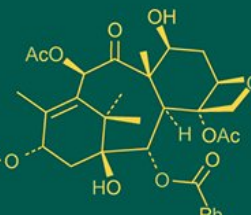
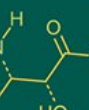
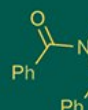


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Population dynamics of *Helicoverpa Armigera* Hübner and their biorational management on chickpea (*Cicer Arietinum* L.)

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Abstract

Chickpea (*Cicer arietinum* L.) is a major source of protein (22.5%), carbohydrates (58.9%) and fats (52%) to the vegetarian population. Among the various factors responsible for the low yield of chickpea as compared to potential yield, the losses caused by biotic and abiotic factors, out of biotic factors, insect pests are a more prominent factor. The present investigation aimed to study the population dynamics and biorational management of *H. armigera* (Hubner) in chickpea. The present investigation "Population dynamics of *Helicoverpa armigera* Hübner and their biorational management on chickpea (*Cicer arietinum* L.)" was carried out at the Institute of Agricultural Sciences, Bundelkhand University, Jhansi during cropping seasons of Rabi 2025-26. The data were recorded at the vegetative stage from 49th Standard Meteorological Week to 52th Standard Meteorological Week and the highest infestation was recorded at the reproductive stage, which was highly dangerous and caused damage to the flowers and pods from 4th Standard Meteorological Week to 12th Standard Meteorological Week. Among the tested bio-pesticides, Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (30 g a.i./ha) was found to be the best treatment as it exhibits the lowest pod infestation, with the highest yield and maximum cost: benefit ratio. It is advisable to early sowing of chickpea crop and, when weather factors are constant and when the gram pod borer (*H. armigera*) population reaches ETL, application of Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (30 g a.i./ha) gives better yield and C: B ratio and good results.

Keywords: Chickpea, *h. armigera*, pod infestation, *cicer arietinum*, etl, c: b ratio, population dynamics, smw

Introduction

Pulses constitute a staple food for the vegetarian population of India and many neighbouring countries. They possess several desirable characteristics that make them valuable crops. Nutritionally, pulses contain approximately 24% protein, 59.6% carbohydrates, and 3.2% minerals, making them an important source of dietary protein and essential nutrients. People use its green leaves and pods in their daily meals as green vegetables and germinated grains for delightful dishes, including excellent breakfast dishes (Sharma *et al.*, 2024) [28]. Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops cultivated worldwide. Globally, it is grown over an area of 16.62 million hectares, with a production of 16.25 million tonnes and an average productivity of 991 kg ha⁻¹. In the diet, chickpeas are used whole, fried, or boiled as seeds and in split form as dal. India leads the globe in both chickpea (*Cicer arietinum* L.) production and consumption (Sharma *et al.*, 2024) [28]. India is the largest producer of chickpea, contributing about 72.32% of the world's production, followed by Australia (6.32%), Pakistan (5.83%), Turkey (3.91%), and Myanmar (3.82%). In India, chickpea occupies about 41% of the total area under pulse cultivation and contributes nearly 48% of the total pulse production. During 2024-25, the crop was cultivated over an area of 121.82 lakh hectares, producing 125.14 lakh tonnes with an average productivity of 1,062 kg ha⁻¹. In Uttar Pradesh, chickpea was grown on 6.64 lakh hectares, yielding 7.16 lakh tonnes with an average productivity of 984 kg ha⁻¹ during the same period (Anonymous, 2025) [5].

b Despite its economic and nutritional importance, chickpea productivity is adversely affected by several biotic constraints. Among these, the gram pod borer, *Helicoverpa armigera* (Hübner), is the most destructive insect pest, causing substantial yield losses. The weather has a big impact on the life cycles, reproduction, and movement of invertebrate pests like insects, mites, and others. (Yadav *et al.*, 2025a) [32, 33, 34]. In India, annual losses due to *H. armigera* infestation in chickpea and pigeon pea have been estimated to exceed ₹12,000 million (Anonymous, 1996) [6]. Under an average temperature of 28°C, the life cycle of *H. armigera* from egg to adult is completed in approximately 30-34 days (Zalucki, 1986) [37]. The larvae attack the crop from the seedling stage to maturity, feeding on leaves, flowers, and pods, thereby reducing both yield and quality. Pod damage caused by *H. armigera* in chickpea has been reported to range from 3.5% to 73.5%, depending on environmental conditions and pest intensity (Patnaik *et al.*, 1991) [21]. *Helicoverpa armigera* is highly destructive owing to its migratory behaviour, polyphagous nature, and remarkable adaptability to diverse climatic conditions. IPM is a decision support system where cultural, mechanical, genetic, biological and regulatory methods are incorporated. (Yadav *et al.*, 2026) [35]. Chemical insecticides continue to play a significant role in the effective management of this pest worldwide (Abbas, 2015) [1]. Insecticides dominate the biopesticide segment, comprising more than 94% of the market, and the vast majority of these sales are derived from the bacterium *Bacillus thuringiensis* Berliner (Bt). (Yadav *et al.*, 2025b) [32, 33, 34]. Among the available management options, chemical control remains one of the most practical, cost-effective, and rapid approaches for minimizing crop losses, and it continues to be widely adopted by farmers. However, the indiscriminate use of conventional insecticides has raised concerns regarding insecticide resistance, environmental contamination, and adverse effects on non-target organisms. Therefore, the evaluation of biorational insecticides has gained considerable importance as a safer and more sustainable alternative for integrated pest management. Biopesticides, including entomopathogenic fungi and bacteria, offer promising, eco-friendly pest management options. (Yadav *et al.*, 2025c) [32, 33, 34]. Indigenous products viz. Neem products are not only effective against crop pests but also ecologically safe and free from residual problems. (Kumar *et al.*, 2024) [18]. Keeping these facts in view, the present investigation was undertaken to evaluate the bio-efficacy of different biorational insecticides against *Helicoverpa armigera* on chickpea under the agro-climatic conditions of the Bundelkhand region.

Methods and Materials

The present investigation entitled “Population dynamics of *Helicoverpa armigera* Hübner and their biorational management on chickpea (*Cicer arietinum* L.)” was carried out at the Experiment, Department of Entomology, Rainfed Agricultural Research Farm Narayan Bagh, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.). During Rabi season of 2025-26. The crop was sown on 15th November with a plot size of 2.5 X 2.5 m². The variety sown was JG-14, and an RBD design was used for management. Eight treatments were used 8 and replicated three times. The larval population were counted from 5 randomly selected plants at weekly intervals starting from

germination to harvesting. In standard weather week basis with a view to study the impact of different weather parameters on pest incidence, a simple correlation between the population of the pest and weather parameters was worked out.

Observations to be recorded

- Estimation of larval population from different biorational insecticides
- Per cent pod damage due to *H. armigera*
- Yield (kg/ha)
- Cost-benefit ratio

Results and Discussion

The data on larval population were recorded on 5 randomly selected plants at weekly intervals from 3 different dates of sowing the crop. The population dynamics of larvae were recorded from the crop germination to harvesting.

Population dynamic of *H. armigera*

The larval population varied from week to week and the larval population was recorded as nil at the vegetative stage of the crop and the population increased at an increasing rate at the reproductive stage up to maturity. Among the crop, highest larval population was recorded with the incidence of larval population (3.0 larva /5 plant) was recorded in 51th, 52th, 6th, 7th, 9th and 10th standard weeks and larval population (2.0 larva /5 plant) was recorded in 49th, 50th, 5th, 8th, 11th and 12th standard weeks and larval population (2.0 larva /5 plant) was recorded in 4th while larval population was nil in the rest standard weeks. Similarly, Singh *et al.* (2005) [24] reported that larval population increased gradually until the first week of December, afterwards declined until the end of January and again population increased from mid-February to the second week of April. Shah and Shahzad (2005) [27] also reported that a positive correlation existed between the larval instars and overall density of *H. armigera* and the average maximum and minimum temperatures, whereas a negative correlation existed between the larval density and the average morning relative humidity. The correlation of population dynamics of *H. armigera* with maximum temperature had a highly significant positive correlation with larval population of *H. armigera*, whereas minimum temperature was negative correlative significant and relative humidity had a non-significant correlation, while rainfall had a non-significant correlation with larval population of *H. armigera*. The larval population of *H. armigera* was recorded at the vegetative stage of the crop and continued until the crop reached the reproductive stage. Therefore, it becomes important to explore the relationship of pest population with current seasonal weather parameters (Prasannakumar and Chander, 2014) [22]. Weather factors such as temperature and relative humidity greatly influence the insect pest population (Siswanto *et al.*, 2008) [29]. The *H. armigera* population peaks influence with favourable weather factors viz., temperature, humidity and rainfall (Tripathi and Sharma, 1985) [30]. The correlation coefficients between larval population and maximum temperature and with minimum temperature (Dindore *et al.*, 2020) [10, 12].

Effect of biorational insecticides against *h. armigera*

The data on larval population were recorded on 5 randomly selected plants in each plot at weekly intervals, starting from

49th standard week up to the maturity of the crop (13th standard week) during 2025-26. The larval incidence was noticed at a later stage of pod formation. The larval population of *H. armigera* was significantly at par in all the treatments before the spray. After one week of the spray, the larval population was diminished and varied from treatment to treatment. The minimum larval population was recorded in Indoxacarb 15.8 EC, *Bacillus thuringiensis*, Chlorantraniliprole 18.5 SC and Spinosad 45 SC (1.33 larvae/5 plant), Flubendiamide 39.35 SC (1.66 larvae/5 plant), NSKE @ 5% (2.66 larvae/5 plant), Azadirachtin 1000 ppm (2.66 larvae/5 plant) and highest larval population was recorded in the control (3.50 larvae/5 plant). Gautam *et al.* (2018) ^[13, 14] reported that all the treatments were found significantly superior over the control and Indoxacarb 15.8 EC performed best among the treatments, followed by neem oil. Anandhi *et al.* (2011) ^[2] corroborate the result; Indoxacarb 15.8 EC significantly suppressed the pod borer population, followed by spinosad and among the plant products, neem seed kernel extract was the best treatment. Sachan and Lal (1990) ^[23] also reported that the use of NSKE @ 5 % was highly effective in suppressing the pod borer population.

Before second spray the incidence of *H. armigera* in chickpea was varied from treatment to treatment which are Chlorantraniliprole 18.5 SC (2.00 larvae/5 plant), Indoxacarb 15.8 EC, Flubendiamide 39.35 SC (2.33 larvae/5

plant), Spinosad 45 SC, *Bacillus thuringiensis* (2.66 larvae/5 plant), NSKE @ 5% (3.00 larvae/5 plant), Azadirachtin 1000 ppm (3.00 larvae/5 plant) and population were increased continues in control and highest larval population was recorded (4.20 larvae/5 plant). After second spray the incidence of *H. armigera* was noticed in different treatments, Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (0.33 larvae/5 plant) is significantly superior over all the treatments which are Chlorantraniliprole 18.5 SC + Neem Oil (0.66 larvae/5 plant), *Bacillus thurengensis* + Profenophos 50 EC, NSKE@ 5% + Spinosad 45 SC, Flubendiamide 39.35 SC + NSKE @ 5%, Spinosad 45 SC + Azadirachtin 1000 (1.00 larvae/5 plant) and Azadirachtin 1000 ppm + *Bacillus thurengensis* (1.33 larvae / 5 plant) were at par with each other and all the treatment were significantly superior over control (4.50 larvae / 5 plant) to reduce the larval population of *H. armigera*. Gautam *et al.* (2018) ^[13] reported that all the treatments were found significantly superior over control and Indoxacarb 15.8 EC performed best among the treatments, followed by neem oil. Anandhi *et al.* (2011) ^[2] corroborate the result; Indoxacarb 15.8 EC significantly suppressed the pod borer population, followed by spinosad and among the plant products, neem seed kernel extract was the best treatment. Sachan and Lal (1990) ^[23] also reported that the use of NSKE @ 5 % was highly effective in suppressing the pod borer population.

Table 1: Population dynamics of *H. armigera* in chickpea during 2025-26

SMW	Max T	Min T	RH (%)	Rainfall (mm)	<i>H. armigera</i>
49	24.5	15.4	78	0.02	2
50	22.4	13.2	74	0.002	2
51	20.3	11.8	72	0.25	3
52	18.5	9.8	70	0.001	3
1	18.2	9.2	68	0.001	0
2	17.2	8.6	66	0.002	0
3	16.6	8.4	65	0.54	0
4	18.4	10.5	63	2.65	1
5	21.4	12.67	68	0.02	2
6	22.6	14.5	71	0.005	3
7	28.8	16.7	72	0.456	3
8	31.5	18.3	75	0.002	2
9	34.5	18.6	76	0.005	3
10	28.2	19.2	78	0.001	3
11	33.71	11.86	78	1.225	2
12	40.71	13.29	80	0.055	2
Max T.					0.877**
Min T.					-0.545*
RH (%)					-0.125 ^{NS}
Rainfall (mm)					0.432 ^{NS}

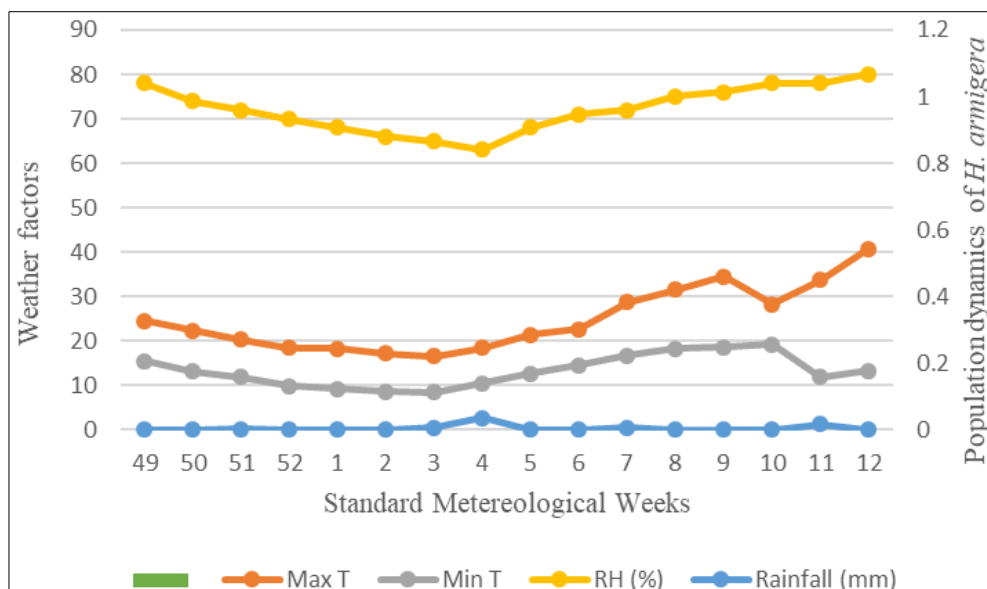


Fig 1: Graphical indication of population dynamics of *H. armigera*

Table 2: Effect of different biorational insecticides against management of *H. armigera*

Sr. no.	Treatments	Larval population/ 5 plants			
		Before first spray	After first spray	Before second spray	After Second spray
1	<i>Bacillus thurengensis</i> (2.5 g/l) + Profenophos 50 EC (700 g a.i./ha)	3.0	1.33	2.66	1.00
2	NSKE@ 5% + Spinosad 45 SC (73 g a.i./ha)	3.2	2.66	3.0	1.00
3	Flubendiamide 39.35 SC @ 25g a.i./ha + NSKE @ 5%	3.0	1.66	2.33	1.00
4	Chlorantraniliprole 18.5 SC @ 30 g a.i./ha + Neem Oil (2 ml/l)	3.2	1.33	2.0	0.66
5	Spinosad 45 SC @ 73 g a.i./ha + Azadirachtin 1000 ppm	3.2	1.33	2.66	1.00
6	Azadirachtin 1000 ppm + <i>Bacillus thurengensis</i> (2.5 g/l)	3.2	2.66	3.0	1.33
7	Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (30 g a.i./ha)	3.2	1.33	2.33	0.33
8	Control	3.0	3.5	4.2	4.5
C.D.		NS	0.734	0.345	0.845
SE(m)		0.617	0.236	0.733	0.335

Table 3: Percent pod damage, yield and C: B ratio of different treatments

Sr. No.	Treatments	Pod damage Mea (%)	Yield Q/ha	C: B ratio
1	<i>Bacillus thurengensis</i> (2.5 g/l) + Profenophos 50 EC (700 g a.i./ha)	2.75	23.5	01:01.5
2	NSKE@ 5% + Spinosad 45 SC (73 g a.i./ha)	2.85	22.1	01:01.4
3	Flubendiamide 39.35 SC @ 25g a.i./ha + NSKE @ 5%	2.5	24.5	01:01.5
4	Chlorantraniliprole 18.5 SC @ 30 g a.i./ha + Neem Oil (2 ml/l)	2	25.5	01:01.6
5	Spinosad 45 SC @ 73 g a.i./ha + Azadirachtin 1000 ppm	2.5	22.8	01:01.4
6	Azadirachtin 1000 ppm + <i>Bacillus thurengensis</i> (2.5 g/l)	3.5	21.5	01:01.4
7	Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (30 g a.i./ha)	1.5	28.5	01:01.8
8	Control	5.5	15.2	---
C.D.		0.585	2.267	---
SE(m)		0.182	0.728	----

Percent pod damage (%)

Pod damage by *H. armigera* in chickpea. The minimum per cent pod damage was recorded in Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (1.50%) and the highest pod damage was recorded in the control (4.36%). Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (1.50%) is significantly superior over all the treatments which are Chlorantraniliprole 18.5 SC + Neem Oil (2.00%), Flubendiamide 39.35 SC + NSKE @ 5% (2.50%) Spinosad

45 SC + Azadirachtin 1000 (2.50%), *Bacillus thurengensis* + Profenophos 50 EC (2.75%), NSKE@ 5% + Spinosad 45 SC (2.85%), Azadirachtin 1000 ppm + *Bacillus thurengensis* (3.50) and all the treatments were significantly superior over control to reduce the pod damage by *H. armigera*. Sachan and Lal (1990) [23] also reported that the use of NSKE @ 5 % was highly effective to suppress the pod borer population.

Yield of chickpea

The maximum yield was recorded in Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (28.50 qt/ha) and the minimum yield was recorded in the control (15.20 qt/ha). Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (28.50 qt/ha) is significantly superior over all the treatments which are Chlorantraniliprole 18.5 SC + Neem Oil (25.50 qt/ha), Flubendiamide 39.35 SC + NSKE @ 5% (24.50 qt/ha) Spinosad 45 SC + Azadirachtin 1000 (22.80 qt/ha), *Bacillus thurengensis* + Profenophos 50 EC (23.50 qt/ha), NSKE@ 5% + Spinosad 45 SC (22.10 qt/ha), Azadirachtin 1000 ppm + *Bacillus thurengensis* (21.50 qt/ha) and all the treatments were significantly superior over control to reduce the pod damage by *H. armigera*. Deshmukh *et al.* (2010) [9] revealed that Indoxacarb 15.8 EC was found to be the most effective in reducing the pod damage of chickpea by *H. armigera*.

Cost: benefit ratio

The cost: benefit ratio varied from 1: 1.36 in Azadirachtin 1000 ppm + *Bacillus thurengensis*, to 1:1.81 in Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (Table 4.3). Indoxacarb 15.8 EC + Chlorantraniliprole 18.5 SC (1: 1.81) is significantly superior over all the treatments which are Chlorantraniliprole 18.5 SC + Neem Oil (1: 1.61), Flubendiamide 39.35 SC + NSKE @ 5% (1: 1.55), *Bacillus thurengensis* + Profenophos 50 EC (1: 1.48) Spinosad 45 SC + Azadirachtin 1000 (1: 1.44), NSKE@ 5% + Spinosad 45 SC (1: 1.40), Azadirachtin 1000 ppm + *Bacillus thurengensis* (1: 1.36). Similarly, Singh *et al.* 2014) reported that Indoxacarb 15.8 EC gave more return based on the C: B ratio.

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Author contribution statement- SS conceived and designed the research; ASN conducted the experiments. ASN and MAV collected the data; SS and PK analysed the data. SS and JKB wrote the manuscript and all the authors read and approved the manuscript.

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