

# Impact of Weather Factors on Seasonal Incidence of Major Pod Borers in Pigeonpea of Western Uttar Pradesh

Sandeep Kumar<sup>1</sup>, Gaje Singh<sup>1</sup>, D.V. Singh<sup>1</sup>, Rajendra Singh<sup>1</sup>, Gopal Singh<sup>2</sup>, Alok<sup>1</sup>, Vimal Kanaujiya<sup>1</sup>, Akash Singh<sup>1</sup> and Vikrant<sup>1</sup>

<sup>1</sup>Department of Entomology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut 250 110, U.P., India

<sup>2</sup>Department of Plant Pathology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut 250 110, U.P., India

(Received 6 August, 2025; Accepted 8 October, 2025)

## ABSTRACT

Pigeonpea (*Cajanus cajan* L. Mill sp.) is a valuable leguminous crop, which helps in the achievement of sustainable agriculture and soil fertility but is devastatingly affected by a complex of pod borers. The present study tested the seasonal incidence and correlation of major pod borers, *Helicoverpa armigera*, *Maruca vitrata*, and *Melanagromyza obtusa* with important abiotic factor in field conditions in the western Uttar Pradesh. The numbers of larvae were observed weekly in the untreated plots and were compared with the meteorological factors (temperature, relative humidity, and rainfall). *H. armigera* demonstrated maximum incidences of 9.00 and 9.60 larvae plant<sup>-1</sup> in the 44<sup>th</sup> and 45<sup>th</sup> Standard Meteorological Weeks (SMW) of 2023 and 2024, respectively, and no significant relation to weather factors. *M. vitrata* had 14.80 and 14.20 larvae plant<sup>-1</sup> in 44<sup>th</sup> and 43<sup>rd</sup> SMW which showed non-significant positive correlation with maximum temperature (0.212) and rainfall (0.289). Non-significant negative correlations were observed with minimum temperature (-0.102), morning relative humidity (-0.063) and evening relative humidity (-0.298) in 2023 and a significant positive correlation with maximum temperature (0.611). Nevertheless, non-significant correlations were observed with minimum temperature (0.247), morning relative humidity (-0.174), evening relative humidity (-0.276) and rainfall (-0.355) in 2024. *M. obtusa* reached its highest level at 9.20 and 9.60 larvae plant<sup>-1</sup> in 45<sup>th</sup> SMW, and also had a significant positive correlation with maximum temperature (0.596) and morning relative humidity (0.607). A highly significant negative correlation was observed with minimum temperature (-0.725). However, non-significant correlations were recorded with evening relative humidity (0.376) and rainfall (-0.046) in 2023 and a significant positive correlation with morning relative humidity (0.593). Nevertheless, non-significant negative correlations were observed in minimum temperature (-0.395), evening relative humidity (-0.219) and rainfall (-0.428). A non-significant negative correlation was also found with maximum temperature (-0.194) in 2024. The findings reveal species-specific population dynamics and weather relationships, emphasizing the need for climate-based monitoring and integrated pest management strategies for sustainable pigeonpea production in western Uttar Pradesh.

**Key words:** *Cajanus cajan*, *Helicoverpa armigera*, *Maruca vitrata*, *Melanagromyza obtusa*, Seasonal Incidence, Abiotic Factors, Correlation.

## Introduction

Pigeonpea (*Cajanus cajan* L. Mill sp.) 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). Numerous abiotic and biotic factors limit the productivity of pigeon pea, which causes a sharp decline in yield and harvests low yields compared to potential yields. Among the biotic stressors, weeds, diseases and insect pests are the broadest obstacles to getting the desired yields. Insect pests are a major factor contributing to the low yields of pigeon pea, damaging the crop at various growth stages. Around 300 species of insect pests attack pigeonpea (Lal, 1998). There are serious risks posed by pests that attack buds, flowers, pods and grains. Major pod borers include the gram pod borer, *Helicoverpa armigera* (Hubner), the plume moth, *Exelastis atomosa* (Walshingham) and the pod fly, *Melanagromyza obtusa* (Malloch) (Karmar and Patra, 2015; Das *et al.*, 2015; Das *et al.*, 2022). These pests make the damaged grain unconsumable hence greatly interfering with yields. It has been reported that pod damage due to borer complex can vary between 20 and 72% (Lateef and Reed, 1983; Patra *et al.*, 2016). It has been claimed that over 250 insect pests have attacked pigeon peas; however, *Helicoverpa armigera*, *Melanagromyza obtusa*, *Maruca vitrata* and *Clavigralla gibbosa* have caused significant harm to crop yield (Srivastava and Nitin, 2011; Thilagam and Gopikrishnan, 2020). *M. vitrata* is a major insect pest of many edible legumes in various regions of America, Asia and Africa (Vijayakumari *et al.*, 2025). A total of seventeen insect species are reported from Uttar Pradesh (Yadav *et al.*, 2016). Looking towards the infestation of pod borer complex against pigeonpea in western Uttar Pradesh, no much work has been reported by the workers and therefore it is necessitated to undertake the present investigation to study the seasonal incidence of ma-

ior pod borers of pigeonpea (*Cajanus cajan* (L.) Millsp.).

## Materials and Methods

A Field experiment was conducted at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, during *Kharif* season of 2023 and 2024. For the assessment of seasonal incidence of *Helicoverpa armigera*, *Maruca vitrata* and *Melanagromyza obtusa* in western Uttar Pradesh. The pigeonpea cultivar Pusa Arhar-16 was sown in randomized block design (RBD). Row to row and plant to plant spacing was 6030 cm respectively. Recommended agronomic practices were adopted to raise the crop.

## Observations

Observations on the incidence of *Helicoverpa armigera*, *Maruca vitrata* and *Melanagromyza obtusa* were recorded on 5 randomly selected plants in untreated control plot at weekly interval. The observations were started to take after 30 days of germination to till occurrence of insects. The population of *Helicoverpa armigera*, *Maruca vitrata* and *Melanagromyza obtusa* were correlated with climatic factors i.e., maximum and minimum temperature, morning and evening relative humidity, and rain fall. Metrological data collected from department of soil science, SVP&T, Meerut.

## Results and Discussion

The objective of the study was to analyse the relationship between the occurrence of *Helicoverpa armigera*, *Maruca vitrata* and *Melanagromyza obtusa* and different abiotic factors, such as temperature, relative humidity, wind velocity and rainfall. Utilizing data collected during the *Kharif* seasons of 2023-24, a regression equation was framed to elucidate the associations between the population of insect pests and the meteorological variables in Table 1-4.

### Incidence of *Helicoverpa armigera* during *Kharif*, 2023 and 2024

The data regarding incidence of *Helicoverpa armigera* *kharif*, 2023 on pigeonpea was observed in 39<sup>th</sup> SMW which was steadily increased up to 49<sup>th</sup> SMW. The maximum (9.00) larval population was observed in 44<sup>th</sup> SMW, at minimum temperature 14.9 °C, maxi-

imum temperature 30.9°C, morning relative humidity 89.7 per cent, evening relative humidity 68.7, and rainfall 0.0 mm, whereas it was minimum 0.40 in 39<sup>th</sup> SMW at minimum temperature 22.7 °C, maximum temperature 33.9°C, morning relative humidity 82.7 per cent, evening relative humidity 67.1, and rainfall 2.0 mm. Thus, larval population during the entire period ranged from 0.40 to 9.00 larvae plant<sup>-1</sup> (Table 1).

Similarly, first incidence of *Helicoverpa armigera* on pigeonpea was observed in 39<sup>th</sup> standard week during *Kharif-2024* which was gradually increased up to 45<sup>th</sup> SMW. The highest (9.60) larval population was observed in 45<sup>th</sup> SMW, at minimum temperature 16.8°C, maximum temperature 30.8 °C, morning relative humidity 94.1 per cent, evening relative humidity 75.6, and rainfall 0.0 mm, whereas it was minimum 0.20 in 39<sup>th</sup> SMW at minimum tempera-

ture 25.5 °C, maximum temperature 34.7 °C, morning relative humidity 81.4 per cent, evening relative humidity 75.4, and rainfall 00 mm. Thus, larval population during the entire period ranged from 0.20 to 9.60 larvae plant<sup>-1</sup> (Table 2). These findings are in close conformity with earlier reports. Singh and Kumar (2013) observed that *H. armigera* infestation on pigeonpea initiated around the 39<sup>th</sup> SMW and gradually increased, attaining a peak between the 42<sup>nd</sup> and 44<sup>th</sup> SMW. Badhani and Patel (2019) also reported that the *H. armigera* attaining peak at 2<sup>nd</sup> week of November (45<sup>th</sup> SMW).

### Correlation between larval population of *Helicoverpa armigera* and weather parameters during *Kharif, 2023 and 2024*

The correlation study conducted during the *Kharif* of 2023 for *Helicoverpa armigera* (Table 3) showed non-

**Table 1.** Seasonal incidence of major pod borer of pigeonpea during *Kharif 2023*

SMW	Mean number of larvae plant <sup>-1</sup>			Temperature (°C)		Weather		Rainfall (mm)
	<i>Helicoverpa armigera</i>	<i>Maruca vitrata</i>	<i>Melanagromyza obtusa</i>	Max.	Min.	Relative humidity (%)		
				Morn.	Even.			
38	0.00	0.80	0.00	33.3	24.5	80.0	71.0	0.0
39	0.40	2.20	0.00	33.9	22.7	82.7	67.1	2.0
40	1.20	4.60	1.60	34.3	19.7	74.3	54.9	0.0
41	2.60	8.00	2.20	34.7	20.0	76.4	55.9	0.0
42	3.80	11.20	3.60	31.9	17.2	81.9	54.4	24.0
43	6.40	13.00	4.40	31.0	15.5	79.1	61.0	0.0
44	9.00	14.80	7.00	30.9	14.9	89.7	68.7	0.0
45	7.00	11.00	9.20	28.5	14.7	87.0	72.3	2.5
46	4.60	7.40	8.20	27.3	12.0	88.9	70.1	0.0
47	2.00	3.80	7.20	26.1	10.7	87.0	67.3	0.0
48	1.80	1.20	4.80	24.6	12.1	93.3	77.3	0.5
49	0.60	0.40	2.40	25.6	10.6	87.6	66.0	0.2

**Table 2.** Seasonal incidence of major pod borer of pigeonpea during *Kharif 2024*

SMW	Mean number of larvae plant <sup>-1</sup>			Temperature (°C)		Weather		Rainfall (mm)
	<i>Helicoverpa armigera</i>	<i>Maruca vitrata</i>	<i>Melanagromyza obtusa</i>	Max.	Min.	Relative humidity (%)		
				Morn.	Even.			
38	0.00	1.00	0.00	31.1	23.7	87.6	77.6	42.0
39	0.20	2.80	0.00	34.7	25.5	81.4	75.4	0.0
40	1.00	5.80	2.00	35.0	23.8	80.6	67.7	0.0
41	2.20	10.80	3.40	34.6	21.4	77.4	57.9	0.0
42	3.20	13.80	4.80	34.2	18.9	77.3	63.3	0.0
43	6.00	14.20	6.00	33.5	18.8	82.3	67.9	0.0
44	8.80	11.40	8.40	33.0	18.0	83.9	68.7	0.0
45	9.60	8.80	9.60	30.8	16.8	94.1	75.6	0.0
46	7.00	6.00	9.20	29.3	16.4	94.0	75.1	0.0
47	3.60	3.80	7.60	25.8	11.3	93.4	75.1	0.0
48	2.00	1.20	3.80	26.5	10.2	89.3	71.0	0.0
49	0.40	0.40	1.60	25.9	9.6	73.1	56.4	0.0

significant positive correlations with maximum temperature (0.080), morning relative humidity (0.262), evening relative humidity (0.062) and rainfall (0.067). A non-significant negative correlation was observed with minimum temperature (-0.321).

During *Kharif* 2024 (Table 4), the correlation study for *H. armigera* was obtained as a non-significant positive correlation with maximum temperature (0.024), morning relative humidity (0.500) and evening relative humidity (0.232). However, non-significant negative correlations were observed with minimum temperature (-0.188) and rainfall (-0.340). (Harshita *et al.*, 2024; Srivastav *et al.*, 2025; Bajya *et al.*, 2025) also found the non-significant correlation with maximum and minimum temperature and other weather parameter.

#### Incidence of *Maruca vitrata* during *Kharif*, 2023 and 2024

The occurrence of *Maruca vitrata* on pigeonpea during *Kharif*- 2023 was first noticed from 38<sup>th</sup> SMW, which was grew up to 44<sup>th</sup> SMW. The maximum (14.80 larvae plant<sup>-1</sup>) population was observed in 44<sup>th</sup> SMW, at minimum temperature 14.9°C, maximum temperature 30.9 °C, morning relative humidity 89.7 per cent, evening relative humidity 68.7, and rainfall 0.0, whereas it was minimum 0.40 larvae plant<sup>-1</sup> in 49<sup>th</sup> standard week at minimum temperature 10.6 °C, maximum temperature 25.6 °C, morning relative humidity 87.6 per cent, evening relative humidity 66.0, and rainfall 0.2 mm. Thus, larval population during the entire period ranged from 0.40 to 14.80 larvae plant<sup>-1</sup> (Table 1).

During 2024 the data pertaining to incidence of *Maruca vitrata* on pigeonpea shown that the population was first noticed in 38<sup>th</sup> SMW, which was steadily increased up to 43<sup>th</sup> SMW. The maximum (14.20 larvae plant<sup>-1</sup>) larval population was observed in 43<sup>th</sup> SMW, at minimum temperature 18.8 °C, maximum temperature 33.5 °C, morning relative humidity 82.3 per cent, evening relative humidity 67.9, and rainfall 0.0, whereas it was minimum 0.40 in 49<sup>th</sup> SMW at minimum temperature 9.6 °C, maximum temperature 25.9 °C, morning relative humidity 73.1 per cent, evening relative humidity 56.4, and rainfall 0.0 mm. Thus, larval population during the entire period ranged from 0.40 to 14.20 larvae plant<sup>-1</sup> (Table 2). The results are in close conformity with the findings that identified by (Taggar *et al.*, 2019; Patel *et al.*, 2022; Bag *et al.*, 2018).

#### Correlation between larval population of *Maruca vitrata* and weather parameters during *Kharif*, 2023 and 2024

The correlation study for *Maruca vitrata* during *Kharif* 2023 (Table 3) showed a non-significant positive correlation with maximum temperature (0.212) and rainfall (0.289). Non-significant negative correlations were observed with minimum temperature (-0.102), morning relative humidity (-0.063) and evening relative humidity (-0.298).

The correlation analysis during the consecutive year *Kharif* 2024 (Table 4) revealed that *M. vitrata* disclosed a significant positive correlation with maximum temperature (0.611). Nevertheless, non-significant correlations were observed with mini-

**Table 3.** Correlation between weather parameters and major pod borer of pigeonpea during *Kharif* 2023

Pod borers	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morn.	Even.	
<i>Helicoverpa armigera</i>	0.080 <sup>NS</sup>	-0.321 <sup>NS</sup>	0.262 <sup>NS</sup>	0.062 <sup>NS</sup>	0.067 <sup>NS</sup>
<i>Maruca vitrata</i>	0.212 <sup>NS</sup>	-0.102 <sup>NS</sup>	-0.063 <sup>NS</sup>	-0.298 <sup>NS</sup>	0.289 <sup>NS</sup>
<i>Melanagromyza obtusa</i>	0.596*	-0.725**	0.607*	0.376 <sup>NS</sup>	-0.046 <sup>NS</sup>

\* Significant at P<0.05 value, \*\* Significant at P<0.01 value, NS= Non-Significant

**Table 4.** Correlation between weather parameters and major pod borer of pigeonpea during *Kharif* 2024

Pod borers	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Morn.	Even.	
<i>Helicoverpa armigera</i>	0.024 <sup>NS</sup>	-0.188 <sup>NS</sup>	0.500 <sup>NS</sup>	0.232 <sup>NS</sup>	-0.340 <sup>NS</sup>
<i>Maruca vitrata</i>	0.611*	0.247 <sup>NS</sup>	-0.174 <sup>NS</sup>	-0.276 <sup>NS</sup>	-0.355 <sup>NS</sup>
<i>Melanagromyza obtusa</i>	-0.194 <sup>NS</sup>	-0.395 <sup>NS</sup>	0.593*	0.219 <sup>NS</sup>	-0.428 <sup>NS</sup>

\* Significant at P<0.05 value, \*\* Significant at P<0.01 value, NS= Non-Significant

mum temperature (0.247), morning relative humidity (-0.174), evening relative humidity (-0.276) and rainfall (-0.355) (Taggar *et al.*, 2019) studied on correlation studies on incidence of *Maruca vitrata* in pigeonpea and stated that maximum temperature had a significant positive influence on *Maruca vitrata* population, which aligns with the findings of the current study during the *kharif* 2024.

#### **Incidence of *Melanagromyza obtusa* during *Kharif*, 2023 and 2024**

The occurrence of *Melanagromyza obtusa* on pigeonpea during *Kharif*-2023 was first noticed from 40<sup>th</sup> SMW, which was grown up to 45<sup>th</sup> SMW. The maximum (9.20 larvae plant<sup>-1</sup>) population was observed in 45<sup>th</sup> SMW, at minimum temperature 14.7 °C, maximum temperature 28.5 °C, morning relative humidity 87.0 per cent, evening relative humidity 72.3, and rainfall 2.5, whereas it was minimum 1.60 larvae plant<sup>-1</sup> in 40<sup>th</sup> SMW at minimum temperature 19.7 °C, maximum temperature 34.3 °C, morning relative humidity 74.3 per cent, evening relative humidity 54.9, and rainfall 0.0 mm. Thus, larval population during the entire period ranged from 1.60 to 9.20 larvae plant<sup>-1</sup> (Table 1).

During 2024 the data pertaining to incidence of *Melanagromyza obtusa* on pigeonpea shown that the population was first noticed in 40<sup>th</sup> SMW, which was steadily increased up to 45<sup>th</sup> SMW. The maximum (9.60 larvae plant<sup>-1</sup>) larval population was observed in 45<sup>th</sup> SMW, at minimum temperature 16.8°C, maximum temperature 30.8 °C, morning relative humidity 94.1 per cent, evening relative humidity 75.6, and rainfall 0.0, whereas it was minimum 1.60 in 49<sup>th</sup> SMW at minimum temperature 9.6 °C, maximum temperature 25.9 °C, morning relative humidity 73.1 per cent, evening relative humidity 56.4, and rainfall 0.0 mm. Thus, larval population during the entire period ranged from 1.60 to 9.60 larvae plant<sup>-1</sup> (Table 2). The results are in close conformity with (Singh *et al.*, 2024) who reported that first appearance of *M. obtusa* larvae and pupa was observed in the 41<sup>st</sup> and 39<sup>th</sup> standard week (SMW). The peak larval population was noticed in the 44<sup>th</sup> SMW at both years, Similar trends of result was also found by (Yadav *et al.*, 2011) reported that the *M. obtusa* incidence was noticed from 40<sup>th</sup> SMW and peaked up to 47<sup>th</sup> week *i.e.* in first week of November.

#### **Correlation between larval population of *Melanagromyza obtusa* and weather parameters during *Kharif*, 2023 and 2024**

The correlation study conducted during the *Kharif* of 2023 for *Melanagromyza obtusa* (Table 3) showed a significant positive correlation with maximum temperature (0.596) and morning relative humidity (0.607). A highly significant negative correlation was observed with minimum temperature (-0.725). However, non-significant correlations were recorded with evening relative humidity (0.376) and rainfall (-0.046).

The incidence of *M. obtusa* was recorded and further analyzed with meteorological variables during consecutive year *Kharif* 2024 (Table 4) and it was perceived that *M. obtusa* disclosed a significant positive correlation with morning relative humidity (0.593). Nevertheless, non-significant negative correlations were observed in minimum temperature (-0.395), evening relative humidity (-0.219) and rainfall (-0.428). A non-significant negative correlation was also found with maximum temperature (-0.194). These results align with (Ramkumar *et al.*, 2023), who reported significant positive correlation between *M. obtusa* incidence and maximum temperature. Similarly, (Sachin Kumar *et al.*, 2019) found non-significant negative correlations with both maximum and minimum temperatures particularly similar to our 2024 seasonal outcomes.

#### **Conclusion**

The investigation into the seasonal incidence of major pod borers, *Helicoverpa armigera*, *Maruca vitrata*, and *Melanagromyza obtusa*, on pigeonpea during the *Kharif* seasons of 2023 and 2024 in western Uttar Pradesh yielded critical insights into their population dynamics and relationship with abiotic factors. The maximum levels of both *Helicoverpa armigera* were 9.00 larvae plant<sup>-1</sup> in the 49<sup>th</sup> Standard Meteorological Week (SMW) of 2023 and maximum to 9.60 larvae plant<sup>-1</sup> at the 45<sup>th</sup> SMW of the 2024 season. In correlation analysis with weather parameters (maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, and rainfall), the *Helicoverpa armigera* did not show significant correlation with any weather parameter during either season for this pest. *Maruca vitrata* were above threshold levels for population growth at the 44<sup>th</sup> SMW of the 2023 season (14.80

larvae plant<sup>-1</sup>) and at the 43<sup>rd</sup> SMW of the 2024 season (14.20 larvae plant<sup>-1</sup>). There was a significant positive correlation present for the 2024 population against maximum temperature (0.611 correlation), while other weather parameters from both seasons were non-significant for *Maruca vitrata* in both seasons. The infestations of *Melanagromyza obtusa* were not first found till later than occurrence for other pests, did possess a maximum of 9.20 larvae plant<sup>-1</sup> in the 45<sup>th</sup> SMW of 2023 and pressed to 9.60 larvae plant<sup>-1</sup> in the 45<sup>th</sup> SMW of 2024. Population dynamics demonstrated a significant positive correlation with maximum temperature (0.596 correlation) and morning relative humidity (0.607) and a highly significant negative correlation to minimum temperature (-0.725 correlation) in the 2023 season. A similar correlation against morning relative humidity (0.593 correlations) was observed in the 2024 season. In conclusion, this study describes the seasonal patterns and different levels of impacts of meteorological factors on the three major pod borer species that infest pigeon pea. The results showed that pest-climate interactions are species specific and further added to the scientific basis for developing IPM (Integrated Pest Management) methods in a timely and targeted manner. With climate data and the timing of peak infestations, this study can provide an important contribution to agro-ecological and sustainable pigeonpea production in western Uttar Pradesh, India, and other similar climates.

**Conflict of Interest-** None

## References

- Anonymous, 2023. Annual report of all India coordinated research on Pigeonpea. Directorate of Pulses Development, Vindhyachal Bhavan, Bhopal-462 004.
- Bag, L. 208. *Studies on seasonal incidence and biology of maruca vitrata (fabricius) on different pigeonpea genotypes*, Govind Ballabh Pant University of Agriculture and Technology Pantnagar-263145, (U.S. Nagar), Uttarakhand, M.Sc. 2018 <https://krishikosh.egranth.ac.in/server/api/core/bitstreams/73c9460b-f37d-477c-ae4c-2019a4d4c2b4/content>
- Bajya, R., Bairwa, D.K., Jat, B.L., Bana, J. K., Hussain, A., Sharma, S.L. and Choudhary, S. 2025. Seasonal Incidence of *Helicoverpa armigera* (Hub.) on Chickpea in Relation to Abiotic Factors Semi-arid Region of Rajasthan. *Biological Forum – An International Journal*. 17(1): 14-18.
- Bhadani, D.J. and Patel, J.J. 2019. Seasonal incidence of lepidopteran pod borers infesting pigeon pea. *International Journal of Pure and Applied Bioscience*. 7(2): 119-126. <https://doi.org/10.18782/2320-7051.7406>
- Das, B.C., Patra, S., Dhote, V.W., Alam, S.K.F., Chatterjee, M.L. and Samanta, A. 2015. Mix formulations: An alternative option for management of gram pod borer, *Helicoverpa armigera* H. and pod fly, *Melanagromyza obtusa* M. in pigeon pea. *Legume Research*. 38(3): 396-401. <https://doi.org/10.5958/0976-0571.2015.00124.1>
- Das, B.C., Patra, S., Samanta, A. and Dhar, P.P. 2022. Evaluation of biorational insecticides and bio-pesticides against pod borer complex in pigeon pea. *International Journal of Bio-resource and Stress Management*. 13(3): 261-267. <https://doi.org/10.23910/1.2022.2620b>
- Haji, A., Tekka, T.A., Yirga Bereka, T., Negasa Andersa, K., Desalegn Nekera, K., Geleta Abdi, G., Lema Abelti, A. and Makiso Urugo, M. 2024. Nutritional composition, bioactive compounds, food applications, and health benefits of pigeonpea (*Cajanus cajan* L. Millsp.). *Legume Science*. 6 (2): e233.
- Karmakar, K. and Patra, S. 2015. Bio-efficacy of some new insecticide molecules against pod borer complex of red gram. *Legume Research*. 38(2): 253-59. <https://doi.org/10.5958/0976-0571.2015.00061.2>
- Kumar, S., Chandra, U., Yadav, S.K., Jyoti, and Kumar, V. 2019. Population dynamics of pigeonpea pod fly (*Melanagromyza obtusa*) and their correlation with abiotic factors in pigeonpea. *Journal of Entomology and Zoology Studies*. 7(6): 784-786.
- Lal, S.S. 1998. Host plant resistance in pigeonpea against the podfly, *Melanagromyza obtusa* Malloch: 1-14
- Lateef, S.S. and Reed, W. 1983. Review of crop losses caused by insect pests of the pigeonpea internationally and in India. *Indian Journal of Entomology (Special Issue)*. 2: 284-291.
- Patel, R.M. and Parmar, H.P.R. 2022. Seasonal activity of spotted pod borer, *Maruca vitrata* (Fabricius) in relation to weather factors infesting cowpea. *Pharma Innovation*. 11(9): 1034-1038.
- Patra, S., Firake, D.M., Azad Thakur, N.S. and Roy, A. 2016. Insect pest complex and crop losses in pigeonpea in medium altitude hill of Meghalaya. *The Bioscan. Supplement on Agronomy*. 11(1): 297-300.
- Ramkumar, Krishna Kant Prajapati, Ram Keval, Kanchan Padwal, G. and Srivastava, C.P. 2023. Seasonal incidence of pod pests complex of pigeonpea, *Cajanus cajan* (L.) Mill Sp. *J. Exp. Zool. India*. 26:1183-1186. DOI: <https://doi.org/10.51470/jez.2023.26.1.1183>, DocID: <https://connectjournals.com/03895.2023.26.1183>
- Sarkar, S., Panda, S., Yadav, K.K. and Kandasamy, P. 2020. Pigeonpea (*Cajanus cajan*) an important food legume in Indian scenario - A review. *Legume Research: An International Journal*. 43(5): 601-610.

- Saxena, R.K., Saxena, K.B. and Varshney, R.K. 2019. Pigeonpea (*Cajanus cajan* L. Mill sp.): An ideal crop for sustainable agriculture. In: J. Al-Khayri, S. Jain and D. Johnson (Eds.), *Advances in Plant Breeding Strategies: Legumes* (pp. 127-149). Springer. [https://doi.org/10.1007/978-3-030-23400-3\\_11](https://doi.org/10.1007/978-3-030-23400-3_11)
- Singh, H. and Kumar, A. 2013. Seasonal incidence of insects associated with pigeonpea. *Journal of Scientific and Applied Research*. 4(1): 1-5.
- Singh, M.K., Dwivedi, S.K. and Yadav, H.S. 2024. Population dynamics of pod fly, *Melanagromyza obtusa* (Malloch) and its natural enemies on pigeonpea. *Entomon*. 49(4): 519-526. <https://doi.org/10.33307/entomon.v49i4.1341>.
- Srivastav, V.K., Tripathi, A. and Dwivedi, A.C. 2025. Spatial and seasonal variation in population dynamics of gram pod borer, *Helicoverpa armigera* (Hübner) Infestations on Chickpea In Tropical Climatic Condition, India. *Journal of Advanced Zoology*. 46(2). <https://jazindia.com>
- Srivastava, C.P. and Nitin, J. 2011. Insect pest management in pigeonpea in Indian scenario: A critical review. *Indian Journal of Entomology*. 73(1):63-75.
- Taggar, G.K., Singh, R., Cheema, H.K. and Singh, P. 2019. Relative abundance, population dynamics and damage potential of spotted pod borer, *Maruca vitrata* (Fabricius) on early pigeonpea in Punjab. *International Journal of Tropical Insect Science*. 39(3): 229-234.
- Thilagam, P. and Gopikrishnan, A. 2020. Integrated pest management module against pod borer complex in pigeonpea (*Cajanus cajan* L.). *Journal Krishi Vigyan*. 9(1): 180-183. <https://doi.org/10.5958/2349-4433.2020.00162.2>
- Vijayakumari, N., Shanthi, M., Anusha, N., Murugan, M., Paripoorani, S., Varanavasiappan, S. and Mohan, M. 2025. Relative toxicity of subspecies of *Bacillus thuringiensis kurstaki* HD-1 and HD-73 against the larvae of legume pod borer, *Maruca vitrata*, F., (Lepidoptera: Crambidae). *Plant Science Today*. 12(1). <https://doi.org/10.14719/pst.6035>
- Yadav, D.K., Sachan, S.K., Singh, G. and Singh, D.V. 2016. Insect pests associated with pigeonpea variety upas -120 in western Uttar Pradesh, India. *Plant Archives*. 16(1): 140-142.
- Yadav, S.K., Ahuja, D.B. and Dhandapani, A. 2011. Seasonal activity of pod fly, *Melanagromyza obtusa* (Malloch.) (Diptera: Agromyzidae) and effect of abiotic factors on its incidence in pigeon pea. *Indian Journal of Entomology*. 73(2): 162-165.
-