Influence of Abiotic Factors on the Seasonal Abundance of Insect Pests in Chickpea, (*Cicer arietinum* L.)

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Abstract

A field experiment was conducted during the *Rabi* 2024–25 at the GPB Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.), India to assess the seasonal incidence of major insect pests of chickpea and their relationship with abiotic factors. Weekly observations from germination to harvest identified the gram pod borer (*Helicoverpa armigera*) and the black aphid (*Aphis craccivora*) as the predominant pests.

H. armigera infestation began in the 48th standard meteorological week (SMW) with 0.3 larvae per five plants, reaching a peak of 5.0 larvae per five plants in the 11th SMW under maximum and minimum temperatures of 35.0°C and 14.5°C with 68.3 per cent relative humidity.

A. craccivora appeared earlier, first noted in the 4th SMW (0.6 aphids/cm twig) and peaking in the 5th SMW (2.2 aphids/cm twig) at a minimum temperature of 7.5°C and 64.7 per cent relative humidity. Correlation analysis showed non-significant positive associations of *H. armigera* with temperature and wind velocity, negative associations with humidity and rainfall and a significant positive correlation with sunshine hours ($r = 0.490$, $p < 0.05$). *A. craccivora* exhibited weak, non-significant negative correlations with most weather variables. The findings emphasize the seasonal dynamics of key chickpea pests and highlight the importance of timely monitoring and integrated pest management under variable environmental conditions.

Introduction

Chickpea (*Cicer arietinum* L.), commonly referred to as gram or Bengal gram, is one of the most important pulse crops cultivated worldwide. India holds the leading position in both area and production (FAOSTAT, 2020). During the 2023–24 season, chickpea production in the country was estimated at 11.6 million tonnes from 10.1 million hectares; however, a 25 per cent decline was anticipated due to reduced sowing area and unfavorable weather conditions (Indian Institute of Pulses Research, 2025).

Nutritionally, chickpea is a valuable source of carbohydrates (60.7%), proteins (21.5%) and fats (6.0%) and is enriched with key vitamins such as niacin (B_3), riboflavin (B_2), pantothenic acid (B_5) and vitamin C (Ahlawat and Om Prakash 1996; Jukanti et al., 2012). Although the crop is attacked by several insect pests including the pod borer, black aphid, cutworm and termites, the gram pod borer (*Helicoverpa armigera* Hubner; Lepidoptera: Noctuidae) has emerged as the most destructive, causing significant economic losses across various crops in India, including chickpea (Ojha et al., 2017).

A single larva of *H. armigera* can damage 25 to 30 pods during its development. It feeds on tender shoots and young pods, boring holes and inserting part of its body inside the pod to consume the developing seeds (Gautam et al., 2018). Fluctuations in the population of insect pests are closely linked to changes in weather parameters. Seasonal abundance is largely influenced by abiotic factors such as temperature, rainfall, relative humidity, sunshine duration and wind velocity. Understanding these ecological determinants is essential for designing effective integrated pest management strategies

(Mathur et al., 2003). Among the various biotic and abiotic stresses, damage caused by *H. armigera*, particularly from the vegetative to pod formation stages, remains a major limiting factor in chickpea production (Dhingra et al., 2003)

Materials and Methods

A field study was carried out during the *Rabi* 2024–25 at the GPB Research Farm, Acharya Narendra Deva University of Agriculture and Technology (ANDUA&T), Kumarganj, Ayodhya, Uttar Pradesh. Chickpea (*Cicer arietinum* L.) variety NDG-1 (Narendra Chana-1) was sown on 13 November 2024 at a spacing of 30 × 10 cm in plot measuring 10 × 10 m. Weekly observations were recorded for the incidence of the gram pod borer (*Helicoverpa armigera*) by counting larvae per five plants and the black aphid

(*Aphis craccivora*) by recording the number of aphids per centimetre of twig. Correlation analysis between pest populations and abiotic factors was performed using weather data (temperature, relative humidity, rainfall and sunshine hours) obtained from the university's Department of Agro-Meteorology.

Results and Discussion

During the study, the pod borer (*Helicoverpa armigera*) and the black aphid (*Aphis craccivora*) were identified as the major insect pests affecting the chickpea crop. The overall incidence remained relatively low, with moderate activity of *H. armigera* and a sparse population of *A. craccivora*. Detailed seasonal trends are summarized in Table 1.

The first appearance of *H. armigera* was observed in the 48th Standard Meteorological Week (SMW) with an average of 0.3 larvae per five plants. The population increased steadily, reaching a maximum of 5 larvae per five plants in the 11th SMW, after which it declined as the crop approached maturity. Comparable trends in seasonal fluctuation were reported by Alok et al. (2022), who observed initial infestation in the 46th SMW and a peak of 8.80 larvae per meter row in the 8th SMW.

A. craccivora appeared later, first detected in the 4th SMW with 0.6 aphids per centimetre of twig. The population reached its highest level (2.2 aphids/cm twig) in the 5th SMW before declining. These observations align with the findings of Maqsood (2017), who reported a peak aphid density in the third week of January. Differences in peak intensity across studies may be attributed to variation in local weather patterns and cultivar-specific responses.

Table 1
Seasonal incidence of chickpea insect pests in relation to weather parameters

SMW	Mean no. of pod borer larvae/5 plant	Mean no. of black aphid/cm twig	Abiotic factors					
			Temperature (^{0}C)		Av. RH (%)	Rainfall (mm)	Wind speed (km/h)	Sunshine (hrs.)
			Min.	Max.				
48	0.3	0.0	9.2	26.1	62.3	00.0	1.3	8.0
49	0.0	0.0	7.7	26.7	62.6	00.0	2.9	8.7
50	0.8	0.0	4.0	23.1	63.5	00.0	2.5	8.1
51	1.0	0.0	6.2	24.6	62.9	00.0	1.1	7.8
52	1.3	0.0	11.0	20.8	70.8	00.0	3.1	3.0
01	0.5	0.0	7.1	15.5	80.5	00.0	3.1	0.5
02	1.0	0.0	6.7	19.1	73.2	00.0	3.1	4.2
03	1.8	0.0	8.8	20.2	70.8	00.0	4.5	5.3
04	0.8	0.6	7.0	22.6	69.6	00.0	2.5	7.1
05	2.8	2.2	7.5	23.7	64.7	00.0	1.7	8.2
06	3.3	1.4	7.6	25.3	58.7	00.0	4.4	9.3
07	3.0	0.0	9.4	26.7	54.9	00.0	3.9	9.7
08	3.8	0.0	10.7	26.1	53.8	00.0	1.7	9.7
09	4.0	0.0	12.5	27.6	59.8	00.0	3.0	8.7
10	4.4	0.0	12.0	28.9	63.4	00.0	4.7	9.6
11	5.0	0.0	14.5	35.0	68.3	00.0	1.9	9.0
12	3.0	0.0	15.0	34.9	64.1	00.0	2.8	9.3
13	2.2	0.0	14.8	35.5	63.6	00.0	3.0	9.5
14	0.5	0.0	16.7	36.9	64.5	00.0	4.6	8.7

Correlation between Major Insect Pests of Chickpea and Abiotic Factors

Correlation analysis indicated that the larval population of *Helicoverpa armigera* showed non-significant positive associations with minimum temperature (r = 0.435), maximum temperature (r = 0.391) and wind

velocity (r = 0.103). Conversely, relative humidity (r = − 0.408) and rainfall (r = − 0.169) were negatively correlated with larval density, though the relationships were non-significant. A notable exception was sunshine duration, which exhibited a significant positive correlation with *H. armigera* populations (r = 0.490, p < 0.05). These results align with the observations of Rakshith *et al*. (2018), who also reported a pronounced positive effect of sunshine hours on pod borer incidence, whereas temperature variables showed weak, non-significant associations.

For *Aphis craccivora*, correlation coefficients revealed non-significant negative relationships with minimum temperature (r = − 0.276), maximum temperature (r = − 0.148), relative humidity (r = − 0.090), rainfall (r = − 0.091) and wind velocity (r = − 0.080). Sunshine hours, however, showed a non-significant positive correlation (r = 0.126) with aphid abundance. These trends partly correspond with the findings of Kumar et al. (2021), who reported negative associations between aphid populations and maximum temperature and relative humidity, while minimum temperature, minimum relative humidity and rainfall demonstrated positive influences on aphid incidence.

Table 2
Correlation of major insect pests of chickpea with abiotic factors during *Rabi* 2024-25

Sr. No.	Insect pests	Weather parameters					
		Temperature (^{0}C)		Av. Relative Humidity (%)	Total rainfall (mm)	Wind speed (km/h)	Sunshine (hrs)
		Min	Max				
1	Pod borer	0.435	0.391	-0.408	-0.169	0.103	0.490*
2	Aphid	-0.276	-0.148	-0.090	-0.091	-0.080	0.126
* Correlation is significant at the 0.05 level (two-tailed)							

Conclusion

The study revealed that *Helicoverpa armigera* and *Aphis craccivora* were the key pests of chickpea, with peak occurrences in the 11th and 5th SMW, respectively. Sunshine hours significantly enhanced *H. armigera* activity, while other weather factors showed weak or negative associations with both pests. These results highlighted the value of weather-based monitoring and timely pest management for protecting chickpea yields. These outcomes underscore the necessity of continuous pest monitoring and the integration of weather-guided management practices to safeguard chickpea productivity.

Declarations

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Authors' Contributions

Yogesh Vaghmarya (YV): Conceptualisation of the experiment, conduct of field experiments, data analysis, interpretation of results and preparation of the original draft.

Pankaj Kumar (PK): Supervision, validation and manuscript review and editing.

Kartikey Tripathi (KT): Field experimentation and data collection.

Sooraj Kumar (SK): Statistical analysis and interpretation of results.

Saurabh Singh Yadav (SSY): Resources, field supervision and proofreading.

Authors' Statement

All authors have read and approved the final version of the manuscript.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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