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Epidemiology and prediction model of Phomopsis blight of eggplant caused by *Phomopsis vexans*

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Phomopsis blight of eggplant occurred almost every year in the months of March-April and October-November in severe forms. One month old seedlings of Pusa Purple Cluster were transplanted every year in both the seasons. The disease intensity (weekly) was recorded in the months of Feb-April and Aug.-Oct. Weekly meteorological data on maximum temperature (X_1), minimum temperature (X_2), morning relative humidity (X_3), evening relative humidity (X_4), rainfall (X_5) and number of rainy days (X_6) were also recorded. Out of ten years data two years data were selected for each leaf spot and fruit rot having maximum disease intensity. Stepwise multiple regression analysis was performed to select as the best fit for predicting the disease under normal epiphytotic. Stepwise multiple regression analysis showed that the mean disease intensity of leaf spot was greatly influenced by the variables maximum temperture (X_1), minimum temperature (X_2), total rainfall (X_5) and number of rainy days (X_6) and fruit rot by maximum temperature (X_1), minimum temperature (X_2), relative humidity evening (X_4) and number of rainy days (X_6). The R^2 values of the functions ranged from 0.5835 to 0.9951. The linear prediction equation for leaf spot : $\dot{Y} = 202.2702 + (-0.49323\ X_1) + (0.1369\ X_5) + (-8.0998\ X_6)$ and for fruit rot $\dot{Y} = 79.0106 + (1.5692\ X_1) + (-3.7674\ X_2) + (-0.3939\ X_4)$ were selected the best fit for predicting the Phomophsis blight of eggplant under normal epiphytotic.

Key words : Eggplant, epidemiology, forecasting, Phomopsis blight, prediction

INTRODUCTION

In most of the tropical and sub tropical areas Phomopsis blight and fruit rot of eggplant incited by *Phomopsis vexans* (Sacc. & Syd.) Harter is considered to be the most serious and wide spread disease. The disease has been reported to cause epiphytotic in many countries like Mauritius in 1950 (Felix *et al.*, 1965), Brazil in 1944 (De Figueiredo and Pereira, 1944), Florida in 1915, 1917 and 1918 (Harrison and Kelbert, 1944), Barbades in 1922-23 (Bourne, 1923) and Philippines in 1935 and 1936 (Palo, 1938). Severe outbreaks of this disease have also been reported in India from Punjab (Panwar *et al.*, 1970), Bombay (Pawar and Patel, 1957), Delhi (Vasudeva, 1960) Bihar (Sinha, 1989), West Bengal (Islam and Pan, 1990), Haryana (Pauwar and Chand, 1969) and Madbya Pradesh (Chowdhury and Hassija, 1979). Phomopsis blight has been kept next to wilt in its destructiveness. Various symptoms incited by *P. vexans* have been recorded like leaf sopt, stem canker, twig blight and damping-off of seedlings (Edgerton and Moreland, 1921), die-back (Decker, 1946), collar canker (Vishunvat, 1992). Very little work has been done to correlate between extent of damage and weather factors. Hence present investigation was undertaken.

MATERIALS AND METHODS

During survey it has been found that Phomopsis blight appears almost every year in moderate to severe form specially in the month of October and April. Hot spots were identified at Imalia Farm and Maharajpur. Field experiment was laid out in a plot (20 × 20 m) during 1983-1999. One month old seedlings of Pusa Purple Cluster were planted in the month of July for leaf spot and in January for fruit rot giving 100 × 60 cm spacing. The crop was fertilized with 120 : 60 : 60 (N : P. K). The per cent disease intensity (PDI) was recorded in the months of Feb-April and Aug.-Oct. as per standard formula.

Meteorological observations obtained from Meteorological Department, JNKVV, Jabalpur on temperature, relative humidity and rainfall were plotted against various degrees of disease intensities. On the basis of these weekly observations, environmental conditions prevailed during the course of disease development were examined.

Simple correlation and stepwise multiple regression analysis were performed using computer facility available at JNKVV, Jabalpur. Stepwise multiple regression analysis were performed to find out the subset of environmental variable (X_1 to X_6) for the purpose of forecasting.

RESULTS AND DISCUSSION

Weekly meteorological data on maximum temperature (X_1), minimum temperature (X_2), morning relative humidity (X_3), evening relative humidity (X_4), ranifall (X_5) and number of rainy days (X_6) for the year 1993 and 1996 were chosen for leaf spot and 1995 and 1999 for fruit rot for correlation studies. The data are presented in Table 1, 2, 3 and 4.

Simple correlation analysis of the variables (X_1......X_6) showed that PDI (Y) in case of leaf spot had significant positive correlation with relative humidity (morning) YX_3 = 0.60032-0.69722, relative humidity YX_4 = 0.29568-0.50990 and rainfall YX_5 = 0.24124 for the year 1993 and 1996, respectively. In case of fruit rot it showed positive but non significant with maximum temperature (YX_1 = 0.21671 – 0.16524) and negative correlation with all other variables fruit rot for variable (X_2) minimum temperature, (X_5) rainfall and (X_6) number of rainy days where they were negatively correlated. Differences were recorded in case of (1) maximum temperature (X_1) leaf spot positively correlated fruit rot negatively correlated ; (2) relative humidity (morning) X_3 and (3) relative humidity evening (X_4) where it was positively correlated with leaf spot and negatively correlated with fruit rot.

Stepwise multiple regression analysis showed that predicted mean PDI of leaf spot was greatly influenced by the variable X_1 (maximum temperature), X_2 (minimum temperature), X_5 (total rainfall) and X_6 (number of rainy days) and fruit fot by X_1 (maximum temperature), X_2 (minimum temperature), X_4 (relative humidity evening) and X_6 (number of rainy days). The R^2 values of the functions ranged from 0.5839 to 0.9951. The linear prediction equation for leaf spot $\hat{Y}$ = 202.2702 + (-0.49323 X_1) + (0.1369 X_5) + (-8.0998 X_6) and for fruit rot $\hat{Y}$ = 79.0106 + (1.5692 X_1) + (-3.7674 X_2) + (-0.3939 X_4) were selected as the best fit for predicting the disease under normal epiphytotics.

The only work on functional relationship was reported from West Bengal by Islam and Pan (1990). They found positive correlation with X_1, X_2, X_4, (R. H. evening) and X_5 (total rainfall). The present investigation does not support the above findings in toto. It is confirmed from the present findings that the growth of the fungus and temperature range (25°C to 30°C) and RH range 60 to 80) are most favourable for disease development. Incidence of the disease in the month of April and October indicates the role of the range of temperature and humidity for disease development.

Table 1 : Correlation of leaf spot and fruit rot intensity with environmental factors

Year	Temperature (°C)		Relative humidity		Rainfall	No. of rainy days
Form of Disease	Maximum (X_1)	Minimum (X_2)	Morning (X_3)	Evening (X_4)	(mm) X_5	(X_6)
1993/Leaf spot	– 0.764415**	– 0.63755*	0.69722*	0.50990	0.24124	– 0.13923
1996/Leaf spot	– 0.48770	– 0.76415*	0.60032	0.29568	– 0.18702	– 0.20260
1995/Fruit rot	0.21671	– 0.91530**	– 0.59909	– 0.93765**	– 0.40966	– 0.40625
1999/Fruit rot	0.16524	– 0.97 02**	– 0.83968**	– 0.88530**	– 0.51265	– 0.76275**

* = Significant at 5 per cent level ; ** = Significant at 1 per cent level.

Table 2 : Correlation matrix of Phomopsis blight intensity with environmental factors during 1993 and 1996

$\hat{Y}$		X_1	X_2	X_3	X_4	X_5	X_6
$\hat{Y}$	a	– 0.76415	– 0.63753	0.69722	0.50990	0.24124	– 0.13923
	b	– 0.48770	– 0.76415*	0.60032	0.29568	– 0.18702	– 0.20260
Maximum Temperature							
X_1	a	—	0.90090	– 0.80768	– 0.60558	– 0.23698	– 0.22495
	b	—	0.84620	– 0.92015	– 0.90631	– 0.28144	– 0.4419
Minimum Temperature							
X_2	a	—	—	– 0.79502	– 0.60607	– 0.43901	– 0.40493
	b	—	—	– 0.87859	– 0.62077	0.03217	0.01360
Relative humidity (mor)							
X_3	a				0.84491	0.49612	0.40438
	b				0.86193	0.37493	0.35001
Relative humidity (eve)							
X_4	a					0.70424	0.63637
	b					0.51708	0.71432
Total rainfall	a	—	—	—	—	—	0.75390
X_5	b	—	—	—	—	—	0.66230

a = 1993 ; b = 1996.

Table 3 : Correlation matrix of Phomopsis blight intensity with environmental factors during 1995 and 1999

$\hat{Y}$		X_1	X_2	X_3	X_4	X_5	X_6
$\hat{Y}$	a	0.21671	– 0.91530	– 0.59909	– 0.93765	– 0.40966	– 0.40625
	b	0.16524	– 0.97102	– 0.83968	– 0.88530	– 0.51265	– 0.76275
Maximum Temperature							
X_1	a	—	– 0.00735	– 0.15480	– 0.29300	– 0.33210	– 0.27133
	b	—	– 0.00505	– 0.28719	– 0.26869	– 0.37483	– 0.53058
Minimum Temperature							
X_2	a	—	—	0.62959	0.94311	0.43559	0.54377
	b	—	—	0.82177	0.77080	0.41163	0.64212
Relative humidity (mor.)							
X_3	a				0.65291	0.37450	0.55102
	b				0.65213	0.52922	0.76807
Relative humidity (eve)							
X_4	a					0.51503	0.61141
	b					0.53567	0.76339
Total rainfall	a	—	—	—	—	—	0.79812
X_5	b	—	—	—	—	—	0.85404
Number of rainy days	a						—
X_6	b						—

a = 1995 ; b = 1999.

Table 4 : Values of coefficient of determination (R^2), adjusted R^2 values and partial regression coefficients for different functionsl equations for four years

Year/Form of Disease	Multiple regression funciton	R^2	R^2Adj
1993/Leaf spot	$\hat{Y} = 202.2702 + (-0.4932\ X_1) + (0.1369\ X_5) + (-8.0998\ X_6)$	0.8827	0.8475
1996/Leaf spot	$\hat{Y} = 207.5516 + (-7.3307\ X_2)$	0.5839	0.5542
1995/Fruit rot	$\hat{Y} = 104.99205 + (-1.3225\ X_4) + (3.2942\ X_6)$	0.9257	0.9120
1999/Fruit rot	$\hat{Y} = 79.0106 + (1.5692\ X_1) + (-3.7674\ X_2) + (-0.3939\ X_4)$	0.9951	0.9937

$\hat{Y}$ = Predicated mean disease severity, X_1 = maximum air temperature, X_2 = minimum air temperature, X_4 = relative humidity (evening), X_5 = total rainfall (mm) and X_6 = number of rainy days.

Thus for causing newer infection high humidity with optimum temperature (around 25°C) and for further development dry weather of temperature around 25°C is required. Temperature above 35°C and below 20°C will not favour the development of the disease. Hence the finding that the increase in the rainfall and RH the disease incidence increases fits well, whereas increase in the disease incidence with increases in maximum temperature and minimum temperature does not fit well. These differences may be due to the tremendous variation in the climate of West Bengal and Madhya Pradesh. As for as the fruit rot is concerned, the disease is favoured by duration of rain (June to October), negatively correlated with minimum temperature and relative humidity (evening). This work experimentally proves the speculations of Palo (1936). Variations in the predictive models in the present investigation with the findings of Islam (1990 and Pan) suggest that the models developed for one agro climatic zone do not fit well for other agro climatic zone.

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