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Impact of Certain Chemical Insecticides Along with Biopesticide on *Helicoverpa armigera* (Hubner) in Chickpea

Rushikesh P. Basugade[1*], Chetan M. Bondre[1], Kevin A. Gawali[2] and Viresh S. Jeur[3]

[1]*Department of Agriculture Entomology, G. H. Raisoni University School of Agriculture Sciences, Saikheda, M.P., India*
[2]*G.H.Raisoni University School of Agriculture Sciences, Saikheda, M.P., India*
[3]*Department of Agriculture Entomology, Dr. PDKV, Akola, India*

**Corresponding author*

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ABSTRACT

To investigate the impact of chemical insecticide along with biopesticides on gram pod borer *Helicoverpa armigera* in chickpea conducted infield condition of G.H.R.U.School of Agriculture Sciences, Saikheda (M.P.) with various treatments. The trials laid out as per experimental design RBD with seven treatment modules including control i.e. Flubendiamide 480SC, Indoxacarb 14.5SC, Spinosad 45SC, HaNPV 250LE + Btk 8L, Novaluron 10EC, HaNPV 250LE. Respectively three spray schedules taken on gram pod borer and after application of all sprays Flubendiamide 480SC expressed as high potential chemical to control population of gram pod borer i.e. only 0.63 larvae/mrl amongst all modules. As result Flubendiamide takes lead role or being superior over other treatments. Rest of treatments also had significant control on gram pod borer followed by Indoxacarb 14.5SC (0.87 larvae/mrl), Spinosad 45SC (1.03 larvae/mrl), HaNPV + Btk (1.18 Larvae mrl), Novaluron 10EC (1.21 Larvae per meter row) at last the least effective or low potential was HaNPV 250LE (1.10 larvae/mrl). Regarding with grain yield also Flubendiamide 480SC proved its effectiveness by recording highest yield amongst all modules (i.e. 20-22 qt/ha).

Introduction

Chickpea, also referred to as garbanzo bean, is an essential legume crop renowned for its nutritious seeds is an immensely nutritious and versatile legume that plays a vital role in agriculture and diets worldwide. With a history of cultivation dating back millennia, it has earned its place as one of the earliest domesticated crops. Renowned for its abundance in protein, fiber, vitamins, and minerals, chickpeas have become an essential dietary staple embraced by various cultures globally. Verma & Gupta (2016). India holds a prominent position in global chickpea production. With its vast agricultural landscape and diverse climates, various states contribute significantly to chickpea cultivation. States like Madhya Pradesh, Uttar Pradesh, Rajasthan, and Maharashtra are among the top producers in India.

In India, the yield of chickpea faces several factors and conditions that lead to a decrease in productivity. These factors can be categorized as biotic and abiotic factors, including challenges like weeds, pests, and insects. Among these factors, insect pests play a particularly crucial role in affecting chickpea yield.

According to Rahman *et al.,* (1982), chickpea crops are affected by eleven distinct insect-pests, with *Helicoverpa armigera* (Hubner) being identified as the most significant and damaging pest. Anwar and Shafique (1993). On average, this pod borer inflicts a 30-40% loss in pod damage, which can escalate to a severe 80-90% under favorable environmental conditions. *Helicoverpa armigera* gram pod borer feed on chickpea crop from its vegetative stage to the maturity of crop. According to Mandal and Roy (2012), the initial larvae of *H. armigera* feed on various parts of chickpea plants, including leaflets, buds, flowers, and pods. As they mature, the later instars create roughly circular openings in the pods, inserting their heads and anterior bodies into them to feed on the developing grains.

While acknowledging its inherent limitations, the utilization of multiple insecticides is commonly employed to achieve effective pest control in the majority of cases. Plant protection in India and many other developing nations primarily relies on the application of synthetic pesticides.

Chemical intervention remains a potent and rapid approach to diminish pest populations. However, to foster sustainable pest management practices and mitigate environmental pollution, the exploration of biopesticides holds significant promise. Biopesticides offer an encouraging substitute, aiming to decrease the dependence on hazardous and costly chemicals while upholding productivity levels and minimizing ecological impacts (Jadhav *et al.,* 2010).

Materials and Methods

The research took place at the trial field of of G.H.R.U. School of Agricultural Sciences, located in Saikheda, Chhindwara (M.P.). The field trial was conducted using a experimental design (RBD) in the agricultural season of 2022-23, with 3 replications and 7 treatments. A total of 21 plots were established for the experiment. The chickpea cultivar JG-36 sown during the first forth night of November, have a spacing of 30cm in-between rows and 10cm in between plants within each row. Weekly observations were made in each plot, measuring the population of gram pod borer per mrl. The larval count were recorded 24 hours before treatment and again after three, seven, and fourteen days following the first, second, and third spray, respectively. These observations were carried out on one-meter row length from selected five plants of each plot. The collected data on larval population before and after treatment were then utilized to calculate the mean and effectiveness of the chemicals on the *H. armigera* larval population. Additionally, grain yield data were also recorded for further analysis.

$$\text{Grain Yield (qt/ha)} = \frac{Grain\ yield\,(Kg\ per\ plot) \times 10000\,(m2)}{Plot\ size\ (m2) \times 100}$$

Grain yield calculated at harvesting.It recorded as kg/plot further converted into qtl/ha.

Results and Discussion

The initial data from the research field were recorded before 24 hours the 1st spray application. The incidence of the *Helicoverpa armigera*, ranged from 1.07 to 1.33 Larvae/mrl. No statistically significant variations were observed in the larval populations among the various treatment plots.

After the first spray, three days later, various treatments were evaluated for their effectiveness in controlling the gram pod borer (As shown in Table

1). Flubendiamide exhibited the highest effectiveness with a larval population of 0.73 larvae/meter row length, followed by Indoxacarb (0.80 larvae/meter row length), Spinosad (0.87 larvae/meter row length), and HaNPV + Btk (1.13 larvae/meter row length). Novaluron also showed effectiveness with a larval population of 1.07 larvae/meter row length, while HaNPV treatment (1.20 Larvae/mrl) was significantly less efficacious compared to other modules or treatment.

7 Days after first spray, Flubendiamide remained the most effective treatment (0.53 larvae/meter row length), followed by Indoxacarb (0.67 larvae/meter row length), Spinosad, and HaNPV + Btk (both with 0.73 larvae/meter row length).

HaNPV treatment also proved effective (0.80 larvae/meter row length), but Novaluron (0.87 larvae/meter row length) was less effective than the other treatments. Fourteen days after the first spray, Flubendiamide continued to demonstrate the highest effectiveness (0.35 larvae/meter row length), followed by Indoxacarb (0.67 larvae/meter row length), Spinosad (0.80 larvae/meter row length), and Novaluron (1.00 larvae/meter row length). HaNPV + Btk treatment resulted in a larval population of 0.87 larvae/meter row length, while HaNPV treatment showed slightly higher effectiveness (0.93 larvae/meter row length).

The second spray was conducted (Table 2), and three days after the second spray, the effectiveness in controlling or minimizing incidence of gram pod borer was observed as the following sequence: Flubendiamide (1.07 larvae/meter row length), Indoxacarb (1.40 larvae/mrl), Spinosad (1.60 larvae/meter row length), HaNPV + Btk (1.67 larvae/meter row length), HaNPV (1.73 larvae/meter row length), and Novaluron (1.80 larvae/meter row length). Seven days after the 2nd spray, Flubendiamide remained the most effective (0.80 larvae/meter row length), followed by Indoxacarb (1.20 larvae/meter row length), Spinosad (1.47 larvae/meter row length), HaNPV + Btk (1.60 larvae/meter row length), Novaluron (1.67 larvae/meter row length), and HaNPV (1.73 larvae/meter row length). Fourteen days after the second spray, the effectiveness order was as follows: Flubendiamide (0.40 larvae/meter row length), Indoxacarb (0.73 larvae/meter row length), Spinosad (1.13 larvae/meter row length), HaNPV + Btk (1.20 larvae/meter row length), Novaluron (1.33 larvae/meter row length), and HaNPV (1.40 larvae/meter row length)

Finally, the third spray was investigated(as shown in Table 3), and three days after the third spray, in comparison to the untreated plots, all insecticidal treatments exhibited notable effectiveness in reducing the gram pod borer larval population (1.33 larvae/meter row length). The most effective treatment was Flubendiamide (0.93 larvae/meter row length), followed by Indoxacarb (1.27 larvae/meter row length), Spinosad (0.87 larvae/meter row length), HaNPV + Btk (1.13 larvae/meter row length), and Novaluron (1.40 larvae/meter row length). HaNPV treatment (1.33 Larvae/mrl) was the less productive in controlling pest. Seven days after the third spray, Flubendiamide remained the most successful treatment (0.60 larvae/meter row length), followed by Indoxacarb (0.73 larvae/meter row length), Spinosad (0.80 larvae/meter row length), HaNPV + Btk (0.87 larvae/meter row length), HaNPV (0.87 larvae/meter row length), and Novaluron (0.93 larvae/meter row length). Fourteen days after the third spray, the effectiveness order was as follows: Flubendiamide (0.27 larvae/meter row length), Indoxacarb (0.47 larvae/meter row length), Spinosad (0.53 larvae/meter row length), HaNPV + Btk (0.60 larvae/meter row length), Novaluron (0.67 larvae/meter row length), and HaNPV (0.73 larvae/meter row length).

All chemical modules or treatments demonstrated significant effectiveness in managing the larval incidence of gram pod borer, with Flubendiamide being most potent treatment throughout the observation period. On the other hand, HaNPV treatment consistently showed relatively lower effectiveness compared to the other treatments.

Table.1 Efficacy of chemical insecticides along with biopesticides on *Helicoverpa armigera*. Population of larvae/meter row length after 1st spray during 2022-23

S.No.	Treatments	Before Spray		After 1st Spray		
		0 DBT	3 DAT	7 DAT	14 DAT	Mean
1	Flubendiamide 480SC @ 200 ml/ha	1.20(1.10)	0.73(0.86)	0.53(0.73)	0.33(0.58)	**0.53(0.72)**
2	Indoxacarb 14.5% SC @ 500ml/ha	1.07(1.03)	0.80(0.89)	0.67(0.82)	0.67(0.82)	**0.71(0.84)**
3	Spinosad45SC @ 200ml/ha	1.20(1.10)	0.87(0.93)	0.73(0.86)	0.80(0.89)	**0.80(0.89)**
4	Novaluron 10 EC @ 375 ml/ha	1.13(1.06)	1.07(1.03)	0.80(0.89)	1.00(1.00)	**0.96(0.98)**
5	HaNPV. 250 LE @ 250mi/ha	1.33(1.06)	1.20(1.10)	0.87(0.93)	0.93(0.97)	**1.00(1.00)**
6	HaNPV 250LE + Btk 8L @ 250ml + 1 kg/ha	1.20(1.10)	1.13(1.06)	0.73(0.86)	0.87(0.93)	**0.91(0.95)**
7	Control	1.27(1.13)	1.27(1.13)	1.35(1.15)	1.47(1.21)	**1.36(1.16)**
	Sem ±	0.28	0.27	0.18	0.11	0.07
	CD at 5%	0.87	0.84	0.56	0.35	0.2

Values in parenthesis are calculated by $\sqrt{n}$
*DAS Days after treatment **DBT Days Before treatment

Table.2 Efficacy of chemical insecticides along with biopesticides on *Helicoverpa armigera*. Population of larvae/meter row length after 2nd spray during 2022-23

S.No.	Treatments	Before Spray		After 2nd Spray		
		0 DBT	3 DAT	7 DAT	14 DAT	Mean
1	Flubendiamide 480SC @ 200 ml/ha	1.53(1.24)	1.07(1.03)	0.80(0.89)	0.40(0.63)	**0.76(0.85)**
2	Indoxacarb 14.5% SC @ 500ml/ha	1.67(1.29)	1.40(1.18)	1.20(1.10)	0.73(0.86)	**1.11(1.05)**
3	Spinosad45SC 200ml/ha	1.87(1.37)	1.60(1.26)	1.47(1.21)	1.13(1.06)	**1.42(1.19)**
4	Novaluron 10 EC @ 375 ml/ha	1.97(1.40)	1.80(1.34)	1.67(1.29)	1.33(1.15)	**1.60(1.26)**
5	HaNPV. 250 LE @ 250mi/ha	1.80(1.34)	1.73(1.32)	1.73(1.32)	1.40(1.18)	**1.62(1.27)**
6	HaNPV 250LE + Btk 8L @ 250ml + 1 kg/ha	1.87(1.37)	1.67(1.29)	1.60(1.26)	1.20(1.10)	**1.49(1.22)**
7	Control	2.20(1.48)	2.13(1.46)	2.27(1.48)	2.27(1.51)	**2.22(1.48)**
	Sem ±	0.16	0.12	0.16	0.06	0.08
	CD at 5%	NS	0.37	50	0.19	0.25

Values in parenthesis are calculated by $\sqrt{n}$
*DAT Days after treatment **DBT Days before treatment

Table.3 Impact of chemical insecticide along with biopesticides on *Helicoverpa armigera*. Population of larvae/meter row length after 3rd spray during 2022-23

S.No.	Treatments	Before Spray		After 3rd Spray		
		0 DBT	3 DAT	7 DAT	14 DAT	Mean
1	Flubendiamide 480SC @ 200 ml/ha	1.07(1.03)	0.93(0.96)	0.60(0.77)	0.27(0.52)	**0.60(0.75)**
2	Indoxacarb 14.5% SC @ 500ml/ha	1.40(1.18)	1.13(1.06)	0.73(0.86)	0.47(0.68)	**0.78(0.87)**
3	Spinosad 45SC @200ml/ha	1.67(1.29)	1.27(1.13)	0.80(0.89)	0.53(0.73)	**0.87(0.93)**
4	Novaluron 10 EC @ 375 ml/ha	1.80(1.34)	1.40(1.18)	0.93(0.97)	0.67(0.82)	**1.00(0.99)**
5	HaNPV. 250 LE @ 250mi/ha	1.73(1.32)	1.47(1.21)	1.00(1.00)	0.73(0.86)	**1.02(1.00)**
6	HaNPV 250LE + Btk 8L @ 250ml + 1 kg/ha	1.53(1.24)	1.33(1.15)	0.87(0.93)	0.60(0.77)	**0.91(0.94)**
7	Control	1.93(1.39)	1.33(1.21)	1.27(1.12)	1.07(1.03)	**1.27(1.12)**
	SEm±	0.14	0.16	0.17	0.1	0.04
	CD at 5%	0.3	0.35	0.36	0.29	0.12

Values in parenthesis are calculated by $\sqrt{n}$
*DAT Days after treatment **DBT Days before treatment

Table.4 Grain Yield Variation Through Diverse Treatment.

Treatment	Comparative Grain Yield (qt/ha)	Comparative Grain Yield kg/ha
Flubendiamide	21.11	1.90
Indoxacarb	20.42	1.838
Spinosad	18.13	1.632
HaNPV + Btk	15.97	1.438
Novaluron	15.42	1.388
HaNPV	11.11	1.02
Untreated	7.54	0.679

A Comprehensive Analysis of Spray Treatments or Combined mean of larval population results or shows that the all treatment modules are successful in effectively managing the incidence of *H.armigera* excluding plot without control i.e. 1.62 larvae/meter row length. Collectively in all modules Flubendiamide 480SC expressed as high potential chemical to control population of gram pod borer i.e. only 0.63 larvae/mrl. As result Flubendiamide takes lead role or being superior over other treatments. Rest of treatments also had significant control on gram pod borer followed by Indoxacarb 14.5SC with 0.87 larvae/mrl, Spinosad 45SC with 1.03 larvae/mrl, HaNPV + Btk with 1.18 larvae/mrl, and Novaluron 10EC with 1.21 larvae/mrl and HaNPV 250LE which recorded 1.10 larvae/mrl which had least effective on amongst all treatment.

The recent research findings show similarities with previous studies conducted by Deshmukh *et al.*, (2010a) indicating that flubendiamide at 0.007% and indoxacarb at 0.0075% were highly effective in reducing the incidence of gram pod borer. Likewise, Babar *et al.,* (2012 a) reported significant reductions in the occurrence of gram pod borer larvae using various insecticides: Flubendiamide (97.02%), Chlorantraniliprole (92.76%), Indoxacarb (91.47%), Spinosad (90.64%), Novaluron (86.66%), Thiodicarb (87.66%).

Additional studies by Ameta and Kumar (2008) observed that applying flubendiamide at 60 g a.i./ha (125 ml/ha) three times resulted in the most substantial decline of *H. armigera* larvae on chili plants, leading to increased yield, as by Indoxacarb at 75 g a.i./ha.

Similarly, for chickpea crops, Gowda *et al.,* (2007) found that Indoxacarb at 25 g a.i./ha showed the highest efficiency in controlling the gram pod borer, *H. armigera*. Moreover, Rahman *et al.,* (2006) identified Indoxacarb as the most potent insecticide against *H. armigera*. In contrast, Dhawan *et al.,* (2006) discovered that on cotton crops, flubendiamide at 50 g a.i./ha outperformed indoxacarb at 75 g a.i./ha in managing *H. armigera* in chickpea.

These collective findings provide valuable insights into effective insecticides for controlling the gram pod borer in various crops, suggesting that both flubendiamide and indoxacarb demonstrate promising results, depending on the specific crop and application methods. Further research is encouraged to explore their long-term effects on pest populations and the environment to develop sustainable pest management strategies for agricultural practices.

Grain yield

Observation recorded on grain yield (kg/ha) at harvest showed significantly outcome of various treatments in increasing the chickpea yield. Among the various treatments, flubendiamide 22.11 qt/ha(1.90 kg/plot) was found to be most effective followed by Indoxacarb 20.42qt/ha (1.838 kg/plot),Spinosad 18.13qt/ha (1.632 kg/plot), HaNPV + Btk 15.97 qt/ha (1.438 kg/plot), Novaluron15.42qt/ha (13.88 kg/plot), HaNPV 11.11qt/ha(1.02 kg/plot) respectively. The yield of untreated plot was 7.54qt/ha (0.679 kg/plot). Previous findings also gives conformity of present investigation as like Babar *et al.,* (2012 b); Dhaka *et al.,* (2015) and Deshmukh *et al.,* (2010b) observed an increased Benifit:Cost B:C ratio in the treatment involving Flubendiamide. They also documented that these flubendiamide treatments yielded the highest crop output, with a production of 1850 kg/ha, followed closely by indoxacarb at 0.0075% concentration, resulting in 1805 kg/ha of chickpea. Dhawan reported that applying 60 g a.i./ha of flubendiamide led to 19.11-21.50 q/ha for seed cotton which was highest cotton yield.

Total seven treatments tested on gram pod borer chickpea among all Flubendiamide found to be most effective and potential chemical to control *Helicoverpa armigera* followed by Indoxacarb and the grain yield among all treatments flubendiamide shows highest potential to grow yield followed by Indoxacarb, Spinosad, HaNPV+Btk, Novaluron and least yielded treatment was HaNPV.

Based on a comprehensive analysis of the current research, it can be inferred that integrating insecticides such as, Flubendiamide 480SC, Indoxacarb 14.5SC and Spinosad 45% SC into a well-designed integrated pest management program can prove highly effective against *Helicoverpa armigera* (Hubner). Notably, these insecticides demonstrate remarkable efficiency, owing to their remarkably low recommended field doses.

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