Correlation of weather variables on emergence of a virus disease bud necrosis disease of greengram incited by *Soybean yellow mottle mosaic virus* at Raichur, Karnataka

ABSTRACT

Greengram [(*Vigna radiata* (L.) Wilczek] is the important pulse crop after chickpea and pigeonpea cultivated in India which is called as "Queen of pulses", The crop is proned to be infected by many fungal and bacterial diseases. In recent years emergence of a virus disease bud necrosis of greengram was noticed in Raichur and the incidence of disease gradually increased in greengram growing areas of Karnataka. Incidence of bud necrosis disease of greengram and correlation with weather factors was studied during *Kharif* 2021 at research plot and MARS, UAS, Raichur, Karnataka. The study reveals that, on all four dates of sowing (25^{th} June, 1^{st} July, 9^{th} July and 23^{rd} July 2021), disease was initiated at 25 DAS and highest disease incidence was observed at 75 DAS. The peak activity of thrips was noticed during August month. The weather variables viz., maximum temperature was more than 32 °C, minimum temperature was more than 22 °C, rainfall was less than 19 mm/day, morning relative humidity was less than 91 per cent, evening relative humidity more than 44 per cent, evaporation 4.3 mm/day and sunshine hours less than 6 hr/day was favorable for bud necrosis disease in four dates of sowing. Whereas, morning relative humidity, evening relative humidity and age of the crops were having positive relationship with progress of bud necrosis on all four dates of sowing. Thrips and rainfall showed a positive correlation with disease incidence in all dates of sowing except the fourth date of sowing.

Keywords: Thrips, rainfall, relative humidity, sunshine hours, symptoms and evaporation

1. INTRODUCTION

Grain legumes are nature's precious gift to mankind and are often named ‘poor man's meat’ as these are rich in protein (16 – 50 %), essential elements, dietary fibre (10 – 23 %) and vitamins (Maphosa and Jideani, 2017). Greengram [(*Vigna radiata* (L.) Wilczek] is the important pulse crop after chickpea and pigeonpea in India which is called as “Queen of pulses”. Worldwide, the crop is covering more than six million hectares per annum. However, Asia alone accounts for 90 per cent of world’s greengram production. India is the world’s largest mungbean producer accounting for about 65 per cent of world’s acreage and 54 per cent of its global production. In India during 2021, about 5.13 million ha area was covered under greengram. Rajasthan (25.53 million ha), Karnataka (4.53 million ha), Maharashtra (3.28 million ha), Madhya Pradesh (1.82 million ha), Odisha (1.63 million ha) and Telangana (0.66 million ha) states are the major producers of greengram in India (Directorate of Economics & Statistics, 2021). Greengram enriches soil fertility through atmospheric nitrogen fixation with the help of *Rhizobium* bacteria nodulation and humus, thus playing a crucial role in sustainable agriculture. It is drought tolerant crop and suitable for dry land farming and predominantly used as intercrop with other crops (Nath *et al.*, 2018). It is short duration crop (<60 days) with wide adaptability (Sharma *et al.*, 2008). Mungbean is proned to be infected by several diseases. Among them bud necrosis disease incited by *Soybean yellow mottle mosaic virus* is a major emerging virus disease and gradually increasing in greengram growing areas of Karnataka (Afreen, 2022). The present investigation was carried out to study the incidence of bud necrosis disease of greengram at different dates of sowing and correlation with weather factors with the disease.

2. MATERIAL AND METHODS

2.1 *Incidence of bud necrosis disease of greengram and correlation with weather factors*

To understand the influence of weather factors on the progress of bud necrosis disease of greengram, experiment was conducted at Centre for Agroclimatic Studies, MARS, Raichur during *Kharif* 2021. Susceptible greengram variety BGS-9 was sown in four different dates (25th June, 1st July, 9th July and 23rd July 2021) by following recommended package of practice as per UAS, Raichur except for disease and thrips management. Observations regarding the thrips populations, disease incidence and meteorological data were recorded in greengram field from 25 DAS to till end of the crop at weekly intervals. Disease progress was monitored by visual observations of infected plants. Later disease incidence was calculated as per formula mentioned below.

$$\text{Disease incidence (\%)} = \frac{\text{Number of plants infected}}{\text{Total no. of plants observed in each plot}} \times 100$$

Thrips population were recorded by tapping the top leaves on a black cloth and sometime by using hand lens from randomly selected plants (three) in the plot, average population was calculated in each week of observation. Meteorological observations such as maximum and minimum temperature, rainfall, morning and evening relative humidity, sunshine hours and evaporation were collected from Meteorological Division, MARS, Raichur on a weekly basis during crop growth period for normal time of sowing (last week of June) and late sown greengram crop. Correlation co-efficient between disease incidence, thrips population and meteorological parameters were determined by Karl Pearson's formula and tested individually for their significance at 5 per cent probability level by using following formula. At the end of the experiment weather parameters which are favourable for disease development was known.

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

Where,

t = test of significance

r = correlation co-efficient

n = number of observations

3. Results and discussion

3.1 *Incidence of bud necrosis disease of greengram and correlation with weather factors and thrips population*

The relationship between disease incidence and weather parameters showed that, in first date of sowing (25th June 2021) no bud necrosis symptoms were observed till 28th standard meteorological week (SMW). The first symptoms of the disease were noticed between 16th July to 22nd July with a disease incidence of 5.37 per cent (29th SMW). The disease incidence increased from 5.37 to 10.49 per cent with less difference in weather parameters (30th SMW). Further, disease reached peak (37.20 %) at 36th SMW due to congenial maximum temperature and minimum temperature of 29.6 to 34.4 °C and 22.5 to 24.5°C respectively with relative humidity (RH I and RH II) of 90 and 67 per cent, evaporation 2.6 mm/day and sunshine hours of 1.8 h/day (Fig. 1). Sunshine hours (2.1 – 6.0 h/day) and less rainfall (1.0 – 5.4 mm) during 30th July to 19th August found more congenial for an increase of thrips population as well as disease incidence. The relationship between disease intensity and thrips population revealed that, occurrence of bud necrosis and thrips vector was noticed during July's second week (4th week after sowing). Further thrips population and disease incidence increased during the subsequent weeks. Maximum thrips population (3.73) was observed during August third week (8th week after sowing). Later it was noticed that thrips population started to decline steadily during successive weeks of September month due to more rainfall (30.4 – 49.60 mm) and less sunshine hours (1.2 – 1.8 h/day) (Fig. 1). Similar results are in confirmity with the findings of Mandal *et al.* (2012).

In second date of sowing (1st July 2021), the first appearance of symptoms was observed between 23rd July to 29th July with incidence of 9.89 per cent (30th SMW) at 25 DAS. The disease incidence increased from 9.89 to 13.04 per cent with least differences in weather parameters (31st SMW). Further, disease reached peak 68.18 per cent at 37th SMW during 75 DAS, due to favorable maximum temperature and minimum temperature of 30.8 °C and 22.2 °C, respectively with sunshine hours of 2.2 h/day (Fig. 2). There was sudden increase of disease from 13.04 to 23.27 per cent during 30th July to 12th August due to dry conditions and more sunshine hours (4.1 to 6.0 h/day) which might have supported multiplication of vector population (2.26 – 3.33). In subsequent weeks, the thrips and disease incidence increased and recorded maximum thrips population (4.26) during August last week (8th week after sowing). Later it was found that, thrips population started to decline steadily during successive weeks of September month (Fig. 2) due to continuous rainfall. Similar results are in confirmity with the findings of Bhatnagar *et al.* (2017).

In third date of sowing (9th July), first onset of bud necrosis symptoms were witnessed between 30th July to 5th August with the incidence of 11.02 (31st SMW) at 25 DAS. The disease incidence increased from 11.02 to 23.75 with less difference in temperature (32nd SMW), but maximum sunshine hours (4.1 – 6.0 h/day) and less rainfall. Further, disease reached peak with 94.79 per cent incidence at 38th SMW during 75 DAS, due to favourable weather parameters (Fig. 3). Later the thrips population and disease increased during the subsequent weeks and recorded maximum thrips population (4.40) during August last week (7th week after sowing) with good sunshine hours (4.5 h/day). Similar results are in confirmity with the findings of Vijayalakshmi *et al.* (2017).

Similarly, in fourth date of sowing (23rd July), bud necrosis disease was initiated between 13th August to 19th August with an incidence of 9.52 (33rd SMW) at 25 DAS. The disease was progressed from 9.52 to 21.75 with less difference in temperature and relative humidity with good sunshine conditions (4.5 h/day) (34th SMW). Further, disease reached with a maximum incidence of 82.13 per cent at 40th SMW during 75 DAS, due to favorable weather factors. Further, the thrips population increased gradually with maximum thrips count (4.61) during August last week (6th week after sowing) (Fig. 4). Later thrips population declined towards October month because of rainfall. Similar results are in confirmity with the findings of Vennila *et al.* (2018).

The correlation of weather parameters with thrips population and disease progree through correlation and multiple linear regression during *Kharif* 2021 showed that, morning relative humidity (r = 0.109, 0.294, 0.793 and 0.489), evening relative humidity (r = 0.134, 0.378, 0.786 and 0.443) and age of the crops (r = 0.996, 0.982, 0.995 and 0.995) were positively correlated with the progress of bud necrosis in all the four dates of sowing respectively (Table 1). Thrips population (r = 0.568, 0.664 and 0.485) and rainfall (r = 0.032, 0.092 and 0.628) showed a positive correlation with disease incidence in all the dates of sowing except fourth date of sowing (r = - 0.391 and - 0.009 respectively). Maximum temperature (r = - 0.206, - 0.339, - 0.607 and - 0.328), minimum temperature (r = - 0.018, - 0.265, - 0.525 and - 0.671) and evaporation (r = - 0.337, - 0.355, - 0.675 and - 0.351) were negatively correlated with the progress of bud necrosis disease in all four date of sowing respectively, whereas sunshine hours (r = - 0.054, - 0.400 and - 0.285 respectively) were negatively correlated with the progress of bud necrosis disease in all three dates of sowing except fourth date of sowing (r = 0.183). Most of the time, the individual weather factor may not be the most favorable for disease development. However, the interaction between the weather parameters have more influence on the disease progress which resulted in highest disease incidence on all dates of sowing, but on third and fourth dates of sowing the crop growth was poor compared to other dates of sowing, because of excess rains coupled with bud necrosis disease of greengram resulted in yield reduction. Similar results are in conformity with the findings of Vinaykumar *et al.* (2019).

The individual weather parameters like morning relative humidity and evening relative humidity showed significant positive correlation with progress of disease in the third (r = 0.793 and 0.786 respectively) date of sowing. Evaporation and minimum temperature showed negative and significant correlation with disease progress (r = - 0.675 and - 0.671) during third and fourth dates of sowing respectively. Maximum temperature, rainfall and sunshine hours not significantly correlated with progress of disease in all four dates of sowing (Table 1). The rainfall pattern was reduced from 35th SMW onwards whereas sunshine hours increased, which might have favored more thrips population and disease spread in 2nd, 3rd and 4th dates of sowing, Hence rainfall was inversely proportional to the disease spread. Similar results are in conformity with the findings of Aishwarya *et al.*, 2019.

The interaction of thrips population with age of the crop (r = 0.351); maximum temperature with minimum temperature (r = 0.707), evaporation (r = 0.881) and sunshine hours (r = 0.843); minimum temperature with evaporation (r = 0.597) and sunshine hours (r = 0.445); association of rainfall with morning relative humidity (r = 0.838) and evening relative humidity (r = 0.822); morning relative humidity with evening relative humidity (r

= 0.965) and age of the crop (r = 0.380); evening relative humidity with age of the crop (r = 0.404) and association of evaporation with sunshine hours (r = 0.708) found significant positive influence on bud necrosis disease in greengram. Therefore, the disease was progressed on all the four dates of sowing (Table 2). Whereas interaction of maximum temperature with rainfall (r = - 0.682), morning relative humidity (r = - 0.926), evening relative humidity (r = - 0.938) and age of the crop (r = - 0.345); minimum temperature with rainfall (r = - 0.555), morning relative humidity (r = - 0.765), evening relative humidity (r = - 0.652) and age of the crop (r = - 0.343); association of rainfall with evaporation (r = - 0.820) and sunshine hours (r= - 0.570); morning relative humidity with evaporation (r = - 0.914) and sunshine hours (r = - 0.721); relationship of evening relative humidity with evaporation (r = - 0.925) and sunshine hours (r = - 0.788); interaction of evaporation with age of the crop (r = - 0.424), showed a significant negative relationship with bud necrosis disease in all four dates of sowing (Table 2).

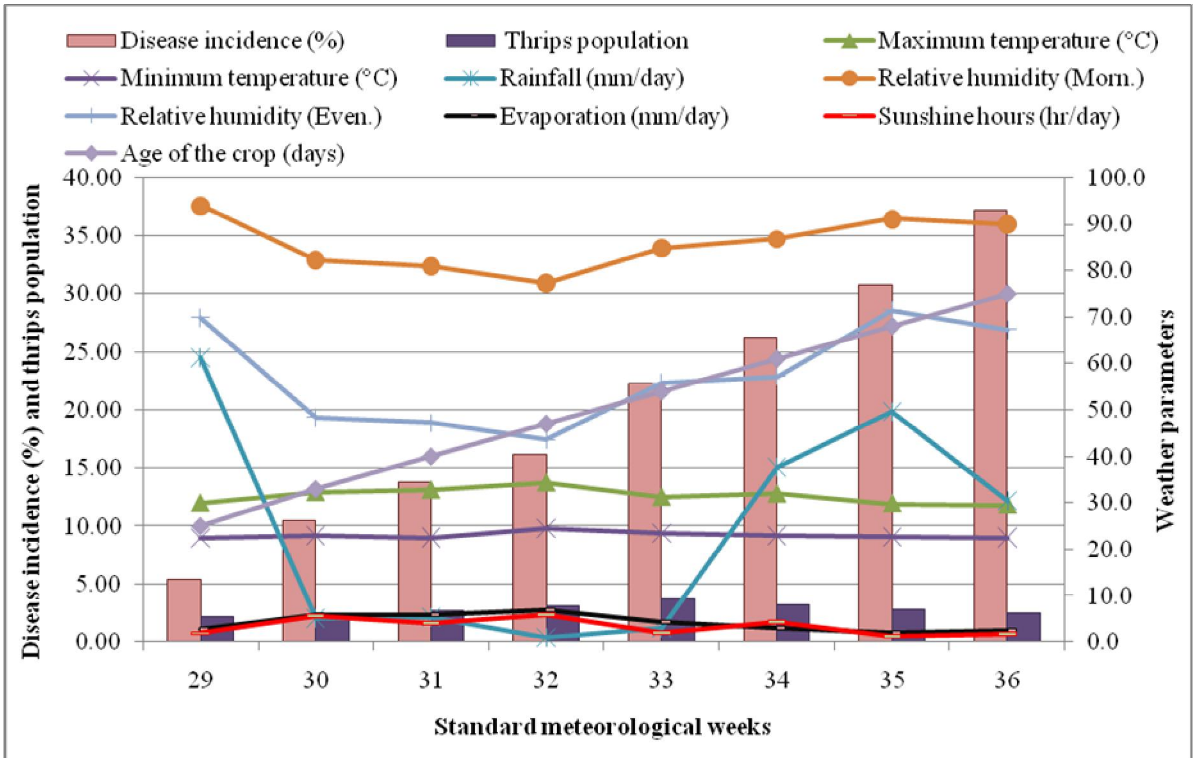

Fig. 1 Influence of weather parameters on progress of bud necrosis disease of greengram during first date of sowing (25th June 2021)

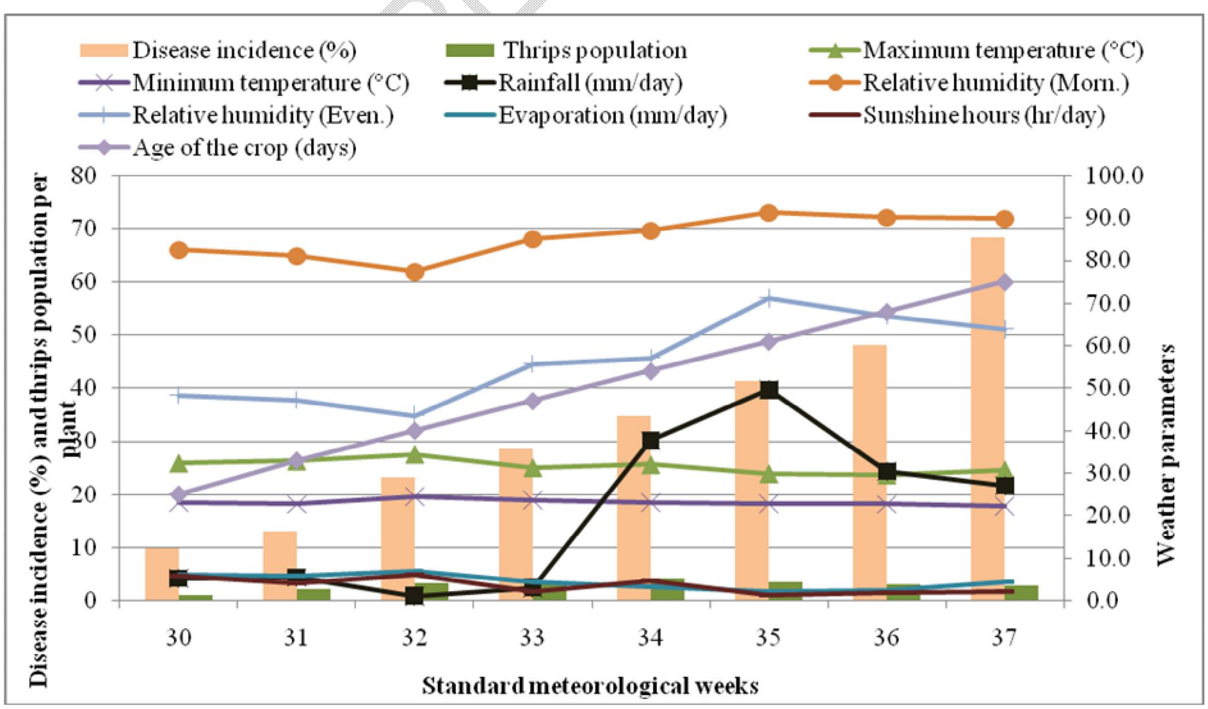

Fig. 2 Influence of weather parameters on progress of bud necrosis disease of greengram during second date of sowing (1st July 2021)

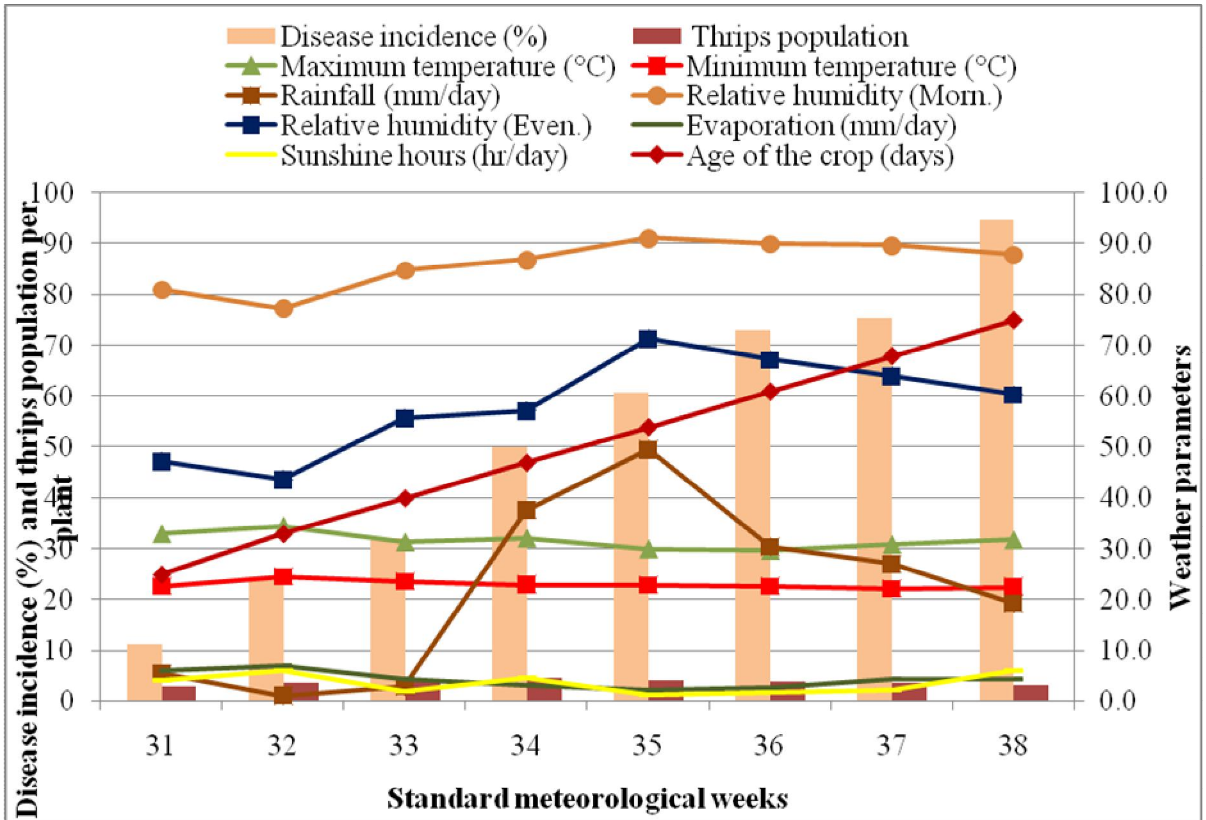

Fig. 3 Influence of weather parameters on progress of bud necrosis disease of greengram during third date of sowing (9th July 2021)

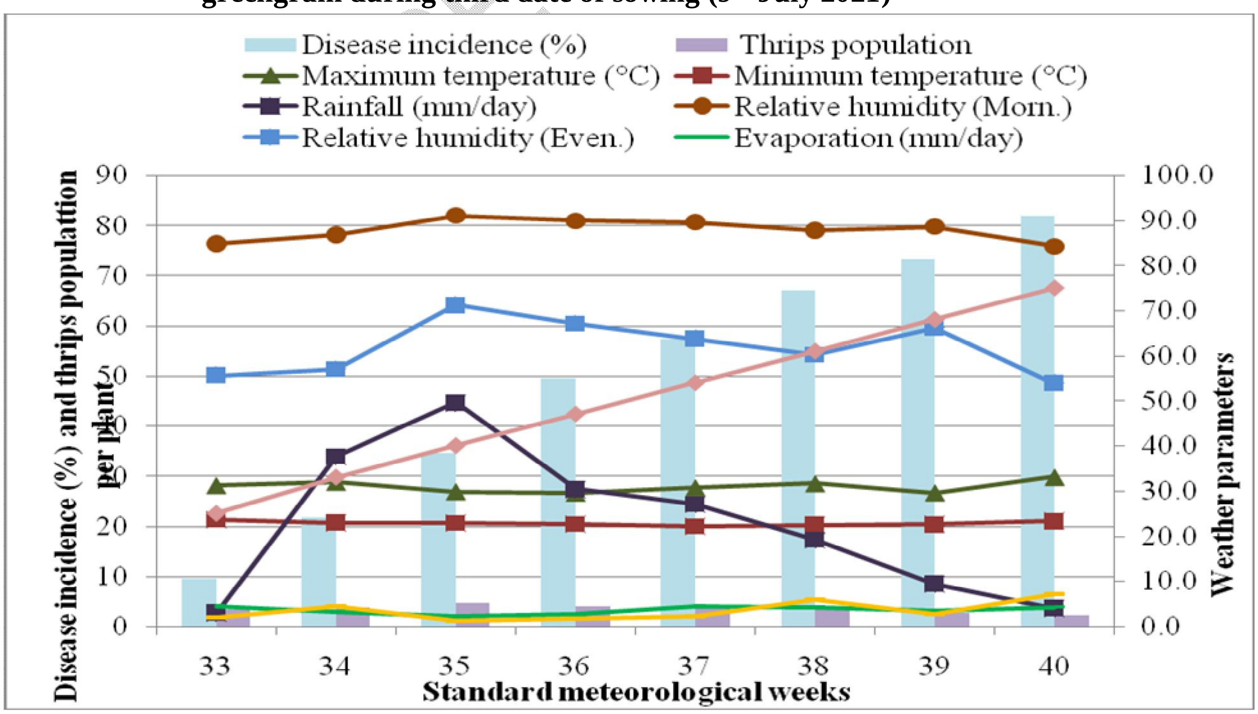

Fig. 4 Influence of weather parameters on progress of bud necrosis disease of greengram during fourth date of sowing (23rd July 2021)

Table 1: Correlation coefficient between weather parameters, thrips population and bud necrosis disease of greengram at different dates of sowing

Parameters	1st DOS	2nd DOS	3rd DOS	4th DOS
Thrips population per leaf X_1	0.568	0.664	0.485	-0.391
Maximum temperature (°C) X_2	-0.206	-0.339	-0.607	-0.328
Minimum temperature (°C) X_3	-0.018	-0.265	-0.525	-0.671*
Rainfall (mm/day) X_4	0.032	0.092	0.628	-0.009
Relative humidity (Morning %)X_5	0.109	0.294	0.793*	0.489
Relative humidity (Evening %) X_6	0.134	0.378	0.786*	0.443
Evaporation (mm/day) X_7	-0.337	-0.355	-0.675*	-0.351
Sunshine hours (h/day) X_8	-0.054	-0.400	-0.285	0.183
Age of the crop (days) X_9	0.996**	0.982**	0.995**	0.995**

* *Correlation is significant at the 0.01 level (2 tailed)
*Correlation is significant at the 0.05 level (2 tailed)
DOS- Date of sowing

Table 2: Correlation coefficient between weather parameters, thrips population and bud necrosis disease of greengram

Parameters	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
Disease incidence (%)	1.000									
Thrips population per leaf X_1	0.408*	1.000								
Maximum temperature(°C) X_2	-0.327	-0.025	1.000							
Minimum temperature (°C) X_3	-0.407*	0.137	0.707**	1.000						
Rainfall (mm/day) X_4	0.122	0.032	-0.682**	-0.555**	1.000					
Relative humidity (Morning %)X_5	0.397*	0.025	-0.926**	-0.765**	0.838**	1.000				
Relative humidity (Evening %) X_6	0.404*	0.078	-0.938**	-0.652**	0.822**	0.965**	1.000			
Evaporation (mm/day) X_7	-0.379*	-0.209	0.881**	0.597**	-0.820**	-0.914**	-0.925**	1.000		
Sunshine hours (h/day) X_8	-0.033	-0.105	0.843**	0.445**	-0.570**	-0.721**	-0.788**	0.708**	1.000	
Age of the crop (days) X_9	0.846**	0.351*	-0.345*	-0.343*	0.152	0.380*	0.404*	-0.424*	-0.114	1.000

** Correlation is significant at the 0.01 level (2-tailed). N=36

*Correlation is significant at the 0.05 level (2-tailed).

4. CONCLUSION

In all four dates of sowing, disease was initiated at 25 DAS and highest disease incidence was observed at 75 DAS. The peak activity of thrips was noticed during August month. Whereas, maximum temperature was more than 32 °C, minimum temperature was more than 22 °C, rainfall was less than 19 mm/day, morning relative humidity was less than 91 per cent, evening relative humidity was more than 44 per cent, evaporation 4.3 mm/day and sunshine hours less than 6 hr/day was favorable for bud necrosis disease in four dates of sowing. Whereas, morning relative humidity, evening relative humidity and age of the crops were positively correlated with the progress of bud necrosis on all four dates of sowing. Thrips and rainfall showed a positive correlation with disease incidence in all dates of sowing except fourth date of sowing. Maximum temperature, minimum temperature and evaporation were negatively correlated with the progress of bud necrosis disease on all four date of sowing, whereas sunshine hours were negatively correlated with the progress of bud necrosis disease on all date of sowing except fourth date of sowing. In all dates of sowing, flowering stage to the pod development stage showed maximum apparent infection rate.

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