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Forecasting models of bacterial leaf spot disease of mulberry for Birbhum district of West Bengal

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A B S T R A C T

Bacterial leaf spot (BLS) caused by *Xanthomonas campestris* pv. *mori* was found to be one of the major foliar diseases in mulberry at farmers field in Birbhum district. BLS incidence appeared in May and continued up to November. The correlation coefficient between disease severity and meteorological parameters revealed that BLS disease severity showed significant positive correlation with max & min temperatures, min relative humidity, rainfall and number of rainy days. Step down multiple regression analysis revealed that the forecasting of BLS could best be done from min temp, minimum relative humidity and number of rainy days.

Keywords: *Xanthomonas campestris* pv. *mori*, meteorological factors, prediction, mulberry.

Introduction

Sericulture is an age-old practice in Birbhum district of West Bengal. The soil and climatic condition is favourable to luxuriant growth of mulberry. Mulberry (*Morus* sp), the sole food plant of silkworm (*Bombyx mori*) is cultivated as bush for its valued foliage in utilization for silkworm rearing. Being a perennial plant it is affected with several diseases caused by fungi, bacteria, virus, mycoplasma and nematode (Rangaswami *et al*. 1978; Sengupta *et al*. 1990). These diseases reduce leaf yield (10-20%) and considerably impair quality as well (Sikdar & Krishnaswami 1980; Umesh Kumar 1991; Qadri *et al*. 1999) Feeding of diseased leaves to the silkworm reduces cocoon yield by 15-20% and also the quality (Noamani *et al*. 1970; Umesh Kumar *et al*. 1993).

Several workers reported influence of weather condition in the development of foliar diseases. Weather based disease forecasting models have been developed for management of wheat rust (Eversmeyer *et al.* 1973), potato blight (Schrodter & Ulrich 1965) and potato late blight (Johnson *et al.* 1996). The current research was designed to study BLS, among others diseases affecting mulberry in Birbhum district of West Bengal, identify relationship between disease severity and meteorological factors and develop a weather based forecasting model.

Materials and Methods

The study was carried out at farmers' fields in Birbhum district which lie between 23°32' 30" and 24° 35' 0" north latitude and 88° 1' 40" and 87° 5' 25" east longitude on popular elite mulberry cultivar S-1. Plantation was maintained as per recommended package of practices. Plants were pruned five times during 4th week of February, 3rd week of April, 3rd week of July, 4th week of September and 1st week of December.

Disease severity data were collected at weekly interval for four years. Disease incidence was recorded by randomly selecting five branches from five plants in each plot. In each plant total number of healthy and diseased leaves was graded into 0 - 5 scale on the basis of percent of leaf area infected. 0 = healthy leaf, 1 = 1 - 5 % leaf area infected, 2 = 6 - 10 % leaf area infected, 3 = 11 -25 % leaf area infected, 4 = 26 - 50 % leaf area infected, 5 = 51 and above leaf area infected. Percent of disease index was calculated according to FAO (1967) formula.

$$\text{Percent disease index} = \frac{\text{Sum of all numerical rating}}{\text{Total no. of leaves counted} \times \text{Maximum grade (5)}} \times 100$$

Daily meteorological factors *viz*. maximum and minimum temperature (^{0}C), maximum and minimum relative humidity (%), rainfall (mm) and number of rainy days were also recorded.

To study of the relationship between meteorological factors with disease severity, meteorological data *viz*. mean maximum and minimum temperature, mean maximum and minimum relative humidity, rainfall and number of rainy days of preceding week were correlated with disease severity. The predicted mean disease severity ($Y = a + b_1x_1 + b_2x_2 + ... + b_6x_6$) was derived by step down multiple regression analysis, where Y denotes the predicted severity on leaf, `a' denotes the intercept and b_1 to b_6 denote partial regression coefficient for x_1 to x_6 meteorological factors. The coefficient of multiple determination (R^2) and partial regression coefficient (b) values were tested at 5 level of significance (Snedecor & Cochran 1967).

Results

Four year mulberry disease survey data revealed that foliar diseases *viz*. bacterial leaf spot (BLS), *Myrothecium* leaf spot (MLS), *Pseudocercospora* leaf spot (PLS) and powdery mildew (PMLD) occurred at farmers' fields in Birbhum district. It was observed that BLS appeared in 3rd week of May and continued up to November; BLS disease severity was found to be above economic threshold level from May to September (Fig. 1).

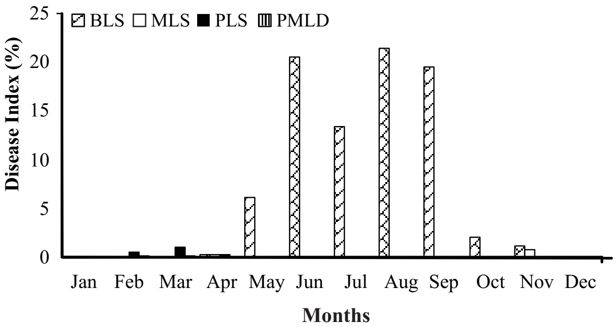

Fig 1. Mulberry disease severity in Birbhum district on S-1 mulberry variety

The result of simple correlation coefficient between the disease severity and meteorological factors (Table 1) was revealed that BLS showed significant positive correlation with average of max & min. temperature, min. relative humidity, rainfall and number of rainy days of preceding seven days (Fig. 2).

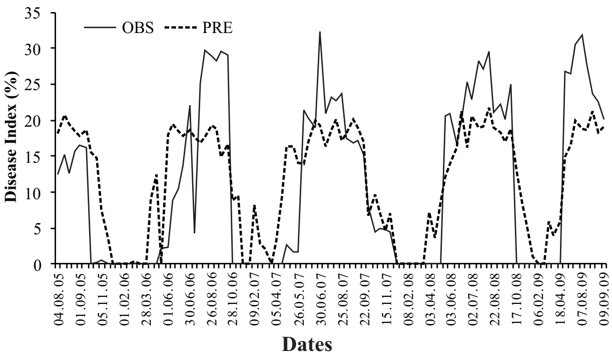

Fig 2. Observed and predicted values of BLS based on min. temperature, min. relative humidity and rainy days of preceding week.

Table 1.
Correlation coefficient between meteorological factors and mulberry disease severity

Meteorological parameters	Bacterial leaf spot	*Myrothecium* leaf spot	*Pseudocercos - pora* leaf spot	Powdery mildew
Maximum temperature (°C)	0.344**	-0.113	- 0.240 *	-0.396**
Minimum temperature (°C)	0.709**	-0.233	- 0.318 **	-0.387**
Maximum R H (%)	0.158	0.031	- 0.083	0.031
Minimum R H (%)	0.648**	-0.155	- 0.236*	-0.184
Rainfall (mm)	0.366**	-0141	- 0.135	-0.114
Rainy days (No.)	0.610**	-0.117	- 0.191*	-0.184

* Significant at 5% level **Significant at 1% level

Table 2.
Stepwise multiple regression equations for prediction of bacterial leaf spot

Stepwise prediction equations	R^2
$Y= -18.68 + (1.38x_2) + (0.89x_6) + (0.15x_4) + (-0.36x_1) + (-0.01x_5)+(0.001x_3)$	0.59
$Y= -18.56 + (1.38x_2) + (0.89x_6) + (0.015x_4) + (-0.36x_1) + (-0.01x_5)$	0.59
$Y= -18.75 + (1.38x_2) + (0.72x_6) + (0.15x_4) + (-0.36x_1)$	0.59
$Y= -28.12 + (1.09x_2) + (0.68x_6) + (0.22x_4)$	0.58
$Y= -32.17 + (1.15x_2) + (0.28x_4)$	0.58
$Y= -25.41 + (1.63x_2)$	0.50

x_1= Max. T (°C) x_4= Min. R H (%)
x_2= Min. T (°C) x_5= Rainfall (mm)
x_3= Max R H(%) x_6= Rainy days (No.)

The step down multiple regression analysis showed that (Table 2) based on co-efficient of multiple determination (R^2) values, meteorological factors like min. temp, min. relative humidity and no. of rainy days were responsible for 58% variation of disease severity. The regression equation developed for prediction of BLS is $Y = -28.12 + 1.093X_2 + 0.677X_6 + 0.215X_4$ (R^2=0.58, P=$1.975X10^{-18}$).

Discussion

The climatic condition of Birbhum district was found congenial for development of BLS in mulberry. The step down multiple regression analysis revealed that minimum temp, number of rainy days and minimum relative humidity were critical meteorological factors that contribute to development of BLS. Several workers reported that initiation and development of bacterial disease is related to frequency of rain, high humidity and moderate temperature (Pavgi *et al*. 1964; Shekhawat & Srivastav 1972; Premlatha Dath *et al*. 1979). It was also observed that 25-27ºC minimum temperature, 4 rainy days and 62-78% minimum relative humidity during preceding 7 days were favourable for epidemic development. Maji (1999) reported that optimum growth of *Xanthomonas campestris* pv. *mori* was observed at 95-100% relative humidity and 30-35ºC temperature under *in vitro* condition.

The prediction equation developed from this study may help in forecasting the mulberry disease severity to the farmers of Birbhum district in advance based on preceeding weather record to take timely decision for executing disease management operation to minimize crop loss.

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