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Rainfall and Temperature Variability Analysis of ZARS, Mandya in Karnataka, India

B.S. Sowmyalatha[1*], K.S. Shubhashree[2] and V. Thimmegowda[3]

[1]Department of Agronomy, College of Agriculture, ZARS, V.C. Farm, Mandya-571 405, University of Agricultural Sciences, Bengaluru, Karnataka, India
[2]AICRP on Small Millets, ZARS, V.C. Farm, Mandya-571 405, University of Agricultural Sciences, Bengaluru, Karnataka, India
[3]ZARS, V.C. Farm, Mandya-571 405,University of Agricultural Sciences, Bengaluru, Karnataka, India
**Corresponding author*

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A B S T R A C T

No doubt the climatic aberrations will severely set back agricultural development in most of the tropical countries particularly India, where an increasing share of the poorest and most vulnerable population resides. Zonal Agricultural Research Station is located at Mandya district of Karnataka lies under agro-climatic zone 6 (Southern dry zone) having longitude of 76° 49.8' E and latitude of 12°34.3' N with 697 meters above mean sea level. Rainfall and temperature data of 28 years (1991-2018) obtained from Agromet observatory, Zonal Agricultural Research Station (ZARS), Mandya, University of Agricultural Sciences, Bengaluru was analysed for variability. The mean annual rainfall of the station is 735.9 mm distributes Pre-monsoon or summer (March-May) of 182.8 mm, south-west monsoon (June-September)of 313.4mm, north-east monsoon (October-December) of 235.4mm and winter season (January-March) of 4.2 mm. The trend indicated that the maximum contribution was from south west monsoon (42.59 %) and lowest during winter (0.57 %) whereas September was the rainiest month (130.66 mm). The standard deviation (SD) was highest (123.4) with Co-efficient of variation (CV) of 39.40 %, which indicates high variability and dependability on rainfall from S-W monsoon. The mean monthly maximum temperature was 34.2°C and mean monthly minimum temperature was 14.4°C. Mean annual maximum temperature was decreasing in a linear path contrastingly and mean minimum temperature was increasing linearly over the years. The annual rainfall variability indicates that 8 years received excess rainfall (21.6 to 57.5 %), 12 years had normal rainfall (-4.0 to 10.4 %),2 years with slight drought (-19.1 to -19.2 %) and 6 years of moderate drought (-29.3 to -42.6%) were recorded. Overall analysis of rainfall and temperature shows variation in distribution and amount of rainfall received.

Introduction

Rainfall and temperature variability's are major factors influencing the agricultural productivity and sustainability in tropics Virmani (1994). Rainfall pattern and the quantity decide the cropping system in the rainfed agriculture. The annual and seasonal

rainfall received and its variability directly influences the success or failure of crop through its favourable or adverse effect on crop growth and yield. Therefore, the study on variability of annual rainfall and temperature are essential in selection of suitable crops and to take up appropriate mitigating measures based on rainfall characteristics and temperature of a given location. Similar rainfall variability analysis was done by Mummigatti *et al.,* (2013), Thimme Gowda *et al.,* (2015) and Hanuman thappa *et al.,* (2016). The monthly and seasonal pattern of rainfall and temperature may helpful in crop planning by identifying the period of drought, normal and excess rainfall (Ray *et al.,* 1980). Such analysis is helpful in prediction of annual and seasonal rainfall probability for the next one or two years and in turn crop planning. Hence, a study was undertaken at Zonal Agricultural Research Station, Mandya district, Karnataka to understand the rainfall and temperature variability for better agricultural planning.

Materials and Methods

A study was taken on annual and seasonal rainfall and temperature variability analysis of Zonal Agricultural Research Station, which is located at Mandya district of Karnataka and lies under agro-climatic zone 6 (Southern dry zone) having longitude of 76° 49.8' E and latitude of 12°34.3' N situated at 697 meters above mean sea level. Rainfall and temperature data of 28 years (1991-2018) was collected from Agromet observatory, Zonal Agricultural Research Station (ZARS), Mandya, University of Agricultural Sciences, Bengaluru. The rainfall and temperature data were collected on daily basis and analysed for standard deviation and Co-efficient of variance using statistical tools. Per cent deviation of rainfall from the normal were categorized using IMD classification *viz.,* E= Excess RF (>19%), N = Normal RF (± 19%), SLD = Slight Drought (> -19 to -25%), MD = Moderate Drought (-26 to -49%) SD = Severe Drought (-50% & above) (Anonymous, 2018).

Results and Discussion

Rainfall data for the period of 28 years from 1991 – 2018 was taken and mean was worked out to estimate the difference in rainfall pattern (Table 1). The rainfall data was then grouped to Southwest monsoon (Jun – Sep), Northeast monsoon (Oct – Dec), Winter (Jan-Feb) and Summer (March-May).

The mean annual rainfall of the station from the past 28 years was 735.9 mm distributed as 182.8 mm during pre-monsoon or summer season, 313.4 mm from South-West monsoon 235.4 mm from North-East monsoon and 4.2 mm during Winter season. The trend indicated that, maximum contribution of rainfall was from south west monsoon (42.59 %) and lowest during winter (0.57 %). High variability and dependability of rainfall from S-W monsoon is indicated by highest standard deviation (SD) (123.4) with Co-efficient of variation (CV) of 39.40 % (Fig. 1).

Annual drought analysis and rainfall variability on decadal basis of ZARS, Mandya

The data on mean annual rainfall, coefficient of variation, standard deviation and its classification are given in Table 2 and 3. The annual rainfall variability during the last 28 years (1991 to 2018) indicates that 8 years received excess rainfall (21.6 to 57.5 %), 12 years with normal rainfall (-4.0 to 10.4 %), 2 years of slightly drought (-19.1 to -19.2 %) and 6 years moderate drought (-29.3 to -42.6 %) were recorded. However, the annual precipitation received in this region was normal (Table 2).

Table.1 Seasonal rainfall pattern & variability of ZARS, Mandya (1991-2018)

Season	Avg. Rainfall	Per cent (%)	SD	CV (%)
South west Monsoon (June-Sep)	313.4	42.59	123.4	39.4
North east Monsoon (Oct- Dec)	235.4	32.00	119.4	50.7
Winter (Jan-Feb)	4.2	0.57	7.9	186.4
Summer (March- May)	182.8	24.84	94.0	51.4
Annual (Total)	**735.9**		**203.5**	**27.7**

SD -Standard Deviation CV-Co-efficient of variance

Table.2 Annual drought analysis of ZARS, Mandya (1991-2018)

Sl.No.	Year	Average Rainfall (mm)	% deviation from the normal	Situation
1	1991	812.5	10.4	N
2	1992	425.8	-42.1	MD
3	1993	763.6	3.8	N
4	1994	520.0	-29.3	MD
5	1995	617.5	-16.1	N
6	1996	1096.5	49.0	E
7	1997	903.7	22.8	E
8	1998	775.0	5.3	N
9	1999	935.2	27.1	E
10	2000	1159.2	57.5	E
11	2001	764.0	3.8	N
12	2002	436.9	-40.6	MD
13	2003	623.0	-15.3	N
14	2004	956.7	30.0	E
15	2005	1021.6	38.8	E
16	2006	512.0	-30.4	MD
17	2007	630.4	-14.3	N
18	2008	706.5	-4.0	N
19	2009	779.7	6.0	N
20	2010	752.5	2.3	N
21	2011	791.0	7.5	N
22	2012	422.6	-42.6	MD
23	2013	595.6	-19.1	SLD
24	2014	951.1	29.3	E
25	2015	594.7	-19.2	SLD
26	2016	485.6	-34.0	MD
27	2017	895.0	21.6	E
28	2018	676.0	-8.1	N

Mean = 735.9 mm, IMD Classification: E= Excess RF (>19%), N = Normal RF (± 19%), SLD = Slight Drought (> -19 to -25%), MD = Moderate Drought (-26 to -49%) SD = Severe Drought (-50% & above)
Source: http://www.imdpune.gov.in

Table.3 Annual Rainfall (mm) variability from 1991to 2018on decadal basis for ZARS, Mandya

Decades	1991-2000	2000-2010	2010-2018
Mean	598.8	476.2	534.0
SD	739.2	765.4	750.8
CV (%)	123.4	160.7	140.6

SD -Standard Deviation CV-Co-efficient of variance

Table.4 Monthly rainfall variability of ZARS, Mandya

Month	Max.	Min.	Mean	SD	CV (%)	% contribution
January	15.6	0.00	1.60	4.11	257.35	0.22
February	29.2	0.00	1.76	5.67	321.39	0.24
March	172.0	0.00	15.25	34.97	229.28	2.11
April	188.0	0.00	53.95	44.13	81.81	7.45
May	304.0	0.00	109.90	81.19	73.88	15.17
June	210.2	0.00	56.59	45.96	81.21	7.81
July	120.8	1.20	48.39	32.27	66.68	6.68
August	217.6	0.00	75.52	67.28	89.09	10.42
September	363.5	30.40	130.66	79.95	61.19	18.04
October	420.8	10.80	162.98	103.68	63.62	22.50
November	256.8	0.00	55.23	56.93	103.10	7.62
December	52.6	0.00	12.60	14.84	117.74	1.74

Max- Maximum Min-Minimum SD -Standard Deviation CV-Co-efficient of variance

Table.5 Characteristics of monthly maximum temperature from 1991-2018 (28 years) at ZARS, Mandya

Month	Max.	Min.	Mean	SD	CV (%)
January	31.7	27.5	29.5	1.2	4.1
February	38.0	29.0	31.7	1.8	5.7
March	37.0	30.0	33.4	1.6	4.9
April	37.0	31.5	34.2	1.4	4.2
May	36.9	29.9	33.3	1.7	5.2
June	32.7	28.3	30.7	1.2	3.9
July	31.5	27.3	29.4	1.1	3.8
August	38.0	27.1	29.7	2.1	6.9
September	33.3	27.7	29.8	1.1	3.6
October	34.5	26.7	29.8	1.6	5.3
November	30.2	27.1	29.4	1.5	5.3
December	29.0	26.8	28.7	1.5	5.3

Max- Maximum Min-Minimum SD -Standard Deviation CV-Co-efficient of variance

Table.6 Characteristics of monthly minimum temperature from 1991-2018 (28 years) at ZARS, Mandya

Month	Max.	Min.	Mean	SD	CV (%)
January	20.6	12.3	14.4	1.7	11.9
February	21.1	11.0	15.9	1.9	11.7
March	21.3	14.0	18.3	1.7	9.1
April	29.9	16.4	21.0	2.2	10.6
May	22.3	16.5	20.4	1.3	6.4
June	22.8	17.3	20.1	1.1	5.3
July	21.1	16.8	19.6	1.1	5.4
August	21.1	15.8	19.6	1.1	5.6
September	22.4	18.0	19.7	0.9	4.4
October	21.2	17.3	19.4	0.9	4.6
November	19.1	15.3	17.9	1.5	8.3
December	16.7	12.2	15.7	2.1	13.6

Max- Maximum Min-Minimum SD-Standard Deviation CV-Co-efficient of variance

Fig.1 Seasonwise rainfall (mm) over the period of 28 years (1991-2018)

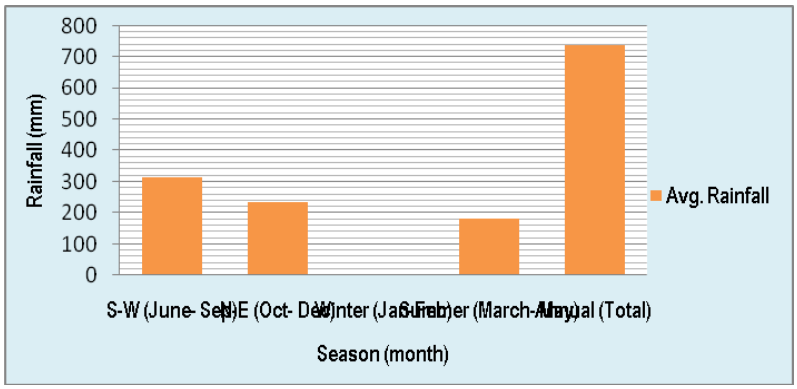


Fig.2 Rainfall trend at ZARS, Mandya (1991-2018)

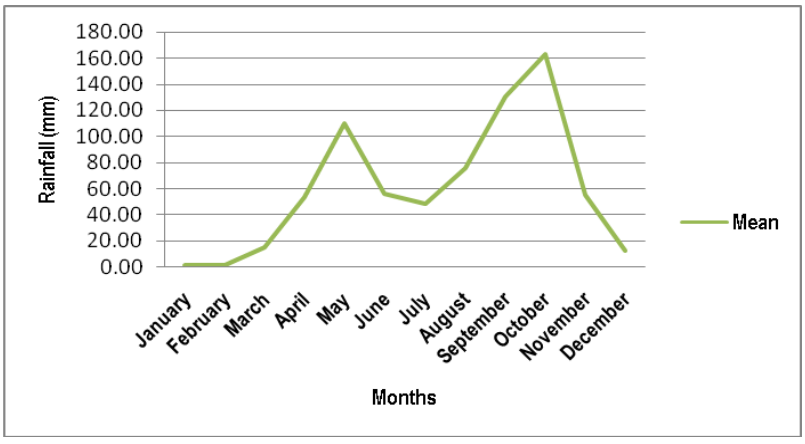
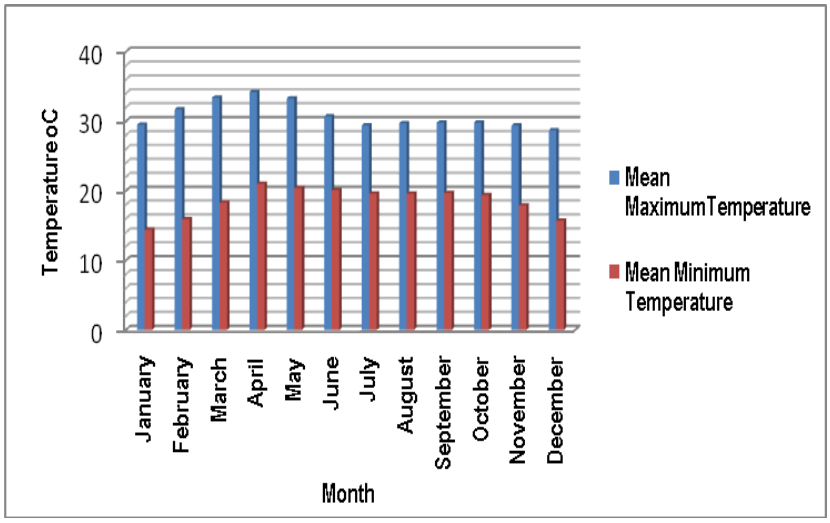


Fig.3 Characteristics of monthly maximum and minimum temperature of ZARS, Mandya



The decadal analysis (Table 3) indicated that over three decades, the average rainfall received was fluctuating and coefficient of variation was also varying. The highest average rainfall of 598.8mm was received during 1991-2000 and lowest 476.2 mm during 2000-2010.

Monthly rainfall variability

The mean annual rainfall of ZARS was found to be 735.9 mm over the past twenty eight years. Mean monthly rainfall varied from 1.60 mm (lowest in January) to 162.98 mm (highest in October) (Table 4 and depicted in Fig. 2). The overall variability analysis of rainfall revealed that receipt of rainfall during the first three months (January to March) was less than 2.57 %. In the subsequent months April and May rainfall increased gradually to 22.62 % whereas from June to October it reached maximum of 65.45%. Similar results were observed from the findings of Tupe *et al.*, 2010 and Singh *et al.*, 2009.

Monthly maximum temperature

The overall variability of mean maximum temperature is presented in table 5 and depicted in Figure 3. The data on mean monthly maximum temperature over 28 years revealed that during summer season (March to May) maximum temperature ranged from 33.3 to 34.2 °C, whereas in *kharif* season (June to September) it was 29.4 to 30.7°C and in *Rabi* season (October to February) it varied between 28.7 to 31.7°C. Higher standard deviation and co-efficient of variation of 1.7 and 5.2 per cent was observed during the month of May in summer season, 2.1 and 6.9 per cent during August in *Kharif* and 1.8 and 5.7 per cent in winter (February), respectively.

Monthly minimum temperature

The mean minimum temperature variability is presented in table 6 and depicted in Figure 3. During summer season (March to May) mean monthly minimum temperature ranged from 18.3 to 21.0 °C, whereas in *kharif* season (June to September) it was 19.6 to 20.1°C and in *Rabi* season (October to February) it varied between 14.4 to 19.4°C. Higher standard deviation and co-efficient of variation of 2.2 and 10.6 per cent was observed during the month of April in summer season, 1.1 and 5.6 per cent during August in *Kharif* and 2.1 and 13.6 per cent in winter (December), respectively.

In conclusion, the above study clearly indicates that significant variability in rainfall and temperature was noticed. The mean annual rainfall of 735.9 mm was received with maximum contribution from south west monsoon and lowest during winter. The highest standard deviation (SD) with lowest Co-efficient of variation (CV) indicates high variability and dependability on rainfall from S-W monsoon. The annual rainfall variability during the last 28 years (1991 to 2018) indicates that 8 years received excess rainfall, 12 years with normal rainfall; 2 years of slightly drought and 6 years moderate drought were recorded. However, the annual precipitation receipt in this region was normal. Summer season recorded maximum temperature followed by *Kharif* and *Rabi* season.

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