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Rainfall variability and probability for crop planning in Solan, Himachal Pradesh

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ABSTRACT

Daily rainfall data of 38 years (1971-2008) was analysed to estimate the long term averages of weekly, monthly, seasonal and annual rainfall and its variability at Solan in Himachal Pradesh. Normal annual rainfall of the area was 1163.9 mm. August received the maximum rainfall of 246.9 mm followed by July 240.3 mm. The stable rainfall period was of 14 weeks spread over 24th to 37th Standard Meteorological Weeks (SMW) which can be considered as an assured period for crop growth. This confirms the onset and withdrawal of South-West monsoon. Different conclusions were madeon the basis of data collected. The probability of receiving 10 and 20 mm of average weekly rainfall during 25th to 39th SMW exceeds 50 per cent. The chances of water stress increases in second fortnight of September for kharif crops. South-West monsoon (11-17 June to 10-18 September) has 60-90 per cent chances of receiving rainfall. The probability of 10-20 mm rainfall in rabi season (1st SMW- 8th SMW) is 50-70 per cent. Since the winter rainfall is uncertain and erratic, residual moisture can be recharged and is essential for the preparation of tree basins, application of fertilizers in temperate fruits and for growing early kharif season crops under rainfed conditions. Well distributed winter rains and early snowfall before January are beneficial for fruit crops and wheat under rainfed conditions. Keeping in view the rainfall pattern and its distribution in the area, suggestions have been made to modify the microclimate with respect to crop planning to increase the quality and productivity under rainfed conditions.

Key words: Rainfall pattern, rainfall probability, crop planning.

INTRODUCTION

The weather and its variability are well known to the farming community and have great impact on crop production. The economy of the farmers is well influenced by weather. The greatest risk to crop yields in Indian agriculture is attributed to the variability of seasonal rainfall and the uncertainty in the amount and its distribution in a given season. Hence, rainfall is one of the prime meteorological factors which controls the water balance of a particular area. Therefore, its amount, time of occurrence and spatial variability controls the agricultural practices adopted in the region. In Himachal Pradesh, 80 per cent of the cultivated area is under rainfed and

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totally dependent on rainfall for water supply which is quite erratic in time and space. Thus the productivity of the crops is very low and unstable. The rainfall pattern decides the cultivation of crops, their varieties, adoption of cultural operations and harvesting of excess rain water of any region (Sinhababu 1977, Budhar et al 1987, Thakur 1998, Kar 2002). Generally, the cropping pattern is suggested considering the rainfall probabilities at different levels (Mahale and Dhane 2003, Rana and Thakur 1998). Studies on rainfall probability in India have also been carried out earlier by many workers (Gabrial and Neuman 1962, Victor et al 1991, Panigrahi 1998). The weekly distribution of rainfall and its probability is helpful in crop planning by identifying the period of drought, normal and excess rainfall (Ray et al 1980). Gupta et al 1975 suggested that the rainfall at 80 per cent probability could safely be taken as assured rainfall, while 50 per cent probability is the medium limit for taking risk. Himachal Pradesh is known for off-seasonal cultivation of vegetables and fruits mainly stone fruits and pome fruits. Scientific study on the quantum and distribution of rainfall if made would enable the farming community to adjust or modify the cropping programme as well as the cultural operations. An attempt has been made to understand the rainfall climatology by analysing the temporal and spatial rainfall distribution and its variability on daily, weekly, seasonal and annual basis for the last 38 years for Solan in Himachal Pradesh. Probability of occurrence of dry and wet spell and their distribution has also been analysed.

MATERIAL AND METHODS

The daily rainfall data of last 38 years (1971-2008) was recorded at meteorological observatory in the department of Soil Science and Water Management situated at the main campus of Dr Y S Parmar University of Horticulture and Forestry, Nauni ($30^{o}15'$N $77^{o}8'$E and 1256.4 m amsl). Weekly, monthly, seasonal and annual rainfall distribution patterns were critically examined and analysed adopting procedure suggested by Panse and Sukhatme (1985).

Rainfall probability of receiving 10, 20, 50, 75 mm and more has been compiled for Standard Meteorological Weeks. A critical investigation was made for spatial and temporal rainfall distribution to find out the stable rainfall period and monthly/annual rainfall patterns under study area. Percentages of weeks and months with no rainfall were also calculated to know the occurrence of dry spells.

RESULTS AND DISCUSSION

Monthly, seasonal and annual rainfall

The highest rainfall of 246.9 mm received during August occurred in 18.8 rainy days followed by July (240.3 mm)

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with their standard deviations of 152.7 mm and 183.6 mm, respectively. The mean monthly rainfall was observed in the month of November (11.1 mm) which was only 1 per cent mean rainfall percentage of annual rainfall having coefficient of variation (CV) of 171 per cent (Table 1).

Mean seasonal rainfall during South-West (SW) monsoon season (June to September) at Solan was 775.16 mm that accounted for 67 per cent of the total annual rainfall with minimum coefficient of variation (20%). Winter season (January to February) experienced only 11 per cent of the total annual rainfall having rainfall of 124.0 mm with standard deviations of 50.8 mm and CV of 41 per cent. Rainfall during summer season (March to May) contributed 16 per cent of the total annual rainfall with CV of 32 per cent. North-East (NE) monsoon period (October to December) accounted for maximum coefficient of variations (58 %) with standard deviations of 43 mm and 74.5 mm of average seasonal rainfall which contributed only 6 per cent of the total annual rainfall. Yet this rainfall is critical for sowing of wheat and leafy vegetables under rainfed conditions. Besides helpful in reducing the moisture stress, maintaining optimum humidity, fulfilling chilling requirement of stone fruits of the area as wet sub surface layers experience less fluctuations in day and night temperatures by maintaining the nitrogen level and soil aeration (Singh and Bhandari 1998).

The mean annual rainfall of Solan is 1163.9 mm (range: 530 to 2606 mm) spread over 90 rainy days with standard deviation of 375.6 mm and CV of 32 per cent. Out of the 38 years, 13 years received less rainfall from normal (Fig 1) in the range of 6 to 51 per cent. In the first decade (1971-1980), the total annual rainfall received at station was much below (range: 551.3-960.7 mm) the normal rainfall except in 1971 and 1977. In the second decade (1981-1990), station recorded highest rainfall of 2606 mm during the year 1988 and increasing trend also showed more rainfall than normal (range: 852.6-1563.0 mm). Similarly, 5 yearly moving averages also showed increasing trend. Whereas, this trend had decreasing pattern afterwards (1991-2000) but closer (range: 916.4 - 1529.9 mm) to the normal value. From the year 2001 onwards, none of the years experienced high annual rainfall than the normal and the trend of 5 yearly moving average also showed decreasing patterns. The lowest annual rainfall (530.3 mm and 600 mm) was recorded during 1984 and 1978 years, respectively.

Highest and lowest rainfall

The highest value of monthly rainfall (1066.4 mm) was recorded in the month of July 1988 which was 444 per cent higher from its monthly average rainfall (Table 3). The station received maximum dry spell

Table 1. Mean monthly, annual and seasonal rainfall during 1971-2008 at Nauni, Solan

Month	Mean rainfall	Mean rainfall as % of years	Standard Deviation	Co-efficient of Variation
JAN	50.72	4.4	39.22	77.33
FEB	73.33	6.3	57.39	78.26
MAR	74.17	6.4	57.37	77.34
APR	45.09	3.9	50.03	110.96
MAY	70.93	6.1	67.87	95.69
JUN	172.12	14.8	126.73	73.63
JUL	240.26	20.6	183.59	76.41
AUG	246.93	21.2	152.68	61.83
SEP	115.85	10.0	98.87	85.34
OCT	28.04	2.4	47.92	170.91
NOV	11.13	1.0	19.03	170.92
DEC	35.29	3.0	51.09	144.77
ANNUAL	1163.87	100.0	375.61	32.27
S-W Monsoon(JUN-SEP)	775.16	66.6	154.13	19.88
N-E Monsoon(OCT-DEC)	74.46	6.4	43.31	58.16
Winter (JAN-FEB)	124.05	10.7	50.78	40.93
Summer (MAR-MAY)	190.19	16.3	60.58	31.85

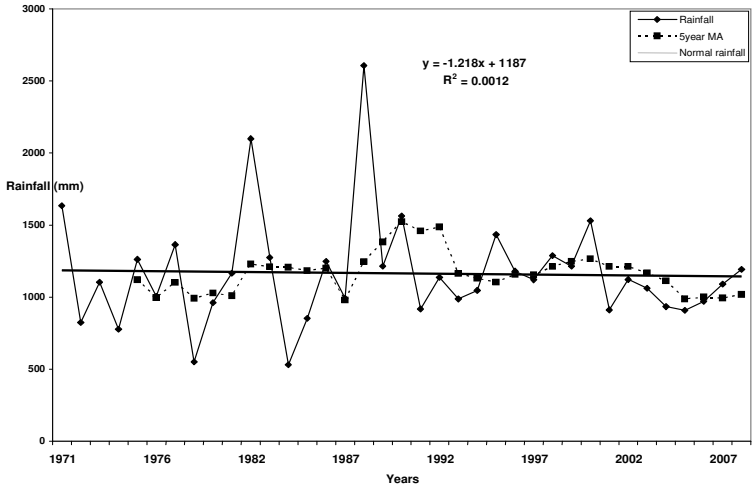


Fig 1 : Annual march of rainfall alongwith 5 yearly moving averages at Nauni, Solan

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period (no rainfall) during October (1971, 76, 77, 79, 81, 84, 88, 92, 93, 95, 99, 00, 01, 05) and November (1973, 74, 75, 76, 79, 81, 83, 84, 85, 87, 91, 94, 96, 98, 99, 00, 01, 02, 05, 07). During North-East (NE) monsoon season, more than 50 per cent of the total years received no rainfall. However less than 20 mm rainfall was recorded in rest of the years. The year 1980 recorded the highest rainfall of 266 mm which was 357 per cent higher than average rainfall of this season.

The highest seasonal rainfall (2053 mm) was recorded during monsoon season of 1988 and 1979 recorded the lowest rainfall of 189 mm which was 24 per cent less than average seasonal rainfall. During North-East monsoon, the area experienced lowest rainfall of 3.0 mm (1999) and highest

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Table 2. Variability of weekly rainfall during 1971-2008 at Nauni, Solan

SMW (Standard Meteorological Weeks)		Total mean rainfall (mm)	Mean rainfall (%)	Standard deviation	Co-efficient of variation	Weeks with no rainfall (%)
1	1-7(Jan)	7.8	0.68	10.5	134.2	47.37
2	8-14	12.7	1.11	18.2	143.1	47.37
3	15-21	16.3	1.43	20.6	126.3	26.32
4	22-28	12.9	1.13	20.6	159.1	42.11
5	29-4(Feb)	19.0	1.66	29.4	154.8	47.37
6	5-11	22.8	1.99	26.9	118.2	31.58
7	12-18	22.2	1.94	26.8	120.8	31.58
8	19-25	19.5	1.71	23.7	121.3	31.58
9	26-4(Mar)	23.0	2.01	31.3	136.1	47.37
10	5-11	13.6	1.19	19.1	140.4	47.37
11	12-18	19.1	1.67	25.6	134.3	63.16
12	19-25	16.5	1.44	21.0	127.3	26.32
13	26-1(Apr)	11.1	0.97	17.9	161.7	47.37
14	2-8	9.9	0.87	20.5	206.5	57.89
15	9-15	9.8	0.85	17.1	175.4	47.37
16	16-22	6.0	0.53	8.8	146.4	57.89
17	23-29	13.4	1.17	21.2	158.4	47.37
18	30-6(May)	9.3	0.81	13.1	141.1	47.37
19	7-13	9.8	0.85	11.0	113.0	26.32
20	14-20	11.9	1.04	14.7	124.0	31.58
21	21-27	19.5	1.70	37.2	191.1	31.58
22	28-3(Jun)	14.9	1.30	15.8	106.4	36.84
23	4-10	39.2	3.43	64.6	164.7	15.79
24	11-17	33.3	2.92	36.6	109.8	15.79
25	18-24	28.2	2.47	21.7	76.7	5.26
26	25-1(Jul)	48.3	4.23	34.4	71.2	5.26