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Correlation of weather parameters with development of leaf spot of safflower caused by *Alternaria carthami*

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Abstract
Alternaria leaf spot is a major destructive fungal disease of safflower (*Carthamus tinctorius* L.) which infects the leaves, stem, head and seed. The experiment was conducted with a view to study the effect of different weather parameters *viz*., rainfall, humidity and temperature on the development of *Alternaria* leaf spot and secondly to develop forecasting model for it. The correlation studies indicated that rainfall, minimum temperature and relative humidity (RH-I and II) had a positive correlation with the disease development in all sowing times whereas the maximum temperature had a negative correlation. The weather conditions during 36 to 45 MW were observed to be the most congenial for the crop infection and further rapid build-up of the disease. The results of regression equation stated that, if the rains received coupled with high humidity above 80% and temperature in the range of 21 to 32^{0}C favours the primary infection of the crop.

Key words *Carthamus tinctorius* L. - *Alternaria carthami* - correlation

Introduction

The leaf spot disease caused by *Alternaria carthami* Chowdhary is a major destructive disease of safflower (*Carthamus tinctorius* L.) grown in India. The disease is endemic in most of the safflower growing areas of Maharashtra, Karnataka and Andhra Pradesh which infects the leaves, stem, head, seed etc and causes severe seed yield loss and also deterioration in the quality of the seed. Under severe infections, disease has been reported to cause 50 per cent loss in seed yield (Indi *et. al.,* 1986). An extensive survey work carried out by Deokar *et al*. (1991) revealed the predominance of *Alternaria* leaf spot disease on safflower in the traditional safflower growing areas in the scarcity zone of Maharashtra state. Weather conditions play a predominant role in determining the course and severity of epidemics. Hence an attempt was made to study the role of different weather parameters *viz*., rainfall, relative humidity and temperature on infection and development of *Alternaria* leaf spot and secondly to develop forecasting model for it.

Materials and Methods

The field experiment was conducted on medium black soil during 2006-07 at Zonal Agricultural Research Station, Solapur, Maharashtra (India) with three sowing dates. The cultivar Phule Kusuma was sown in three plots of 100 m^2 each at one month interval i.e. Second fortnight of August (Early), second fortnight of September (Normal) and second fortnight of October (Late). The crop was fertilized with 50 kg N and 25 kg P_2O_5 per hectare as a basal dose. Recommended agronomic practices like spacing, weeding, hoeing, irrigation were followed in the plot. Crop was protected against aphid and capsule borer by spraying Dimethoate 30 EC and Endosulfan 35 EC @ 0.05 %, respectively.

Twenty plants each from early, normal and late sown crop were scored for the *Alternaria* leaf spot disease at weekly intervals using 0-9 scale (Anonymous, 2006) started from 20 DAS. The per cent disease intensity (PDI) was calculated by using the formula given by Mayee and Datar (1986).

$$PDI = \frac{\text{Sum of individual rating}}{\text{Number of leaves examined x Maximum disease grade}} \times 100$$

The grain yield was recorded at harvest. Observations on maximum and minimum temperatures, relative humidity and rainfall were recorded weekly from sowing to maturity and the average disease intensity was correlated with different weather parameters.

Results

The rate of disease build-up was correlated with the weather parameters during the crop growth for early, normal and late sowing are presented in Table 2. The correlation studies indicated that in early sowing, the rainfall, minimum temperature and relative humidity (RH-I and II) showed a positive correlation with the disease development whereas the maximum temperature showed negative correlation. The weather conditions during 36 to 45 MW were, observed to be the most congenial for the crop infection and further rapid build-up of the disease. During this period, a total of 334.8 mm rainfall was received coupled with relative humidity in the range of 88 to 93% and favourable temperatures in the range of 21 to 32^{0}C. Further, it was observed that in early sown condition that rains received during 36 to 38 MW (197.8 mm) coupled with relative high humidity (in the range of 88 to 91%) resulted in primary infection of the crop (10% disease incidence) at rosette stage. The congenial climatic conditions during 40 MW (33.4 mm rainfall coupled with 92% relative humidity) resulted in rapid development of the disease (25% disease incidence) at bud initiation stage. Further, 93.4 mm rains received during 45 MW i.e. flowering stage of the crop coupled with 89 % relative humidity resulted in rapid build up of the disease up to 70%.

In normal sowing, the disease showed a highly significant positive correlation with rainfall, minimum temperature and relative humidity (RH-I and II), whereas, the maximum temperature had a negative correlation. A total of 33.4 mm rains received during 40 to 42 MW coupled with relative humidity in the range of 77 to 92% which resulted in primary infection of the crop (5% disease incidence) during elongation stage. Further, 93.4 mm rains received during 45 MW with 89% relative humidity resulted in further build up of the disease up to 25% during bud initiation stage of the crop. In late sowing, the disease had significant positive correlation with rainfall and relative humidity-I and positive correlation with minimum temperature and relative humidity-II, but the maximum temperature showed a negative correlation. The rains received during 44 and 45 MW (95.6 mm) coupled with relative humidity in the range of 84 to 89% resulted in primary infection of the crop (5% disease incidence) during rosette stage and further build up of the disease was up to 10% till elongation stage. Further disease build up was ceased due to lack of congenial climatic conditions (rains or high humidity above 80%) till maturity of the crop.

Discussion and Conclusion

Saharan and Saharan (2004) observed significantly positive correlation between the disease severity and certain weather parameters (cumulative rainy days and cumulative rainfall) in *Alternaria* leaf blight of cluster bean. At Phaltan, the disease had a positive correlation with rainfall, temperature and relative humidity. Also the climatic conditions during 45th meteorological week (mw) (15.2mm rainfall coupled with 98 percent relative humidity) helped for development of the *Alternaria* leaf spot disease in safflower (Anonymous, 2007). Sangeetha and Siddaramaiah (2007) reported maximum temperature of 27-28ºC minimum temperature of 14 - 15ºC and average relative humidity more than 65% was found favourable for *Alternaria* blight development of Indian mustard (*Brassica juncea* (Linn.).

The stepwise regression analysis for early, normal and late sowing is presented in Table 3. The results of the regression analysis between dependant variable (rate of increase of disease) Vs. independent variables *viz*., rainfall, humidity and minimum temperature were significant, whereas it was non-significant in respect of maximum temperature. The results of regression

equation stated that, if the rains received coupled with high humidity above 80% and temperature in the range of 21 to 32^{0}C favours the primary infection of the crop generally in rosette stage. Saharan and Saharan (2004) reported the step-wise multiple regression analysis of data which revealed that minimum temperature, relative humidity in the evening and sunshine and cumulative rainfall played a major role in *Alternaria* leaf blight disease development of cluster bean. The *Alternaria* incidence showed the great influence on seed yield. There was 43.96 per cent of reduction in yield in early sowing (6.5 q/ha) as compared to the normal sowing (11.6 q/ha) whereas 6.89 per cent less in late sowing (10.80 q/ha).

This study indicate that rainfall, minimum temperature and relative humidity (RH-I and II) had a positive correlation with the disease development and rains received coupled with high humidity above 80% and temperature in the range of 21 to 32^{0}C favours the primary infection to the crop.

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Table 1. Scale/Description of the symptom for *Alternaria* leaf spot of safflower.

Scale	Description of the symptom
0	Leaves free from infection
1	Small irregular spots covering <1% leaf area
3	Small irregular brown spots with concentric rings covering 1-10% leaf area
5	Lesions enlarging, irregular brown with concentric rings covering 11-25% leaf area
7	Lesions coalease to form irregular and appears as a typical blight symptom covering 26-50% leaf area
9	Lesions coalease to form irregular and appears as a typical blight symptom covering >51% leaf area

Table 2 . Correlation value between disease index of *Alternaria* leaf spot of safflower and Environmental weather factors.

Weather factors	CORRELATION COEFFICIENT 'R' VALUE		
	Early sowing	Normal sowing	Late sowing
Rainfall (mm)	+0.280	+0.848**	+0.871**
Maximum Temperature (^{o}C)	-0.244	-0.244	-0.293
Minimum Temperature (^{o}C)	+0.094	+0.230	+0.430
Relative Humidity-I	+0.101	+0.421	+0.659*
Relative Humidity-II	+0.288	+0.199	+0.372

Table value of r at 5 % = 0.532
at 1 % = 0.661

Table 3. Regression analysis of early, normal and late sowing

MW No	Average PDI	Rate of Increase	Rainfall Mm	Max T	Min T	RH-I	RH-II
36*	**0.00**	**0**	**49.9**	**34.0**	**22.0**	**88**	**51**
37	0.28	0.28	75.6	32.4	22.2	93	62
38	2.60	2.32	72.3	30.0	21.9	91	68
39	2.60	0	8.1	31.6	22.3	91	59
40	3.48	0.88	33.4	29.4	22.0	92	73
41	3.48	0	0.0	33.3	20.5	81	43
42	5.16	1.68	0.0	34.2	18.9	77	36
43	5.72	0.56	0.0	33.2	19.3	72	38
44	6.92	1.2	2.1	31.9	19.8	84	56
45	7.72	0.8	93.4	30.1	18.5	89	47
46	7.96	0.24	0.0	31.4	16.3	82	40
47	8.12	0.16	0.0	30.8	19.3	77	50
48	8.12	0	0.0	31.9	17.8	81	38
40**	**0**	**0**	**33.4**	**29.4**	**22.0**	**92**	**73**
41	0	0	0.0	33.3	20.5	81	43
42	0.08	0.08	0.0	34.2	18.9	77	36
43	0.44	0.36	0.0	33.2	19.3	72	38
44	1.16	0.72	2.1	31.9	19.8	84	56
45	3.16	2	93.4	30.1	18.5	89	47
46	3.48	0.32	0.0	31.4	16.3	82	40
47	3.64	0.16	0.0	30.8	19.3	77	50
48	3.64	0	0.0	31.9	17.8	81	38
49	3.64	0	0.0	31.3	14.7	76	32
50	3.64	0	0.0	31.2	13.8	80	33
51	3.64	0	0.0	31.5	11.3	78	32
52	3.64	0	0.0	30.6	12.8	81	40
44***	**0.28**	**0.28**	**2.1**	**31.9**	**19.8**	**84**	**56**
45	2.16	1.88	93.4	30.1	18.5	89	47
46	3.16	1	0.0	31.4	16.3	82	40
47	3.16	0	0.0	30.8	19.3	77	50
48	3.16	0	0.0	31.9	17.8	81	38
49	3.16	0	0.0	31.3	14.7	76	32
50	3.16	0	0.0	31.2	13.8	80	33
51	3.16	0	0.0	31.5	11.3	78	32
52	3.16	0	0.0	30.6	12.8	81	40
1	3.16	0	0.0	30.3	12.4	79	38
2	3.16	0	0.0	29.9	13.2	80	42
3	3.16	0	0.0	32.4	14.5	71	33
4	3.16	0	0.0	33.3	15.3	69	31
		r value	**+0.621****	**-0.194**	**+0.341***	**+0.403****	**+0.353***
			a= 0.193	**a= 3.389**	**a= -0.773**	**a= -3.027**	**a= -0.486**
			b= 0.013	**b= -0.095**	**b= 0.066**	**b= 0.042**	**b= 0.020**

Regression Equation Y = a + bX

Where, Y = Dependant variable i.e. Disease (rate of increase)

X = Independent variable viz., Rainfall, Humidity (RH-I & RH-II), Max. & Min. Temp.

a = Intercept Coefficient, b= Regression Coefficient

Table value of r at 5 %= 0.325 and at 1 %= 0.381 *- Early sowing, **- Normal sowing and ***- Late sowing