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Influence of spacing on the progress of Corynespora leaf spot in cotton

P. MOUNIKA, S. L. BHATTIPROLU*, S. KHAYUM AHAMMED AND M. SREEKANTH
Department of Plant Pathology, Agricultural College, Bapatla-155101
**Email : bhattiprolu2005yahoo.co.in*

Abstract : Influence of different spacing(s) on the progress of Corynespora leaf spot severity in cotton and its relation to weather parameters was assessed during *kharif* 2021-2022. The disease was scored at three days interval by adopting 0 to 4scale and per cent disease index (PDI) was subjected to correlation and regression analysis to identify the critical weather parameters for the development of Corynespora leaf spot. Significant negative correlation was observed between PDI and maximum temperature, minimum temperature, rain fall, wind speed and evaporation whereas sunshine hours showed significant and positive correlation at all four spacing(s). Evening relative humidity expressed significant negative correlation in 75 x 30 cm and 75 x 45 cm. Evening relative humidity, wind speed and evaporation were found as critical weather parameters for the progress of Corynespora leaf spot at all four spacing(s). Assessment of area under disease progress curve (AUDPC) under different spacing(s) revealed the highest AUDPC of 645.0 in 60 cm X 30 cm while the least AUDPC (585) in 75 x 45 cm at boll maturity and bursting stage.

Keywords: Corynespora leaf spot, cotton, disease progress curve, spacing, weather parameters

Cotton is an important fibre crop worldwide. Cotton is referred to as “King of Fibres” and also as “White Gold”. India is the largest country in the world with 41 per cent (13.50 M ha) of world cotton area and 25.59 per cent (29.0 M bales) of world cotton production with 487 kg lint/ha followed by United states (3.52 M ha; 14.7 M bales; 909 kg lint/ha) and China (3.25 M/ha; 29.0 M bales; 1943 kg lint/ha area, production and productivity, respectively) (Anonymous, 2022). Corynespora target spot caused lint yield loss in susceptible cotton cultivars as high as 224-448 kg/ha equivalent to 5 to 40 per cent (Conner *et al.*, 2013; Hagan *et al.*, 2015). Foliar diseases in cotton (fungal, bacterial and viral boll rot) were estimated to cause yield losses up to 20 to 30 per cent in India. Among all the fungal foliar diseases, Corynespora leaf spot caused by *Corynespora cassiicola* has been increasing its prevalence and severity (Salunkhe *et al.*, 2019). Corynespora leaf spot has been observed in Andhra Pradesh since 2017 and emerged as major leaf spot in cotton (Anonymous, 2020).

Increasing plant density is a promising approach for improving cotton yields and net profits. High density planting system (HDPS) is advocated to improve the productivity in light soils under rainfed conditions by increasing the plant population and decreasing the crop duration, cost of picking besides suitability for picking. Higher plant density under narrow plant spacing ensured higher seed cotton yield in all cotton genotypes and lesser CLCV infestation in MNH - 886 and MNH - 814 (Iqbal *et al.*, 2012) and in IUB 13 (Iqbal *et al.*, 2021). Alternaria leaf spot disease was found with significant intensity in closer spacing (2.2 lakh/ha) over wider spacing (1.11 lakh/ha) whereas, different HDP spacing(s) didn’t influence the incidence of bacterial blight and grey mildew. However, higher density with closer row spacing recorded greater PDI of these diseases (Pandagale *et al.*, 2020). Keeping in view of the regular occurrence of Corynespora leaf spot as major leaf spot disease in recent years, the present study was conducted to know the

effect of environmental factors on their development, under different spacing (s).

MATERIALS AND METHODS

Field experiment was conducted to assess the severity of cotton Corynespora leaf spot in relation to weather parameters through correlation and regression analysis during *kharif* 2021-2022 at RARS, Lam, Guntur. Four plots were maintained using variety LHDP-5 Cotton with four different spacing(s) *viz.*, 75 x 30 cm, 75 x 45 cm, 60 x 30 cm and 60 x 45 cm in an area of 100 sq m each. Data on the severity of Corynespora leaf spot was recorded from 15 days after sowing (DAS) up to harvesting at three day intervals. The data was recorded in 10 plants tagged randomly in each plot and in each plant 10 leaves, three from bottom, four from middle and three from top portion were scored for disease by using 0-4 scale given by Shoe Raj (1988) and PDI was calculated (Wheeler, 1969).

$$PDI = \frac{\text{Sum of all the individual ratings}}{\text{Total number of leaves scored} \times \text{Maximum disease grade}}$$

Weather parameters were recorded at the meteorological observatory, RARS, Lam, Guntur. Mean of each parameter was calculated at three days intervals, whereas rainfall was totaled for three days. Correlation and multiple regression analysis were carried out between PDI and weather parameters *viz.*, maximum temperature (°C), minimum temperature (°C), morning relative humidity (%), evening relative humidity (%), rain fall (mm), sunshine hours and wind velocity (kmph) using excel programme to identify the critical parameters for the development of Corynespora leaf spot disease.

The disease index was correlated with weather data and multiple regression equations were worked out by using the formula given by Gomez and Gomez (1984).

$Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5$ Where, a = Intercept, b = Regression coefficient, X1 to X5 = Dependent weather variables.

RESULTS AND DISCUSSION

Corynespora leaf spot disease first appeared on 09.09.2021 in all spacing(s) at 55 DAS with 3.25 PDI, 3.00 PDI, 3.50 PDI and 3.25 PDI in 75 x 30 cm, 75 x 45 cm, 60 x 30 cm and 60 x 45 cm, respectively, when the corresponding Tmax, Tmin, RH I, RH II, SSH, Rf, Rd, WS and Evap. were 31.53°C, 24.83 °C, 94 per cent, 69 per cent, 4 hrs/day, 3.4 mm, 0, 8.3 kmph and 4.0 mm, respectively. The disease reached maximum at the harvesting stage (02.12.2021) with PDI of 46.5, 43.5, 48.0 and 45.75 in 75 x 30 cm, 75 x 45 cm, 60 x 30 cm and 60 x 45 cm, respectively when the corresponding T_{max}, T_{min}, RH I, RH II, SSH, Rf, Rd, WS and Evap. were 29.2 °C, 19.57 °C, 95.27 per cent, 54.37 per cent, 6.6 hrs/day, 1.27 mm, 0, 3.6 kmph and 3.4 mm, respectively(Table 1). The data on per cent disease index was subjected to multiple linear regression (MLR) and correlation with weather variables.

Assessment of correlation coefficient (r) values revealed that maximum temperature, minimum temperature, rain fall, wind speed and evaporation were significant with negative correlation whereas sunshine hours showed significant and positive correlation with PDI as all four spacing(s). Evening relative humidity expressed significant negative correlation in 75 x 30 cm and 75 x 45 cm. Morning relative humidity and number of rainy days were found non-significant with negative correlation at all four spacing (s) whereas evening relative humidity was also non significant with negative correlation at 60 cm x 30 cm and 60 x 45 cm (Table 2).

Regression analysis revealed that evening relative humidity, wind speed and evaporation contributed for 73 per cent (R2=0.73) variation in PDI at (75 x 30 cm); 75 per

Table 1. Progression of cotton Corynespora leaf spot in relation to weather parameters under different spacing(s) during *kharif* 2021-2022

Date of observation	Temperature (°C)		Relative humidity (%)		Sunshine hours	Rainfall (mm)	Rainy days	Wind Speed	Evaporation (mm)	PDI			
	Max. (Tmax)	Min. (Tmin)	Morn. (RH I)	Even. (RH II)	(hrs/day) (SSH)	(Rf)	(Rd)	(kmph) (WS)	(Evap.)	75 x 30 cm	75 x 45 cm	60 x 30 cm	60 x 45 cm
09.09.2021	31.53	24.83	94.10	69.13	4.0	3.40	0	8.30	4.07	3.25	3.00	3.50	3.25
13.09.2021	32.03	25.37	97.73	67.50	4.2	1.13	0	8.00	5.00	4.50	4.00	4.75	4.50
16.09.2021	32.00	24.83	98.03	65.97	3.9	9.23	1	7.60	4.73	5.25	5.25	5.75	5.50
20.09.2021	30.53	24.40	98.70	73.10	3.9	14.10	1	6.50	4.27	6.50	6.25	7.00	6.75
23.09.2021	30.03	23.87	95.07	77.63	4.2	21.77	1	6.20	3.40	7.75	7.50	8.75	7.50
27.09.2021	30.10	24.40	94.87	79.33	5.2	17.07	1	5.27	3.33	10.50	9.25	11.00	10.25
30.09.2021	30.47	24.77	94.97	76.10	5.7	48.60	1	4.17	3.73	11.75	10.50	12.75	12.00
04.10.2021	30.57	24.87	98.60	73.50	5.7	40.80	1	3.70	4.37	13.50	11.75	14.50	13.25
07.10.2021	31.57	24.83	98.60	74.13	5.4	37.13	0	3.63	4.53	15.25	13.25	16.00	14.75
11.10.2021	31.63	24.47	95.57	72.37	5.1	0.60	0	3.70	3.90	17.50	14.75	18.00	16.00
14.10.2021	32.13	24.90	95.40	74.53	5.6	0.60	0	3.60	3.83	19.00	15.50	19.75	17.50
18.10.2021	31.50	24.50	90.23	70.17	5.9	0.60	0	3.70	4.00	22.75	17.00	23.25	19.75
21.10.2021	31.50	23.83	89.37	67.83	5.8	0.00	0	3.63	4.47	24.00	19.00	25.00	21.75
25.10.2021	30.10	23.03	89.70	62.23	4.4	7.33	0	3.53	3.83	22.50	21.25	26.25	23.00
28.10.2021	29.03	22.90	84.53	73.50	3.2	8.17	0	3.67	3.03	24.75	23.50	27.00	25.25
01.11.2021	28.17	22.37	88.33	78.67	2.7	8.17	0	3.93	2.33	26.00	24.75	28.75	26.75
04.11.2021	28.37	21.47	88.67	87.93	3.2	1.30	1	3.70	2.57	27.75	26.00	30.50	28.00
08.11.2021	28.17	20.90	99.50	83.00	3.3	5.33	1	4.20	2.73	29.50	27.75	32.00	30.25
11.11.2021	28.87	21.93	95.93	81.93	3.8	7.27	2	4.73	2.80	32.00	29.50	34.75	32.5
15.11.2021	28.23	22.43	93.10	83.33	3.9	22.67	2	5.97	2.20	34.50	32.00	37.00	34.75
18.11.2021	29.00	22.97	93.27	79.17	4.6	19.07	1	5.07	2.50	39.00	34.75	40.25	38.25
22.11.2021	27.87	21.93	94.40	82.97	4.8	18.73	1	4.90	2.27	41.75	38.50	43.00	41.00
25.11.2021	28.50	21.43	96.33	71.43	5.7	2.87	0	3.97	2.93	43.00	40.00	44.75	42.50
29.11.2021	28.53	19.57	93.17	65.83	6.4	1.60	0	4.23	2.77	44.75	41.25	46.00	44.00
02.12.2021	29.20	19.57	95.27	54.37	6.6	1.27	0	3.60	3.40	46.50	43.50	48.00	45.75
06.12.2021	29.73	19.63	95.50	57.17	6.4	1.27	0	3.80	3.47	43.00	40.75	44.75	42.00
09.12.2021	28.67	19.90	98.20	59.97	6.2	1.27	0	3.90	3.57	41.00	39.00	42.00	41.25
13.12.2021	27.70	18.13	98.53	64.10	6.8	0.00	0	3.50	3.33	40.25	37.75	40.75	40.00
16.12.2021	26.70	15.80	98.97	63.53	6.8	0.00	0	2.87	3.17	38.75	36.00	39.25	41.00
20.12.2021	27.67	14.77	99.27	66.00	6.6	0.00	0	2.40	3.13	37.00	34.50	38.00	37.25
23.12.2021	28.60	15.90	99.37	65.63	5.9	0.00	0	2.60	2.60	34.75	32.25	36.75	35.00
27.12.2021	29.10	17.67	98.93	69.73	6.2	0.00	0	3.17	3.13	32.50	30.00	34.00	32.75
30.12.2021	29.10	17.63	98.87	69.07	6.4	0.00	0	3.30	3.07	30.00	28.25	31.50	30.25
03.01.2022	29.60	16.70	99.10	68.77	6.2	0.00	0	3.80	4.03	27.50	26.00	28.25	27.75
06.01.2022	29.07	16.67	99.77	72.77	5.6	3.40	1	3.93	3.17	26.25	25.25	27.00	26.00
10.01.2022	27.60	18.10	99.50	82.67	5.3	12.20	1	4.40	2.30	24.25	23.75	25.25	23.75
13.01.2022	26.60	18.07	99.50	93.10	5.9	12.20	1	3.73	1.33	20.50	20.00	23.00	20.00
17.01.2022	27.63	18.13	99.00	91.13	6.3	8.80	0	3.77	2.33	18.25	17.75	20.50	18.00
20.01.2022	29.23	18.27	99.27	81.43	7.0	0.00	0	3.43	4.20	16.00	15.00	16.75	16.25

Table 2. Correlation between severity of Corynespora leaf spot of cotton and weather factors

S. No.	Variable	Correlation co-efficient (r)			
		75 x 30 cm	**75 x 45 cm**	**60 x 30 cm**	**60 x 45 cm**
1	Maximum temperature (°C)	–0.623**	–0.666**	–0.640**	–0.653**
2	Minimum temperature (°C)	–0.581**	–0.617**	–0.577**	–0.602**
3	Morning relative humidity (%)	–0.310NS	0.002NS	–0.055NS	–0.014NS
4	Evening relative humidity (%)	–0.282**	–0.272**	–0.255NS	–0.279NS
5	Sunshine hours (h day-1)	0.361*	0.349*	0.328*	0.345*
6	Rainfall (mm)	–0.352*	–0.350*	–0.345*	–0.347*
7	Rainy days	–0.142NS	–0.128NS	–0.124NS	–0.131NS
8	Wind speed (km h-1)	–0.553**	–0.538**	–0.559**	–0.548**
9	Evaporation (mm)	–0.518**	–0.544**	–0.546**	–0.528**
	No. of observations	39	39	39	39

*Significant at p < 5% **Significant at p < 1% NS: Non Significant

Table 3. Regression analysis of Per cent Disease Index of Corynespora leaf spot at different spacing (s) with weather factors

Variable	Spacing											
	75 30 cm			75 x 45 cm			60 x 30 cm			60 x 45 cm		
	Regression Co-efficient (b)	Standard error (E)	t-value	Regression Co-efficient (b)	Standard error (E)	t-value	Regression Co-efficient (b)	Standard error (E)	t-value	Regression Co-efficient (b)	Standard error (E)	t-value
Evening relative humidity	–0.91**	0.14	–6.13	–0.88**	0.13	–6.52	–0.9**	0.14	–6.09	–0.92**	0.14	–6.30
Wind speed	–2.37**	0.87	–2.73	–2.00**	0.78	–2.53	–2.46**	0.87	–2.82	–2.29**	0.85	–2.67
Evaporation	–11.83**	1.69	–6.96	–11.76**	1.53	–7.64	–12.38**	1.69	–7.29	–12.12**	1.67	–7.24

**Significant at 1% level

cent (R2=0.75) at 75 x 45 cm; 74 per cent (R2 = 0.74) at 60 x 30 cm or 60 x 45 cm (Table 3). All these three parameters were significant and negatively correlated with PDI.

Y = 142.2 – 0.91(RH II) – 2.37 (WS) – 11.83 (Evap.) (75 x 30 cm)

Y = 135.8 – 0.88 (RH II) – 2.00 (WS) – 11.76 (Evap.) (75 x 45 cm)

Y = 145.38 – 0.9 (RH II) – 2.46 (WS) – 12.38 (Evap.) (60 x 30 cm)

Y = 143.4 – 0.92 (RH II) – 2.29 (WS) – 12.12 (Evap.) (60 x 45 cm)

Area under Disease Progress Curve (AUDPC) was assessed for different spacing(s). Highest area under disease was identified at boll maturity and bursting stage in all spacing(s). Among the four spacing(s) highest area was observed in 60 x 30 cm while the least area under disease curve was observed in 75 x 45 cm spacing (Table 4).

Significant negative correlation between disease severity and evening relative humidity was observed in early blight of tomato (Rajendra *et al.*, 2017), brown leaf spot of rice (Dhaliwal *et al.*, 2018). Maximum temperature, morning relative humidity and evaporation accounted for 74 per cent (R2=0.74) variation in PDI of Corynespora leaf spot under 75 x 10 cm in LHDP1 cotton variety (Yamuna *et al.*, 2021a). Significant positive correlation was observed with maximum temperature, sunshine hours and evaporation; evening relative humidity and rainfall showed significant negative correlation in case of Alternaria leaf spot (Yamuna *et al.*, 2021b). Sunshine hours, the number of rainy days and wind speed are the common critical parameters contributing to the development of Alternaria and Corynespora leaf spots in (Roshan *et al.*, 2022)

Based on the results it is concluded that

Table 4. AUDPC values of progression of Corynespora leaf spot of cotton in relation to weather parameters

Stage of the crop	No of days	75 x 30 cm		75 x 45 cm		60 x 30 cm		60 x 45 cm	
	after sowing	PDI	AUDPC	PDI	AUDPC	PDI	AUDPC	PDI	AUDPC
Seedling stage	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squaring stage	45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	60	3.25	24.38	3.00	22.50	3.50	26.25	3.25	24.38
Flowering stage	75	7.75	82.50	7.50	78.75	8.75	91.88	7.50	80.63
	90	15.25	172.50	13.25	155.63	16.00	185.63	14.75	166.88
Boll formation and	105	24.00	294.38	19.00	241.88	25.00	307.50	21.75	273.75
boll development stage	120	27.75	388.13	32.00	337.50	30.50	416.25	28.00	373.13
	135	39.00	500.63	34.75	455.63	40.25	530.63	38.25	496.88
Boll maturity and	150	46.50	641.25	43.50	586.88	48.00	661.88	45.75	630.00
bursting	165	37.00	626.25	34.50	585.00	38.00	645.00	37.25	622.50
Boll bursting and	180	27.50	480.00	26.00	453.75	28.25	496.88	27.75	487.50
picking stage	195	18.25	339.38	17.75	328.13	20.50	365.63	18.00	343.13

at all four spacing(s) of 75 x 30 cm, 75 x 45 cm, 60 x 30 cm and 60 x 45 cm, evening relative humidity, wind speed and evaporation showed negative influence on disease severity and exulted maximum influence on disease development indicating that effect of spacing was not significant under the test conditions.

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