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Soil Moisture Adequacy Index (SMAI) of Jamner and Padalsare stations of Jalgaon district

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■ **ABSTRACT :** Water is limiting factor for crop production and development. The success of dry land farming mainly depends on the evenly distributed rainfall during crop growing period when the rainfall before insufficient to meet the potential needs of transpiration, the root zone of soil moisture is utilized for transpiration. This causes soil moisture storage and a situation, which may be designed as group drought occurs. Water deficit study is one of the important aspects in rainfed farming as well as in water resource planning management and allocation of irrigation water studies on water deficit pattern during different year would provide basic information for evaluating climate potential of an area for agriculture planning and development. Soil moisture plays an important role in crop productivity besides weather parameters in rainfed in general and drought prone areas of Jalgaon district in particular, plants survive on available water of the soil. Soil Moisture Adequacy Index above 25% is found from 23rd MW, it is 100% in 22nd MW at Jamner station. The average weekly rainfall is available predominantly from 23rd MW at Jamner station in *Kharif* and 41st MW at *Rabi* season. Soil Moisture Adequacy Index above 25% from 23rd MW and found to be 100% in 51st MW at Padalsare station. The average weekly rainfall is available predominantly from 25th MW at Padalsare station in *Kharif* and 41st MW at *Rabi* season.

■ **KEY WORDS :** Soil moisture adequacy index

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Dependence of Indian agriculture in the monsoon is old as civilization. Rainfall is considered as principle source of water. The success or failure of crop particularly under rainfall condition is closely linked with the rainfall pattern and the basic source of water is precipitation in the form of rainfall and snowfall. India receive adequate amount of rainfall annually through the four different type weather phenomenon, South-West monsoon 74 per cent, North-East monsoon 5 per cent, pre-monsoon 13 per cent, and post monsoon 10 per cent (Patil and Kale, 1989). Rainfall is one of the most important natural resources for human being in rain fed farming. The crop planning and it success depend upon amount and distribution of rainfall. Weekly data are more useful than monthly, seasonal and annual rainfall for planning agriculture operation (Jahangirdhar and Thote, 1983).

The Arabian Sea branch of the monsoon heavily precipitates, between the last week of May and the first week of June. In the first week of July the monsoon is established all over India. The withdrawal of monsoon starts in September in north India. The crucial months

for agriculture are July and August and fate of rained *Kharif* crop largely depends upon amount and distribution of rain especially during these two months. Even though most parts India is blessed with fairly high rainfall, average annual rainfall of India is 1140 mm. The agriculture productivity remains poor. One of the reasons for this poor productivity is the non-availability of water for timely application to the crop. Irrigation being artificial application of water, necessarily entails heavy investment and majority of the farmers being poor cannot afford it and depends on rainfed farming. The three fourth of the net cultivated area of India is under rainfed agriculture and is greatly influenced by the characteristic of the monsoon (Gupta and Singh, 1990).

Crop production is highly fluctuating in rainfed agriculture and drought prone areas of Jalgaon, because of erratic nature of rainfall in quantum space and time. Soil moisture plays an important role in crop productivity besides weather parameters in rainfed in general and drought prone areas of Jalgaon district in particular, plants survive on available water of the soil. Available water capacity of the soil will depend upon, depth of the soil and it's physical parameters. Many scientists have studied the climatic and soil situation and developed WATBAL models or climatic water balance at location. These models are useful for keeping account of soil moisture on daily or weekly or monthly basis during crop growth period (Victor and Sastry, 1984).

Jalgaon is one of the districts in Khandesh region in Maharashtra. It is situated in between 21.3°N-S latitude and 75.34° longitude and 208.5 m altitude with average annual rainfall 750mm. The average maximum temperature is 40-46°C and average minimum temperature is 4-17°C. For the present study two stations in Jalgaon district *viz.*, namely Jamner and Padalsare were selected.

Adequacy index helps to gain additional information in the seasonal cycle and frequency of various levels of irrigation requirements. Most useful purpose for which a adequacy index might be estimated namely as a device for summarizing and periodically disseminating drought information is needed by government agencies and other groups, leaving wide regional or national interest or responsibilities, usually in terms of crop progress and production aspects. The consumptive use of water of crops can be estimated by using pan- evaporimeter as a guide (Bathkal, 1965).

Ultimate objective of irrigation to any crop is to supplements the soil moisture so that the crop can have adequate moisture for its optimum growth and yield.

Besides rainfall, next important parameter is soil; crops grow on soil in presence of weather. Whatever rain falls on the soil gets accumulated in the soil, depending upon its physical properties particularly depth, infiltration rate, field capacity, wilting point etc. soil moisture created due to rainfall gets lost due to surface runoff, drainage and evaporation. The other parameters are temperature, humidity, wind, sunshine etc. in short evaporation of soil moisture is a function of all climatic parameters and be measured daily by using US open pan-evaporimeter.

Many other scientists have developed climatic water balance procedure or soil moisture adequacy index. In drought prone areas of Maharashtra soils vary in depth from location to location. Crops grown in soils differ in their water requirements depending on their duration, stages and species etc. The present study was carried out with the following objectives to study weekly soil moisture adequacy index for the Jamner and Padalsare stations of Jalgaon district.

METHODOLOGY

The methodology adopted and data collected to estimate adequacy index in Jalgaon district are discussed in the following parts of this chapter.

Location of study area:

Jalgaon is one of the district of Khandesh regions in Maharashtra. It is situated in between 21.3° North-South latitude and 75.34° longitude and 208.5 m altitude with average annual rainfall 750 mm and average maximum temperature is 40-46°C, average minimum temperature is 4-17°C. The selected stations are as follows.

Jamner station:

Jamner is situated in 20°.48' North-South latitude and 75°.47' altitude with average maximum temperature 32-37°C and minimum average temperature 5-16°C. The weekly potential evaporation was found 542.6 mm in *Kharif* and 319 mm in *Rabi.*

Padalsare station:

Padalsare is situated in 21°.10' North-South latitude

and 75°.00' East-West longitude with average maximum temperature 30-35°C and average minimum temperature 4-15°C. The weekly potential evaporation was found 645.5 mm in *Kharif* and 345.8mm in *Rabi.*

Soil of the study area:

The soils in Jalgaon district are dominantly clay in texture with major area coming under medium deep to deep black soil. The information collected from district Soil Survey Office, Jalgaon and the report of National Bureau of Soil Survey and Land use planning. Soil depth ranges between 45-150 cm. Available water holding capacity in Jalgaon was found to be 150 mm for an average soil depth of 90 cm and bulk density of 1.65 g/cc.

Collection of meteorological data:

The daily rainfall and evaporation data (1989-2018) of Belval, Bhusawal, Jamner, Padalsare was collected from Surface Water Technology Centre, Hydrology Project, Department of Irrigation, Govt. of Maharashtra, Nashik. The WATBAL model was developed by Keig and McAlpine (1974), it is used to estimate the soil moisture adequacy index of the above stations.

Evapo-transpiration:

Evapo-transpiration is the combine process of evaporation and transpiration means evaporation from surface of the soil and transpiration occurs with the help of plant tissue.

PET can be calculated by Thornthawaite and Samans formula as follows:

$e = 1.6\ (10\ t/I)^a$

in which,

e= Unadjusted potential evapo-transpiration, cm/month

t= Mean air temperature, °C

I = Annual or seasonal heat index, the summation of twelve values of monthly heat indices (i) when

$I = (t/5)^{1.514}$

a=An empirical exponent computed by the equation

$a = 0.000000675I^3 - 0.0000771\ I^2 + 0.01792\ I + 0.49239$

Evapo-transpiration is made up of two terms as discussed above. It denotes the quantity of water transpired by plants during their growth or retained in plant tissue, plus the moisture evaporated from the surface of the soil and the vegetation.

Potential evapo-transpiration:

The evapo-transpiration from a large vegetation covered land surface with adequate moisture at all times. Thornthwaite (1948) PET as the ET from an actively growing short green vegetation completely shading the ground and never short of moisture availability.

Actual evapo-transpiration:

The actual evapo-transpiration (AET) was considered to take place at the potential rate, when precipitation exceeded the potential evapo-transpiration during particular week and also when moisture in the soil is near field capacity.

Soil moisture adequacy index:

The soil moisture adequacy index is estimated by the formula,

$$\text{SMAI Z} \frac{\text{AP}}{\text{PE}} \text{x } 100$$

where,

AE = Actual evapo-transpiration.

PE = Potential evapo-transpiration.

■ RESULTS AND DISCUSSION

The daily rainfall and evaporation data were converted into weekly data. The Soil Moisture Adequacy Index was workout by using WATBAL model. Results related to soil moisture adequacy index and water balance is described under this chapter.

Soil moisture adequacy index:

Soil moisture adequacy index for Jamner and Padalsare was calculated by using WATBAL model. The weekly rainfall and evaporation data (1989-2018) was used for these stations.

Jamner Station

It is seen from Table 1 that, the Soil Moisture Adequacy Index above 25% is found from 23rd MW, it is 100% in 22nd MW at Jamner station.

It is inferred from Fig. 1 and 2; the average weekly rainfall is available predominantly from 23rd MW at Jamner station in *Kharif* and 41st MW at *Rabi* season. The soil moisture storage at > 150 mm is maximum at 34th MW. The excess amount of moisture is available from 31st MW to 36th MW at this station.

Padalsare station:

It is inferred from Table 1 that, the soil moisture adequacy index above 25% from 23rd MW and found to be 100% in 51st MW at Padalsare station.

It is seen from Fig. 3 and 4; the average weekly rainfall is available predominantly from 25th MW at Padalsare station in *Kharif* and 41st MW at *Rabi* season. The soil moisture storage at 150 mm is maximum at 33rd MW. The excess amount of moisture is available from 31st MW to 33rd MW at this station.

Table 1 : Weekly soil moisture adequacy at Jamner and Padalsare

Week	Rain mm	PE mm	AE mm	AE/PEx100 (%)	Rain mm	PE mm	AE mm	AE/PEx100 (%)
	Jamner				Padalsare			
22	2.3	40.1	4.7	12	9.3	32	3.9	12
23	21.8	29.3	10.8	37	12.5	32.7	10.4	32
24	28.3	21.4	15.2	71	20.8	31.7	14.5	46
25	63.7	23.9	18.4	77	30.3	30.8	17.8	58
26	16.6	23.5	17.4	74	45.7	30.2	20.9	69
27	31.6	22.6	18.3	81	36	30.3	21.9	72
28	37	27.9	25.4	91	40	30.3	25.1	83
29	47.7	28.7	26.1	91	44.1	30.7	28.9	94
30	41.5	27.6	26.2	95	46.1	29.9	27.9	93
31	38.4	21.2	19.9	94	41.6	29.9	27.7	93
32	52.3	19.6	18.5	94	36.2	30.6	28.1	92
33	17.2	20.5	19.4	95	36	30.2	29.5	98
34	57.6	22.4	21.4	96	30.5	30.7	29.3	95
35	28.1	24.9	23.5	94	40.1	30.7	29.7	97
36	36.5	25.4	23.6	93	33.8	30.5	28.3	93
37	229	25.5	23.5	92	27.2	31	28.3	91
38	36	19.5	17.5	90	32.6	21.9	20.9	95
39	22.8	21.6	19.3	89	30.1	23.4	22.1	94
40	16.6	19.4	16.9	87	12.5	21.2	19.2	90
41	27.7	18.7	15.4	82	15	21.6	18.9	88
42	9	19	16.5	87	15.6	21.1	17.5	83
43	7.5	19.8	16.3	82	6.5	22.5	17.1	76
44	25	20.1	15.5	77	1.8	21.6	14.3	66
45	10.4	19.1	13.5	71	4.3	21.1	12.2	58
46	2.3	17.9	11.6	65	1.3	21.9	11.4	52
47	3	20.5	11.9	58	2.5	22	9.5	43
48	5.1	21.2	10.2	48	5.1	22.7	7.7	34
49	4.7	19.2	7.9	41	5.1	21.4	6.9	32
50	1	20	6.9	34	0	222	4.8	21
51	1.2	19.3	5.7	29	0	22	3.8	17
52	0	20.3	4.9	24	0	22.3	3.2	14
1	2.9	20.8	5.8	28	3.2	21.3	4.9	23
2	2.1	20.9	5.1	24	1.9	21.8	3.4	16
3	1	20.6	3.2	15	0	20.6	2.3	11
4	0.1	20	2.4	12	0	21.8	1.9	09
5	0.1	20.2	1.8	09	0.5	22	1.6	07
6	2.2	20	2.8	14	1.4	21.2	2.4	11
7	0.1	19.1	1.2	06	0	21	0.9	04
8	0	19.9	1	05	0	20.5	0.7	03

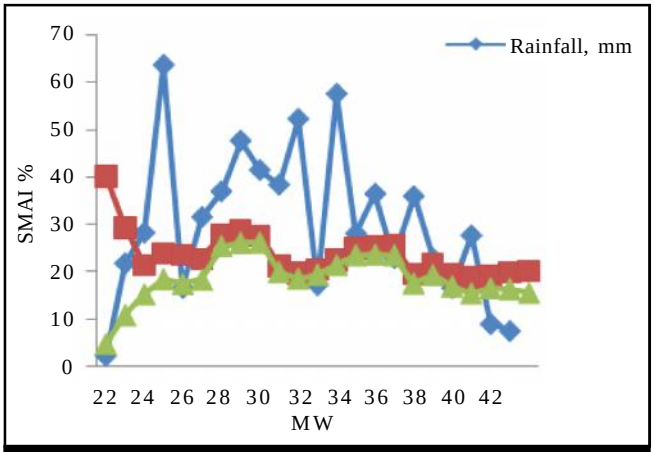

Fig. 1 : Weekly availability of moisture at Jamner in *Kharif*

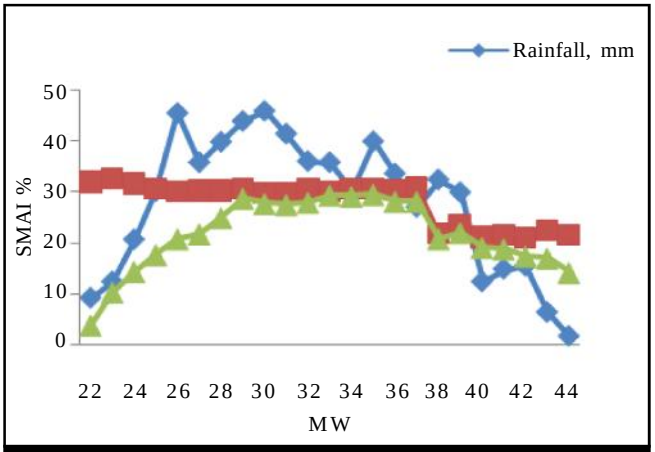

Fig. 3 : Weekly availability of moisture at Padalsare in *Kharif*

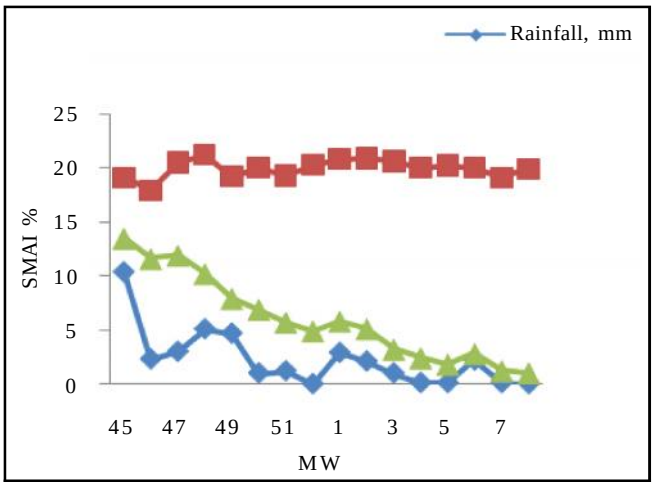

Fig. 2 : Weekly availability of moisture at Jamner in *Rabi*

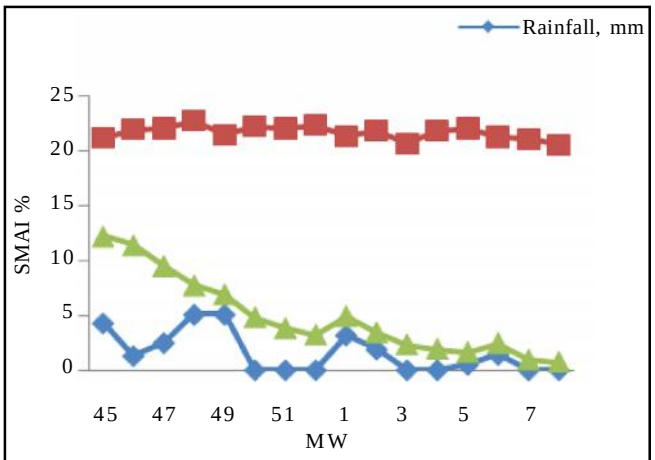

Fig. 4 : Weekly availability of moisture at Padalsare in *Rabi*

Conclusion:

The soil moisture adequacy index model (WATBAL) developed by Keig and McAlpine (1974) was used to work out index for Jamner and Padalsare stations. The 30 years (1989-2018) daily data of rainfall and evaporation were collected from surface water data center, Nashik. Using weekly data of rainfall and evaporation, WATBAL model determine the moisture adequacy index for above stations.

Results of the present study show that the maximum amount of water is available during 28th to 31st MW at both the stations. It is essential for crop growth and maximizing the yield. The soil moisture adequacy index plays an important in crop planning of the season.

The important conclusion drawn from the above study is that rainfall occurs from 23rd MW and built up 26th MW at all the stations. At both the stations, required amount of water is not found in *Rabi* season. The soil moisture adequacy index and water balance study is important crop planning and disseminating drought information.

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