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Influnce of weather parameters on the development of Alternaria leaf spot in cotton

I.VENKATESH, S. L. BHATTIPROLU*, J. KRISHNA PRASADJI AND G. RAMACHANDRA RAO

Acharya N. G. Ranga Agricultural University, Department of Plant Pathology, Agricultural College, Bapatla – 522 101

**E-mail : bhattiprolu2023@gmail.com*

ABSTRACT: The effect of weather factors on the development of Alternaria leaf spot in susceptible cotton variety Narasimha (NA 1325) was investigated during *kharif* 2012-2013 at Regional Agricultural Research Station, Lam Farm, Guntur. Weekly data on disease score at different phenological stages of the crop was recorded on randomly labeled plants and per cent disease intensity (PDI) was correlated with weather parameters. Alternaria leaf spot of cotton appeared during 37th meteorological week at the seedling stage and reached its peak {31.8%) during the 5th meteorological week at the boll maturity stage. Significant negative correlation was observed for maximum temperature and minimum temperature with per cent disease intensity, while morning relative humidity and sunshine hours were positive and significantly correlated. Multiple linear regression of PDI indicated that for every one per cent increase in morning relative humidity there was corresponding increase of 0.80 in per cent disease index of Alternaria leaf spot and suggests preventive and / or protective measures are to be taken up with recommended fungicides like mancozeb and propiconazole.

Key words: Alternaria leaf spot, cotton, phonological stages, weather parameters

Cotton is referred to as "King of Fibres" and also known as "White Gold". India produced 375 lakh bales of 170kg lint in 2013-2014 from an area of 115.53 lakh ha with a productivity of 552kg/ha. India's share in global cotton exports is around 22 per cent (Anonymous 2014).

Cotton crop is affected by fungal, bacterial and viral diseases. In India, foliar diseases have been estimated to cause yield losses up to 20 to 30 per cent. Leaf spot/blight caused by *Alternaria macrospora* Zimm. is the most commonly occurring disease in Andhra Pradesh causing losses to the tune of 26.59 per cent (Monga *et al.*, 2013) and 38.23 per cent (Bhattiprolu and Prasada Rao, 2009). Understanding the influence of weather factors on host stage and disease development is prerequisite to strategically manage the disease. Hence an experiment was conducted to assess the progress of Alternaria leaf spot in relation to environmental factors along with phenological stage of the crop

The effect of weather factors on the development of Alternaria leaf spot in susceptible cotton variety Narasimha (NA 1325) was investigated at RARS, Lam Farm, Guntur. The crop was raised on 8th August 2012 in a bulk plot with an area of 150 m^2. Twenty five plants, in the middle rows, at random, were tagged and Alternaria leaf spot was scored on 0 to 4scale (Sheo Raj, 1988) at weekly intervals on labeled plants up to the end of the February and expressed as Percent Disease Intensity (PDI) using Wheelers formula:

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Total Number of leaves scored x maximum disease grade}} \times 100$$

Phenological stage of the crop was also recorded during the study. Meteorological data (maximum temperature, minimum

temperature, morning relative humidity, evening relative humidity, rain fall, sunshine hours) was recorded daily from sowing onwards and weekly means were calculated while rainfall during the standard meteorological week was totaled. Correlation between progress of Alternaria leaf spot severity and weather factors was calculated and multiple regression equation was derived using Excel programme.

Alternaria leaf spot of cotton appeared during 37th meteorological week (12th – 18th Sept), with mean maximum temperature 34.1^{0}C, mean minimum temperature 26.1^{0}C, mean morning relative humidity 81.7 per cent (RH I), mean evening relative humidity 60.3 per cent (RH II), sunshine hours 3.54 h/day (SSH), rainfall 5.2 mm/day at the seedling stage (Table 1). Alternaria leaf spot increased progressively and reached its peak 31.8 per cent during the fifth meteorological week (Jan 30-Feb 5), with mean maximum temperature 30.5^{0}C, mean minimum temperature 17.7^{0}C, RH I 97.1 per cent, RH II 54.7 per cent, SSH 4.8 h/day, there was no rain fall at the boll maturity stage (Fig.1).

Significant negative correlation was observed for maximum temperature and

Table 1. Appearance and progress of Alternaria leaf spot in NA 1325 during *kharif* 2012-13

SW	Period	Phenological stage	Temperature (^{0}C)		Relative humidity (%)		Sun Shine (hr)	Rain-fall (mm)	Alter-naria leaf spot (PDI)
			Maxi-mum	Mini-mum	Morning	Evening			
32	8-14Aug	Germination stage	32.9	24.5	87.3	65.7	5.7	78.2	0.0
33	15 21Aug	Cotyledonary stage	33.9	24.9	88.7	62.0	6.2	12.2	0.0
34	22-28Aug	3 leaf stage	33.3	25.0	89.7	63.3	3.2	10.8	0.0
35	Aug 29-Sep 4	5 leaf stage	32.3	24.0	90.0	69.9	3.7	76.8	0.0
36	5-Sep11	7 leaf stage	32.6	25.8	86.9	69.4	3.2	1.4	0.0
37	12-18Sep	9 leaf stage	34.1	26.1	81.7	60.3	3.2	35.4	5.2
38	19-24Sep	9 leaf stage	31.7	23.5	94.7	75.4	4.4	95.2	7.2
39	Sep26-Oct 2	Primary branching stage	30.0	24.2	94.1	82.9	2.8	60.4	13.6
40	3-9Oct	Primary branching stage	33.4	24.2	90.4	57.1	5.0	6.0	12.2
41	10-16Oct	2 branching stage	32.2	23.4	87.6	61.6	7.3	21.4	15.0
42	17-23Oct	4 branching stage	30.4	22.3	95.6	72.7	4.7	30.2	15.2
43	24-30 Oct	4 branching stage	31.9	22.4	92.3	61.3	7.3	0.0	16.2
44	Oct 31 Nov 6	6 branching stage	28.5	20.7	94.7	85.1	1.9	210.6	16.4
45	7- 13 Nov	8 branching stage	30.6	20.0	94.9	55.7	7.6	0.0	16.6
46	14- 20 Nov	Initial flowering stage	30.4	15.8	84.9	45.4	8.7	0.0	22.0
47	21- 27 Nov	Flowering stage	30.8	21.2	95.1	65.9	4.5	0.0	23.0
48	Nov 28-Dec 4	Flowering stage	30.6	19.2	91.3	57.0	6.5	0.0	23.1
49	5- 11 Dec	Flowering stage	31.8	19.7	94.4	55.7	5.6	0.0	23.6
50	12- 18 Dec	Flowering stage	31.0	18.4	97.7	53.0	7.0	0.0	24.0
51	19- 25 Dec	Flowering stage	30.4	16.8	96.9	49.0	7.4	0.0	24.2
52	Dec 26-Jan 1	Boll formation stage	29.5	18.2	93.7	66.6	4.1	0.0	27.0
1	2-8 Jan	Boll formation stage	31.6	19.8	98.3	55.3	5.3	0.0	27.4
2	9-15 Jan	Boll formation stage	31.3	16.6	92.1	44.0	7.3	0.0	28.0
3	16-22 Jan	Boll maturity stage	30.9	17.1	98.0	49.3	7.6	0.0	28.4
4	23- 29 Jan	Boll maturity stage	30.8	18.4	97.3	54.7	6.1	0.0	30.0
5	Jan 30-Feb 5	Boll maturity stage	30.5	17.7	97.1	54.7	4.8	0.0	31.8
6	6- 12 Feb	Initial boll bursting stage	31.8	19.1	96.6	50.9	6.7	0.0	29.6
7	13- 19 Feb	Boll bursting stage	30.2	20.9	92.6	58.6	6.3	115.0	28.2
8	20- 26 Feb	Harvesting stage	32.0	19.2	96.7	54.6	7.8	0.0	27.0

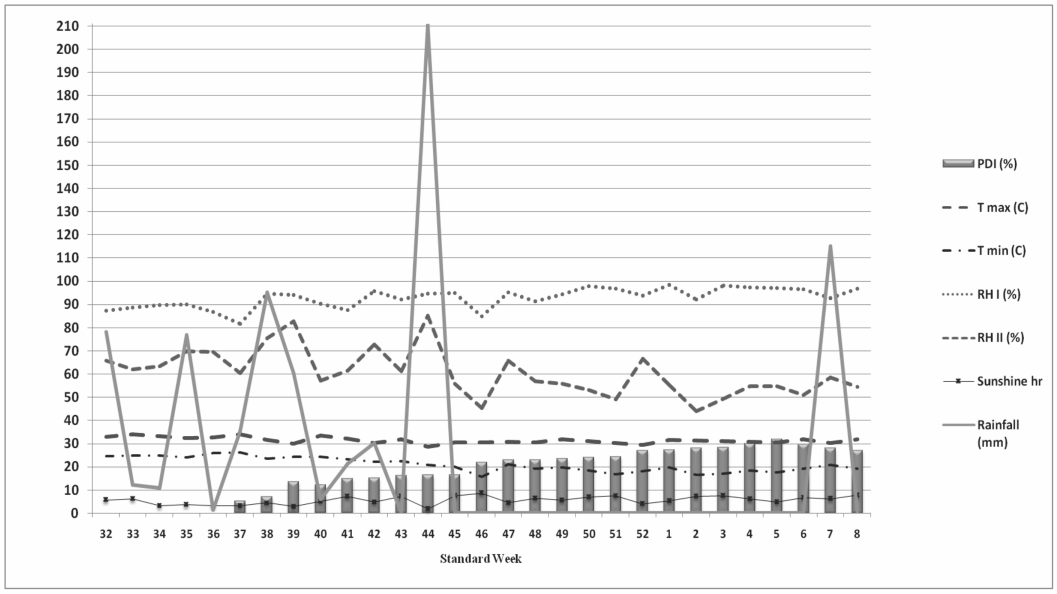

Fig. 1. Progress of Alternaria leaf spot in relation to weather factors along with the phenological stages of the crop

minimum temperature with PDI while morning relative humidity was positive and significantly correlated. Sunshine hours showed positive and significant correlation whereas negative and non significant correlation was obtained with rain fall during the period of study (Table 2). The data on per cent disease index was subjected to step up multiple linear regression analysis (Table 3) and the following equation was obtained:

Y=126.6 - 4.25 T max + 0.78 Morn RH - 0.68 Even RH.

The coefficient of determination (R^2) was 0.841, which showed that weather factors caused variation in per cent disease index to the extent of 84.1 per cent. It was also observed from the step up regression equation that among weather factors studied the partial regression coefficient (b) for morning relative humidity was significant and positively correlated (0.78) whereas maximum temperature (-4.25) and evening relative humidity (-0.68) had significant and negative correlation with per cent disease index. Therefore, it was evident that for every one per cent increase in morning relative humidity there was corresponding increase of 0.78 in percent disease index of Alternaria leaf spot, whereas one per cent increase in maximum temperature and evening relative humidity led to corresponding decrease in per cent disease index of Alternaria leaf spot of 4.25 per cent and 0.68 per cent, respectively.

Table 2. Correlation between Alternaria leaf spot and weather factors during *kharif*, 2012-2013

Variable	Correlation co-efficient (r)
X1 Maximum temperature (^{0}C)	-0.61*
X2 Minimum temperature (^{0}C)	-0.87*
X3 Morning relative humidity (%)	0.66*
X4 Evening relative humidity (%)	-0.53*
X5 Sunshine hours (hrs/day)	0.47*
X6 Rainfall (mm/day)	-0.29 NS

These results are in conformity with earlier reports. Singh and Ratnoo (2013) observed that 28.8 -31°C and 86 – 93 per cent RH were conducive for Alternaria leaf spot (*A, gossypina*). They also recorded negative correlation of PDI with minimum temperature and positive correlation with maximum RH. Temperature regime of 20 –30°C with prolonged high humidity (>80%) and frequent rains favoured *A. macrospora* infection and disease development in

Table 3. Multiple linear regression analysis of per cent disease index of Alternaria leaf spot and weather factors during *kharif*, 2012-2013

Variable	RegressionCo-efficient (b)	Standard error (E)	t-value
X1 Maximum temperature	-4.25*	2.04	-2.08
X2 Minimum temperature	-0.07	1.19	-0.06
X3 Morning relative humidity	0.78*	0.28	2.74
X4 Evening relative humidity	-0.68*	0.32	-2.13
X5 Sunshine hours	-0.77	0.86	-0.90
X6 Rainfall	-0.01	0.03	-0.21

Intercept (a) = 126.6 F cal value = 19.5 T tab value = 2.05
Per cent of variation attributable to the Regression (R^2) = 84.1 %
*Significant at 5% level NS - Non significant

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). Progress of Alternaria leaf spot in safflower was negatively correlated with maximum temperature, relative humidity (I & II) and positively correlated with minimum temperature and age of the crop. Receipt of rains coupled with high humidity above 90% and temperature in the range of 23 to 30°C triggered primary infection of the crop and rapid progress occurred as the plant matured. Present studies suggest preventive and / or protective measures with recommended fungicides like mancozeb and propiconazole against Alternaria leaf spot under the above mentioned weather conditions.

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