Impact of Climatic Parameter on Cotton Yield of Three Districts in Marathwada (Maharashtra), India

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Research Article

Abstract: Weather plays an important role in agricultural production. It has a profound influence on crop growth, development and yields. Weather factors show spatial variations in an area at a given time, temporal variations at a given place, and year-to-year variations for a given place and time. On the basis of this effect of weather on the cotton yield of three districts of Marathwada, Aurangabad, Beed and Jalna the present paper is based. The statistical analysis such as Multiple Regression and Correlation is applied to check the significance.

Keywords: Agriculture, Climatic Variable, Multiple Regression, Correlation and t-test.

1 Introduction

The day by day change in climate is one of the biggest situations in front of world which effect directly on the production of the agriculture all over the world. Indian is primarily is agricultural based country and thus the country economy is directly depends upon agriculture and agricultural Productive, Since in Indian 75% to 80% agriculture is depend upon rainfall directly, therefore temperature and rainfall plays a vital role in Indian agricultural system. Thus the Indian has two –third of its total cropped area under Rainfed. Therefore 65% to 75% of agricultural in Indian is mainly depend upon natural factors such, humidity, temperature, rainfall and so on.

Thus the purpose of choosing cotton crop under the study because Maharashtra is the largest cotton growing state in a country and Marathwada and Vidarbha contribute a maximum area under this crops.

2 Review of literature

Day by day increasing the global warning becomes a critical issue for developing country like Indian. The increase in global warming due to increase in average temperature of earth's near the surface air and ocean. N.H. Ravindranath et. Al (9) studied climate change modelling for India and its results show as that Indian sub-continent are likely to experience a warming of over 3^0-5^0 C are there might significant changes in situation such as floods, drought and intensity.NAT COM [8] has projected at the end of 21st century there is increase in rainfall in India up to 15-40% and mean annual temperature will be increase by 3^0-6^0C.Shafiqur Rahman [13] observed that agriculture production will heavily depends upon rainfall and atmospheric temperature. Raghava Reddy et. al. [11] increase in global temperature will affect the agriculture production in India. Usman Shakoor, et, al [15] observed the overall extent of negative impact of temperature is greater than the positive effect of rainfall in the region. S. Angles et. al (12) studied rainfed agriculture supports 40 percent of the Indian population and contributes 44 percent to the national food basket. David et al [1971] show important of rainfall, which has to be in sufficient quantity, but also at a period and at a pace adequate to the vegetative cycle of the plant. Kanga et. Al [2004], the quantity of the rainy season is indeed determined by several parameters, it duration, which depends on the onset and cessation dates of the monsoon, its distribution and its variability. Al Bergel et. al [1985] statistical analysis shows a positive link between precipitation and the variation of cotton production in Burkina faro. They found significant positive coefficients off correlation of 0.72 for the whole cotton zone and 0.67 for most intensive area of production. Bella-Medjo et al. [2005] , in terms of yield analysis, precipitation in the north of Cameroon revealed a positive and significant correlation coefficient of 0.59, in the country has annual rainfall below 600mm/annum and south zone where rainfall exceeds 600mm per annum shows no significant results. Therefore this paper analysis statistically the important of Temperature, Humidity, Rainfall, Wind Velocity on cotton yield. More specially the cotton plant has water stress at two stages of its growth, right after it has been sown and the second state during its blooming phase. If unfortunately if dry special over in between this two stages there are more possibility of getting less yield. These studies motives toward the analyses of Aurangabad Beed and Jalna district of Marathwada (Maharashtra) Indian.

3 Selection of study area

The Marathwada region is famous for its some what erratic rainfall and dry rest of the season. The region comprises eight districts of which only Aurangabad, Beed and Jalna are consider. The Aurangabad and Jalna is rich in economic due to large industrial area, but the rural area

is mostly depends upon the agriculture specially cotton as a cash crop.

4 Data and method

The data used for this paper are the time series data in rainfall, minimum & maximum temperature relatively humidity minimum and maximum from 22 to 53 Metrological weeks. The data of this three district from 1977 to 2007 were obtained by India meteorological department, Pune. Obtained on CD disk. The secondary data of area production and yield of Aurangabad, Beed and Jalna were obtained from Epitome of agricultural – part I and part II.

The regression analysis in applied to the yield data.

The data on temperature, rainfall, humidity and wind velocity over the years are considering it the time series data which varies over time to time are taken in to consideration.

The effect of climatic parameters on yield and the percentage of contribution. This statistical method such as Multiple Regression Analysis, Percentage of contribution, Correlation and coefficient of determination, t-test are used.

5 Multiple Regression analysis

The multiple Regression Analysis study by the cob-Douglas functions was used for analysis purpose (Gujarati 2003) . Bhanumurthy (2002) explained that this technique does have few weaknesses like inflexibility but still can handle multiple inputs in more generalized form as mentioned in the studies.

The equation of a multiple regression the is given as:-

$Y= a +b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6$

Where Y is the observation of dependent variable. X_1,X_2, X_3, X_4, X_5, X_6 as the observation of independent variable a is the intercept of the time on the vertical axis and b is the slope of Regression line in order to fit Regression line scatter diagram and contribution of variable. toward the yield (as dependent variable) against the time series data of Temperature -minimum, Temperature -maximum ,Humidity-Minimum, Humidity- Maximum (relative humidity), Wind Velocity, and Rainfall from the Metrological weeks 21 to 52(June to December) were calculate manually in Microsoft excel and the Minitab software.

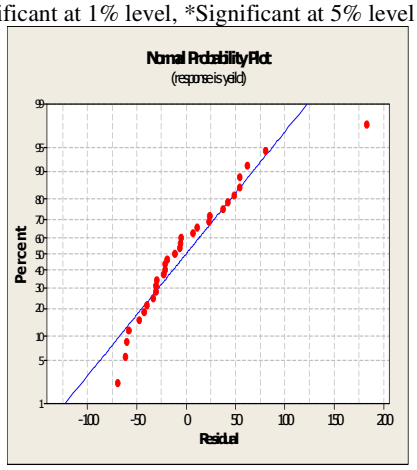
We have calculated estimated value for Yield for 30 years by using fitted Multiple Linear Regression Model (Aurangabad)

$Y = -2232.5+31.872 X_1+18.982 X_2+2.079 X_3+11.688 X_4-3.569 X_5-0.6178 X_6$

Table 1: Multiple Linear Regression Analysis

Variable	Parameters	Values	Percentage contribution
Intercept	a =	-2232.5**	-
T-min	b-1=	31.872**	3.04%
T-max	b-2=	18.982**	1.37%
RH-min	b-3=	2.079*	16.36%
RH-max	b-4=	11.688**	25.59%
Wind.Vel	b-5=	-3.569*	2.81%
RF	b-6=	-0.6178**	50.82%
	R-square =	36.18%**	100 %

Note: ** Significant at 1% level, *Significant at 5% level



The result indicated that out of six climatic variables under study temperature Minimum, Maximum, humidity Minimum & Maximum has positive impact on yield, where as the wind Velocity and rainfall has negative impact on yield. The value of R-square is 0.3618 in found to be significance at 1% level of significant indicates that 36.18% variation in the yield of cotton explain by six climate parameters under study. The percentages of contribution of selected climatic variables in the variation of cotton yield are also shown in the table. The Maximum contribution in the variation of cotton yield is observed by the climatic variable rainfall (50.82%) followed by Relative Humidity max (25.59%) Relative Humidity min (16.36%), Temperature min (3.04%)

Beed

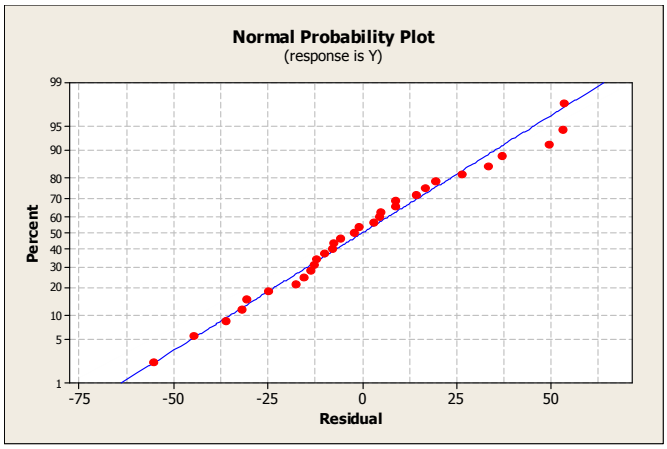
The estimated value for Yield for 30 years by using fitted Multiple Linear Regression Model (Beed)

Y = 186.205 + 8.92119 X1 - 6.04978 X2 - 3.5552 X3 + 1.53259 X4 + 1.91206 X5 + 0.874011 X6

Table 2: Multiple Linear Regression Analysis

Variable	Parameters	Values	Percentage contribution
Intercept	a =	186.205**	-
T-min	b-1=	8.92119 *	1.80%
T-max	b-2=	- 6.04978*	0.32%
RH-min	b-3=	- 3.5552 *	23.52%
RH-max	b-4=	1.53259*	29.54%
Wind.Vel	b-5=	1.91206*	0.12%
RF	b-6=	0.874011**	44.67%
	R-square =	48.45%**	100%

Note: ** Significant at 1% level, *Significant at 5% level



From the observation it conclude that Temperature min Temperature max, Humidity-max and Humidity-min and Wind Velocity and rainfall show positive contribution toward cotton yield, where the value of r2-equance is 42-87 which indicates the variability of yield. The percentages of contribution of selected climatic variables in the variation of cotton yield are also shown in the table. The Maximum contribution in the variation of cotton yield is observed by the climatic variable rainfall (44.70%) followed by Relative Humidity max (29.54%) Relative Humidity min (23.52%), Temperature min (1.78%).

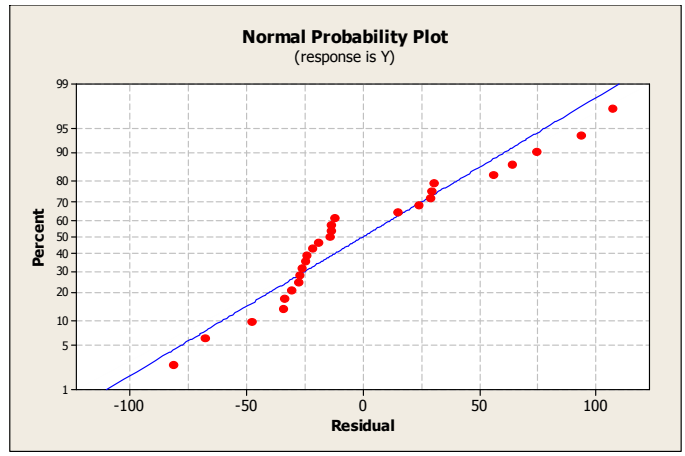
The estimated value for Yield for 30 years by using fitted Multiple Linear Regression Model (Jalna)

Y = -934.666 + 13.4302 X1 + 13.2332 X2 + 1.83524 X3 + 5.3499 X4 - 16.3788 X5 + 0.0311166 X6

Table 3: Multiple Linear Regression Analysis

Variable	Parameters	Values	Percentage contribution
Intercept	a =	-934.666**	-
T-min	b-1=	13.4302 **	0.71%
T-max	b-2=	13.233**	1.59%
RH-min	b-3=	1.83524*	37.31%
RH-max	b-4=	5.3499**	19.27%
Wind.Vel	b-5=	- 16.3788*	14.84%
RF	b-6=	0.0311166**	26.28%
	R-square =	65.05%**	100%

Note: ** Significant at 1% level, *Significant at 5% level



From the above table it indicated that the all the climatic parameter shows that positive response towards the cotton yield expected the wind velocity. The value of R2-square is 65.05% which show the percentage of variability of yield. The percentage of contribution of climatic parametric where the maximum contribution (37.30) by Humidity minimum which is followed by (26.28) by rainfall, (19.27) by Humidity maximum and wind velocity (14.84)%.

5 Correlation Coefficient

The correlation coefficient determines the magnitude and strength of linear relationship between the two variables under study. It always lies between -1 to +1. The value +1. Indicating a perfect positive correlation and the value -1 indicating a perfect negative Correlation . A correlation coefficient close to or equal to zero indicates no relationship or very poor relationship between the variables. A positive correlation coefficient indicates a positive (upward) relationship and a negative correlation coefficient indicates a negative (downward) relationship between the variables. The strength of linear relationship between the variables and yeild (X_1)are calculated to determine the trend of temperature(min.X_2-maxX_3,)relative humidity(hmin X_4-hmax X_5), rainfall(X_6),wind velocity(X_7) and agriculture production and it is measured by the correlation coefficient. The correlation coefficients between temperature, relative humidity, rainfall, wind velocity and yield were calculated as follows. Given the pairs of values (x_i,y_i), (x_2,yi),...., (x_n,y_n), the Karl Pearson's formula for Calculating the correlation coefficient 'r' is given by:

$$r=\sum (x_i-x)(y_i-y) / \sqrt{(x_i-x)^2 \sum (y_i-y)^2} \quad , i=1,2,.....,n.$$

Testing the significance of the correlation coefficient

In testing the significance of the correlation coefficient, the following null (H_0) and alternative (H_1) hypothesis were considered.

Hypothesis: H_0: $\rho=0$ against H_i: $\rho\neq0$

Where, ρ is the population correlation coefficient.

The appropriate test statistics for testing the above Hypothesis is $t = r\sqrt{(n-2)} / \sqrt{(1-r^2)}$,
deg. freedom = n-2 = 20
Significant value for t at 5% level = 2.086

The following table represents the values of the correlation coefficients and the test statistics represented within the bracket.

Table 4: Table of Correlation coefficients and t values

Districts	$r(x_1,x_2)$	$r(x_1,x_3)$	$r(x_1,x_4)$	$r(x_1,x_5)$	$r(x_1,x_6)$	$r(x_1,x_7)$
Aurangabad	0.2738 (1.667) (Insignificant)	-0.0482 (1.968) (Insignificant)	0.1117 (1.433) (Insignificant)	0.3784 (2.860) (significant)	-0.0434 (1.054) (Insignificant)	-0.1073 (1.281) (Insignificant)
Beed	0.2541 (1.312) (Insignificant)	-0.0258 (1.441) (Insignificant)	-0.3308 (3.346) (significant)	-0.0606 (1.975) (Insignificant)	0.0068 (0.7296) (Insignificant)	0.3315 (3.081) (significant)
Jalna	-0.1467 (0.7584) (Insignificant)	-0.1231 (1.773) (Insignificant)	0.4375 (1.600) (Insignificant)	0.4656 (2.103) (significant)	-0.6965 (4.052) (significant)	0.1894 (0.04407) (Insignificant)

Note: The parenthesis indicate t-values

The above table shows the correlation coefficients between the variable Temperature (min & max), Relative Humidity (h.min & h.max), Rainfall, and Wind Velocity against the Cotton yield. The highest positive (0.3784) is observed between humidity max(X_5) and the cotton yield (X_1) for Aurangabad district. The highest positive (0.3315) and negative (-0.3308) between yield(X_1) and humidity min(X_4), rainfall(X_7) was observed for Beed district. The most higher positive (0.4656) significant correlation of cotton lint(X_1) and humidity max(X_5),similarly most highest negative (-0.6965) correlation of cotton lint(X_1) and wind velocity(X_6) was observed for Jalna district.

Conclusion

On the basis of data analysis it indicates that the crop under the investigation is totally depends on rainfall followed by temperature maximum and relative humidity minimum. The investigation shows that the area and production has increased in all three districts but the inconsistence of the lower yield remains same over the years. Then also this district has great motivation towards the cotton crop. Cotton crop is most valuable crop for Marathwada over the years.

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