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Progress of Alternaria leaf spot in cotton influenced by weather parameters

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ABSTRACT

The effect of weather factors on the progress of Alternaria leaf spot in *Bt* Cotton hybrid Jaadoo BG II was investigated at the Regional Agricultural Research Station, Lam, Guntur during *Kharif* 2018 and 2019. Disease was scored by adopting a standard scale of 0 to 4 in ten plants tagged randomly to obtain the per cent disease index. Weather parameters were recorded at the Agrometeorological observatory, RARS, Lam, Guntur. Multiple regression equations with independent weather variables were derived using Excel programme to identify the critical parameters. Results of the pooled analysis showed that minimum temperature and evaporation were positively and significantly correlated with per cent disease index. Regression analysis revealed that minimum temperature, morning relative humidity and evaporation as critical factors causing variability of 86.7% in per cent disease index. These results were discussed with previous equations realized under given environmental conditions.

Key words: Alternaria leaf spot, cotton, regression analysis, weather parameters

Cotton is an important commercial crop in India with a production of 337.23 lakh bales of 170 kg lint in 2022-2023 from an area of 130.49 lakh ha with a productivity of 439 kg/ha, which is far behind the leading countries. Andhra Pradesh stands in sixth position both in cultivated area (6.95 Lakh ha) and production (18.85 Lakh bales) and fourth in productivity with 461kg lint ha^{-1} in India (Anonymous 2022-23). Cotton productivity in India is extremely poor due to a variety of factors, including diseases. *Alternaria* spp including *A. macrospora* Zimm., *A. alternata* (Fr.) Keissler cause leaf spot/blight and under congenial conditions lead to severe defoliation and reduction in boll formation. The estimated yield loss was to the tune of 38.23% in cotton variety LRA 5166 (Bhattiprolu and Prasada Rao, 2009) and 33.43% in variety Jayadhar (Chattannavar *et al.*, 2010). Understanding the influence of weather factors on disease progress is prerequisite to strategically manage the disease. Previous data (2013 to 2017) showed that maximum temperature, minimum temperature, number of rainy days and wind speed significantly influenced the development of Alternaria leaf spot (Bhattiprolu and Monga, 2018). Hence the experiment was continued to assess the progress of Alternaria leaf spot, during *Kharif* 2018 and 2019 in relation to environmental factors to develop forecast models.

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MATERIALS AND METHODS

In view of the importance of the disease, studies were carried out under the All India Coordinated Research Project on Cotton to investigate the appearance and progress of Alternaria leaf spot in *Bt* Cotton hybrid Jaadoo BG II during *Kharif* 2018 and 2019, in relation to environmental factors at Regional Agricultural Research Station, Lam, Guntur. The crop was raised in a bulk plot of 150 m^2. Alternaria leaf spot was scored on 0 to 4 scale (Sheo Raj, 1988) in randomly labelled plants, at weekly intervals during the season and expressed as Per cent Disease Index (PDI) using Wheeler's formula: PDI= Sum of numerical ratings × 100/ Total number of leaves scored x maximum disease grade (Wheeler, 1969). Meteorological data (maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, rainfall, rainy days, sunshine hours, evaporation and wind speed) were recorded daily from sowing onwards and weekly means were calculated while rainfall

during the standard meteorological week (SMW) was totalled. Correlation between PDI of Alternaria leaf spot and weather factors was calculated to understand the quantitative relationship. Year wise multiple regression equations with independent weather variables to identify the critical parameters for development of the disease were derived using Excel programme. Both disease and weather data of 2018 and 2019 were pooled to predict the intensity of Alternaria leaf spot of cotton.

RESULTS AND DISCUSSION

Alternaria leaf spot appeared in 36th SMW during September 2018 when the mean maximum temperature was 34.9°C; mean minimum temperature was 26.0°C; mean morning relative humidity was 83.6% (RH I); mean evening relative humidity was 57.6% (RH II); rainfall was nil; sun shine duration was 8.23 hours; wind speed was 8.87kmph and evaporation was 8.86mm. Alternaria leaf spot attained a maximum PDI of 22.5 on Jaadoo BG II during 43rd SMD *i.e.*, last week of October, during which the mean maximum temperature was 34.2°C; mean minimum temperature was 21.3°C; mean RH I was 86.9%; mean RH II was 52.4%; rainfall was nil; sun shine duration was 8.54 hours; wind speed was 6.59 kmph and evaporation was 5.67mm (Table 1a and Fig. 1). Significant positive correlation with RH I was recorded, while RH II expressed significant negative correlation with per cent disease index (Table 2). Multiple linear regression analysis revealed that RH I, RH II and rainfall significantly influenced the progress of Alternaria leaf spot (R^2=0.915) during *Kharif* 2018 (Table 3).

Alternaria leaf spot appeared in 35th SMW during August 2019 when the mean maximum temperature was 35.6°C; mean minimum temperature was 26.6°C; mean morning relative humidity was 86.6% (RH I); mean evening relative humidity was 66.0% (RH II); rainfall was 20.7mm in two rainy days; sun shine duration was 6.36 hours; wind speed was 8.53kmph and evaporation was 6.53mm. Alternaria leaf spot attained a maximum PDI of 30.0 during 43rd SMW *i.e.*, last week of October, during which the mean maximum temperature was 31.07°C; mean minimum temperature was 24.4°C; mean RH I was 91.4%; mean RH II was 83.7%; rainfall was 40.6mm in 4 rainy days; sun shine duration was 2.64 hours; wind speed was 4.71kmph and evaporation was 3.17mm (Table 1b and Fig.1). Significant positive correlation with rainfall and no. of rainy days was recorded, while sun shine hours, wind speed and evaporation expressed significant negative correlation with PDI (Table 3). Multiple linear regression analysis revealed that rainfall, no. of rainy days and evaporation significantly influenced the progress of Alternaria leaf spot (R^2=0.877) whereas no. of sunshine hours showed partial influence (R^2=0.461) during *Kharif* 2019 (Table 3).

Correlation analysis of pooled data (2018 and 2019) indicated that minimum temperature, number of rainy days and evaporation showed significant positive correlation with per cent disease index. Multiple regression analysis of pooled data revealed that minimum temperature, morning relative humidity,

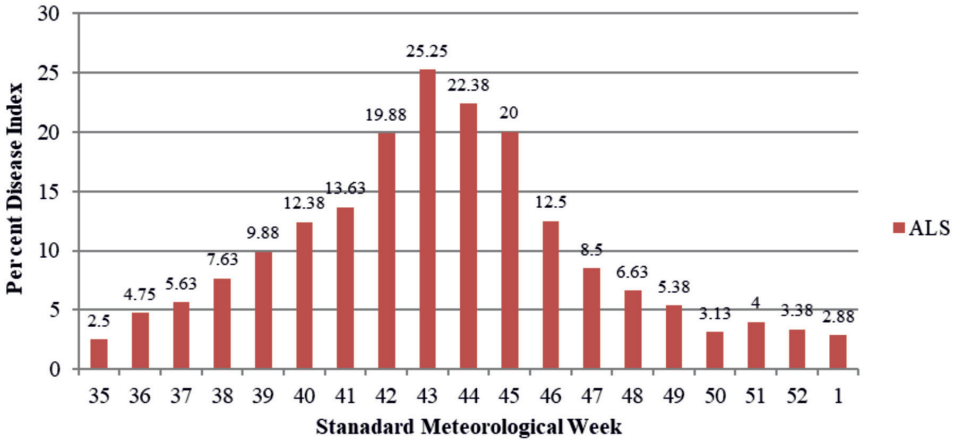

Fig. 1. Progress of Alternaria leaf spot (Average PDI of 2018 and 2019) in Jaadoo BG II cotton

Table 1a. Progress of Alternaria leaf spot in relation to weather parameters at RARS, Lam, Guntur during 2018-19

SMW	Month & Date	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Rainy days	Sun shine duration (hours)	Wind speed (km/h)	Evaporation (mm)	PDI of Alternaria leaf spot
		Maximum	Minimum	I	II						
36	3-9 September 2018	34.9	26.0	83.6	57.6	0	0	8.23	8.87	8.86	1.5
37	10-16 September	36.1	26.5	81.7	54.3	14.6	1	7.24	5.5	7.44	2.0
38	17-23 September	32.6	24.4	86.3	73.0	43.2	2	2.89	7.24	4.6	3.5
39	24-30 September	35. 6	24.9	82.3	52.6	3.0	1	6.44	5.39	5.86	7.0
40	1-7 October	35.57	25.0	83.6	53.1	0	0	8.66	7.29	3.87	9.75
41	8-14 October	34.9	23.1	88.3	47.7	0	0	4.49	7.21	7.31	10.25
42	15-21 October	32.4	24.4	90.7	69.2	26.6	2	4.07	4.8	6.47	15.25
43	22-28 October	34.2	21.3	86.9	52.4	0	0	8.54	6.59	5.67	22.5
44	29 October - 4 November	34.0	21.6	89.6	52.0	0.3	0	4.67	7.17	9.13	20
45	5-11 November	34.4	21.3	89.4	51.6	0	0	4.74	7.0	8.2	17.25
46	12-18 November	33.8	21.4	89.1	59.6	2.0	0	5.44	5.86	5.73	9.25
47	19-25 November	32.7	22.9	87.9	62.6	0	0	5.11	4.93	6.1	8.25
48	26 November – 2 December	32.1	18.8	87.6	57.1	0	0	7.01	4.49	4.01	7.75
49	3-9 December	31.0	20.7	87.0	65.1	1.8	0	2.01	4.83	5.17	6.75
50	10-16 December	31.0	19.1	85.6	62.9	0	0	2.03	4.71	5.93	5.5
51	17-23 December	26. 9	17.4	88.3	74.1	67.3	2	2.94	2.33	7.7	7.25
52	24-31 December	29.4	16.3	85.7	65.1	2.1	0	4.91	3.57	2.99	6.0
1	1-7 January 2019	29.1	14.3	90.3	61.1	0	0	6.61	3.5	3.58	5.75

Note: SMW - Standard meteorological week; PDI – Per cent disease index.

Table 1b. Progress of Alternaria leaf spot in relation to weather parameters at RARS, Lam, Guntur during 2019-20

SMW	Month & Date	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Rainy days	Sun shine duration (hours)	Wind speed (km/h)	Evaporation (mm)	PDI of Alternaria leaf spot
		Maximum	Minimum	I	II						
35	27August-2 September 2019	35.6	26.6	86.6	66.0	20.7	2	6.36	8.53	6.53	5.00
36	3-9 September	33.8	25.6	88.3	65.4	6.0	0	6.21	10.16	3.00	8.00
37	10-16 September	37.0	26.3	86.6	65.3	73.6	2	7.86	8.10	3.94	9.25
38	17-23 September	32.3	24.9	90.6	84.3	81.8	4	3.8	7.83	2.69	11.75
39	24-30 September	35.6	24.9	82.3	52.6	3.0	1	6.44	5.39	5.86	12.75
40	1-7 October	33.7	25.1	90.3	70.4	5.6	1	2.16	2.40	3.51	15.00
41	8-14 October	32.9	25.1	92.0	72.3	61.0	3	3.34	2.07	3.71	17.00
42	15-21 October	31.5	24.7	94.1	82.9	74.4	3	0	2.89	3.29	24.50
43	22-28 October	31.1	24.4	91.4	83.7	40.6	4	2.64	4.71	3.17	30.00
44	29 October - 4 November	31.5	24.8	91.1	74.1	41.0	2	4.53	3.49	3.54	24.75
45	5-11 November	33.1	22.4	92.9	72.0	0	0	6.19	3.49	3.94	22.75
46	12-18 November	32.2	23.3	93.4	74.6	0	0	5.71	3.61	4.51	15.75
47	19-25 November	31. 7	22.0	93.3	80.9	0	0	4.96	4.01	4.17	8.75
48	26 November – 2 December	31.0	20.7	90.3	84.7	0	0	4.49	4.50	4.09	5.50
49	3-9 December	30.4	19.9	88.7	88.6	1.6	0	2.03	3.57	3.49	4.00
50	10-16 December	31.1	18.1	92.4	79.3	0	0	4.86	3.30	4.09	0.75

Note: SMW - Standard meteorological week; PDI – Per cent disease index.

Table 2. Correlation between Alternaria leaf spot (PDI) and weather factors in cotton (Pooled data of 2018 and 2019)

Weather Parameter	Correlation coefficient (r)		
	2018	2019	Pooled
Maximum temperature (^{0}C)	0.12NS	-0.37NS	0.35NS
Minimum temperature (^{0}C)	-0.23NS	0.27NS	0.45*
Morning relative humidity (%)	0.81**	-0.21NS	0.39NS
Evening relative humidity (%)	-0.56*	0.21NS	-040NS
Rain fall(mm/wk)	-0.48NS	0.58*	0.28NS
Rainy days	0.29NS	0.71**	0.45*
Sunshine hours (hrs/day)	0.05NS	-0.68**	-0.13NS
Wind speed (km/h)	0.22NS	-0.53*	-0.04NS
Evaporation	0.44NS	-0.66*	0.46*

** Significant at 1% level; *Significant at 5% level; NS-Non significant.

rainfall, rainy days and evaporation significantly influenced the progress of Alternaria leaf spot causing variability of 94.6% in per cent disease index. Moving averages of dependent as well as independent variables prompted the highest coefficient of determination (Bhattiprolu and Monga, 2018).

Gowdar *et al*. (2007) recorded significant negative correlation of disease incidence with rain, minimum temperature, morning and evening relative humidity, and positive correlation with maximum temperature during 1999-2000 and significant negative correlation of all the parameters with disease incidence during 2000-2001. During the present investigation correlation of weather parameters with PDI of Alternaria leaf spot was analysed and thus differences were observed. Hosagoudar (2012) observed that maximum, minimum temperatures, RH (morning and evening) and rainy days significantly influenced the intensity of Alternaria leaf spot in cotton. Temperature regime of 20 - 30°C with prolonged high humidity (>80%) and frequent rains favoured *A. macrospora* infection and disease development in cotton (Johnson *et al.*, 2013). Minimum temperature and afternoon relative humidity were found critical to forecast the Alternaria blight disease in cotton genotypes (Venkatesh *et al.*, 2013). Singh and Ratnoo (2013) observed that 28.8-31°C and 86-93% RH were conducive for Alternaria leaf spot (*A. gossypina*) and recorded negative correlation of PDI with minimum temperature and positive correlation with maximum relative humidity. Significant negative correlation of PDI with maximum, minimum temperatures and positive correlation with morning RH and sunshine hours was recorded in cotton variety, Narasimha (Venkatesh *et al.*, 2016). Pooled data of 2013 to 2017 revealed that minimum temperature, evening relative humidity, rain fall and number of rainy days were negatively correlated and significantly influenced the development of Alternaria leaf spot while number of sunshine hours and evaporation showed positive significant influence in Jaadoo BG II (Bhattiprolu and Monga, 2018).

Table 3. Multiple Regression Equations developed for Alternaria leaf spot at Guntur (2018 and 2019)

Year	Multiple Regression Equation	Coefficient of determination (R^2)
2018	Y = -02 + 2.44 RH I** – 0.86 RH II** + 0.29 RF**	0.915
2019	Y = - 39.20 - 0.39 RF* + 10.66 RD** - 7.34 Evap.**	0.877
	Y = 30.67 – 3.64 SSH**	0.461
Pooled	Y= - 238.66 + 0.87 min T** + 2.38 RH I** -0.61 RF** + 14.27 RD** + 3.20 Evap.**	0.946

**Significant at 1%; * Significant at 5%
Y = PDI of Alternaria leaf spot; Min T = Minimum Temperature; RH I = Morning Humidity; RH II = Evening Relative Humidity; RF = Rainfall; RD = Rainy Days; S = Sunshine Hours; E = Evaporation and W = Wind Speed.

Siva Prasad *et al*. (2019) observed that irrespective of time of sowing, number of rainy days, RH II, sunshine hours, wind speed and evaporation were critical parameters in determining the progress of Alternaria leaf spot. Roshan Baba *et al*. (2022) observed certain differences in weather factors influencing the progress of diseases in different genotypes. Sunshine hours, minimum temperature in Jaadoo BG II; morning relative humidity, evening relative humidity and number of rainy days in RCH 2 BG II; sunshine hours and wind speed in L 1060 contributed with R^2 value of 0.77, 0.692 and 0.85, respectively.

It is concluded that variation in weather parameters during consecutive years leads to variability in PDI as a result of interaction among the independent weather variables. Minimum temperature, morning relative humidity and evaporation are the critical parameters contributing to the progress of Alternaria leaf spot in cotton and farmers are advised take up preventive and / or protective measures with recommended fungicides like 0.3% copper oxychloride or 0.1% propiconazole under favourable weather conditions as given under weekly advisories from the University.

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