**Original Research Article**

**Influence of weather parameters on population dynamics of pod borer, *Helicoverpa armigera* in medium duration pigeonpea in Eastern Plateau and Hill region of India**

**ABSTRACT**

The impact of weather parameters on pod borer, *Helicoverpa armigera* population dynamics in medium duration pigeonpea was investigated in 2023–2024 and 2024–2025 in Eastern Plateau and Hill region conditions of India. The population alteration pattern of *H. armigera* was observed to be more or less the same in both years. The highest incidence of *H. armigera* in pigeonpea in the region occurred during the 45th Standard Meteorological Week, both years (0.07 to 3.40 numbers per plant). The correlation analysis between *H. armigera* population and weather parameters showed a significant positive correlation between larval population of *H. armigera* and relative humidity (7:00 am) and mean relative humidity (*p*<0.05). The linear regression model based on weather parameters as an independent variable and *H. armigera* population as a dependent variable explained 35 per cent *H. armigera* population variability in pigeonpea. Environmental factors played a determining factor in *H. armigera* population dynamics.

Keywords: Population dynamics, *Helicoverpa armigera*, Pigeonpea, weather parameters.

**INTRODUCTION**

Pigeonpea (Cajanus cajan L. Millsp.) is a vital leguminous crop grown extensively in tropical and subtropical regions, especially in Asia and Africa (Sarkar *et al.,* 2020). It serves as an important source of protein for millions (Haji *et al.,* 2024). It plays a significant role in sustainable agriculture due to its ability to fix atmospheric nitrogen and improve soil fertility (Saxena *et al.,* 2019). The world’s largest producer of pigeonpea is India, with an area of 46 lakh hectares, producing approximately 38 lakh tons, and has a productivity of 837 kg/ha. It is grown on 2.27 lakh hectares in Jharkhand, yielding roughly 2.47 lakh tons with a productivity of 1088 kg/ha (Anonymous, 2023). Despite its agronomic and nutritional importance, pigeonpea productivity remains low and inconsistent, largely due to biotic stresses, with insect pests being among the most destructive.

Among the insect pests infesting pigeonpea, the gram pod borer, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae), is the most destructive and economically important (Mishra *et al*., 2021). This polyphagous pest causes severe damage to legumes by feeding on buds, flowers, and pods, leading to substantial yield losses that can exceed up to 90% under favourable conditions (Sheikh *et al*., 2024). The larvae exhibit high mobility and voracious feeding behaviour, and their management is complicated by their resistance to several classes of insecticides.

The population dynamics of *H. armigera* are highly influenced by seasonal variations, crop phenology, and environmental factors such as temperature, humidity, and rainfall (Huang *et al*., 2020). Its incidence often varies across different crop stages, with peak infestations typically observed during the flowering and podding phases (Kambrekar 2016). Despite its importance, there is limited localized information on the seasonal fluctuation and population build-up patterns of *H. armigera* in pigeonpea ecosystems, which is critical for designing timely and effective integrated pest management (IPM) strategies (Sharma *et al*., 2010).

The present study aimed to elucidate the seasonal dynamics of pod borer, *H. armigera,* in medium-duration pigeonpea by monitoring its incidence across crop stages and correlating population trends with prevailing weather conditions. Understanding these dynamics will support early warning systems, improve pest forecasting, and enhance the efficiency of control measures, thereby contributing to more sustainable pigeonpea production.

**MATERIALS AND METHODS**

The field experiments were conducted at the Research Farm of Birsa Agricultural University (BAU), Kanke, Ranchi (23o17’ N latitude and 85o19’ E longitude, elevation 625 m above mean sea level) during *Kharif* 2023-24 and 2024-25. For this experiment, seeds of the susceptible genotype, namely BAUPP 22-12 were collected from the Department of Genetics and Plant Breeding of BAU, Ranchi, Jharkhand, India. Pigeonpea seeds were seeded in good soil conditions, and all agronomical packages of practices (except the application of pesticides) were followed with a spacing and plot size of 75 cm x 20 cm and 12 m2, respectively, to raise the crops in the Randomized Block Design (RBD). Randomly selected 5 plants from each replication were considered for observation. Data on the population of pod borer were recorded from the same plants from the first appearance to till maturity of the crop.

The data on weather parameters viz., minimum and maximum temperature (0C), relative humidity (RH) (%), and rainfall (mm) were collected from the agro-meteorological observatory of the Birsa Agricultural University, Ranchi, India. The mean and simple correlation and regression were calculated by using R software to find out the effect of different weather parameters on the incidence and development of pod borer in pigeonpea. The validation of the developed regression model for *H. armigera* was done using observed and predicted values, and the results are presented in the scatter plot. The figures in the article were drawn using Microsoft Office Excel 2010 and R software.

**RESULTS AND DISCUSSION**

The population of pod borer, *H. armigera,* in medium duration variety was recorded between the 36th to 3rd meteorological weeks during 2023–24, ranging from 0.07 to 3.53 larvae per plant. Similarly, during 2024–25, the incidence of pod borer, *H. armigera*, occurred between the 37th to 2nd meteorological weeks, with a population range of 0.07 to 3.27 larvae per plant (Figures 1 and 2). The present pest population observations were aligned with Bijewar *et al.,* (2018), Harshita *et al.,* (2024), Thilagam and Gopikrishnan (2020), Jakhar *et al.,* (2016), and Gore *et al.,* (2024).The highest number of larvae (3.53 and 2.27 per plant) was found in the 45th meteorological week of the years 2023-24 and 2024-25, respectively. A similar observation was made by Kumar and Soni (2018) that the incidence of the *H. armigera* started in the 1st week of October and reached a peak level of 1.39 larvae/five plants in the 4th week of October (at 14.80–33.50°C and RH 47.30–66.30%).

Weather factors played a major role that significantly influencing the population dynamics of *H. armigera* in medium-duration pigeonpea varieties. The data on the correlation between the pooled incidence of *H. armigera* with weather parameters showed a significant relationship (Table 1). The correlation analysis revealed that there was a significant positive correlation between larval population of *H. armigera* and percent relative humidity (7 am) (r= 0.37\*) and mean percent relative humidity (r= 0.40\*) (*p*<0.05) based on pooled data of both the years (Figure 3) (Table 1). Temperature (r=0.181), and evaporation (r=0.207) showed positive and negative relationships with rainfall (r=-0.152), with *H. armigera* population dynamics, but they were statistically non-significant. Sharma *et al.* (2020) also observed similar results that the relative humidity showed a positive correlation (0.149) with the incidence of pod borer and weather parameters. Another similar result was obtained by Chandra and Singh (2014) when *H. armigera* population in chickpea crop was correlated with relative humidity, showing a positive correlation (r= 0.52). Thus, the result of this study contributes to understanding the seasonal incidence of the pest during the *Kharif* season of years 2023-24 and 2024-25. Considering multiple weather parameters as independent variables and *H. armigera* population as the dependent variable, linear regression analyses were carried out based on pooled data of 2023-24 and 2024-25 (Table 2). The best fit regression model for *H. armigera* population dynamics understanding, weather parameters with five-lag weeks, were found the best fit. The regression model explained 35 per cent variability of *H. armigera* population fluctuation in the Eastern Plateau and Hill Region of India. The validation presented in the scatter plot showed good validation of the present developed model (Figure 4). A similar type of experiment was carried out by Arumugam *et al.* (2023) that stepwise regression analysis showed maximum temperature and relative humidity were the most important factors contributing to 68% variation in the incidence of *A. purpureus* on palas. Similarly, the population dynamics of mites and thrips in cowpea in the eastern region of India highly depended on relative humidity (Moanaro and Choudhary, 2016). The present observations are in agreement with Kumar and Rao (2015) who reported a positive association between the larval population of *Maruca vitrata* and relative humidity based on their correlation analysis. Singh *et al.* (2013) conducted an experiment indicating that relative humidity has a statistically significant negative correlation with *H. armigera* population. So, it is suggested that an increase in population density of *H. armigera* was associated with relative humidity.

**CONCLUSION**

So, it can be concluded that an increase in *H. armigera* population on pigeonpea of Eastern Plateau and Hill Region was associated with relative humidity, which seems to be a regulatory factors of population build-up. Based on these results, management strategies for *H. armigera* can be devised in the region.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Authors hereby declare that no generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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**Figure 1**: Pod borer, *Helicoverpa armigera* population on medium duration pigeonpea in the eastern plateau and hill region during 2023-24.

**Figure 2**: Pod borer, *Helicoverpa armigera* population on medium duration pigeonpea in the eastern plateau and hill region during 2024-25.

**Table 1:** Correlation co-efficient between weather variables and pod borer, Helicoverpa armigera population on medium duration pigeonpea based on pooled data (2023-24 and 2024-25).

|  |  |
| --- | --- |
| Insect pests | Weather variables  |
| Maximum temperature (ºC) | Relative humidity (%) (7 am) | Relative humidity (%) 2 pm | Mean Relative humidity (%)  | Rainfall(mm) | Evaporation (mm) |
| *Helicoverpa armigera* | 0.181 | 0.373\* | 0.272 | 0.408\* | -0.152 | 0.207 |

\*Significant at 0.05

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S. No.** | **Insect pest** | **Regression equation** | **R2** | ***f*-cal** | ***P-*value** |
| 1. | *Helicoverpa armigera* | Y= 5.78\*-0.17 (Temp. Max.) +0.83\*\* at 5 lags | 0.35 | 12.42 | <0.001 |

**Table 2:** Stepwise regression model equation for pod borer, H. armigera of medium duration pigeonpea based on pooled data (2023-24 and 2024-25).

\*Denotes constant estimated from the data; \*\* random error term



(B).

(A).

**Figure No. 3**: Correlation pie charts for understanding the influence of weather parameters on *Helicoverpa armigera* population dynamics during both years (A.) 2023-24 and (B). 2024-25.

**Figure 4:** Validation of pod borer, Helicoverpa armigera, weather-based models on pigeonpea during the years 2023-24 (A) and 2024-25 (B).