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Rainfall probability during dormant and growing seasons of apple in Himachal Pradesh

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ABSTRACT

Variation of seasonal rainfall and probabilities of occurrence of assured weekly rainfall provide useful information for efficient agricultural management. In the present study, seven stations of Himachal Pradesh have been selected for the analysis of the rainfall data. In general, the station Dalhousie received the higher rainfall during both the growing and dormant seasons along with annual rainfall. Probability percentage of receiving 10 mm, 20 mm, 50 mm and 75 mm rainfall have been computed for standard weeks during growing and dormant seasons at four stations Katrain, Bajaura, Mashobra and Nauni (Solan). A critical examination for spatial and temporal probability distribution revealed that high rainfall belt is located in the north western part of the state. For better apple production, monsoon rainfall plays significant role. It not only moderates the temperature during summer but also recharges the much-needed moisture, which almost depletes by mid June. Well distributed winter rains and early snowfall before January are beneficial in providing chilling, optimal flowering and good fruit set.

Key words: Rainfall probability, apple growing season

India's economy is dependent on the agricultural production, which in turn is dependent on the monsoon rainfall and its distribution. The year to year fluctuation in rainfall as well as the fluctuation within the monsoon season governs the crop growth, development and yield. Earlier studies on rainfall probability in India have been carried by many workers (Hundal *et. al.,* 2002; Das and Chowdhury, 1992; Budhar and Gopalaswamy 1987; Victor and Sastry, 1979). The weekly distribution of rainfall and their probability is helpful in crop planning by identifying the periods of drought, normal and excess rainfall (Ray *et al,* 1980). The cropping system of Himachal Pradesh is predominantly fruit based mainly pome and stone fruits. The apple crop is very sensitive to the weather variables and abnormal weather (Table 1). The present investigation is aimed at analyzing the rainfall distribution and variability during growing period (fruit set to fruit harvest) from March to July (leaf fall to bud burst) from November to February respectively in apple crop.

MATERIALS AND METHODS

Daily rainfall data of four stations namely: Katrain (32^o N, 77^o E and 1550 m amsl) Bajaura (31^o 8'N, 77^o 6'E and 1090 m amsl), Mashobra (31^{o}10'N, 77^{o}10'E and 2286 m amsl) Nauni (30^{o}15'N, 77^o 8' and 1256m amsl) have been collected from observatories and the data for Kotgarh (31^o 19'N, 77^o 28'E), Kotkhai (31^o 07'N, 77^o 32'E) and Dalhousie (32^o 32'N, 75^o 59'E) have been collected from India Meteorological Department and compiled into weekly, monthly, seasonal and annual for analysis. Probability of receiving 10, 20, 50 and 75 mm rainfall has been computed for standard meteorological weeks during the growing and dormant seasons. From daily rainfall data the total amount of precipitation received during the growing and dormant seasons of apple at all the seven stations have been worked out separately. The total rainfall corresponding to the span of the growing and dormant duration was cumulated for each year and then averaged for the entire period. A critical examination was made of the spatial and temporal rainfall distribution to find out the homogenous rainfall zones. The probability values for different rainfall were also worked out for these stations and examined to find out, if there is any typical pattern and if so, how far this pattern is distributed.

RESULTS AND DISCUSSION

The average rainfall for the growing season Table 2) ranges from 397 mm (at Bajaura) to 1401 mm (at Dalhousie). For the dormant period, the rainfall ranges from 237 mm (at Kotkhai) to 554 mm (at Dalhousie) indicating a wide variation in seasonal rainfall at different locations. Dalhousie station recorded highest annual rainfall for both the seasons and it was the lowest at Bajaura during growing season. Next to Dalhousie station Mashobra, Kotgarh and Kotkhai received higher rainfall during the growing seasons. For apple cultivation the rainfall during the growing season is considered more important than the dormant season. Other important area of apple production is the Kullu valley in which Katrain and Bajaura stations fall, and both these stations receive good rainfall during both the growing and dormant seasons.

Table 1: Possible effects of abnormal weather variables

S.No.	Parameters	Remarks
1.	Precipitation during March to May (150 – 200 mm)	1. Recharge and maintaining of soil moisture regime. 2. Control of canopy temperatures. 3. Maintaining optimum humidity.
2.	During winter temperature should be below 20 °C but it must be below 7 °C for 1200-1600 hours, and 150-200 mm well distribution precipitation.	1. Very crucial for induction of dormancy, bud break and ensuring flowering in apple. 2. Precipitation in the form of snow is most beneficial for chilling, nitrogen and soil aeration. 3. Early rains/snow (>100 mm) (November –January) are more beneficial in fulfilling chilling requirement.
3.	High Temperature in Spring (≥25 °C)	1. Affecting chilling requirements. 2. Increase the pace of development. 3. Enhanced sprouting.
4.	High temperature during April (≥26 °C)	1. Dry and unsticky pollen grains. 2. Poor pollination by insects. 3. Poor Germination of pollen grains. 4. Slow growth of pollen tube. 5. Fruit setting reduced. 6. Reduced yield up to 25 per cent.
5.	Low humidity (<40 %) at flowering and setting	1. Desiccation of pollen/bud. 2. Killing of pollen grains. 3. Low fruit settings.

Table 2: Rainfall (mm) during growing and dormant duration of apple crop

Station	Season		Annual
	Growing March - July	Dormant November-February	
Katrain (32° N, 77° E)	477.1	440.1	1224.0
Bajaura (31° 8'N, 77° 6'E)	397.0	344.9	948.5
Dalhousie (32° 32'N, 75° 59'E)	1400.9	554.3	2118.3
Kotgarh (31° 19'N, 77° 28'E)	705.8	236.7	1100.5
Kotkhai (31° 07'N, 77° 32'E)	719.1	237.5	1022.3
Mashobra (31°10'N, 77°10'E)	1027	343.7	1370.7
Nauni (30°15'N, 77° 8')	870.1	252.9	1315.6

Monthly rainfall

October for Katrain, November for Bajaura & Mashobra and April for Nauni are months with high rainfall variability (Table 3). July and August are the wettest at all the four stations. In respect of seasonal rainfall, post monsoon and winter seasons are the most variable followed by the summer season whereas the south west monsoon season is the least variable in respect of receiving rainfall.

Probabilities of weekly rainfall

The probabilities of occurrence of 10, 20, 50 and 75 mm rainfall in a week were calculated for all four stations.

13th week (March 26 - 1 April): This is the most crucial week for the apple crop since flowering starts during this week. There is probability of more than 60 per cent for receiving 10 mm rainfall at all the apple growing stations (Table 4). At Nauni this probability was only 33 per cent but it is not an apple growing area. The probability of 20 mm rainfall at Katrain was 71 per cent but at Bajaura, Mashobra and Nauni it decreased drastically. This indicates that Katrain receives more rainfall during the week as compared to rest of the stations. This week onward the probability

Table 3: Monthly and seasonal characteristics of rainfall

Months	Katrain		Bajaura		Mashobra		Nauni	
	Rainfall (mm)	CV (%)	Rainfall (mm)	CV (%)	Rainfall (mm)	CV (%)	Rainfall (mm)	CV (%)
Mar	192	49	130	54	105	55	75	116
Apl	113	65	76	66	60	78	63	171
May	79	58	79	68	78	85	96	151
Summer	384	29	284	34	243	68	233	136
Jun	59	63	23	59	176	55	193	77
Jul	164	52	143	50	279	36	297	75
Aug	151	46	124	54	320	36	256	67
Sep	104	97	67	91	114	70	124	79
South West Monsoon	477	32	397	36	88	53	870	54
Oct	80	129	27	140	39	158	21	130
Nov	35	100	26	148	25	167	13	145
Dec	58	99	34	144	41	105	34	88
Post Monsoon	173	140	87	112	64	159	48	119
Jan	76	75	87	64	62	80	[illegible]	75
Feb	115	58	95	54	72	63	74	69
Winter	190	33	181	32	175	85	178	69
Annual	1224	21	948	22	1370	18	1316	58

Table 4: Probability (%) of weekly rainfall occurrence during the growing period

Standard Week /station	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
10 mm																		
Katrain	71	67	67	48	62	67	48	48	48	33	24	48	52	57	43	76	71	90
Bajaura	57	64	50	43	54	46	61	61	46	39	39	43	43	50	61	75	64	75
Mashobra	60	36	48	48	36	40	60	56	52	44	52	76	80	84	88	96	85	99
Nauni	33	25	38	25	25	21	46	50	25	42	54	54	75	71	75	83	88	83
20 mm																		
Katrain	71	57	48	38	38	43	38	14	38	10	14	29	29	24	19	52	57	76
Bajaura	26	44	33	30	21	27	27	29	24	16	18	26	19	33	28	61	68	41
Mashobra	24	20	28	32	32	24	36	48	28	36	44	60	76	76	72	84	76	99
Nauni	13	17	21	13	13	17	21	29	08	13	21	29	54	71	58	54	71	71
50 mm																		
Katrain	14	10	19	14	10	14	14	05	05	00	05	05	05	10	10	29	33	33
Bajaura	16	16	11	04	09	07	08	16	09	05	04	09	09	13	11	33	29	22
Mashobra	04	08	08	08	08	08	12	04	12	00	20	28	32	40	20	60	68	64
Nauni	04	08	13	08	04	04	13	13	00	04	13	17	38	46	42	33	42	46
75 mm																		
Katrain	05	05	19	00	05	05	10	00	05	00	00	05	00	05	05	05	19	19
Bajaura	02	00	00	00	00	00	00	02	01	00	00	00	01	01	03	04	06	11
Mashobra	00	00	00	08	08	12	04	00	04	00	08	16	24	28	28	44	56	76
Nauni	04	04	00	08	04	04	13	04	00	04	00	13	29	38	25	13	25	29

continuously decreases at all the stations till 19th week. However, the probability of rainfall occurrence during 14th and 15th weeks augurs well for apple crop.

19th week (April 30 - 6 May): In this week the fruit growth and development starts in apple and for this rainfall and humidity are important. Lack of rainfall and low humidity adversely affect both fruit growth and development. The probability of occurrence of 10 and 20 mm rainfall increases again during this week at all apple growing areas. Almost probability persisted for next two weeks.

Table 5: Probability (%) of weekly rainfall occurrence during the dormant period

Standard Week /station	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09
10 mm																		
Katrain	10	24	14	19	24	00	38	38	48	52	48	29	48	62	67	81	57	67
Bajaura	08	11	11	18	14	07	14	18	39	18	50	50	87	57	49	68	57	54
Mashobra	04	16	16	16	20	08	20	20	44	24	36	40	36	48	48	56	52	56
Nauni	00	00	12	17	12	12	12	21	38	25	46	29	38	38	29	54	46	46
20 mm																		
Katrain	10	19	10	10	19	08	33	38	38	29	24	24	38	38	52	57	57	52
Bajaura	01	05	11	03	05	07	05	12	34	11	29	36	77	27	46	53	43	48
Mashobra	04	12	04	04	20	12	08	20	44	24	24	28	32	20	24	44	40	44
Nauni	00	00	04	08	04	00	08	13	25	16	20	20	16	16	13	32	21	31

25th week (18 – 24 June): The monsoon normally gets established over the whole state by this week. The region of highest rainfall is Mashobra and Nauni where the probability of 10 mm rainfall is 80 and 75 per cent, respectively. It drops to 32 % and 24% for 50 mm and 75 mm rainfall. The zone of low rainfall is observed at Bajaura and Katrain where the probability of 10 mm rainfall was 43 and 52 per cent respectively. One can expect rainfall of 10 mm at Bajaura in 4 out of 10 years in this week. For next six weeks the rainfall increases at all the stations under the influence of south-west monsoon. This is the wettest period over the whole state.

44th week (Oct. 29 – 4 November): Monsoon starts retreating from 36th week at all the stations and amount of rainfall gradually decreases, reaching the lowest during 44th week. From the 45th week the influence of the western disturbances starts in the northern part of the middle Himalaya and the probability of receiving 10 mm rainfall at Katrain and Mashobra increases. Now the winter season starts and the probability of rainfall increases with increasing frequency of western disturbances. This feature continues till 9th week after which the effect of western disturbances starts decreasing. During the dormant period, probabilities of 50 and 75 mm rainfall occurrence were below 20 per cent at all the stations.

52nd week (24-31 December): Plant enters dormancy during this week with both the preceding and following weeks having relatively high probability of rainfall occurrence. The rainfall is very crucial for the preparation of basins and application of fertilizer in temperate fruits. Assured rainfall decreases in southern of Himachal Pradesh and increases in the northern and eastern regions.

In general, the high rainfall belt lays in the north-western part of Himachal Pradesh i.e. Mashobra, Katrain and Dalhousie. Probability of rainfall and snowfall here is also high at these stations for fulfilling chilling requirement. Early intercultural operations like preparation of basins, training and pruning can be done at these stations easily. Apple crop prospects in this area are very good and suitable for rainfed crop cultivation also. Low chilling varieties of apple may be suitable for the hills, and stone fruits for the valleys around Bajaura station with supplementary irrigation. Here farmers can grow pomegranate crop with facility of supplementary irrigation. At Nauni the annual rainfall is higher than that at Bajaura but at the same time it is highly variable and the winter rainfall is also low. The stone fruit types are suitable for this area along with low chilling varieties of pears.

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