

Seasonal Population Dynamics of *Helicoverpa armigera* in Chickpea and Its Association with Weather Parameters in Meerut, India

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Abstract

Gram pod borer, *Helicoverpa armigera* (Hübner) is more serious insect pest of chickpea and the knowledge of its population dynamics during each season is essential for proper pest monitoring. In the present study, population dynamics of *Helicoverpa armigera* in relation to abiotic factors were studied during *rabi* seasons of 2022-23 and 2023-24 in the Crop Research Centre at Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh. Weekly observations of larval populations were recorded from the 46th to the 14th standard meteorological week (SMW), and their relationships with maximum, minimum, and mean temperatures, morning relative humidity, and rainfall were examined using correlation analysis. The first occurrence of *Helicoverpa armigera* was recorded during the 48th SMW, with 0.30 and 0.10 larvae per 10 plants in 2022-23 and 2023-24, respectively. The population peaked at 12.20 larvae per 10 plants during the 10th SMW in 2022-23 and 12.40 larvae per 10 plants during the 11th SMW in 2023-24. Larval abundance was significantly correlated with maximum, minimum, and mean temperatures in both seasons. Rainfall had positive non-significant correlation while morning relative humidity had negative non-significant correlation. These results confirm the significance of season-specific pest monitoring and locally demonstrate the involvement of temperature in the variations in gram pod borer population in chickpea.

Introduction

Chickpea (*Cicer arietinum* L.) is a significant cool-season pulse crop which provides nutritional protein, carbohydrate, minerals and other nutrients to human diets. It also contributes to pulse farming systems, farm livelihoods, and increased food security, especially in South Asian countries where India, being an important producer and consumer, is the case (Jukanti *et al.*, 2012;

Merga & Haji, 2019). Although, it is an important crop, it suffers from various biotic stresses such as insect pests which could lead to significant loss when attacking reproductive parts and developing seeds.

Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae) is a highly polyphagous gram pod borer, occurring in a wide range of cultivated wild botanical host.

It has a wide host range, high breeding potential, and is capable of adult movement, which can lead to persistent infestation and predictions of local abundance based on larval and/or adult abundance data not being predictive (Jones *et al.*, 2019; Yadav *et al.*, 2022; Zalucki *et al.*, 1986). The young larvae feed on the leaves, while the older larvae tend to feed on the buds, flowers, pods and developing seeds. Knowing the occurrence of the pest in a season is important for timely monitoring and management in chickpea, as it can affect the quantity and quality of the chickpea crop when feeding on pods and seeds (Yadav *et al.*, 2022; Sharma *et al.*, 2005).

Helicoverpa armigera is not the same at all times in the chickpea season depending on local seasonal conditions and crop development. Shah and Shahzad (2005) documented seasonal fluctuations in eggs and larval stages on chickpea, with populations increasing later in the season before declining near crop maturity. The field studies of India have also documented variations in the timing of first occurrence and maximum abundance among the various study areas and seasons. The increase was recorded seasonally up to a peak during the 15th standard meteorological week (SMW) by Kumar *et al.*, (2015) at Meerut. Yadav *et al.*, (2024) reported peak larval population in two seasons at 6th SMW and 7th SMW at Kanpur while incomplete data obtained from Jobner showed that first appearance of larvae occurred 50th SMW and peak was recorded 8th SMW (Kumawat *et al.*, 2025). Singh *et*

al., (2025) found first incidence in the 6th SMW and peak abundance in the 11th SMW in Deoria. With such variation, it may not be possible to assume that the same population pattern can be applied to different areas or seasons.

One of the factors widely studied to account for changes in gram pod borer populations is weather. The relationship among temperature, relative humidity and rainfall, and insect activity and survival can be positive or negative, and can be strong or weak among different studies. Singh *et al.*, (2015) recorded significant positive association between larval abundance with maximum and minimum temperature in chickpea while Kumar *et al.*, (2015) identified positive relationship of temperature and negative relationship of relative humidity for larval abundance in chickpea at Meerut location. Mehra and Singh (2023) and Kumawat *et al.*, (2025) also reported positive temperature association. Research is not consistent though, Yadav *et al.*, (2024) found positive correlations with minimum temperature and negative correlations with maximum temperature, and the relationships for rainfall varied by season. Yousuf *et al.*, (2024) also studied the relationship between biotic and abiotic stresses and pest incidence in Kabuli chickpea and found more evidence supporting the premise that weather-pest relationships must be considered in the context of crop and environmental conditions.

These variations underscore the need for local multi-seasonal monitoring to determine if there are similar relationships for pest occurrence and weather associations as seen locally. Correlation of a single variable with larval abundance can be made and a statistical relationship can be found, however the changes in larvae abundance due to variations in one variable are not necessarily caused by the one variable and may simultaneously be influenced by changes in other variables. However, for some species repeated observations over the week could help describe population build-up, and give a local evidence base for planning field surveillance activities. Based on this, the present study was carried out under the Rabi condition 2022-23 and 2023-24 at the Crops Research centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, to characterize the population dynamics of *Helicoverpa armigera* from 46th SMW to 14th SMW and to find out association of maximum, minimum and mean temperature, morning relative humidity and rainfall respectively to population of insects.

Material and methods

The field trials were conducted at the Crop Research Centre (CRC) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh,

during the *rabi* seasons of 2022-23 and 2023-24. To investigate the fluctuation in population of *Helicoverpa armigera* in relation to abiotic factors like temperature, relative humidity and rainfall on Chickpea. A plot size of 10×10 m² by sowing chickpea variety 'Sadbhawna' in a row to row spacing is 30 cm and plant to plant spacing is 10 cm during both the year of *rabi*, 2022-23 and *rabi*, 2023-24. A weekly observation of *Helicoverpa armigera* larvae was made from 3 weeks after sowing till the harvesting of crop from 10 randomly selected tagged plants in chickpea plots. The larval population of *Helicoverpa armigera* was assessed by direct visual counting from the initial appearance of the pest until harvest of the crop.

The population build-up of the gram pod borer was determined by calculating the mean number of larvae per 10 plant. Simultaneously, the meteorological parameters, namely temperature, relative humidity and rainfall, were obtained from the Department of Soil Science, SVPUA&T, Meerut. The relationship between the population of *Helicoverpa armigera* and the prevailing meteorological parameters was determined through simple correlation analysis. The correlation coefficient was calculated using the following formula:

$$r = \frac{[\Sigma xy - (\Sigma x)(\Sigma y)/N]}{[(\Sigma x^2 - (\Sigma x)^2/N)(\Sigma y^2 - (\Sigma y)^2/N)]}$$

Where:

r = Simple correlation coefficient

x = Population of the pest

y = Meteorological parameter

n = Number of observations

Results and Discussion

The population fluctuation of *Helicoverpa armigera* in chickpea was monitored from the 46th to the 14th standard meteorological week (SMW) during *rabi* 2022-23. The larval population ranged from 0.00 to 12.20 larvae per 10 plants during the observation period (Table 1). The first occurrence of *H. armigera* was recorded during the 48th SMW, when the larval population was 0.30 larvae per 10 plants with maximum and minimum temperatures and mean temperature were 27.8, 11.2°C and 19.5°C, respectively. Morning relative humidity was 80.5 per cent and no rainfall was recorded. Thereafter, the larval population increased gradually and the highest larval population of *Helicoverpa armigera* during *rabi* 2022-23 was recorded during the 10th SMW, reaching 12.20 larvae per 10 plants. During this week, the maximum and minimum temperatures were 32.06 and 14.91°C, respectively, with a mean temperature of 23.49°C. Morning relative humidity was 64.12 per cent and 100.2 mm rainfall was received, which was the highest rainfall recorded during the observation period. After that, the larval population decreased to 10.30 larvae per 10 plants during the 11th SMW and further declined to 7.20, 6.80 and 5.05 larvae per 10 plants during the 12th, 13th and 14th SMWs, respectively.

During *rabi* 2023-24, the larval population ranged from 0.00 to 12.40 larvae per 10 plants (Table 2). The first occurrence of *H. armigera* was recorded during the 48th SMW, with 0.10 larvae per 10 plants with maximum and minimum temperatures during this week were 27.2 and 11.5°C, respectively. The larval population increased gradually and recorded highest with 12.40 larvae per 10 plants during the 11th SMW with the maximum, minimum temperatures and mean temperature were 33.0, 15.6°C and 24.3°C, respectively, with morning relative humidity was 61.4 per cent and no rainfall was recorded. After attaining the peak population during the 11th SMW, the larval population declined to 8.10 larvae per 10 plants during the 12th SMW. It subsequently decreased to 7.30 and 6.50 larvae per 10 plants during the 13th and 14th SMWs, respectively. During the 14th SMW, the maximum and minimum temperatures were 29.6 and 16.8°C, respectively, with a mean temperature of 23.2°C. Morning relative humidity was 69.6 per cent and 37.5 mm rainfall was recorded.

Helicoverpa armigera was found for the first time in 48th standard meteorological week (SMW) of both the seasons of *rabi* 2022-23 and 2023-24 with 0.30 and 0.10 larval per 10 plants, respectively. Mishra *et al.*, (2021) also reported the same

observations from the first occurrence of gram pod borer during 48th SMW on chickpea at Ayodhya, Uttar Pradesh. Alok *et al.*, (2022), had initial infestation around 46th SMW and economic threshold level reached at 48th SMW. The highest numbers of larvae were recorded at the 10th SMW in 2022-23 and at the 11th SMW in 2023-24 in the present study. Singh *et al.*, (2023) also reported peak populations during the 12th and 11th SMWs in two seasons at Meerut, Uttar Pradesh. Similarly, Devi *et al.*, (2024), reported peak populations during the 8th and 7th SMW, during *rabi* 2022-23 and 2023-24, respectively.

Correlation of *H. armigera* population with abiotic factors

The relationship between the larval population of *Helicoverpa armigera* and different weather parameters was determined through Pearson's correlation analysis for *rabi* 2022-23 and 2023-24. The correlation coefficients (r) for maximum temperature, minimum temperature, mean temperature, morning relative humidity and rainfall were assessed at the 5 per cent level are presented in Table 3.

During *rabi* 2022-23, maximum temperature, Minimum temperature and mean temperature showed a significant positive correlation with the larval population of *H. armigera* with $r = 0.462$, 0.439 and 0.456 . Morning relative humidity showed a negative but non-significant correlation ($r = -0.389$), whereas rainfall exhibited a positive but non-significant correlation ($r = 0.354$).

During *rabi* 2023-24, maximum temperature showed a significant positive correlation with larval population ($r = 0.448$). Minimum temperature ($r = 0.469$) and mean temperature ($r = 0.465$) also showed significant positive correlations. Morning relative humidity exhibited a negative but non-significant correlation with larval population ($r = -0.433$), while rainfall showed a positive but non-significant relationship ($r = 0.273$). Overall, the correlation analysis indicated that the larval population of *H. armigera* was positively associated with maximum temperature, minimum temperature, mean temperature and rainfall, whereas an inverse relationship was observed with morning relative humidity.

The present findings are also comparable with those reported by Singh, *et al.*, (2025) at Deoria, Uttar Pradesh, where larval population showed significant positive correlations with maximum temperature ($r = 0.837$) and minimum temperature ($r = 0.804$). Kumawat *et al.*, (2025) also reported a significant positive correlation between maximum temperature and larval incidence ($r = 0.56$). Kumar *et al.*, (2015) at Meerut, who recorded a negative correlation between larval population and relative humidity ($r = -0.569$). Devi *et al.*, (2024) recorded a positive, non-significant association between rainfall and larval population during *rabi* 2022-23.

Conclusion

The study revealed seasonal changes in the abundance of *Helicoverpa armigera* in chickpeas during both the *rabi* seasons, with

initial occurrence in the 48th SMW and maximum occurrence in the 10th SMW in 2022-23 and in the 11th SMW in 2023-24, respectively. Larval abundance was significantly and positively correlated with maximum, minimum, and mean temperatures, while morning relative humidity and rainfall were not. The results indicate that temperature parameters may be used to explain seasonal variation in pest numbers within the range of conditions experienced in this study. Regular field surveillance, supported by local weather observations, may help identify periods of increasing infestation and inform timely pest-management decisions. These relationships are preliminary and require further observations at other locations and seasonal periods for validation and the establishment of location specific forecasting methods.

Table 1 Population dynamics of *Helicoverpa armigera* in relation to abiotic factors during *rabi* 2022-23

SMW	Duration	Mean Larval Pop. (per 10 plants)	Temp (°C) Max	Temp (°C) Min	Mean Temp (°C)	Morning RH (%)	Rainfall (mm)
46	12-18 November 2022	0	28.2	14.5	21.35	76.5	0
47	19-25 November 2022	0	27.4	12.3	19.85	78	0.7
48	26 November-2 December 2022	0.30	27.8	11.2	19.5	80.5	0
49	3-9 December 2022	0.60	25.4	8.3	16.85	82.4	0
50	10-16 December 2022	0.90	23.8	8.6	16.2	85	0
51	17-23 December 2022	1.30	21.8	7	14.4	87.2	0
52	24-31 December 2022	1.80	18.9	6.1	12.5	88.5	1.1
1	1-7 January 2023	2.40	15.3	5.07	10.18	89	0
2	8-14 January 2023	3.13	15.5	5.37	10.43	86.5	0
3	15-21 January 2023	4.00	17.37	5.02	11.19	84.8	13
4	22-28 January 2023	4.50	20.56	6.64	13.6	83.14	11
5	29 January-4 February 2023	6.57	21.07	6	13.54	90.1	0
6	5-11 February 2023	7.80	23.34	9	16.17	84.42	0
7	12-18 February 2023	9.30	26.99	11.17	19.08	71.7	0
8	19-25 February 2023	10.80	29.87	13	21.44	70.8	0
9	26 February-4 March 2023	11.40	31.06	13.61	22.34	68.57	0
10	5-11 March 2023	12.20	32.06	14.91	23.49	64.12	100.2
11	12-18 March 2023	10.30	31.64	15.61	23.63	68.42	25
12	19-25 March 2023	7.20	29.59	14.54	22.07	85.71	2.8
13	26 March-1 April 2023	6.80	29.63	14.16	21.9	68.57	0
14	2-8 April 2023	5.05	34.93	17.36	26.15	60.88	0

Table 2 Population dynamics of *Helicoverpa armigera* in relation to abiotic factors during *rabi* 2023-24

SMW	Duration	Mean Larval Pop. (per 10 plants)	Temp (°C) Max	Temp (°C) Min	Mean Temp (°C)	Morning RH (%)	Rainfall (mm)
46	12-18 November 2023	0	28.5	14.2	21.35	75	2.5
47	19-25 November 2023	0	27.8	12	19.9	77.5	0
48	26 November-2 December 2023	0.1	27.2	11.5	19.35	79	0
49	3-9 December 2023	0.3	25	8.5	16.75	83	0.5
50	10-16 December 2023	1.35	23.5	8	15.75	86	0.2
51	17-23 December 2023	2.25	21	7.2	14.1	88	0
52	24-30 December 2023	3.15	18.5	6	12.25	89.5	0
1	31 December 2023-6 January 2024	3.8	16	5.2	10.6	91	0
2	7-13 January 2024	4.05	16.5	5.5	11	89	0
3	14-20 January 2024	4.5	18	5.8	11.9	87.5	0
4	21-27 January 2024	4.83	20.6	6.6	13.6	88.1	0
5	28 January-3 February 2024	5.27	21.1	6	13.55	90.9	0.2
6	4-10 February 2024	6.1	25.1	9.5	17.3	83.4	11
7	11-17 February 2024	7.4	27	11.2	19.1	84.4	0
8	18-24 February 2024	8	29.9	13	21.45	74.7	0
9	25 February-2 March 2024	9.33	31.2	14.2	22.7	73	0
10	3-9 March 2024	11	32.1	14.9	23.5	68.6	1
11	10-16 March 2024	12.4	33	15.6	24.3	61.4	0
12	17-23 March 2024	8.1	24	12.6	18.3	85.7	2
13	24-30 March 2024	7.3	29.3	16.6	22.95	75.9	106.2
14	31 March-6 April 2024	6.5	29.6	16.8	23.2	69.6	37.5

Table 3 Correlation between larval population of *Helicoverpa armigera* with Metereological Parameters during *rabi* 2022-23 and 2023-24

Weather parameters	Correlation coefficient (r) 2022–23	Correlation coefficient (r) 2023–24
Maximum temperature (°C)	0.462*	0.448*
Minimum temperature (°C)	0.439*	0.469*
Mean temperature (°C)	0.456*	0.465*
Relative humidity, Morning (%)	−0.389 NS	−0.433 NS
Rainfall (mm)	0.354 NS	0.273 NS

* Significant at 5%; ** Significant at 1%; NS Non-significant.

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