Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; Sp 9(5): 577-581
Received: 02-07-2020
Accepted: 05-08-2020

Vyavhare YV
Ph. D Scholar, Department of Plant Pathology, Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahmednagar, Maharashtra, India

Mane SS
Ph. D Scholar, Department of Plant Pathology, Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahmednagar, Maharashtra, India

Khaire PB
Ph. D Scholar, Department of Plant Pathology, Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahmednagar, Maharashtra, India

Joshi MS
Professor, Department of Plant Pathology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, District Ratnagiri, Maharashtra, India

Corresponding Author:
Vyavhare YV
Ph. D Scholar, Department of Plant Pathology, Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahmednagar, Maharashtra, India

Epidemiological studies on foliar diseases of groundnut in Konkan region

Vyavhare YV, Mane SS, Khaire PB and Joshi MS

Abstract
Groundnut (*Arachis hypogia* L.) is the thirteenth most important crop plant grown for food in the tropical, subtropical, and temperate zones of the world. It is extensively grown in India. A foliar disease of groundnut is one of the important factors limiting groundnut productivity in India. In the course of Kharif, 2010, early leaf spot progress was highly influenced by average temperature and crop age and, for late-leaf growth, maximum and crop age were very advantageous for epidemiologic studies on the early, late spot and rust disease with respect to weather parameters. Moreover, the evaporation rate and crop age played a predominant role in rust development in groundnut under Dapoli conditions. The correlation studies between pod yield with early, late leaf spots and rust diseases showed that pod yield is positively correlated with the haulm yield, whereas negatively correlated with early leaf spot, late leaf spot, and rust diseases indicating that these diseases collectively influence the yield and hence timely control of these diseases is essential.

Keywords: epidemiological studies, foliar, diseases, groundnut, Konkan region

1. Introduction

Groundnut (*Arachis hypogia* L.) is the thirteenth most important crop plant grown for food in the tropical, subtropical, and temperate zones of the world. In India, China, the USA, Nigeria, and Western Africa it has been cultivated extensively (Mangelesdrof, 1961) [16]. It is a prime oily seed crop in India, which covers some 28% of the region covered by oilseed and contributes 25.4% of the overall production of oilseeds. India is the world's largest soil nut producer with an average area of 38, 16% and 32, 01%, while it is the eighth largest producer in the world (Anonymous, 2002a) [1]. The area under kharif groundnut in Maharashtra was 3.47 lakh hectares with a production of 3.59 lakh tonnes. The average productivity was 1035 kg/ha while in the rabi season, the crop occupied an area of 0.69 lakh hectares with 1.00 lakh tones of production and productivity of 1444 kg/ha (Anonymous, 2002a) [1]. Even though the groundnut is not a traditional crop of the Konkan region, it is very popular amongst the farmers of this region being a commercial crop. Groundnut is successfully grown in the Konkan region in both Kharif and Rabi seasons. The area under groundnut in the Konkan region is 0.019 lakh hectares with 0.016 lakh tonnes of production and productivity of 842 kg/ha in kharif season. In rabi season area under the crop is 0.041 lakh hectares with 0.089 lakh tonnes of production and productivity of 2171 kg/ha (Patil, 2006) [19].

The oil content of groundnuts is about 40 to 54% and the protein content ranges from 22 to 32% depending on the variety. It's a decent source of vitamins. A, B, B2, E. It has many commercial applications. Being a legume, it is valued for its nitrogen-fixing ability and is an important component in many crop rotation activities. Nimbiar *et al*. (1980) [18] calculated that the yield per hectare of groundnut pod is approximately 3.5 tonnes, with a fixing power of approximately 190 kg N / ha. Occurrence of several diseases, during different phases of crop growth, poses a major threat to its productivity. Tirmali (2001) [21] reported three foliar diseases *viz*. ELS (*Cercospora arachidicola* Hori), LLS (*Phaeoisariopsis personata* (Berk and Curt.)), and Rust (*Puccinia arachidis* Speg.) are responsible for the low productivity of the crop under Konkan conditions. The three foliar diseases are largely airborne in nature and occur in an outbreak manner (Mayee, 1986) [15]. Epidemics of these soil diseases are heavily affected by predominant environmental variables such as temperature, relative humidity, wind speed, etc. during the different stages of crop development. It is therefore deemed important to compare the weather parameters with the production of disease during crop growth in order to forecast the weather-based alert system. The key purpose of this research was to examine the growth period of plants and diseases at the leaf, plant and population levels. A comparison of the level of plant and disease development has enabled the timing of the time of extreme disease production in relation to the stage of plant production.

2 Materials and Methods

2.1 Weather relationship of foliar diseases of groundnut.

2.1.1 Correlation and regression analysis

Methodology

The susceptible groundnut cv. `Konkan Gaurav' was sown in the Kharif season of 2010 at Agronomy farm, College of Agriculture, Dapoli on an area of 10 R near by the meteorological observatory. All standard and recommended packages of practices were followed except fungicide application to record the disease severity for each disease (ELS, LSS & Rust). The crop was regularly observed for initiation of disease symptoms. Fifty plants were randomly tagged separately for each disease for recording observations on disease severity. These observations were recorded at weekly interval separately for each disease throughout the cropping period. The weekly percent disease intensity was calculated as mentioned above.

The weather parameters *viz*. maximum temperature, minimum temperature, mean temperature, relative humidity I, relative humidity II, average rainfall, evaporation and wind velocity were recorded daily and weekly average values of each parameter were calculated. Correlation and regression analysis was carried out by following the standard statistical method. All the weather parameters and crop age were taken as independent variables (X) and the amount of disease as dependant variables (ELS as Y1, LSS as Y2 and rust as Y3). Stepwise multiple regression analysis was also carried out.

The linear prediction equation used was:

$$y=b0+b1x1+b2x2\ldots\ldots\ldots\ldots\ldots bnxn$$

Where,

y = Predicted disease severity
bo =Intercept
b1 b2….bn=regression coefficients
x1 x2....xn=independents variables

The goodness of fit of multiple regression models was evaluated by the coefficient of multiple determination (R2), correlation coefficient (r), regression coefficient (b), test for significance of regression coefficients, standard error (S.E.), residual sum of squares (RSS) as suggested by Madden (1986) and Cornell and Berger (1987) [8].

2.1.2 Method of recording observations

Eight plants per treatment per replication were randomly selected for recording disease incidence for early leaf spot (ELS), late leaf spot (LLS) and rust separately at the start of the experiment for recording observations.

2.2 Apparent infection rate

Development of foliar diseases was influenced by variation in weather conditions as evidenced by variation in disease severity. The disease severity was recorded using 0 to 9 scales as described for a survey of the disease at seven days interval after the first appearance of the disease and continued till weather conditions become unfavorable for further development of the disease. The severities recorded at different intervals were converted into apparent infection rates (r) according to Vanderplank (1963) as follows:

$$r = \frac{1}{t_2 - t_1}\left(\log_e \frac{X_2}{1 - X_2} - \log_e \frac{X_1}{1 - X_1}\right)$$

Where X1 and X2 are the proportions of infected tissue on dates ti and t2

2.3 Per cent disease intensity (PDI)

The per cent disease intensity was computed by the formula given by McKinney (1923).

$$\text{PDI} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of leaves examined X Maximum rating}} \text{x } 100$$

2.4 Per cent disease control (PDC)

The per cent disease control was calculated by using the formula given below:

$$\text{PDI} = \frac{\text{PDI in control} - \text{PDI in treatment}}{\text{PDI in control}} \text{x } 100$$

2.5 Harvesting

For recording pod and haulm yields, different plots were harvested separately and their dry weights were recorded.

3 Results

3.1 Effect of weather factors and crop age on the development of ELS, LLS and rust

The weather is a major decisive factor in development and spread of airborne fungal diseases. Knowledge of the predisposing factors for disease development can be used for delimiting risky zones and periods for the disease in question and for organizing a meteorological disease forecasting service. Symptoms of early leaf spot were first observed at 31st meteorological week. Intensity decreased in the 32nd meteorological week and then increased from 36th meteorological week. From 36th meteorological week onwards, there was rapid increase in the intensity of early leaf spot (ELS) and it reached at its maximum (55.77 per cent) during 43rd meteorological week.

The symptoms of late leaf spot (LLS) appeared during 38th meteorological week. From 39th meteorological week onwards, there was rapid increase in the intensity of late leaf spots (LLS) which reached its maximum (42.15 per cent) during 43rd meteorological week.

The symptoms of rust were observed quite late during 41st meteorological week. From 42nd meteorological week onwards, there were rapid increases in the intensity of rust which reached to its peak (50.28 per cent) during 43rd meteorological week when crop was in harvesting stage.

3.2 Epidemic growth of Early Leaf spot, Late Leaf Spot and Rust

It is seen from the data (Table 1) that the initiation of the ELS was noticed at 31st meteorological week. The Apparent Infection Rate (AIR) was 0.0823 in 33rdmeteorological week (3rd Week of August) which gradually declined to 0.0328 and 0.0271 in 34th and 35th meteorological weeks respectively. Then it increased to 0.0385 in 36th meteorological week. The rate of infection was almost constant during 34th to 41st metrological week ranging between 0.02 to 0.04. This indicated that, the ELS infectivity is almost constant at flowering and pod development stage.It could be seen from the data that the initiation of the LLS was noticed at 38th meteorological week.

Thereafter, the apparent infection rate (0.1330) increased in 40th meteorological week (1st Week of October) reaching at its peak. After that, there was decline in AIR in 41st and 42nd meteorological weeks respectively. It is apparent from the data (Table 1) that the initiation of the rust was noticed quite late in the 41st meteorological week. Thereafter the apparent infection rate (AIR) increased to 0.1056 in 42nd meteorological week (3rd Week of October).

3.3 Correlation studies

The correlation analysis for LLS revealed that there was significant positive correlation with maximum temperature (ryX1=0.8044) (26.30-32^0 C), mean temperature (ryX3=0.7162) (24.30-27.4^0 C), relative humidity I (ryX4=0.1105) (94-98%), sunshine (ryX8=0.7035) (0.2-7hrs/day), evaporation (ryX9=0.3933) (0.5-3.6mm) and crop age (ryX11=0.8038) (1-126days) with LSS (Y2). However, there was significant negative correlation with minimum temperature (ryX2=0.3916) (21.20–23.7^0 C), relative humidity II (ryX5=0.5114) (75-97%), mean relative humidity (ryX6=0.5006) (86-96.5%), wind speed (ryX7=0.5567) (2.5-9.6km/hr) and rainfall (ryX10=0.5797) (7-590.4mm).

The correlation studies of rust revealed that there was significant positive correlation with maximum temperature (ryX1=0.5154) (26.30-32^0 C), mean temperature (ryX3=0.4065) (24.30-27.4^0 C), relative humidity I (ryX4=0.1453) (94-98%), sunshine (ryX8=0.3859) (0.2-7hrs/day), evaporation (ryX9=0.1503) (0.5-3.6mm) and crop age (ryX11=0.6245) (1-126days) with rust development (Y3). However, there were significant negative correlation with minimum temperature (ryX2=0.4006) (21.20–23.7^0 C), relative humidity II (ryX5=0.2273) (75-97%), mean relative humidity (ryX6=0.2073) (86-96.5%), wind speed (ryX7=0.4021) (2.5-9.6km/hr) and rainfall (ryX10=-0.4435) (7- 590.4mm).

It is revealed from Table 1 that out of 11 variables maximum temperature, mean temperature. RH-1, sunshine, evaporation and crop age has significantly positive correlation with all the three diseases. Whereas, minimum temperature, relative humidity-I, mean relative humidity wind speed and rainfall had significantly negative correlation with the disease under study.

Table 1: Correlation between weather parameters, crop age and intensity of early leaf spot (ELS), late leaf spot (LLS) and rust diseases of groundnut during Kharif, 2010.

Variables	Max. temp	Min. temp	Mean temp	RH-I	RH-II	Mean RH	Wind speed	Sun shine	Evapo Ration	Rain fall	Crop age	PDI		
												ELS	LLS	Rust
Max. temp	-	-0.333	+0.944	+0.026	-0.730	-0.735	-0.656	+0.780	+0.453	-0.563	+0.783	+0.799**	+0.804**	+0.515*
Min. temp	-	-	-0.003	-0.200	+0.148	+0.119	+0.343	-0.226	-0.286	+0.181	-0.515	-0.785**	-0.391	-0.400
Mean. temp	-	-	-	-0.042	-0.722	-0.738	-0.576	+0.749	+0.381	-0.534	+0.651	+0.778**	+0.716**	+0.406
RH-I	-	-	-	-	-0.161	-0.004	-0.312	-0.056	+0.296	-0.117	+0.245	+0.302	+0.110	+0.145
RH-II	-	-	-	-	-	+0.987	+0.612	-0.699	-0.650	+0.450	-0.362	-0.460*	-0.511*	-0.227
Mean –RH	-	-	-	-	-	-	+0.571	-0.717	-0.611	+0.438	-0.328	-0.418	-0.500*	-0.207
Wind speed	-	-	-	-	-	-	-	-0.592	-0.530	-0.690	-0.583	-0.620**	-0.556*	-0.402
Sunshine	-	-	-	-	-	-	-	-	+0.702	-0.717	+0.672	+0.706**	+0.703**	+0.385
Evaporation	-	-	-	-	-	-	-	-	-	-0.656	+0.470	+0.591**	+0.393	+0.150
Rainfall	-	-	-	-	-	-	-	-	-	-	-0.625	-0.661**	-0.579**	-0.443
Crop age	-	-	-	-	-	-	-	-	-	-	-	+0.982**	+0.803**	+0.624**

3.4 Multiple regression analysis

Out of eleven independent variables, development of ELS was dependant significantly on evaporation (X9) which had 99 per cent role in the disease development. The development of LLS was dependant on sunshine (X8) and crop age (X11). All the weather parameters (X1 to X11) played 75 per cent role in late leaf spot development. The development of rust intensity was depended on crop age (X11). All the weather parameters (X1 to X11) had 50 per cent role in rust development in groundnut during kharif 2010.

Table 2: Multiple regression results for ELS

Source of variation	Degree of freedom	Sum of squares	Mean sum of squares	F-ratio	F- probability
Regression	11	5401.568	491.05	156.42	1.000
Residual	9	34.5309	3.836		
Total	20	5636.099			

Table 3: Multiple regression results for LLS

Source of variation	Degree of freedom	Sum of squares	Mean sum of squares	F-ratio	F-Probability
Regression	11	2662.9	242.08	3.115	1.000
Residual	9	854.73	94.96		
Total	20	3517.63			

Table 4: Multiple regression results for Rust

Source of variation	Degree of freedom	Sum of squares	Mean sum of squares	F-ratio	F-probability
Regression	11	1656.05	145.91	1.0244	1.00
Residual	9	1566.80	174.08		
Total	20	3171.86			

4 Discussion

4.1 Epidemiological studies

Over all weather conditions during cropping period were maximum air temperature (26.30-320^0 C), minimum air temperature (17.40–250^0 C), mean air temperature (24.30-27.40^0 C), relative humidity I (94-98%), relative humidity II (61.5–95.2%), mean relative humidity (78.5 – 95.6%), wind velocity (2.3-11.3km/hr), sunshine hrs (0.2-7hrs/day), evaporation (0.5-3.6mm) and rainfall (7-590.4mm). Under these conditions the severity of ELS, LSS and rust was 55.77, 42.16 and 50.28 per cent respectively. Hazarika *et al*. (2000) [11] also found that optimum temperature (28.30 and 28.60^0 C), high relative humidity (97.2 and 98.5%) and high rainfall (9.5

and 11.7mm) during the rainy season were favorable for development of leaf spot and rust diseases.

The progressive disease development of early leaf spot was observed from 31st meteorological week to 43rd meteorological week with the terminal severity of 55.77 per cent. There was slight fluctuation in the weekly apparent infection rate (AIR). However, the rate of infection was almost constant during 34th to 41st metrological weeks which ranged between 0.02 and 0.04. This indicated that once there is establishment of primary infection in the crop the disease progresses with time and age of the crop under favourable weather conditions. Development of late leaf spot initiated in the 38th meteorological week. Thereafter, there was linear increase in disease severity, which reached at its peak (42.15%) in 43rd meteorological week. The disease development coincided with the pod development stage of the crop. Anonymous (1990) [3] studied correlation between various weather parameters, crop age, leaf spots and rust severity and reported that maximum temperature (250_350^0 C), minimum temperature (170_230^0 C), mean temperature (260_300^0 C) and relative humidity between 60 to 70 per cent were most congenial for development and spread of both the diseases during peg formation to pod maturity.

In the present investigation, there was significant positive correlation between maximum temperature, mean temperature, relative humidity I, sunshine period, evaporation and crop age with development of ELS and LSS. The maximum temperature ranged between 26.30-320^0 C, mean temperature between 25.10-27.50^0 C, relative humidity I between 94-98 per cent, sunshine period between 0.2-7hrs/day, evaporation between (0.5-3.6mm/day) and crop age was 1-126 days. These findings partially agree with Lakshmi *et al*. (2010) [12] who stated that there is significant positive correlation between ELS and LSS development with maximum temperature, mean temperature, sunshine hrs, evaporation and crop age. However, they found that humidity was not a contributing factor. Narayana (2004) [17] also reported significant positive correlation between early, late leaf spot and rust incidence with maximum temperature, mean temperature, relative humidity I, sunshine hrs, evaporation and crop age.

During present investigation minimum temperature, relative humidity-II, mean relative humidity, wind speed and rainfall was negatively correlated with early, late leaf spot and rust incidence. The minimum temperature ranged between (21.20-23.70^0 C), relative humidity II ranged between (75-97%), mean relative humidity ranged between (86-96.5%), wind speed ranged between (2.5-9.6km/hr) and rainfall ranged between (0-38.02cm). Narayana 2004 [17] also found significant negative correlation between early and late leaf spot and rust incidence with minimum temperature, relative humidity-II, mean relative humidity, wind speed and Rainfall. Further, Benagi *et al*. (1998) [6] also reported that disease severity of LSS was negatively correlated with minimum temperature, relative humidity and rainfall under Karnataka conditions. Gulgunde and Kurundkar (2002) [10] reported similar trend of negative correlation between minimum temperature, humidity I and humidity II with ELS and LSS development.

In present studies, the rust infection was observed at pod maturity stage. However, the correlation and regression analysis studies between weather factors and rust incidence indicated that an increase in evaporation rate (X9) by one unit reduces rust by 3.07 percent whereas crop age (X11) increases rust severity by 0.240 percent. The results of stepwise regression analysis revealed that the contribution of other weather factors in rust development was non-significant. These findings do not agree with Lakshmi *et al*. (2010) [12] who recorded significant effect of evaporation on rust development. Although, the weather relationship and regression studies for development of ELS, LSS and rust were worked out, it is a mere indication that needs to be studied further for a period of 5 years to develop an efficient forecasting model. The present investigation is the first step in this direction.

In the present investigation, disease prediction model obtained for early leaf spot is Y1= -40.55+1.362X3 + 0.415X11, for late leaf spot Y2 = -102.098 + 3.4888 X1 + 0.1598X11 and Rust is Y3 =-2.30-3.07X9 + 0.240X11. Similar type of disease prediction model was put forth by Lakshmi *et al.* (2010) [12] for leaf spot and rust of groundnut. In which, for leaf spot Y = -197.12 + 8.56 X1 + 7.32 X3 + 0.20 X11 and for rust Y = -345.16+ 0.41 X11 + 4.80 X9.

5 References

1. Anonymous 2002a. Agricultural Statistics. http://agri.Mah.nic.in.
2. Anonymous: NATP Mission Mode Research Project on Development of weather based forewarning systems for crop pests and diseases. AICRP on Agrometeorology, CRIDA, Hyderabad, 2002b, 9 -10.
3. Anonymous: Research Council Meeting, Plant Protection Sub-committee, Irrigation Research Scheme, Wakawali, 1990.
4. Adiver SS, Anahosur KH, Giriraj K, Naik SI. Forecasting studies for foliar diseases of groundnut (*Arachis hypogaea* L.). Karnataka J Agric. Sci 1998;11(1):96-99.
5. Alderman SC, Nutter FW. Effect of temperature and relative humidity on development of *Cercosporidium personatum* on peanut in Georgia. Plant Dis 1994;78:690-694.
6. Benagi VJ, Advani MR, Srikant Kulkarni, Kulkarni S. Epidemiological factors in relation to development and prediction of late leaf spot of groundnut. Karnataka J Agri. Sci 1998;11(3):679-683.
7. Bulbule SV, Mayee CD. Influence of weather parameters on pattern of Uredospores of Groundnut Rust. J Mycol. Pl. Pathol 1997;27(2):172-174.
8. Cornell JA, Berger BD. Factors that influence the value of coefficient of determimation in simple linear and non-linear regression models. Phytopathology 1987;77:63-70.
9. Dubey SC. Role of weather on development of cercosporaleaf spot (*Cercospora arachidicola*) on groundnut (*Arachis hypogaea*). Indian Journal of Agricultural Sciences 2005;75(4):232-234.
10. Galgunde LP, Kurundkar BP. Occurrence of groundnut diseases as influenced by weather parameters in rabi crop. J Maharashtra Agri. Univ 2002;27(1):113.
11. Hazarika DK, Dubey LN, Das KK. Effect of sowing dates weather factors on development of Leaf spots and rust of Groundnut. J Mycol. Pl. Pathol 2000;30(1):27-30.
12. Lakshmi KV, Reddy DR, Verma NR. Weather based pest and Disease Forewarning Model in Groundnut. Indian J Plant Prot 2010;38(1):20-30.
13. Lokhande NM, Newaskar VB, Lanjewar RD. Epidemiology and forecasting of leaf rust of groundnut. J Soils and Crops 1998;8(2):216-218.
14. Lokhande NM, Newaskar VB, Lanjewar RD. Epidemiology and forecasting of leaf rust of groundnut. J Soils and Crops 1998;8(2):216-218.

15. Mayee CD, Datar VV. Phytopathometry, Marathwada Agricultural University, Parbhani 1986,198-199.
16. Mangelesdrof PC. Biology, food and people. Economic Botany 1961;15:279-288.
17. Narayana L. Studies on Groundnut early and late leaf spots and rust severity correlated with weather parameters. M.Sc. Thesis (Unpbl.), Dr. B.S.K.K.V., Dapoli (M.S.), 2004.
18. Nimbiar PT, Rego TJ, Shrinivas RB. Comparison of the requirements and utilization of nitrogen by genotypes of sorghum and nodulating and no nodulating groundnut field. Crop Res 1986:15:165-179.
19. Patil AJ. Research review report on oil seed crops presented in Joint Agresco, 2006 held at Dr. B.S.K.K.V., Dapoli, 2006.
20. Srikanta Das, Raj SK, Das S. Comparison between logistic and Gompertz equations for predicting groundnut rust epidemic. Indian Phytopath 2000;53(1):71-75.
21. Tirmali AM, Pawar DR. Efficacy of different fungicides against rust disease of groundnut. J Maharashtra agric. Univ 2000;25(3):308.