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Influence of temperature and relative humidity on population dynamics of thrips and leaf curl disease incidence in blackgram genotypes

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Abstract
The insect pests and diseases of blackgram continue to pose a serious threat to the plant growth and yield. The sucking pests in blackgram are economically most important that not only cause the direct damage by feeding but also by transmission of different viral diseases. Sucking pest complex in blackgram include an array of sucking pests out of which thrips, whitefly and aphids are the most important. The leaf curl disease caused by GBNV in blackgram is transmitted through thrips. A study was conducted involving 25 blackgram genotypes to screen them against leaf curl disease. The results obtained from the study indicated that the leaf curl disease incidence (%) and thrips population (Number plant^{-1}) varied significantly among the genotypes. Late sowing of the crop coincided with higher temperatures, lower relative humidity and high vector population resulting in higher leaf curl disease incidence. The correlation studies indicated that the leaf curl disease incidence (%) was negatively associated with the mean and morning relative humidity (%) and positively associated with mean, maximum and minimum temperatures.

Keywords: Blackgram, thrips population, leaf curl disease, GBNV, weather, temperature, relative humidity

Introduction
Blackgram is the third most important pulse crop after pigeonpea and chickpea with an annual production of 3.56 million tones (Commodity Profile for Pulses-March, 2019). Blackgram crop is of high nutritional importance with 25% seed protein content and dietary fibers. The blackgram crop is exposed to different biotic and abiotic stresses during its growth period. The major abiotic stresses are the salinity stress and water deficit stress. The biotic stresses of blackgram include various fungal diseases especially cercospora leaf spot (*C. canescens, C. cruenta*), powdery mildew (*Erysiphe polygoni*) and root rot disease (*Rhizoctonia solani*).
The blackgram is infected by an array of scucking pests that limit the growth, development and yield of the crop. The major sucking pests of blackgram are whitefly (*Bemisia tabaci*), thrips (*Thrips tabaci*) and aphids (*Aphis craccivora*). The sucking pests of blackgram not only cause damage by sap feeding but also transmit deadly viral diseases that influence the crop growth and severely affect the yields. The major viral disease of blackgram are mungbean yellow mosaic virus (MYMYV), groundnut bud necrosis virus (GBNV) and Urdbean leaf crinkle virus (ULCV) transmitted by whitefly, thrips and both aphids and whitefly respectively.
The bud necrosis disease caused by GBNV in blackgram that belongs to *Tospovirus* is becoming a serious threat (Biswas *et al*., 2009) [3]. The field symptoms of bud necrosis in blackgram include necrosis of all plant parts including leaves, stem, petiole, growing point of plant, bud and pod. Early infection leads to severe stunting with profuse axillary shoots and necrosis of the tips. The tip necrosis further lead to the complete necrosis and death of the plant.
The leaf curl disease caused by GBNV transmitted through thrips in blackgram reduce the yields by 52% (Biswas *et al*., 2009) [3]. During the *rabi* 2018-19 the major blackgram growing districts of Andhra Pradesh were severely affected by leaf curl disease with more than 6% area being affected (Prasad 2019) [4]. In view of this, a research study was carried out to screen the

varieties and genotypes of blackgram against thrips and leaf curl disease during the late *rabi* season 2018-19 and 2019-20.

Material and Methods

A field trial was conducted involving twenty five blackgram genotypes as treatments (LBG 623, LBG 752, LBG 787, LBG 806, LBG 808, LBG 818, LBG 822, LBG 828, LBG 881, LBG 884, LBG 888, LBG 951, GKB 1, GKB 2, GKB 3, GKB 4, GBG 1, VBG 13-3, VBG 14-16, TBG 125, TBG 129, TBG 104, PBG 32-2, PU 31 and TU 40) in three replications at RARS, Lam.

Leaf Curl Disease Incidence (%)

The percent disease incidence was measured by recording the number of plants showing the disease symptoms of leaf curl virus disease per the total number of plants per plot. (Tamilnayagan, 2017) [1].

$$\text{PDI (\%)} = \frac{\text{Number of Plants showing leaf curl symptoms}}{\text{Total numberof plants per plot}}$$

The disease incidence percentage of Leaf curl virus disease was given as per 1-4 scale and the genotypes were categorized as resistant, moderately resistant, moderately susceptible and susceptible (Table 1).

Table 1: Categories used in the assessment of variation among the blackgram genotypes for leaf curl disease resistance

Disease scale	Percent infection	Category
1	1-10%	Resistant
2	11- 30%	Moderately resistant
3	31- 41%	Moderately susceptible
4	41 -100%	Susceptible

Thrips population (Number plant^{-1})

The thrips population was recorded on the top three young leaves and were recorded from each leaflet of the lower surface of the trifoliate leaf in the middle canopy using a magnifying lens on the ten randomly selected plants of a single genotype.

Results

The twenty five genotypes were grouped in to four different categories based on their reactivity to the leaf curl disease. 8 genotypes (LBG 884, LBG 888, GBG 1, VBG-13-3, TBG 129, PBG 32-2, TU40, GKB 3) under resistant category, 8 genotypes (LBG 806, LBG 808, LBG 818, LBG 881, GKB 1, GKB 2, GKB 4, VBG 14-16) as moderately resistant, 6 genotypes (LBG 752, LBG 787, LBG 822, LBG 828, LBG 951,PU31) were placed under moderately susceptible category and 3 genotypes (LBG 623, TBG 125, TBG 104) were found susceptible. The thrips population and the leaf curl disease incidence (%) of the blackgram genotypes showed significant variation among the genotypes during both late *rabi* 2018-19 and 2019-20.

The mean values of leaf curl disease incidence and the thrips population of the genotypic categories were given at 20, 40, 60 DAS and maturity during late *rabi* 2018-19 and 2019-20 (Table 2 & 3). The leaf curl disease incidence among the resistant genotypes ranged from 5.10 to 12.00% at maturity with a mean value of 9.09%. The leaf curl disease incidence in moderately resistant genotypes at maturity ranged between 18.40 and 34.43% with a mean value of 22.58%. The leaf curl disease incidence in case of moderately susceptible genotypes at maturity ranged between 33.53 and 44.77% with a mean value of 37.11%. The susceptible genotypes showed leaf curl disease (%) values raged from 46.17 to 49.37 with a mean value of 49% at maturity.

The maximum thrips population was observed at 60 DAS and the 60 DAS thrips population value in the resistant genotypes ranged between 5.3 and 11.6 plant^{-1} with a mean value of 7.85 plant^{-1}. In moderately resistant genotypes the thrips population at 60 DAS ranged from 5.5 to 11.7 plant^{-1} with a mean value of 9.03 plant^{-1}. The thrips population among the moderately susceptible genotypes ranged between 7.8 to 12.0 plant^{-1} and the mean value is 9.57 plant^{-1}. The thrips population in the susceptible genotypes ranged from 8.2 to 13.6 plant^{-1} with a mean number of 11.42 plant^{-1}.

Table 2: Variability in leaf curl disease incidence (%) among the blackgram genotypes

Genotype Category	40 DAS			60 DAS			At Maturity		
	Late *rabi* 2018-19	Late r*abi* 2019-20	Pooled mean	Late *rabi* 2018-19	Late r*abi* 2019-20	Pooled mean	Late *rabi* 2018-19	Late r*abi* 2019-20	Pooled mean
Resistant Genotypes	3.64	4.23	3.93	6.34	6.85	6.60	9.11	9.07	9.09
Moderately Resistant Genotypes	7.68	8.08	7.88	17.39	17.99	17.69	22.73	22.43	22.58
Moderately susceptible genotypes	12.21	13.08	12.65	27.37	28.09	27.73	35.17	35.94	35.56
Susceptible Genotypes	15.37	15.67	15.52	34.52	35.20	34.86	41.63	42.23	41.93
SE(m)±	0.57	0.44	0.47	0.80	0.93	0.84	0.60	0.73	0.64
CD(0.05)	1.63	1.25	1.33	2.28	2.64	2.40	1.69	2.08	1.81
CV (%)	6.04	4.45	4.82	5.60	6.35	5.82	3.59	4.39	3.83

Table 3: Variability in thrips population (Number plant^{-1}) among the blackgram genotypes

Genotype Category	20 DAS			40 DAS			60 DAS			At Maturity		
	Late *rabi* 2018-19	Late r*abi* 2019-20	Pooled mean	Late *rabi* 2018-19	Late r*abi* 2019-20	Pooled mean	Late *rabi* 2018-19	Late r*abi* 2019-20	Pooled mean	Late *rabi* 2018-19	Late r*abi* 2019-20	Pooled mean
Resistant Genotypes	0.8	2.05	1.41	2.30	3.30	2.80	6.38	9.25	7.85	0.86	0.86	0.86
Moderately resistant genotypes	1.10	2.32	1.71	2.93	3.95	3.44	7.54	10.57	9.03	0.96	0.92	0.95
Moderately susceptible genotypes	1.47	2.77	2.13	3.45	4.57	4.20	8.03	11.15	9.57	0.97	0.93	0.97
Susceptible Genotypes	1.63	2.93	2.26	3.8	5.1	4.45	10.26	12.00	11.42	1.02	1.05	1.02
SE(m)±	0.47	0.31	0.32	0.31	0.30	0.19	0.47	0.29	0.28	0.15	0.19	0.14
CD(0.05)	1.34	0.89	0.92	0.89	0.86	0.55	1.35	0.83	0.80	0.43	0.55	0.39
CV (%)	13.43	6.07	7.38	5.48	4.53	3.12	5.17	2.68	2.81	4.72	6.02	4.33

Correlation studies of thrips and disease incidence with Environmental factors: The temperature (Maximum, Minimum and Mean) and Relative Humidity (RH I, RH II and Mean RH) values were recorded during the crop growth period of both Late *Rabi* 2019 and 2020 on a daily basis. The values obtained were averaged so as to coincide with the dates of sampling and the pooled means of both the seasons was considered to observe the correlations between the environmental factors with disease incidence (%) and Thrips number per plant (Table 4).

Table 4: Relation between the thrips population and weather parameters

Crop stage	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	RH I (%)	RH II (%)	Mean RH (%)	Mean DI (%)	Thrips
20 DAS	32.2	19.0	25.6	89.7	42.1	65.9	0.0	1.8
40 DAS	36.0	22.9	29.4	86.3	31.8	59.1	9.1	3.5
60 DAS	37.4	25.2	31.3	84.2	35.8	60.0	19.4	9.0
At maturity	39.5	26.3	32.9	80.3	38.4	59.4	24.5	0.9
Correlation								
D I (%)	0.977**	0.985**	0.985**	-0.974**	-0.264	-0.770**	--	--

**Indicates a highly significant correlation at 0.01 level of significance

Temperature with disease incidence (%) and Thrips population

The leaf curl disease incidence (%) was recorded in blackgram genotypes for every twenty days. During the first 20 Days of crop growth the disease incidence percentage was observed to be zero. The disease symptoms started to appear on the susceptible genotypes approximately from 25 days after sowing. At 40 DAS stage the average disease incidence (%) has been increased to 9.1 %. At 60 DAS stage the disease incidence percentage showed the same exponential growth and was of 19.4 %. At 80 DAS stage the increase in disease percentage was observed to be flat than the previous raise with an incidence percentage of 24.5%.

Relative Humidity (%) with disease incidence (%) and Thrips population

The disease incidence (%) was observed to be significantly and negatively correlated with morning and mean relative humidity. A non-significant correlation was observed with the afternoon relative humidity in Fig 3. This indicates the increase in disease incidence with the decrease in Atmospheric Relative humidity. The thrips population (No. per plant) was also observed to be negatively associated with the relative humidity and the association was significant up to 60 DAS stage and the population has decreased in blackgram genotypes up on reaching maturity stage in Fig 4.

Discussions

Atmospheric temperature has a positive and significant correlation with the leaf curl disease incidence in blackgram in Fig 1. The temperatures not only increased the disease incidence (%) but also the severity of the disease. Similar results were obtained previously by Shew & Lucas (1991) in tobacco with TSWV incidence, Dhaka *et al.* (2018) [5] in groundnut with GBNV incidence and Srivastava *et al.* (2012) [6] in Blackgram with MYMV incidence. Thrips (*Thrips palmi*) is the vector of leaf curl disease (Biswas *et al.*, 2009) [3] the thrips population was observed in the field approximately after 14 DAS. The thrips incidence showed a significant increase in population with the increase in temperature in Fig 2. Thereafter at maturity a steep fall in the thrips population was observed. The thrips population showed positive association with the atmospheric temperature. These results are in line with Vijayalakshmi *et al.* (2017) [7] in groundnut and Kumar and Singh (2016) [8] in blackgram. The prevailing weather conditions play a major role in thrips and leaf curl disease outbreak. The clear weather conditions with no rains associated during the crop growth period has favored the thrips population. Vijayalakshmi, 1994 who has studied the epidemiology of thrips and leaf curl disease stated that higher temperatures coupled with 70 ± 10 RH and bright sunshine hours will favor the thrips outbreak which were in corroboration with Krishnaveni (1998) [9]; Funderburk (2012); Jamuna *et al.* (2019) [11] in groundnut and Kumar and Singh (2016) [8] in blackgram.

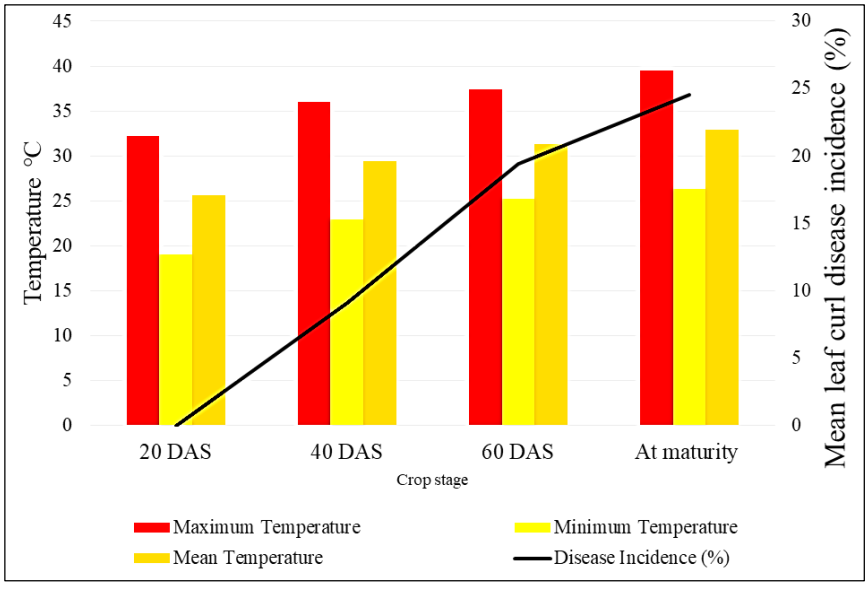

Fig 1: Correlation of temperature with mean leaf curl disease incidence in blackgram

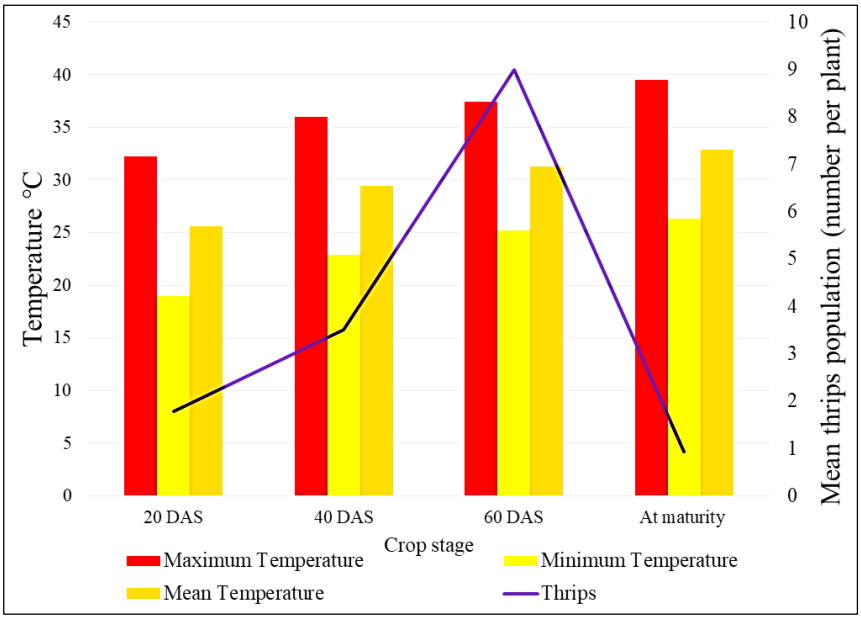

Fig 2: Correlation of temperature with mean thrips population in blackgram

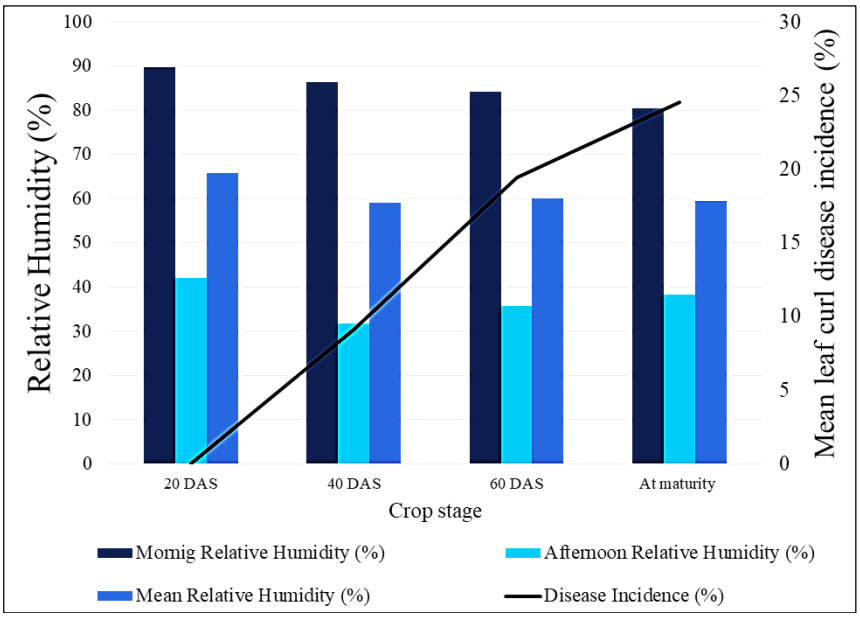

Fig 3: Correlation of relative humidity with mean leaf curl disease incidence in blackgram

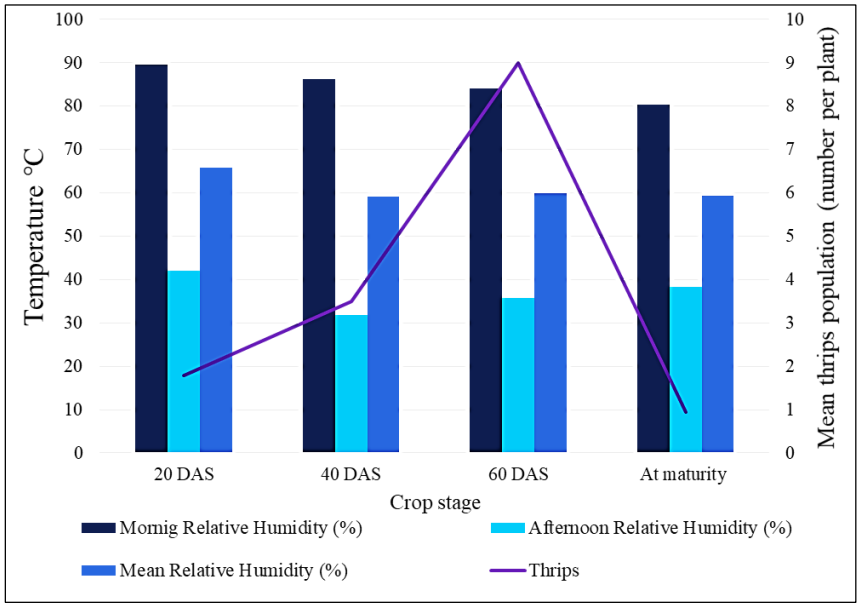

Fig 4: Correlation of relative humidity with mean thrips population in blackgram

Conclusion

Hence, it can be concluded that the thrips population show peak flight periods at higher temperatures dry weather conditions. The late *rabi* sowing of blackgram results in decreased yields due to higher leaf curl disease incidence. The resistant genotypes were less affected by the disease with lower thrips population.

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