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Impact of Key Insect Pests on Cowpea and their Relationship with Weather Parameters

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Cowpea (*Vigna unguiculata* L.) is a vital pulse crop with substantial nutritional value in India that faces production challenges due to various biotic and abiotic factors. Among the biotic factors that affects cowpea, pests such as *Maruca vitrata* and *Riptortus pedestris* significantly impact cowpea yields. This study aimed to evaluate the seasonal incidence of these pests and analyze their correlations with weather parameters in Thiruvananthapuram, Kerala.

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Methodology: Field observations were conducted over the cropping season to record pest populations across Standard Meteorological Weeks (SMWs). The population of the pod bugs and pod borers were taken from five plants. Statistical analyses were performed to identify correlations between pest incidence and key weather factors.
Key Findings: The incidence of *R. pedestris* peaked in the 16th SMW, reaching 7.54 bugs per five plants. This pest displayed a significant positive correlation with maximum temperature (r = 0.637) and minimum temperature (r = 0.559) and a negative correlation with evening relative humidity (r =-0.480). Similarly, *M. vitrata* larval populations peaked during the same period at 2.65 larvae per five plants, showing a similar temperature-dependent correlation.
Implications: The temperature-sensitive incidence patterns observed underscore the need for integrated pest management (IPM) strategies that address climatic factors to enhance cowpea sustainability. This data provides valuable insights for future pest forecasting and management efforts.

Keywords: Pest incidence; seasonal correlation; cowpea pest; pod bugs and pod borers.

1. INTRODUCTION

Major pulse crops grown in India include pigeonpea, mungbean, urdbean, chickpea, horse gram and cowpea. Among these, cowpea (*Vigna unguiculata* L.) from the Fabaceae family is one of the oldest known food sources. It provides essential daily nutrition to a large portion of the population. India is considered to be the largest producer and consumer of pulses, accounting for nearly 25% of global production and 27% of global consumption (Srivastava et al., 2010). As reported by Sekhar and Bhatt, 2012 pulse production remained nearly stagnant for around 40 years. The total production of food grains in India has declined from 16% in 1950 to 8% in 2022-23 (Tiwari and Shivhare, 2016). The biotic and abiotic factors such as the presence of pests, diseases and parasitic weeds are the causes of this reduction. Drought and poor soil fertility is another reason for declining harvests (Singh and Jackai, 1985).

A total of 21 insect pest species have been recorded damaging the cowpea crop from germination to maturity with most pests emerging during the pod-bearing stage of cowpea. *Maruca vitrata* is regarded as the most dangerous and significant pod borer that causes considerable damage during the flowering period (Patel et al., 1985). Its destructive impact during critical stages of crop growth, especially flowering and pod development as well as its focus on economically important parts like flower buds, flowers, and pods makes it a major constraint to achieve potential productivity. Losses of 42% to 80% due to pod damage alone have been reported (Halder and Srinivasan, 2011).

Pod bugs are another serious pest that attacks cowpea, particularly during the post-flowering phase. These bugs feed by extracting sap from the developing pods that affects both the quantity and quality of the harvest (Prasad et al., 2021). Both nymphs and adults pierce the pod walls and extract nutrients from the developing grains which leads to premature pod shedding, deformation and grain shrivelling that reduces grain yield (Srujana and Keval, 2014).

The present study was to know the seasonal incidence of pod bugs and pod borer that infest cowpea with weather parameters during the year 2024.

2. MATERIALS AND METHODS

A field study was conducted at the College of Agriculture, Vellayani during 2024 to monitor the seasonal incidence of pod bugs and pod borers infesting cowpea. The variety used in the study was Githika, released by Kerala Agricultural University.

2.1 Seasonal Incidence of Pod Bug, *Riptortus pedestris* in Cowpea

Data on the incidence of pod bugs were collected using a fixed plot sampling technique. From each plot, five plants were randomly selected and tagged to count the number of nymphs on each of the tagged plants. The sampling was done through direct counting at biweekly intervals during different phases of crop. Observations were taken in the morning hours to count the number of nymphs of pod bugs in the experimental plots. The average number of pod bug nymphs that attack cowpea was counted at each stage of crop. Then the values were correlated with weather parameters recorded during the crop period to assess the impact of temperature, relative humidity, rainfall, and wind speed on the population dynamics of the pests.

2.2 Seasonal Incidence of Pod borer, *Maruca vitrata* in Cowpea

The seasonal incidence of *M. vitrata* was observed by taking five plants randomly and the total number of larvae was recorded. Observations were made biweekly from the flowering period until the maturity stage. Finally, the larval population of *M. vitrata* was correlated with various weather parameters to assess their correlation effects. For this purpose, biweekly data on different weather parameters were collected from the meteorological observatory of College of Agriculture, Vellayani.

3. RESULTS AND DISCUSSION

3.1 Seasonal Incidence of Pod Bug, *Riptortus pedestris* in Cowpea

The mean population dynamics of *R. pedestris* (pod bugs) per five cowpea plants across Standard Meteorological Weeks (SMW) 9 to 31 is presented in Fig. 1, along with corresponding changes in key abiotic factors such as maximum and minimum temperatures, total rainfall, wind speed, and relative humidity (RH I and RH II).

The pod bug population was initiated at 0.6 bugs per five plants during the 9th SMW followed by a gradual increase that peaked at 7.54 bugs per five plants in the 16th SMW (Table 1). After this peak, the population began to decline, dropping to 0.6 bugs per five plants by the 31st SMW. This rise and fall in the pod bug population appeared to be influenced by variations in abiotic factors. Maximum temperature remained relatively stable, ranging between 32.5°C and 34.2°C while minimum temperature fluctuated between 22°C and 24.3°C without significant deviation across the observation period. Total rainfall showed more variability, with two distinct peaks; the first occurring in the 19th SMW at 37.4 mm and the highest recorded during the 22nd SMW at 46.6 mm, although most other weeks experienced low or no rainfall. Wind speed, on the other hand remained consistently low, ranging between 0.4 and 8.2 km/hr, without notable fluctuations throughout the study period.

The relative humidity exhibited consistent trends, particularly RH I and RH II. RH I fluctuated between 73% and 83%, while RH II showed more variation, ranging from 62% to 90% peaking during the 19th SMW and gradually declining thereafter. The highest pod bug population of 7.54 bugs per five plants was observed in the 16th SMW, which coincided with moderate temperature ranges, approximately 33°C for the maximum and 23°C for the minimum, as well as minimal rainfall. Conversely, during periods of higher rainfall, 22nd SMW where 46.6 mm of rainfall was recorded, the pod bug population declined, suggesting that excessive rainfall could negatively affect pod bug population growth. Higher relative humidity, particularly RH II, was also recorded during the weeks with increased rainfall and was associated with a reduction in the pod bug population.

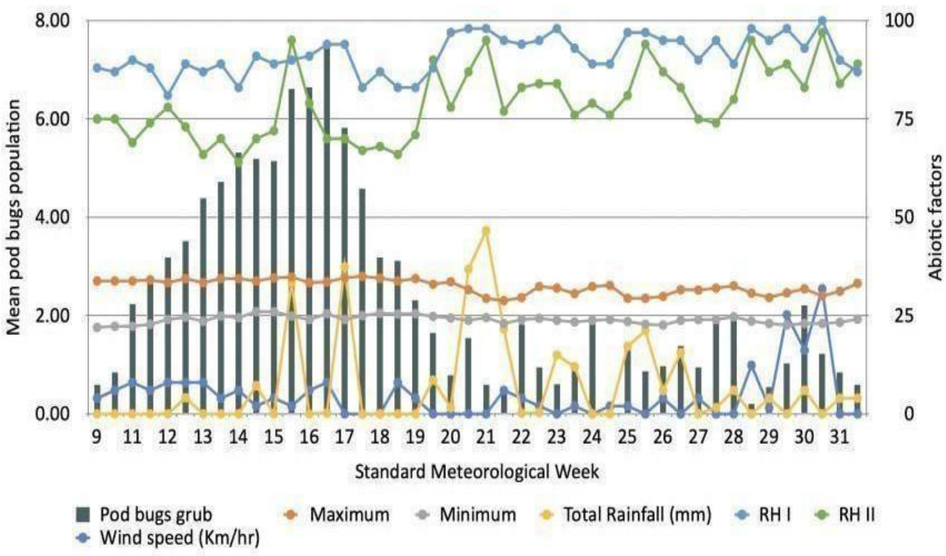

Fig. 1. Seasonal incidence of pod bugs in relation to weather parameter

Recent research by Rahman, 2022 documented *R. pedestris* as a new pest affecting mungbean fields in Bangladesh. The first sightings were on April 5th in 2018, 2019, and 2020 with peak populations occurring in the second and third weeks of April, reaching 6 bugs per ten plants for nymphs and 7 bugs per ten plants for adults. This three-year study indicates that *R. pedestris* populations were highest during pod-bearing stages, emphasizing a critical period for crop vulnerability. These observations align with previous studies indicating that *R. pedestris* typically appears in later crop growth stages, causing significant damage by piercing pods and seeds, ultimately reducing yield.

Correlation studies with weather parameters revealed that incidence of *R. pedestris* exhibited a significant positive correlation with atmospheric maximum temperature (r = 0.637) and atmospheric minimum temperature (r = 0.559). A significantly negative correlation was observed with evening relative humidity (r = -0.480) and did not show any significant correlation with other abiotic factors (Fig. 2).

The current correlation study is in line with the temperature-dependent trends observed by Mahipal *et al*., 2017. A significantly negative correlation with evening relative humidity (r = -0.480) supports the theory that drier conditions favour pest activity.

These findings of the current study also align with similar trends observed in the study conducted by Soratur *et al*., 2017. The study on pod bugs reported a significant negative correlation with morning relative humidity (r = -0.643) and a positive correlation with maximum temperature (r = 0.466). This implies that a higher temperature promotes the growth of the pod bug population. Whereas, the increased humidity during morning or evening hours tends to limit the activity of pod-sucking bugs.

In contrast, Reddy *et al*., 2017 observed significant negative correlations with maximum temperature (r = -0.512) and evaporation (r = -0.510), while morning relative humidity showed a positive correlation (r = 0.071). Such contrasting results may reflect variations due to crop type, regional climatic conditions, or other environmental factors influencing the impact of temperature and humidity on the incidence of *R. pedestris.*

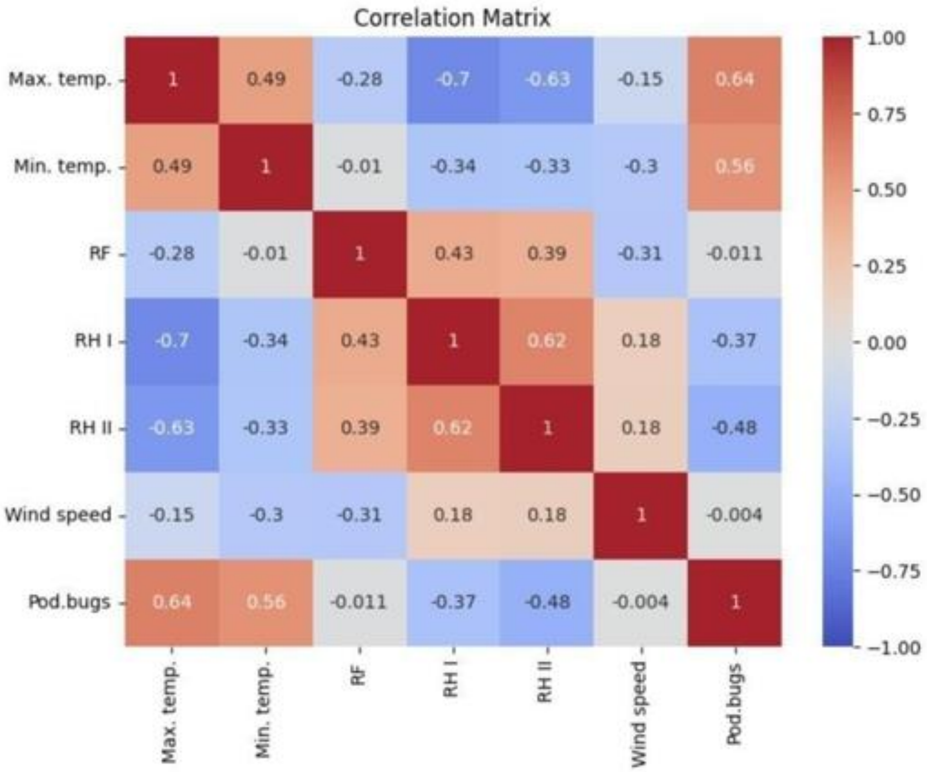

Fig. 2. Correlation analysis of pod bugs with weather parameters

3.2 Population Dynamics of Pod Borer, *Maruca vitrata* infestation in Cowpea

The trend for the seasonal incidence of pod borers (*M. vitrata*) began with a relatively low population during the early SMWs (Fig. 3). The initial incidence was observed on the 9th SMW with 0.50 larvae per plant. However, the population reached its first notable increase by 13th SMW (Table 1). A significant peak is observed from the 16th SMW, where the mean pod borer population rises to 2.75 larvae per plant. This increase coincides with a period of higher minimum and maximum temperatures suggesting that pod borers thrive under warmer conditions. During this peak, the rainfall remains low indicating that pod borers are less influenced by moisture or rainfall. After the 16th SMW the population starts to decline gradually, but it remains sustained through to 22nd SMW even though temperatures continue to fluctuate slightly.

The seasonal incidence of pod borers in cowpea, as shown in Fig. 3, demonstrates how larval populations fluctuate in response to weather parameters over the 9th to 31st SMW. The mean population of pod borer larvae begins to rise

noticeably around the 12th SMW, reaching its peak in the 16th SMW at approximately 2.75 larvae per plant. Following this peak, the larval population gradually declined, with smaller peaks occurring around the 21st and 25th SMWs before tapering off to low levels by the 31st SMW.

Throughout this period, the maximum temperature remains relatively steady, fluctuating between 25°C and 30°C. This temperature stability likely provides favuorable conditions for pod borer development, particularly during the peak weeks. The minimum temperature remains within a narrower range, between 15°C and 20°C, further supporting larval growth within a suitable temperature.

Relative humidity in the morning (RH I) consistently stays high, between 75% and 90%, while evening relative humidity (RH II) fluctuates slightly more, generally ranging from 60% to 85%. The relatively high humidity levels, particularly in the morning, likely contribute to a favourable microclimatic environment for pod borer activity. This interaction between pod borer incidence and weather parameters emphasizes the importance of stable temperature and humidity conditions, while sporadic rainfall and low wind speeds appear to have minimal impact on the observed population trends.

Muchhadiya *et al*. (2020) reported a similar seasonal incidence pattern, noting the onset of *M. vitrata* populations in the 37th SMW, peaking between the 39th and 42nd SMW. Soratur *et al*. (2017) also recorded peak activity during the 43rd SMW, reinforcing that *M. vitrata* consistently peaks in October across various regions and years.

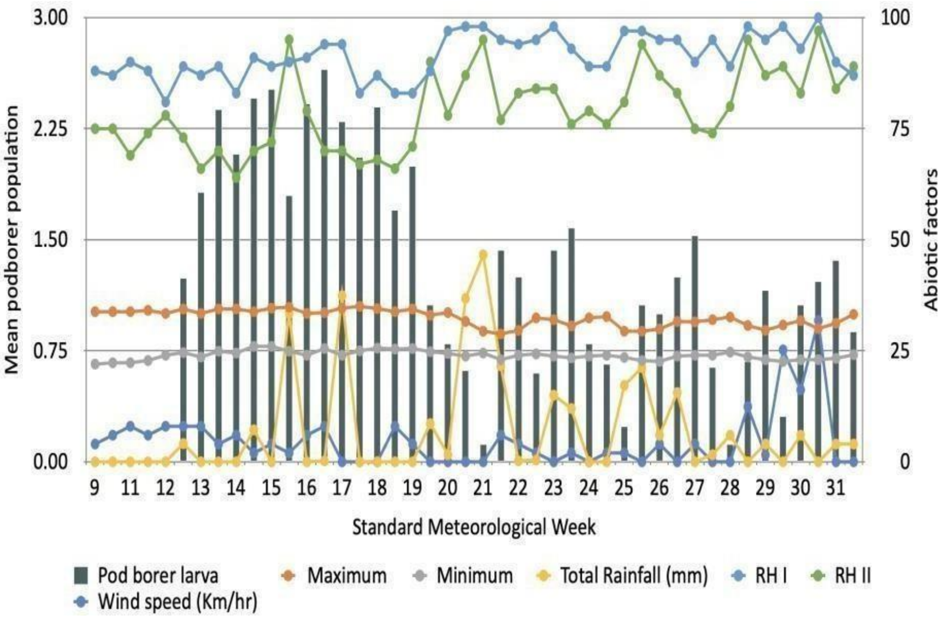

Fig. 3. Seasonal incidence of pod borers in relation to weather parameters

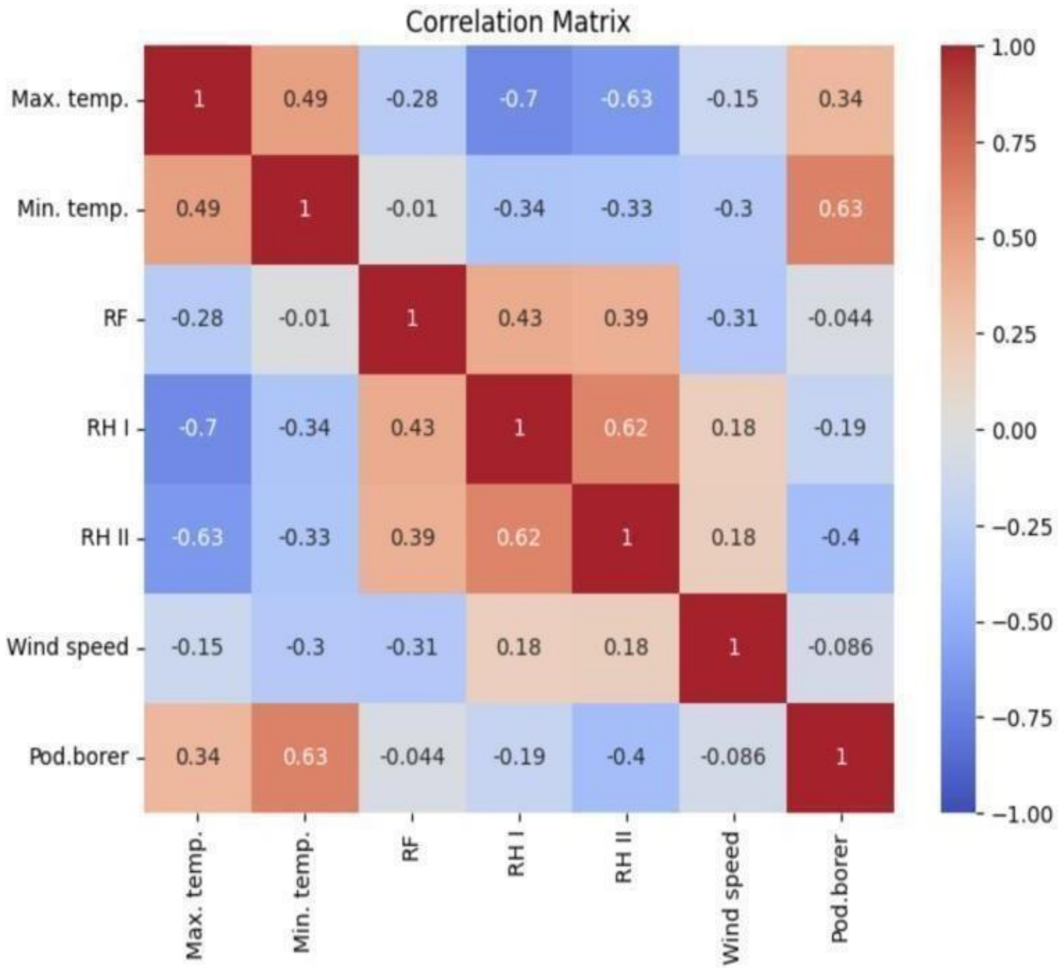

Fig. 4 Correlation matrix of pod borers in relation to weather parameters

Table 1. Data on the seasonal incidence of pod bugs and pod borers affecting cowpea during the year 2024

SMW	Month	Atmospheric Temp		Total Rainfall (mm)	Relative humidity		Wind speed (Km /hr)	Mean no. of pest population/ five plants	
		Maxim um	Mini mum		I	II		Pod borer larva	Pod bugs grub
9	4- Mar	33.8	22	0	88	75	4	0.00	0.60
10	8-Mar	33.8	22.3	0	87	75	6	0.00	0.86
11	11-Mar	33.8	22.3	0	90	69	8	0.00	2.24
11	15-Mar	34.1	22.8	0	88	74	6	0.00	2.66
12	19-Mar	33.4	24	0	81	78	8	0.00	3.20
12	23-Mar	34.4	24.6	4.1	89	73	8	1.24	3.53
13	26-Mar	33.4	23.6	0	87	66	8	1.82	4.40
13	29-Mar	34.4	24.9	0	89	70	4	2.38	4.73
14	1-Apr	34.4	24.5	0	83	64	6	2.08	5.33
14	5-Apr	33.8	26	7.2	91	70	2	2.46	5.20
15	9-Apr	34.6	26	0	89	72	4	2.52	5.16
15	12-Apr	34.8	24.9	33.4	90	95	2	1.80	6.62
16	16-Apr	33.4	24	0	91	79	6	2.42	6.66
16	19-Apr	33.6	25.5	0.2	94	70	8	2.65	7.54
17	25-Apr	34.6	24	37.4	94	70	0	2.30	5.83
17	29-Apr	35	25	0	83	67	0	2.06	4.60
18	3-May	34.5	25.6	0	87	68	0	2.40	3.20
18	6-May	33.8	25.4	0	83	66	8	1.70	3.13
19	10-May	34.4	25.5	0	83	71	4	2.00	2.33
19	13-May	3	24.8	8.6	88	90	0	1.06	1.66
20	16-May	33.6	24.4	1.6	97	78	0	0.80	0.80
20	20-May	31.6	23.8	36.8	98	87	0	0.62	1.56
21	23-May	29.4	24.5	46.6	98	95	0	0.12	0.60
21	27-May	28.8	23	21.6	95	77	6	1.43	0.50
22	31-May	29.6	24	0.2	94	83	4	1.25	1.83
22	3-Jun	32.4	24.3	0.4	95	84	2	0.60	0.96
23	6-Jun	32	23.8	15	98	84	0	1.43	0.62
23	10-Jun	30.6	23.4	12	93	76	2	1.58	1.02
24	14-Jun	32.4	23.8	0	89	79	0	0.80	1.93
24	17-Jun	32.7	24	0	89	76	2	0.66	0.00

SMW	Month	Atmospheric Temp		Total Rainfall (mm)	Relative humidity		Wind speed (Km /hr)	Mean no. of pest population/ five plants	
		Maxim um	Mini mum		I	II		Pod borer larva	Pod bugs grub
25	21-Jun	29.4	23.5	17.2	97	81	2	0.24	1.48
25	24-Jun	29.4	22.8	21.2	97	94	0	1.06	0.88
26	28-Jun	29.9	22.6	6	95	87	4	1.00	0.98
26	1-Jul	31.6	23.8	15.6	95	83	0	1.25	1.40
27	4-Jul	31.5	24	0	90	75	4	1.53	0.96
27	8-Jul	32	24	1.6	95	74	0	0.64	1.98
28	12-Jul	32.6	24.7	6	89	80	0	0.12	2.02
28	15-Jul	30.7	23.6	0	98	95	12.4	0.68	0.22
29	19-Jul	29.6	23	4	95	87	1.6	1.16	0.56
29	22-Jul	30.8	22.6	0	98	89	25.2	0.31	1.04
30	25-Jul	31.8	23	6	93	83	16.2	1.06	2.22
30	29-Jul	30	23	0	100	97	31.8	1.22	1.24
31	1-Aug	31.2	23.3	4	90	84	0	1.36	0.86
31	5-Aug	33.2	24.1	4	87	89	0	0.88	0.60

Correlations between pod borer population on cowpea and maximum temperature (r= 0.345), and minimum temperature (r= 0.630) were found to have a positive correlation, whereas with evening relative humidity (r= -0.396) it was found to have a significant negative correlation (Fig. 4).

The results of this study align closely with the findings by Patel *et al*. (2022) on the incidence of *M. vitrata* in cowpea, particularly in observing peak pest activity during the reproductive stages of the plant, influenced positively by maximum temperature. Patel *et al.* reported a peak incidence of *M. vitrata* during the 41st SMW, with 6.97 larvae per plant, correlating with maximum temperature (r = 0.625) and bright sunshine hours (r = 0.586). This temperature-dependent pattern suggests that higher temperatures favour the population growth of *M. vitrata*.

Further analysis in this study reveals additional insights into the relationship between pod damage and weather parameters as reported by Shravani *et al.*, 2015, Where maximum temperature (r = 0.660), minimum temperature (r = 0.143), and morning relative humidity (r = 0.112) showed a positive but non-significant influence on pod damage, rainfall (r = -0.228) and evening relative humidity (r = -0.007) exhibited a negative and non-significant impact.

4. CONCLUSION

The study shows the population dynamics of key pests, like pod bugs and pod borers infesting cowpea, with weather parameters. It proves that *R. pedestris* and *M. vitrata* populations exhibited peak incidence during the 16th SMW with a positive correlation with temperature and a negative correlation with humidity. This study highlights the important role of abiotic factors in pest outbreaks that are usually favoured by the activity of pests. The results of pest correlation with climatic factors indicate that higher temperatures were responsible for increased pest population, whereas the presence of rainfall had a negative impact on their population. Adequate monitoring of these pests and their environmental correlations are essential for developing effective management practices to reduce yield losses in cowpea cultivation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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