A study on the variability in rainfall and relationship of weather parameters with cotton crop in Jalgaon district of Maharashtra

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ABSTRACT

The present investigations were undertaken in order to study the variability of annual and seasonal rainfall in Jalgaon district and to find out the relationship between weather parameters and area, production and productivity of cotton. The secondary data on area, production and productivity of cotton in Jalgaon district from the year 1991 to 2018 were collected from Epitome of Maharashtra and the data on rainfall and weather parameters were collected from Oil Seeds Research Station, Jalgaon, Maharshtra. The study revealed that the annual normal rainfall from 1991 to 2018 was 763.7 mm. Rainfall during monsoon (June to September) contributed 88.6 per cent of the annual rainfall. The contribution of pre-monsoon (March to May), post-monsoon (October to November) and winter (December to February) rainfall to the annual was 2.5, 6.7 and 2.3 per cent respectively. The production of cotton in Jalgaon district was highly dependent on relative humidity at evening and bright sunshine hours. However wind velocity was adversely affecting the productivity of cotton in the district.

Keywords: Rainfall; variability; cotton; area; production

INTRODUCTION

Rainfall is the most important weather factor that determines the agricultural production in India. Due to large amount of variability in rainfall, the farmers are facing major problem in getting remunerative yield of crops. Cotton is an important fiber crop of global importance and it is grown in tropical and subtropical regions of more than 80 countries of the world (Pushpa and Raveendran 2010). It is an important agriculture commodity traded all over the world.

Among the states, Maharashtra was reported as leading in cotton acreage (44.05 lakh ha) followed by Gujarat (26.66 lakh ha), Telangana (18.59 lakh ha), Haryana (7.01 lakh ha) and Rajasthan (6.44 lakh ha) (Anon 2020). Cotton is an important cash crop of Jalgaon district and about 96 per cent of the cotton area is rainfed. The crop is grown in kharif season and sowing is generally done with the onset of monsoon.

Ayinde et al (2011) observed the effect of climate change on agricultural productivity in Nigeria and reported that there was variation in the trend pattern of rainfall. Temperature was not relatively constant either. Temperature change was revealed to exert negative effect while rainfall change exerted positive effect on agricultural productivity.

Kumar (2014) carried out the study for understanding of relationship between climatic factors and sugarcane productivity in India and found that climatic factors viz actual rainfall, average maximum and average minimum temperature had a statistically significant impact on sugarcane productivity. The study concluded that there was non-linear relationship between climatic factors and sugarcane productivity in India. Mali et al (2014) reported that rainfall was negatively correlated with sugar recovery from sugarcane. Burning in sugarcane was found to be inversely correlated with rainfall and bright sunshine hours and evaporation were positively correlated with burning. Bhagat et al (2020b) reported that the productivity of green gram was mostly influenced by rainfall and number of rainy days and the wind velocity and relative humidity in the evening indirectly influenced

the productivity of green gram in Jalgaon district of Maharashtra.

Looking to the adverse climatic situation and persistent changes in the area, production and productivity of cotton in Jalgaon district, Maharashtra, the present investigations were undertaken in order to study the variability of annual and seasonal rainfall in Jalgaon district and to understand the relationship between weather parameters and area, production and productivity of cotton.

METHODOLOGY

The secondary data on area, production and productivity of cotton in Jalgaon district from the year 1991 to 2018 were collected from Epitome of Maharashtra and the data on rainfall and weather parameters were collected from Oil Seeds Research Station, Jalgaon, Maharashtra. It was observed from the rainfall data that the highest total annual rainfall was 1401.8 mm in 2006 and the lowest was 366.8 in 2012.

Table 1. Monthly and seasonal of rainfall (mm) in Jalgaon district (1991-2018)

	Rainfall (mm)			PCAR
	Mean	SD	CV (%)	
January	5.5	10.0	181.8	0.7
February	9.2	17.2	187.0	1.2
March	4.4	9.6	218.2	0.6
April	4.6	10.3	223.9	0.6
May	17.4	38.5	221.3	2.3
June	136.8	99.3	72.6	17.9
July	227.5	105.3	46.3	29.8
August	178.0	115.4	64.8	23.3
September	134.0	81.7	61.0	17.5
October	38.1	48.1	126.2	5.0
November	16.4	37.9	231.1	2.1
December	9.9	24.5	247.5	1.3
Annual	763.7	214.8	28.1	100
Pre-monsoon (March-May)	19.0	35.3	185.8	2.5
Monsoon (June-September)	676.3	205.3	30.4	88.5
Post-monsoon (October-November)	50.8	62.4	122.8	6.7
Winter (December-February)	17.6	31.1	176.7	2.3

PCAR= Per cent contribution to annual rainfall

Descriptive statistics

The mean, standard deviation and coefficient of variation were calculated for monthly and seasonal rainfall of the district during the study period using following equations (Panse and Sukhatme 1985):

$$\bar{X} = \frac{\sum X_i}{N}$$

where X_i= Arithmetic mean, $\sum X_i$= Sum of all observations, N= Total number of observations

$$S.D.(\sigma) = \sqrt{\frac{\sum(Xi - \bar{X})^2}{N-1}}$$

where σ= Standard deviation, Xi= Each value from the observation, $\bar{X}$= Mean value of variable, N= Total number of observations

Correlation

The correlation is used to describe a linear relationship between two random variables. A correlation coefficient in between -1 to +1 indicates a pair of variables that vary together precisely; one variable being related to the other by means of negative or positive scaling factor. If X_i is the weather parameter (T_{max}, T_{min}, RH_I, RH_{II}, wind velocity, evaporation, BSS and rainfall respectively) and Y_i is the area/production productivity of cotton:

$$r = \frac{\sum X_i Y_i - \frac{(\sum X_i)(\sum Y_i)}{n}}{\sqrt{\left(\sum X_i^2 - \frac{(\sum X_i)^2}{n}\right)} \cdot \sqrt{\left(\sum Y_i^2 - \frac{(\sum Y_i)^2}{n}\right)}}$$

RESULTS and DISCUSSION

Rainfall characteristics of Jalgaon district are depicted in (Table 1). The annual normal rainfall from 1991 to 2018 was 763.7 mm. Similar results were reported by Bhagat et al (2021). The coefficient of variation of annual rainfall was 28.1 per cent indicating that it was stable. Rainfall during July was the highest (227.5 mm) which contributed to 29.8 per cent of annual rainfall (763.7 mm) and it was followed by August (178.0 mm) contributing 23.3 per cent. Rainfall in June and September months contributed 17.9 and 17.5 per cent of the annual rainfall respectively. Rainfall in March (4.4 mm) and April (4.6 mm) was the least and

contributed only 0.6 per cent to the annual rainfall which was followed by January (5.5 mm), February (9.2 mm) and December (9.9 mm) months.

The coefficient of variation was also highest during December (247.5%) and it was followed by November (231.1%), April (223.9%), June (221.3%) and other months like March (218.2%), February (187.0%) and January (181.8%) showed comparably higher coefficient of variation (Figs 1, 2). The coefficient of variation was least during the high rainfall month of July (46.3%) and it was followed by September (61.0%) and August (64.8%). Rainfall during monsoon (June to September) contributed 88.5 per cent of the annual rainfall. The contribution of pre-monsoon (March to May), post-monsoon (October to November) and winter (December to February) rainfall to the annual was 2.5, 6.7 and 2.3 per cent respectively.

The correlation coefficients for different pairs of variables are assessed and are shown in Table 2. The area under cotton crop in Jalgaon district was positively correlated with production (0.84) and productivity of cotton (0.67) and it was followed by relative humidity at evening (0.61) and bright sunshine hours (0.47). Similar findings were reported by Bhagat et al (2020b) in case of correlation between relative humidity at evening and productivity of green gram in Jalgaon district. However area under cotton had shown highly significant negative correlation with wind velocity (0.59) and it was significant at 1 per cent level of significance. Similar results were reported by Bhagat et al (2020a) in case of pigeonpea in Jalgaon district. The production of cotton was highly positively correlated with productivity of cotton (0.95) and it was followed by relative humidity at evening (0.61) and bright sunshine hours (0.42).

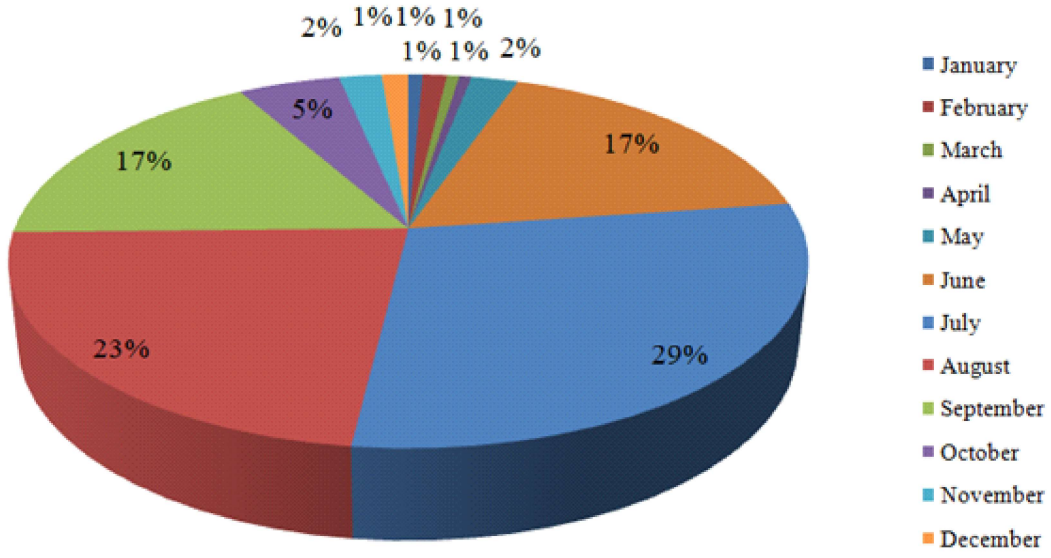

Fig 1. Month-wise per cent contribution to annual rainfall in Jalgaon district (1991-2018)

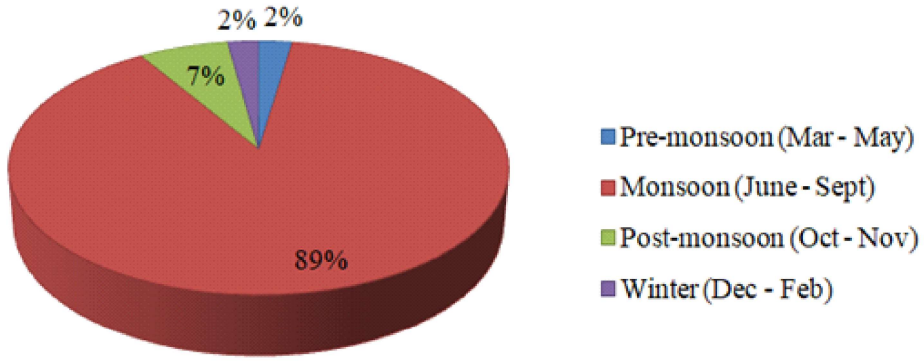

Fig 2. Season-wise per cent contribution to annual rainfall in Jalgaon district (1991-2018)

Table 2. Inter-relationship between area, production and productivity of cotton and weather parameters (1991-2018)

Factor	A	P	Y	T_{max}	T_{min}	RH-I	RH-II	BSS	Evaporation	Wind velocity	Rainfall	Number of rainy days
A	1.00											
P	0.84**	1.00										
Y	0.67**	0.95**	1.00									
T_{max}	-0.34	-0.41*	-0.38*	1.00								
T_{min}	-0.06	-0.04	-0.03	0.41*	1.00							
RH-I	-0.09	-0.09	-0.08	-0.28	-0.41*	1.00						
RH-II	0.61**	0.61**	0.55**	-0.69**	-0.39*	0.59*	1.00					
BSS	0.47*	0.42*	0.35	0.17	0.08	-0.30	0.06	1.00				
Evaporation	0.08	-0.02	-0.04	0.27	0.23	-0.32	-0.22	0.52**	1.00			
Wind velocity	-0.59**	-0.65**	-0.61**	0.09	0.03	0.24	-0.28	-0.40*	0.39*	1.00		
Rainfall	0.03	0.16	0.20	-0.57**	-0.46*	0.28	0.40*	-0.16	-0.17	0.07	1.00	
Number of rainy days	0.17	0.04	0.14	-0.56**	-0.20	0.14	0.25	-0.28	-0.14	0.12	0.64**	1.00

A= Area, P= Production, Y= Yield, T_{max}= Maximum temperature, T_{min}= Minimum temperature, RH= Relative humidity, *Significant at 5% LoS, **Significant at 1% LoS

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