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# Comparative efficacy of *Bacillus thuringiensis* with botanicals and chemicals against gram pod borer *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) on cowpea [*Vigna unguiculata* (L.) Walp.]

**Sindhuja Yerrabala, Halavath Sai Kumar and Usha Yadav**

**Abstract**
The present field studies were conducted during Kharif 2019 at Central agriculture field, SHUATS (Sam Higginbottom University of Agriculture, Technology, and Sciences), Allahabad, Uttar Pradesh (India). The results revealed that all the eight treatments *Bacillus thuringiensis*, neem seed kernel extract (NSKE), garlic chilli kerosene extract (GCKE), neem leaf extract, neem oil, fipronil, cypermethrin reduced the infestation as compared to the untreated control. The minimum percent of infestation was observed in fipronil 5% SC (1.51) followed by cypermethrin 25 EC (1.79), *Bacillus thuringiensis* (2.20), neem seed kernel extract 5% (2.29), neem oil 5% (2.58), garlic chilli kerosene extract 5% (2.75), neem leaf extract 5% (3.10). In an assessment of the cost-benefit ratio, interesting results were achieved. Among the treatment studied, the best and most economical treatment was T6 fipronil 5 SC (1:1.90) followed by T7 cypermethrin 25EC (1:1.70), T1 *Bacillus thuringiensis* (1:1.60), T2 neem seed kernel extract (1:1.54), T5 neem oil (1:1.34), T3 garlic chilli kerosene extract (1:1.40), T4 neem leaf extract (1:1.10) as compared to T0 Control.

**Keywords:** Cowpea, *Helicoverpa armigera*, *Bacillus thuringiensis*, botanicals, chemicals, cost-benefit ratio

## Introduction
The cowpea (*Vigna unguiculata* L.) is an annual herbaceous legume from the genus vigna belonging to the family Leguminosae. It is an important grain legume in the tropics and sub-tropics. It is native to central Africa and is eaten in the form of grains, green pods, and leaves. The roots are eaten in Sudan and Ethiopia and the peduncles and stems are used as fibers in Nigeria. Cowpea is known as vegetable meat due to the high amount of protein in the grain with better biological value on a dry weight basis. Cowpea is usually preferred by farmers because of its role in increasing soil fertility through nitrogen-fixation and the production of nutritious fodder for livestock. (Oyewale 2013).

Rough estimates indicate that annual global production is around 2 million tons from an area of 5 million hectares. India accounts for about 0.9 million tons of production from an area of around 1.5 million ha. In India, cowpea is grown in almost 1.3 m ha particularly in Western, Central, and peninsular regions in some of the Indian states including Maharashtra. In India, the major area under grain cowpea is confined to the states of Uttar Pradesh, Karnataka, Tamil Nadu, Andhra Pradesh, and Kerala where it is mainly sown as a mixed crop with other legumes and cereals. Despite its importance in food farming, the acreage and production are not being recorded in the crop census of the country as it is rarely grown as an entire crop. (Lakshmikanth and Kumar 2018) [11].

Cowpea seed is a nutritious component in the human diet and cheap livestock feed as well and hence considered as vegetable meat due to the high amount of protein in the grain with better biological value on a dry weight basis. Both green and dried seeds are suitable for canning and boiling as well. The nutritive value of 100 gm of cowpea contains water-70.4 g, energy- 336 kcal, Carbohydrates-20.76 g, Protein-7.73 g, Lipid-0.53 g, Iron-0.005%, fiber-6.5 g, sugar-3.30 g, calcium-24 mg, iron (Fe)-2.51 mg, magnesium (Mg)-53, phosphorous (P)-156 mg, potassium (K)-278, sodium (Na)-4 mg, zinc (Zn)-1.29 mg, vitamin C-0.4 mg, thiamin-0.202 mg, riboflavin-0.055 mg, niacin-0.495 mg, vitamin B6-0.100, folate-208 µg, vitamin A-1 µg, vitamin K -1.7 µg. (USDA).

Gram Pod borer *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is one of the major insect pests of cowpea and has great economic importance (Ahmed and Awan, 2013) [2].

It is the most devastating insect pest of grain legumes in the tropics and subtropics because of its extensive host range, distribution, and destructiveness. *Helicoverpa armigera* is a polyphagous pest that feeds on almost 182 plant species which belongs to 47 families and had attained a status of national pest, due to its destructiveness at critical stages of crop growth *viz*., flowering and pod development stages especially to the economic plant parts such as flowers and pods, it become as a significant constraint to attain the maximum productivity from grain legumes.

The caterpillars of gram pod borer not only defoliate the leaves but also feed on seeds. While feeding on the developing seeds it's nearly half of the anterior body portion remains inside while the rest of the half portion remains hanging outside. A single larva may destroy 30-40 pods before it reaches maturity. The caterpillars feed on their fellows if suitable vegetation is not available i.e., cannibalism. They pupate in the soil. The pod damage due to *Helicoverpa armigera* on cowpea crop could increase up to 100% in India. The best way to overcome this damage is to destroy the pest at its initial stage of the life cycle.

## Materials and Methods

The trial was conducted in Kharif, season 2019 the central research field, SHUATS, Allahabad (U.P.). The trial was laid out in a randomized block design consisting of eight different treatments. Each treatment was replicated thrice and Cowpea variety Lafa (super long) was used for the study. After observing a sufficient level of insect population, the application of treatments for the management of the gram pod borer was undertaken. The data were subjected to statistical analysis. The yield per plot was also recorded.

## Results and Discussion

### Evaluation of *Bacillus thuringiensis* with botanicals and chemicals against gram pod borer [*Helicoverpa armigera*] (Hubner) on cowpea. (First spray)

The data on the percent infestation of gram pod borer on three days after spray revealed that Bt. botanicals and chemical treatments were significantly superior over control. Among all the treatments lowest percent infestation of gram pod borer was recorded in (T6) fipronil 5 SC (2.20) followed by (T7) Cypermethrin 25 EC (2.47), (T1) *Bacillus thuringiensis* (3.07), (T2) Neem seed kernel extract 5% (3.13), (T5) Neem oil 5% (3.20), (T3) Garlic chilli kerosene extract 5% (3.53). Treatment Neem leaf extract 5% (4.13) was the least effective among all the treatments. All the treatments were found to significantly differ over control.

The data on the percent infestation of gram pod borer on seven days after spray revealed that botanicals and chemical treatments were significantly superior over control. Among all the treatments highest reduction of pod borer population was recorded in (T6) fipronil 5 SC (1.80) followed by (T7) Cypermethrin 25 EC (2.00), (T1) Bacillus thuringiensis (2.60), (T2) Neem seed kernel extract 5% (2.73), (T5) Neem oil 5% (2.93), (T3) garlic chilli kerosene extract 5% (3.13). Treatment neem leaf extract 5% (3.67) was the least effective among all the treatments. All the treatments were found to significantly differ over control.

The data on the percent infestation of gram pod borer on fourteen days after spray revealed that botanicals and chemical treatments were significantly superior over control. Among all the treatments highest reduction of pod borer population was recorded in (T6) fipronil 5 SC (1.93) followed by (T7) Cypermethrin 25 EC (2.13), (T1) *Bacillus thuringiensis* (2.80), (T2) Neem seed kernel extract 5% (2.87), (T5) Neem oil 5% (3.13), (T3) garlic chilli kerosene extract 5% (3.40). Treatment Neem leaf extract 5% (3.93) was the least effective among all the treatments. All the treatments were found to significantly differ over control.

The mean data of the first spray (3, 7 & 14 days after spray) on the percent infestation of gram pod borer revealed that all treatments were significantly superior over control. Among all the treatments highest reduction of pod borer population was recorded in (T6) fipronil 5 SC (1.98) followed by (T7) Cypermethrin 25 EC (2.20), (T1) *Bacillus thuringiensis* (2.82), (T2) Neem seed kernel extract 5% (2.91), (T5) Neem oil 5% (3.09), (T3) garlic chilli kerosene extract 5% (3.35). Treatment Neem leaf extract 5% (3.91) was the least effective among all the treatments. All the treatments were found to significantly differ over control.

### Evaluation of *Bacillus thuringiensis* with botanicals and chemicals against gram pod borer [*Helicoverpa armigera*] (Hubner) on cowpea. (Second spray)

The data on the percent infestation of gram pod borer on three days after spray revealed that chemicals and botanicals treatments were significantly superior over control. Among all the treatments highest reduction of pod borer population was recorded in (T6) fipronil 5 SC (1.53) followed by (T7) Cypermethrin 25 EC (1.80), (T1) *Bacillus thuringiensis* (2.20), (T2) Neem seed kernel extract 5% (2.27), (T5) Neem oil 5% (2.60), (T3) garlic chilli kerosene extract 5% (2.73). Treatment Neem leaf extract 5% (2.87) was the least effective among all the treatments. All the treatments were found to significantly differ over control.

The data on the percent infestation of gram pod borer on seven days after spray revealed that chemicals and botanicals treatments were significantly superior over control. Among all the treatments highest reduction of pod borer population was recorded in (T6) fipronil 5 SC (0.93) followed by (T7) Cypermethrin 25 EC (1.53), (T1) *Bacillus thuringiensis* (1.67), (T2) Neem seed kernel extract 5% (1.80), (T5) Neem oil 5% (2.13), (T3) garlic chilli kerosene extract 5% (2.20). Treatment neem leaf extract 5% (2.33) was the least effective among all the treatments. All the treatments were found to significantly differ over control.

The data on the percent infestation of gram pod borer on fourteen days after spray revealed that chemicals and botanicals treatments were significantly superior over control. Among all the treatments highest reduction of pod borer population was recorded in (T6) fipronil 5 SC (0.67) followed by (T7) Cypermethrin 25 EC (0.80), (T1) *Bacillus thuringiensis* (0.87), (T2) Neem seed kernel extract 5% (0.93), (T5) Neem oil 5% (1.47), (T3) garlic chilli kerosene extract 5% (1.53). Treatment Neem leaf extract 5% (1.67) was the least effective among all the treatments. All the treatments were found to significantly differ over control.

The mean data of the second spray (3, 7 & 14 days after spray) on the larval population of gram pod borer revealed that all treatments were significantly superior over control. Among all the treatments highest reduction of pod borer population was recorded in (T6) fipronil 5 SC (1.04) followed by (T7) Cypermethrin 25 EC (1.38), (T1) Bacillus thuringiensis (1.58), (T2) Neem seed kernel extract 5% (1.67), (T5) Neem oil 5% (2.07), (T3) garlic chilli kerosene extract 5% (2.15). Treatment neem leaf extract 5% (2.29) was the least effective among all the treatments.

**Evaluation of *Bacillus thuringiensis* with botanicals and chemicals against gram pod borer [*Helicoverpa armigera*] (Hubner) on cowpea. (First spray and Second spray overall mean) and Benefit-cost ratio (BCR)**

The result represented in the overall mean (First & Second Spray) reveals that all the treatments were significantly superior over control. Among all the treatments highest reduction of pod borer population was recorded in (T6) fipronil 5 SC (1.51) followed by (T7) Cypermethrin 25 EC (1.79), (T1) *Bacillus thuringiensis* (2.20), (T2) Neem seed kernel extract 5% (2.29), (T5) Neem oil 5% (2.58), (T3) garlic chilli kerosene extract 5% (2.75). Treatment neem leaf extract 5% (3.10) was the least effective among all the treatments. All the treatments were found to significantly differ over control. The yields among the treatment were significant. The highest yield was recorded in fipronil 5 SC (17.65 q/ha) followed by Cypermethrin 25 EC (16.21 q/ha), *Bacillus thuringiensis* (15.83 q/ha), NSKE (15.16 q/ha), Neem oil (14.35 q/ha), GCKE (13.92 q/ha), Neem leaf extract (12.26q/ha) as compared to control (9.4 q/ha). When cost benefit-ratio was worked out, an interesting result was achieved. Among the treatment studied, the best and most economical treatment was fipronil (1:1.90), followed by Cypermethrin 25 EC (1:1.70), *Bacillus thuringiensis* (1:1.60), NSKE (1:1.54), Neem oil (1:1.34), GCKE (1:1.4), Neem leaf extract (1:10)

**Table 1:** Shows in table treatments and dosage

| S. No. | Treatments | Dosage (gm/ml) | % Infestation | | | | | | | Overall mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | First spray | | | | Second spray | | | |
| | | | 1 DBS | 3 DAS | 7 DAS | 14 DAS | 3 DAS | 7 DAS | 14 DAS | |
| T1 | *Bacillus thuringiensis* | 2 g/lit | 2.295 (5.27) | 1.752 (3.07) | 1.612 (2.60) | 1.673 (2.80) | 1.483 (2.20) | 1.292 (1.67) | 0.932 (0.87) | 1.483 (2.20) |
| T2 | NSKE 5% | 5 ml/lit | 2.251 (5.07) | 1.769 (3.13) | 1.652 (2.73) | 1.694 (2.87) | 1.506 (2.27) | 1.341 (1.80) | 0.964 (0.93) | 1.513 (2.29) |
| T3 | GCKE 5% | 10 ml/lit | 2.264 (5.13) | 1.878 (3.53) | 1.769 (3.13) | 1.843 (3.40) | 1.652 (2.73) | 1.483 (2.20) | 1.236 (1.53) | 1.658 (2.75) |
| T4 | Neem leaf extract | 50 ml/lit | 2.161 (4.67) | 2.032 (4.13) | 1.915 (3.67) | 1.982 (3.93) | 1.694 (2.87) | 1.526 (2.33) | 1.292 (1.67) | 1.760 (3.10) |
| T5 | Neem oil | 5 ml/lit | 2.280 (5.20) | 1.788 (3.20) | 1.711 (2.93) | 1.769 (3.13) | 1.612 (2.60) | 1.459 (2.13) | 1.212 (1.47) | 1.606 (2.58) |
| T6 | Fipronil 5 SC | 2 ml/lit | 2.264 (5.13) | 1.483 (2.20) | 1.341 (1.80) | 1.389 (1.93) | 1.236 (1.53) | 0.964 (0.93) | 0.818 (0.67) | 1.228 (1.51) |
| T7 | Cypermethrin 25 EC | 1 ml/lit | 2.206 (4.87) | 1.571 (2.47) | 1.414 (2.00) | 1.459 (2.13) | 1.341 (1.80) | 1.236 (1.53) | 0.894 (0.80) | 1.337 (1.79) |
| T0 | Control (Untreated) | - | 2.220 (4.93) | 2.338 (5.47) | 2.381 (5.67) | 2.475 (6.13) | 2.658 (7.07) | 2.720 (7.4) | 2.805 (7.87) | 2.570 (6.61) |
| F-test | | - | NS | S | S | S | S | S | S | S |
| S. Ed. | | - | 0.3 | 0.175 | 0.187 | 0.208 | 0.217 | 0.191 | 0.2 | 0.217 |
| C. D. (P=0.05) | | - | 0.64 | 0.375 | 0.403 | 0.446 | 0.467 | 0.41 | 0.429 | 0.465 |

*Figures in parenthesis are square root transformation. *Figures in (Mean values) are no transformation. *DBS: Day before spray; DAS: Day after spray.

## Conclusion

Among all the treatments, Fipronil was found most effective against gram pod borer (*Helicoverpa armigera*). Followed by Cypermethrin, *Bacillus thuringiensis*, NSKE, Neem oil, garlic chilli kerosene extract, and neem leaf extract are effective. Fipronil gave the highest benefit & cost ratio under Allahabad agro-climatic conditions. The present finding is limited to one crop season (June to October 2019) under Allahabad agro-climatic condition as such more trails are required for future thrust.

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