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Influence of Weather Parameters on Occurrence of Alternaria Leaf Spot of Cotton under High Density and Normal Planting Systems

Ch. Yamuna[1*], S.L. Bhattiprolu[2], V. Prasanna Kumari[3] and Ch. Chiranjeevi[4]

[1]Ph.D. Scholar, Department of Plant Pathology,
Agricultural College, ANGRAU, Bapatla, (Andhra Pradesh), India.
[2]Principal Scientist, AICRP on Cotton, Regional Agricultural Research Station,
Lam, ANGRAU, (Andhra Pradesh), India.
[3]Professor, Department of Plant Pathology,
Agricultural College, ANGRAU, Bapatla, (Andhra Pradesh), India.
[4]Professor and Head, Department of Entomology,
Agricultural College, ANGRAU, Bapatla, (Andhra Pradesh), India.

(Corresponding author: Ch. Yamuna)*
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ABSTRACT: The effect of weather factors on the development of Alternaria leaf spot in LHDP-1 variety was investigated during *kharif* 2018-2019 at Regional Agricultural Research Station, Lam farm, Guntur. The data on per cent disease index (PDI) of Alternaria leaf spot was recorded at three days interval under high density planting system (HDPS) and normal planting system (NPS) along with weather parameters. The disease appeared in the second week of Augustand reached peak of 29.71 PDI under HDPS as against 27.81 PDI under NPS during boll maturity stage. Significant positive correlation was observed with maximum temperature, sunshine hours and evaporation whereas evening relative humidity and rainfall showed significant negative correlation under HDPS. Under NPS maximum temperature, morning relative humidity, sunshine hours and evaporation showed significant positive correlation; evening relative humidity and rainfall showed significant negative correlation. From the full model regression equation, it was found that coefficient of determination (R^2) was 0.779 under high density planting system and 0.95 under normal planting system.

Keywords: Alternaria leaf spot, cotton, high density planting system, weather parameters.

INTRODUCTION

Cotton is referred to as "King of Fibers" and also known as "White Gold". It is one of the most important commercial crops in the state of Andhra Pradesh occupying an area of 5.86 lakh ha with a productivity of 580 kg lint/ha. In India, it occupies an area of 125.84 lakh ha with an annual production of 360 lakh bales of 170 kg and a productivity of 486 kg lint/ha (AICRP, 2020). More than a dozen foliar diseases are reported to affect yield of seed cotton and quality of the lint (Sharma and Chauhan, 1985). Leaf spot rank third among the cotton diseases in India. Among the leaf spot diseases Alternaria leaf spot causes losses to the tune of 26.59 per cent (Monga *et al*., 2013) and 38.23 per cent (Bhattiprolu and Prasad Rao, 2009). Keeping in view the seriousness of the Alternaria leaf spot, the present study was conducted to know the effect of environmental factors on Alternaria disease development under high density planting system and normal planting system.

MATERIALS AND METHODS

Experimental design. The present investigation was conducted at Regional Agricultural Research Station, Lam farm, Guntur during 2018-2019 with cotton variety, LHDP-1. The crop was sown under high density planting system by adopting 75 cm × 10 cm spacing and normal planting system with 105 cm × 60 cmspacing in an area of 100 m^2 each. The sowing was done with hand dibbling and the recommended fertilizer dose was applied. The crop was sown on 23.07.2018 and the observations on the disease intensity were recorded at three days interval from August to December.

Observations and data analysis. The data was recorded on 10 plants tagged randomly and from each plant 10 leaves from bottom, middle and top were taken for scoring the disease by using 0-4 scale given by Raj, (1988). The per cent disease index was calculated by using the formula.

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Total no. of leaves scored} \times \text{maximum rating}}$$

The weather data during crop growth period were collected from automatic weather station and the relative humidity was calculated by using hygrometer. Means of each parameter were calculated at three days interval, whereas rainfall was totaled for three days. The per cent disease index was correlated with weather data and multiple regression equations were worked out by using the formula given by Gomez and Gomez, (1984).

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$$

Where, a = Intercept, b = Regression coefficient, X_1 to X_5 = Dependent weather variables

RESULTS AND DISCUSSION

Alternaria leaf spot disease under HDPS first appeared on 13.8.18, when the means of maximum temperature (T_{max}), minimum temperature (T_{min}), morning relative humidity (RH I), evening relative humidity (RH II), sunshine hours (SSH), total rainfall (Rf), means of rainy days (Rd), wind speed (WS) and evaporation (Evap.) were 31°C, 23.7°C, 87.6%, 67%, 0.0hrs/day, 36.6 mm, 2, 12.1 kmph and 3.4 mm, respectively. The disease reached maximum at boll maturity stage (25.10.2018) with PDI of 29.71 when the means of T_{max}, T_{min}, RH I, RH II, SSH, total Rf, means of WS, Evap. were 34°C, 22°C, 84.6%, 58.6%, 7.6hrs/day, 0.0 mm, 2 kmph and 6.3 mm, respectively (Table 1).

Table 1: Progression of Alternaria leaf spot in relation to weather parameters under High Density Planting System (HDPS) and Normal Planting System (NPS) of cotton.

Date of observation	Temperature (°C)		Relative humidity (%)		Sunshine hours (hrs/day) (SSH)	Rainfall (mm) (Rf)	Rainy days (Rd)	Wind Speed (kmph) (WS)	Evaporation (mm) (Evap.)	Per cent Disease Index	
	Max (T_{max})	Min (T_{min})	Morn. (RH I)	Even. (RH II)						HDPS	NPS
13.08.2018	31.0	23.7	87.6	67.0	0.0	36.6	2.0	12.1	3.4	8.12	3.66
16.08.2018	30.1	23.6	86.3	65.6	0.0	36.8	3.0	9.6	2.4	10.20	4.06
20.08.2018	32.5	24.4	89.2	71.0	2.7	73.4	2.0	13.9	3.1	10.42	4.10
23.08.2018	32.3	25.1	81.3	59.0	6.1	0.8	0.0	12.7	4.9	10.75	4.27
27.08.2018	33.4	25.1	84.5	61.7	6.4	1.1	0.0	8.9	6.4	13.57	7.81
30.08.2018	33.9	26.3	83.0	62.0	8.5	14.4	1.0	7.3	6.8	14.25	8.42
03.09.2018	34.2	25.5	84.7	62.2	6.1	0.0	0.0	5.7	5.6	15.59	10.31
06.09.2018	35.3	26.4	83.6	58.3	7.9	0.0	0.0	10.1	9.0	16.8	12.39
10.09.2018	35.1	25.8	83.7	56.0	8.5	0.0	0.0	7.9	9.2	18.81	14.47
13.09.2018	36.3	26.5	78.3	57.0	6.8	0.0	0.0	5.5	9.1	16.25	14.20
17.09.2018	35.8	26.3	85.0	57.5	6.7	14.6	1.0	5.8	5.1	14.78	14.47
20.09.2018	33.0	24.0	88.3	75.6	2.4	41.2	2.0	6.8	4.0	10.34	12.91
24.09.2018	32.1	24.4	83.5	65.5	3.4	2.0	0.0	6.6	4.8	14.78	14.47
27.09.2018	35.9	24.2	84.6	56.3	6.2	3.0	1.0	5.0	5.8	18.01	16.04
01.10.2018	35.2	25.5	81.2	49.2	7.3	0.0	0.0	5.1	5.3	18.78	16.75
04.10.2018	35.9	26.1	81.0	48.0	9.2	0.0	0.0	3.8	7.8	19.08	16.97
08.10.2018	34.8	23.9	87.0	57.7	7.8	0.0	0.0	4.3	7.1	21.04	17.5
11.10.2018	35.4	22.5	88.0	49.3	2.0	0.0	0.0	6.6	7.1	22.04	19.79
15.10.2018	34.0	23.6	86.4	64.2	5.5	20.7	1.0	8.9	7.6	22.58	20.72
18.10.2018	31.5	26.5	90.0	82.1	1.5	05.9	1.0	5.5	3.7	24.58	17.91
22.10.2018	33.6	21.7	93.0	51.7	7.1	0.0	0.0	7.1	5.2	29.01	26.66
25.10.2018	34.0	22.0	84.6	58.6	7.6	0.0	0.0	2.0	6.3	29.71	27.81
29.10.2018	34.4	21.0	86.2	50.0	9.1	0.0	0.0	11.2	6.8	24.22	26.50
01.11.2018	33.3	20.0	91.6	53.0	5.5	0.3	0.0	7.8	7.1	20.22	26.25
05.11.2018	34.4	23.2	90.0	48.5	2.8	0.0	0.0	7.7	7.1	18.50	23.50
08.11.2018	34.5	21.5	92.0	51.3	6.2	0.0	0.0	8.6	7.5	16.95	22.95
12.11.2018	34.1	20.3	88.2	52.2	4.1	0.0	0.0	7.4	6.8	17.33	21.04
15.11.2018	34.4	19.1	89.3	57.0	5.2	0.0	0.0	6.5	6.1	10.20	15.00
19.11.2018	33.1	24.3	87.7	61.5	5.8	2.0	0.0	5.2	5.0	10.61	11.56
22.11.2018	33.6	23.4	87.0	64.0	7.3	0.0	0.0	6.5	5.3	11.42	10.83
26.11.2018	31.8	20.4	89.2	64.0	3.6	0.0	0.0	5.3	4.6	14.24	9.47
29.11.2018	32.2	18.5	86.6	58.3	9.0	0.0	0.0	3.9	4.5	13.03	9.58
03.12.2018	31.9	20.5	84.7	53.0	5.1	0.0	0.0	4.4	4.4	9.54	8.85
06.12.2018	30.2	20.8	86.6	77.0	2.7	1.8	0.0	5.1	4.7	8.87	6.66
10.12.2018	31.0	20.1	88.0	63.0	0.0	0.0	0.0	5.7	4.8	8.60	8.12
13.12.2018	31.1	19.5	88.0	60.0	1.2	0.0	0.0	4.7	5.0	7.12	8.22
17.12.2018	29.8	18.5	86.5	72.2	2.6	31.2	1.0	8.7	3.9	8.06	7.18
20.12.2018	25.2	17.4	88.3	76.3	1.1	36.1	1.0	10.1	2.0	12.9	9.16
24.12.2018	29.1	16.7	86.7	65.2	5.0	0.0	0.0	2.9	2.7	13.24	9.55
27.12.2018	30.3	18.3	83.0	62.6	4.9	0.0	0.0	3.5	4.0	15.20	10.93
31.12.2018	28.7	14.8	87.1	67.1	4.8	2.1	0.0	2.6	3.2	16.45	11.55

Assessment of correlation coefficient (r) values revealed significant positive correlation of T_{max} (0.429), SSH (0.507) and Evap. (0.465) with PDI whereas RH II (-0.488) and Rf (-0.379) had significant negative correlation with PDI. Non significant positive correlation of T_{min} (0.176) and RH I (0.159); non-significant negative correlation of Rd (-0.240) and WS (-0.154) with PDI was observed (Table 2). Multiple regression of PDI resulted in the following equation (Table 2).

$Y = -110.788 + 1.304$ RH I $+ 6.063$ Rd $+1.784$ SSH $- 0.960$ WS $+ 1.613$ Evap. ($R^2 = 0.776$)

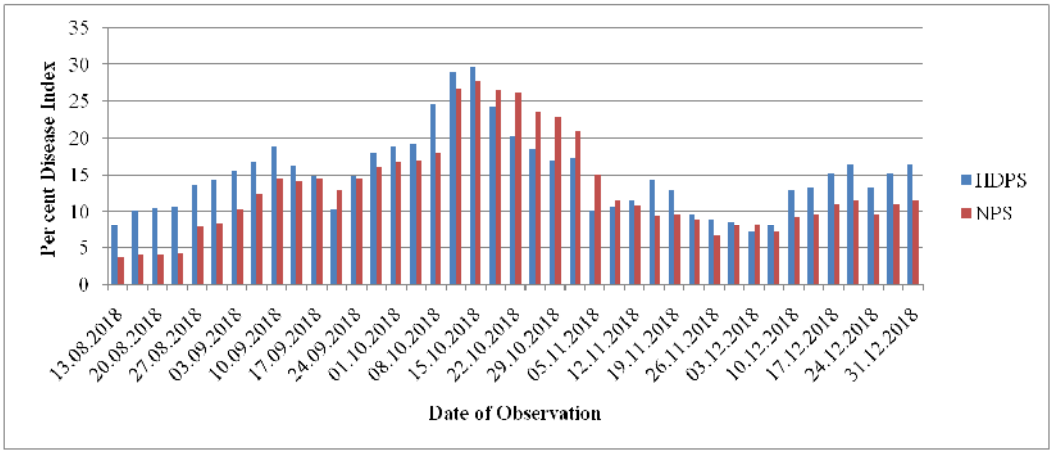

Fig. 1. Per cent Disease Index of Alternaria leaf spot in Cotton under High Density and Normal Planting Systems.

Thus, it was observed that the coefficient of determination (R^2) for PDI was 0.776 which showed that weather factors were able to influence PDI to an extent of 77%. Thus, for every one per cent increase in RH I, Rd, SSH and Evap. corresponding increase of 1.303, 6.063, 1.784 and 1.613 per cent increase of PDI; for every one per cent decrease in WS there is corresponding decrease of 0.96 in PDI. Other parameters *viz.*, T_{max} (0.184), RH II (0.228) and Rf (0.143) showed partial influence on the progress of Alternaria leaf spot.

In comparison to HDPS, Alternaria leaf spot under NPS was 3.66 PDI on 13.8.18 as against 8.12 PDI under HDPS and reached peak of 27.8 PDI on 25.10.2018 at boll maturity stage (Table 1). Significant positive correlation of T_{max} (0.489), RH I (0.376), SSH (0.377) and Evap. (0.547); negative correlation of RH II (-0.652) and Rf (-0.478) and rainy days (-0.360) with PDI was observed. Non-significant positive correlation of T_{min} (0.083) and negative or relation of WS (-0.160) was recorded (Table 2). Multiple regression of PDI with weather parameter resulted in the following equation (Table 2).

Table 2: Correlation and multiple linear regression analysis of per cent disease index of Alternaria leaf spot under High Density Planting System (HDPS) and Normal Planting System (NPS) of cotton with weather factors.

S.No.	Variable	Alternaria Leaf Spot							
		Correlation co-efficient (r)		Regression co-efficient (b)		Standard error (E)		t-value	
		HDPS	NPS	HDPS	NPS	HDPS	NPS	HDPS	NPS
1.	Maximum temperature (^{0}C)	0.429**	0.489**	-3.97*	-0.35 NS	1.45	1.58	-2.73	-0.22
2.	Minimum temperature (^{0}C)	0.176 NS	0.083 NS	1.70*	-2.67**	0.83	0.74	2.05	-3.58
3.	Morning relative humidity (%)	0.159 NS	0.376*	1.77**	0.63 NS	0.42	0.45	4.17	1.40
4.	Evening relative humidity (%)	-0.488**	-0.652**	-0.47 NS	0.14 NS	0.24	0.17	-1.93	0.84
5.	Sunshine hours (h day^{-1})	0.507**	0.377*	2.10**	0.66 NS	0.48	0.56	4.34	1.18
6.	Rainfall (mm)	-0.379*	-0.478**	-0.19 NS	-0.12*	0.26	0.18	-0.74	-2.67
7.	Rainy days	-0240 NS	-0.360*	11.59*	2.42 NS	5.00	3.89	2.31	0.62
8.	Wind speed (km h-^{1})	-0.154 NS	-0.160 NS	-1.52*	-1.54*	0.63	0.56	-2.41	-2.74
9.	Evaporation (mm)	0.465 **	0.547**	3.10*	1.42 NS	1.05	0.98	2.94	1.44

Intercept (a) = -36.53, F cal value = 6.82, (R^2) = 0.77
*Significant at p < 5% ; **Significant at p < 1%; NS: Non-Significant

Table 3: Regression of significant weather variables with Per cent Disease Index (PDI) of Alternaria leaf spot under High Density Planting System of cotton.

Variable	Regression Co-efficient (b)	Standard error (E)	t-value
Morning relative humidity	1.303**	0.28	4.49
Rainy days	6.063**	1.92	3.14
Sunshine hours	1.784**	0.44	4.01
Wind speed	-0.959*	0.38	-2.48
Evaporation	1.613**	0.53	3.03

Y = -110.78 + 1.303 (RH I) + 6.063 (Rd) + 1.784 (SSH) – 0.959 (WS) + 1.613 (Evap.); Intercept (a) = -110.78; F cal value = 9.542, (R^2) = 0.776

*Significant at 5% level **Significant at 1% level NS - Non Significant

Table 4: Regression of significant weather variables with Per cent Disease Index (PDI) of Alternaria leaf spot under Normal Planting System of cotton.

Variable	Regression Co-efficient (b)	Standard error (E)	t-value
Morning relative humidity	1.247**	0.27	4.49
Evening relative humidity	-0.430*	0.16	-2.55
Evaporation	1.475*	0.65	2.26

Y= -75.94 + 1.247 (RH I) – 0.430 (RH II) + 1.475 (Evap.), Intercept (a) = -75.94; (R^2) = 0.633%, Fcal= 21.27
*Significant at 5% level **Significant at 1% level NS - Non-Significant

Y = -75.94 + 1.247 (RH I) – 0.430 (RH II) + 1.475 (Evap.) (R^2 = 0.633)

Under NPS RH I, RH II and Evap. significantly influenced PDI with 63.3% variability. For every one per cent increase in RH I and Evap. corresponding increase of 1.247 and 1.475 for every one per cent decrease in RH II, 0.43 per cent decrease in PDI was inferred. Relative humidity coupled with evaporation commonly contributed to under both planting systems whereas RH II, Rd and SSH also significantly influenced the progress of disease under HDPS.

Dickinson and Bottomely, (1980) observed that high relative humidity of 90% to 100% was ideal for germination, growth and sporulation of *A. alternata* of cotton. Chattannavar *et al.*, (2002) reported that severity of Alternaria blight on cotton was more between 20 and 28°C temperature and 65-90% of relative humidity with frequent rainfall. Weather factors *viz*., temperature 7.0 to 25.1°C, relative humidity 24.1 to 89.6%, total rainfall 0.0 to 26.6mm, wind velocity 1.2 to 3.6 kmph and sunshine 3.4 to 10.2 h/day favoured development of maximum disease of Alternaria blight (Dubey, 2005). Rainfall, number of rainy days, minimum temperature and relative humidity (RH I and II) were significantly and positively correlated, whereas the maximum temperature showed significant and negative correlation with Alternaria leaf spot disease development in safflower (Murumkar *et al*., 2008).

Minimum temperature and afternoon relative humidity were found critical to forecast the Alternaria blight disease in cotton genotypes (Venkatesh *et al.*, 2013). Venkatesh *et al*., (2016) reported significant negative correlation of Alternaria leaf spot with maximum temperature and minimum temperature while morning relative humidity and sunshine hours expressed significant and positive correlation in Narasimha variety of cotton. Maximum, minimum temperatures, number of rainy days and wind speed significantly favoured the development of Alternaria leaf spot in Bt cotton hybrid, Jaadoo BG II (Bhattiprolu and Monga, 2018). Evening relative humidity, rainfall, number of rainy days, sunshine hours and morning evaporation significantly influenced the disease development while minimum temperature, wind speed and morning relative humidity showed partial influence on disease progress (Prasad *et al.*, 2019). The difference in the role of different weather parameters indicate the importance of variety/hybrid in developing prediction models for the disease and also plant spacing.

CONCLUSION

Based on the present investigation to understand the influence of weather under HDPS it can be concluded that the development of Alternaria leaf spot had a positive correlation with maximum temperature, sunshine hours and evaporation; negative correlation with evening relative humidity. Relative humidity coupled with evaporation was critical for the progress of the disease under HDPS whereas number of rainy days, sun shine hours and wind speed also contributed for diseases development under NPS. This clearly indicates the role of spacing in disease dynamics.

FUTURE SCOPE

The Prediction equations derived in this study will be revalidated for future study.

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Conflicts of Interest. All the authors declared that there is no conflict of interest and Authors have seen, read and approved the manuscript being submitted.

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