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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

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)

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

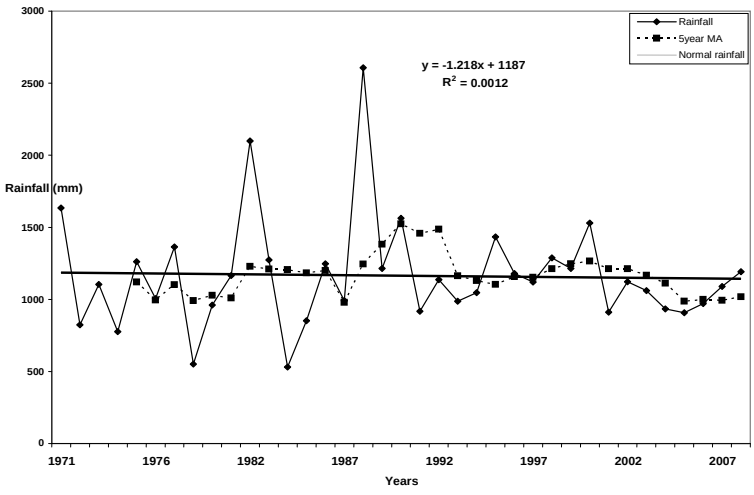

Fig 1 : Annual march of rainfall alongwith 5 yearly moving averages at Nauni, Solan

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

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

27	2-8	52.4	4.58	51.0	97.5	5.26
28	9-15	65.0	5.69	59.4	91.4	10.53
29	16-22	69.2	6.05	107.2	155.0	0.00
30	23-29	32.5	2.85	30.0	92.2	5.26
31	30-5(Aug)	63.6	5.57	71.0	111.6	0.00
32	6-12	39.9	3.49	30.8	77.1	5.26
33	13-19	83.2	7.28	69.1	83.0	5.26
34	20-26	38.1	3.34	38.8	101.6	15.79
35	27-2(Sep)	30.4	2.66	29.4	96.5	5.26
36	3-9	57.1	5.00	62.1	108.8	21.05
37	10-16	28.3	2.48	35.6	125.7	15.79
38	17-23	34.0	2.97	75.2	221.4	42.11
39	24-30	8.5	0.74	14.8	174.9	52.63
40	1-7 (Oct)	4.7	0.41	8.9	189.8	68.42
41	8-14	7.6	0.67	19.3	254.0	68.42
42	15-21	20.3	1.78	60.3	296.5	52.63
43	22-28	1.1	0.10	3.8	342.7	89.47
44	29-4 (Nov)	1.0	0.09	3.4	335.2	94.74
45	5-11	3.5	0.31	10.6	297.6	78.95
46	12-18	1.6	0.14	4.2	255.4	84.21
47	19-25	3.3	0.29	6.6	198.5	68.42
48	26-2 (Dec)	2.7	0.24	7.2	266.0	73.68
49	3-9	3.5	0.30	9.6	278.1	73.68
50	10-16	3.5	0.30	8.5	245.2	68.42
51	17-23	5.6	0.49	17.4	311.0	73.68
52	24-31	12.1	1.06	40.3	333.7	68.42

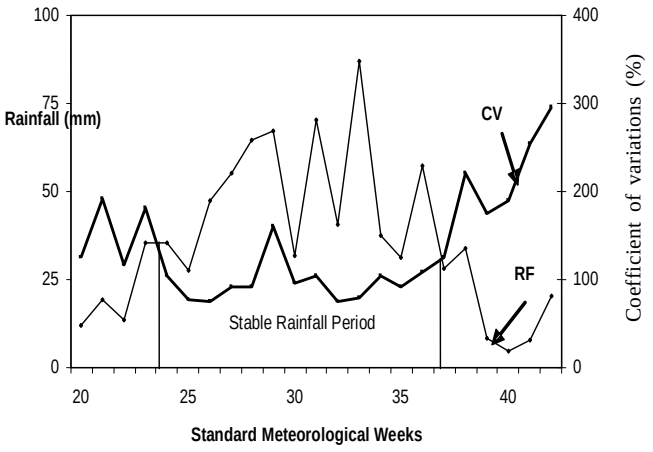

Fig 2 : Mean weekly rainfall pattern at Solan

Table 3. Highest and lowest values of rainfall during 1971-2008 at Nauni, Solan

Month	Highest rainfall (mm)	Highest rainfall (% of mean)	Lowest rainfall (mm)	Lowest rainfall (% of mean)
JAN	142.7(1992)	281.4	3.0(1984)a	5.9
FEB	228(2007)	310.9	4.4(2006)b	6.0
MAR	191(1981)	257.5	5.3(1984)c	7.1
APR	225(1983)	499.0	1.8(1989)d	4.0
MAY	307(1987)	432.8	2.0(1980)	2.8
JUN	655(1982)	380.5	27(2005)	15.7
JUL	1066.4(1988)	443.8	42.5(1982)e	17.7
AUG	683(1982)	276.6	21.7(1980)f	8.8
SEP	382.6(1988)	330.2	1.0(2001)g	0.9
OCT	264.1(1998)	941.9	3.4(1994)h	12.1
NOV	68.8(1989)	618.0	1.0(1988)i	9.0
DEC	200(1980)	566.7	0.4(2002)j	1.1
ANNUAL	2606 (1988)	223.9	530.3(1984)	45.6
S-W Monsoon (JUN-SEP)	2053(1988)	264.8	189(1979)	24.4
N-E Monsoon (OCT-DEC)	266(1980)	357.2	3.0(1999)k	4.0
Winter (JAN-FEB)	228(2007)	183.8	27.8(1984)	22.4
Summer (MAR-MAY)	520.4(1981)	273.6	26.6(1984)	14.0

No Rainfall Years
a. 1977, 81, 86, 2007 b. 1977 c. 2004 d. 1973 e. 1981 f. 1979 g. 1979, 1980
h. 1971, 76, 77, 79, 81, 84, 88, 92, 93, 95, 99, 2000, 2001, 2005
i. 1973, 74, 75, 76, 79, 81, 83, 84, 85, 87, 91, 94, 96, 98, 99, 2000, 2001, 2002, 2005, 2007
j. 1975, 76, 77, 81, 82, 93, 98, 2000 k. 1999

of 266.0 mm (1980). Winter received the minimum rainfall (27.8 mm) during the year 1984 which was 22 per cent less than the average seasonal rainfall. Similarly, summer experienced highest rainfall (520.4 mm) in 1981 which was 274 per cent higher than the average. In respect of seasonal rainfall, North-East monsoon and winters are the

most variable followed by the summer season whereas the South-West monsoon is the least variable in respect of receiving rainfall.

Weekly rainfall distribution

The data on variability of weekly rainfall during the year 1971-2008 at Solan are presented in Table 2. The data revealed that during winter 6th SMW received maximum rainfall of 22.8 mm (2 % of mean annual rainfall) with standard deviation of 26.9 mm and CV of 118.2 per cent whereas 32 per cent of weeks experienced no rainfall. The highest weekly rainfall of 83.2 mm was recorded during 33rd SMW (13-19, August) which constituted 7.3 per cent of mean rainfall with CV 83 per cent and SD of 69.1 mm. The highest coefficient of variation was observed in the month of October (43rd SMW) followed by 44th SMW and 52nd SMW. Similarly, highest per cent of average rainfall with no rain was recorded during 45th SMW followed by 43rd SMW. In November-December weekly rainfall was only 20 per cent.

During monsoon, the average weekly rainfall ranged from 28.2-83.2 mm. The weak monsoon through occurred on 34th and 36th SMW. SMW (25th to 34th) remained wet periods with its peaks on 33rd SMW followed by 29th SMW and 28th SMW. Hence, mean weekly rainfall of 24th to 37th SMW are considered as a stable

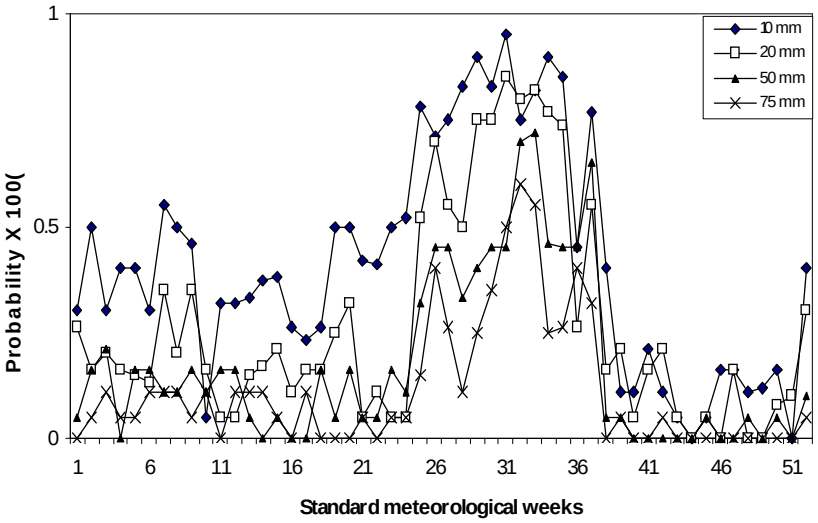

Fig 3 : Probability at different limits of rainfall at Nauni, Solan

rainfall period. Since, average weekly rainfall ranged from 28.3 mm to 83.2 mm with corresponding CV less than 110 per cent. Thus the total average growing period is of 14 weeks at Solan (Fig 2).

Weekly rainfall probabilities and crop planning

The weekly probability of rainfall receiving 10, 20, 50, 75 mm and more rainfall has been computed for Standard Meteorological Weeks (Table 4). The data on weekly probability analysis of rainfall revealed that from 1st to 26th and from 37th to 51st SMW, the probability of more than 150 mm rainfall is zero. The probability of up to 20 mm rainfall is 52-70 per cent during the winter (1st to 9th SMW). This is the most critical week for the stone fruits for induction of dormancy, bud break and ensuring flowering. This precipitation (rainfall + snowfall) is very crucial for maintaining and recharging of soil moisture regime, controlling the temperature fluctuations and maintaining the atmospheric humidity. On the other hand, it is also beneficial for enhancing the germination and vegetative growth of wheat sown under rainfed conditions. Precipitation in the form of snow is most beneficial for maintaining the chilling requirement, nitrogen fixation and soil aeration. There is possibility of abnormal weather (hail storms) during 5th to 9th SMW which reduces the fruit yield by more than 50 per cent depending on the severity of the hazard as it affects the flowering, fruit setting by killing or dilution of pollen grains, affecting fruit development and quality of fruits.

During summer (10th to 21st SMW) the probability of 75 mm or more rainfall is less (5-11 %). The probability of 45 mm rainfall is 50 per cent during 13th week which persisted for next two weeks. It has sufficient potential for conserving soil moisture for sowing of maize crop. Maize sowing may be advanced to last week of April to first week of May. Solan has good potential for growing tomato and capsicum as major cash crops. There is sufficient moisture for sowing of tomato and capsicum (early varieties) in raised nursery beds and sowing of dwarf varieties of french bean in the leveled fields. During this season there is possibility of occurrence of dust storms which reduces the fruit yield of apricot and plum.

The monsoon normally gets established over the whole state by 24th SMW. The highest rainfall of 250 mm or more is received during 27th, 28th 32nd 33rd and 34th SMW with a probability value of 0.05, 0.16, 0.25, 0.45 and 0.11, respectively. Whereas, the probability of 20-50 mm rainfall is more than 80 per cent during 25th -35th SMW hence, this period is considered as a stable rainfall period and is the wettest period in the area. Further the probability drops to 33 and 24 per cent for 50 mm and 75 mm rainfall, respectively. Thus harvesting of excess water for pre-

Table 4. Probability values of weekly rainfall

SMW (Standard Meteorological Weeks)		Probability values (mm)					
		10	20	50	75	100	250
1	1-7(Jan)	0.30	0.26	0.05	0.00	0.00	0.00
2	8-14	0.50	0.16	0.16	0.05	0.05	0.00
3	15-21	0.30	0.20	0.21	0.11	0.11	0.00
4	22-28	0.40	0.16	0.00	0.05	0.05	0.00
5	29-4(Feb)	0.40	0.15	0.16	0.05	0.11	0.00
6	5-11	0.30	0.13	0.16	0.11	0.16	0.00
7	12-18	0.55	0.35	0.11	0.11	0.11	0.00
8	19-25	0.50	0.20	0.11	0.11	0.11	0.00
9	26-4(Mar)	0.46	0.35	0.16	0.05	0.11	0.00
10	5-11	0.05	0.16	0.11	0.11	0.11	0.00
11	12-18	0.32	0.05	0.16	0.00	0.05	0.00
12	19-25	0.32	0.05	0.16	0.11	0.11	0.00
13	26-1(Apr)	0.33	0.15	0.05	0.11	0.11	0.00
14	2-8	0.37	0.17	0.00	0.11	0.11	0.00
15	9-15	0.38	0.21	0.05	0.05	0.05	0.00
16	16-22	0.26	0.11	0.00	0.00	0.00	0.00
17	23-29	0.23	0.16	0.00	0.11	0.11	0.00
18	30-6(May)	0.26	0.16	0.16	0.00	0.00	0.00
19	7-13	0.50	0.25	0.05	0.00	0.00	0.00
20	14-20	0.50	0.32	0.16	0.00	0.00	0.00
21	21-27	0.42	0.05	0.05	0.05	0.05	0.05
22	28-3(Jun)	0.41	0.11	0.05	0.00	0.00	0.00
23	4-10	0.50	0.05	0.16	0.05	0.11	0.00
24	11-17	0.52	0.05	0.11	0.05	0.16	0.00
25	18-24	0.78	0.52	0.32	0.15	0.11	0.00
26	25-1(Jul)	0.71	0.70	0.45	0.40	0.32	0.00
27	2-8	0.75	0.55	0.45	0.26	0.42	0.05
28	9-15	0.83	0.50	0.33	0.11	0.37	0.16
29	16-22	0.90	0.75	0.40	0.25	0.26	0.00
30	23-29	0.83	0.75	0.45	0.35	0.32	0.00

31	30-5(Aug)	0.95	0.85	0.45	0.50	0.40	0.25
32	6-12	0.75	0.80	0.70	0.60	0.50	0.45
33	13-19	0.82	0.82	0.72	0.55	0.53	0.11
34	20-26	0.90	0.77	0.46	0.25	0.11	0.00
35	27-2(Sep)	0.85	0.74	0.45	0.26	0.40	0.00
36	3-9	0.45	0.26	0.45	0.40	0.40	0.11
37	10-16	0.77	0.55	0.65	0.32	0.24	0.00
38	17-23	0.40	0.16	0.05	0.00	0.05	0.00
39	24-30	0.11	0.21	0.05	0.05	0.05	0.00
40	1-7 (Oct)	0.11	0.05	0.00	0.00	0.00	0.00
41	8-14	0.21	0.16	0.00	0.00	0.05	0.00
42	15-21	0.11	0.21	0.00	0.05	0.05	0.00
43	22-28	0.05	0.05	0.00	0.00	0.00	0.00
44	29-4(Nov)	0.00	0.00	0.00	0.00	0.00	0.00
45	5-11	0.05	0.05	0.05	0.00	0.00	0.00
46	12-18	0.16	0.00	0.00	0.00	0.00	0.00
47	19-25	0.16	0.16	0.00	0.00	0.00	0.00
48	26-2(Dec)	0.11	0.00	0.05	0.00	0.00	0.00
49	3-9	0.12	0.00	0.00	0.00	0.00	0.00
50	10-16	0.16	0.08	0.05	0.00	0.00	0.00
51	17-23	0.00	0.10	0.00	0.00	0.05	0.00
52	24-31	0.40	0.30	0.10	0.05	0.00	0.05

sowing irrigation in order to get good germination and plant stand for rabi crops can be done through various water harvesting techniques (roof water harvesting, water harvesting ponds etc). Monsoon rains are very essential for establishing the early, normal and row vegetables particularly tomato and capsicum as these vegetables are the major cash crops of the area. Simultaneously, rainy season also maintains the stone fruit canopy structure.

During N-E monsoon period the probability of 50 and 75 mm rainfall becomes less than 10 per cent. The area receives rainfall due to western disturbances during this period. The weeks between 40-49th SMW are very crucial for planting of rabi crops because there is 75 to 90 per cent probability of receiving less than 10 mm rainfall. The region also experiences severe moisture stress, hence, conservation of soil moisture is of utmost importance by applying mulches (black UV mulch, grass-straw mulch) for tree basins and

selecting different crop varieties suitable for early sown conditions having drought tolerance for subsequent periods. For early sown conditions, cultivars of wheat like VL-616 and HS-227, among pulses lentil and oilseed crops like toria, brown sarson, gobhi sarson as pure crops or toria+gobhi sarson as inter-crops can be sown in the fist fortnight of October as these crops have high tolerance to drought conditions (Thakur 1998). On 52nd SMW, there is relatively high probability of rainfall occurrence. This rainfall is very crucial for the preparation of tree basins and application of fertilizers in temperate fruits. The possibility of snow fall is also very important for fulfilling the chilling requirement.

The normal mean annual rainfall is 1163.9 mm with 32 per cent variability; with standard deviation of 375.61 mm. The trends of annual rainfall along with the five yearly moving averages had shown decreasing pattern in the recent years with $Y = -1.218X + 1187$ and $R^2 = 0.0012$. The normal annual rainfall has decreased by 179.8 mm in 45 days. Thus weekly rainfall probability analysis is considered as useful tool for crop planning, watershed characterization and development of water harvesting techniques. Based on rainfall probability analysis hence, the recommended cultural operations for nursery raising and for fruit crops are shown in Table 5.

Table 5. Possible effects of rainfall variability and crop planning.

Season	SMW	Possible effects	Cultural operations	Crop planning
Summer (Mar-May)	13-15	Recharge soil moisture, maintains optimum humidity and air temperature	Nursery bed preparation	Nursery raising of early varieties of tomato, capsicum and sowing of French bean (dwarf var.)
		Peach leaf curl Powdery mildew in pea	Spray carbendazime (50g/100lt.H_2O) in winter sown pea and peach	Check buds in stone fruit trees. Spray before bud break in peach as protection against this fungal infection is very difficult after bud break.
	10-21	Dust storms/ hail stormsTemperature fluctuations	Use anti-hail nets	Reduce the fruit yield and quality up to 40 per cent or even more.
Monsoon (Jun-Sep)	24-37	Bukey rot of tomato (Black spot on green tomato) Leaf rot of capsicum	Spray ridomil (2. 5g/lt. H_2O) at an interval of 10-15 days	Sufficient moisture for new plantations. Excellent period for sowing of rainy season tomatoes, vegetables

		Powdery mildew in stone fruits	Remove the infected twigs and burn them at far away place	New fruit plantations. Develop water harvesting structures (ponds, deep channels on the sides of fields, V-notch on tree basins)
N-E Monsoon (Oct-Dec)	40-50	Severe moisture stress, low atmospheric humidity Light showers in mid Nov.	Apply mulch (Black UV/ grass-straw mulch)	Congenial period for sowing of early varieties of wheat, pulses, oil seed crops as inter cropping during mid Nov(40-41 SMW)
	(Dec) 51-52	Light showers with snowfall Maintain the soil moisture, chilling requirements, nitrogen level and soil aeration	Application of FYM and chemical fertilizers to stone fruits, white wash the stems, Bodo-paste over broken twigs	Sowing of winter vegetables like turnip, spinach and garlic (first week of Dec)
Winter (Jan-Feb)	52- 4 (Jan)	Night temperature remains <= 4°C , Frost damage	Frost protection – apply light sprinkler irrigation at late night, saw/dust mulch on vegetables (leafy veg.),FYM to fields, use covers for nursery raising/ new fruit plantations	Frost resistant var. of rabi vegetable and floricultural crops.
	5-9 (Feb)	If temperature high (>=25°C)Affecting chilling requirements in plum, peach and pears and early flowering/poor flowering in apricot	Apply light irrigation, if possible, to delay flowering and maintaining temperature fluctuations	Level the beds for summer sowing if vacant to break the capillaries and avoid water loss by evaporation

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