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Epidemiology of powdery mildew of cowpea in Konkan region of Maharashtra

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Abstract
The knowledge of specific weather conditions congenial for development of powdery mildew disease of cowpea is important to adopt timely and need based management practices. The present investigation on relationship between weather variables and per cent disease intensity, in early sown and mid sown crop the weather parameters i.e., maximum and minimum temperatures, wind speed, bright sunshine hours, rate of evaporation and crop age were the predominant parameters contributing to the disease development While in case of late sown crop the weather parameters *viz*, maximum and minimum temperatures, morning and evening relative humidity, bright sunshine hours and crop age played a predominant role in disease development. Results present investigation showed that, maximum temperature (29 to 31 ^{0}C), minimum temperature (14 to 19 ^{0}C), relative humidity (55 to 95%), wind speed (3.2 to 4 Km/hr), evaporation (4.5-5.2 mm), sunshine hours (7.5 to 8.5) and crop age (45-55 days) were positively and highly significant in disease development.

Keywords: Cowpea, *erysiphe polygoni*, epidemiology, powdery mildew, correlation, regression

Introduction
Powdery mildew is serious disease of cowpea incited by *Erysiphe polygoni* (DC) causing considerable losses. The disease is generally known to appear from the early flowering to pod maturity stage and its development depends on cultivars, sowing dates and prevailing weather conditions. It has been observed for the past several years that powdery mildew occurs in traces during November-December and prevails as such up to February or second fort night of March. This pattern of development of powdery mildew seems to be related to weather parameters. In order to understand the role of weather variables in disease development, the present investigation was carried out during the year 2012-13 and 2013-2014.

Materials and Methods
The field experiment was conducted at Department of Agril. Botany, College of Agriculture, Dapoli, during, *Rabi* 2012-13 and 2013-2014. Recommended dose of fertilizers were applied and plots were irrigated for better seed germination. All intercultural operations were performed regularly. For recording the observation on powdery mildew 5 plants per treatment per replication were randomly selected and tagged. Visual observation on powdery mildew intensity was recorded on the bottom, middle and top trifoliate of selected plant at 3 days interval. Numerical grades were assigned to the amount of disease observed applying 0-5 disease rating scale (Singh *et al* [8]., 1994) and per cent disease intensity was computed by applying the formulae (Wheeler [11] 1969) as given below:

$$\text{PDI} = \frac{\text{Sum of Numerical Rating}}{\text{No. of leaves observed /plant X Maximum grade}} \times 100$$

Simultaneously, meteorological data on maximum and minimum temperature, morning and evening relative humidity, wind speed, bright sunshine hours and evaporation were also recorded. Correlations and regression equations between disease severity and above independent factors were worked out by using standard procedure given by Gomez and

Gomez[4] (1984). The severity of cowpea powdery mildew was recorded during the crop season and in order to find out the role of meteorological factors on disease development.

Result and Discussion

Correlation Analysis

The results of simple linear correlation analysis presented in table 1 revealed that, out of eight independent variables, seven weather parameters and crop age played a significant role in correlation with per cent disease intensity of powdery mildew. The results indicated that the minimum temperature, morning humidity, wind speed, bright sunshine hours, rate of evaporation and crop age showed significant and positive correlation with powdery mildew intensity in all the sowing dates. In pooled analysis, minimum temperature (r =0.698), morning humidity (r = 0.887), wind speed (r = 0.735), bright sunshine hours (r = 0.608), rate of evaporation (r = 0.653) and crop age (r = 0.925) in first sown crop, wind speed (r = 0.865), bright sunshine hours (r = 0.584), rate of evaporation (r = 0.763) and crop age (r = 0.946) in second sown crop and minimum temperature (r = 0.656), evening humidity (r = 0.709), wind speed (r = 0.560) and crop age (r = 0.946) in third sown crop were found significant and positively correlated with powdery mildew intensity. Morning humidity (r = -0.768) was significantly and negatively correlated with disease intensity in third sown crop.

As it is quite obvious that no weather factor can independently influence the powdery mildew disease, the results of multiple regression analysis would throw more light in establishing the influence of various weather factors on this disease. Therefore, the step down regression analysis was carried out for studying the contribution of individual weather parameter and to find out parameters responsible for major contribution in disease development.

Regression Analysis

In regression analysis in first sown crop the regression coefficients of minimum temperature, morning humidity, rate of evaporation and crop age during *Rabi* 2012-13 and minimum temperature, bright sunshine hours and crop age during *Rabi* 2013-14 were found positive and significant. The regression coefficients of crop age during *Rabi* 2012-13 and morning humidity, evening humidity and crop age during *Rabi* 2013-14 were found positively significant in second sown crop. In case of third sown crop the regression coefficients of maximum temperature, morning humidity, bright sunshine hours and crop age during *Rabi* 2012-13 and crop age during *Rabi* 2013-14 were found significant. The results of step down regression equations presented in table 2 revealed that, an increased in minimum temperature by one unit could cause increase in 2.45 and 3.79 per cent disease intensity during *Rabi* 2012-13 and *Rabi* 2013-14, respectively in first sown crop. Morning humidity increase by one unit could cause increase in disease intensity by 2.54 and 10.66 in first and third sown crop during *Rabi* 2012-13 and morning as well as evening humidity decreased disease intensity by 2.48 and 1.61 per cent respectively in second sown crop during *Rabi* 2013-14. Bright sunshine hours was found significant and positive by unit change in BSS which reduces the disease intensity by 36.24 per cent in third sown crop during *Rabi* 2012-13 and increases disease intensity by 13.68 per cent in first sown crop during *Rabi* 2013-14. The crop age was found significant and could cause increases the disease intensity by 1.56, 0.97 and 0.70 per cent during *Rabi* 2012-13 and 0.86, 0.51 and 0.86 per cent during *Rabi* 2013-14 in first, second and third sown crop, respectively.

The value of coefficient of multiple determinations (R-square) indicated per cent variation in disease intensity by independent variables.

Results indicated that the minimum temperature, morning relative humidity, wind speed, bright sunshine hours, rate of evaporation and crop age showed significant and positive correlation with powdery mildew intensity in all the sowing dates. The congenial weather parameters viz, maximum temperature (29 to 31^{0}C), minimum temperature (14 to 19 ^{0}C), relative humidity (55 to 95%), wind speed (3.2 to 4 Km/hr), evaporation (4.5-5.2 mm), bright sunshine hours (7.5 to 8.5) and crop age (45 to 55 days) were played important role in powdery mildew disease development in cowpea.

Similar results were recorded by Balamurali Krishnan and Jeyarajan [2] (1997), Pandey and Pandey [6] (2002), Saharan and Sheoran [7] (1988) and Thakur *et al* [10]. (2004). Adams *et al*. [1] (1986) observed that sudden reduction in RH was the main environmental factor that trigger active discharge of powdery mildew conidia and also reported that conidia produced normally and ready for dispersal at day time when temperature, RH, wind speed and solar radiation were actually fluctuating within the canopy micro-climate. Solanki *et al* [9] (1999) studied the development and progress of powdery mildew of mustard in relation to meteorological factors. In correlation studies, mean temperature, number of trapped conidia and crop stage were significantly positively correlated and regression analysis accounted for the 75 per cent variation. Gadre *et al.*[3] (2002) studied the effect of different meteorological factors on the incidence of *Alternaria* leaf blight, white rust and powdery mildew of mustard under south Konkan agro-climatic conditions and reported that, among the various weather variables which could influence the diseases, sunshine and crop age were highly significant. Maximum, minimum and mean temperatures were significant for powdery mildew.

Table 1: Correlation coefficients of disease intensity with weather parameters and biological factor at three different sowing dates.

Variables	2012-2013			2013-14			Pooled		
	Coefficients			Coefficients			Coefficients		
	1st Sowing (47th MW)	2nd Sowing (49th MW)	3rd Sowing (51st MW)	1st Sowing (47th MW)	2nd Sowing (49th MW)	3rd Sowing (51st MW)	1st Sowing (47th MW)	2nd Sowing (49th MW)	3rd Sowing (51st MW)
T max	0.271	0.108	-0.048	-0.792*	-0.035	0.738*	-0.208	0.053	0.537
T min	0.197	0.434	0.682*	0.622*	0.124	0.369	0.698*	0.488	0.656*
RH-I	0.786*	0.144	-0.407	0.809*	-0.604*	-0.687*	0.887*	-0.464	-0.768*
RH-II	0.473	0.547	0.450	0.274	-0.591*	0.504	0.478	0.009	0.709*
Wind speed	0.662*	0.658*	0.604*	0.432	0.782*	0.354	0.735*	0.865*	0.560*
BSS	0.594*	0.422	0.126	0.077	0.539	0.144	0.608*	0.584*	0.144
Evaporation	0.570*	0.597*	0.624*	0.250	0.506	-0.206	0.653*	0.763*	0.139
Crop Age	0.900*	0.964*	0.952*	0.938*	0.898*	0.928*	0.925*	0.946*	0.946*

***=** coefficients significant at 5% level of significance

Table 2: Correlation analysis and regression coefficients for relationships between disease severity and weather parameters.

Dates of Sowing	Year	Coefficient of multiple determination (R^2)	Regression Equation
47th MW (15th Nov.)	2012-13	0.986	$Y = -43.956 +2.45^* X_2 +2.54^* X_3 -4.68 X_5 -10.27 ^*X_7 +1.56^* X_8$
	2013-14	0.966	$Y = -143.99 -3.79 ^*X_2 -4.84 X_5 +13.68^* X_6 +0.86 ^*X_8$
	Pooled	0.986	$Y = 53.09 +9.59 X_5 -4.70 X_6 -16.85^* X_7 +1.49^* X_8$
49th MW (1st Dec.)	2012-13	0.973	$Y = -169.96 -3.63 X_1 -2.43 X_2 +3.59 X_3 -14.65 X_6 +21.47 X_7 +0.97^* X_8$
	2013-14	0.899	$Y = - 267.40 +2.35 X_1 -2.48^* X_3 -1.61^*X_4 +0.51^* X_8$
	Pooled	0.964	$Y = - 28.93 – 2.79^* X1 +3.93^* X_2 +8.88^* X_6 +0.64^* X_8$
51st MW (15th Dec.)	2012-13	0.988	$Y = - 730.71 – 5.77^* X_1 - 3.48 X_2 +10.66 ^*X_3 – 8.20 X_5 – 36.24^* X_6 +0.70 ^*X_8$
	2013-14	0.877	$Y = 86.49 +0.87 X_1 -1.24 X_3 +0.86^* X_8$
	Pooled	0.994	$Y = - 115.47 -4.62^* X_1 +6.63^* X_2 +0.90 X_3 +0.43 X_4 +8.97 X_6 +0.64^* X_8$

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