**Population Dynamics of *Helicoverpa armigera* and *Maruca vitrata* in Pigeon pea: Interrelationship with weather parameters**

**ABSTRACT**

Pigeon pea (*Cajanus cajan* L.), a vital protein-rich pulse crop, suffers significant yield losses due to insect pests, particularly *Helicoverpa armigera* and *Maruca vitrata*. A field study was conducted at the Agronomy Farm, Rajasthan College of Agriculture, Udaipur, during Kharif 2024 to investigate the seasonal incidence and population dynamics of these pests on the pigeon pea variety Tuar Dharti 80, and their correlation with weather parameters. Weekly observations from tagged plants revealed that *H. armigera* and *M. vitrata* appeared from the 41st and 40th Standard Meteorological Weeks (SMW), respectively, peaking in late November. Pest populations were negatively correlated with maximum and minimum temperatures, morning and evening relative humidity, and rainfall, with most correlations being statistically significant. These findings highlight the influence of abiotic factors on pest dynamics and emphasize the importance of weather-based pest forecasting for effective integrated pest management (IPM).

**Keywords**: *Helicoverpa armigera*, *Maruca vitrata*, pigeon pea, seasonal incidence, weather correlation, integrated pest management

**Introduction**

“The pulses, being a rich source of proteins with high nutritional value, occupy a special role in the diet of human beings. Pulses contain nearly 30 per cent protein that supplements the energy-rich cereal diet. Among the pulses, pigeon pea, consisting of 20-21 per cent protein, occupies an important place next to chickpea and is widely grown in semi-arid tropical regions of the world. *Cajanas cajan* (L) Millsp., commonly referred to as pigeon pea, belongs to the family Fabaceae and is believed to have originated in India” (Muchhadiya et al., 2024). “The crop is now cultivated in more than 50 countries throughout Asia, Africa, the Americas and Australia” (Volp et al., 2025). “It may be consumed in the form of split pulse or Dal by human beings; in addition, the immature green seeds and pods are eaten as a green vegetable. India is the largest producer of pigeon pea in the world, producing 4.34 million tonnes from an area of 5.05 million hectares, with a productivity of 859 kg/ha during 2023-24. The major pigeon pea cultivating states are Karnataka (1.337 million hectares), Maharashtra (1.111 million hectares), Uttar Pradesh (0.35 million hectares), Andhra Pradesh (0.232 million hectares), Gujarat (0.227 million hectares), and Jharkhand (0.185 million hectares)” (ANGRAU Red gram Outlook Report 2023-24). Rajasthan produces 5680 MT from an area of 6327 hectares (Anonymous,2022-23) Like other grain legumes, pigeon pea is prone to a wide range of biotic constraints; the incidence of an array of insect pests is one of them. From seedling to maturity, in India, this crop is attacked by over 200 different species of insects and mites (Patangi and Chiranjeevi, 2017; Srinivasa et al., 2023; Yadav et al., 2024). A pod borer complex causes 77.04 per cent pod damage and 68.70 per cent grain damage, causing low yields (Awasthi and Bhatnagar, 1983; War et al., 2024). The study focuses on the seasonal incidence and dynamics of *Helicoverpa armigera* and *Maruca vitrata* in pigeon pea, aiming to understand their initiation and extent of damage at various crop growth stages and their relationship with weather conditions. Given the influence of changing abiotic factors and varietal shifts, pest patterns may vary over time. Therefore, monitoring pest occurrence in relation to environmental factors is crucial for timely warnings and the development of effective integrated pest management strategies. This research specifically examines the seasonal presence of these pests and their correlation with weather parameters in pigeon pea crops.

**MATERIALS AND METHOD**

To study the population dynamics of *Helicoverpa* *armigera* and *Maruca vitrata,* a field trial was laid out at the Agronomy farm, Rajasthan College of Agriculture, Udaipur, during *Kharif* 2024. The seeds of pigeon pea variety Tuar Dharti 80 were sown with a spacing of 60x20 (R x P).

The field was divided into four quadrates. From each quadrate, five plant observations plants were selected at random and tagged. The pest data were recorded from these five plants throughout the season by following the procedure as described below.

***Helicoverpa armigera*:** Number of larvae was recorded at a weekly interval starting from bud initiation till harvest from tagged plants and the mean was worked out. At the time of harvest, 100 pods were randomly collected and observed for pod damage by *H. armigera (*large irregular hole). From this, per cent pod damage was worked out.

***Maruca vitrata***: The Number of larvae and number was recorded at a weekly interval starting from bud initiation till harvest from tagged selected plants and the mean was worked out. Weekly recorded pest data were correlated with the corresponding weather factors.

To study the influence of various abiotic factors (minimum and maximum temperature, morning and evening relative humidity, and rainfall) on the incidence of population dynamics of insect pests in pigeon pea, the correlation coefficient was worked out.

**RESULT AND DISCUSSION**

The major insect pests observed throughout the cropping season were only studied for population dynamics in response to weather conditions. The major pests studied were viz., Pod borer, *Helicoverpa armigera* (Hubner), and Spotted pod borer, *Maruca vitrata* (Fabricius), were recorded on pigeon peavariety Tuar Dharti 80 from the 29th to the 2nd Standard Meteorological Week (SMW) at regular weekly intervals. The population of these pests correlated with weather factors like maximum and minimum temperature, maximum and minimum relative humidity, and rainfall.

**Pod borer, *Helicoverpa armigera* (Hubner)**

First appearance of the Pod borer larvae was observed on 08th October (41stSMW). The number of Pod borer larvae was recorded as a weekly average per plant and the data are presented in **Table 1** and illustrated in **Figure 1**

From **Table 1**, it was seen that Pod borer larvae population appeared from 41st SMW and was available upto the 2nd SMW (15 January to 21 January, 2025). Pod borerlarvae population attained its peak (4.2 larvae /plant) during 48th SMW (26 November - 2 December), when maximum and minimum temperatures were 27.30 and 9.70 °C, respectively, whereas morning and evening relative humidity were 81.4 and 30.5 %, respectively, and here was no rainfall received during this week. Whereas Bhadani and Patel (2019) reported peak population of *H. armigera* during 2nd week of November i.e. 45 SMW. These results are in agreement with Soni *et al.* (2018) who reported the peak of the population was recorded in the fourth week of October 2016. There after the population of the pest started decreasing gradually.

Correlation studies revealed that maximum temperature, minimum temperature, morning relative humidity, and evening relative humidity showed significant negative correlation (r= -0.631, -0.934,-0.412,-0.797, respectively) with Pod borerlarvae population (Table 2). Further, Rainfall showed a negative correlation (r=-0.299) with Pod borer larvae population, but statistically found non-significant **(Table 2).** The present results are in agreement with Kapoor and Shankar (2019) who reported a significantly negative correlation with relative humidity morning and evening.

**Spotted pod borer, *Maruca vitrata* Fabricius**

**Larvae**

First appearance of the Spotted pod borer larvae was observed on 1st October (40th SMW). The number of Spotted pod borer larvae was recorded as a weekly average per plant and the data are presented in **Table 1** and illustrated in **Figure 1.**

From **Table 1**, it was seen that Spotted pod borer larvae population appeared from 40th SMW and was available up to the 2nd SMW (15 January to 21 January). Spotted pod borerlarvae population attained its peak (3.4 larvae /plant) during 47th SMW (19 November to 25 November), when maximum and minimum temperatures were 26.7 and 9.1 °C, respectively, whereas morning and evening relative humidity were 82.1 and 27.2 %, respectively, and here was no rainfall received during this week. The results of the present investigation conformity with the findings Pandey *et al.* (2015) found the initiation from 44th standard meteorological week (SMW) and continued until 50th SMW. The Peak population was noticed twice in 46th and 48th standard week with 0.30 and 0.30larva/ plant respectively.

Correlation studies revealed that maximum temperature, minimum temperature, morning relative humidity, and evening relative humidity showed negative correlation (r= -0.423, -0.792, -0.485, -0.822, respectively) with Pod borerlarvae population, but statistically found to be significant (Table 2). Further, Rainfall showed a negative correlation (r=-0.312) with Pod borer larvae population, but was statistically found to be non-significant **(Table 2).**

The present correlation studies results are in consistent with the findings of Keval *et al*. (2018) who reported that spotted pod borer (*M. vitrata*) exhibited a significant positive correlation with maximum temperature. Similarly, Sreekanth (2015) reported that “highly significant correlation was obtained between *M. vitrata* and maximum temperature”. The present correlation studies results are in consistent with the findings of Dharavath *et al*. (2021) recorded “the overall correlation of weather parameters with seasonal incidence of *M. vitrata* found to minimum temperature, evening relative humidity and rainfall showed negative correlation”.

**4.1.2.2 Webs**

First time the webs of the Spotted pod borer were observed on 1st October (40th SMW). The number of Spotted pod borer webs was recorded as a weekly average per plant and the data are presented in **Table 1** and illustrated in **Figure 1**

From **Table 1**, it was seen that Spotted pod borer webs formed from 40th SMW and were seen up to the 2ndSMW (15 January to 21 January). Spotted pod borerwebs attained its peak (3.9 web/plant) during 47th SMW (19 November to 25 November), when maximum and minimum temperatures were 26.7 and 9.1 °C, respectively, whereas morning and evening relative humidity were 82.1 and 27.2 %, respectively, and here was no rainfall received during this week.

Correlation studies revealed that maximum temperature, minimum temperature, morning relative humidity, and evening relative humidity showed negative correlation (r= -0.488, -0.857, -0.471, -0.853 , respectively) with Pod borerlarvae population, but statistically found to be significant (Table 4.2). Further, Rainfall showed a negative correlation (r=-0.329) with **Pod borer** larvae population, but statistically found to be non-significant **(Table 2).**

**Table 1:** **Effect of weather parameter on incidence of major insect pest complex of Pigeon pea**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S.N. | SMW | Date of observations  Year 2024-25 | Temperature(ºC) | | Average RH (%) | | Total Rainfall (mm) | *Helicoverpa armigera*  Larvae/plant | *Maruca virata* | |
| Max. | Min. | Morning | Evening | Larvae/plant | Webs/plant |
| 1. | 29 | 17 July - 22 July | 32.57 | 25.71 | 85.00 | 72.71 | 11.50 | 0.00 | 0.00 | 0.00 |
| 2 | 30 | 23 July - 29 July | 31.46 | 25.30 | 82.86 | 72.57 | 8.30 | 0.00 | 0.00 | 0.00 |
| 3 | 31 | 30 July -5 Aug | 29.57 | 23.91 | 92.57 | 82.57 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | 32 | 6 Aug-12 Aug | 29.21 | 23.40 | 90.14 | 78.14 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 33 | 13 Aug-19 Aug | 31.34 | 23.93 | 85.71 | 64.14 | 41.50 | 0.00 | 0.00 | 0.00 |
| 6 | 34 | 20 Aug-26 Aug | 31.47 | 23.59 | 87.14 | 77.86 | 13.40 | 0.00 | 0.00 | 0.00 |
| 7 | 35 | 27 Aug-2 Sept | 28.06 | 22.43 | 92.43 | 81.57 | 4.00 | 0.00 | 0.00 | 0.00 |
| 8 | 36 | 3 Sept -9 Sept | 30.41 | 23.16 | 94.71 | 76.29 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 37 | 10 Sept-16 Sept | 30.37 | 22.86 | 85.00 | 65.14 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | 38 | 17 Sept - 23 Sept | 32.56 | 22.39 | 80.00 | 54.00 | 1.30 | 0.00 | 0.00 | 0.00 |
| 11 | 39 | 24 Sept- 30 Sept | 33.89 | 24.13 | 89.86 | 66.29 | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 | 40 | 1 Oct – 7 Oct | 33.19 | 21.26 | 84.29 | 47.43 | 0.00 | 0.00 | 0.20 | 0.30 |
| 13 | 41 | 8 Oct-14 Oct | 31.33 | 20.76 | 85.71 | 51.86 | 0.00 | 0.60 | 0.70 | 1.10 |
| 14 | 42 | 15 Oct-21 Oct | 32.11 | 19.04 | 85.43 | 39.86 | 0.00 | 0.90 | 1.00 | 1.50 |
| 15 | 43 | 22 Oct- 28 Oct | 32.69 | 18.21 | 81.43 | 40.14 | 2.62 | 1.30 | 1.20 | 1.60 |
| 16 | 44 | 29 Oct- 4 Nov | 34.74 | 17.71 | 69.00 | 35.71 | 0.00 | 1.80 | 1.60 | 1.80 |
| 17 | 45 | 5 Nov-11 Nov | 33.51 | 15.80 | 74.43 | 32.86 | 0.00 | 2.40 | 1.80 | 2.10 |
| 18 | 46 | 12 Nov-18 Nov | 30.41 | 12.99 | 85.29 | 31.00 | 0.00 | 2.40 | 2.20 | 2.40 |
| 19 | 47 | 19 Nov-25 Nov | 26.74 | 9.16 | 82.29 | 27.29 | 0.00 | 3.10 | 3.40 | 3.90 |
| 20 | 48 | 26 Nov-2 Dec | 27.30 | 9.70 | 81.43 | 30.57 | 0.00 | 4.20 | 3.00 | 3.40 |
| 21 | 49 | 3 Dec-9 Dec | 26.40 | 8.56 | 84.86 | 28.29 | 0.00 | 4.00 | 2.80 | 3.20 |
| 22 | 50 | 10 Dec-16 Dec | 22.74 | 4.34 | 79.57 | 28.29 | 0.00 | 3.60 | 2.40 | 2.90 |
| 23 | 51 | 17 Dec-23 Dec | 27.46 | 8.36 | 78.43 | 52.29 | 0.00 | 3.40 | 1.80 | 2.40 |
| 24 | 52 | 24 Dec-31Dec | 23.44 | 10.64 | 90.43 | 55.00 | 6.40 | 3.10 | 1.20 | 1.90 |
| 25 | 1 | 08 Jan-14 Jan | 26.21 | 6.93 | 86.14 | 29.57 | 0.00 | 2.90 | 0.80 | 1.50 |
| 26 | 2 | 15 Jan-21 Jan | 25.09 | 7.09 | 84.57 | 39.71 | 0.00 | 1.80 | 0.60 | 1.20 |

**\*SMW:** Standard meteorological week

**Fig 1.** **Graph showing the effect of weather parameter on incidence of major insect pest complex of Pigeon pea**

**Table 2: Correlation coefficient (r) of major insect pests of Pigeon pea with prevailing weather parameters.**

|  |  |  |  |
| --- | --- | --- | --- |
| Weather parameters | *Helicoverpa armigera*  Larvae/plant | *Maruca virata* | |
| Larvae/plant | Webs/plant |
| Correlation with maximum temperature | -0.631\* | -0.423\* | -0.488\* |
| Correlation with minimum temperature | -0.934\* | -0.792\* | -0.857\* |
| Correlation with morning relative humidity | -0.412\* | -0.485\* | -0.471\* |
| Correlation with evening relative humidity | -0.797\* | -0.822\* | -0.853\* |
| Correlation with rainfall | -0.299NS | -0.312 NS | -0.329 NS |

\* Correlation is significant at the P =0.05 level

**Conclusion**

The findings highlight the influence of abiotic factors on pest dynamics and emphasize the importance of weather-based pest forecasting for effective integrated pest management (IPM). Monitoring pest occurrence in relation to environmental factors is crucial for timely warnings and the development of effective integrated pest management strategies. This research specifically examines the seasonal presence of these pests and their correlation with weather parameters in pigeon pea crops.

**Disclaimer (Artificial intelligence)**

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.

**REFERENCE**

ANGRAU Red gram Outlook Report- June to May 2023-24, Crop Outlook Reports of Andhra Pradesh, Achraya NG Ranga Agricultural University

Anonymous, 2022 -23. Department of agriculture and farmers welfare. Govt of Rajasthan

Patange, N.R., & Chiranjeevi. B. (2017). Bioefficacy of newer insecticides against pigeonpea (Cajanus cajan L. Millsp.) pod borers. *population*, 10(11): 12-13.

Awasthi, J. K., & A. Bhatnagar. "A note on damage caused by pod borer complex in pigeon pea." (1983): 37-40.

Soni, K.K., Kumar, A., Shrivastava, P., Sahu, P.S., & Khan, H.H. (2018). Studies on population dynamics of Helicoverpa armigera and Melanagromyza obtusa in pigeon pea, *J. of Ent. and Zoo. Stu.* 6(6): 61-64.

Bhadani, D.J. and Patel, J.J. (2019). Seasonal Incidence of Pod Fly, M. obtusa Infesting pigeon pea. Inte. J. of pure and appl. biosciences, 7(2):44-50.

Keval, R., Hanumanth, S. G., & Chakravarty, S. (2018). Seasonal Incidence of Major Insect Pests on Early Maturing Pigeon pea [Cajanus cajan (L.) Millsp.] in Relation to Abiotic Factors of Varanasi Region of Indo-Gangetic Plain. Advances in Research. 17(5):1-13.

Pandey, A. K., Keval, R., & Yadav, A. (2015). Population dynamics of legume pod borer Maruca Vitrata (Geyer) and blue butterfly Lampides boeticus L. on short duration pigeonpea. *Res Environ Life Sci*, *8*, 777-778.

Dharavath, N., Kharbade, S. B., Sthool, V. A., Balasubramanian, R., & Shaikh, A. A. (2021). Population dynamics and forewarning models for prediction of population of Maruca vitrata under different sowing window and pigeonpea varieties.

Kapoor, B., & Shankar, U. (2019). Seasonal incidence of Maruca vitrata Geyer and Helicoverpa armigera Hubner on black gram (Vigna mungo L. Hepper). *Journal of Entomology and Zoology Studies*, *7*(5), 1083-1087.

Volp, T. M., Jat, B. L., Jaba, J., Zalucki, M. P., & Furlong, M. J. (2025). Integrated pest management in pigeonpea: progress and prospects. *Journal of Applied Entomology*.

Muchhadiya, D. V., Patel, J. J., Patel, D. R., & Patel, R. B. (2024). Estimation of Yield Losses Caused by Insect Pests on Pigeon Pea (Cajanus cajan (L.) Millsp.). *International Journal of Plant & Soil Science*, *36*(3), 410–414.

Srinivasa Rao, M., Rama Rao, C. A., Raju, B. M. K., Subba Rao, A. V. M., Gayatri, D. L. A., Islam, A., ... & Chaudhari, S. K. (2023). Pest scenario of Helicoverpa armigera (Hub.) on pigeonpea during future climate change periods under RCP based projections in India. *Scientific Reports*, *13*(1), 6788.

Yadav, S. K., Singh, D. R., Umrao, R. S., Yadav , A., Yadav , V., & Yadav , G. (2024). Studies on Seasonal Incidence of Gram Pod Borer, Helicoverpa armigera (Hubner) on Chickpea Crop. *International Journal of Environment and Climate Change*, *14*(3), 349–354.

War, W. A., Rasool , J., Bhat , A. A., Sheikh , S. A., Hussain, K., Parthiban M, & Fatimah , N. (2024). An Overview of the Biological Aspects, Nature of Damage and Strategies for Managing the Gram Pod Borer (Helicoverpa armigera Hubner) in Chickpea: A review. *Journal of Scientific Research and Reports*, *30*(5), 643–659.