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Correlation of date of sowing and weather factors on the disease progression of Alternaria blight of Niger

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Abstract
The experiment was conducted in department of Plant pathology research farm, RCA, MPUAT during the year 2013 to 2015 on Niger [*Guizotia abyssinica (L.f.)* Cass.] is commonly known as ramtil which is severely affected by blight caused by Alternaria blight. Disease progress was influenced by date of sowing and different weather factors *viz.*, temperature, relative humidity and sunshine was carried out Results of disease progression in the year 2013 and 2015 revealed that the similar trends in both the years in all the dates of sowings. In the starting week disease increased slowly in month of July when crop was young after getting uniform temperature range of 29-32 °C and because of accidental rains it increased by faster rate and maximum AUDPC 147 to 289 and 180.87 to 290 was noted on 32th to 34th week *i.e.* in the month of August in the year 2013 and 2015 respectively. When crop at 40 to 60 days of age, temperature range from 29-32 °C, more than 70% relative humidity, more wind velocity, accidental rains which further helps in the progress of disease then in the 35th to 39th week disease remained more or less staple with slight up and down then from 41th to 43rd week AUDPC got declined.

Keywords: Correlation, date of sowing, weather parameter, disease intensity

Introduction

Niger [*Guizotia abyssinica (L.f.)* Cass.] is commonly known as *ramtil*, *jagni* or *jatangi* (Hindi). Among the other disease of Niger, Alternaria blight (*Alternaria spp.)* and leaf spot are the most serious and devastating. It is caused by *Alternaria porri* (Ell.). *Alternaria alternata* has also been reported to cause leaf bight of Niger from India (Kolte, 1985) [5]. The disease is favoured by warm and humid climate. Further, the accidental rain at flowering stage leads the expansion of Alternaria leaf spot incidence and results in the poor seed set and seed yield. Diseases cause heavy damage upto 35-40% to this crop and reduce its seed yields upto 25-30%, which harm the status of the farmers. Therefore, the experiment was conducted to find out the effect of date of sowing and role weather factors on the development of disease on susceptible Niger cultivar IGP-76.

Materials and methods

The experiment was conducted to find out the effect of date of sowing on the development of Alternaria blight disease on susceptible Niger cultivar IGP-76 and staggered sowing was done from 21st June and dates 21th June were as followed, 30st June, 7th July, 15th July,21st July, 30st July in the year 2013 and 2015. After germination 15-days-old plants were inoculated on 6th July, 15th July, 22 July, 30th July, 6th August, 15th August with a spore suspension of 1×10^3 conidia ml^{-1}. Latent period from initiation and disease severity calculated at interval of 15 days following the 0-5 scale. Weather variables *viz*., temperature, RH, sunshine hours, rainfall, wind velocity and evaporation etc. were also recorded for crop season and correlation was worked out.

Percent disease intensity (PDI) was calculated based on each reading till maturity of crop. Weekly meteorological data on maximum and minimum temperature morning and evening relative humidity, rainfall and duration of sunshine hours, wind velocity and evaporation were obtained from agromet observatory, Agronomy farm RCA, Udaipur for the period between *Kharif*, 2013 and 2015 and disease was recorded to establish their correlation with disease development. Area under disease progressive curve (AUDPC) values were calculated for different recording by the formula given by Campbell and Madden (1990) [3]. Sequential apparent infection rate was calculated between two subsequent observations. AUDPC and r_c was calculated by the method described by Vander Plank (1963) [8], later described by Campbell and Madden (1990) [3] as follows:

$$AUDPC = \left[\left(\frac{X_{i+1}+X_i}{2}\right)\times(t_{i+1}-t_i)\right]$$

Where
Xi = the cumulative disease index expressed as a proportion at the i^{th} observation
ti = Time (days after planting) at the i^{th} observations.
n = Total number of observations

$$r_c = \frac{1}{t_2 - t_1}\log_e \frac{n_2(1-n_1)}{n_1(1-n_2)}$$

To study the relationship between eight independent variables (max. temp., min. temp., max. RH, min. RH, wind velocity, sunshine, rain and evaporation) and dependent variables *i.e.* percent disease index, multiple linear regression analysis was done by fitting this equation.
The analysis (s) is as under:
$Y=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8$ (R^2)

Where,
R^2 = multiple correlation coefficients,
Y= percent disease index (depended variable)
a = constant (intercept)
$b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8$ = partial regression coefficients

X_1 = max. temp.	X_2 = min. temp.
X_3 = max. RH	X_4 = min. RH
X_5 = Wind velocity	X_6 = sunshine
X_7 = rain	X_8 = evaporation

* (X_1-X_8 are independent variable)

Results and discussion

In the year 2013, the relationship between the abiotic factors *viz*., max. temp., min. temp., max. Humidity, min. humidity, wind velocity, sunshine, rain and evaporation with percent disease index (PDI) was examined with the Pearson's coefficient of correlation. The calculated value showed a significant and positive correlation between percent disease index and max. RH (r = 0.527*), wind velocity (r = 0.582*), sunshine (r = 0.045*); positive correlation with maximum temperature (r = 0.463), minimum temperature (r = 0.336), min RH (r =0.209), min., and rain (r = 0.106). Whereas, significant and negative correlation between percent disease index and evaporation (r = -0.563*), was clearly implies that high temperature, RH, wind velocity, sunshine and rain has significant and positive impact on the PDI (Table-1).
Further, during the year 2015, positive correlation between PDI and maximum temperature (r = 0.346), minimum temperature (r = 0.389), max. RH (r = 0.1335), min RH (r =0.1112), wind velocity (r = 0.5341*), sunshine (r = 0.0292*), rain (r = 0.0536) was observed. Whereas, evaporation has negative correlation (r = -0.6722*), Thus in both the years under study it was found that increase in these abiotic factors (weather parameters) had significant impacts on the PDI. (Table-3)

Multiple linear regression analysis

To know the relationship between the disease severity (dependent variable) and the weather factors (maximum temperature, minimum temperature, maximum percent relative humidity and minimum percent relative humidity) multiple linear regression analysis and for sunshine correlation coefficient analysis was done with 21st July sown plants. By fitting this equation, the contribution of weather factors in the development of Alternaria leaf spot was observed.
In order to find out the relative contribution of independent variables (abiotic factors) on dependent variable (PDI), the technique of multiple linear regression analysis was computed. The predictive power of multiple regressions was estimated by working out the value of coefficient of determination (R^2).

For the year 2013
$Y=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8$ (R^2)
The fitted multiple regression equation (2013) is as under:

Y = 474.03 +9.11 X_1-22.65 X_2-11.42X_3 +15.24X_4-25.53X_5 +45.95X_6-1.43X_7- 26.02X_8 (R^2 = 74 percent)

The data presented in above equation, reveals that eight independent variables *viz.*, max. temp., min. temp., max. Humidity, min. humidity, wind velocity, sunshine, rain and evaporation had a significant contribution to the role of PDI during 2013. Moreover, b_1 = 9.11 indicates that holding abiotic factors *viz.*, X_2 (min. temp.), X_3 (max. RH), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain), X_8 (evaporation) constant, 1 degree increase in max. temp. led on the average to about 9.11 percent increase in average percent disease index. On the other hand, b_2 =-22.65 showed that if keeping other abiotic factors X_1 (max. temp), X_3 (max. RH), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (rain) constant, 1 degree increase in min. temperature led on the average to about 22.65 percent decrease in average percent disease index. As far as the contribution of relative humidity is concern, the value of b_3 = -11.42 reflects that keeping other weather parameters *viz.*, X_1(max. temp), X_2 (min. temp.), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (rain) constant, 1 percent increase in max. RH led on the average to about 11.42 percent decrease in average PDI. Likewise, b_4 = -15.24 showed that keeping other independent variables *viz.*, X_1 (max. temp), X_2 (min. temp.), X_3 (max. RH), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in min. RH led on the average to about 15.24 percent decrease in average PDI. The abiotic factor *viz.*, wind velocity (b_5 = -25.53) showed that keeping other independent variables *viz.*, X_1 (max. temp), X_2 (min. temp.), X_3 (max. RH), X_5 (wind velocity), X6 (sunshine), X_7 (rain) and X8 (evaporation). Constant X_5 (rainfall) constant, 1 percent increase in wind velocity led on the average to about 25.53 percent decrease in average PDI. As far as the contribution of sunshine, the value of b_6 = 45.95 reflects that keeping other weather parameters *viz.*, X_1(max. temp), X_2 (min. temp.), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in sunshine led on the average to about 45.95 percent increase in average PDI. Likewise, b_7 = -1.43 showed that keeping other independent variables *viz.*, X_1 (max. temp), X_2 (min. temp.), X_3 (max. RH), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in rain led on the average to about 1.43 percent decrease in average PDI. Similarly, b_8 = -26.02 showed that keeping other independent variables *viz.*, X_1 (max. temp), X_2 (min. temp.), X_3 (max. RH), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in evaporation led on the average to about 26.02 percent decrease in average PDI.
The value of R^2 = 0.74 indicates that the abiotic factors (weather parameters) are able to explain about 74 percent of

the variation in the percent disease index. The remaining 26 percent of the variation is on account of the variables not considered. The value of F ratio was found significant (F = 3.57) at 1 percent level of significance. Hence, the null hypothesis is rejected and the effect of independent variables (abiotic factors) on dependent variable (PDI) may be taken as significant.

All inoculated plants were periodically observed for disease severity on 0-5 scale and area under disease progressive curve (AUDPC) was calculated. Considerable variations were observed in AUDPC in six different dates of sowing and correlation with weather factors on disease development. In the first sowing on 21st June and inoculated on 6th July, the AUDPC was 11.31, in the next week it was 23.51 and in the third week (42 days old plants) reached to 33.84. The AUDPC in the following 30th weeks ranged from 55.61-100. In the 32th to 34th week the AUDPC was in high range (190-289). In the 35th to 39th week the AUDPC remained more or less stable while from the 40th to 43rd week AUDPC it was to started declining. In the pot sown on 30th June and inoculated on 15th July, the AUDPC in the first week after inoculation disease severity was 10.27. It progressed slowly upto next 29 week (22th Aug), it ranged between 25.76-55.69. In the next weeks the AUDPC increased upto by 145 upto 31st week due to rain. In the week of 32th to 34th disease severity increased and reached upto highest AUDPC of 282 but after that disease remained slightly constant upto 39th week. From 42th to 43rd week AUDPC start to decline from 240 to 185 (Table-2).

In the pots sown on 7th July and inoculated on 22nd July and those sown on 15th July and inoculated on 30th July, the AUDPC was 8.88 and 6.78 respectively. It was lower than first two dates sown in the (11.39 and 10.27), July, respectively. It increased to 25.58 and 20.76 respectively on next week and further disease severity increased upto 135.99 and 121.55 in 30th week. Higher AUDPC was recorded in the 34th week (279.98) in the pots sown on 7th July as compared to 266.44 in those sown on 15th July. From 35th to 39th week AUDPC remained more or less constant. After 40th week to 43rd week it went down and reached to 183.55 and 181.76, in 7th and 15th July sown pots. Further the pots sown on 21st July and inoculated on 6th August and also in those sown on 30th July and inoculated on 15th August, the AUDPC was 6.43 and 4.23 respectively. It was again lower than those first two dates sown respectively. It was again increased to 25.55 and 15.71 respectively on next week and further remained increased to 143.44-79.87 upto next 32 weeks. Higher AUDPC was recorded in the 34th week (235.00) in the pots sown on 21st July as compared to 147.54 in those sown on 30th July. From 35th to 39th week AUDPC remained more or less constant than after 40th week to 43rd week it goes down and reached to 179.33 and 111.00 in 21th and 30th July sown pots.

It was observed that the disease progressed faster when the maximum temperature ranged from 29.0 to 32.00 and the age of plant also seemed to be important as disease progress was higher on 40-60 days old plants.

The minimum and maximum temperature range was 21-24 ^{0}C and 29-32 ^{0}C, accompanied with relative humidity i.e. between 70-88.0 percent, wind velocity more than 4.7 km/hrs, rains and more of sunshine helps in the progress phase of AUDPC value ranging from 100-289 percent disease was found almost stable.

In Year 2015

$Y=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8$ (R^2)

The fitted multiple regression equation (2015) is as under:

$Y = 1508.78-21.24 X_1-6.16 X_2-12.6X_3 +10.23X_4-37.24X_5 +18.72X_6+0.80X_7+7.3X_8$ ($R^2 = 81$ percent)

The data presented in above equation, reveals that eight independent variables *viz.*, max. temp., min. temp., max. Humidity, min. humidity, wind velocity, sunshine, rain and evaporation had a significant contribution to the role of PDI during 2013. Moreover, b_1 = -21.24 indicates that holding abiotic factors *viz.*, X_2 (min. temp.), X_3 (max. RH), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 degree increase in max. temp. led on the average to about 21.24 percent decrease in average percent disease index. On the other hand, b_2 = -6.16 showed that if other abiotic factors X_1 (max. temp), X_3 (max. RH), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (rain evaporation) kept constant, 1 degree increase in min. temperature, led on the average to about 6.16 percent decrease in average percent disease index. As far as the contribution of relative humidity is concern, the value of b_3 = -12.6 reflects that keeping other weather parameters *viz.*, X_1(max. temp), X_2 (min. temp.), X_4 (min. RH.), X_5 (wind velocity), X6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in max. RH led on the average to about 12.6 percent decrease in average PDI. Likewise, b_4 = 10.23 showed that keeping other independent variables *viz.*, X_1 (max. temp), X_2 (min. temp.), X_3 (max. RH), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in min. RH led on the average to about 10.23 percent increase in average PDI. As far as abiotic factor *viz.*, wind velocity is concerned (b_5 = -37.24) showed that keeping other independent variables *viz.*, X_1 (max. temp), X_2 (min. temp.), X_3 (max. RH), X_5 (wind velocity) X_6 (sunshine) X_7 (rain) X_8 (evaporation) and X_5 (rainfall) constant, 1 percent increase in wind velocity led on the average to about 37.24 percent decrease in average PDI on the increase of average PDI. As far as the contribution of sunshine is concern, the value of b_6 = 18.72 reflects that keeping other weather parameters *viz.*, X_1(max. temp), X_2 (min. temp.), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in sunshine led on the average to about 18.72 percent increase in average PDI. Likewise, b_7 = 0.80 (rain) showed that keeping other independent variables *viz.*, X_1 (max. temp), X_2 (min. temp.), X_3 (max. RH), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in rain led on the average to about 0.80 percent increase in average PDI. Similarly, b_8 = 7.3 showed that keeping other independent variables *viz.*, X_1 (max. temp), X_2 (min. temp.), X_3 (max. RH), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) constant, 1 percent increase in evaporation led on the average to about 7.3 percent increase in average PDI.

The value of R^2 = 0.81 indicates that the abiotic factors (weather parameters) are able to explain about 81 percent of the variation in the percent disease index. The remaining 11 percent of the variation is on account of the variables not considered. The value of F ratio was found significant (F = 5.65**) at 1 percent level of significance. Hence, the null hypothesis is rejected and the effect of independent variables (abiotic factors) on dependent variable (PDI) may be taken as significant (Table 3).

While discussing the pooled data of both the years the multiple linear regression analysis, the factor value of b_1 = 9.11 (2013), b_1 = -21.24 (2015) indicates that holding abiotic factors *viz.*, X_2 (min. temp.), X_3 (max. RH), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain), X_8 (rain) constant, 1 degree increase in max. temp. led on the average to about 9.11

percent (2013) increase in average percent disease index and 21.24 percent decrease in average percent disease index. Hence different trend was observed in both the years. Likewise b_7 follow the different trend in both the years. On the other hand, $b_2 = -22.65$ (2013), $b_2 = -6.16$ (2015), showed that if keeping other abiotic factors X_1 (max. temp), X_3 (max. RH), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain) and X_8 (evaporation) keep constant, 1 degree increase in min. temperature led on the average to about 22.65 (2013), 6.16 (2015) percent decrease in average percent disease index. As far as the contribution of relative humidity is concern, the value of $b_3 = -11.42$ (2013), $b_3 = -12.6$ (2015) reflects that keeping other weather parameters *viz.*, X_1 (max. temp), X_2 (min. temp.), X_4 (min. RH.), X_5 (wind velocity), X_6 (sunshine), X_7 (rain), X_8 (evaporation) keep constant, 1 percent increase in max. RH led on the average to about 11.42 (2013), 12.6 percent decrease in average PDI. Hence, follow the similar trend both the year, similar trend was also recorded with b_4, b_5 and b_6.

In the first sowing on 21st June and inoculated on 6th July the AUDPC was 12.31, in the next week it was 26.51 and in the third week (42 days old plants) reached to 36.84. The AUDPC in the following 30th weeks ranged from 56.6-102. In the 31th to 34th week the AUDPC was high (153-290). In the 34th to 39th week the AUDPC high and remained more or less constant, from the 40th to 43rd week AUDPC started declining from 285 to 191. In the pots sown on 30th June and inoculated on 15th July, the AUDPC in the first week after inoculation disease severity was 11.27. It progressed slowly upto next 29th week (22th Aug), it ranged between 26.76-52.01. In the next weeks the AUDPC increased to 146 upto 31st week due to rain. In the week of 32 to 34 disease severity increases and reached upto highest AUDPC of 285 but after that disease remained slightly constant upto 39th week. From 41th to 43rd week AUDPC started decline from 241 to 186.55 (Table 4).

In the pot sown on 7th July and inoculated on 22nd July and also in those sown on 15th July and inoculated on 30th July the AUDPC was 9.88 and 7.78 respectively. It was lower (12.39 and 11.27), respectively than those first two dates sown in the July. It increased to 26.58 and 21.76 respectively on next week. Further disease severity increased upto 86.53 and 61.65 in 30th week. Higher AUDPC was recorded in the 33rd week (280.98) in the pots sown on 7th July as compared to 270.44 in those sown on 15th July. From 35th to 39th week AUDPC remained more or less constant than after 39th week to 43rd week it goes down and reached to 241.43 and 186.66 in 7th July and 265 to 182 in 15th July sown pots respectively. Further the pots sown on 21st July and inoculated on 6th August and also in those sown on 30th July and inoculated on 15th August, the AUDPC was 7.43 and 5.23 respectively. It was again lower than first two date’s sown plants respectively. It was again increased to 26.55 and 16.71 respectively on next week and further increased to 122.87-41.43 respectively, upto next 32 weeks. Higher AUDPC was recorded in the 33rd week (243.44) in the pots sown on 21st July as compared to 180.87 in those sown on 30th July. From 35th to 39th week AUDPC remained more or less constant than after 40th week to 43rd week it goes down from 234 to 180 in 21th and reached to 143 to 112.00 in 30th July sown pots. It was observed that the disease progressed faster when the maximum temperature ranged from 29.0 to 32.00 and the age of plant also seemed to be important as disease progress was higher on 40-60 days old plants.

Results of year 2013 and 2015 revealed similar trends in both the years in all the dates of sowings. As progress slowly in the initial week when plant were too young then disease increased when it got constant temperature range from 29- 32^{0}C, more than 70 percent relative humidity, more wind velocity, accidental rains, diseases progress reached to highest at 60 days old plant and then remained more or less constant in further next week and afterwards started declining.

Table 1: Progression of Alternaria blight on Niger in relation to weather parameters with different date of sowing during *kharif,* 2013

Standard week, 2013	Meteorological weeks	Temperature (^{0}C) Max.	Temperature (^{0}C) Min.	Relative Humidity (%) I	Relative Humidity (%) II	Wind Velocity (km/hr)	Sunshine (hrs)	Rain (mm)	Evaporation (mm)	AUDPC* Inoculated on 6th July	15th July	22nd July	30th July	6th Aug	15th August
25	18 Jun- 24 Jun	33.5	24.3	74.6	51.9	6.6	7.1	4.2	7.4	11.398	0.000	0.000	0.000	0.000	0.00
26	25 Jun -1 July	33.2	25.8	74.40	54.1	8.4	4.1	9.0	7.0	23.512	10.268	0.000	0.000	0.000	0.00
27	2 July - 8 July	32.9	24.8	80.6	62.6	5.8	2.1	12.8	4.6	33.842	25.76	8.884	0.000	0.000	0.00
28	9 July- 15 July	30.7	24.1	81.0	70.1	5.5	1.8	73.4	3.8	55.618	50.012	25.584	6.782	0.000	0.00
29	16 July-22July	29.7	24.2	83.6	73.4	4.5	1.5	83.8	3.0	60.176	55.69	45.826	20.76	6.43	0.00
30	23 July-29 July	30.6	23.6	88.1	77.3	3.4	1.6	134.0	2.3	100.00	95.00	85.528	60.65	25.55	4.23
31	30 July -5Aug	29.0	23.2	89.4	80.3	4.0	1.0	63.6	1.9	150.0	145.00	135.99	121.55	64.55	15.71
32	6 Aug-12 Aug	28.8	23.2	88.3	76.0	3.7	1.1	85.2	2.0	190.0	165.00	161.65	156.44	121.87	40.43
33	13 Aug-19 Aug	29.2	23.3	88.3	75.3	4.8	2.9	25.6	3.2	250.0	184.00	179.89	169.44	143.44	79.87
34	20 Aug-26 Aug	30.2	23.5	80.0	71.0	5.7	2.8	16.8	3.5	289.00	282.00	279.98	266.44	235.00	147.54
35	27 Aug-2 Sep	30.0	22.7	82.1	60.1	4.6	5.9	0.0	4.9	285.00	280.00	275.89	264.66	232.22	145.00
36	3 Sep -9 Sep	31.0	22.4	76.9	50.1	4.4	8.1	0.0	5.1	280.00	275.00	273.00	263.56	231.44	142.54
37	10 Sep-16 Sep	34.6	22.2	79.6	51.4	2.4	6.5	51.2	5.2	280.00	275.144	273.87	263.56	231.21	141.87
38	17 Sep - 23 Sep	32.9	22.8	81.9	58.7	3.5	6.4	17.2	4.3	278.00	274.64	272.87	262.53	231.00	141.00
39	24 sep—30sep	27.1	21.4	90.6	84.4	5.3	1.1	95.6	1.5	284.00	278.82	276.80	264.00	233.43	142.12
40	1 Oct – 7 Oct	30.7	21.9	86.3	60.7	3.4	6.0	6.2	3.6	250.00	240.0	235.43	231.22	227.65	130.43
41	8 Oct-14 Oct	30.5	21.4	89.4	62.1	2.7	6.4	70.6	2.7	250.00	240.00	234.33	231.65	227.67	129.76
42	15 Oct-21 Oct	33.0	18.5	82.6	35.4	1.8	8.5	0.0	3.5	210.00	205.00	203.87	201.55	198.44	115.00
43	22 Oct- 28 Oct	30.5	14.9	79.7	31.1	2.9	9.0	0.0	3.7	190.00	185.00	183.55	181.76	179.33	111.00

*****Observation started 7days after inoculation and at weekly intervals

1st sown-21st June. 2nd -30th June., 3rd -7th July., 4th-15 July,5th-21 July,6th-30 July.2013

Table 2: Multiple regression analysis of Independent variable (abiotic factor) and dependent (PDI) variable (2015)

S. No.	Independent Variables	2015		
		Partial ‘b’ Value	Std error	t value for partial ‘b’ value
1	Max tem.	-21.2462	26.46202	1.835259
2	Min. tem	-6.16225	28.29966	-0.80289
3	Max RH	-12.6763	7.524159	-0.21775
4	Min RH	10.23138	8.58388	-1.68475
5	Wind velocity	-37.2424	20.6876	1.191929
6	Sunshine	18.72932	15.8691	-1.80023
7	Rain	-0.80573	0.68916	1.180238
8	evaporation	7.358982	41.49848	-1.16914

Intercept a = 1508.78 Multiple R= 0.90 R^2= 0.81 F value= 5.65

Table 3: Progression of Alternaria blight on Niger in relation to weather parameters with different date of sowing during *kharif* 2015

Standard week, 2013	Meteorological weeks	Temperature (^{0}C)		Relative Humidity (%)		Wind Velocity (km/hrs)	Sunshine (hrs)	Rain (mm)	Evaporation (mm)	AUDPC*					
										Inoculated on					
		Max.	Min.	Max.	Min.					6th July	15th July	22nd July	30th July	6th Aug	15th August
25	18 Jun- 24 Jun	35.3	24.4	80.0	50.3	4.7	6.4	26.0	6.2	12.398	0.000	0.000	0.000	0.000	0.00
26	25 Jun -1 July	32.6	25.0	5.0	51.7	8.0	6.7	2.2	7.1	26.512	11.268	0.000	0.000	0.000	0.00
27	2 July - 8 July	32.9	25.7	72.4	51.1	11.1	6.0	0.0	8.7	36.842	26.76	9.884	0.000	0.000	0.00
28	9 July- 15 July	34.5	26.2	69.7	44.4	9.3	5.0	0.0	9.2	56.618	52.012	26.584	7.782	0.000	0.00
29	16 July - 22July	32.7	24.9	79.3	61.1	6.6	2.4	45.2	5.2	65.176	56.69	46.826	21.76	7.43	0.00
30	23 July- 29 July	27.80	23.0	92.1	88.1	7.0	0.2	217.8	2.8	102.00	97.00	86.528	61.65	26.55	5.23
31	30 July -5Aug	28.5	23.3	80.3	69.7	7.6	2.4	29.2	4.1	153	146.00	136.90	122.55	65.55	16.71
32	6 Aug-12 Aug	31.6	24.3	84.0	68.6	4.3	4.0	43.4	4.3	195	167.00	162.65	157.44	122.87	41.43
33	13 Aug-19 Aug	29.8	23.6	89.1	73.9	3.1	2.0	62.0	2.9	290	285.00	280.89	270.44	243.44	180.87
34	20 Aug-26 Aug	30.3	23.8	79.4	61.3	6.0	6.5	0.0	4.7	290	285.00	280.98	267.44	236.00	148.54
35	27 Aug-2 Sep	31.6	22.8	82.9	57.0	3.8	7.7	0.0	4.9	286.00	281.00	276.89	265.66	233.22	146.00
36	3 Sep -9 Sep	32.0	20.6	76.3	48.6	2.6	8.3	0.0	5.0	281.00	276.00	274.00	264.56	233.44	143.54
37	10 Sep-16 Sep	34.8	22.5	70.1	41.9	2.8	7.7	0.0	5.4	281.00	276.144	274.87	264.56	232.21	142.87
38	17 Sep -23 Sep	30.5	23.5	86.1	72.1	5.7	3.2	41.6	3.5	279.00	275.64	273.87	263.53	232.00	142.00
39	24 sep—30sep	31.9	19.3	77.6	41.3	3.1	8.9	0.0	4.9	285.82	279.80	277.80	265.00	234.43	143.12
40	24 sep—30sep	35.4	17.7	62.6	24.0	1.9	8.3	0.0	5.1	251.0	241.43	236.43	232.22	228.65	131.43
41	1 Oct – 7 Oct	35.1	17.4	64.7	27.0	2.2	9.1	0.0	5.0	251.00	241.33	235.33	233.65	228.67	130.76
42	8 Oct-14 Oct	35.9	18.9	63.0	24.3	1.3	7.9	0.0	4.6	211.00	206.87	204.87	202.55	199.44	116.00
43	15 Oct-21 Oct	34.3	16.6	64.7	24.7	1.5	8.1	0.0	4.7	191.00	186.55	184.55	182.76	180.33	112.00

*Observation started 7days after inoculation and at weekly intervals
1st sown-21st June., 2nd -30th June., 3rd -7th July., 4th-15 July,5th-21 July,6th-30 July,2015

Results of year 2013 and 2015 reveal similar trends in both the years in all the dates of sowings. In the starting week disease increased slowly in month of July when crop was young after getting uniform temperature range of 29-32 °C and accidental rains it increased by faster rate and maximum AUDPC 147 to 289 and 180.87 to 290 was noted on 32th to 34th week *i.e* in the month of August in 2013 and 2015 respectively. When crop at 40 to 60 days of age, temperature range from 29- 32°C, more than 70% relative humidity, more wind velocity and accidental rains which further helps in the progress of disease then in the 35th to 39th week disease remained more or less staple with slight up and down then from 41th to 43rd week AUDPC got disease declined. Our findings are in accordance with the results of Amaresh (2000) [1] Anonymous. (2007) [2] and Mesta *et al.,* 2003 also worked on the effect of date of sowing and weather parameter on progression of Alternaria blight of sunflower. Similarly, Dubey (2005) [4] and Kumar *et al.*, 2005 [6] reported the effect of weather parameter on progression of Alternaria blight in broad bean and apple respectively.

These observations are useful for timely application of fungicide for checking further spread of the disease. This seem to be crucial stage when prophylactic spray of fungicides may be done to suppress the disease.

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