The climatic variability during Kharif season in Prayagraj and Varansi district for last one decade.

ABSTRACT

The present study attempts to know the trend of selected weather parameters and to analyse the impact of weather parameters on Yield of rice in Prayagraj and Varanasi district. The secondary data of weather parameters for the study was obtained from Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS).The weather data of Varanasi were obtained from Banaras Hindu University (BHU), Varanasi for the period from 2008 to 2018. The parameters consider viz., maximum temperature, minimum temperature, sun shine hour, rainfall and rice yield for the study. The variability terms (SD and CV) were computed over seasonal and annual periods for Maximum and Minimum Temperature, Rainfall of Prayagraj and Varanasi districts during 2008 to 2018.The long term trend in maximum, minimum temperature and rainfall, solar radiation has been calculated on monthly, seasonal and annual for Prayagraj and Varanasi. Trend was studied in 10 years period seasonal trend was observed for five seasons i.e. summer (March to May), south west monsoon (June to September), post monsoon (October and November), winter (December to February) and Kharif (June to november.) by using liner trend analysis. the linear trend value.The trend analysis revealed that the maximum temperature and minimum temperature showed a positive trend at Prayagraj whereas and rainfall and solar radiation showed a negative trend and the trend over a period during study period 2008-2018.Trend of one decades (2008-2018) was showed an decrease in Maximum Temperature, Minimum Temperature and Rainfall. at Varanasi .The yield of Rice in Varanasi was positively correlated with rainfall; however negatively and significantly correlated with maximum temperature and minimum temperature and bright sun shine.

Keyword- weather parameters, trend, variability, Maximum, Minimum Temperature, rainfall

Introduction

Weather is one of the key components that control agricultural production. In some cases, it has been stated that as much as 80% of the variability of agricultural production is due to the variability in weather conditions, especially for rain fed production systems (**Fageria, 1992**). Each species and each age-group of plants has its

own climatic condition (upper and lower limit), beyond these limits a plant gets considerably damaged, or even die. The critical agro-meteorological variables associated with agricultural production are air temperature, solar radiation and precipitation. Other weather factors that can affect crop production include relative humidity, wind and soil temperature **(*Gerrit ,2000*).**

Air temperature is the main weather variable that regulates the rate of vegetative and reproductive development (**Hodges, 1991**). Solar radiation provides the energy for the processes that drive photosynthesis, affecting carbohydrate partitioning and biomass growth of the individual plant components (**Boote and Loomis, 1991**).

Some aspect of climate change such as longer growing seasons and warmer temperature may bring benefit (in cold regions), there will also be a range of adverse impacts, including reduce water availability, greater water need, and more frequent extreme weather. These impacts may put agricultural activities at significant risk **(Jones and Briffa, 1992**).

These environmental changes are likely to increase the pressure on Indian agriculture. Some studies conducted in India generally confirm the trend of agricultural decline with climate change. Recently it has been projected that there is a probability of 10-40% loss in crop production in India by 2080-2100 due to global warming **(Rosenzweig and Parrry, 1994; Fischer *et al.* 2002; IPCC, 2007b).**

MATERIALS AND METHODS

The research work on the topic entitled "Trend Analysis of Temperature, Rainfall and their Effect on Yield of Rice crop in Eastern U.P."was carried out for 10 year rice yield data. The details of the materials used and methods adopted during the course of investigation have been described in this chapter under the following headings.

3.5: Variability and trend analysis

The variability terms (SD and CV) were computed over seasonal and annual periods for Maximum and Minimum Temperature , Rainfall of Prayagraj and Varanasi districts during 2008 to 2018. The long term trend in maximum, minimum temperature and rainfall, solar radiation has been calculated on monthly, seasonal and annual for Prayagraj and Varanasi. Trend was studied in 10 years period seasonal trend was observed for five seasons i.e. summer (March to May),

south west monsoon (June to September), post monsoon (October and November), winter (December to February) and Kharif (June to november.) by using liner trend analysis. the linear trend value, represented by the slope of a simple least square regression line with time ,was determined as suggested by **Wigley and Jones (1981).**

3.6: Standard deviation

Standard deviation of maximum, minimum temperature, rainfall has been calculated on monthly, seasonal, and annual basis by using the expression.

$$SD\ (\sigma) = \sqrt{\frac{\sum(X - \bar{X})^2}{n-1}}$$

X = Rainfall frequency

$\bar{x}$ = Mean rainfall

n = Number of years

3.7: Coefficient variation

Coefficient of variation (C.V) of maximum, minimum temperature , rainfall has been calculated over monthly, seasonal and annual basis by using the expression

CV % = (standard deviation/ mean)X 100

3.8: Mean

It is the sum of given observation divided by total number of observation Mathematical formula for average.

Mean= Sum of the Observation / No. of Numbers

3.9 :Correlation Analysis

Correlation is a term that refers to the strength of a relationship between two variables. A strong or high correlation means that two or more variables have a strong relationship with is other, while a weak or low correlation means that the variables are hardly related. Correlation analysis is the process of studying the strength of that relationship with available statistical data. **Cohen *et al*.(2014)**

$$\mathbf{r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\, n\Sigma x^2 - (\Sigma x)^2\,]\,[\, n\Sigma y^2 - (\Sigma y)^2\,]}}}$$

Significant of correlation was checked at 5% level by using of critical values for pearson correlation.

RESULTS AND DISCUSSION

Climate Variability of Maximum and Minimum Temperature, Rainfall and Solar Radiation at Prayagraj and Varanasi.

4.1 Temperature

The maximum mean temperature 33. 76^{0}C and 31.40°C was found in kharifseason during the period of 2008-2018 at Prayagraj and Varanasirespectively.Seasonal variation of mean temperature 39.13^{0}C and 36.63^{0}C in Summer, 35.99^{0}C and 34.29^{0}C in SW Monsoon, 30.83^{0}C and 27.74^{0}C in post monsoon and 25.36^{0}Cand 22.99^{0}C in winter season at Prayagraj and Varanasi. Maximum mean temperature 42.34^{0}C and 39.63^{0}C was found in month of May at Prayagraj and Varanasi. Data appended in Table 1, 2. and 3.Minimum mean temperature was found 20.74^{0}C and 19.87^{0}Cin kharif season during the period of 2008-2018 at Prayagraj and Varanasi.

Seasonal variation of mean temperature 22.20^{0}Cand 21.73^{0}C in summer, 27.81^{0}C and 26.57^{0}C in SW Monsoon, 16.54^{0}C and 15.48^{0}C in post monsoon and 10.47^{0}C and 10.66^{0}C in winter seasonatPrayagraj and Varanasi. Minimum mean temperature 9.35^{0}C and 9.40^{0}C was found in month of January at Prayagraj and Varanasi. Data appended in Table 1, 2.and 3.Kharif season C.V and S.D was 25.45 % and 8.30 during the period 2008 to 2018 and seasonal C.V of maximum temperature 8.39, 9.32, 2.73 and 5.52% during summer, South-West monsoon, post monsoon and winter respectively.Highest C.V were39.0in May and lowest in month of October with value of 17.47% during one decades (2008-2018) for prayagraj. The values 8.33^{0}C and 23.07% were representing standard deviation and coefficient of variation of maximum temperature in kharif season respectively during 2008 to 2018 at Varanasi, whereas coefficient of variability were represents 36.71% and 15.63% the highest and lowest during May and September, respectively.

Monthly S.D of maximum temperature was observed more in , June and March with values 4.03 and 3.63 respectively and least value in August 2.04 as a result there was higher C.V during May as 36.71% respectively at Varanasi. (Table 2)Monthly minimum temperature showed highest and lowest standard deviation of 13.41 and 1.29 in August and July respectively, whereas coefficient of variation was more significant in July, June, and May months when their values were 26.33, 26.18, and 24.14%, respectively and was least significant in November month

with 4.86% presented in Table 1.at Prayagraj. Monthly standard deviation of minimum temperature at Varanasi varied between 2.9 to 3.13 during January to December (Table 2), The values 8.0,9.10 and 11.8%,11.64 were the standard deviation and coefficient of variation during the one decades in kharif season at Varanasi and Prayagraj District. Table 3 Standard deviation values were 5.25, 1.99, 8.97 and 3.80 , 8.02 during summer, South-West monsoon, post-monsoon, winter seasons and *kharif*, respectively. at Varanasi.

Increase in atmospheric cloud and dust trap the incoming solar radiation during daytime and it causes warning during night time as a consequence there was increase in minimum temperature. Singh *et al.*, (2008) concluded that seasonal analysis of different variable that showed the greatest changes in maximum temperature and mean temperature were during the post-monsoon season, while minimum temperature experienced the greatest change in the monsoon season. Mahi (1996) supported increase in minimum temperature of 1.6^0C at Ludhiana, Punjab during the 25 years period. Similar result has showed by Bhutiyani*et al*. (2007), they suggest a significant rise in minimum air temperature in north-western Himalaya, with winter warming occurring at a faster rate.

Similar results were given by (Ahmed, 1991) where he found the highest coefficient of variation of 6.9% in *kharif* season. Analysis of temporal and spatial variation of absolute maximum temperature of 16 stations was made to explain the cause of temporal and spatial variations of maximum and absolute maximum from the point of synoptic meteorology. The mean temperature in India is projected to increase by 0.1^0C to 0.3^0CV in summer and 0.3^0C in winter by 2010 and to 0.4^0C to 2^0C in summer and 1.1^0C to 4.5^0C in winter by 2070 (IPCC] 1996).

4.2Rainfall

Rainfall data appended in Table 1, 2 & 3 showed that season and monthly variation in standard deviation and coefficient of variation characteristics of Rainfall at Prayagraj and Varanasi. S.D. was found highest of 10.40 mm and 12.24 mm for prayagraj and Varanasi respectively during the period of 2008 and 2018. C.V. was 7.91 per cent and 9.09 per cent for the period of 2008-2018. S.D. was highest South-West monsoon of the order of 15.54mm and 18.81 mm, lowest in summer season at 2.59 mm and 2.02 mm therefore C.V. was highest in South-West monsoon with 0.40 per cent and 0.40 per cent. Lowest in Post monsoon season with 0.09

per cent and 0.12per cent. Standard deviation were 2.59, 8.00 mm and 2.02, 4.15mm during summer, post monsoon and coefficient of variation were 0.12 and 0.16 per cent during summer, and winter season at the, respectively (Table 1, Tab 2 and 3).

Monthly basis analysis showed that the standard deviation and coefficient of variation values were highest of 19.34mm, and 11.76 per cent in July and October, and 19.79 mm , 11.13 per cent, in July and October, whereas lowest values of 0.70 mm and 0.74per cent in December and April, and 0.23 mm 0.21 per cent in December, respectively for period of 2008-2018.at Prayagraj and Varanasi.

4.3. Solar radiation

Standard deviation of annual solar radiation for periods of 2008 to 2018 for Prayagraj and Varanasidistrict was1.790MJ/m², 2.52 MJ/m² and C.V. varied, 2.20% and 1.46% for period 2008-2018, respectively, seasonal standard deviation of solar radiation 2.76 $MJ/m^2$and 2.25$MJ/m^2$was highest during Post monsoon , SW monsoonand lowest1.26 $MJ/m^2$and 0.90 MJ/m^2during Winter (Jan-Feb) and post monsoon. C.V. values were highest3.35% and 2.81%during Summer (March-May) and lowest1.30% and 2.04% during Post monsoon (Oct-Dec) and SW monsoonappended in (Table 1, and 2 Table).

In case of monthly standard deviation , highest2.57$MJ/m^2$and 2.42 MJ/m^2 in month of October , June and lowest0.92 MJ/m^2 and 0.56 MJ/m^2in December. Coefficients of variations were highest 4.60% and 5.11% May, April and lowest 1.02% and 0.73 %was recorded in January during period of 2008-2018 at Prayagraj and Varanasi (Table 1 and Table 2).

Table 1 : Seasonal and monthly mean value, standard deviation and coefficient of variation of maximum and minimum temperature, rainfall and solar radiation at Prayagraj during 2008-2018.

Periods	Temperature (^{0}C)						Rainfall(mm)			Solar radiation(MJ/m^2)		
	Max			Min			Mean	S.D.	C.V.(%)	Mean	S.D.	C.V.(%)
	Mean	S.D.	C.V.(%)	Mean	S.D.	C.V.(%)						
Seasonal												
Summer (March-May)	39.13	4.67	8.39	22.20	4.62	4.81	0.30	2.59	0.12	5.17	1.54	3.35
SW Monsoon (June-Sept)	35.99	3.86	9.32	27.81	7.08	3.93	6.28	15.54	0.40	4.66	1.53	3.04
Post monsoon (Oct - Dec)	30.83	11.31	2.73	16.54	8.86	1.87	0.71	8.00	0.09	3.59	2.76	1.30
Winter (Jan-Feb)	25.36	4.59	5.52	10.47	2.70	3.88	0.63	3.92	0.16	2.50	1.26	1.98
Monthly												
January	22.79	4.20	18.58	9.35	2.46	6.89	0.73	4.80	4.07	2.26	1.23	1.02
February	28.20	3.09	25.11	11.71	2.39	9.31	0.51	2.61	2.11	2.75	1.13	1.62
March	34.68	3.56	31.12	17.47	3.38	14.09	0.39	2.90	2.52	4.05	1.29	2.77
April	40.47	3.04	37.43	22.62	2.57	20.05	0.11	0.84	0.74	5.01	1.30	3.71
May	42.34	3.34	39.00	26.57	1.94	24.64	0.41	3.28	2.87	5.93	1.34	4.60
June	40.43	4.19	36.24	28.07	1.90	26.18	3.31	10.01	6.70	5.78	1.59	4.19
July	34.84	2.73	32.11	27.62	1.29	26.33	8.95	19.34	10.40	4.27	1.62	2.65
August	34.11	2.33	31.78	28.22	13.41	14.81	8.89	18.55	9.66	4.21	1.17	3.04
September	34.75	1.69	33.07	27.34	3.56	23.78	3.69	10.40	6.71	4.34	1.08	3.26
October	35.31	1.84	17.47	23.20	3.59	19.62	1.88	13.63	11.76	4.49	2.57	1.92
November	31.33	2.11	29.22	15.77	10.92	4.86	0.15	1.32	1.17	3.63	1.24	2.39
December	25.86	3.37	22.48	10.60	5.00	5.61	0.07	0.70	0.63	2.39	0.92	1.47

Table 2 : Seasonal and monthly mean value, standard deviation and coefficient of variation of maximum and minimum temperature, rainfall and solar radiation at Varanasi during 2008-2018.

Periods	Temperature (^{0}C)						Rainfall(mm)			Solar radiation (MJ/m^2)		
	Max.			Min.			Mean	S.D.	C.V.(%)	Mean	S.D.	C.V.(%)
	Mean	S.D.	C.V.(%)	Mean	S.D.	C.V.(%)						
Seasonal												
Summer (March-May)	36.63	4.70	7.79	21.73	5.25	4.14	0.41	2.02	0.20	6.30	2.24	2.81
SW Monsoon (June-Sept)	34.29	9.73	3.52	26.57	1.99	13.36	7.58	18.81	0.40	4.58	2.25	2.04
Post monsoon (Oct - Dec)	27.74	4.39	6.32	15.48	8.97	1.73	0.52	4.15	0.12	2.12	0.90	2.37
Winter (Jan-Feb)	22.99	4.25	5.41	10.66	3.20	3.33	0.83	3.87	0.21	1.94	0.93	2.09
Monthly												
January	20.70	3.92	16.78	9.40	2.99	6.41	0.83	3.79	2.96	1.50	0.77	0.73
February	25.52	2.99	22.53	12.06	2.83	9.24	0.82	3.96	3.14	2.44	0.84	1.6
March	32.10	3.63	28.47	16.55	2.80	13.75	0.39	1.63	1.24	4.19	1.44	2.75
April	38.24	3.52	34.72	21.92	2.47	19.46	0.43	2.57	2.14	7.04	1.93	5.11
May	39.63	2.92	36.71	26.76	3.97	22.79	0.40	1.73	1.33	7.70	1.50	6.2
June	38.34	4.03	34.31	27.83	2.12	25.70	3.73	12.26	8.54	7.03	2.42	4.61
July	32.93	2.89	30.04	26.66	1.91	24.75	11.05	19.02	7.97	4.16	1.83	2.33
August	32.51	2.04	30.47	26.26	1.54	24.72	8.66	19.79	11.13	3.64	1.33	2.3
September	33.50	17.86	15.63	25.53	1.65	23.88	5.11	13.70	8.59	3.53	1.09	2.44
October	30.6	2.26	28.34	17.2	12.40	4.80	0.00	6.88	6.88	2.4	0.84	1.56
November	28.49	2.70	25.79	14.71	3.41	11.30	0.16	1.73	1.57	2.04	0.59	1.45
December	23.21	3.05	20.16	10.28	3.13	7.15	0.02	0.23	0.21	1.44	0.56	0.88

Table 3 :Kharif mean value, standard deviation and coefficient of variation of maximum and minimum temperature, rainfall and solar radiation at Prayagraj and Varanasi during 2008-2018.

Location	Temperature (^{0}C)								Rainfall(mm)				Solar radiation (MJ/m^2)			
	Max				Min											
	Mean	S.D.	Trend /yr	C.V. (%)	Mean	S.D.	Trend /yr	C.V. (%)	Mean	S.D.	Trend /yr	C.V. (%)	Mean	S.D.	Trend /yr	C.V. (%)
Prayagraj	33.76	8.30	-0.18	25.48	20.74	9.10	-0.11	11.64	2.50	10.40	-0.01	7.91	3.99	1.79	-0.02	2.20
Varanasi	31.40	8.33	0.01	23.07	19.87	8.02	-0.00	11.85	3.14	12.24	-0.001	9.09	3.98	2.52	0.002	1.46

Conclusion-

In this study the climatic variability and effect of weather parameter on yield of rice crop. and From the study it was concluded that weather plays an important role in rice production in Prayagraj and Varanasi during 2008-2018. Weather variable have both positive and negative effect with rice yield, It was found that the yield of rice in Prayagraj was positively correlated with average maximum temperature, minimum temperature, and rainfall, however negatively correlated with sun shine hour. Hence the yield of rice is more dependent on rainfall, maximum temperature and minimum temperature. This suggested that yield of rice was negatively affected by increase in the sun shine hour.

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