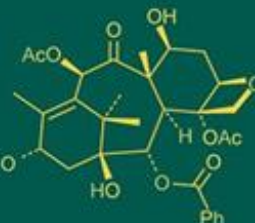
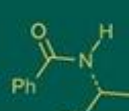
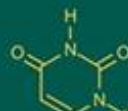
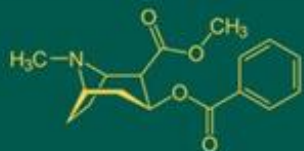


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Efficacy of new-generation insecticides and chitin inhibitors against *Helicoverpa armigera* in tomato under field conditions of Jamtara

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Abstract

The tomato fruit borer, *Helicoverpa armigera* (Hubner), is a major pest limiting tomato productivity in Jharkhand. A two-year field experiment (2023–24 and 2024–25) was conducted in farmers' fields of Jamtara district to optimize insecticide doses using chitin inhibitors along with new-generation insecticides against *H. armigera*. The trial was laid out in a Randomized Block Design with eight treatments and three replications on tomato variety Swarn Baibhav. Four sprays were applied at 15-day intervals beginning 15 days after transplanting. Observations on larval population were recorded at 24 hrs before spray and at 3, 7, 10, and 15 days after each spray. Pooled results revealed that Chlorantraniliprole 18.5% SC @ 25 g a.i./ha + Novaluron 10% EC @ 100 g a.i./ha (T6) was the most effective treatment, consistently showing lowest larval population after all sprays, followed by Chlorantraniliprole 18.5% SC @ 30 g a.i./ha (T4). Lambda cyhalothrin 5% EC alone was comparatively less effective, while the control recorded the highest larval infestation throughout both years. The study concludes that integrating a chitin inhibitor (Novaluron) with a new-generation insecticide (Chlorantraniliprole) significantly enhances control efficacy and can be recommended for tomato fruit borer management in the Jamtara region.

Keywords: *Helicoverpa armigera*, tomato, insecticide optimization, chitin inhibitor, chlorantraniliprole, lambda cyhalothrin, novaluron

1. Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops in Jharkhand and a critical income-generating crop for farmers of Jamtara district. However, tomato productivity is severely constrained by insect pests, of which the fruit borer, *Helicoverpa armigera* (Hubner), is the most damaging. The pest attacks flowers and fruits, causing direct yield loss of up to 60–70% under severe infestation. Its high reproductive capacity, polyphagous nature, and ability to develop resistance against commonly used insecticides make its management challenging (Erayya *et al.*, 2013) ^[1].

Chemical control remains the most widely adopted method, but over-reliance on conventional insecticides such as pyrethroids and organophosphates has led to resistance development and reduced field efficacy. Therefore, integrating new-generation molecules such as Chlorantraniliprole (a ryanodine receptor modulator) and insect growth regulators such as Novaluron (a chitin synthesis inhibitor) represents a promising strategy. Optimizing their doses and determining the best combinations under local agro-climatic conditions is essential for achieving effective management while delaying resistance buildup (Sharma *et al.*, 2022; Kumar *et al.*, 2023) ^[2, 3].

The present investigation aimed to evaluate the efficacy of selective insecticides and their combinations for managing *H. armigera* on tomato under the field conditions of Jamtara district (Jharkhand) during two consecutive years (2023–24 and 2024–25)

2. Materials and Methods

The field experiment was conducted during two consecutive cropping seasons (2023–24 and 2024–25) in farmers' fields of Jamtara district, Jharkhand. The experiment was laid out in a Randomized Block Design (RBD) with eight treatments replicated three times. The tomato hybrid Swarn Baibhav was used as the test crop, and seedlings were transplanted on 4 September 2023

during the first season and 1 September 2024 during the second season. Four insecticidal applications were made at 15-day intervals, commencing at 15 days after transplanting (DAT) and continuing up to 60 DAT. The incidence of *Helicoverpa armigera* larvae was first observed approximately 14 days after the first insecticidal spray. Larval population was recorded on a per-plant basis 24 hours before each spray and subsequently at 3, 7, 10, and 15 days after spraying (DAS). Whenever required, the recorded data were transformed using the square-root transformation $\sqrt{(x+0.5)}$ prior to statistical analysis. The experiment comprised eight treatment combinations (T₁-T₈) involving Lambda-cyhalothrin, Chlorantraniliprole, Novaluron,

and their combinations at different application rates.

3. Results and Discussion

3.1 Effect of insecticidal treatments afterst spray

Larval population was first recorded at 15 DAS of first spray, Chlorantraniliprole 18.5% SC @ 25 g a.i./ha + Novaluron (T₆) showed the lowest larval population (0.09), followed by Chlorantraniliprole @ 30 g a.i./ha (T₄). The highest larval population was observed in untreated control (0.64). The combined treatment T₆ significantly outperformed other treatments (Table.1).

Table 1: Impact of some new insecticide molecules on larval mortality of *Helicoverpa armigera* observed after 1st spray during the experimental year 2023-24 & 2024-25 (Pooled Value)

Treatment detail		Larval Population of <i>H. armigera</i> per plant after 1 st Spray	
		24 hrs before, 3 DAS ,7 DAS, 10 DAS	15 DAS
T ₁	Four spray of Lambda cyhalothrin 5% EC @ 15 gram a.i. per ha.	0	0.22 (0.85)
T ₂	Four spray of Lambda cyhalothrin 5% EC @ 10 gram a.i. per ha.	0	0.24 (0.86)
T ₃	Four spray of Lambda cyhalothrin 5% EC @ 10 gram a.i. per ha. mixed with Novaluron 10% EC @ 100 gram a.i. per ha.	0	0.16 (0.81)
T ₄	Four spray of Chlorantraniliprole 18.5% SC @ 30 gram a.i. per ha.	0	0.12 (0.79)
T ₅	Four spray of Chlorantraniliprole 18.5% SC @ 25 gram a.i. per ha.	0	0.14 (0.80)
T ₆	Four spray of Chlorantraniliprole 18.5% SC @ 25 gram a.i. per ha. mixed with Novaluron 10% EC @ 100 gram a.i. per ha.	0	0.09 (0.77)
T ₇	Four spray of Novaluron 10% EC @ 100 gram a.i. per ha.	0	0.27 (0.88)
T ₈	Control (Four spray of plain water)	0	0.64 (1.07)
C.D. (P= 0.05%)			0.101

Legend: Figure in parentheses are square root transformed

3.2 Effect afternd spray

By the second spray, slight variation in larval population was observed among treatments table.2).

Again, the lowest larval mean population was recorded in T₃ (0.15) and T₆ (0.17), where Novaluron was integrated with Lambda cyhalothrin or Chlorantraniliprole. Control consistently recorded the highest population (1.22). These findings indicate that combining a chitin inhibitor with pyrethroid or diamide enhances residual control.

3.3 Effect afterrrd spray

The trend remained consistent after the third spray (Table.3). T₆ (0.40) and T₃ (0.41) maintained the minimum larval population. Chlorantraniliprole alone at 30 g a.i./ha (T₄) also remained

effective with a mean of 0.44. Pyrethroid-based treatments (T₁, T₂) were moderately effective but inferior to T₃, T₄, and T₆. Control (T₈) showed a steep increase, reaching 2.66 larvae/plant.

3.4 Effect afterth spray

After the final spray (Table.4), T₃ (0.63) and T₆ (0.58) again recorded significantly lowest larval populations compared with all other treatments. Chlorantraniliprole alone (T₄) also performed well. Lambda cyhalothrin (T₁, T₂) was less effective at later crop stages, possibly due to higher resistance level of *H. armigera* against pyrethroids. The control had the highest mean of 4.54 larvae per plant.

Table 2: Impact of some new insecticide molecules on larval mortality of *Helicoverpa armigera* observed after 2nd spray during the experimental year 2023-24 & 2024-25 (Pooled Value)

Treatment detail		No. of Larva 24 hrs before	Larval Population of <i>H. armigera</i> per plant after 2 nd Spray				
			3 DAS	7 DAS	10 DAS	15 DAS	Mean
T ₁	Four spray of Lambda cyhalothrin 5% EC @ 15 gram a.i. per ha.	0.27 (0.88)	0.06 (0.75)	0.12 (0.79)	0.22 (0.85)	0.52 (1.01)	0.23 (0.85)
T ₂	Four spray of Lambda cyhalothrin 5% EC @ 10 gram a.i. per ha.	0.24 (0.86)	0.06 (0.75)	0.19 (0.83)	0.29 (0.89)	0.54 (1.02)	0.27 (0.87)
T ₃	Four spray of Lambda cyhalothrin 5% EC @ 10 gram a.i. per ha. mixed with Novaluron 10% EC @ 100 gram a.i. per ha.	0.16 (0.81)	0.03 (0.73)	0.06 (0.75)	0.12 (0.79)	0.40 (0.95)	0.15 (0.80)
T ₄	Four spray of Chlorantraniliprole 18.5% SC @ 30 gram a.i. per ha.	0.12 (0.79)	0.09 (0.77)	0.06 (0.75)	0.16 (0.81)	0.44 (0.97)	0.19 (0.82)
T ₅	Four spray of Chlorantraniliprole 18.5% SC @ 25 gram a.i. per ha.	0.17 (0.82)	0.08 (0.76)	0.09 (0.77)	0.19 (0.83)	0.52 (1.01)	0.22 (0.84)
T ₆	Four spray of Chlorantraniliprole 18.5% SC @ 25 gram a.i. per ha. mixed with Novaluron 10% EC @ 100 gram a.i. per ha.	0.09 (0.77)	0.12 (0.79)	0.03 (0.73)	0.12 (0.79)	0.40 (0.95)	0.17 (0.81)
T ₇	Four spray of Novaluron 10% EC @ 100 gram a.i. per ha.	0.27 (0.88)	0.19 (0.83)	0.19 (0.83)	0.31 (0.90)	0.69 (1.09)	0.34 (0.91)
T ₈	Control (Four spray of plain water)	0.60 (1.05)	0.82 (1.15)	1.04 (1.24)	1.30 (1.34)	1.72 (1.49)	1.22 (1.30)
C.D. (P= 0.05%)		0.115	0.148	0.105	0.062	0.047	

Legend: Figure in parentheses are square root transformed

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Table 3: Impact of some new insecticide molecules on larval mortality of *Helicoverpa armigera* observed after 3rd spray during the experimental year 2023-24 & 2024-25 (Pooled Value)

Treatment detail		No. of Larva 24 hrs before	Larval Population of <i>H. armigera</i> per plant after 3 rd Spray				
			3 DAS	7 DAS	10 DAS	15 DAS	Mean
T1	Four spray of Lambda cyhalothrin 5% EC @ 15 gram a.i. per ha.	0.48 (0.99)	0.26 (0.87)	0.35 (0.92)	0.58 (1.04)	1.18 (1.30)	0.59 (1.03)
T2	Four spray of Lambda cyhalothrin 5% EC @ 10 gram a.i. per ha.	0.58 (1.04)	0.35 (0.92)	0.48 (0.99)	0.67 (1.08)	0.96 (1.21)	0.61 (1.05)
T3	Four spray of Lambda cyhalothrin 5% EC @ 10 gram a.i. per ha. mixed with Novaluron 10% EC @ 100 gram a.i. per ha.	0.40 (0.95)	0.16 (0.81)	0.22 (0.85)	0.46 (0.98)	0.82 (1.15)	0.41 (0.95)
T4	Four spray of Chlorantraniliprole 18.5% SC @ 30 gram a.i. per ha.	0.40 (0.95)	0.35 (0.92)	0.24 (0.86)	0.44 (0.97)	0.75 (1.12)	0.44 (0.97)
T5	Four spray of Chlorantraniliprole 18.5% SC @ 25 gram a.i. per ha.	0.52 (1.01)	0.42 (0.96)	0.35 (0.92)	0.54 (1.02)	0.89 (1.18)	0.55 (1.02)
T6	Four spray of Chlorantraniliprole 18.5% SC @ 25 gram a.i. per ha. mixed with Novaluron 10% EC @ 100 gram a.i. per ha.	0.40 (0.95)	0.31 (0.90)	0.19 (0.83)	0.35 (0.92)	0.75 (1.12)	0.40 (0.94)
T7	Four spray of Novaluron 10% EC @ 100 gram a.i. per ha.	0.64 (1.07)	0.62 (1.06)	0.64 (1.07)	0.85 (1.16)	1.06 (1.25)	0.79 (1.13)
T8	Control (Four spray of plain water)	1.75 (1.50)	2.06 (1.60)	2.49 (1.73)	2.78 (1.81)	3.30 (1.95)	2.66 (1.77)
C.D. (P= 0.05%)		0.071	0.105	0.137	0.191	0.192	

Legend: Figure in parentheses are square root transformed

Table 4: Impact of some new insecticide molecules on larval mortality of *Helicoverpa armigera* observed after 4th spray during the experimental year 2023-24 & 2024-25 (Pooled Value)

Treatment detail		No. of Larva 24 hrs before	Larval Population of <i>H. armigera</i> per plant after 4 th Spray				
			3 DAS	7 DAS	10 DAS	15 DAS	Mean
T1	Four spray of Lambda cyhalothrin 5% EC @ 15 gram a.i. per ha.	0.89 (1.18)	0.36 (0.93)	0.52 (1.01)	1.16 (1.29)	1.52 (1.42)	0.89 (1.16)
T2	Four spray of Lambda cyhalothrin 5% EC @ 10 gram a.i. per ha.	0.92 (1.19)	0.42 (0.96)	0.64 (1.07)	1.19 (1.30)	1.60 (1.45)	0.96 (1.19)
T3	Four spray of Lambda cyhalothrin 5% EC @ 10 gram a.i. per ha. mixed with Novaluron 10% EC @ 100 gram a.i. per ha.	0.85 (1.16)	0.14 (0.80)	0.38 (0.94)	0.69 (1.09)	1.30 (1.34)	0.63 (1.04)
T4	Four spray of Chlorantraniliprole 18.5% SC @ 30 gram a.i. per ha.	0.75 (1.12)	0.48 (0.99)	0.29 (0.89)	0.64 (1.07)	1.19 (1.30)	0.65 (1.06)
T5	Four spray of Chlorantraniliprole 18.5% SC @ 25 gram a.i. per ha.	0.89 (1.18)	0.58 (1.04)	0.46 (0.98)	0.87 (1.17)	1.46 (1.40)	0.84 (1.15)
T6	Four spray of Chlorantraniliprole 18.5% SC @ 25 gram a.i. per ha. mixed with Novaluron 10% EC @ 100 gram a.i. per ha.	0.75 (1.12)	0.46 (0.98)	0.19 (0.83)	0.52 (1.01)	1.14 (1.28)	0.58 (1.02)
T7	Four spray of Novaluron 10% EC @ 100 gram a.i. per ha.	1.06 (1.25)	0.96 (1.21)	0.75 (1.12)	1.19 (1.30)	1.78 (1.51)	1.17 (1.28)
T8	Control (Four spray of plain water)	3.30 (1.95)	3.78 (2.07)	4.25 (2.18)	4.93 (2.33)	5.21 (2.39)	4.54 (2.24)
C.D. (P= 0.05%)		0.186	0.210	0.138	0.179	0.119	

Legend: Figure in parentheses are square root transformed

Discussion

The insecticidal treatments significantly reduced the larval population of *Helicoverpa armigera* compared with the untreated control throughout the study. After the first spray, Chlorantraniliprole 18.5% SC + Novaluron (T6) recorded the lowest larval population, followed by Chlorantraniliprole alone (T4), indicating the superior efficacy of combining a diamide insecticide with a chitin synthesis inhibitor. Similar results were reported by Padhan and Raghuraman (2019) [4] and Sharma et al. (2022) [2], who found that Chlorantraniliprole alone and in combination with Novaluron provided effective and prolonged control of *H. armigera*.

Following the second spray, T3 (Lambda-cyhalothrin + Novaluron) and T6 again recorded the lowest larval populations, suggesting that Novaluron enhanced the persistence and residual efficacy of both pyrethroid- and diamide-based insecticides. These findings are consistent with Kumar et al. (2023) [3] and Gupta et al. (2023) [5], who reported superior suppression of *H. armigera* through combinations of Chlorantraniliprole or pyrethroids with chitin synthesis inhibitors.

A similar trend was observed after the third and fourth sprays, with T6 consistently performing best, followed by T3 and T4, while the untreated control recorded the highest larval population. The sustained effectiveness of these combination treatments indicates that insecticides with different modes of action provide better and longer-lasting control of *H. armigera*. Similar observations were reported by Choudhary et al. (2021) [6] and Lalhluzuala and Kumar (2022) [7], who also found

Chlorantraniliprole-based treatments to be highly effective in reducing tomato fruit borer infestation.

4. Conclusion

The study clearly demonstrates that integrating a chitin synthesis inhibitor (Novaluron) with a new-generation insecticide significantly improves the management of *Helicoverpa armigera*. The treatment Chlorantraniliprole 18.5% SC @ 25 g a.i./ha + Novaluron 10% EC @ 100 g a.i./ha (T6) proved to be the most effective across all four sprays and over both experimental years. Chlorantraniliprole 30 g a.i./ha (T4) was the next best treatment. Lambda cyhalothrin alone showed moderate efficacy and is not recommended as a standalone molecule for fruit borer control in Jamtara. Thus, T6 can be recommended as the optimal treatment for effective management of *H. armigera* in tomato under the agro-climatic conditions of Jamtara, Jharkhand.

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