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Rainfall distribution pattern for crop planning in Raichur region (Karnataka), India

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ABSTRACT

Rainfall during monsoon season and its variability governs the cropping system in the rainfed regions of Raichur. Daily rainfall data of one hundred fourteen years (1913-2020) have been analyzed for establishing the long term averages of monthly, seasonal and annual rainfall and its variability. The overall mean annual rainfall at Raichur region was 672.6 mm with average rainy days of 42 days, and distribution of 486.2 mm, 124.5 mm, 55.9 mm and 6.0 mm in monsoon, post monsoon, summer and winter respectively. The coefficient of variation of 29.8 indicated that rainfall was more or less stable over the years. Monthly rainfall had unimodel peak, September receives maximum mean rainfall of 148.1 mm followed by August (124.8 mm). Within the rainy season, September was the highest rainfall contributing month (22 per cent) followed by August (18.6 per cent). There is an ample scope for rain water harvesting from July to September which can be utilized as crop saving irrigation as well as pre sowing irrigation for succeeding *Rabi* crops which are generally sown on residual soil moisture. The study also revealed that the rainfall and rainy days during monsoon season ranged from 157.8 to 813.7 mm and 21 to 66 days respectively. According to '*Nakshatras'*, the traditional system of rainfall distribution for agriculture, revealed that the period from *Punarvasu* to *Chitta* received good amount of rainfall during which crops like groundnut, sunflower, maize, Bajra and pulses like greengram, pigeon pea and chick pea can be taken up.

Key words : *Seasonal rainfall, Rainy days, Nakshatra-wise rainfall and Constellation*

Introduction

Dryland agriculture will be adversely affected by an increase or decrease of rainfall and shifting of time of rainfall. The annual and seasonal rainfall received and its variability directly influences the success or failure of crops through its beneficial or adverse effect on growth and yield. Therefore, the study of variability of annual and seasonal rainfall is essential in selection of suitable crops and to take appropriate mitigating measures based on rainfall characteristics. Pradhan *et al.* (2020) analyzed the long-term rainfall data (1986-2018) of Bastar region revealed decreasing trend in total quantum of annual rainfall with varying frequency and distribution. Ghosh *et al.* (2021) assessed the climatological risk in terms of the dry week probabilities and length of the growing period of Indian Sundarbans region for successful crop planning, by using long term rainfall data from 1984 to 2018 received in Gosaba CD (Community Development) block of Indian Sundarbans. Singh *et al.* (2021) examined and compared the new innovative trend analysis of monthly, seasonal and annual rainfall with traditional trend analysis methods in relation to soybean productivity in western Maharashtra. Rainfall analysis for crop planning was carried out in different regions of the country as reported by Sevak, *et al.* (2018), Panda

and Sahu, 2019; Abebe, 2020 and Jaydip *et al.* (2021). A similar attempt was made to analyze the rainfall distribution pattern in monthly, seasonally, annually and *nakshatra*-wise for Raichur region.

There is considerable traditional knowledge of variability of rainfall patterns has been carried out for several centuries in India. The periods used by the farmers are however, not weeks or months but so-called *"Nakshatras"* which are 13 or 14-day periods based on solar calendar. The *Nakshatras* are constellations through which the sun passes in a year. There are 27 *Nakshatras* in a year viz., *Purvashada, Uttarabadrapada, Shravana, Danista, Purvabhadra, Uttarabhadra, Revathi, Ashwini, Bharini, Krutika, Rohini, Mrugashira, Aridhra, Punarvasu, Pushya, Aslesha, Makha, Pubba, Uttara, Hastha, Chitta, Swathi, Vishaka, Anuradha, Jyeshta* and *Moola Nakshatras.* Of these, the periods from *Rohini* to *Chitta* Nakshatras cover the monsoon season (Varshneya *et al.*, 2011).

Chinchorkar *et al.* (2013) on their study of rainfall variability at Anand in middle Gujarat region concluded that rainfall during *Punarvasu* and *Pushya* is more assured than in other *Nakshatras*, while it is least assured during *Magha* and *Pubba Nakshatras*. Chabbra and Haris (2014) compiled the indigenous knowledge related to climatic parameters, their forecasting during different time periods of a year (*Nakshatras*) based on experiences of the farmers and comparing indigenous knowledge with modern scientific analysis of weather data and their relationship with wheat and *rabi* maize yield in Patna, Bihar. While, Hazra *et al.* (2014) proposed a model of two distributions for each *Nakshatra* periods for the Eastern plateau of India. In the present study *Nakshatra* based rainfall analysis has been carried out in order to study the trend in each *Nakshatra* period besides monthly, seasonal and annual rainfall analysis and its impact on the crops for Raichur district.

Materials and Methods

The daily rainfall data recorded at Agro-meteorological Centre, Main Agricultural Research Station, Raichur for 107 years from 1913 to 2020 was used to analyze *Nakshatra*-wise rainfall and rainfall distribution pattern for Raichur district. Of the 27 *Nakshatras*, 12 *Nakshatras* from *Rohini* (May 25 to June 7) to *Swati* (October 24 to November 5) were

Table 1. Monthly mean, highest and lowest rainfall and rainy days along with SD and CV as observed at Raichur

Month	Particulars	Lowest (mm)	Highest (mm)	Mean (mm)	SDmm/ days	CV (%)	% of annual
January	Rainfall	0	54.5	2.5	8.0	324.0	0.4
	Rainy day/s	0	3	0.2	0.6	259.4	0.6
February	Rainfall	0	70.8	3.5	9.9	277.9	0.5
	Rainy day/s	0	3	0.3	0.7	245.3	0.7
March	Rainfall	0	102.0	5.8	16.4	282.0	0.9
	Rainy day/s	0	4	0.4	0.7	196.3	0.9
April	Rainfall	0	116.7	16.9	22.9	135.6	2.5
	Rainy day/s	0	7	1.4	1.4	102.7	3.2
May	Rainfall	0	205.6	33.1	36.3	109.6	4.9
	Rainy day/s	0	11	2.5	2.0	80.6	6.0
June	Rainfall	12.0	313.4	94.2	61.7	65.5	14.0
	Rainy day/s	1.0	13	6.3	2.7	43.5	14.9
July	Rainfall	5.8	324.7	119.1	71.0	59.6	17.7
	Rainy day/s	1.0	16	8.2	3.5	43.2	19.4
August	Rainfall	0	397.0	124.8	78.6	63.0	18.6
	Rainy day/s	0	19	8.1	3.6	44.4	19.2
September	Rainfall	0.8	486.4	148.1	90.4	61.0	22.0
	Rainy day/s	0	18	8.1	3.7	45.2	19.2
October	Rainfall	0	672.6	96.9	102.2	105.4	14.4
	Rainy day/s	0	16	4.8	2.9	60.4	11.5
November	Rainfall	0	158.2	23.3	33.2	142.5	3.5
	Rainy day/s	0	7	1.6	1.7	108.5	3.7
December	Rainfall	0	106.0	4.2	14.6	347.0	0.6
	Rainy day/s	0	4	0.3	0.8	251.9	0.7

considered for the analysis. The mean, standard deviation, coefficient of variation (CV), minimum and maximum of *Nakshatra*-wise rainfall was calculated by use of statistical methods.

Results and Discussion

Annual rainfall : The overall mean total annual rainfall of Raichur region for the past one hundred seven years (1913-2020) was 672.6 mm spread over 42 rainy days. The lowest and highest rainfall and rainy days recorded was 263.3 mm and 1320.8 mm and 19 and 65 days respectively. The standard deviation and coefficient of variation for annual rainfall was 200 mm and 29.8 per cent where as for annual rainy days it was 9.1 days and 21.8 per cent respectively (Table 2). Raichur region annual rainfall variation against average rainfall of 107 years (1913-2020) was depicted in Fig. 1.

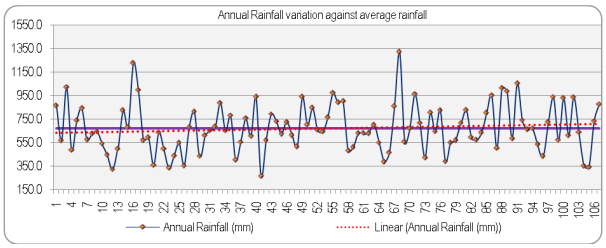

Fig. 1. Raichur annual rainfall variation against average rainfall

Seasonal rainfall : The average seasonal rainfall along with rainy days and its variability during the seasons winter (January - February), summer (March- May), Monsoon (June - September) and Post monsoon (October - December) is presented in Table 2. South west (SW) monsoon season contributes 72.4 per cent of mean annual rainfall. Rainfall during this period varied between 157.8 mm to 813.7 mm with mean value of 486.2 mm with 30 mean rainy days. Total amount of rainfall received during north east (NE) monsoon was 18.5 per cent of the mean annual rainfall. The mean rainfall during this period was 124.5 mm. The summer rains contributed 8.3 per cent (55.9 mm) of the mean annual rainfall. The winter rainfall contributed less than one per cent (6.0 mm) to the mean annual rainfall. The quantum of rainfall received during south west monsoon appears to be sufficient to raise a successful crop, however CV exceeds 30% indicate risk in crop production because of low dependability. However, on deep black soils, redgram or cotton can be taken up.

Monthly rainfall : Rainfall quantum and distribution during different months is presented in Table 1. It is evident that monthly rainfall had unimodal peak. September month receives maximum mean rainfall of 148.1 mm distributed in 8 mean rainy days followed by August (124.8 mm) in 8 rainy days. Monthly rainfall during November to May remained lowest in the range of 2.2 to 33.1 mm. The highest rainfall of 672.6 mm was reported in the October month followed by September 486.4 mm. The highest coefficient of variation is noticed during the start of the year, i.e. from January to May and November – December. The lowest coefficient of variation is confined to monsoon season indicating the dependability and reliability of rainfall during monsoon season. Monthly CV is however higher and sowing operations can commence only from last

Table 2. Characteristics of annual and seasonal rainfall and rainy days as observed at Raichur

Year / Seasons	Particulars	Lowest (mm)	Highest (mm)	Mean (mm)	SDmm/ days	CV(%)	% of annual rainfall
Annual	Rainfall	263.3	1320.8	672.6	200.3	29.8	-
	Rainy days	19	65	42.0	9.1	21.8	-
Winter	Rainfall	0.0	70.8	6.0	12.3	205.2	0.9
	Rainy days	0	6	0.5	1.4	504.7	1.3
Summer /Pre-monsoon	Rainfall	2.4	205.6	55.9	44.8	80.3	8.3
	Rainy days	0	22	4.3	4.2	379.6	10.1
Monsoon	Rainfall	157.8	813.7	486.2	152.1	31.3	72.4
	Rainy days	2	66	30.5	13.5	176.3	72.7
Post monsoon	Rainfall	0.0	680.4	124.5	110.1	88.5	18.5
	Rainy days	0	27	6.7	5.4	420.8	16.0

Annual : January – December Winter : January – February Summer : March- May
Monsoon : June - September Post monsoon: October - December
SD : Standard Deviation CV : Coefficient of variation

week of June to first fortnight of July. Nevertheless, onset of monsoon of late is often delayed and is becoming more undependable. Hence, climate smart crops, i.e. crops less sensitive to time of sowing like redgram, little millet, castor or desi cotton etc. could be preferred under unexpected delays.

Characterization of *nakshatra*-wise rainfall: Twelve *nakshatras* were considered for analysis because this period coincides with the crop growing period of both *kharif* and *rabi* seasons. Maximum rainfall occurred in *Uttara* (73.8 mm) followed by *Magha* (62.9 mm) (Table 3 & Fig. 2). Rainfall was received in all *nakshatras* and good amount of rainfall was received from *Aridhra* (22 June to 5 July) to *Hasta* (27 September to 10 October). Rainfall was lowest (20.3 mm) in *Swati*. The CV of rainfall was lowest (70%) in *Uttara* while it was highest (233.1 %) in *Swati*. Rainfall in *Aridhra* and *Uttara* are more assured than in other *nakshatras* while it is the least assured in *Swati* and *Chitta nakshatras*. As indicated earlier sowing can commence from *Mrigashira* or *Aridhra* depending on soaking rains during *Kharif*. On deep black soils *rabi* sowing may commence from *Punarvasu* onwards.

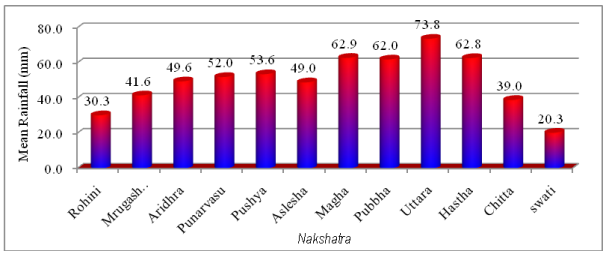

Fig. 2. *Nakshatra*-wise mean rainfall (mm) of Raichur

Conclusion

Based on the above analysis, the following recommendations for the region could be made to increase the crop production per unit area under rainfed conditions. About 72.4 per cent of the total average annual rainfall coincides with the monsoon season and is received during a short time span of two to three months between June to September due to southwest monsoon in less number of rainy days. Rainfall received during summer (March - May) season can be utilized for summer ploughing to make the land ready for final field preparation. With normal onset of rainfall, sowing of main crop like redgram + Jowar or sole sunflower in shallow soils and redgram + blackgram in medium and deep soils can be taken up. In the event of mid season drought, mulching will be help in reducing soil evaporation and conserving moisture in top layers of the soil. In the event of terminal drought, and under receding soil moisture conditions, crop requires supplementary irrigation. The major portion of monsoon rainfall is generally lost through runoff which can be stored through the construction of suitable water harvesting structures as on-farm reservoirs which could be utilized for life saving irrigation for *rabi* crops.

Crop selection for rainfall in different *Nakshatra* periods

From the above analysis it is clear that the period from *Aridhra* to *Uttara* which covers the monsoon period with adequate amount of rainfall during

Table 3. Statistical characteristics of *Nakshatra*-wise rainfall in Raichur

Season	Nakshatra	Period	Rainfall			Highest rainfall	
			Mean (mm)	SD (mm)	CV (%)	Amount (mm)	Year
Pre-monsoon	Rohini	May 25-Jun.7	30.3	32.3	106.7	122.4	1995
	Mrigashira	Jun.8-Jun.21	41.6	38.8	93.3	258.6	1996
Monsoon	Aridhra	Jun.22-Jul.5	49.6	41.0	82.8	214.8	2007
	Punarvasu	Jul.6-Jul.19	52.0	49.2	94.5	218.0	1921
	Pushya	Jul.20-Aug.2	53.6	52.0	96.9	313.2	1934
	Ashlesha	Aug.3-Aug.16	49.0	44.2	90.2	193.9	1948
	Magha	Aug.17-Aug.30	62.9	64.3	102.2	366.6	2014
	Purva	Aug.31-Sept.12	62.0	56.5	91.0	212.3	1943
	Uttara	Sept.13-Sept.26	73.8	63.9	86.6	352.3	1949
Post-monsoon	Hasta	Sept.27-Oct.10	62.8	75.1	119.5	437.4	2009
	Chitta	Oct.11-Oct.23	39.0	57.5	147.4	296.1	1998
	Swati	Oct.24-Nov.5	20.3	47.3	233.1	409.7	1916

which crops like greengram, redgram, *kharif* sorghum, sunflower, maize bajra could be grown. With irrigation facility paddy, cotton, sugarcane, chilli can be taken up. The Nakshatra-wise mean rainfall is shown in Fig.1. *Mrigashira* and *Aridhra Nakshatras* received good amount of rainfall during which one can take up crops like finger millet, pigeon pea and groundnut. The period *Uttara* to *Hasta* received good rainfall which is suitable for *Rabi* crops like chickpea. The pre-monsoon period like *Rohini*, received an average of 30.3 mm rainfall during which land preparation can be taken up while the period from *Punarvasu* to *Chitta Nakshatras* are suited for sowing of Kharif crops like Paddy, Sugarcane, Bajra and Sunflower.

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