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# Evaluation of some newer insecticides against *Helicoverpa armigera* Hub. in pea (*Pisum sativum* L.)

**MG Koulagi, BV Deore, YS Saindane and CS Patil**

**Abstract**
Present research entitled "Evaluation of some newer insecticides against *Helicoverpa armigera* Hub. in pea (*Pisum sativum* L.)" was conducted during *rabi*-2022-23 at Research Farm, Post Graduate Institute, MPKV, Rahuri and comprised seven treatments *viz.*, $T_1$-Spinosad 45% SC, $T_2$-*Beauveria bassiana* 1.15% WP, $T_3$-Flubendiamide 39.35% SC, $T_4$-*Bacillus thuringiensis* var. *kurstaki*, $T_5$-Azadirachtin 10000 ppm, $T_6$-Chlorantraniliprole 18.5% SC and $T_7$-Untreated control laid out in RBD with three replications. Based on the performance of different treatments, chlorantraniliprole was proved to be highly effective by recording lowest percent of pod damage (7.62%**)**, the data was at par with flubendiamide by registering 7.79% pod damage. Spinosad (8.40% pod damage), azadirachtin (12.38% pod damage), *Beauveria bassiana* (12.72% pod damage), *Bacillus thuringiensis var kurstaki* (13.01% pod damage) were next to follow in the order of effectiveness. Untreated control recorded highest (25.69% pod damage) infestation. ICBR ratio was found highest in *Beauveria bassiana* (1:41.80) followed by *Bacillus thuringiensis* var. *kurstaki* (1:27.54), azadirachtin (1:26.20), chlorantraniliprole (1:25.68), flubendiamide (1:25.51), and spinosad (1:15.41), respectively.

**Keywords:** Pea, pod damage, *Helicoverpa armigera*, pod borer and benefit- cost ratio

## Introduction
Pea (*Pisum sativum* L.) is important herbaceous annual crops in leguminaceae family which is majorly grown in temperate climates, and it is categorised into field pea and garden pea. In India, it is grown in an area of 0.64 million ha with a production of 0.88 MT and productivity is 1375 kg/ha. It is grown in all states of the country during the *rabi* season (Singh *et al*., 2001) [13]. The major pea producing states in India are Uttar Pradesh, Madhya Pradesh, Punjab, Himachal Pradesh, Orissa, Karnataka, Maharashtra, Haryana, etc. Uttar Pradesh is the leading state in both area (361.00 thousand ha) and production (562.00 thousand tonnes). Himachal Pradesh has the highest productivity (25.72 q/ha), which trailed by Rajasthan with productivity of 24.34 q/ha (Anonymous, 2022) [2]. The crop is susceptible to various insect like pod borers, stem fly, leaf miner, aphid and thrips. The pod borer, *Helicoverpa armigera* (Hub.) is one of the serious insect pests affecting vegetable peas during the flowering and pod stages can inflict severe damage to the crop, making them a significant constraint in vegetable pea production (Vaibhav *et al*., 2018) [15]. *H. armigera* completes its life cycle (from egg to adult) in 4 to 5 weeks at an average temperature of 28 °C. A female moth can lay up to 500-600 eggs. Eggs are generally laid on leaves, pods, and flowers. First to third instar larvae generally feed on leaves, twigs, and flowers. In later stages, larger larvae shift to developing pods by making holes/bores and consume entire developing seeds. Pod borers can cause yield losses up to 90 percent depending upon the insect density and susceptibility of cultivars (Mahmood *et al*., 2021) [9]. These pests are managed by usage of pesticides, as the productivity of crops depends on the effective management strategy of these pests (Jeyanthi and Kombairaju, 2005) [8]. Various methods have been tried for the control of insect-pests. But use of chemical method is an important approach for their control because of its quick action, effectiveness and adaptability to various situations. Hence, the present experiment was conducted to assess the performance of these insecticides for the management of *Helicoverpa armigera* Hub. on pea.

## Materials and Methods
The investigation was conducted during *rabi* season of 2022-23 at Research Farm, Post Graduate Institute, MPKV, Rahuri. The field trial was laid down in randomized block design (RBD) with 3 replications and 7 treatments *viz.* $T_1$- Spinosad 45% SC, $T_2$- *Beauveria bassiana* 1.15% WP, $T_3$- Flubendiamide 39.35% SC, $T_4$- *Bacillus thuringiensis* var. *kurstaki (Bt)*, $T_5$–

Azadirachtin 10000 ppm, $T_6$– Chlorantraniliprole 18.50% SC, $T_7$- Untreated control, Pea variety Phule Priya was dibbled in a plot size of (3m x 3m) at a spacing of (30x10 cm). Insecticides of different chemical groups were selected and the treatments were imposed as foliar sprays against the pea pod borer. Total two sprays were given at an interval of 15 days, initiating the first spray at pod initiation stage. Quantity of spray fluid required per plot was calculated by spraying untreated control plot with water, taking into consideration the recommended rate of 500 lit/ha. Five plants from each plot were selected randomly for recording the observations. The data on percent pod damage was recorded a day before spray and 1, 3, 7 and 14 days after each spray. Percent pod damage was worked out by using following formula (Birah *et al*., 2012) [4].

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

**Results and Discussion**

The data on the mean (1st, 3rd, 7th & 14th) pod damage caused by pod borer after first spray revealed that chlorantraniliprole 18.5% SC found as most effective treatment by recording the lowest pod damage of 8.96 percent. Equally effective was flubendiamide 39.35% SC, which registered a mean damage of 9.21 percent. It was followed by spinosad 45% SC, with a damage of 10.97 percent. Azadirachtin 10000 ppm, *Beauveria bassiana* 1.15% WP, and *Bacillus thuringiensis* var. *kurstaki* exhibited similar results, all recording pod damage of 13.52 percent, 14.81 percent, and 15.04 percent, respectively. In contrast, the untreated control experienced the highest pod damage, reaching to 23.57 percent.

The data on the Mean (1st, 3rd, 7th & 14th) pod damage caused by pod borer after second spray revealed that chlorantraniliprole maintained its superiority, recording lowest pod damage of 6.56 percent. Equally effective was flubendiamide 39.35% SC, which registered a mean damage of 6.66 percent. This was followed by spinosad 45% SC with damage of 8.79 percent. The next treatments in the order of effectiveness were *Beauveria bassiana* 1.15% WP, *Bacillus thuringiensis* var. *kurstaki*, and azadirachtin 10000 ppm, being at par with each other and recorded 11.04 percent, 11.38 percent and 11.70 percent pod damage respectively. The highest (27.38%) pod damage was recorded in untreated control.

The mean data of two sprays revealed that, chlorantraniliprole 18.50% SC was proved to be the most promising insecticide against pod borer *Helicoverpa armigera* Hub. by recording lowest percent damage of pods (7.62%) and this was found at par with flubendiamide 39.35% SC, which recorded 7.79 percent pod damage. The next treatments in the order of effectiveness were spinosad 45% SC, azadirachtin 10000 ppm, *Beauveria bassiana* 1.15% WP, *Bacillus thuringiensis* var. *kurstaki* with pod damage percentage of 9.76, 12.38, 12.72 and 13.01 percent, respectively. As regards, percent reduction in pod damage over control, chlorantraniliprole 18.50% SC exceeds over rest of the treatments with 70.34 percent reduction in pod damage followed by flubendiamide 39.35% SC (69.68%). *Bacillus thuringiensis* var. *kurstaki* reported least percent reduction in pod damage to the tune of 49.36 percent.

The results of present investigation are in close agreement with result of Deshmukh *et al*. (2010) [6] who reported that flubendiamide 0.007 percent, spinosad 0.009 percent were found the most effective in reducing pod damage by *H. armigera*in chickpea. Singh *et al*. (2013) [14] reported spinosad 45 SC as most effective against *Helicoverpa armigera* (Hubner) on chickpea. Dhaka *et al.* (2015) [7] reported minimum pod damage by pod borer in the treatment of flubendiamide 39.35% SC with 10.73 percent pod damage, followed by spinosad 45% SC on pea. Patel *et al.* (2015) [10] found that chlorantraniliprole 18.5% SC registered the lowest pod damage due to pod borer in pigeon pea. Abhilasha (2016) [1] reported flubendiamide as most effective for control of pod borer in pea. Patel and Chaudhari (2016) [11] recorded pod damage at harvest was lowest in the treatment of chlorantraniliprole (0.46 percent), followed by flubendiamide (1.02%). Chitralekha *et al.* (2018) [5] found chlorantraniliprole 18.5% SC was the best treatment in management of pod borer with minimum pod damage (20.23%) in chickpea. Banerjee and Pal (2021) [3] observed that chlorantraniliprole 18.5 SC was the most effective in control of pod borer damage in field pea. Saiteja and Kumar (2022) [12] recorded spinosad 45% SC (15.21%) as effective treatment in control of pod borer in pea.

The study further indicated that $T_6$ (chlorantraniliprole @ 18.5 Sc) registered highest yield of 11.90 t/ha. This was followed by $T_3$ (flubendiamide @ 39.35 SC) registering 11.46 t/ha with 68.03 percent increase over untreated control. Treatments $T_1$ (spinosad, 10.84 t/ha), $T_5$ (azadirachtin, 10.22 t/ha), $T_2$ (Beauveria bassiana, 10.03 t/ha), and $T_4$ (*Bacillus thuringiensis* var. *kurstaki*, 9.96 t/ha) were next to follow in the order. Untreated plot has recorded 6.82 t/ha yield. Highest cost of plant protection/ha (Rs. 9800/ha) was recorded in the treatment spinosad 45% SC, while minimum cost (Rs. 3000/ha) was incurred in *Beauveria bassiana* 1.15% WP for two sprays. The highest ICBR ratio was obtained from plot treated with *Beauveria bassiana* 1.15% WP (1:41.80) followed by *Bacillus thuringiensis* var. *kurstaki* and azadirachtin 10000 ppm, with ICBR ratio of 1:27.54 and 1:26.20 rupees, respectively. Besides that, chlorantraniliprole 18.50% SC, flubendiamide 39.35% SC, and spinosad 45% SC, reported ICBR ratio of 1:25.68, 25.51 and 1:15.41 rupees, respectively.

The present findings are in close agreement with Dhaka *et al.* (2015) [7] who reported highest pea yield (95.84 q/ha) in the plot treated with flubendiamide 39.35% SC and it was followed by spinosad 45% SC (91.63 q/ ha), neemarin 1500 ppm (72.78 q/ha), and *Bacillus thuringiensis* (68.99 q/ha). Banerjee and Pal (2021) [3] observed that the highest yield of garden pea was obtained from the plot treated with chlorantraniliprole 18.5 SC. Saiteja and Kumar (2022) [12] reported that the plot treated spinosad 45% SC has recorded comparatively higher yield (16.40 q/ha) of garden pea, followed by *Beauveria bassiana* 1.5% SG and *Bacillus thuringiensis* with 13.25 q/ha and 11.80 q/ha, respectively.

**Table 1:** Evaluation of insecticides against pea pod borer, *Helicoverpa armigera* Hub. after first spray

| Treatment details | Dosage/ha (gm/ml) | Pre-count (1 DBS) | Percent pod damage | | | | Mean | Mean percent reduction over control |
|---|---|---|---|---|---|---|---|---|
| | | | 1 DAS | 3 DAS | 7 DAS | 14 DAS | | |
| $T_1$ - Spinosad 45% SC | 150 | 19.75 (26.38) | 15.49 (23.17) [a] | 7.27 (15.63) [b] | 8.69 (17.13) [b] | 12.43 (20.62) [b] | 10.97 (19.34) [b] | 53.46 |
| $T_2$ - *Beauveria bassiana* 1.15% WP | 2500 | 20.08 (26.61) | 19.81 (26.42) [c] | 17.52 (24.74) [d] | 8.80 (17.23) [b] | 13.11 (21.22) [b] | 14.81 (22.63) [c] | 37.17 |
| $T_3$ - Flubendiamide 39.35% SC | 100 | 19.59 (26.26) | 14.86 (22.67) [a] | 5.59 (13.62) [a] | 6.05 (14.23) [a] | 10.35 (18.75) [a] | 9.21 (17.66) [a] | 60.92 |
| $T_4$ - *Bacillus thuringiensis* var. *kurstaki (Bt)* | 750 | 20.18 (26.68) | 19.94 (26.52) [c] | 17.74 (24.90) [d] | 8.98 (17.42) [b] | 13.52 (21.57) [b] | 15.04 (22.82) [c] | 36.19 |
| $T_5$ - Azadirachtin 10000 ppm | 500 | 20.39 (26.84) | 17.84 (24.98) [b] | 9.03 (17.47) [c] | 10.67 (19.06) [c] | 15.42 (23.12) [c] | 13.52 (21.34) [c] | 42.64 |
| $T_6$ - Chlorantraniliprole 18.50% SC | 150 | 19.90 (26.49) | 14.69 (22.52) [a] | 5.15 (13.09) [a] | 5.89[a] (14.03) [c] | 10.10 (18.53) [a] | 8.96 (17.41) [a] | 61.99 |
| $T_7$ - Untreated control | - | 20.52 (26.93) | 21.68 (27.75) [d] | 22.48 (28.30) [e] | 23.96 (29.31) [d] | 26.15 (30.75) [d] | 23.57 (29.04) [d] | - |
| S. Em (±) | - | 0.54 | 0.40 | 0.58 | 0.53 | 0.44 | 0.49 | - |
| C.D (5%) | - | NS | 1.22 | 1.80 | 1.63 | 1.36 | 1.50 | - |

*Figures in the parentheses are arcsine transformed value
*DBS: Days before spray
*DAS: Days after spray

**Table 2:** Evaluation of insecticides against pea pod borer, *Helicoverpa armigera* Hub. after second spray

| Treatment details | Dosage/ha (gm/a.i.) | Pre-count (1 DBS) | Percent pod damage | | | | Mean | Mean percent reduction over control |
|---|---|---|---|---|---|---|---|---|
| | | | 1 DAS | 3 DAS | 7 DAS | 14 DAS | | |
| $T_1$ - Spinosad 45% SC | 150 | 12.43 (20.62) [b] | 9.69 (18.12) [b] | 4.83 (12.67) [b] | 7.07 (15.41) [b] | 9.94 (18.36) [b] | 8.79 (17.24) [b] | 67.90 |
| $T_2$ - *Beauveria bassiana* 1.15% WP | 2500 | 13.11 (21.22) [b] | 12.96 (21.10) [c] | 10.87 (19.21) [d] | 6.99 (15.31) [b] | 11.28 (19.60) [c] | 11.04 (19.41) [c] | 59.68 |
| $T_3$ - Flubendiamide 39.35% SC | 100 | 10.35 (18.75) [a] | 7.38 (15.74) [a] | 3.02 (9.94) [a] | 5.08 (13.00) [a] | 7.45 (15.82) [a] | 6.66 (14.95) [a] | 75.68 |
| $T_4$ - *Bacillus thuringiensis* var. *kurstaki (Bt)* | 750 | 13.52 (21.57) [b] | 13.29 (21.37) [c] | 11.14 (19.49) [d] | 7.44 (15.81) [b] | 11.53 (19.85) [c] | 11.38 (19.72) [c] | 58.44 |
| $T_5$ - Azadirachtin 10000 ppm | 500 | 15.42 (23.12) [c] | 12.60 (20.78) [c] | 7.69 (16.08) [c] | 9.56 (18.00) [c] | 13.21 (21.31) [c] | 11.70 (20.00) [c] | 57.27 |
| $T_6$ - Chlorantraniliprole 18.50% SC | 150 | 10.10 (18.53) [a] | 7.22 (15.58) [a] | 3.27 (10.99) [a] | 4.86 (12.71) [a] | 7.34 (15.68) [a] | 6.56 (14.83) [a] | 76.04 |
| $T_7$ - Untreated control | - | 26.15 (30.75) [d] | 26.56 (31.01) [d] | 27.24 (31.46) [e] | 27.98 (31.94) [d] | 28.98 (32.57) [d] | 27.38 (31.55) [d] | - |
| S. Em (±) | - | 0.44 | 0.50 | 0.64 | 0.53 | 0.56 | 0.53 | - |
| C.D (5%) | - | 1.36 | 1.54 | 1.97 | 1.64 | 1.72 | 1.65 | - |

*Figures in the parentheses are arcsine transformed values
*DBS: Days before spray
*DAS: Days after spray

**Table 3:** Cumulative effect of insecticides against pea pod borer, *Helicoverpa armigera* Hub.

| Treatment details | Dosage/ha (gm/a.i.) | Percent pod damage (On number basis) | | Mean | Mean percent reduction over control |
|---|---|---|---|---|---|
| | | I Spray | II Spray | | |
| $T_1$ - Spinosad 45% SC | 150 | 10.97 (19.34) [b] | 8.79 (17.24) [b] | 9.76 (18.20) [b] | 62.01 |
| $T_2$ - *Beauveria bassiana* 1.15% WP | 2500 | 14.81 (22.63) [c] | 11.04 (19.41) [c] | 12.72 (20.89) [c] | 50.48 |
| $T_3$ - Flubendiamide 39.35% SC | 100 | 9.21 (17.66) [a] | 6.66 (14.95) [a] | 7.79 (16.21) [a] | 69.68 |
| $T_4$ - *Bacillus thuringiensis* var. *kurstaki (Bt)* | 750 | 15.04 (22.82) [c] | 11.38 (19.72) [c] | 13.01 (21.14) [c] | 49.36 |
| $T_5$ - Azadirachtin 10000 ppm | 500 | 13.52 (21.34) [c] | 11.70 (20.00) [c] | 12.38 (20.60) [c] | 51.81 |
| $T_6$ - Chlorantraniliprole 18.50% SC | 150 | 8.96 (17.41) [a] | 6.56 (14.83) [a] | 7.62 (16.03) [a] | 70.34 |
| $T_7$ - Untreated control | - | 23.57 (29.04) [d] | 27.38 (31.55) [d] | 25.69 (30.45) [d] | - |
| S. Em (±) | - | 0.49 | 0.53 | 0.51 | - |
| C.D (5%) | - | 1.50 | 1.65 | 1.58 | - |

*Figures in the parentheses are arcsine transformed value

**Table 4:** Incremental cost benefit ratio of different treatments on pea

| Treatment details | Quantity of insecticide/ha (g/ml) (B) | Yield (t/ha) (C) | Increase in yield over control (t/ha) (D) | Value of increase in yield (Rs./ha) (E) | Cost of insecticides for 2 applications (Rs./ha) (F) | Application cost for two applications (Rs./ha) (G) | Total cost of application (H= F+G) | Net profit (Rs./ha) (I=E-H) | ICBR (J=I/H) |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$ - Spinosad 45% SC | 150 | 10.84 | 4.02 | 160800 | 7800 | 2000 | 9800 | 151000 | 1:15.41 |
| $T_2$ - *Beauveria bassiana* 1.15% WP | 2500 | 10.03 | 3.21 | 128400 | 1000 | 2000 | 3000 | 125400 | 1:41.80 |
| $T_3$ - Flubendiamide 39.35% SC | 100 | 11.46 | 4.64 | 185600 | 5000 | 2000 | 7000 | 178600 | 1:25.51 |
| $T_4$ - *Bacillus thuringiensis* var. *kurstaki (Bt)* | 750 | 9.96 | 3.14 | 125600 | 2400 | 2000 | 4400 | 121200 | 1:27.54 |
| $T_5$ - Azadirachtin 10000 ppm | 500 | 10.22 | 3.40 | 136000 | 3000 | 2000 | 5000 | 131000 | 1:26.20 |
| $T_6$ - Chlorantraniliprole 18.50% SC | 150 | 11.90 | 5.08 | 203200 | 5700 | 2000 | 7700 | 195500 | 1:25.68 |
| $T_7$ - Untreated control | - | 6.82 | - | - | - | - | - | - | - |

Total cost = Cost of insecticides + Application cost

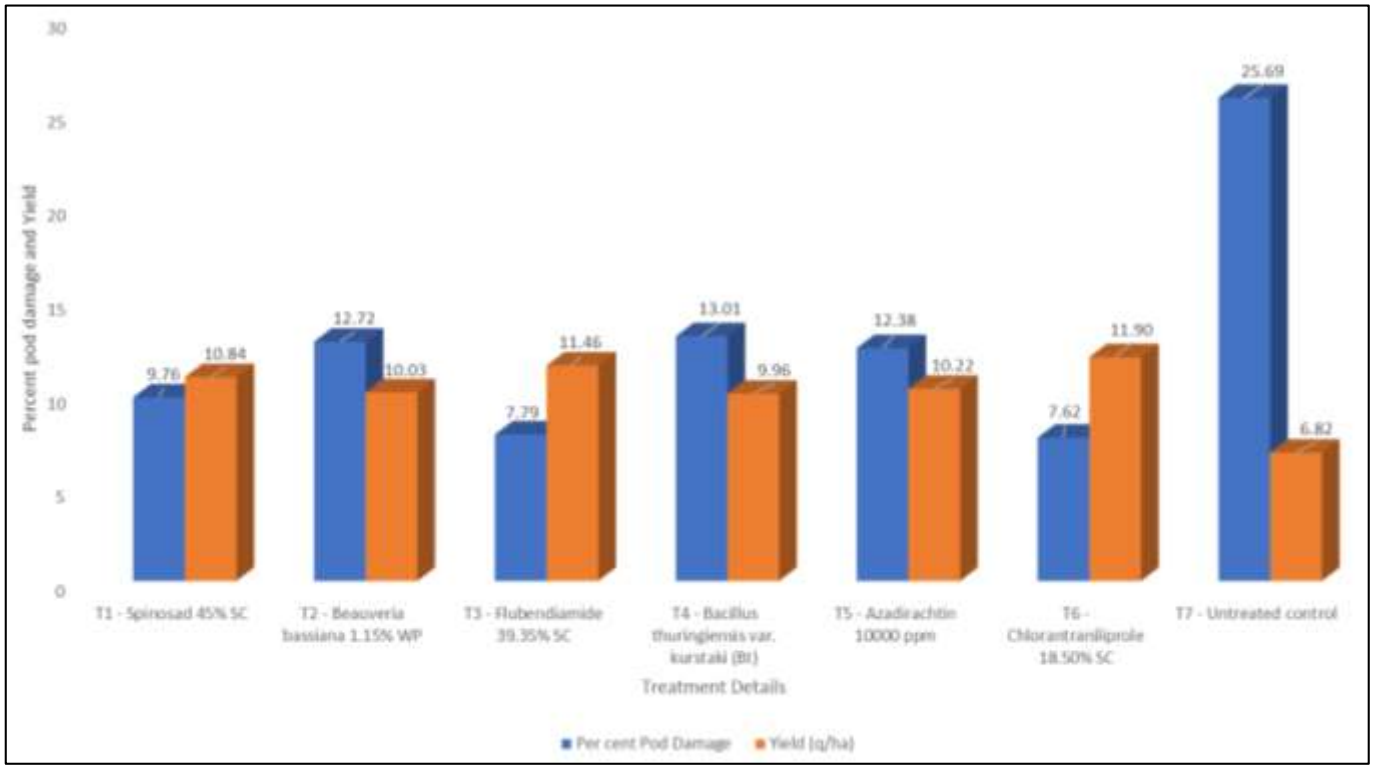


**Fig 1:** Influence of insecticides on percent pod damage caused by *H. armigera* in pea (*Pisum sativum*) and yield

## Conclusion

Chlorantraniliprole 18.50% SC proved to be the most effective treatment by recording lowest pod damage (7.62%), highest reduction of pod damage (70.34%) over control also noted highest yield of pea (11.90 t/ha) and this was found at par with flubendiamide 39.35% SC with 7.79 percent pod damage, 69.68 percent reduction of pod damage over control and yield of 11.46 t/ha. Though the highest ICBR was registered by *Beauveria bassiana* 1.15% WP (1:41.80), the chlorantraniliprole 18.50% SC registered highest net profit.

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