RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 5 | Issue 2 | October, 2012 | 240 –243

Characterization of rainfall of different sub montane zone for Maharashtra state

S.S. CHINCHORKAR, F.G. SAYYAD, G.R. PATEL, S.K. PATEL AND B.K.YADUVANSHI

Received : 27.03.2012; Revised : 25.08.2012; Accepted : 26.09.2012

See end of the Paper for authors' affiliations

Correspondence to:

S.S. CHINCHORKAR
Polytechnic in Agricultural Engineering (A.A.U.), DAHOD (GUJARAT) INDIA
Email : ssc2008@in.com

ABSTRACT : The daily rainfall data for the period of 13 years (1989-2001) of different 15 rain gauges stations form the sub montane zone of Maharashtra were collected considered for analysis. Average weekly rainfall of all stations was calculated form the daily rainfall. The weekly assured rainfall values at 50 and 75% probability levels were computed by incomplete gamma distribution. Weekly assured rainfall was considered for moisture availability index (MAI). The wet and dry spells were calculated by Markov Chain model. The onset and withdrawal of monsoon were decided by weekly rainfall frequency distribution method. The overall situation of the moisture availability period, onset and withdrawal of monsoon assured rainfall, dry and wet spell. From the assured total rainfall at 50 to 75 per cent probability it is clear that the maximum rainfall was received in the month of July and August especially in 28, 29 and 30 mw.

KEY WORDS : Rainfall characterization, Moisture availability index (MAI), Markov chain Model

HOW TO CITE THIS PAPER : Chichorkar, S.S., Sayyad, F.G., Patel, G.R., Patel, S.K. and Yaduvanshi, B.K. (2012). Characterization of rainfall of different sub montane zone for Maharashtra state. *Internat. J. Agric. Engg.*, **5**(2) : 240-243

Agriculture is the backbone of Indian economy. Agricultural production is closely related with rainfall. Advanced farm technology has a great potential to increase crop production. The main reason for very low and highly unstable yields in these areas is the availability of adequate soil moisture during active growth period of the crops. Onset, progress, intensity, temporal and spatial distribution of monsoon rains decides the fate of dry land agriculture. The distribution of rainfall is the matter of more serious concern than the total amount of rainfall.

The farmers have adopted their farming system by experience of generations without proper knowledge of agro-climatic conditions, effective cropping pattern and importance of scheduling of irrigation. Hence, study of rainfall characteristics is very important in general and drought prone areas. This includes mean rainfall, its deviation and variability, withdrawal of monsoon, the duration, and frequency with their interaction with crop and soil so that this resources can be put to more efficient use in agricultural planning.

The cropping patterns are basically dependent on MAI. Hargreaves (1971) defined MAI is the ratio of assured rainfall expected at 75% probability level and estimated potential evapotranspiration for the concerned period. Bhishnoi (1980) has defined MAI as

MAI = AE/PE

where MAI = Moisture Adequacy Index, AE= Actual evapotranspiration, PE= Potential evapotranspiration

The knowledge of rainfall variability and MAI with the soil type of particular area is necessary. MAI is the prime factor for crop planning, especially in the tropics where it varies both in time and space. MAI were worked out on the basis of average monthly rainfall (Raman and Murthy, 1971) and crop planning was done. If there are dry spells in between, causing crop failure the monthly MAI at different risk levels for agricultural planning of majority of season's crops, the weekly MAI values will be more suitable.

METHODOLOGY

The weekly meteorological rainfall data of different stations under sub montane zone of Maharashtra state was collected for the study and rainfall variability, Potential evapotranspiration (PET), moisture availability index (MAI), moisture availability periods etc. were computed. The data were collected form India Meteorological Department (IMD), Pune from 13 years (1989-2001) were available which has been analyzed. For MAI calculation actual weekly rainfall data were used.

The Markov chain model was used to estimate the conditional probability of dry and wet spell. For determining dry and wet spell the limit of 15 mm rainfall at initial growth

stage of the crop and 30 mm rainfall at active growth stage were considered. If the rainfall was equal to or grater than 15 mm, in a particular meteorological week, that week was considered to be wet, otherwise it was considered as dry in initial growth stage. Similarly in active growth stage the rainfall was grater than or equal to 30mm in a particular meteorological week, that week was considered as wet, otherwise it was dry.

Rainfall variability:

Studies of the variability of annual and seasonal rainfall, frequency of dry spell on monthly and weekly basis provide useful information for knowing the climatic potential of agricultural production. Mean weekly standard deviation (SD) and coefficient of variation (CV) has been computed for the period of 1989 to 2001. The weekly rainfall data of that period from sub montane zone of Maharashtra was used. The measure of variability of distribution about the mean is the coefficient of variation, which can be expressed as :

$$CV = \frac{100 * \pm}{\overline{X}}$$

Where as σ = Standard deviation of weekly rainfall and $\overline{X}$ = mean weekly rainfall

Onset and withdrawal of monsoon:

The frequency analysis of weekly rainfall was carried out on the basis of weekly data of 13 years. For deciding the onset and withdrawal of monsoon, frequency of weekly rainfall of 21 mw to 25mw was considered. During this period, the week which show sudden rise in the frequency of rainfall was considered as onset of monsoon.

Computation of weekly PET :

It is assumed in all agrometeorological studies that potential evapotranspiration express the maximum demand of the atmosphere, while actual evapotranspiration may sometimes be higher than PET covering the soil surface completely. It has been found that early stage of crop growth (3 to 4 weeks), actual evapotranspiration is about a quarter of potential rate due to small. India Meteorology Department, Pune has installed 35 lysimeters in various soils and climatic zones of the country to find out the water requirement of different crops. Venkatraman *et al.*(1976) found that the cumulative seasonal ET is about 70 per cent of the cumulative PE. It has, therefore, been considered for this study that the difference between weekly averages rainfall and PE of the corresponding period will go into stored soil moisture and plants can use it even after the end of rainy season.

Computation of weekly MAI :

Mean weekly rainfall of past 13 years was used for estimation of actual evapotranspiration (AE). By using weekly AE and weekly PET, the weekly MAI was calculated as:

$$MAI = AE/PE$$

where MAI = Moisture Adequacy Index, AE= Actual evapotranspiration, PE= Potential evapotranspiration.

Moisture availability periods:

The MAI for 50,100 and 200 mm available water holding capacity were calculated which represented shallow, medium and deep soils. The growth period was considered as the period during which the MAI was more that 0.5 at the time of sowing and active vegetative growth period and more than 0.3 at the time of maturity. All the periods during active vegetative growth for which MAI was less than 0.5 were considered as stress period.

Computation of dry and wet spells:

Markov chain model property can be utilized to understand the time evolutionary processes in the atmospheric system since metrological events occur in sequence. Markov chains can be used to answer and analyze similar problems involving dynamic system. Markov chain and geometrical distribution of sequences of dry and wet events are related. For example, the distribution of wet spells of length k is given by:

$$P(w=k)=(1-P1)P1^{k} \quad P1=P(w/w)$$

and probability of wet sequences with length greater than k is

$$P(w=k)=P1^{k}$$

RESULTS AND DISCUSSION

This zone covers Kolhapur, Nasik and Satara. The soils of sub montane zone are characterized as very shallow soils 50 mm available water holding capacity, medium soil having 100 mm available water holding capacity and deep with 200 mm available water holding capacity were considered.

Rainfall of sub montane zone:

The grouping of sub montane zone of Maharashtra based on climatic parameters. The different stations/tahsils in sub montane zone are grouped into five rainfall zones are Rainfall Zone-I: Panhala,Surgana, Peth and Javoli Rainfall Zone-II- Ajara, Bhudergad, Patan, Mulshi, Shahuwadi, Rainfall Zone-III- Maval,Shirala, Rainfall Zone-IV- Karveer,Gadhinglaj. Rainfall Zone-IV- Kagal and Karad.

The rainfall distribution (mean S.D.and C.V.) of the zone is given in Table 1. The rainfall zone-I covers the different stations of sub montane zone of Maharashtra which covers Panhala,Surgana, Peth and Javoli.

Peth :

The mean annual rainfall of Peth was 2278.4 mm with SD

of 626.1 and CV covers 27.5 (Table 1). The distribution of annual rainfall in different season's *viz*., pre-monsoon, monsoon and post-monsoon was 2.7, 2197.5 and 78.2 mm respectively with SD of 9.4, 600.7 and 49.6 mm, respectively with CV of 346.4, 127.3 and 64.4 per cent. It was high deviation and less variability in monsoon season.

The MAI values for the meteorological weeks from 22 to 42 in three types of soils are reported in Table 2 for deciding the water availability periods, the number of weeks having MAI values $\geq$ 0.3 and $\geq$ 0.5 were counted.

The water availability period, at 50 per cent probability level for $\geq$ 0.3 was 19 weeks in shallow and deep soils. While $\geq$ 0.5 MAI it was 18 weeks in shallow and deep soils and 19 weeks in medium soils. Hence, period of 18 to 19 weeks will be available for crop growth in shallow, medium and deep soil once in two year *i.e.* long duration crops of 130-150 days can be grown in this area with 50 per cent.

The water availability period, at 75 per cent probability level for $\geq$ 0.3 is 15 weeks in shallow soils, 18 weeks in medium and deep soils. While $\geq$ 0.5 MAI it is 14 weeks in shallow, 15 weeks in medium soils and 16 weeks in deep soils. Thus period of 14 to 18 weeks will be available for crop growth and development, 7.5 times in 10 years *i.e.* medium and long duration crops of 90-130 days can be grown in this area.

For good germination and emergence growth of crops, the chances of getting rainfall $\geq$ 15 mm at more than 50 per cent probability are from 24 to 42 mw. Therefore, farmer should take their sowing operation in 24 to 27 mw. In these weeks probability of getting rainfall subsequent week (w/w) is more than 50 per cent. For growth and development, probability of getting rain $\geq$ 30mm is given in Table 3. The probability of getting rain $\geq$ 30 mm in 28 is 69 per cent probability of getting

Table 1 : Rainfall distribution (mean S.D. and C.V.) of zone-I

Rainfall zone	Annual rainfall			Pre monsoon			Monsoon			Post monsoon		
	Mean (mm)	S.D (mm)	C.V. (%)	Mean (mm)	S.D (mm)	C.V. (%)	Mean (mm)	S.D (mm)	C.V. (%)	Mean (mm)	S.D (mm)	C.V. (%)
I												
Peth	2278.4	626.1	27.5	2.7	9.4	346.4	2197.5	600.7	127.3	78.2	49.6	63.4
Javoli	1739.8	461.9	26.5	43.4	24.8	57.0	1517.8	424.8	28	178.6	156.4	87.6

Table 2 : MAI for assured rainfall at different probability levels in various types of soils at Peth

MW	PET(mm)	At 50 % probability				At 75 % probability			
		P (mm)	Shallow soil	Medium soil	Deep soil	P (mm)	Shallow soil	Medium soil	Deep soil
22	64.4	0.0	0.01	0.02	0.02	0	0.01	0.02	0.02
23	59.5	9.0	0.26	0.15	0.09	0	0.01	0.02	0.02
24	54.6	38.0	1	0.61	0.43	3	0.09	0.05	0.02
25	45.5	72.0	1	1.0	1	44	1	0.71	0.48
26	39.9	56	1	1.0	1	24	0.69	0.58	0.52
27	37.1	50	1	1.0	1	15	0.43	0.44	0.46
28	35.0	83	1	1.0	1	24	0.69	0.56	0.52
29	33.6	219	1	1.0	1	128	1	1	1
30	33.6	221	1	1.0	1	153	1	1	1
31	30.8	126	1	1.0	1	88	1	1	1
32	31.5	122	1	1.0	1	57	1	1	1
33	30.8	132	1	1.0	1	69	1	1	1
34	32.2	169	1	1.0	1	96	1	1	1
35	30.8	124	1	1.0	1	73	1	1	1
36	30.1	133	1	1.0	1	60	1	1	1
37	32.9	58	1	1.0	1	35	1	1	1
38	33.6	27	1	1.0	1	12	1	1	1
39	32.2	36	1	1.0	1	8	1	1	1
40	33.6	0	1	1.0	1	0	0.11	0.87	1
41	32.9	0	0.39	1.0	1	0	0.01	0.39	1
42	31.5	19	0.56	0.79	1	10	0.29	0.35	1

Table 3 : Conditional rainfall probability (%) of Peth

Mw	Rainfall probability (%)							
	At ≥ 15 mm				At ≥ 30 mm			
	W	W/W	D/W	W/D	W	W/W	D/W	W/D
23	38	60	62	40	38	60	38	40
24	62	88	100	12	46	67	100	33
25	92	83	100	17	85	45	100	55
26	85	82	0	18	54	100	0	0
27	69	100	75	0	54	100	33	0
28	92	100	100	0	69	100	100	0
29	100	100	0	0	100	100	0	0
30	100	100	0	0	100	92	0	8
31	100	100	0	0	92	100	100	0
32	100	100	0	0	100	100	0	0
33	100	100	0	0	100	100	0	0
34	100	100	0	0	100	92	0	8
35	100	100	0	15	92	83	100	17
36	85	100	100	0	85	91	0	9
37	100	69	0	31	77	70	0	30
38	69	78	0	22	54	71	33	29
39	54	57	67	43	54	57	33	43
40	62	0	20	100	46	0	14	100
41	8	0	58	100	8	0	25	100
42	54	14	17	86	23	33	0	67
43	15	0	36	100	8	0	33	100
44	31	0	0	100	31	0	0	100

rain in the next week (w/w) is also 100%. Thus if sowing is done in 24 mw then 27, 28 and 29mw will coincide with growth of period of crop.

Conclusion:

By considering the overall situation of the moisture availability period, onset and withdrawal of monsoon, assured rainfall, dry and wet spell and different soil moisture conditions, the cropping pattern is suggested for sub montane zone of Maharashtra. Rainfall was variable at all stations in this zone. Peth received the highest rainfall (2278.4mm) Most of the soils were medium and deep with reddish brown in colour. From assured rainfall at 50 per cent and 75 per cent probability level it is clear that maximum rainfall was received in the month of July and August in 28,29 and 30mw.

Authors' affiliations:

F.G. SAYYAD, G.R. PATEL, S.K. PATEL AND B.K. YADUVANSHI, Polytechnic in Agricultural Engineering (A.A.U.), DAHOD (GUJARAT) INDIA

REFERENCES

Bhishnoi,O.P. (1980). The behavior of moisture adequacy index and its utilization for exploiting the agriculture potential in Punjab and Haryana. *Mausam*, **31**(1): 157-164.

Hargreves, G.H. (1971). Precipitation, dependability and potential for agriculture production in north east Brazil, Publ. No.74-D-159 EMBRANA and Utha State Univ.(USB). 123 pp.

Raman,C.R.V. and Murthy, S.B. (1971). Water availability periods for crops planning. Scientific Report No.173. Division of Agril. Meteorology, IMD, Pune.pp. 1-9

Venkataraman, S., Sarkar,R.P. and Subha Rao, K. (1976). A comparative study of evapotranspiration of wheat at Akola, Pune and New Delhi. India.Met.Dept. Prepublished Sci.Rep. 76-16.

***