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# Efficacy and economics of different insecticides against gram pod borer, *Helicoverpa armigera* (Hubner)

**Mubashir Moosan and Ashwani Kumar**

**Abstract**
The research work entitled "Evaluation of different insecticides against gram pod borer, *Helicoverpa armigera* (Hubner)" was undertaken at CRF, Prayagraj, Allahabad, Uttar Pradesh, with eight treatments including control viz. (T1) HMO-Horticulture Mineral oil, (T2) *Beauveria bassiana*, (T3) *Metarhizium anisopliae*, (T4) *Bacillus thuringiensis* Var. *Krustaki*, (T5) Neem oil, (T6) Emamectin benzoate 5% SG, (T7) Novaluron and (T0) Untreated control in RBD with three replications targeting for the evaluation of different insecticides against gram pod borer, *H. armigera*. Data was taken on chickpea pod borer population. The larval population of chickpea pod borer *H. armigera* on third, seventh and fourteen days after spraying revealed that the Effective treatment for pod borer is T6-Emamectin benzoate followed by T7-Novaluron, T4-*Bacillus thuringiensis* Var. *Krustaki*, T2-*Beauveria bassiana* and T3-*Metarhizium anisopliae* and among the botanicals and petroleum byproducts, the best treatment with minimum percentage of pod borer was recorded in T5-Neem oil followed by T1-HMO. The B:C ratio of various insecticides treatments were calculated and interesting results were achieved. The maximum B:C ratio (1:4.8) was recorded for T6-Emamectin benzoate followed by T7-Novaluron (1:4.5), T4-*Bacillus thuringiensis* Var. *Krustaki* (1:4.1), T2-*Beauveria bassiana* (1:3.9), T3-*Metarhizium anisopliae* (1:3.8), T5- Neem oil (1:3.6), T1-HMO (1:3.3) and the minimum B:C ratio was noted in T0-Control plot (1:2.3).

**Keywords:** Economics, efficacy, insecticides, *Helicoerpa armigera* pod borer

## Introduction

Gram (chick pea) is the crop of tropical, subtropical and temperate region and widely grown in Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan and Maharashtra which is popularly used as a protein adjunct to starchy diets. Seeds are widely consumed as pulse and in the form of flour which is largely fed to the horse and eaten after roasting. Seeds of chick pea contain 17.1% proteins, 5.3% fats, 16.2% carbohydrates, 3.9% fibres and 2.7% minerals. (Gautam *et al.*, 2018) [5]

Chickpea (*Cicer arietinum* L.) is grown widely in the world because the seeds are a rich source of protein for the rapidly increasing population. However, the production and productivity of chickpea have been experienced drastically because of biotic and abiotic stresses. It is vulnerable to a broad range of pathogens and the mainly severe pest being gram pod borer, *H. armigera* (Hübner). *H. armigera* is a cosmopolitan and widely distributed insect pest in the world. It is a serious pest of all legumes. (Meena *et al.*, 2018) [11].

Gram commonly known as a 'chickpea' or chana is a very important pulse crop that grows as a seed of a plant named Cicer arietinum in the Leguminosae family. India is the largest chickpea producer as well as consumer in the world. Chickpea is the world's third most important food legume. It contains 25% proteins, which is the maximum provided by any pulse and 61.1% carbohydrates. However, high yield is limited by the insect pests attacking chickpea. Chickpea is attacked by 57 insect species among them *H. armigera* (Lepidoptera: Noctuidae), is a highly polyphagous pest which infests many host plants. The *H. armigera*, commonly known as cotton bollworm or American bollworm, is a major polyphagous noctuid pest in Asia, causing heavy damage to agricultural, horticultural and ornamental crops. *H. armigera* is the most serious pest of chickpea and other crop plants all over the world. In severe cases, it causes about 75 to 90% losses in seed yield, and it was pointed out that gram pod borer damage leaves, tender shoots, apical tips, floral buds and pods. Many conventional and modern techniques of pest control have been tested in an attempt to avoid the losses caused by the chickpea pod borer. (Jerusha *et al.*, 2018) [8]

**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 PUSA 362 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.

$$\text{Percent of pod damage} = \frac{\text{Number of infected pods}}{\text{Total number of pods}} \times 100$$

**Cost benefit ratio of treatments**

Cost effectiveness of each treatment was assessed 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

$$\text{B:C Ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

**Results and Discussion**

All the insecticides were found very effective and significantly superior over untreated control. Through observation and calculations, it was found out that, the effective treatment of mean larval population of pod borer is T6-Emamectin benzoate (0.733), followed by T7-Novaluron (0.933), T4-*Bacillus thuringiensis* Var. Krustaki (1.6), T2-*Beauveria bassiana* (1.6) and T3-*Metarhizium anisopliae* (1.889). Then comes botanicals and petroleum products. Among the botanicals and petroleum byproducts the best treatment with minimum percentage of pod borer was recorded in T5-Neem oil (1.956) followed by T1-HMO (2.6). All treatments were significantly superior over the control T0 (3.22).

T6-Emamectin benzoate was found to be the best treatment with a minimum percent of infestation of pod borer and minimum larval population (0.733) and a maximum yield (2050 Kg/ha) as it was supported by Tekam *et al. (*2018) [14] with similar value of 0.32 and also by Chitralekha *et al. (*2018) [4] with a similar value of 1.51.

T7-Novaluron was found as the next effective treatment with a minimum larval population (0.933) and yield of (1966.7 kg/ha) as it was supported by Chitralekha *et al. (*2018) [4] with a similar value of 0.97.

T4-*Bacillus thuringiensis Var. Krustaki*, was found as the next effective treatment with a minimum larval population (1.6) and yield of (1750 kg/ha) as it was supported by Bhagat *et al* (2020) [7] with similar value of 0.92 and by Chitralekha *et al.* (2018) [4] with a similar value of 1.55.

T2-*Beauveria bassiana* was found as the next effective treatment with a minimum larval population (1.6) and yield of (1666.7 kg/ha) as it was supported by Bajya *et al.* (2015) [3] with similar value of 1.67 and Bhagat *et al* (2020) [7] with similar value of 0.92.

T3-*Metarhizium anisopliae* was found as the next effective treatment with a minimum larval population (1.889) and yield of (1639 kg/ha) as it was supported by Tekam *et al.* (2018) [14] with similar value of 1.45 and by Adsure and Mohite. (2015) [1] with similar value of 0.92.

Among the botanicals and petroleum byproducts the best treatment with minimum percentage of pod borer was recorded in the botanical- Neem Oil. T5- Neem Oil found as the next effective treatment with a minimum larval population (1.956) and yield of (1550 kg/plot) as it was supported by Gautam *et al.* (2018) [5] with a similar value of 1.00, Kumar *et al.* (2018) [10]. T1-HMO found as the next effective treatment with a minimum larval population (2.6) and yield of (1416.7 kg/ha).

**Cost-Benefit ratio**

The study revealed the treatment with emamectin benzoate 5 WG @ 15.0 g a.i./ha was found as best treatment with minimum larval population of *H. armigera*. as well as cost benefit ratio (1:4.8). Similar finding of value 1:2.02 was made by Sarnaik *et al.* (2017) [13]

The treatment with Novaluron was found as second-best treatment with minimum larval population of *H. armigera* as well as cost benefit ratio (1:4.5). Similar findings were made by similar finding of value 1:2.76 by Babar *et al*. (2012) [2].

The treatment with *Beauveria bassiana* found to be a sustainable and efficient treatment *with a* cost benefit ratio of 1:3.90. Similar findings were made by similar finding of value 1:12.6 by Ghugal *et al*. (2013) [6].

The treatment with *Metarhizium anisopliae* found to be an efficient treatment *with a* cost benefit ratio of 1:3.80. Similar findings were made by similar finding of value 1:5.59 by Ghugal *et al*. (2013) [6]. The treatment with *Bacillus thuringiensis Var. Krustaki* found to be an efficient treatment *with a* cost benefit ratio of 1:4.1. Similar findings were made by similar finding of value 1:4.91 by Kumar *et al.* (2019) [9].

The treatment with Neem oil found to be an efficient organic treatment *with a* cost benefit ratio of 1:3.6. Similar findings were made by similar finding of value 1:2.41 by Santhosh, K., and Kumar, A. (2022) [12]. The minimum C: B ratio was noted in T1-HMO (1:3.3) followed by T0-Control plot (1:2.3).

**Table 1:** Field efficacy of different insecticides against gram pod borer, *H. armigera* during *rabi* season of 2021-2022-(First spray)

| Treatment | | Larval population of *H. armigera*/five plants (First spray) | | | | Mean |
|---|---|---|---|---|---|---|
| | | 1 DBS | 3 DAS | 7 DAS | 14 DAS | |
| T0 | Control | 3.67 | 3.73 | 3.53 | 3.53 | 3.60 |
| T1 | HMO- Horticulture mineral oil (3%) | 3.73 | 3.20 | 3.00 | 2.87 | 3.02 |
| T2 | *Beauveria bassiana* 1.5% L.F | 3.53 | 2.93 | 2.60 | 2.26 | 2.60 |
| T3 | *Metarhizium anisopliae* | 3.67 | 3.00 | 2.67 | 2.33 | 2.66 |
| T4 | *Bacillus thuringiensis Var. Krustaki* 0.5% WP | 3.53 | 3.00 | 2.53 | 2.20 | 2.57 |
| T5 | Neem oil | 3.67 | 3.13 | 2.80 | 2.60 | 2.84 |
| T6 | Emamectin Benzoate 5% SG | 3.33 | 2.53 | 1.93 | 1.53 | 2.00 |
| T7 | Novaluron 10% EC | 3.46 | 2.66 | 2.00 | 1.60 | 2.08 |
| | F-Test | NS | S | S | S | _ |
| | S.Ed(+) | NA | 0.27 | 0.27 | 0.25 | _ |
| | C.D(5%) | | 0.76 | 0.76 | 0.70 | _ |

DAS: Day After Spray; NS-Non-Significant; S-Significant.

**Table 2:** Field efficacy of different insecticides against gram pod borer, *H. armigera* during *rabi* season of 2021-2022-(Second spray)

| Treatment | | Larval population of *H. armigera*/five plants (second spray) | | | |
|---|---|---|---|---|---|
| | | 3 DAS | 7 DAS | 14 DAS | Mean |
| T0 | Control | 3.20 | 3.40 | 3.06 | 3.22 |
| T1 | HMO-Horticulture mineral oil (3%) | 2.66 | 2.60 | 2.53 | 2.60 |
| T2 | *Beauveria bassiana* 1.5% L.F | 1.80 | 1.53 | 1.46 | 1.60 |
| T3 | *Metarhizium anisopliae* | 2.00 | 1.86 | 1.80 | 1.88 |
| T4 | *Bacillus thuringiensis Var. Krustaki* 0.5% WP | 1.80 | 1.60 | 1.40 | 1.60 |
| T5 | Neem oil | 2.06 | 1.93 | 1.86 | 1.95 |
| T6 | Emamectin Benzoate 5% SG | 0.93 | 0.73 | 0.53 | 0.73 |
| T7 | Novaluron 10% EC | 1.13 | 0.93 | 0.73 | 0.93 |
| | F-Test | S | S | S | _ |
| | S.Ed(+) | 0.25 | 0.26 | 0.24 | |
| | C.D (5%) | 0.69 | 0.72 | 0.67 | _ |

DAS: Day After Spray; NS-Non-Significant; S-Significant.

**Table 3:** Economics of the treatments

| Treatment symbols | Treatments | Yield (kg/ha) | Gross return (₹)/ha) | Total cost of cultivation (₹) | Net return (₹) | B:C Ratio |
|---|---|---|---|---|---|---|
| T0 | Control | 966.00 | 53130 | 22320 | 30810 | 1:2.3 |
| T1 | HMO-Horticulture mineral oil (3%) | 1416.67 | 77916 | 23325 | 54591 | 1:3.3 |
| T2 | *Beauveria bassiana* 1.5% L.F | 1666.67 | 91666 | 23345 | 68321 | 1:3.9 |
| T3 | *Metarhizium anisopliae* | 1638.89 | 90138 | 23470 | 66668 | 1:3.8 |
| T4 | *Bacillus thuringiensis* Var. *Krustaki* 0.5% WP | 1750.00 | 96250 | 23620 | 72630 | 1:4.1 |
| T5 | Neem oil | 1555.00 | 85525 | 23620 | 61905 | 1:3.6 |
| T6 | Emamectin benzoate | 2050.00 | 112750 | 23615 | 89135 | 1:4.8 |
| T7 | Novaluron 10% EC | 1966.00 | 108130 | 24020 | 84110 | 1:4.5 |

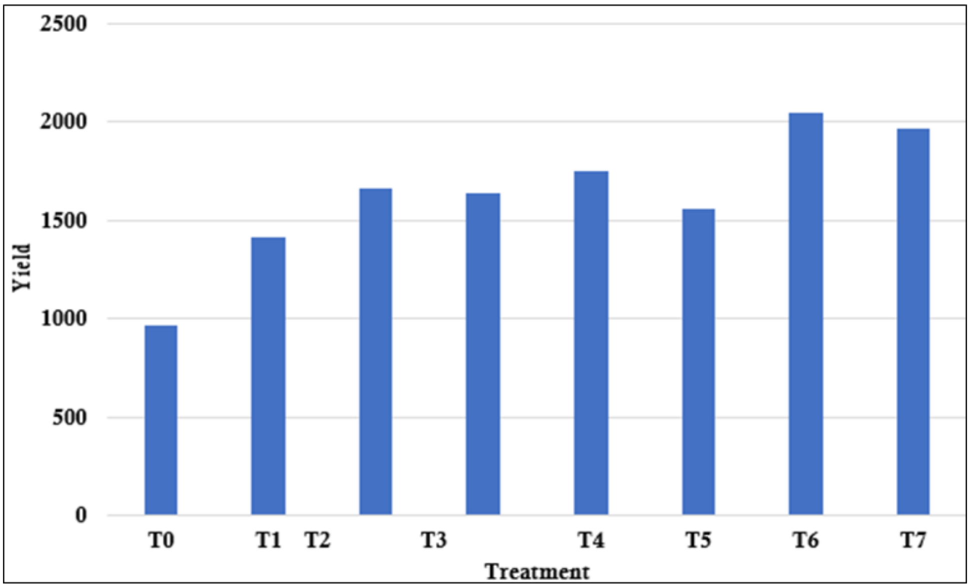


**Fig 1:** Graphical representation of yield of chickpea influenced by different treatments

**Conclusion**

From the view of the present analysis, it can be concluded that for controlling the chickpea pod borer, the insecticides Emamectin benzoate, Novaluron were most efficient and economical. Bio pesticides like *Bacillus thuringiensis* Var. *Krustaki*, *Beauveria bassiana* and *Metarhizium anisopliae* were also very much efficient. These bio pesticides can be easily incorporated in Integrated Pest Management Programme as an effective tool against gram pod borer as they are less burden to the nature and human health. Neem oil which is a botanical and very much used in organic agriculture promises minimum control and a petroleum byproduct like HMO-Horticultural mineral oil seems to provide the least control against Chick pea pod borer.

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