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Development of the Regression Model to Predict Pigeon Pea Yield Using Meteorological Variables for Marathwada Region (Maharashtra)

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ABSTRACT

The study was carried out at Department of Agricultural Meteorology, VNMKV, Parbhani to find the quantitative relationship between weather parameters and district level yield of pigeon pea. For this purpose, 30 years (1982-83 to 2011-12) weather and crop yield records of different district of Marathwada region of Maharashtra (India) were collected. A twenty-eight-week crop period model was recommended for pre harvest forecast due to higher R^2 value and lower simulated forecast deviation. The time trend, maximum temperature, morning and evening relative humidity significantly affected crop yield. In Aurangabad equation shows that the Tmin. and Tmean has positively significant effect on yield. In latur the equation shows that all weather parameters have highly positively significant effect Tmax., Tmin., Tmean, RH I, RH II, Rainfall and R.D. effect on yield.In osmanabad equation show that the Tmin.and Tmean have negatively significant effect on yield while other variables show non-significant effect on yield. While in Parbhani and Beed District all the weather parameters have no significant effect on yield.

Key words: *Pigeon pea, correlation, regression model, Meteorological variables.*

INTRODUCTION

Pigeon pea [*Cajanus cajan* (L.) Millsp.] is one of the important pulse of the tropics and sub-tropics. Pigeon pea crop grown in approximately 50 countries viz. Asia, Africa and the America, mostly as in intercrop with cereals. India has a virtual monopoly in pigeon pea production by accounting 90 per cent of world's total production. It is the preferred pulse crop in dryland areas where it is intercropped or grown in mixed cropping systems with cereals or other short duration annuals[2]. The study presented here is to see how different climatic variables affect the crop during crop growing season. Correlation study for a week period gives a preliminary idea about the effect of any particular weather variable on the yield during that week. The problem of predicting crop yield has occupied the attention of agronomist, Soil scientist, plant physiologist as well as Meteorologist for many years. The methods of predicting yield ranges from statistical approach[7] to crop simulation models[1,6]. The former depends heavily on empirical correlation between yield and climatic variables.

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While the later simulated the crop biophysical processes that underline crop growth and development to produce grain yield. Parthasarathy *et al*[4] have developed prediction equation model, for total Indian food grain production using monsoon rainfall. The study presented here is to see how different climatic variables affect the crop during crop growing season. Correlation study for a week period gives a preliminary idea about the effect of any particular weather variable on the yield during that week.

MATERIALS AND METHODS

The methodology consisted of the collection of historological weather and crop yield data of each district of the Marathwada region. The data were collected from the different agromet observatories present at different research centers which comes under VNMKV, Parbhani. The district wise data of 30 years (1982-83 to 2011-12) on net sown areas, production, yield of Pigeon pea yield (kg ha^{-1}) data for Marathwada region was collected from statistical department of Aurangabad and Latur, indiastat.com., Agriculture related website, and research station comes under VNMKV, Parbhani. Daily value of the meteorological elements viz., maximum and minimum temperature, maximum and minimum relative humidity, rainfall, number of rainy days and sunshine duration were collected from Indian Meteorological Department, Pune. Others climatic variables that affect yield, were derived using observed meteorological parameters. Soil considered under study is black soil. Pigeon pea is sown in 25th week (18-25th June). Total duration of crop varies from 180-200 days.

Statistical analysis

Statistical Tools and Techniques Employed for Analysis. In order to investigate the objectives laid out for the present study the following statistical tools were employed.

- Correlation
- Regression analysis.

Correlation

After analyzing weather and crop data, the correlation worked out between weather parameter and yield of crop.

Correlation is a measure of intensity or degree of linear relationship between two variables for 'n' pair of observations. Numerical measure of correlation coefficient is given by,

$$R(x,y) = \frac{\Sigma XY - (\Sigma X)(\Sigma Y)/n}{\sqrt{[(\Sigma X^2 - (\Sigma X^2)/n)(\Sigma Y^2 - (\Sigma Y^2)/n)]}}$$

Where, R is the correlation coefficient, x and y are two related variables and n is the sample size.

The significance of the correlation coefficient (r) is tested by using 't' statistics and is given by,

$$t = \frac{r\sqrt{(n-2)}}{\sqrt{(1-r^2)}}$$

Where, r is the correlation coefficient

Test statistics value is compared with critical value at (n-2) degrees of freedom at given level of significance.

Regression

Regression is the average relationship between dependent (response) and independent (explanatory) variables.

The general form of the regression model is,

$Y=\alpha + \beta1X1+\beta2X2+ \beta3X3+ \beta4X4+ \beta5X5 +\in$

Where,

Y= dependent variable, α =intercept, $\beta1$, $\beta2$, $\beta3$, $\beta4$, $\beta5$ = Regression coefficients, X_1= Max. Temperature, X_2= Min. Temperature, X_3= Mean Temp. X_4=RH-I, X_5=RH-II, X_6= Avg. RH, X_7=Rainfall and X_8 = R.D.

$\in$ = error term

RESULTS AND DISCUSSION

Multiple regression coefficients for different weather parameters which found positively or negatively significant with grain yield at different districts of Marathwada region, were worked out and given in the table. The Multiple regression models fitted with weather parameter at Aurangabad in order to forecasting for pigeon pea yield was given below.

Table 1: Multiple regression analysis between weather parameter and pigeon pea yield at Aurangabad district

Sr. No.	Weather parameters	Regression coefficient (Bi)	(SE)	't' value	Path coefficient
1	Tmax.	-37.48	180.38	-0.208	-1.170
2	Tmin.	163.96	153.61	1.067	8.96
3	Tmean	-58.89	309.73	-0.190	-2.123
4	RH I	24.27	142.01	0.171	6.47
5	RH II	38.47	140.25	0.274	1.053
6	Rainfall	2.985	2.81	1.060	2.660
7	R.D.	-1.52	3.59	-0.424	-9.708
B_0 = 102.64, F value = 3.775, R^2 = 0.59 SEY =147.86					

The resultant multiple regression equation was derived and expressed as

$Y = 102.64 – 37.48 X_1 + 163.96 X_2 – 58.89 X_3 + 24.27 X_4 + 38.47 X_5 + 2.98 X_6 – 1.52 X_7$,

Where

X_1 = Tmax., X_2 = Tmin., X_3 = Tmean, X_4 = RH I, X_5 = RH II, X_6 = AVR, X_7 = Rainfall, X_8 = Rainy days, and R^2 = Regression coefficient.

The above equation shows that the Tmin. (0.677**) and Tmean (0.473**) has positively significant effect on yield[3].

Table 2: Multiple regression analysis between weather parameter and pigeon pea yield at Beed district

Sr. No.	Weather parameters	Regression coefficient (Bi)	(SE)	't' value	Path coefficient
1	Tmax.	-6.92	160.02	-0.043	-4.165
2	Tmin.	-62.53	160.37	-0.390	-4.255
3	Tmean	35.45	317.38	0.112	1.334
4	RH I	975.94	254.44	3.836	4.534
5	RH II	983.48	256.58	3.833	4.379
6	Rainfall	1.784	2.00	0.890	2.034
7	R.D.	0.159	2.80	0.057	1.382
B_0 = 386.070, F value = 3.293, R^2 = 0.55 SEY =137.09					

The resultant multiple regression equation was derived and expressed as

$Y = 386.070 – 6.92 X_1 – 62.53 X_2 + 35.45 X_3 + 975.94 X_4 + 983.33 X_5 + 1.784 X_6 + 0.159 X_7$

The above equation shows that the all-weather parameters have non-significant effect on yield.

Table 3: Multiple regression analysis between weather parameter and pigeon pea yield at Latur district

Sr. No.	Weather parameters	Regression coefficient (Bi)	(SE)	't' value	Path coefficient
1	Tmax.	65.541	177.630	0.369	-5.447
2	Tmin.	164.353	171.760	0.957	7.891
3	Tmean	-373.996	378.640	-0.988	-7.269
4	RH I	4.395	6.956	0.632	-5.714
5	RH II	-1.235	8.861	-0.139	-5.788
6	Rainfall	4.349	4.163	1.045	3.209
7	R.D.	-5.909	4.548	-1.299	-4.787
B_0 = 4603.20, F value = 1.753, R^2 = 0.50 SEY =349.81					

The resultant multiple regression equation was derived and expressed as

$Y = 4603.20 + 65.54 X_1 + 164.35 X_2 – 373.99 X_3 + 4.395 X_4 – 1.235 X_5 + 4.349 X_6 - 5.909 X_7$

The above equation showed that the all-weather parameters have highly positively significant effect Tmax. (0.505**) Tmin. (0.508**), Tmean (0.507**), RH I (0.513**), RH II (0.503**), Rainfall (0.518**) and R.D. (0.500**) effect on yield, Rajesh *et al*[5].

Table 4: Multiple regression analysis between weather parameter and Pigeon pea yield at Osmanabad district

Sr. No.	Weather parameters	Regression coefficient (Bi)	(SE)	't' value	Path coefficient
1	Tmax.	-369.922	1548.631	-0.239	-1.008
2	Tmin.	-463.433	1522.104	-0.304	-2.484
3	Tmean	771.007	3067.144	0.251	2.472
4	RH I	101.755	134.877	0.754	1.544
5	RH II	130.314	138.714	0.939	-4.305
6	Rainfall	4.840	3.276	1.478	2.697
7	R.D.	0.011	3.836	0.003	5.920
B_0 = 2046.50, F value = 1.974, R^2 = 0.42 SEY =221.20					

The resultant multiple regression equation was derived and expressed as

$Y = 2046.50 – 369.92 X_1 – 463.43 X_2 + 771.00 X_3 + 101.75 X_4 + 130.31 X_5 + 3.4.84 X_6 + 0.011 X_7$

The above equation showed that the Tmin. (-0.541**) and Tmean (-0.528**) have negatively significant effect on yield while other variables show non-significant effect on yield.

Table: 5 Multiple regression analysis between weather parameter and Pigeon pea yield at Parbhani district

Sr. No.	Weather parameters	Regression coefficient (Bi)	(SE)	't' value	Path coefficient
1	Tmax.	-12.122	21.099	0.571	-3.771
2	Tmin.	-3.784	16.243	0.818	-5.032
3	RH I	-4.706	3.966	0.248	1.606
4	RH II	6.824	4.910	0.178	1.409
5	Rainfall	1.887	1.653	0.265	3.478
6	R.D.	-5.078	4.204	0.239	-2.203
B_0 = 1063.35, F value = 0.689, R^2 = 0.21, SEY =175.91					

The resultant multiple regression model was derived and expressed as

$Y = 1063.35 – 12.12 X_1 – 3.784 X_2 – 4.706 X_3 + 6.824 X_4 + 1.887 X_5 – 5.078X_6$

The above equation showed that the all-weather parameters have non-significant effect on yield.

Table 6: District wise Correlation coefficient between weather parameter and yield of pigeon pea. (Database 1983-2012)

Sr. No.	District name	Weather parameters						
		Tmax (^{0}C)	Tmin (^{0}C)	Tmean (^{0}C)	RH I (%)	RH II (%)	Rainfall (cm)	No. of rainy days
1	Aurangabad	-0.055	0.677**	0.473*	-0.171	0.187	0.185	0.172
2	Beed	0.245	-0.285	-0.072	0.061	0.155	0.275	0.0
3	Latur	0.505**	0.508**	0.507**	0.513**	0.503**	0.518**	0.500**
4	Osmanabad	-0.192	-0.541**	-0.528**	-0.248	0.173	0.180	0.031
5	Parbhani	-0.099	-0.062	-0.096	-0.034	0.158	0.178	-0.023

*(0.365) significant at 5 %, ** (0.468) significant at 1 %

CONCLUSION

From the results it is concluded that weather condition of Latur district was favorable or suitable for better yield harvest of pigeon pea crop. In situ observations are necessary to get better result for yield prediction. Validation of the regression model is required for practical utilization to give yield prediction of pigeon pea.

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