Research Paper :

Prediction model for bacterial blight of cotton

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SUMMARY

Protected and unprotected plots of cotton variety, PA 183 were grown during the year 2003-04 in the field of Marathwada Agricultural University, Parbhani. Intensity of bacterial blight was recorded from occurrence of the disease till harvest of the crop at weekly interval. Meteorological parameters such as temperature (^{0}C), relative humidity (%), rainfall (mm), wind velocity (kmph) and bright sunshine (hrs) were used to develop multiple regression equation for prediction of bacterial blight intensity. Results indicated that prediction equations developed on the basis of meteorological parameters prevailing 4 and 7 days prior to bacterial blight intensity suffered from high prediction error. When prediction equations were developed based on cumulative sum of meteorological parameters had high value of coefficient of determination and low prediction error.

Key words : Bacterial blight, Meteorological parameters, Prediction, multiple regression, Cotton

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Bacterial blight of cotton caused by *Xanthomonas axonopodis* pv. *malvacearum* is one of the serious diseases of cotton.Disease is widely prevalent in cotton growing areas of India (Verma, 1986 and Srinivasan, 1994), causing losses upto 30 per cent (Mishra and Krishna, 2001 and Patil *et al*., 2001 and 2003) which may be very high if it appears in epidemic form. A few management strategies available against the disease do not provide adequate protection. Since weather based forecasting module is not available growers often either undertake excess chemical management or undertake it very late when the disease has already resulted in appreciable loss. Thus, there is a acute need to formulate weather based forecasting system so that growers can undertake timely plant protection. In the light of this situation present study was undertaken to formulate weather based forecasting module for prediction of bacterial blight in cotton (var. PA 183).

MATERIALS AND METHODS

Two plots of cotton variety PA 183 were raised at Meteorology Department of Marathwada Agricultural University Campus, Parbhani having gross area of 25 x 20 metres each. One of the plots did not receive any fungicidal application. The other plot was protected with recommended fungicidal application (Copper oxychloride 0.25 %). Crop was sown at the spacing of 45 x 30 cm^2. Experimental plots were applied with recommended fertilizers. The plots were kept weed free by regular hoeings and hand weedings. Insecticidal (dimethoate, metasystox, endosulfan, quinalphos) application was made to protect these plots from insect damage. Bacterial blight intensity was recorded in 0 to 4 scale. Per cent disease intensity was computed on the basis of observations recorded on 5 plants at random from each plot. Observations were continued from occurrence of disease till 180 days of crop growth *i.e.* crop harvest, at weekly interval. The cotton hybrid, PA 183 was sown on 4.7.2003.Daily observations of meteorological parameters such as minimum and maximum temperature (0^oC), RH (%, a.m.), RH (%, p.m.), rainfall (mm), wind velocity (kmph), bright sunshine (hrs) were recorded at Meteorological Laboratory located near to Experimental Plot at Marathwada Agricultural University, Parbhani during the crop growth period. From these observations, minimum temperature/day, minimum relative humidity/day, etc. were computed.

Multiple regressions between meteorological parameters and disease intensity were worked out to disentangle and measure the effect of meteorological parameters on disease intensity. Meteorological parameters were considered as independent

(X) variables while disease intensity was considered as dependent (Y) variable :

X_1 = Minimum temperature (^{0}C)
X_2 = Maximum temperature (^{0}C)
X_3 = Relative humidity (a.m.)
X_4 = Relative humidity (p.m.)
X_5 = Rainfall (mm)
X_6 = Wind velocity (kmph)
X_7 = Bright sunshine (hrs)

For multiple regressions the formula was setup as.

$$Y = b_0+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7 \ldots\ldots+b_n x_n$$

where,

bo = interception point and b_1 to b_n were regression coefficients for respective X variables.

The prediction error was computed by using following formula:

$$\textbf{Error of forecast} = \frac{\sqrt{\frac{(1-R^2)\,x\,Y^{SS}}{n\,x\,n-1}}}{\overline{Y}}$$

RESULTS AND DISCUSSION

Multiple regression equations based on observations of meteorological parameters, 4 and 7 days prior to bacterial blight intensity indicated that goodness of fit was not significant and also regression coefficients for individual meteorological parameters were not significant (Table 1). Coefficients of determination for prediction system, 4 days prior to bacterial intensity were 0.636 and 0.603 in protected and unprotected crops, respectively and the prediction error was 7.86 and 9.10 per cent, respectively. For prediction system based on observations of meteorological parameters 7 days prior to bacterial blight intensity, coefficients of determination were 0.632 and 0.598 in protected and unprotected crops, respectively. The prediction errors for the aforesaid crops were 7.90 and 9.16, respectively.

Goodness of fit was significant for the prediction systems based on cumulative sum of meteorological parameters 4 and 7 days before bacterial blight intensity in protected and unprotected crops at M.A.U. campus (Table 1). For individual meteorological parameters

Table 1 : Multiple regression equation for prediction of bacterial blight intensity (Y) in cotton variety PA 183 on the basis of meteorological parameters (X variables) during 2003-04.

Sr. No.	Meteorological parameters	Regression coefficient							
		MAU field							
		Protected				Unprotected			
		Days before bacterial blight intensity				Days before bacterial blight intensity			
		Individual		Cumulative sum		Individual		Cumulative sum	
		4	7	4	7	4	7	4	7
	Bo	-37.8671	155.282	-55.859	-30.5569	-46.2796	226.99	-48.9607	-26.2242
1.	Minimum temperature (^{o}C)	-0.258311 (0.757001)	1.22543 (0.817505)	0.0803097* (0.0287285)	0.111261* (0.0378768)	-0.579843 (1.13440)	1.66796 (1.22702)	0.1279597* (0.0470057)	0.149579 (0.07085130
2.	Maximum temperature (^{o}C)	1.89124 (1.53751)	-1.86872 (1.91943)	0.547819 (0.0440943)	-0.0643901 (0.0568336)	2.70626 (2.30402)	-2.879508 (2.88093)	-0.0562134 (0.0721473)	-0.0402422 (0.106311)
3.	Per cent relative humidity (a.m.)	0.189835 (0.205599)	-0.581762 (0.382926)	-0.00870465 (0.00634322)	0.00385301 (0.00954794)	0.172984 (0.308099)	-0.868549 (0.574744)	-0.0214126 (0.0103788)	-0.00050161 (0.0178601)
4.	Per cent relative humidity (p.m.)	-0.327515 (0.148411)	-0.434912 (0.220099)	0.000183713 (0.00042366)	-0.0218259 (0.0123923)	-0.403758 (0.222400)	-0.562484 (0.330352)	0.000736981 (0.00069320)	-0.0405468 (0.0231807)
5.	Rainfall (mm)	-	1.39561 (0.745083)	0.0686817 (0.0442562)	-0.00428467 (0.0529437)	-	2.03962 (1.11832)	0.0750832 (0.0724123)	-0.0290580 (0.0990349)
6.	Wind speed (kmph)	-0.584616 (1.16278)	-0.242352 (1.16034)	0.0746698 (0.0792467)	0.163565 (0.120281)	-0.749939 (1.74247)	-3.75704 (1.74158)	0.00341965 (0.129746)	0.251821 (0.224995)
7.	Bright sunshine hours	-0.792831 (1.03157)	-0.336200 (2.04839)	0.0928845 (0.0766845)	0.0324218 (0.0992826)	1.28882 (1.54584)	-4.41762 (3.07448)	0.153457 (0.125472)	-0.0280893 (0.0185715)
	F	2.326	1.72	37.06*	40.2597*	2.02	1.487	28.28*	23.29*
	R2	0.636	0.632	0.974	0.976	0.603	0.598	0.966	0.959
	SE(Y)	3.57402	3.83808	1.02609	0.985511	5.35581	5.76069	1.6789	1.84347
	Prediction error (%)	7.86	7.90	2.10	2.28	9.10	9.16	2.66	2.93

* The figures in parentheses are standard errors of regression coefficients.

regression coefficients were significant for both the situations in protected crop and for observations of meteorological parameters 4 days prior to bacterial blight intensity in unprotected crop. The coefficients of determination were 0.974 and 0.976, and 0.966 and 0.959 in protected and unprotected crops for prediction system based on observations of meteorological parameters 4 and 7 days prior to bacterial blight intensity. The prediction errors for these situations were 2.10 and 2.02 and 2.66 and 2.93 per cent, respectively.

The prediction systems based on meteorological parameters 4 and 7 days prior to bacterial blight intensity in protected and unprotected crops have shown non-significance for goodness of fit (Table 2). Also the individual regression coefficients for respective meteorological parameters were not significant. The coefficients of determination for meteorological observations, 4 days prior to bacterial blight intensity were 0.466 and 0.484 in protected and unprotected crops, respectively. The errors of prediction at these situations were 9.52 and 10.37 per cent, respectively. The coefficients of determinations for protected and unprotected crops for the equations based on observations of meteorological parameters, 7 days prior to bacterial blight intensity were 0.562 and 0.520, respectively. The errors of prediction at these situations were 8.62 and 10.01 per cent, respectively.

Multiple regression equations for prediction of bacterial blight intensity based on cumulative sum of observations of meteorological parameters 4 and 7 days earlier to bacterial blight intensity indicated that goodness of fit was significant (Table 2). Regression coefficient for bright sunshine hours was significant for the equation based on observations 4 days prior to disease intensity. For prediction system based on observations of meteorological parameters, 7 days prior to disease intensity, mean temperature (^{0}C), mean relative humidity (%) and bright sunshine hours have shown significance for regression coefficient. The coefficient of determination for the system based on observations 4 days earlier to disease intensity were 0.914 and 0.877 in protected and unprotected crops, respectively and the prediction error at these situations were 4.42 and 5.06, respectively. For prediction system based on observations, 7 days earlier to disease intensity, coefficients of determination were 0.962 and 0.949 in protected and unprotected crops, respectively. The prediction errors for these situations were 2.54 and 3.26.

Results indicate that prediction based on existing meteorological parameters have shown poor linear

Table 2 : Multiple regression equation for prediction of bacterial blight intensity (Y) in cotton variety PA 183 on the basis of mean and cumulative temperature and relative humidity with other meteorological parameters (X variables)

Sr. No.	Meteorological parameters	Regression coefficient							
		Days before bacterial blight intensity							
		Protected (individual)		Unprotected (Individual)		Protected (cumulative sum)		Unprotected (cumulative sum)	
		4	7	4	7	4	7	4	7
	Bo	Bo 26.2249	43.5343	41.2214	53.477	-100.06	-31.6947	121.666	-31.0142
1.	Mean temperature (^{o}C)	0.308766 (0.569788)	0.6817630 (0.371141)	0.349676 (0.803199)	0.812827 (0.557911)	0.0339333 (0.0284694)	0.0798109* (0.0267409)	0.0732100 (0.0458758)	0.135813* (0.0444841)
2.	Mean per cent relative humidity (a.m.)	-0.356155 (0.164501)	-0.474752 (0.205377)	-0.535189 (0.231887)	-0.584682 (0.308730)	0.0134594 (0.00127411)	-0.0252658* (0.00720439)	-0.000595816 (0.00210999)	-0.0441711* (0.0119847)
3.	Rainfall (mm)	-	0.895364 (0.507576)	-	1.20647 (0.763004)	0.125767 (0.0688944)	-0.0169693 (0.0506800)	-0.0913262 (0.119511)	-0.0257396 (0.0843072)
4.	Wind speed (kmph)	-1.11421 (1.09958)	-1.90614 (0.990080)	-1.5721 (1.55001)	-2.89989 (1.48832)	0.0337383 (0.130211)	0.177283 (0.107692)	0.00512600 (0.2140457)	0.218342 (0.179149)
5.	Bright sunshine hours	1.04998 (0.761536)	-1.50915 (1.12127)	0.00578192 (1.07350)	1.49854 (1.68553)	0.0940577 (0.0226928)	-0.110468* (0.00157682)	-0.172947* (0.0422256)	-0.146684* (0.0262308)
	F	2.18	2.31	2.35	1.95	21.28*	45.62*	12.85*	33.5*
	R2	0.466	0.562	0.484	0.52	0.914	0.962	0.877	0.949
	SE(Y)	3.87183	3.69438	5.4579	5.55351	1.74451	1.08766	2.80847	1.80934
	Prediction error (%)	9.52	8.62	10.37	10.01	4.42	2.54	5.06	3.26

relationship and high prediction error. Therefore, prediction at these situations was possible with high prediction error. However, when cumulative sum of individual meteorological parameters was considered for formulation of equations, all the equations had high coefficient of determination indicating strong linear relationship and prediction by this way would be more practicable.

Few workers in past have tried to develop the prediction equations on the basis of meteorological parameters (Degaonkar and Kirtiwar, 1997 and Khan and Rashid, 2001). Khan and Rashid (2001) formulated 4 variable models consisting of soil temperature and pH and rainfall and relative humidity based on observations of 1997 and 1998. Deogaonkar and Kirtiwar (1997) formulated multiple regression equation with a linear relationship having R^2 value of 0.682. These workers concluded that linear relationship of meteorological variables with bacterial blight intensity was moderate and such kind of prediction suffers from moderate prediction error. Present study reveals that prediction system based on cumulative values of meteorological parameters are suitable because of strong linear relationship and low prediction error than existing values of meteorological parameters at 4 and 7 days prior to bacterial blight intensity.

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