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Analysis of groundnut late leaf spot disease progress and it's severity in relation to weather parameters

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Abstract
An experiment was conducted to know the influence of different weather parameters on late leaf spot (LLS) of groundnut on susceptible genotype K-6 under different dates of sowing during *rabi* 2017-18 in sandy soil. Correlation studies between severity of late leaf spots and weather parameters during *rabi* 2017-18 revealed that age of the crop (r = 0.908*) and relative humidity at morning (r = 0.411*) were significant and positively correlated with PDI whereas maximum temperature (r = -0.385*), minimum temperature (r = -0.644*) and relative humidity at evening (r = -0.388*) were significant and negatively correlated with PDI. Regression analysis of LLS PDI with weather factors revealed that age of the crop and maximum temperature influenced the development of LLS in K-6 genotype in all three sowings. AUDPC values for LLS per cent disease severity revealed that the third sowing has low AUDPC value with less disease severity. Hence, during *rabi* late sowing is more preferred than early sowing.

Keywords: groundnut, late leaf spot, weather, disease severity

Introduction

Groundnut (*Arachis hypogaea*. L.]), is one of the world's major important leguminous oilseed crop belongs to the family Fabaceae. It was found to be originated in South America, where the genus *Arachis* is widely distributed. It is cultivated in more than 100 countries in six continents. China and India are the largest producers of groundnut. It is cultivated as *kharif* and *rabi* crop in India in an area of 4.60 M ha. With a production of 6.73 M t and productivity of 1465 kg ha^{-1}. Andhra Pradesh is one of the leading states of the crop with 0.75 M ha of area producing 0.80 M t with a productivity of 1034 kg ha^{-1} (Anon., 2018) [1].

It is very important cash crop for small scale farmers. Groundnut kernel has high protein (25-28 %) and oil content (43- 55%) (Naeem *et al*., 2009) [8]. The crop is mostly confined to countries located between 40^0 N and 40^0 S. It is grown in tropical and subtropical regions of the world. Groundnut grows best in light-textured, deep, well-drained soils with no hindrance to penetration of the sharp point of the peg (Tweneboah, 2000) [11]. India, losses in the yield of groundnut crop due to the leaf spots have been estimated to be in the range of 15 to 50% in major groundnut growing areas of India and Andhra Pradesh (Subrahmanyam *et al*., 1980) [10]. Late leaf spot (LLS) caused by *Phaeoisariopsis personata* (Berk. & Curt.) is more destructive and occurs late, *i.e.*, during flowering time and, causes severe defoliation and reduces both haulm and pod yields by more than 50% (McDonald *et al*., 1985) [6]. Several attempts have been made to control the disease by chemicals, but so far no meaningful control is achieved. Hence, studies on the weather factors in relation to disease development and understanding the mechanism of disease resistance is necessary.

Materials and methods

A field experiment was conducted in *rabi* 2017-18 to study the relationship between late leaf spot diseases of groundnut and weather parameters. Susceptible variety (K 6) was sown with three different dates of sowings each at ten days interval. The severity of leaf spots was recorded (1-9 scale) in 10 quadrats (5 m x 5 m) at five day interval commencing from the first appearance of disease up to ten days before harvesting. Meteorological data such as rainfall, maximum temperature, minimum temperature, morning relative humidity and evening relative humidity, wind velocity, sunshine hours (h/day) and age of the crop were collected from the Meteorological Station located at Agricultural College Farm, Bapatla. Correlation and regression analyses were performed to determine the influence of weather conditions on the severity of late leaf spots of groundnut. Per cent disease index was calculated based on the standard 1-9 point scale (Subrahmanyam *et al*., 1995) [9] however the scale was modified by subtracting -1 as a common factor for all the numerical scale values in order to obtain 0 % PDI for no disease instead of 11.1 % PDI on 1-9 scale and PDI values were calculated based on the following formula.

$$PDI = \frac{[x_1(1-1) + x_2(2-1) + \ldots + x_9(9-1)]}{N \times (9-1)} \times 100$$

Where, x is number of samples in each score and N is the total samples scored Correlation and regression analysis was performed by following Gomez and Gomez (1984) [5].Disease severity was correlated with weather parameters. Area Under Disease Progress Curve (AUDPC) was be calculated for K-6 genotype in all three sowings by using the formula as suggested by Wilcoxson *et al.* (1975) [12].

$$AUDPC = \sum_{i=1}^{K} \frac{1}{2}(S_i + S_{i-1}) \times d$$

Where,
Si = Disease incidence at i^{th} day of evaluation,
K= Number of successive evaluation of the disease,
d= Interval between i and i-1 evaluation of disease
The data obtained from all the experiments were statistically analyzed following the standard procedures (Gomez and Gomez, 1984) [5].

Results and discussion

Correlation studies were undertaken at Agricultural College Farm, Bapatla to study the relationship between PDI of late leaf spot of groundnut in relation to weather parameters during *rabi* 2017-18. The data on the weather parameters *viz.*, maximum temperature (^{0}C), minimum temperature (^{0}C), rainfall (mm), relative humidity (R.H. % 8.30 A.M.) and relative humidity (R.H. % 5.30 P.M.), sunshine hours and wind speed (kmph) were recorded at every five days interval up to 10 days before harvesting. Late leaf spot disease on groundnut was first observed on 20.11.17 with severity of 5.8% when the corresponding mean of age of the crop, maximum temperature, minimum temperature, R.H at A.M, at P.M, sunshine hours, rainfall and wind velocity were 40 days, 32.3 ^{0}C, 23.4 ^{0}C, 85%, 75.8%, 6.6 h/day, 21.00 mm and 2.1 kmph respectively. The disease has progressed with the age of the crop from the initiation to harvesting in all different dates of sowings. In the first date of sowing (11.10.2017), the severity varied between 5.8 – 92.8, 4.0 – 91.7, in second date of sowing (21.10.2017) and 4.7 – 83.4 in third date of sowing (31.10.2017) (Table 1). Maximum severity was observed with first date of sowing 92.8 % (09.01.2018) as the mean temperature during crop growth was highest (31.06 ^{0}C) among three dates of sowing. This is in accordance with the reports made by Yang *et al*. (2001) [13] that warm weather has been found to be associated with epidemics of *Cercospora* leaf spot of soyabean and found that, there was <50 per cent disease severity early in the season and reached to 70 per cent and more at the end of the season.

Table 1: Disease first occurrence, crop and terminal disease severity of late leaf spot of groundnut in each date of sowing

S. No.	Date of sowing	Date of first observation of disease	Age of the crop	Terminal disease severity of late leaf spot (PDI)
1	11.10.2017	20.11.2017	40 DAS	92.83
2	21.10.2017	30.11.2017	40 DAS	91.69
3	31.10.2017	25.12.2017	55 DAS	83.36

Among the studied weather parameters, age of the crop (r = 0.908*) and relative humidity at morning (r = 0.411*) were significant and positively correlated with PDI whereas maximum temperature (r = -0.385*), minimum temperature (r = -0.644*) and relative humidity at evening (r = -0.388*) were significant and negatively correlated with PDI and there was non-significant negative correlation with rainfall (r = -0.247) and sunshine hours (r = -0.039) and wind velocity (r = -0.016) (Table 2, Fig. 1)
Bhavani *et al*. (2018) [3] conducted weather based experiments on late leaf spot of groundnut in different cultivars and reported that PDI of K-6 showed significant negative correlation with minimum temperature (r = -0.819*).

Table 2: Correlation studies between groundnut late leaf spot and weather factors 2017-2018

Variable	Correlation co-efficient "r"
X_1 Age of the crop (days)	0.908^{**}
X_2 Maximum temperature (^{0}C)	-0.385^{**}
X_3 Minimum temperature (^{0}C)	-0.644^{**}
X_4 Relative humidity at AM (%)	0.411^{**}
X_5 Relative humidity at PM (%)	-0.388^{**}
X_6 Sunshine hours (h)	-0.039^{NS}
X_7 Rainfall (mm)	-0.247^{NS}
X_8 Wind velocity (Kmph)	-0.016^{NS}

**Significant at 1% level N=48 r tab= 0.372 NS=Non-Significant

The data on per cent disease index was subjected to multiple linear regression (MLR) and correlation with weather variables. Regression analysis were performed with LLS severity as dependent variable, and maximum temperature, minimum temperature, morning relative humidity, and evening relative humidity, rainfall, sunshine hours and wind speed as independent variables. Stepwise multiple regression analysis was performed using the following equation:

y =bo + b1x1 + b2x2+ b3x3……………………… + bnxn

Where y = per cent disease index. The results were presented in the Table 3 and 4

Table 3: Regression studies between weather variables and severity of late leaf spot in groundnut during *rabi*, 2017-2018

S. No.	Regression equation	F value	Standard Error	R^2
1	Y= -110.33+1.635X1-0.616X2+5.251X3-0.006X4-0.395X5+1.446X6-0.503X7-0.4268X8	28.418	13.773	0.853
2	Y= -118.930+1.618X1-0.767X2+5.173X3+0.108X4-0.401X5+0.984X6-0.487X7	32.668	13.714	0.851
3	Y= -77.237+1.596X1-1.422X2+4.790X3+0.030X4-0.462X5+0.356X6	38.058	13.697	0.848
4	Y= -69.359+1.592X1-1.614X2+4.748X3+0.020X4-0.435X5	46.713	13.541	0.848
5	Y= -85.573+1.551X1-0.814X2+3.303X3-0.053X4	58.136	13.542	0.844
6	Y= -89.999+1.546X1-0.802X2+3.289X3	79.304	13.388	0.844
7	Y= -138.043+1.3444X1+3.126X2	110.724	13.771	0.831
8	Y= -37.784+1.278X1	216.259	13.880	0.825

Table 4: Regression studies between weather variables and severity of LLS during *rabi* 2107-18

S. No.	Variables	Partial regression Coefficients (b)	Standard Error (E)	P value
Y	LLS (PDI)			
X_1	Age of the crop (days)	1.278	0.087	0.000
X_2	Maximum temperature (°C)	3.126	2.374	0.194

*Significant at $p \leq 0.05$ Intercept (a) = -138.043 N=48

X1=Age of the crop X2= Maximum temperature X3= Minimum temperature
X4= Morning relative humidity X5= Evening relative humidity X6=Sunshine hours
X7= Wind speed X8= Rainfall

Multiple regression analysis yielded eight distinct equations for late leaf spot severity with R^2 values ranging from 0.853 to 0.825 ($P \leq 0.05$). However, the best fit equation was obtained with age of the crop and maximum temperature as independent variables (equation 7).

Y= -138.043+1.3444 (age of the crop) +3.126 (maximum temperature)

N = 48 R^2 = 0.831 F value = 110.72 Standard error = 13.77
* Significant at 5%

The results revealed that age of the crop, maximum temperature alone showed 83.1 % role for LLS severity in equation 7, where as in equation 1 all the independent factors were contributing 85.3 % role for disease severity. Regression analysis of LLS PDI with weather factors revealed that age of the crop and maximum temperature influenced the development of LLS in K-6 genotype in all three sowings. Results were in accordance with the reports made by Bhavani *et al.* (2017) [2] that maximum temperature influenced the development of LLS disease of groundnut. Mukundraj and Shanta (2010) [7] reported that the age of the plant determined the susceptibility of the plant.

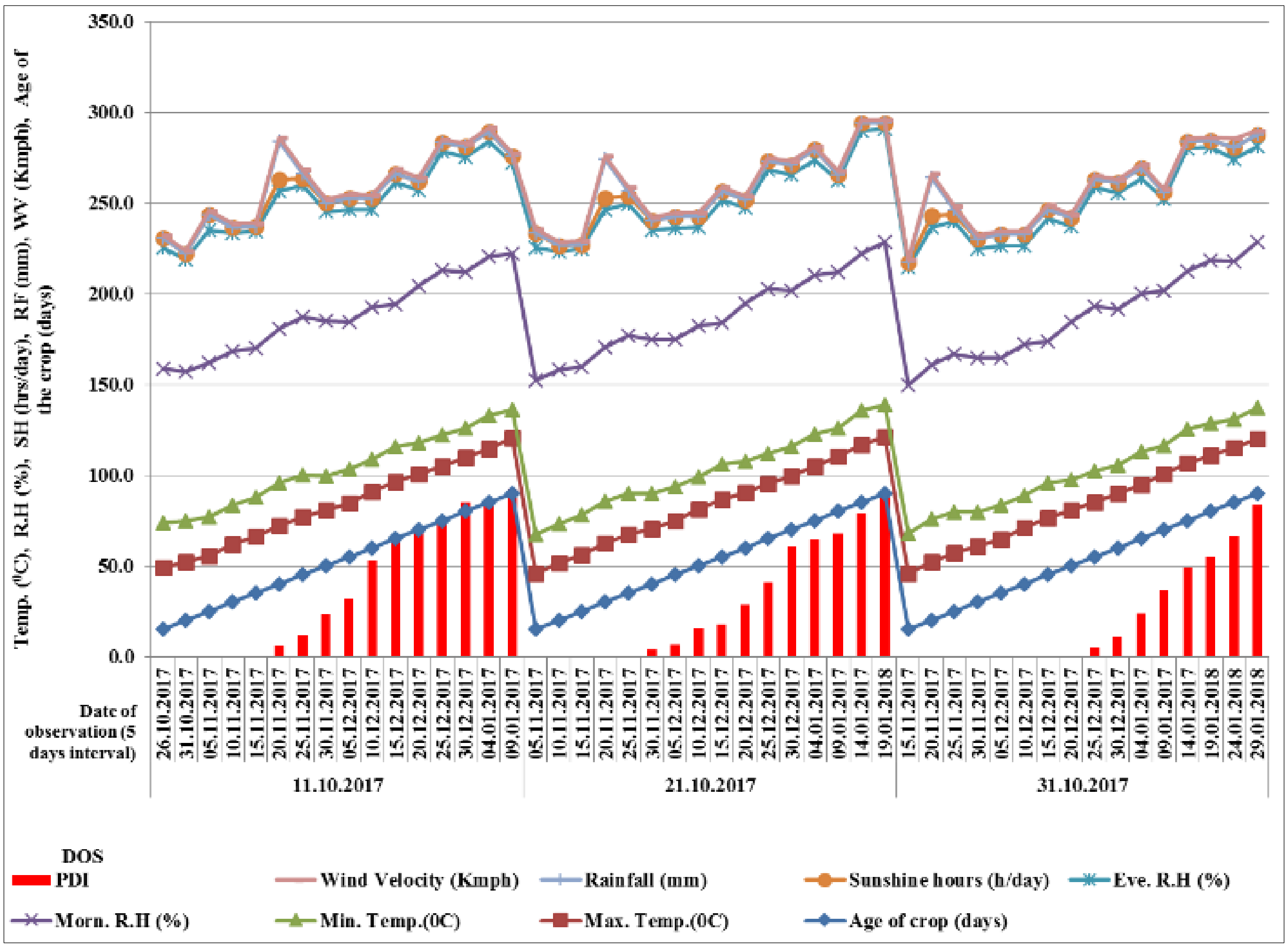

Fig 1: Dynamics of late leaf spot of groundnut with weather parameters in different dates of sowing during *rabi* 2017-18

Audpc (Area Under Disease Progress Curve) Of Late Leaf Disease

In this study AUDPC values were calculated for LLS per cent disease severity recorded at five days interval for three sowings and the results are furnished in the (Table 5, Fig. 2) by following (Wilcoxson *et al.*, 1975) [12]. These results revealed that the third sowing has low AUDPC (2,012.57) value is with less disease severity and first sowing recorded high AUDPC value (3,878.74) with high disease severity.

So, during *rabi* late sowing was more preferred than early sowing.

The results are in agreement with Dandnaik *et al.* (1996) [4] reported that in post rainy seasons the severity of leaf spot shows decreasing trend with successive delay in planting dates.

Table 5: AUDPC values of late leaf spot of groundnut in different sowings

Sowings	Audpc Values
1st SOWING	3,878.74
2nd SOWING	3,024.04
3rd SOWING	2,012.57

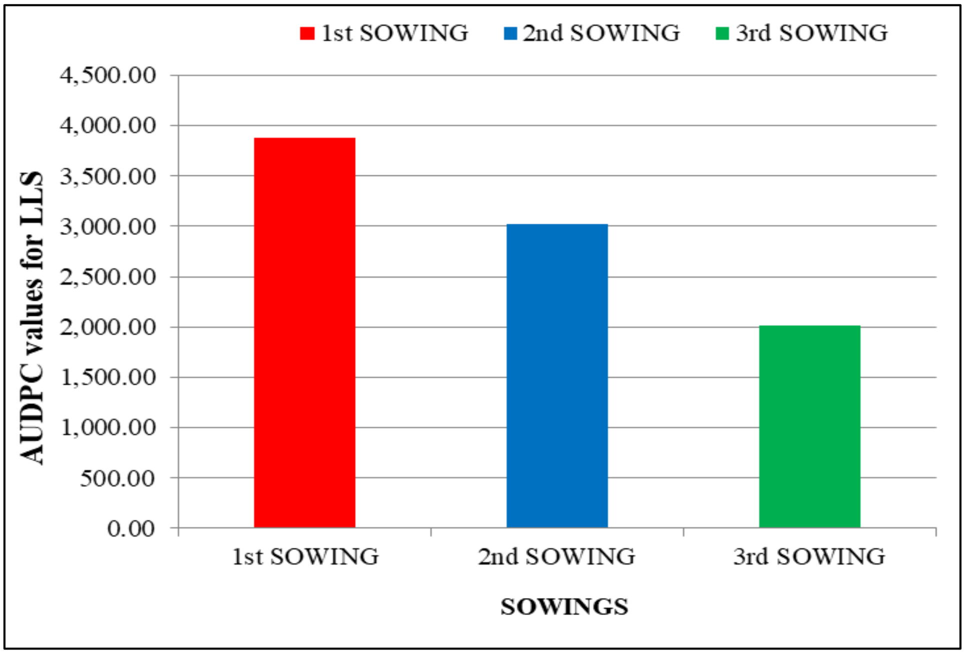

Fig 2: AUDPC of LLS showing differential reaction in different sowings during *rabi* 2017-18

Conclusion

This research documented that leaf spot disease is widespread and uniform in blackgram fields. The information generated through this study could help the blackgram growers regarding disease management and selection of resistant cultivars, improving profitability and achieving food security. The outcome of the current endeavor clearly indicated the prospects of characterization to design the specific diagnostic tools and also to design regional specific management practices.

This research documented that age of the crop (r = 0.908*) and relative humidity at morning (r = 0.411*) were significant and positively correlated with PDI whereas maximum temperature (r = -0.385*), minimum temperature (r = -0.644*) and relative humidity at evening (r = -0.388*) were significant and negatively correlated with PDI. Regression analysis of LLS PDI with weather factors revealed that age of the crop and maximum temperature influenced the development of LLS in K-6 genotype in all three sowings. AUDPC values for LLS per cent disease severity revealed that the third sowing has low AUDPC value with less disease severity. Hence, late sowing during *rabi* is more preferred than early sowing to escape from the disease attack. The information generated through this study could help the groundnut growers regarding disease management and selection of cultivars, improving profitability and achieving food security.

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