

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

## Suitability of Pomegranate Seasons (*Bahars*) for its Optimum Production

A. D. Bhagat<sup>1</sup>, P. G. Popale<sup>2</sup>

PhD Scholar, Department of Irrigation and Drainage Engineering, Dr. ASCAE&T, Mahatma Phule Krishi Vidyapeeth,  
Rahuri, Dist-Ahmednagar (MS), India<sup>1,2</sup>

**ABSTRACT:** The study was carried out to plan a suitable pomegranate bahar for optimum production of pomegranate for Solapur district in the semi-arid zone of Maharashtra. Generally crop planning, rainfall analysis and water balance studies are being carried out to determine seasonal and weekly rainfall, water surplus/ deficit for different standard meteorological weeks. The result reveals that the Water requirement at 70% probability for *Ambe*, *Mrig* and *Hasta bahar* are 1696.42, 1327.4 and 1260.5 liters/year/tree respectively for mature (5<sup>th</sup> year) pomegranate tree. The lowest water requirement was found in *Hasta bahar*. The average climate, for *Ambe bahar*: Arid and very poor moisture adequacy index, for *Mrig bahar*: Variate between semi-arid to dry sub-humid and poor to good moisture adequacy index and for *Hasta bahar*: Variate between semi-arid to arid and poor moisture adequacy index. The most adequate beneficial and productive *bahar* for pomegranate is *Hasta bahar* as compare to *Ambe* and *Mrig bahar*.

**KEYWORDS:** Pomegranate, Hasta bahar, Optimum Production etc.

### I. INTRODUCTION

Pomegranate is a deciduous fruit crop and somewhat thorny large shrub or small tree (*Punica granatum L.*) belonging to the family Punicaceae, native to semi-tropical Asia and naturalized in the Mediterranean region in very early times [10]. The total pomegranate production in the world is 1.15 MT out of which India produce 0.5 MT [3]. India over 0.13 Mha areas is under pomegranate of which 0.098Mha area is in Maharashtra, producing about 85 % of total Indian production. At present statistics state produced 5.55 lakh metric tonnes in 2009-2010 [7]. But the productivity in India is still low (<6.7 t/ha) as compared to the major pomegranate producing countries like Israel, Iran, Morocco, Egypt, Afghanistan, Spain, Turkey, China, Greece, Japan, France and Italy (>40 t/ha) (2). But in India, Maharashtra is leading producer of pomegranate followed by Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu. The Ganesh, Bhagwa, Ruby, Arakta and Mridula are different varieties of pomegranates produced in Maharashtra. In Maharashtra pomegranate is commercially cultivated in Solapur, Nasik, Sangli, Ahmednagar, Pune, Dhule, Aurangabad, Satara, Osmanabad and Latur districts. The major pomegranate growing *tahsils* in Solapur district are Karmala, Barsi, Madha, Mohol, Mangalvedha, Sangola, Malsiras, Pandharpur, Akalkot etc (Indian Horticulture Database, 2009). In this region, three flowering *bahars* are promoted for pomegranate production [8]. *Bahar* is a local also widely used to express flowering seasons of horticulture crop. Here bahar ward used for flowering seasons of pomegranate. Thus, flowering seasons are defined as: *Ambe bahar* flowering period (January - February) and harvesting period (June-July), *Mrig bahar* flowering period (June-July) and harvesting period (December-January) and *Hasta bahar* flowering period (September-October) and harvesting period (January-February).

### II. REVIEW SURVEY

#### Planning for Crop Production

The weekly information for crop growing period is determined by considering the normal onset of monsoon week as datum. The information so generated is misleading, because it does not represent the actual crop growing season. The onset of monsoon is variable in each year as compared to normal week of onset of monsoon and leads to different dates

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

of sowing of crops in each year. Further, analyses of rainfall and water balance are carried out to provide a single set of decision leading to suggest static recommendations for crop planning. This approach has been termed as “Meteorological approach”. Several researchers have carried out studies on rainfall analysis for crop planning at district level, but the variability in rainfall and soils is very large within the district too. Therefore, need to make plan for cropping and its production at Tahsil level for management of crop growing season in a more successful manner.

## III. MATERIALS AND METHODS

### Historical Data Collection

In this study, the following data collected from various authenticated sources.

- The daily rainfall data of 33 years (1975–2007) collected from Indian Meteorological Department, Pune.
- Meteorological data: Daily parameters (i.e. maximum temperature ( $T_{\max}$ ,  $^{\circ}\text{C}$ ) and minimum temperature ( $T_{\min}$ ,  $^{\circ}\text{C}$ ), maximum relative humidity ( $\text{RH}_{\max}$ , %) and minimum relative humidity ( $\text{RH}_{\min}$ , %), pan evaporation ( $E_{\text{pan}}$ , mm), wind speed (WS,  $\text{kmhr}^{-1}$ ) at height of 2.0 m, sun shine hours (SSHr, hr), rainfall (R, mm)) etc. collected from Indian meteorological department, Pune.
- In order to carry out the study, the meteorological data and data pertaining to soils and *bahars* pattern collected from various sources (i.e. ADO, Govt. district office, Solapur).

### Evaluation of Drought

Weekly, monthly and *bahar* wise rainfalls determined for each year. Weekly, monthly and *bahar* wise events then classified as drought, normal and surplus months depending upon the following criteria [9] [12]. If ‘m’ is the mean weekly / monthly rainfall, then a week / month receiving rainfall less than  $A_1$  is defined as drought, in between  $A_1$  and  $A_2$  is normal month and above  $A_2$  is surplus month, where  $A_1 = m / 2$  (50 %) and  $A_2 = 2m$  (200%). Also if ‘y’ is the long term mean annual rainfall then the year is said to be classify as drought or normal or surplus as follows; drought year: if the year’s is less than or equal to  $y - s$  amount, Normal year: if the year’s rainfall in between  $y + s$  and  $y - s$  amount. Surplus year: if the year’s rainfall is greater than or equal to  $y + s$  amount. Where ‘s’ is the standard deviation of the annual rainfall series.

### Pomegranate Evapotranspiration (ETp)

The weekly values of ETr and kc used to obtain weekly values of Pomegranate evapotranspiration (ETp) by equation for *Ambe*, *Mrig* and *Hasta bahars*.

$$\text{ETp} = \text{ETr} \times \text{kc} \quad \dots\dots (1)$$

Where,

ETp = Pomegranate evapotranspiration (mm/day),

ETr = Reference crop evapotranspiration (mm/day),

kc = Crop coefficient of pomegranate

### Water Balance Study

It states that in a specified period of time, all water entering a specified area must either go into storage within its boundaries, be consumed there in, be exported there from or flow out either on the surface or underground. So for its computation, procedure introduced by [6] was used. The detailed explanation of water balance parameters shown in Fig. 1.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

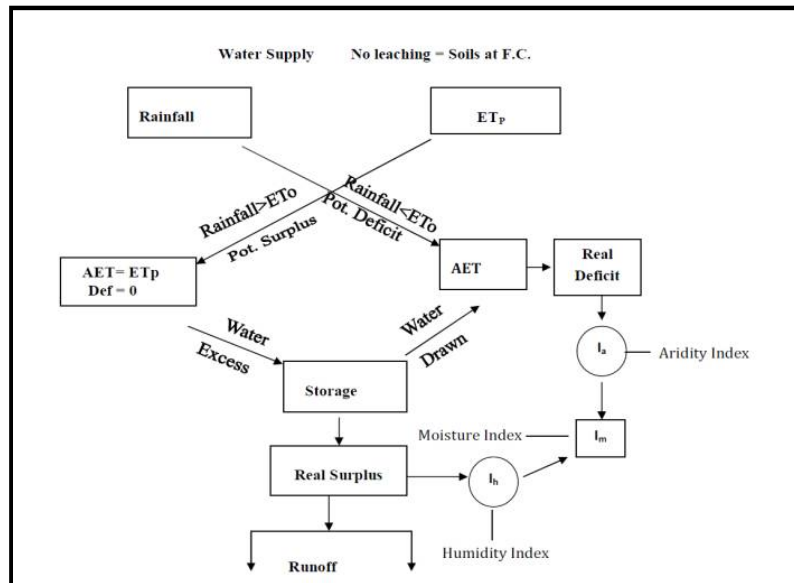


Fig. 1 Generalized flow diagram of the climatic water balance

## Climatological Indices

On the basis of above parameters climatological indices such as humidity index ( $I_h$ ), aridity index ( $I_a$ ), moisture index ( $I_m$ ) and moisture adequacy index ( $I_{ma}$ ) were computed by using the following expressions (Thornthwaite and Mather, 1955):

$$I_h = \frac{SUR}{ET_0} \times 100 \quad (2)$$

$$I_a = \frac{DEF}{ET_0} \times 100 \quad (3)$$

$$I_{ma} = \frac{AET}{ET_0} \times 100 \quad (4)$$

$$I_m = I_h - I_a \quad (5)$$

## Determination of Climatic Shift

The annual moisture index represents the type of prevailing climate in an area. On the basis of moisture index, following criteria has been suggested by Subramanian and Shastri (1969) to distinguish the climate

Moisture index, %	Type of climate
> 100	A - Per humid
80 - 100	B4 - Humid
60 - 80	B3 - Humid
40 - 60	B2 - Humid
20 - 40	B1 - Humid
0 - 20	C2 - Moist sub humid
-33.3 - 0	C1 - Dry sub humid
-66.7 - -33.3	D - Semi-arid
-100 - -66.7	E - Arid

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

## Moisture Adequacy Index

[5] has suggested following criteria for weekly soil moisture adequacy index:

$$MAI = AE / PE \times 100$$

Classification of MAI on Weekly basis are decided as follows

- i) MAI  $\geq$  75 % -Excellent
- ii) MAI = 50 to 74 % -Good (Adequate moisture)
- iii) MAI = 49 to 24 % -Poor
- iv) MAI < 24 % -Very Poor Moisture stress

If MAI = 0 to 49, during active growth stages of the crop, it is considered as drought. Where, AE and PE are actual and potential evapotranspiration for the period.

## Planning for Pomegranate Production

Selection of crops, crop seasons and cropping pattern depends on the length of growing season and occurrences of dry spells if temperature is not a limiting factor. Length of growing season is decided on the basis of period of moisture availability for crop growth. The length of growing season was determined [8].  $I_{ma}$  is the moisture adequacy index which is the ratio of AET/ET<sub>r</sub>. The predominant micro climatic condition in general was used to distinguish the stations for crop planning. Station were grouped into five categories viz.; arid, semi-arid, dry sub-humid, wet sub-humid and humid. Arid *stations* having arid climate for more than 60 per cent years, semi-arid *stations* having semi-arid climate for more than 60 per cent years and arid to semi-arid *stations* for rest of the fluctuations in climate. Similarly for dry sub-humid, wet sub-humid and humid. Further, [13] had suggested a method to identify and quantify seasonal rainfall variability. Accordingly; rainfall characteristics and water surplus/deficit and moisture adequacy index were determined for different weeks of different *bahars* for efficient crop planning.

## IV. RESULTS AND DISCUSSION

### Weekly Drought Investigation of Ambe bahar

Table 1 revealed that the average weekly drought of *Ambe bahar* for all *stations* of the Solapur district. The number of drought weeks highest in Akluj is 943 weeks with 76.98 per cent and lowest in Solapur is 760 weeks with 70.05 per cent. The number of normal weeks highest in North Solapur is 157 weeks with 14.47 per cent and lowest in Pandharpur is 95 weeks with 8.92 per cent. Similarly the number of surplus weeks highest in Akalkot is 177 weeks with 15.32 per cent and lowest in Akluj is 129 weeks with 11.17 per cent. The percentage of coefficient of variation between Drought, Normal and surplus weeks for every *station* highest in Malsiras *station* is 120.18 per cent and lowest in Solapur is 95.39 per cent.

Table 1 Weekly Drought investigation of *Ambe bahar* for all *stations*

Sr. No	Name of Station	No. of Drought Week	No. of Normal Week	No. of surplus Week	% of drought week	% of normal week	% of Surplus week	Coeff. of variance in %
1.	Akalkot	843	135	177	72.99	11.69	15.32	103.17
2.	Akluj	914	112	129	79.13	9.70	11.17	119.01
3.	Jeyur	943	126	156	76.98	10.29	12.73	113.46
4.	Karmala	890	107	158	77.06	9.26	13.68	113.79
5.	Madha	920	128	177	75.10	10.45	14.45	108.68
6.	Barsi	829	155	171	71.77	13.42	14.81	99.90
7.	Malsiras	919	103	133	79.57	8.92	11.52	120.18
8.	Mangalvedha	881	118	156	76.28	10.22	13.51	111.68
9.	Pandharpur	888	95	172	76.88	8.23	14.89	113.59
10.	Sangola	866	119	170	74.98	10.30	14.72	108.40
11.	Mohol	864	109	182	74.81	9.44	15.76	108.16
12.	Solapur	760	157	168	70.05	14.47	15.48	95.39
13.	S. Solapur	785	134	166	72.35	12.35	15.30	101.47
14.	N. Solapur	786	139	160	72.44	12.81	14.75	101.65

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

### Weekly Drought Investigation of *Mrig bahar*

Table 2 reveal that the average weekly drought of *Mrig bahar* for all *stations* of the Solapur district. The number of drought weeks highest in Akluj is 784 weeks with 67.88 per cent and lowest in Solapur is 653 weeks with 58.43 per cent. The number of normal weeks highest in North Solapur is 256 weeks with 23.59 per cent and lowest in Malsiras is 191 weeks with 16.54 per cent. Similarly the number of surplus weeks highest in Akalkot is 216 weeks with 18.70 per cent and lowest in Akluj is 166 weeks with 14.37 per cent. The percentage of coefficient of variation between Drought, Normal and surplus weeks for every *station* highest in Malsiras station is 89.76 per cent and lowest in Solapur is 65.75 per cent.

**Table 2 Weekly Drought investigation of *Mrig bahar* for all *stations***

Sr. No.	Name of Station	No. of Drought Week	No. of Normal Week	No. of surplus Week	% of drought week	% of normal week	% of Surplus week	Coeff. of variance in %
1.	Akalkot	692	247	216	59.91	21.39	18.70	69.17
2.	Akluj	781	208	166	67.62	18.01	14.37	89.24
3.	Jeyur	792	238	195	64.65	19.43	15.92	81.54
4.	Karmala	737	221	197	63.81	19.13	17.06	79.24
5.	Madha	761	267	197	62.12	21.80	16.08	75.29
6.	Barsi	708	239	208	61.30	20.69	18.01	72.77
7.	Malsiras	784	191	180	67.88	16.54	15.58	89.76
8.	Mangalvedha	740	225	190	64.07	19.48	16.45	79.98
9.	Pandharpur	738	215	202	63.90	18.61	17.49	79.42
10.	Sangola	738	219	198	63.90	18.96	17.14	79.45
11.	Mohol	721	236	198	62.42	20.43	17.14	75.74
12.	Solapur	634	256	195	58.43	23.59	17.97	65.75
13.	S. Solapur	653	225	207	60.18	20.74	19.08	69.81
14.	N. Solapur	658	237	190	60.65	21.84	17.51	71.26

### Weekly Drought Investigation in *Hasta bahar*

Table 3 revealed that the average weekly drought of *Hasta bahar* for all *stations* of the Solapur district. The number of drought weeks highest in Akluj is 933 weeks with 76.16 per cent and lowest in Solapur is 779 weeks with 71.80 per cent. The number of normal weeks highest in North Solapur is 149 weeks with 13.73 per cent and lowest in Malsiras is 108 weeks with 9.35 per cent. Similarly the number of surplus weeks highest in Madha is 181 weeks with 15.67 per cent and lowest in Akluj is 145 weeks with 12.55 per cent. The percentage of coefficient of variation between Drought, Normal and surplus weeks for every *station* highest in Malsiras *station* is 115.74 per cent and lowest in Solapur is 99.94 per cent.

**Table 3 Weekly Drought investigation of *Hasta bahar* for all *stations***

Sr. No.	Name of Station	No. of Drought week	No. of Normal Week	No. of surplus Week	% of drought week	% of normal week	% of Surplus week	Coeff. of variance in %
1.	Akalkot	844	136	175	73.07	11.77	15.15	103.37
2.	Akluj	887	123	145	76.80	10.65	12.55	112.96
3.	Jeyur	933	117	175	76.16	9.55	14.29	111.50
4.	Karmala	875	120	160	75.76	10.39	13.85	110.34
5.	Madha	916	130	179	74.78	10.61	14.61	107.84
6.	Barsi	857	125	173	74.20	10.82	14.98	106.36
7.	Malsiras	899	108	148	77.84	9.35	12.81	115.74
8.	Mangalvedha	859	136	160	74.37	11.77	13.85	106.67
9.	Pandharpur	867	118	170	75.06	10.22	14.72	108.63

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

10.	Sangola	871	121	163	75.41	10.48	14.11	109.46
11.	Mohol	861	113	181	74.55	9.78	15.67	107.44
12.	Solapur	779	149	157	71.80	13.73	14.47	99.94
13.	S. Solapur	782	137	166	72.07	12.63	15.30	100.73
14.	N. Solapur	789	142	154	72.72	13.09	14.19	102.34

### Pomegranate evapotranspiration (ETp) in different bahars for mature tree (5<sup>th</sup> Year)

Table 4 revealed that, for Ambe bahar, at 70% probability level weekly pomegranate evapotranspiration (ETp) ranges from 4.87 to 85.52 litres/day/tree. The total pomegranate evapotranspiration (ETp) at 70% probability level over a period of 35 weeks of phenological stages in *Ambe bahar* is 1696.42 litres/year/tree. For Mrig bahar, at 70% probability level weekly pomegranate evapotranspiration (ETp) ranges from 10.39 to 54.78 liters/day/tree. The total pomegranate evapotranspiration (ETp) at 70% probability level over a period of 35 weeks of phenological stages in *Mrig bahar* is 1327.4 litres/year/tree. For Hasta bahar at 70% probability level weekly pomegranate evapotranspiration (ETp) ranges from 5.95 to 54.29 litres/day/tree. The total pomegranate evapotranspiration (ETp) at 70% probability level over a period of 35 weeks of phenological stages in *Hasta bahar* is 1260.5 litres/year/tree. Above result of weekly values of pomegranate evapotranspiration (ETp) of *Ambe*, *Mrig* and *Hasta bahar* revealed that lowest water requirement at 70% probability occurred in *Hasta bahar* followed by *Mrig* and *Hasta bahar*.

**Table 4 The values of evapotranspiration (ETp) for mature pomegranate tree (litres/day/tree) at 70% probability levels**

M W	Ambe bahar	M W	Mrig bahar	M W	Hasta bahar
49	4.87	18	10.39	32	5.95
50	7.54	19	16.46	33	8.98
51	10.74	20	22.28	34	12.23
52	14.02	21	27.58	35	16.36
1	15.25	22	31.71	36	20.48
2	17.38	23	28.24	37	21.40
3	----	24	32.15	38	26.06
4	26.04	25	34.93	39	25.72
5	30.45	26	35.61	40	29.07
6	35.73	27	39.25	41	32.21
7	39.99	28	39.15	42	36.38
8	47.66	29	43.69	43	42.20
9	55.21	30	41.69	44	39.69
10	60.27	31	46.93	45	42.60
11	64.27	32	47.76	46	42.44
12	69.97	33	47.30	47	41.79
13	70.88	34	49.47	48	40.51
14	77.43	35	51.62	49	39.27
15	75.86	36	54.78	50	39.84
16	82.14	37	50.15	51	43.56
17	81.42	38	52.09	52	44.35
18	84.11	39	45.61	1	40.88
19	84.22	40	44.57	2	39.40
20	85.52	41	43.61	3	----
21	79.87	42	44.46	4	42.23
22	75.60	43	46.64	5	42.98
23	57.81	44	40.02	6	44.68



## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

24	54.48	45	38.44	7	45.26
25	50.88	46	35.17	8	48.66
26	45.49	47	33.80	9	51.34
27	43.85	48	31.70	10	50.03
28	39.43	49	29.71	11	48.87
29	39.55	50	29.09	12	51.23
30	33.57	51	30.39	13	49.59
31	34.94	52	31.02	14	54.29
(l/y/tree)	1696	(l/y/tree)	1327	(l/y/tree)	1260

### Water Balance and Its Parameters

#### For Ambe bahar

The Table 5 revealed that, for all the *stations*, the highest maximum value of rainfall, actual evapotranspiration (AET), water deficit, water surplus, humidity index ( $I_h$ ), aridity index ( $I_a$ ), moisture index ( $I_m$ ), moisture adequacy index ( $I_{ma}$ ) are occurred in Solapur (339.69), Solapur (222.72), Akluj (1118.91), Akluj (139.52), Akluj (11.73), Akluj (88.97), Solapur (-72.77) and Solapur (17.90) respectively. Similarly, minimum value occurred in Mangalvedha (224.93), Akluj (137.36), Solapur (1033.55), Mangalvedha (67.95), Mangalvedha (5.95), Solapur (82.10), Mangalvedha (-81.96) and Akluj (11.03) respectively. Above results express that moisture status in different *stations* which indicates high water deficit and aridity index occurs in Mangalvedha *station*. Similarly, high surplus water, moisture index and moisture adequacy index occur in Solapur *station*.

**Table 5 Average seasonal water balance and its different parameters for Ambe bahar**

Station	Rain-fall (mm)	Pomegranate ET (mm)	AET (mm)	Water Deficit (mm)	Water Surplus (mm)	Humidity Index ( $I_h$ )	Aridity Index ( $I_a$ )	Moisture Index ( $I_m$ )	Moisture adequacy Index ( $I_{ma}$ )
Akalkot	307.1	1256.2	188.4	1067.8	118.64	9.54	84.94	-75.4	15.06
Akluj	276.8	1256.2	137.3	1118.9	139.52	11.73	88.97	-77.2	11.03
Jeyur	234.6	1256.2	154.5	1101.7	80.05	6.42	87.56	-81.1	12.44
Karmala	241.8	1256.2	155.2	1101.0	86.70	7.08	87.54	-80.4	12.46
Madha	235.1	1256.2	159.9	1096.3	75.24	6.11	87.13	-81.0	12.87
Barsi	266.5	1256.2	180.7	1075.5	85.81	6.90	85.52	-78.6	14.48
Malsiras	244.6	1256.2	140.1	1116.1	104.47	8.59	88.75	-80.1	11.25
Mangalvedha	224.9	1256.2	156.9	1099.2	67.95	5.45	87.41	-81.9	12.59
Pandharpur	274.5	1256.2	174.7	1081.5	99.81	7.95	86.07	-78.1	13.93
Sangola	261.2	1256.2	172.0	1084.2	89.21	7.11	86.27	-79.1	13.73
Mohol	237.6	1256.2	165.9	1090.3	71.68	5.73	86.66	-80.9	13.34
Solapur	339.6	1256.2	222.7	1033.5	116.98	9.33	82.10	-72.7	17.90
S. Solapur	316.7	1256.2	204.8	1051.4	111.85	8.89	83.61	-74.7	16.39
N. Solapur	318.0	1256.2	201.7	1054.5	116.37	9.25	83.89	-74.6	16.11
Average	269.9	1256.2	172.5	1083.7	97.45	7.86	86.17	-78.3	13.83

#### For Mrig bahar

The Table 6 revealed that, in all the *stations*, the highest maximum value of rainfall, actual evapotranspiration (AET), water deficit, water surplus, humidity index ( $I_h$ ), aridity index ( $I_a$ ), moisture index ( $I_m$ ), moisture adequacy index ( $I_{ma}$ ) are occurred in Akalkot (708.21), Akalkot (365.70), Malsiras (679.72), Akalkot (342.51), Akalkot (36.64), Akluj (61.36), Akalkot (-24.72) and Akalkot (38.34) respectively. Similarly, minimum value occurred in Jeyur (547.94), Malsiras (273.22), Akalkot (587.23), Jeyur (253.82), Jeyur (27.37), Akalkot (61.36), Jeyur (-41.45) and Akluj (38.64) respectively. Above results express that moisture status in different *stations* which indicates high water deficit and

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

aridity index occurs in Malsiras and Akluj respectively. Similarly, high surplus water, moisture index and moisture adequacy index occur in Akalkot station.

**Table 6 Average seasonal water balance and its different parameters for *Mrig bahar***

Station	Rain-fall, mm	Pomegranate ET, mm	AET, mm	Water Deficit, mm	Water Surplus, mm	Humidity Index ( $I_h$ )	Aridity Index ( $I_a$ )	Moisture Index ( $I_m$ )	Moisture adequacy Index ( $I_{ma}$ )
Akalkot	708.2	952.9	365.7	587.23	342.51	36.64	61.36	-24.72	38.64
Akluj	589.4	952.9	275.7	677.21	313.75	34.88	70.69	-35.81	29.31
Jeyur	547.9	952.9	294.1	658.82	253.82	27.37	68.82	-41.45	31.18
Karmala	597.0	952.9	309.8	643.10	287.22	30.93	67.14	-36.21	32.86
Madha	621.6	952.9	321.6	631.26	300.21	32.44	65.71	-33.27	34.29
Barsi	606.9	952.9	336.2	616.70	270.69	29.18	64.42	-35.24	35.58
Malsiras	576.2	952.9	273.2	679.72	303.04	33.41	70.99	-37.58	29.01
Mangalvedha	570.3	952.9	305.2	647.64	265.08	28.33	67.65	-39.32	32.35
Pandharpur	654.1	952.9	331.5	621.40	322.66	33.91	65.07	-31.16	34.93
Sangola	649.9	952.9	326.2	626.73	323.73	34.43	65.50	-31.06	34.50
Mohol	579.6	952.9	318.6	634.33	261.05	28.07	66.22	-38.14	33.78
Solapur	692.9	952.9	364.3	588.62	328.67	35.02	61.51	-26.49	38.49
S. Solapur	699.0	952.9	361.7	591.19	337.35	35.94	61.81	-25.87	38.19
N. Solapur	678.5	952.9	348.7	604.14	329.76	35.15	63.29	-28.14	36.71
Average	626.5	952.9	323.7	629.15	302.82	32.55	65.73	-33.18	34.27

### For *Hasta bahar*

The Table 7 revealed that, in all the stations, the highest maximum value of rainfall, actual evapotranspiration (AET), water deficit, water surplus, humidity index ( $I_h$ ), aridity index ( $I_a$ ), moisture index ( $I_m$ ), moisture adequacy index ( $I_{ma}$ ) are occurred in South Solapur (440.09), South Solapur (148.58), Malsiras (827.35), Akalkot (300.55), Akalkot (32.35), Malsiras (87.62), South Solapur (-52.11) and South Solapur (15.88) respectively. Similarly, minimum value occurred in Akluj (336.78), Akluj (111.03), Solapur (789.01), Jeyur (225.54), Jeyur (24.08), Solapur (83.63), Jeyur (-63.27) and Akluj (11.85) respectively. Above results express that moisture status in different stations which indicates high water deficit and aridity index occurs in Malsiras and Akluj station respectively. Similarly, high surplus water, moisture index and moisture index occur in Akalkot, Akalkot and South Solapur stations respectively.

**Table 7 Average seasonal water balance and its different parameters for *Hasta bahar***

Station	Rain-fall (mm)	Pomegranate ET (mm)	AET (mm)	Water Deficit (mm)	Water Surplus (mm)	Humidity Index ( $I_h$ )	Aridity Index ( $I_a$ )	Moisture Index ( $I_m$ )	Moisture adequacy Index ( $I_{ma}$ )
Akalkot	438.5	943.4	142.9	798.21	300.55	32.35	84.57	-52.2	15.22
Akluj	336.7	943.4	111.0	825.20	229.00	24.62	87.46	-62.8	11.85
Jeyur	337.8	943.4	115.5	823.93	225.54	24.08	87.35	-63.2	12.27
Karmala	386.4	943.4	125.0	814.78	265.01	28.40	86.33	-57.9	13.33
Madha	426.2	943.4	140.9	798.77	288.83	30.86	84.51	-53.6	15.15
Barsi	375.1	943.4	129.3	811.90	250.78	26.98	86.03	-59.0	13.76
Malsiras	353.0	943.4	111.4	827.35	244.17	26.43	87.62	-61.1	11.94
Mangalvedha	385.5	943.4	135.7	804.35	253.69	27.28	85.14	-57.8	14.55
Pandharpur	429.1	943.4	138.7	802.62	295.56	31.10	85.03	-53.9	14.78



## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

Sangola	428.9	943.4	138.9	800.85	293.57	31.41	84.84	-53.4	14.81
Mohol	383.9	943.4	134.7	806.46	254.19	27.11	85.38	-58.2	14.41
Solapur	413.5	943.4	148.1	789.01	269.53	28.88	83.63	-54.7	15.78
S. Solapur	440.0	943.4	148.5	791.18	295.06	31.66	83.77	-52.1	15.88
N. Solapur	411.4	943.4	141.1	800.25	275.48	29.43	84.84	-55.4	14.96
Average	396.2	943.4	133.0	806.77	267.21	28.61	85.46	-56.8	14.19

### Climatic Shift in Ambe, Mrig, and Hasta bahar

The moisture index, which is the basis for climatic classification, has been studied based on pomegranate *bahar* wise change in climate. Such diagram for climatic change for pomegranate *Ambe*, *Mrig*, *Hasta bahar* in different stations are shown in Fig. 2. These figures indicate the fluctuation of moisture index ( $I_m$ ) in different years of study period.

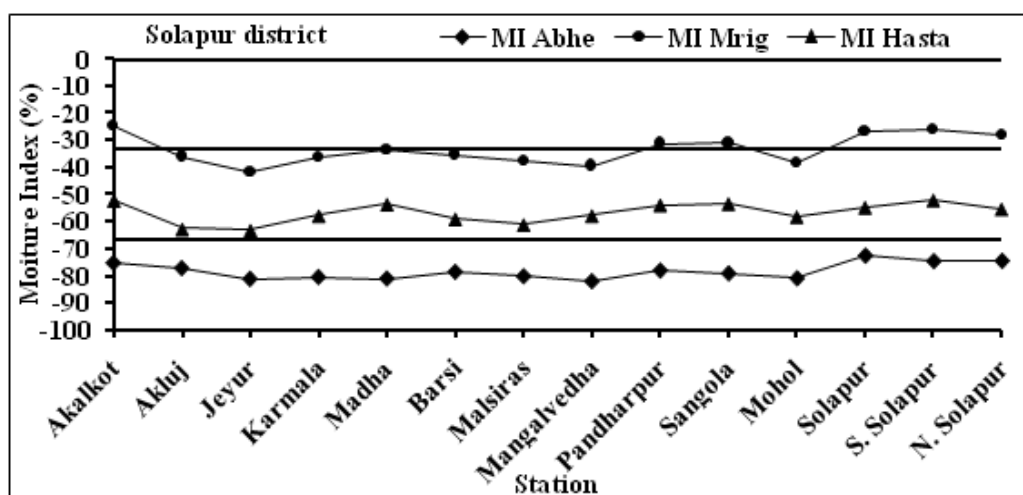


Fig. 2 Climatic shift in Ambe, Mrig and Hasta bahar for all the stations

From Table 5 revealed that the climate in *Ambe bahar* is completely arid with average moisture index (-78.31) per cent. Highest and lowest moisture index for *Ambe bahar* are observed in Solapur (-72.77) and Mangalvedha (-81.96) respectively. From Table 6, it is observed that the climate in *Mrig bahar* is quietly on the boundary of semi-arid to dry sub-humid and dry sub-humid to dry sub-humid with average moisture index (-33.18) per cent. Highest and lowest moisture index for *Mrig bahar* are observed in Akalkot (-24.72) and Jeyur (-41.45) respectively. Also the Table 7 revealed that the climate in *Hasta bahar* is semi-arid with average moisture index (-56.85) percent. Highest and lowest moisture index for *Hasta bahar* are observed in South Solapur (-52.11) and Jeyur (-63.27) respectively. The moisture adequacy indices in *Ambe*, *Mrig* and *Hasta* are very poor, in between very poor to poor and poor shown in Fig. 3 respectively.

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

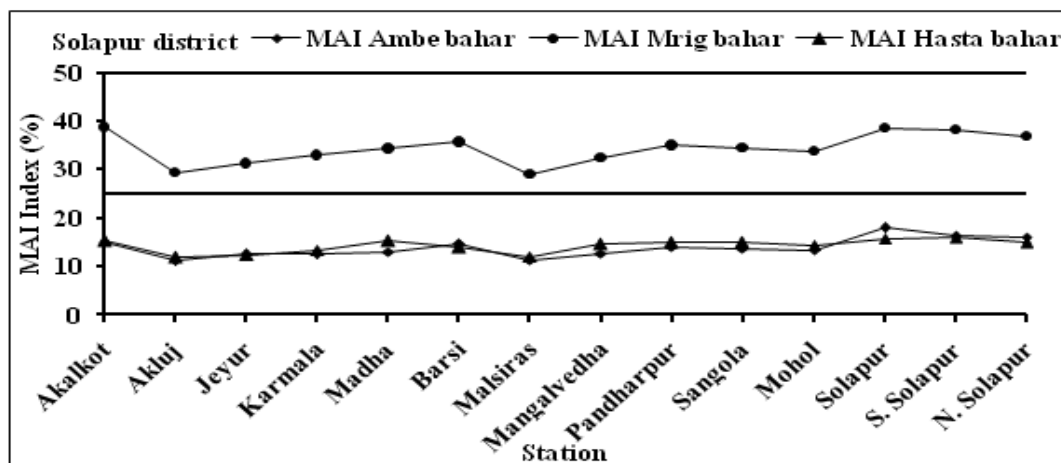


Fig. 3 Moisture adequacy index of Ambe, Mrig and Hasta bahar for all the stations

The characterisation of climate is an important tool for crop planning. The study on predominant shift in climate of Ambe bahar of pomegranate in different stations revealed that only one type of climatic condition prevail in the district viz.; arid, having arid climate for 100 per cent years (>31 years). Thus the predominant climate for Ambe bahar of pomegranate at all stations of Solapur district is arid and study on predominant shift in climate of Hasta bahar of pomegranate in different stations revealed that only one type of climatic condition prevail in the district viz.; semi-arid, having semi-arid climate for 100 per cent years (>31 years). Thus the predominant climate for Hasta bahar of pomegranate at all stations of Solapur district is semi-arid. Similarly study on predominant shift in climate of Mrig bahar of pomegranate in different stations reveal that two types of climatic conditions prevails in the district viz.; semi-arid, having semi-arid climate for 35 per cent years (>10 years) and dry sub-humid, having dry sub-humid climate for 65 per cent years (>21 years). Thus the predominant climates for Mrig bahar of pomegranate at every stations of Solapur district are semi-arid and dry sub-humid. The complete arid climate is not good for pomegranate tree also fruit quality and its appearance [14]. In arid climate temperature and humidity fluctuation is very high. Also unavailability of rainfall, there is need of external irrigation facility to fulfill water requirement but semi-arid climate play important role in pomegranate production, fruit quality and appearance also [1]. In semi-arid climate temperature and humidity fluctuation is very low as compared to arid and dry sub-humid climate [4]. In dry sub-humid climate abrupt climatic changes occurred often and high disease and pest spreading chances due water surplus. So dry sub-humid climate unsuitable for proper and without risk production [11].

### Selection of Appropriate bahar for Pomegranate Production

Pomegranate bahar wise drought investigation, water requirement, climatic shifting analysis revealed that Hasta bahar of pomegranate is most appropriate, beneficial and least risk, quality, disease free production of pomegranate. In Hasta bahar of pomegranate less water required, minimum fluctuation of climatic parameters like temperature, humidity, sunshine hour, wind speed and rainfall and uniform climatic shifting occurred as compare to Ambe and Mrig bahar of pomegranate. Finally most appropriate bahar for growers is Hasta bahar.

### V. CONCLUSIONS

1. The percentage high water drought months, weeks are observed in Malsiras followed by Akluj and that of high surplus months, weeks are observed in Solapur followed by South Solapur, Akalkot stations for every pomegranate bahar for mature (5<sup>th</sup> year) pomegranate tree.
2. Water requirement at 70% probability of Ambe, Mrig and Hasta bahar is 1696.42, 1327.4 and 1260.5 litres/year/tree respectively for mature (5<sup>th</sup> year) pomegranate tree. The lowest water requirement is found in Hasta bahar.

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 10, October 2017

3. The abrupt change, large variation from mean values of meteorological parameters are occurred in *Ambe* and *Mrig bahar* than that of *Hasta bahar* but in *Hasta bahar* uniform variation of all parameter occurred which is helpful for healthy and disease free growth of pomegranate tree also good for pomegranate production. The most adequate beneficial and productive *bahar* for pomegranate is ***Hasta bahar*** as compare to *Ambe* and *Mrig bahar*. Pomegranate *bahar* wise moisture index reveal that moisture status in the *Hasta bahar* is very good for plant growth and disease free production of pomegranate.

### REFERENCES

- [1] Ericka W. and E.Contributor. 2009. Article on climate for Pomegranate. Google.com.
- [2] Holland, D and I. Bar-Ya'akov. 2008. The pomegranate: New interest in an ancient fruit. *Chronica Horticulturae* 48, 12-15.
- [3] Holland, D., K. Hatib, and I. Bar-Ya'akov. 2009. Pomegranate: Botany, horticulture, breeding. In: Janick J (Ed) *Horticultural Reviews* (Vol. 35), John Wiley and Sons, New Jersey, pp 127-191.
- [4] Humphries, A. W. And F. J. Roberts. 1964. The effect of wind on plant growth and soil moisture relations: a re-assessment. *Division of Plant Industry, C.S.I.R.O. Nedlands*, Western Australia.
- [5] Krishnan, A. 1979. Definitions of drought and factors relevant to specifications of agricultural and hydrological droughts. Proc. International. Symposium on hydrological aspects of droughts, New Delhi, India: Indian Institute of Technology. 1.67-102
- [6] Thornthwaite, C. W. and J. R. Mather. 1955. The Water Balance Climate. 8(1). *Dreseal Inst. of Tech.*, New Jersey. USA: 104.
- [7] NRCP., 2011. National Research Centre on Pomegranate, Solapur, Maharashtra, India.
- [8] NRCP., 2009. National Research Centre on Pomegranate, Solapur, Maharashtra, India.
- [9] Ramdas, L. A. and A. K. Mallik. 1948. Agriculture situation in India.
- [10] Ravikumar K. T. 2009. Department of Agricultural Economics College of Agriculture, *Dharwad University of Agricultural Sciences*, Dharwad
- [11] Seidhom, S. H. and Abd-El-Rahman. 2011. Prediction of Traditional Climatic Changes Effect on Pomegranate Trees under Desert Condition in ELMaghara, Egypt. *Journal of American Science*, 7(5)
- [12] Sharma, H. C., H. S. Chauhan, and S. Ram. 1979. Probability analysis of rainfall for crop planning. *J Agric. Engg* XVII (3): 87-94.
- [13] Stewart, J. 1991. Principles and performance of response farming .pp 361-382.In: Climatic risks in crop productions- Models and management for semiarid tropics and subtropics, Edited by Russell C. Muchow and Jennifer A. Bellamy, CAB International, United Kingdom.p.548
- [14] Weerakkody P. and Jenny Jobling. 2009. The effect of maturity, sunburn and the application of sunscreens on the internal and external qualities of pomegranate fruit grown in Australia. *Scientia Horticulturae*. 3461; No of Pages 5