crop was gradually increased as the crop advanced in age.

In each plot the numbers of larva was counted on 5 randomly selected plants in each plot. The pre-treatment count was made a day before the first spray and second spray whereas, the post-treatment counts were made on $3^{rd}$, $7^{th}$ and $14^{th}$ day after each spray. The larval population over control against gram pod borer (*H. armigera*) was calculated by considering the mean of three observations recorded at $3^{rd}$, $7^{th}$, and $14^{th}$ day after first and second spray.

The cost benefit ratio of each treatment was assessed based on net returns. Net return of each treatment was worked out by deducting total cost of the treatment from gross returns. Total cost of production included both cultivation as well as plant protection charges.

Gross return = Marketable Yield x Market price

Net return = Gross return – Total cost

$$\text{Benefit Cost Ratio } = \frac{\text{Net returns}}{\text{Total cost}} \times 100$$

## 3. RESULTS

Result showed that three days after spraying all the treatments were significantly superior over control after first spray. The most effective treatment in reducing number of larval population of gram pod borer was Emamectin benzoate 5SG (2.77 larvae/5 plants) followed by Spinosad 45SC (2.97 larvae/5 plants), Profenofos40%+ Cypermethrin4% (3.10 larvae/5 plants), *Bacillus thuringiensis* @ 5mg/ml (3.33 larvae/5 plants), *Beauveria bassiana* @ $1\times10^{10}$ conidia/ml (3.53 larvae/5 plants), Neem oil 5% (3.79 larvae/5 plants), Neem seed kernal extract 5% (4.08 larvae/5 plants). NSKE 5% was least effective treatment.

Larval population of *Helicoverpa armigera* on three days after spraying reveled that all the treatments were significantly superior over control after second spray.The most effective treatment for controlling the larval population of gram pod borer was Emamectin benzoate 5SG (1.88 larvae/5 plants) which was followed by Spinosad 45SC (2.24 larvae/5 plants), Profenofos40%+Cypermethrin4% (2.44 larvae/5 plants), *Bacillus thuringiensis*@5mg/ml (2.70 larvae/5 plants), *Beauvaria bassiana* @ $1\times10^{10}$ conidia/ml (2.95 larvae/5 plants), Neem oil 5% (3.20 larvae/5 plants), Neem seed kernal extract5% (3.46 larvae/5 plants) is found to be least effective among all the treatments. Maximum number of larvae population was recorded in untreated control (6.37).

The larval population of gram pod borer on Chickpea after first and second spray revealed that allthe insecticidal treatments were significantly superior over control. The most effective treatment for controlling larval population of pod borer was Emamectin benzoate 5SG (2.32 larvae/5 plants) followed by Spinosad 45 SC (2.60 larvae/5 plants), Profenofos 40% + Cypermethrin 4%(2.77 larvae/5 plants), *Bacillus thuringiensis* @ 5mg/ml (3.01 larvae/5 plants), *Beauveria bassiana* @ $1\times10^{10}$ conidia/ml (3.24 larvae/5 plants), Neem oil 5% (3.49 larvae/5 plants), Neem seed kernal extract5% (3.77 larvae/5 plants) was found to be least effective among all the treatments. Maximum number of larvae of *H. armigera* was recorded in control (5.84).

The cost benefit ratio worked out, interesting result was achieved. The best and most economical treatment found was Emamectin benzoate 5% with a cost benefit ratio of (1:3.87), followed by Profenofos 40% + Cypermethrin 4% EC (1:3.42), Spinosad45 (1:3.27), *Bacillus thuringiensis* (1:2.93), *Beauveria bassiana* (1:2.83), Neem oil 5% (1:2.25) and NSKE 5% (1:1.75) was found minimum cost benefit ratio among the treatments over untreated control. Control plot T0 cost benefit ratio was (1:1.54).

**Table 1. Effect of selected chemicals and biopesticides on the larval population of pod borer [*Helicoverpa armigera* (Hubner)] on chickpea after first and second spray**

| Treatments | | Number of larval population/ 5 plants (No.) | | | | | | | | | | | Yield (q/ha) | C:BRatio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st spray | | | | | 2nd spray | | | | | | | |
| | | One day before spray | 3rd DAS | 7 DAS | 14 DAS | Mean | One day before Spray | 3 DAS | 7 DAS | 14 DAS | Mean | Over all mean (1 and 2spray) | | |
| **T0** | Control | 5.00 | $5.20^{a}$ | $5.33^{a}$ | $5.40^{a}$ | $5.310^{a}$ | $5.40^{a}$ | $5.80^{a}$ | $6.73^{a}$ | $6.60^{a}$ | $6.37^{a}$ | 5.84 | 11.00 | 1:1.54 |
| **T1** | Neem seed kernal extract 5% @ 50ml/lit | 5.20 | $4.26^{b}$ | $3.86^{b}$ | $4.13^{b}$ | $4.083^{b}$ | $4.13^{b}$ | $3.86^{b}$ | $3.06^{b}$ | $3.46^{b}$ | $3.46^{b}$ | 3.77 | 13.33 | 1:1.75 |
| **T2** | Neem oil 5% @ 50ml/lit | 5.20 | $4.13^{b}$ | $3.60^{c}$ | $3.66^{c}$ | $3.797^{c}$ | $3.66^{c}$ | $3.60^{c}$ | $2.80^{c}$ | $3.20^{c}$ | $3.20^{bc}$ | 3.49 | 17.08 | 1:2.25 |
| **T3** | *Bacillus thuringiensis*@ 5 mg/ml @ 2gm/lit | 5.33 | $3.53^{d}$ | $3.13^{e}$ | $3.33^{de}$ | $3.330^{d}$ | $3.33^{de}$ | $3.20^{e}$ | $2.26^{e}$ | $2.66^{e}$ | $2.70^{cde}$ | 3.01 | 22.5 | 1:2.93 |
| **T4** | *Beauveria bassiana*@1×10$^{10}$conidia/ml @2gm/lit | 5.13 | $3.80^{c}$ | $3.33^{d}$ | $3.46^{cd}$ | $3.530^{d}$ | $3.46^{cd}$ | $3.40^{d}$ | $2.53^{d}$ | $2.93^{d}$ | $2.95^{bcd}$ | 3.24 | 21.25 | 1:2.83 |
| **T5** | Profenofos40%+Cypermethrin4% EC @ 3ml/lit | 5.33 | $3.33^{de}$ | $2.86^{f}$ | $3.13^{ef}$ | $3.107^{e}$ | $3.13^{ef}$ | $2.80^{f}$ | $2.06^{ef}$ | $2.46^{ef}$ | $2.44^{def}$ | 2.77 | 25.83 | 1:3.42 |
| **T6** | Spinosad 45% SC @ 0.5ml/lit | 5.33 | $3.20^{ef}$ | $2.73^{g}$ | $3.00^{fg}$ | $2.977^{ef}$ | $3.00^{fg}$ | $2.60^{g}$ | $1.86^{f}$ | $2.26^{f}$ | $2.24^{ef}$ | 2.60 | 26.66 | 1:3.27 |
| **T7** | Emamectin benzoate5% SG @1gm/lit | 5.46 | $3.00^{f}$ | $2.53^{h}$ | $2.80^{g}$ | $2.777^{f}$ | $2.80^{g}$ | $2.40^{h}$ | $1.40^{g}$ | $1.86^{g}$ | $1.88^{f}$ | 2.32 | 29.16 | 1:3.87 |
| **Overall Mean** | | 5.24 | 3.40 | 3.42 | 3.61 | 3.61 | 3.61 | 3.45 | 2.83 | 3.17 | 3.15 | 3.38 | | |
| **F- test** | | **NS** | S | S | S | S | S | S | S | S | S | S | | |
| **S. Ed. (±)** | | **0.13** | 0.45 | 0.488 | 0.10 | 0.392 | 0.10 | 0.08 | 0.12 | 0.10 | 0.3 | 0.44 | | |
| **C. D. (P = 0.05)** | | **-** | 0.216 | 0.111 | 0.224 | 0.216 | 0.224 | 0.177 | 0.255 | 0.22 | 0.569 | 1.04 | | |

## 4. DISCUSSION

All the insecticides were found very effective and significantly superior over untreated control. Among all seven treatments minimum larval number of gram pod borer was found using Emamectin benzoate 5% as the similar findings reported by Yadav et al. [6], Rani et al. [7] Abbas et al. [8], Bhamare et al. (2020) and Kambrekar et al. [9] who reported that Emamectin benzoate 5% SG was the most effective treatment to control *Helicoverpa armigera* larval population. The biopesticide Spinosad 45 SC was found to be effective treatment similar finding of Lavanya and Kumar [10], Rashid et al. *[11]*, Gayathri and kumar [12], Kumar et al. [13] reported that Spinosad 45 SC was effective treatment for reducing larval population of *Helicoverpa armigera.* as well Profenofos 40% + Cypermethrin 4% EC was found to be effective in reduction of the number of larva as found by Jadhav et al. [14] who reported that Profenofos 40% + Cypermethrin 4% EC was effective against *Helicoverpa armigera*.

When the cost benefit ratio worked out, the higher cost benefit ratio was obtained from Emamectin benzoate (1:3.87) as the similar findings was done by Shah et al. [15], Bharti et al. [16], and Kambrekar et al. [9] , followed by the Profenofos 40%+Cypermethrin 4% EC exhibited a cost benefit ratio of (1:3.42) as found by Jadhav *et el.* [14] followed by Spinosad 45 SC with a cost benefit ratio of (1:3.27) similar findings of Nitish et al. [17], Keval et al. [18] Choudhary et al. [19] and Chandra et al. [20].

## 5. CONCLUSION

According to the results of the investigation, the management of the gram pod borer (Helicoverpa armigera) shows good potential, and the most effective treatment out of seven is Emamectin benzoate 5 SG. It also gave the highest cost benefit ratio and marketable yield followed by Spinosad 45 SC, Profenofos40%+ Cypermethrin4%, *Bacillus thuringiensis*@ 5mg/ml, *Beauveria bassiana*@ $1{\times}10^{10}$, Neem oil 5%, NSKE 5%. NSKE 5% is least effective among the treatments. These goods also aid in lowering environmental pollution. As a result, it can be effectively included as treatments in an IPM program.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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