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Correlation of Different Weather Parameters with Blumeriella Leaf Spot Disease Development and Disease Intensity in Kashmir Valley

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Abstract Cherry an important temperate fruit found to face a serious threat due to Blumeriella leaf spot disease caused by *Cylindrosporiumpadi.* Development of disease mostly depends on certain weather parameters like temperatures, average maximum and minimum relative humidity and average rainfall. In the present study, the disease appeared during the first fortnight of June when the average atmospheric temperatures both maximum and minimum were 27.30^{0}C and 8.88^{0}C, respectively, with average relative humidity both maximum and minimum 71.21 and 49.21% and reached the maximum rate during the second fortnight of June which coincided with the favorable temperature, rainfall and relative humidity for its progress. The percent disease intensity on leaves showed positive correlation with average maximum relative humidity and average rainfall. Thus both high humidity, optimum temperature and rains significantly favored the development of Blumeriella leaf spot disease in Kashmir valley.

Keywords Cherry, Blumeriella leaf spot, Temperature, Humidity, Rainfall.

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Introduction

Cherry is an important temperate fruit and season's first tree fruit to reach the market and therefore, fetches premium price. The primary cherry producing countries contributing to world's annual production of 2256 thousand MT are Turkey, USA, Iran, Italy, Chile, Uzbekistan and China [1]. In India, cherry is mainly grown in the state of Jammu and Kashmir (J&K) and to some extent in the North-Western Himalayan region of Himachal Pradesh and Uttarakhand hills. Exports of cherry from Jammu and Kashmir State earn substantial foreign exchange up to 150.00 crores [2]. The cherry fruit is mostly consumed as fresh, besides being used in confectionery, ice-creams, bakery, Juice-making, syruping and liquors. Cherry wood and fruit are also usable in veneer industry,dying, pharmaceutical and food industries [3]. Owing to its high content of vitamin C and other chemicals that might act as antioxidants, cherries are used to prevent cancer and other cardiovascular diseases besides treating osteoarthritis and gout [4, 5]. Cherry productivity per unit area is low owing to many biotic and abiotic factors. Among the diseases, Blumeriella leaf spot (BLS)

caused by *Cylindrosporiumpadi* has assumed an alarming proportion in the major cherry growing countries of the world and causes huge economic losses [6, 7].

Development of disease mostly depends on certain weather parameters like temperatures, average maximum and minimum relative humidity and average rainfall. Information on factors favoring sporulation, spore dispersal, spore germination, penetration and disease development has emerged from various workers. Several workers reported that temperatures of 15-20^{0}C are most favorable for disease development [8, 9]. While, Eisensmith and Jones in 1981 observed that optimal temperature of 17.2-22^{0}C coupled with 100% RH were necessary for establishment of infection and disease development by *Blumeriellajaapii.* In India no attempt has been made to study the effect of various weather parameters on BLS disease, so the study was undertaken to observe the effects of various factors like temperature, humidity and rainfall on development and intensity of BLS in Kashmir valley.

Materials and Methods

Experimental trial

Four cherry trees aging 8-10 years, of cultivar Bigarreau Napoleon (Double) were randomly selected and earmarked in the last week of May 2014 in the orchard of Division of Fruit Sciences SKUAST-K, Shalimar. Marked trees were examined regularly for first appearance of disease and subsequently at 14 days interval for recording the disease intensity on leaves according to the scale by Schuster and Tobutt [10].

Recording of weather parameters

The data regarding rainfall, number of rainy days, minimum and maximum temperature and minimum and maximum relative humidity were obtained from meteorological observatory Division of Agronomy SKUAST-K, Shalimar. The rate of disease progress was calculated by using the following formula.

$$R = \frac{2.303}{T_2 - T_1} \text{ Log } 10 \frac{X_2}{X_1}$$

Where, R = rate of disease progress or infection rate, T_2-T_1=time interval, X_1 = disease at time T_1, X_2 = disease at time T_2.

Statistical analysis

The data on various weather parameters and disease development with regard to disease intensity of Blumeriella leaf spot disease was subjected to statistical analysis to find out the positive correlations, if any existed.

Results and Discussion

The data presented in Table 1 and Figure 1 revealed

Table 1. Effect of weather parameters on the development of Blumeriella leaf spot disease under field conditions. *Average of fourteen days.

Date of observation (fortnightly)	Average temperature (^{0}C)*		Average rainfall (mm)*	Average relative humidity*		Disease intensity (%)	Disease progress rate (units per day)
	Maximum	Minimum		Maximum	Minimum	Leaves	Leaves
25 May 2014	19.89	08.92	1.03	84.85	62.92	00.00	0.0000
08 Jun 2014	27.30	08.88	1.02	71.21	49.21	01.10	0.0066
22 Jun 2014	29.79	11.45	2.05	69.78	41.21	02.34	0.0524
06 Jul 2014	28.50	13.72	4.70	79.21	46.57	04.68	0.0481
20 Jul 2014	29.75	15.89	1.97	75.35	51.85	07.34	0.0312
03 Aug 2014	32.46	18.30	3.17	80.07	46.14	16.25	0.0552
17 Aug 2014	31.02	16.45	2.14	76.28	50.57	25.25	0.0306
31 Aug 2014	27.10	12.90	5.57	82.64	56.71	44.37	0.0391
14 Sep 2014	21.40	13.60	13.4	92.00	83.10	56.87	0.0172
28 Sep 2014	27.00	10.90	4.50	84.30	55.20	58.25	0.0016

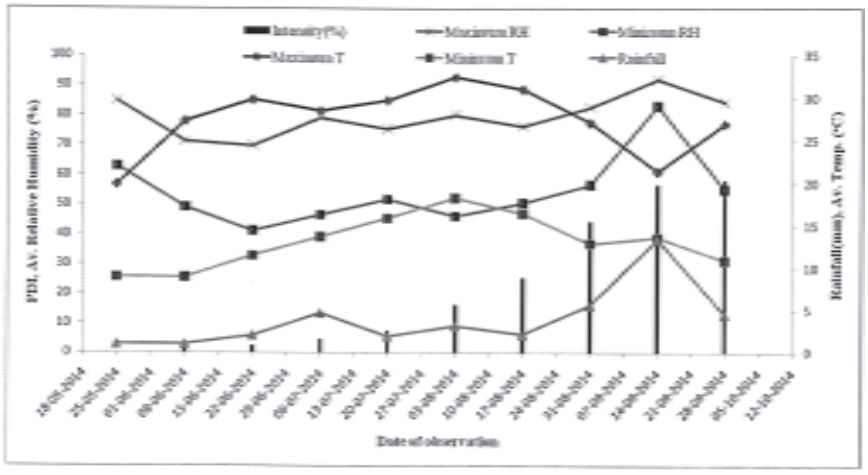

Fig. 1. Effect of weather parameters on the development of Blumeriella leaf spot disease under field conditions.

that the disease on leaves under field conditions initiated in the second week of June, when the average atmospheric temperatures both maximum and minimum were 27.30^{0}C and 8.88^{0}C, respectively, with average relative humidity both maximum and minimum 71.21 and 49.21% respectively. Gradual increased in average minimum relative humidity from 49.21 to 83.10%, coupled with moderate rainfall favored the gradual spread of disease from 01.10 to 58.25%. The maximum rate of disease progress was observed during the second fortnight of June which coincided with the favorable rainfall and relative humidity for its progress.

The correlation coefficients and multiple regression of per cent disease intensity with various weather parameters like average maximum and minimum temperatures, average maximum and minimum relative humidity and average rainfall are presented in (Table 2). The percent disease intensity on leaves showed positive correlation with average maximum relative humidity and average rainfall with correlation coefficients of 0.69 and 0.73, respectively. However a non-significant correlation was observed with average minimum relative humidity, average minimum and maximum temperatures.

Table 2. Correlation coefficients between disease intensity of Blumeriella leaf spot disease with respect to weather parameters during 2014.

Weather factors	Correlation coefficient (*r*) with disease intensity	*p* value
Maximum temperature (x_1)	-0.21	0.550
Minimum temperature (x_2)	0.11	0.750
Rainfall (x_3)	0.73	0.016
Maximum relative humidity (x_4)	0.69	0.027
Minimum relative humidity (x_5)	0.59	0.071

Multiple regression indicated that a functional relationship existed between disease intensity and corresponding weather parameters with coefficient of determination of 0.93 (Table 3). Coefficient of determination explains fitness of regression equation and indicates proportion of variation in dependent variable (Y) explained by independent variables (Xi) for a linear regression model. The multiple regression equation was developed for predicting the disease intensity by using linear regression model. In this model among the different variables, the variable factors influencing the disease intensity (Y) will be taken and those which have in significant or least effect will be climinated automatically.

The correlation and multiple regression analysis clearly showed the importance of weather parameters in favoring and predicting disease intensity. The re-

Table 3. Multiple regression equation indicating the relationship of meteorological factors with disease intensity (Y). *Significant at 5% level of significance.

Multiple regression equation	R^2	Adjusted R^2
$Y= -702.77+13.88_{X1} -8.93_{X2} -0.25_{X3}+ 3.93_{X4}+2.74_{X5}$	0.93	0.84
t stat (4.31) (-3.86) (-2.14)* (3.75)* (2.80)		

gression equation also revealed that if weather parameters at particular time are known, disease intensity can be predicted using the regression model.

Correlation of disease development with meteorological factors revealed that the per cent disease intensity was highly and positively correlated with the average maximum relative humidity ($r = 0.69$), followed by average rainfall ($r = 0.73$). The present investigation is in complete agreement with various workers who also reported that high humidity and high rainfall were necessary and favorable for Blumeriella leaf spot infection and disease development [8—11].

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