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Rainfall variations and its correlation with groundnut productivity

Pandya PA[1], Mashru HH[2], Patel RJ[3], Rank HD[4]
[1, 2, 3, 4] College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh, Gujarat, India

Abstract
A study was planned to assess the rainfall variation and its correlation with productivity of *Kharif* Groundnut for Junagadh District, Gujarat, India. The analysis was done for seasonal, monthly, fortnightly as well as weekly rainfall. The results indicated that for the seasonal rainfall, arithmetic mean, standard deviation and coefficient of variation was found as 954 mm, 358 mm and 37% respectively. Highest CV was found as 91% for September while lowest as 51% for July. July contributed 42% of the total seasonal rainfall. The lowest coefficient of variation was 67% for third fortnight. 27SMW has high rainfall with low CV% as. The correlation coefficient between seasonal rainfall and groundnut yield was found as 0.79. The correlation of June was highest with coefficient as 0.68 and lowest in August with coefficient as 0.26. In case of weekly rainfall, highest positive correlation was observed to be 0.73 for the SMW22 followed by SMW39, 24 and 23. The rainfall and groundnut yield was highly negatively correlated with coefficient as -0.30 for the 34SMW.

Keywords: rainfall variation, groundnut productivity, rainfall analysis, standard meteorological week, kharif groundnut

1. Introduction
India ranks first among the rain fed agricultural countries of the world in terms of both area and production. Due to population pressure on agricultural lands, the scarceness is concentrated in rain fed regions. Climate in Indian rain fed regions is characterized by complex climatic deficiencies, manifested as water scarcity for rain fed crop production. The climate is largely semi-arid and dry sub-humid with a short (occasionally intense) wet season followed by long dry season. Rainfall is highly unreliable, both in time and space, with strong risks of dry spells at critical growth stages even during good rainfall years. Groundnut (*Arachishypogaea L.*) is one of the vastly cultivated oilseed crops in the world as it is cultivated in more than 100 countries and that is why it is referred to as a universal crop. Despite being an alien crop, India ranked second in the world in its acreage after china however its productivity was very less *i.e.* 1485 kg/ha as compare 3500 kg/ha in China [1]. Groundnut requires on an average 400-500 mm of water but it varies with soil type, agro-climates and genotype. Total rainfall to a tune of 400-600 mm, well-distributed over the entire growth period during *Kharif* results in good yield. Among the various constraints for low yield, the principal one is erratic, insufficient and unevenly distributed rainfall during *Kharif*. The water scarcity zone of Gujarat is characterized by an inadequate and ill-distributed, unpredictable rainfall [2]. The distribution of rainfall within the crop period is more important than the total amount of rainfall in season as the response of various phases of crop growth is different with respect to availability of moisture [3]. Therefore, many researchers have evaluated rainfall variability by finding out mean, standard deviation and coefficient of variation and other parameters [4, 5, 6, 7]. Researchers have also analyzed daily rainfall data for establishing the long term averages of weekly, monthly, seasonal and annual rainfall and its variability [8]. Rainfall distribution has been found to have profound effect on crop performance in rainfed agriculture for variety of crops [9, 10, 11]. Correlation was used to determine associations between crop yield and rainfall by researchers [12, 13]. Such study based on past records of rainfall and yield, helps to analyze effect of rainfall in particular phase of the season on crop yield which may be useful in crop management practices, contingent planning and other crucial decision making. Keeping above points in view, a study was planned with objective to evaluate rainfall variability and correlation analysis between rainfall and groundnut yield for Junagadh District, Gujarat, India

2. Materials and Methods
Junagadh is located at southwest of Gujarat State. The average annual rainfall of Junagadh is 900 mm. *Kharif* Groundnut is sown in the beginning of monsoon depending on the commencement of rainfall. The crop period of Groundnut is 115 to 120 days and about 100 to 110 days for late sowing varieties. The analysis of rainfall variability for the present study was done for seasonal rainfall as well as splitting the rainfall in different durations by four approaches.

1. Seasonal rainfall
2. Monthly rainfall
3. Fortnightly rainfall
4. Weekly rainfall

In the study area usually monsoon commences at the start of June and gets withdrawn by the end of September. Therefore, rainfall of these four months was considered for the analysis for data of 17 years from 1997 to 2013. The rainfall data was collected from meteorological station of Junagadh Agricultural University. Nomenclature for the fortnightly rainfall used in the study is given in table 1.

Table 1: Nomenclature for fortnightly rainfall

Sr. No.	Duration	Nomenclature
1	28 May-10 Jun	1F
2	11 Jun-24 Jun	2F
3	25 Jun-08 July	3F
4	09 Jun-22 July	4F
5	23 July-05 August	5F
6	06 August-19 August	6F
7	20 August-2 September	7F
8	03 September-16 September	8F
9	17 September- 30 September	9F

In week wise rainfall approach, the weekly rainfall records of 18 standard metrological weeks from 22nd SMW to 39th 18 weeks which falls in the rainy season between 28 May to 29 July were analyzed. The seasonal, monthly, fortnightly as well as weekly rainfall variability was evaluated by arithmetic mean, standard deviation and coefficient of variation (CV%). If the change in one variable affects a change in the other variable, the two Variables are said to be correlated and the degree of association ship (or extent of the Relationship) is known as correlation. The correlation is expressed by co-relation coefficient r which ranges from -1 to +1 with -1 as most negatively and +1 as most positively correlated. The correlation of productivity of groundnut with total seasonal rainfall as well as each of 4 months, 9 fortnight and 18 SMW was carried out.

Table 2: Nomenclature for weekly rainfall

Sr. No.	Duration	SMW	Sr. No.	Duration	SMW
1	28 May-03 Jun	22	10	30 July-05 August	31
2	04 Jun-10 Jun	23	11	06 August-12 August	32
3	11 Jun- 17 Jun	24	12	13 August-19 August	33
4	18 Jun-24 Jun	25	13	20 August-26 August	34
5	25 Jun-01 July	26	14	27 August-02 September	35
6	02 July-08 July	27	15	03 Setember-09 September	36
7	09 July-15 July	28	16	10 September-16 September	37
8	16 July-22 July	29	17	17 September-23 September	38
9	23 July-29 July	30	18	24 September-30 September	39

3. Results and Discussion

3.1 Rainfall Variability

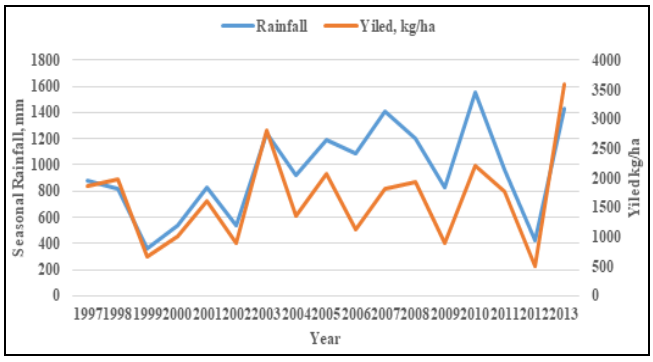

Fig 1: Seasonal rainfall of and Groundnut yield for Junagadh district

The seasonal rainfall and yield of groundnut of seventeen years is shown in Fig. 1. Highest yield for study period was 2802 kg/ha in 2003 while lowest yield was recorded as 508 kg/ha in 2012, the average yield of these seventeen years was 1652 kg/ha. For the seasonal rainfall, the highest rainfall was observed in 2010 (1557 mm) and lowest 361 mm in 1999, the arithmetic mean of seasonal rainfall was found as 954 mm. Standard deviation and CV% were 358 mm and 37% respectively. The rainfall variation for monthly rainfall data is given in table 3. It reveals that highest average rainfall occurred in the month of July and lowest was recorded as 177 mm for the month of September. The highest coefficient of variation was found to be 91% for the month of September with standard deviation as 161 mm which suggests that there is a wide variation in the monthly rainfall of September. Rainfall of July is least varied among all months with coefficient of variation as 51%. July month contributed 42% of the total seasonal rainfall, for the rest of the three months, 19 to 20% of the seasonal rainfall occurred for each month.

Table 3: Monthly rainfall variability

Sr. No	Month	Arithmetic Mean, mm	Standard Deviation, mm	CV (%)
1	June	191	132	69
2	July	404	207	51
3	August	180	129	72
4	September	177	161	91

The results of fortnightly rainfall variability are given in table 4. Temporal distribution of seasonal rainfall with respect to various fortnights is almost uniform for second, third and fourth fortnight. Highest average rainfall is 179 mm in fifth fortnight (23 July-05 August) which alone contributed about 18% of seasonal rainfall out of 9 fortnights while lowest rainfall was observed at commencement of monsoon *i.e.* 17 mm in first fortnight. From 2F to 7F, coefficient of variation is less as well as rainfall is also high. Rainfall of 1F and 8F has high standard deviation than arithmetic mean and varied highly as coefficient of variation was 146% and 124% respectively. The lowest coefficient of variation was 67% for third fortnight (25 Jun—08 July). Thus low CV% and high rainfall in 3F revels that if groundnut is shown keeping in view that most critical stage for water requirement falls in this fortnight will be beneficial for crop production.

Table 4: Fortnightly Rainfall Variability

Sr. No	Fortnight	Arithmetic Mean, mm	Standard Deviation, mm	CV (%)
1	1F	17	24	146
2	2F	120	113	94
3	3F	140	93	67
4	4F	133	113	85
5	5F	179	113	74
6	6F	114	108	94
7	7F	68	64	93
8	8F	113	140	124
9	9F	71	67	96

When seasonal rainfall is splitted in weekly rainfall, the variability was very high. The highest average rainfall was 113 mm for SMW 10. out of total 18 weeks, 10 weeks showed high value CV as standard deviation was higher than average (table 5). The highest average rainfall was 113 mm for SMW 10, *i.e.* from 30 July to 05 August. The SMW 23 (04 Jun-10 Jun), 22 (28May-03Jun) and 34 (20 August-26 August) was observed to have lower average rainfall of 14 mm, 26 mm and 33 mm respectively. The highest CV was found to be 170% and 151% for the standard meteorological week 39(24September-30September) and 37(10 September-16 September) respectively. The lowest CV% was found to be 73% and 79% for the standard meteorological week 27 (02 July-08 July) and 38 (17 September-23 September) respectively. Third fortnight is a combination of 26 and 27 SMW. From table 4 and table 5 it can be noted that 26 SMW has high CV% and low rainfall and 27 SMW has high rainfall and low CV% which advocates that splitting the period into smaller duration, more precise information may be obtained as second half of 3F i.e. 27SMW is reliable for critical stage of crop with respect to irrigation as compare to first half. 3F and 27SMW has high rainfall with low value of CV%. The period of maximum sensitivity to drought occurs between 50-80 days after sowing, the period of maximum flowering and vegetative growth. For getting higher yield, sowing done such that this most critical duration falls in 3F or 27SMW.

Table 5: Weekly rainfall variability

Sr. No	SMW	Arithmetic Mean, mm	Standard Deviation, mm	CV (%)
1	22	26	21	80
2	23	14	16	112
3	24	90	120	133
4	25	55	61	111
5	26	60	85	141
6	27	100	73	73
7	28	79	82	105
8	29	54	66	122
9	30	84	80	96
10	31	113	112	99
11	32	81	104	128
12	33	35	35	99
13	34	33	33	99
14	35	44	62	140
15	36	60	60	100
16	37	90	136	151
17	38	50	39	79
18	39	37	63	170

3.2 Correlation Analysis

The correlation coefficient between seasonal rainfall and yield found as 0.79. When rainfall is splitted in monthly, fortnightly and weekly rainfall, its relation with yield was appraised. The correlation analysis between monthly rainfall and yield indicates that rainfall of all months is positively correlated with groundnut yield (Fig. 2). The correlation of June was highest with correlation coefficient as 0.68 followed by 0.45 in September. Correlation coefficient between rainfall of August and groundnut yield was lowest i.e. 0.26.

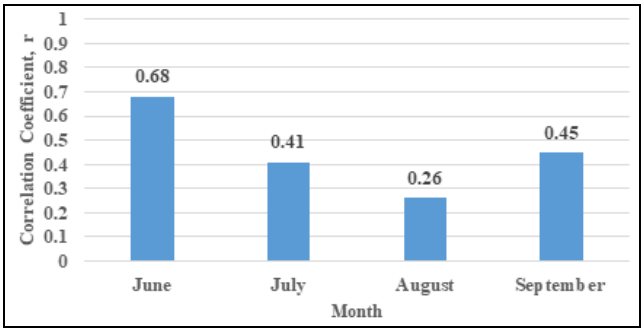

Fig 2: Correlation between monthly rainfall and yield

The results of correlation coefficients between fortnightly rainfall and groundnut yield are shown in Fig 3. Out of 9 fortnights, highest positive correlation coefficient was observed as 0.73 for the 2F (11 June-24 June). It indicates that correlation coefficient as 0.63 in June when splitted in to two fortnights, 2F has very high correlation and 1F as low correlation with yield of groundnut as most of the years, sowing might be done in 2F. For 1F, 5F and 7F has almost same correlation coefficient was observed. Rainfall of three fortnights, i.e. 3F, 7F and 9F was recorded to have almost no correlation with yield.

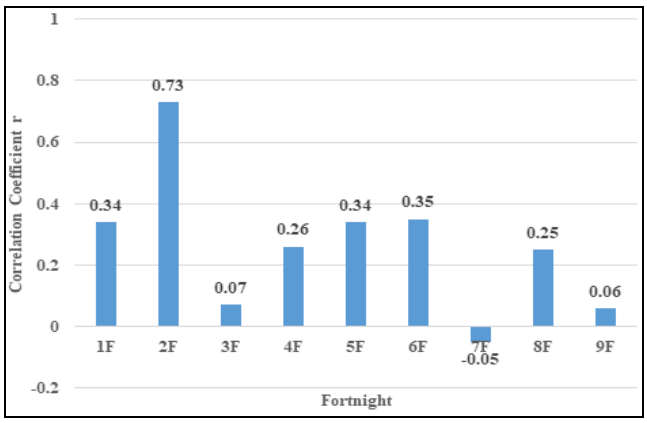

Fig 3: Correlation between fortnightly rainfall and yield

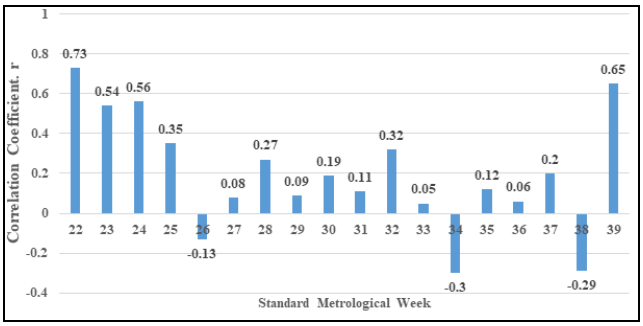

Fig 4: Correlation between weekly rainfall and groundnut yield

Correlation coefficient between weekly rainfall and groundnut yield is shown is Fig. 4. Highest positive correlation coefficient was observed as 0.73 for the 22SMW (28May-03June) which suggests that rainfall during this week is very important for higher productivity of groundnut in the region. The correlation of yield with rainfall of SMW23, SMW24 and SMW39 was also higher side. SMW

34 and 38 were reported to have high negative correlation with CV as -30% and -29% which indicates that as per the past records, high rainfall during this week has negative effect on crop production in the district. SMWs 27, 29, 33 and 36 were found to have almost no correlation with yield of groundnut. 7F (r= -0.05) is combination of SMW34 and SMW35, in these two weeks SMW34 is highly negatively correlated (r=-0.30) as compare to SMW35 (r=0.12).

4. Conclusion

Arithmetic mean and coefficient of variation of seasonal rainfall of Junagadh is 954 mm and 37% respectively. July which contributed 42% of the total seasonal rainfall lowest CV 51%. The lowest CV% was 67% for third fortnight. The seasonal correlation coefficient was found as 0.79. The correlation of June was highest as 0.68 and August was lowest as 0.26. In case of weekly rainfall, highest positive correlation was observed to be 0.73 for the SMW22. SMW 26, 34 and 38 showed negative correlation with yield of groundnut. It may be concluded that splitting the longer duration into shorter one, better idea about relationship between rainfall and yield can be obtained.

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