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RESEARCH ARTICLE

Weather–pest relationships: Seasonal incidence of sucking pests on *Vigna radiata* (L.) R. Wilczek (mungbean) in eastern Uttar Pradesh

Manish Kumar[1], Sudip Das[2], Shilpa Kaushik[3*], Abhishek Kumar Yadav[4], Bhupal Hatzade[5], Satyabrata Sarangi[6], Kavi Sumi[7], Sunil Kumar[8], Shiv Bachan[9], Sunil Singh[9], Pradeep Yadav[4], Vandana Yadav[1] & Pankaj Kumar[1]

[1]Department of Entomology, College of Agriculture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya 224 229, Uttar Pradesh, India

[2]Department of Plant Physiology and Biochemistry, Bihar Agricultural College, Bihar Agricultural University, Sabour Bhagalpur 813 210, Bihar, India

[3]Krishi Vigyan Kendra Bilaspur 495 006, Chhattisgarh, India

[4]Department of Entomology, College of Agriculture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur 208 002, Uttar Pradesh, India

[5]Department of Entomology, Bihar Agricultural College, Bihar Agricultural University, Sabour, Bhagalpur 813 210, Bihar, India

[6]Department of Entomology, Odisha University of Agriculture and Technology, Bhubaneswar 751 003, Odisha, India

[7]All India Coordinated Research Project on Kharif pulses, School of Agricultural Sciences, Nagaland university 798 627, India

[8]Indian Council of Agricultural Research, Indian Institute of Farming Systems Research, Modipuram, Meerut 250 110, Uttar Pradesh, India

[9]Department of Botany, Udai Pratap College, Varanasi, 221 002, Uttar Pradesh, India

*Correspondence email - ShilpaKaushik23@gmail.com

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Abstract

A field investigation was conducted to evaluate the seasonal incidence of major sucking pests of *Vigna radiata* (L.) R. Wilczek (mungbean)and their correlation with meteorological parameters under eastern Uttar Pradesh conditions. During the experimental period, incidence of sucking pests of Mungbean was recorded. Studies revealed that incidence of whitefly (*Bemisia tabaci*) was from 31st Standard Meteorological Week (SW). The highest incidence of whitefly was recorded at 37th SW (14.6 whitefly/cage). The incidence of Jassid (*Empoasca kerri,*) was recorded for the first time on 31st SW and peak incidence was recorded at 36th SW (6.30 jassids/cage). Thrips (*Caliothrips indicus*) was first time observed during 34th SW. The peak incidence of jassid was recorded at 35th SW with 3.6 per 10 flowers. White fly population had non- significant negative correlation with maximum and minimum temperature and non-significant and positive correlation with sunshine, relative humidity and rainfall. The correlation between population of jassid and weather parameters revealed that among all the weather parameters only sunshine ($r = 0.692^*$) showed significant positive correlation. Thrips showed a non-significant negative correlation with minimum temperature and relative humidity. There was a positive and non-significant correlation between thrips population and maximum temperature, rainfall and sunshine hours. The findings bring out the influence of specific weather variables on the dynamics of some key sucking pests in mungbean. They bring out the importance of integrating climatic data into pest monitoring and forecasting systems for sustainable crop protection.

Keywords: abiotic factors; jassids; mungbean; sucking pests; thrips; weather parameter; whitefly

Introduction

Vigna radiata (L.) R. Wilczek (mungbean) is a significant short-duration pulse crop that is widely grown by farmers in South and Southeast Asia. In the vegetarian diet, it occupies a prominent place because it provides protein and essential micronutrients (1). In mungbean cultivation, India ranks first in the world; it accounts for almost 65 % of the total area and over 54 % of production in the world (2). The crop improves soil fertility biologically fixing nitrogen and fits well in different cropping systems because of its short maturity period (3). However, the major constraints to mungbean production are insect-pests attacking it; particularly sucking pests are very much damaging. Whitefly (*Bemisia tabaci*), jassid (*Empoasca kerri*) and thrips (*Caliothrips indicus*) these are the major pests which suck phloem sap disrupting photosynthesis leaves curl up to whole leaflets learning stunted growth eventually resulting in huge yield loss (4, 5). Another significant aspect is that whiteflies are vectors of mungbean yellow mosaic virus (MYMV), which is strong and prevalent in mungbean production areas (6). The sucking pests' population dynamics is very much influenced by environmental and meteorological factors. Such parameters as temperature, relative humidity, rainfall, wind speed and sunshine hours have long been reported to play major roles in the buildup and spread of pest populations (7). For example, jassid and whitefly populations have maximum temperatures positively and rainfall and humidity inversely correlated with them in most legume ecosystems (8, 9). their population would increase. At the same time, thrips populations reach their peak during hot and dry conditions whereby easy for them to multiply rapidly as well as disperse (10). A good relationship between weather parameters and pest population would give room for forecasting outbreaks. Although these connections have been acknowledged, there haven't been many thorough studies examining the relationship between pest dynamics and meteorological factors in the agro-ecological conditions of eastern Uttar Pradesh. Therefore, the present investigation was conducted with the following objectives: (i) to study the seasonal incidence and severity of *Bemisia tabaci*, *Empoasca kerri* and *Caliothrips indicus* on mungbean crops in eastern Uttar Pradesh; and (ii) to examine their correlation with key weather parameters for understanding pest–climate interactions. The findings are meant to support the creation of ecologically sound pest management plans and predictive models tailored to the local climate.

Materials and Methods

Experimental site

The experimental site (Ayodhya) was selected as it represents the typical agro-ecological conditions of eastern Uttar Pradesh, where *Vigna radiata* (L.) R. Wilczek (mungbean) is extensively cultivated. Conducting the study during *Kharif* 2022 allowed us to capture pest incidence during the major growing season when climatic variability is high, making the results representative for the region geographically, The farm is located on the university's main campus situated in Ayodhya district of eastern Uttar Pradesh India, lies from 26.47°N latitude, 82.12°E longitude and an altitude of 113 m from mean sea level. The alluvial soils of this geographical region are reported to be flat, well drained and moderately fertile being less in available nitrogen and medium in available phosphorus and potash. The normal pH of soils ranges from 7.2 to 8.4. The soil type of the area is sandy to loam textured, alkaline type, typical to Gangetic plain. The climate of this area is subtropical and semi-arid with an average rainfall of about 1070 mm. A major part of rain received from mid-June September. The minimum and maximum average temperature of this area range from 7.9 -27.4 °C and 17.9-38.5 °C respectively. The summer temperature often exceeding 40 °C in the month of May and June.

Meteorological observations

The data on meteorological parameter *viz*. minimum and maximum temperature (°C), relative humidity (%), rainfall (mm) and sunshine hours of the study period were collected from Department of Agro-meteorology, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya and have been given in Table 1 and Fig. 1.

Cultural operations

Field preparation

The first ploughing was done by tractor-drown soil turning plough followed by two cross harrowing to get a fine seedbed. Ridge and furrows were prepared at 60 cm apart in a plot size of 3×1.8 m^2. Plant to plant distance maintained 10 cm.

Table 1. Standard weekly meteorological data during the crop season *Kharif*, 2022

Date	Standard meteorological weeks	Temperature °C		Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
		Max	Min			
29july-4 Aug	30	32.2	25.1	83.6	83.6	1.4
5 Aug-11Aug	31	32.8	25.7	83	21.2	2.5
12Aug-18Aug	32	33.6	26.2	81.5	8	7.5
19-Aug-25 Aug	33	32.5	25.4	84.4	31.8	5.7
25Aug-1Sep	34	32.5	25.5	83	65.2	7.6
2 Sep-8 Sep	35	33.7	25.5	78.4	18.8	4
9 Sep-15 Sep	36	34.8	24.7	74.1	11.4	7.9
15 Sep-22 Sep	37	31.5	24.4	85.4	98.6	5
23 Sep-28 Sep	38	31.9	24.7	83.4	70.8	4.4
29 Sep-4 Oct	39	32.5	23.9	84.2	21.2	5

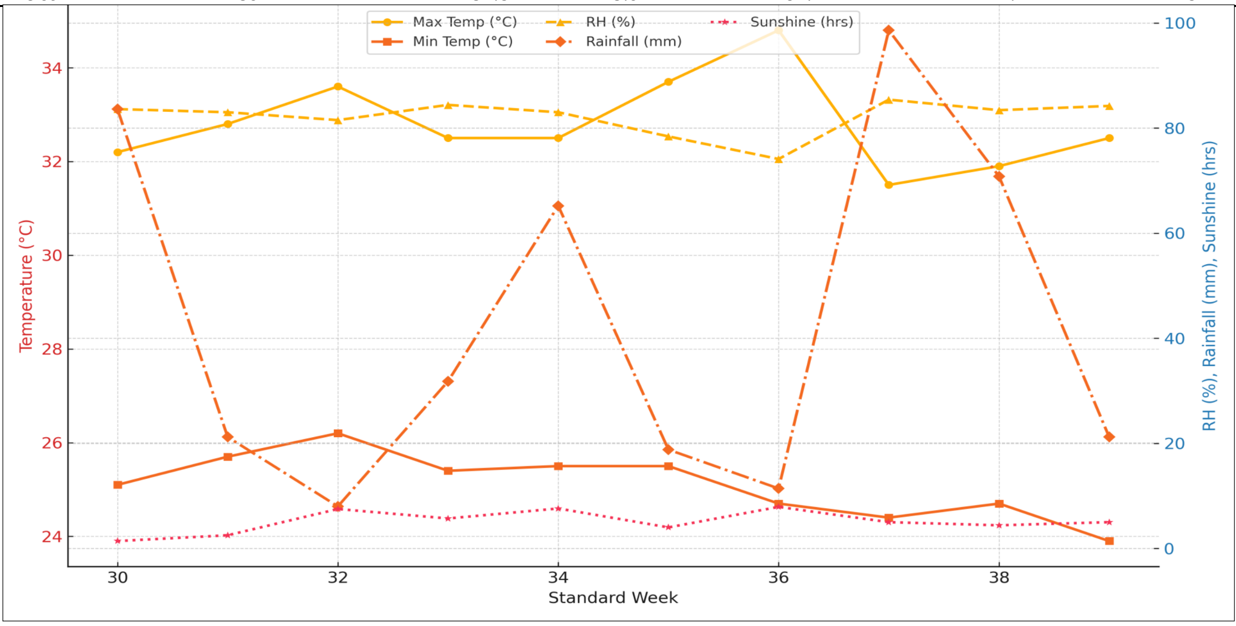

Fig. 1. Standard weekly meteorological data during the crop season *Kharif* 2022.

Fertilizer application

The basal application of fertilizers at the rate of 25 kg Nitrogen (N), 50 kg phosphate (P_2O_5) and 25 kg potash (K_2O) per hectare was applied as per recommendation. The *Kharif* crop requires one life saving irrigation, which applied during the early pod formation stage. The other agronomical practices thinning, weeding, etc. were carried out at proper time.

Sowing of seeds

Sowing of seeds were done during *Kharif* 2022 as per layout plan of research. Two seeds per hill were dibbled at the depth of 4-5 cm, maintaining 10 cm distance. After complete germination and establishment of plants, thinning was done to keep one plant per hill in whole experimental field.

Intercultural operations

Standard recommended agronomic practices for green gram were followed in all over experimental fields during experimentation. One manual weeding was done 20-25 days after sowing and second was done as per the requirement. Other recommended cultural practices were performed when required.

Record the seasonal occurrence of insect pests on *kharif* mungbean

The estimation of seasonal occurrence of insect pest on *Kharif* mungbean was conducted at Students' Instructional Farm (SIF), Acharya Narendra Deva University of Agriculture and Technology. The plot size kept 6×6 m with border 1 m, line to line spacing kept 30 cm and plant to plant spacing kept 10 cm.

Observations recorded

The crop was regularly monitored in the morning hours and data was recorded on the population of the major insect pest at weekly intervals from germination to harvest.

Sampling technique

The seasonal occurrence of sucking insect pests on mungbean was recorded from 5 randomly selected places by using rectangular spilt cage for whitefly, jassid and visual counts for thrips (per 10 flowers).

Description of split cage

Split cage (60 cm height and 45 cm width on all sides) made of wooden frames and covered with black cloth on all sides, except one side which was fitted a glass pane. While taking the observations glass pane side was kept facing the sun at 5 places at each plot. The whitefly being phototactic, migrated to the glass pane and was counted visually. This method of sampling is being used by Chhabra and others at Punjab Agriculture University, Ludhiana and Indian Institute of Pulse Research, Kanpur and is found most satisfactory in field counting of the adult whitefly, as the whitefly are quick flyer and even a little disturbance of plants, they fly away. Care was taken not to disturb the plants before putting them in the cage. The whitefly population was released by opening the cage after counting in the same plot.

Correlation coefficient between the population of the major insect pests of rice with abiotic factor

The daily meteorological data were obtained from the Department of Meteorology and U & AT Ayodhya and weekly means were worked out. The data on the pest population were correlated with the maximum and minimum temperature, average relative humidity and rainfall to study the effect of these variables on the population of Thrips, Jassids and whitefly by using the Eqn. 1.

$$\mathrm{rxy} = \frac{\dfrac{\sum xy\text{-}(\sum x)(\sum y)}{n}}{\left[\sum x^2 - \dfrac{(\sum x)^2}{n}\right]\left[\sum y2 - \dfrac{(\sum y)^2}{n}\right]} \quad \text{(Eqn. 1)}$$

Where,

R= simple correlation coefficient

x & y= character under study

n= number of observations

Statistical analysis

The correlation coefficient method was applied to the relationship between the incidence of insect pests and the weather parameters. Correlation analysis with the support of SPSS software (SPSS, 2021), it was feasible to determine the relationship between meteorological factors that included maximum and the lowest temperature (°C), early and late afternoon relative humidity (%), rainfall amount (mm) and the amount of insect-pest damage.

Results and Discussion

Whitefly Bemisia tabaci (Aleyrodidae: Hemiptera)

Incidence (Table 2 and Fig. 2) of whitefly (6.1 whitefly/cage) started during the 31st SW (SW) and 37th SW marked the peak population (14.6 whitefly/cage). Maximum and minimum temperature during the 37th SW were 31.5 °C and 24.4 °C, respectively, with a relative humidity of 85.4 %, 98.6 mm of rainfall and 5 hr of sunshine. The 36th SW had a minimum whitefly population of 4.6 per cage when maximum and minimum temperature, relative humidity, rainfall and sunshine hours was 34.8 °C, 24.7 °C, 74.1 %, 11.4 mm and 7.9 hr, respectively. The current results are consistent with one previous study reported that the *B. tabaci* population peaked in the first week of September, or the 36th SW, at 14.20 whitefly per cage when the maximum temperature, minimum temperature and relative humidity were each 36.1 °C and 21.7 °C and 90 %, respectively. Thereafter, the population began to decline (11).

Table 2. Incidence of sucking insect pests on Mungbean during *Kharif* 2022

Standard meteorological weeks (SW)	White fly/cage	Jassid/cage	Thrips /10 flowers	Weather parameters				
				Temperature (°C)		Relative	Rainfall	Sunshine
				Min.	Max.			
30	0.0	0.0	0.0	25.1	32.4	83.6	83.6	1.4
31	6.1	1.4	0.0	25.7	32.8	83.0	21.2	2.5
32	10.8	2.6	0.0	26.2	33.6	81.5	8.2	7.5
33	9.6	4.2	0.0	25.4	32.5	84.4	31.8	5.7
34	7.8	4.8	1.8	25.5	32.2	83.0	65.2	7.6
35	6.4	5.4	3.6	25.5	33.7	78.4	18.8	4.0
36	4.6	6.8	2.4	24.7	34.8	74.1	11.4	7.9
37	14.6	4.2	3.4	24.4	31.5	85.4	98.6	5.0
38	11.6	3.1	2.8	24.7	31.9	83.4	70.8	4.4
39	7.8	2.0	0.0	23.9	32.5	84.2	21.2	5.0

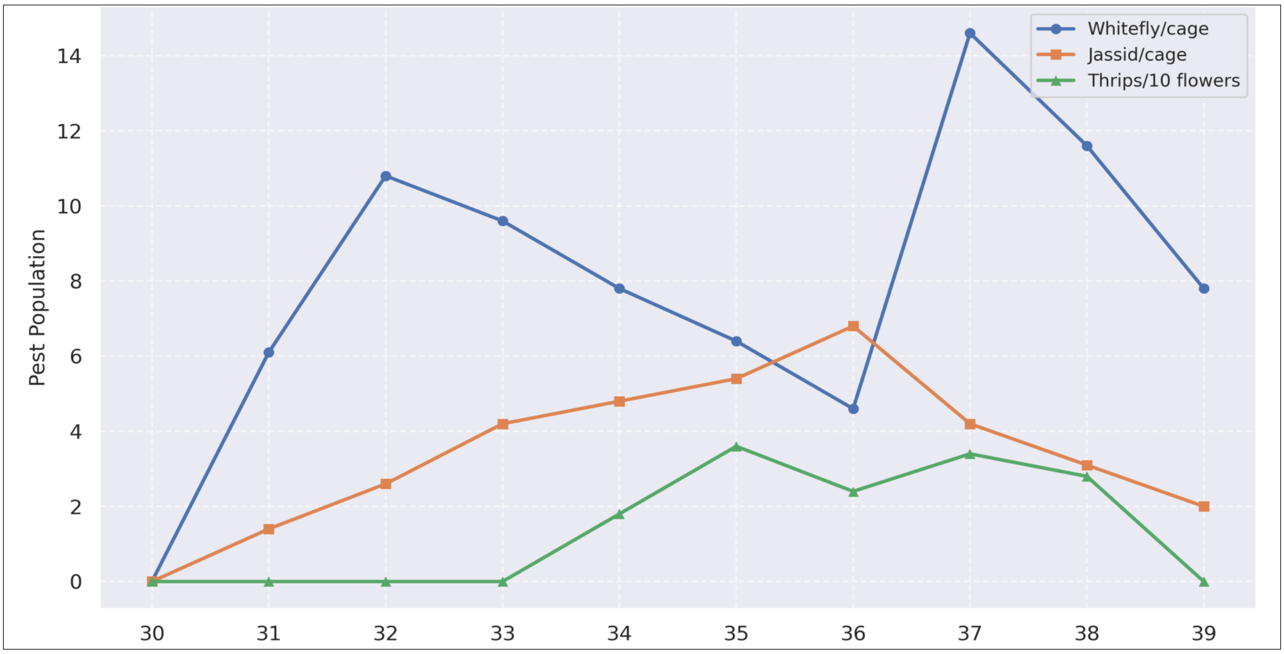

Fig. 2. Incidence of sucking insect pests on mungbean during *Kharif* 2022.

Correlation analysis (Table 3 and Fig. 3) Whitefly incidence showed population of *B. tabaci* had non-significant negative correlation with maximum and minimum temperature (r = -0.416 and (r = -0.109) and non-significant and positive correlation was found with sunshine (r = 0.387), relative humidity (r = 0.380) and rainfall (r = 0.176). The present findings support with previous report which supported that the maximum temperature had negative nonsignificant correlation and rainfall showed positive, non-significant correlation with whitefly (12).

Jassid *Empoasca kerri* (Cicadellidae: Hemiptera)

Incidence (Table 2 and Fig. 2) jassid was first noted at the 31st SW with minimum (1.4 jassid/cage) and showed an increasing trend up to the 36th SW with maximum jassid population (6.8 jassid/cage). Maximum temperature during this time was 34.8 ℃ and minimum temperature was 24.7 ℃. Similar finding report by one prior report observed that during the cropping period, the pest population of jassids ranged from 1.20 to 6.30 cages per plant. The number of jassids grew steadily until the 36th SW, when it reached its highest point (6.30 jassids/cage/plant) (13).

Table 3. Relationship of insect pests incidence with weather factors during *Kharif* 2022

Insect pests	Weather parameters				
	Temperature (°C)		Relative humidity (%)	Rainfall (mm)	Sunshine (hrs)
	Min.	Max.			
Whitefly	-0.109 (NS)	-0.416 (NS)	0.380 (NS)	0.176 (NS)	0.387 (NS)
Jassid	-0.048 (NS)	0.441 (NS)	-0.622 (NS)	-0.221 (NS)	0.692*
Thrips	-0.254 (NS)	0.012 (NS)	-0.337 (NS)	0.308 (NS)	0.163 (NS)

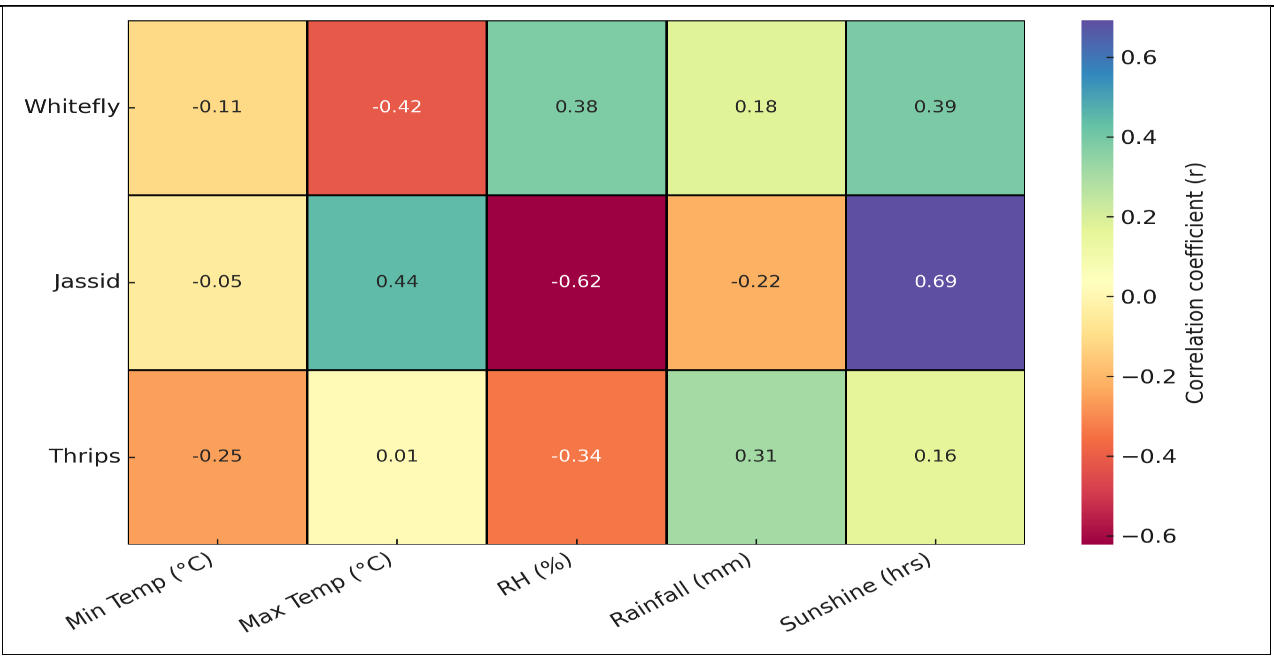

Fig. 3. Relationship of insect pest incidence with weather factors during *Kharif* 2022.

Correlation analysis of all the weather parameters, only sunshine (r = 0.692*) demonstrated a significant positive correlation with jassid incidence, while the maximum temperature (r = 0.441) showed a non-significant positive correlation with jassid population (Table 3 and Fig. 3). In contrast, there was a negative and insignificant correlation found between the jassid population and rainfall (r = -0.221), relative humidity (r = -0.622) and minimum temperature (r = 0.048). The present findings agree with one former study which reported that sunshine hours had exhibited a significant positive correlation (r=0.69) while minimum temperature, relative humidity and rainfall were expressed non-significant negative correlations (13).

Thrips *Caliothrips indicus* (Phlaeothripidae: Thysanoptera)

Thrips incidence (Table 2 and Fig. 2) was first observed during 34th SW with lowest population (1.8 thrips/10 flowers). The mean population of thrips peaked at 3.6 per 10 flowers during the 35th SW with maximum and minimum temperatures of 33.7 °C and 25.5 °C, respectively. Relative humidity was 78.4 % and there were 18.8 mm of rainfall and 7.6 hr of sunshine. The results are in partial agreement with the findings of prior research which reported that thrips population was counted from the 38th SW to the 42nd SW, with the maximum number occurring in the 41st SW at 1.2 thrips/5 plants. 38th SW (1.1 thrips/5 plants) had the lowest thrips population (14).

Correlation analysis (Table 3 and Fig. 3) incidence showed of thrips had nonsignificant negative correlation with minimum temperature (r = -0.254) and relative humidity (r = -0.337). Positive and non-significant correlation was observed between thrips population and maximum temperature (r = 0.012), rainfall (r = 0.308) and sunshine hours (r = 0.163). The present findings are conformity with previous study which reported that the minimum temperature (r=-0.35) and rainfall had a non-significant and negative correlation with thrips population (15).

Conclusion

This study offers important new information on the seasonal occurrence and population dynamics of 3 important sucking pests on eastern Uttar Pradesh's *Vigna radiata* (L.) R. Wilczek (mungbean) crops: *Caliothrips indicus*, *Empoasca kerri* and *Bemisia tabaci*. It also discusses how these pests relate to the current weather conditions. According to the results, *B. tabaci* and *E. kerri* first appeared during the 31st SW and their peak populations were observed on the 37th and 36th SW, respectively. Thrips incidence began slightly later, during the 34th SW and peaked in the 35th SW. Correlation analysis indicated that *B. tabaci* population showed weak, non-significant negative correlations with maximum and minimum temperatures, while positive but non-significant correlations were observed with relative humidity, rainfall and sunshine hours. For *E. kerri*, sunshine hours demonstrated a significant positive correlation, suggesting that increased solar radiation may favor its population build-up. Other weather parameters exhibited non-significant effects. The population of *C. indicus* also showed non-significant correlations with all the weather variables assessed, although a weak positive trend with temperature and rainfall was noted. The overall results underscore the complexity of interactions between insect pest populations and climatic variables. While no single weather parameter was consistently predictive across all three pests, sunshine hours emerged as a potentially important factor influencing jassid activity. This finding has direct implications for Integrated Pest Management (IPM), as sunshine hours could serve as an early-warning indicator for jassid outbreaks. Farmers can use such information to time their interventions more effectively, including the deployment of biocontrol agents, adoption of resistant cultivars, or need-based insecticide sprays, thereby reducing unnecessary pesticide applications. These findings align with previous studies and support the need for localized pest monitoring integrated with weather data to improve forecasting accuracy. Given the increasing unpredictability of weather patterns due to climate variability, such studies are critical for developing climate-resilient IPM strategies. Further long-term investigations across different agro -ecological zones and cropping seasons are recommended to validate and refine pest-weather models for timely intervention and sustainable mungbean production.

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Authors' contributions

MK, AKY, PV, SS, SB, SK, SD and PY conducted the experiment, performed the conceptualization, data analysis and data curation. Supervision, methodology and review were done by PK. AKY, VY, KS, SS and BH prepared the final draft and revision. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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