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The Pharma Innovation

**ISSN (E): 2277-7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.23**
TPI 2022; 11(7): 3401-3404

www.thepharmajournal.com
Received: 03-04-2022
Accepted: 13-06-2022

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# Field efficacy and economics of different insecticides against pod borer [*Helicoverpa armigera* (Hubner)] on chickpea (*Cicer arietinum* L.)

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**Abstract**
The field trial was conducted at the Central Research Farm (CRF), SHUATS, Naini, Prayagraj during *rabi* season 2021. Consists of eight treatments including control *viz,* $T_1$- Novaluron 10 EC, $T_2$- Flubendiamide 480 SC, $T_3$ - Chlorantraniliprole 18.5 SC, $T_4$- Spinosad 45 SC, $T_5$- *Ha*NPV, $T_6$ NSKE 5%, $T_7$- *Bacillus thuringiensis* and $T_0$- untreated control in RBD with three replications targeting to evaluate the efficacy of selected insecticides on the incidence of *H. armigera* on Chickpea. Data was taken on per cent pod damage of chickpea pod borer. The per cent pod damage of chickpea pod borer *Helicoverpa armigera* on third, seventh and fourteen days after spraying revealed that the treatment Spinosad 45 SC (7.25%) found superior followed by Chlorantraniliprole 18.5 SC (8.76%), Novaluron 10 EC (9.79%), Flubendiamide 480 SC (11.49%), *Ha*NPV (13.20%), *Bacillus thuringiensis* (14.48%) and NSKE 5% (14.81%) as compared to control (21.38%). When the cost benefit ratio was worked out, the results were quite interesting. Among the treatments studied, the best and most economical treatment was Spinosad 45 SC (1:2.41), followed by Chlorantraniliprole 18.5 SC (1:2.37), Novaluron 10 EC (1:2.31), Flubendiamide 480 SC (1:2.15), *Ha*NPV (1:1.97), *Bacillus thuringiensis* (1:1.77) and NSKE 5% (1:1.69) as compared to Control (1:1.26).

**Keywords:** Chickpea, *Cicer arietinum,* economics, efficacy, *Helicoverpa armigera*, insecticides

## Introduction

Chickpea (*Cicer arietinum* L.), a member of Fabaceae, belongs to family "Leguminosae", subfamily "Papilonidae" having diploid number of chromosomes 2n=16 is an important pulse crop. It is a self-pollinated crop and is second most important food legume crop after common bean. (Gayatri L and Kumar A 2021) [6]. which has been considered as 'King of Pulses'. It is generally grown under rainfed or residual soil moisture conditions in Rabi season and the plant grows to 20-50 cm height and has small, feathery leaves on either side of the stem. (Spoorthi *et al.*, 2017) [17].

There are two types of chickpea based upon seed size, color and shape known as Desi and Kabuli. Desi type contributes about 85% of world annual chickpea production while kabuli type contributes 15%. (Abbas *et al.*, 2021) [1] It contains an excellent source of the essential nutrients *viz*., 21 per cent protein, 2.2 per cent fat and 62 per cent carbohydrates. It also contains calcium of about 190 mg/100g, Iron 90.5 mg/100g and Phosphorus 280 mg/100g. Chickpea is a very important component of cropping systems of the dry and rainfed areas because it can fix 80 to 120 kg nitrogen per hectare through symbiotic nitrogen fixation (Singh *et al.*, 2015) [16].

The per cent chickpea crop area covered in major states India is Madhya Pradesh (32.97%), Maharashtra (18.36%), Rajasthan (16.70%), Andra Pradesh (8.55%), Karnataka (8.21%), Uttar Pradesh (6.85%) and Gujarat (2.92%). In India, the area under chickpea was 7.37 million hectares with a production of 5.89 million tonnes with productivity of 799 kg/ha. In Karnataka, the crop is grown in an area of 6.05 lakh hectares with a productivity of 937 kg/ha. (Prasanna *et al.*, 2020) [13].

Among biotic factors chickpea is infested by nearly 60 insects' species in which cutworm, *Agrotis ipsilon* (Ratt.), gram pod borer, *Helicoverpa armigera* (Hub.), semilooper, *Autographa nigrisigna* (Walk.), and aphid, *Aphis craccivora* (Koch.) are the pests of major importance. Among these, the major damage is caused by gram pod borer which is polyphagous in nature; *H. armigera* is one of the serious pests of chickpea, which feeds more than 150 crops throughout the world. (Vikrant *et al*., 2018) [19].

## Materials and Methods

The experiment was conducted during *rabi* season 2021 at Central Research Field (CRF) of Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, Uttar Pradesh, India, in a randomized block design with eight treatments replicated three times using variety Chirag Var seeds in a plot size of 2m×2m at a spacing of 30cm ×10cm with a recommended package of practices excluding plant protection. The soil of the experimental site was well drained and medium high. The population of gram pod borer recorded one day before spraying and on 3rd day, 7th day and 14th day after insecticidal application. The populations of gram pod borer were recorded on 5 randomly selected and tagged plants from each plot and then it was converted into percent of damage by following formula. Percentage pod damage was calculated with the following formula suggested by Gayathri and Kumar (2021) [6].

$$\% \text{ pod damage} = \frac{\text{No of infested pods}}{\text{Total no of pods}} \times 100$$

## Preparation of insecticidal solution

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.

The spray solution of desired concentration was prepared by adoption the following formula: Nitharwal *et al.* (2017) [12].

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

Where

V= Volume of a formulated pesticide required.

C= Concentration required.

A= Volume of total solution to be prepared.

% a.i. = given Percentage strength of a formulated pesticide.

## Cost Benefit ratio

Cost effectiveness 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

$$\text{Benefit Cost Ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

## Results and Discussion

The result of the expriment evalution of different insecticides and biopesticticides against pod borer *Helicoverpa armigera* (Hubner) on chickpea (*Cicer arietinum* L.) to study cost benefit ratio during *rabi*, 2021. The data so obtained through observation on various aspects were subjected to statistical analysis wherever necessary and the compiled mean data are tabulated in the following pages. Results thus obtained is presented aspect wise here under.

The data on the percent infestation of pod damage of gram pod borer on Chickpea 3rd, 7th and 14th day after first spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments $T_4$ Spinosad 45 SC (7.85%) was found to be the most effective treatment among all followed by $T_3$ chlorantraniliprole 18.5 SC (9.72%), $T_1$ Novaluron 10 EC (10.73%), $T_2$ Flubendiamide 480 SC (12.43%), $T_5$ *Ha*NPV (14.04%), $T_7$ *Bacillus thuringiensis* (15.43%) and $T_6$ NSKE 5% (15.69%) was least effective among all the treatments. Control plot $T_0$ (19.33%) infestation.

**Table 1:** Effect of certain insecticides on the incidence of gram pod borer (*H. armigera*) on chickpea during *rabi* season of 2021-22 (First spray)

| Treatments | | Per cent pod damage | | | | |
|---|---|---|---|---|---|---|
| | | | After spray | | | |
| | | 1DBS | 3rd Day | 7th Day | 14th Day | Mean |
| $T_0$ | Control | 16.92 | 17.53 | 18.49 | 21.99 | 19.33 |
| $T_1$ | Novaluron 10EC | 15.61 | 10.43 | 8.79 | 12.98 | 10.73 |
| $T_2$ | Flubendiamide 480 SC | 15.66 | 12.31 | 10.36 | 14.63 | 12.43 |
| $T_3$ | Chlorantraniliprole 18.5 SC | 15.35 | 9.31 | 7.97 | 11.89 | 9.72 |
| $T_4$ | Spinosad 45 SC | 15.24 | 7.26 | 5.67 | 9.61 | 7.85 |
| $T_5$ | *Ha*NPV | 15.60 | 13.69 | 12.04 | 16.40 | 14.04 |
| $T_6$ | NSKE 5% | 15.94 | 15.20 | 13.84 | 18.02 | 15.69 |
| $T_7$ | *Bacillus thuringiensis* 1 X $10^9$ FU/ml | 15.61 | 14.91 | 13.55 | 17.85 | 15.43 |
| Overall Mean | | 15.74 | 12.58 | 11.34 | 15.42 | 13.15 |
| F- test | | NS | S | S | S | S |
| S. Ed. (±) | | 0.444 | 0.704 | 0.488 | 0.745 | 0.392 |
| C. D. (P = 0.05) | | - | 1.512 | 1.814 | 1.598 | 0.842 |

DBS = Day before Spray

The data on the percent infestation of pod damage of gram pod borer on Chickpea 3rd,7th and 14th day after second spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments $T_4$ Spinosad 45 SC (6.66%) was found to be the most effective treatment among all followed by $T_3$ chlorantraniliprole 18.5 SC (7.79%), $T_1$ Novaluron 10 EC (8.86%), $T_2$ Flubendiamide 480 SC (10.55%), $T_5$ *Ha*NPV (12.36%), $T_7$ *Bacillus thuringiensis* (13.53%) and $T_6$ NSKE 5% (13.93%) was least effective among all the treatments. Control plot $T_0$ (23.42%) infestation.

**Table 2:** Effect of certain insecticides on the incidence of gram pod borer (*H. armigera*) on chickpea during *rabi* season of 2021-22 (Second spray)

| Treatments | | Per cent pod damage | | | | |
|---|---|---|---|---|---|---|
| | | 1DBS | After spray | | | |
| | | | 3rd Day | 7th Day | 14th Day | Mean |
| T0 | Control | 21.99 | 22.09 | 23.90 | 24.27 | 23.42 |
| T1 | Novaluron 10EC | 12.98 | 8.85 | 6.81 | 10.92 | 8.86 |
| T2 | Flubendiamide 480 SC | 14.63 | 10.54 | 8.52 | 12.58 | 10.55 |
| T3 | Chlorantraniliprole 18.5 SC | 11.89 | 7.75 | 5.77 | 9.87 | 7.79 |
| T4 | Spinosad 45 SC | 9.613 | 6.17 | 5.31 | 8.51 | 6.66 |
| T5 | *Ha*NPV | 16.40 | 12.21 | 10.43 | 14.31 | 12.36 |
| T6 | NSKE 5% | 18.02 | 13.94 | 11.90 | 15.96 | 13.93 |
| T7 | *Bacillus thuringiensis* 1 X $10^9$ CFU/ml | 17.85 | 13.56 | 11.38 | 15.65 | 13.53 |
| Overall Mean | | 15.424 | 11.89 | 10.50 | 14.01 | 12.14 |
| F- test | | S | S | S | S | S |
| S. Ed. (±) | | 0.745 | 0.688 | 0.537 | 0.204 | 0.630 |
| C. D. (P = 0.05) | | 1.598 | 1.477 | 1.154 | 1.396 | 1.352 |

DBS = Day before Spray.

**Table 3:** Economics of Cultivation

| SR. No: | Treatment | Yield of q/ha | Cost of yield (₹) | Total cost of yield (₹) | Common cost (₹) | Treatment cost (₹) | Total cost (₹) | B:C ratio |
|---|---|---|---|---|---|---|---|---|
| $T_1$ | Novaluron 10EC | 22.00 | 5500 ₹/q | 121000 | 48210 | 3950 | 52160 | 1:2.31 |
| $T_2$ | Flubendiamide 480 SC | 21.66 | 5500 ₹/q | 119130 | 48210 | 6980 | 55190 | 1:2.15 |
| $T_3$ | Chlorantraniliprole 18.5 SC | 22.75 | 5500 ₹/q | 125125 | 48210 | 4460 | 52670 | 1:2.37 |
| $T_4$ | Spinosad 45 SC | 23.61 | 5500 ₹/q | 129855 | 48210 | 5522 | 53732 | 1:2.41 |
| $T_5$ | *Ha*NPV | 18.33 | 5500 ₹/q | 100815 | 48210 | 2772 | 50982 | 1:1.97 |
| $T_6$ | NSKE 5% | 15.66 | 5500 ₹/q | 86130 | 48210 | 2500 | 50710 | 1:1.69 |
| $T_7$ | *Bacillus thuringiensis* 1 X $10^9$ CFU/ml | 16.50 | 5500 ₹/q | 90750 | 48210 | 2940 | 51150 | 1:1.77 |
| $T_0$ | Control | 11.08 | 5500 ₹/q | 60940 | 48210 | - | 48210 | 1:1.26 |

## Discussion

All the insecticides were found very effective and significantly superior over untreated control. The minimum par cent pod damage was recorded in $T_4$ Spinosad 45 SC with a minimum per cent of infestation of pod borer (7.25%) as the similar findings was reported by Upadhyay *et al*. (2020) [18] (6.67%), Chitralekha and Verma. (2018) [4]. (10.3%), $T_3$ chlorantraniliprole 18.5 SC was found to be the next best treatment with a minimum per cent of infestation of pod borer (8.76%) as the similar findings was made by Sarnaik *et al.* (2017) [15] (7.14%). Khorasiya *et al*. (2018) [7] (13.78%). $T_1$ Novaluron 10 EC was found as the next effective treatment with a minimum per cent of infestation (9.79%) as the similar findings was made by Upadhyay *et al*. (2020) [18] (10.67%). $T_2$ Flubendiamide 480 SC was found to be the next best treatment with a minimum per cent of infestation of pod borer (11.49%) as the similar findings was made by Nikoshe *et al*. (2015) [11] (12.13%). $T_5$ *Ha*NPV was the next effective treatment with a minimum per cent of infestation (13.20%) as the similar findings was made by Meena *et al*. (2018) [10] (11.83%), Kumar *et al*. (2019) [8] (15.43%), Khorasiya *et al.* (2018) [7] (15.25%). $T_7$ *Bacillus thuringiensis* was the next effective treatment with a minimum per cent of infestation (14.48) as the similar findings was made by Kumar *et al.* (2019) [8] (14.10%), Meena *et al*. (2018) [10] (12.10%). T6 NSKE 5% was the next effective treatment with a minimum per cent of infestation (14.81%) as the similar findings was made by Kumar *et al*. (2019) [8] (13.45%).

## Benefit Cost Ratio

Higher cost benefit ratio (1:2.41) was obtained from $T_4$ Spinosad 45 SC as the similar finding was made by Nitharwal *et al*. (2017) [12] (1:2.40), Chandra *et al.* (2017) [3] (1:2.36), Lavanya and Kumar (2022) [9] (1:3.01). the study revealed the treatment $T_3$-Chlorantraniliprole 18.5 SC has the cost benefit ratio of (1:2.37) as the similar findings were made by Khorasiya *et al.* (2018) [7] (1:2.78), the treatment $T_1$ Novaluron 10 EC exhibited the benefit cost ratio of (1:2.31) as the similar findings were made by Upadhyay *et al*. (2020) [18] (1:2.15). the treatment $T_2$ Flubendiamide 480 SC exhibited the benefit cost ratio of (1:2.15) as the similar findings were made by Dinesh *et al*. (2017) [5] (1:1.42), Lavanya and Kumar (2022) [9] (1:1.96). the treatment $T_5$ *Ha*NPV exhibited the benefit cost ratio of (1:1.97) as the similar findings were made by Dinesh *et al.* (2017) [5] (1:1.35), Byrappa (2012) [2] (1:1.62). the treatment $T_7$ *Bacillus thuringiensis* exhibited the benefit cost ratio of (1:1.77) as the similar findings were made by Sai *et al.* (2020) [14] (1:1.64), Byrappa *et al.* (2012) [2] (1:1.83), Dinesh *et al*. (2017) [5] (1:1.22). The minimum cost benefit ratio (C: B) was recorded in $T_6$ NSKE 5% (1:1.69) as the similar findings were made by Chandra *et al.* (2017) [3] (1:1.20), Sai *et al.* (2020) [14] (1:2.23).

## Conclusion

From the findings present investigated holds a good promise in the gram pod borer (*Helicoverpa armigera*) management and it showed that Spinosad 45% SC is most effective out of seven treatments. It also gave the highest cost benefit ratio and marketable yield. Chlorantraniliprole, Novaluron, Flubendiamide, *Ha*NPV, *Bacillus thuringiensis*, NSKE 5% also effective control on gram pod borer. NSKE 5% is least effective among the treatments. These plant products also helps in reducing pollution in the environments. Hence it can be suitably incorporated as treatments in IPM programme.

**Acknowledgements**
The authors are grateful to Prof. (Dr.) Rajendra B. Lal Hon'ble Vice Chancellor SHUATS, Prof. (Dr.) Shailesh Marker, Director of research, (Dr.) Deepak Lal, Dean of Pg studies, Prof. (Dr.) Gautam Gosh, Dean, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology And Sciences, for taking their keen interest and encouragement to carry out this research work.

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