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Phenophasic and Seasonal Water Requirement of Major Kharif Crops in Different Agroclimatic Zones of Gujarat State*

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ABSTRACT

The average seasonal water requirements for pearlmillet ranges from 292 to 336 mm, for sorghum crop 329 to 380, for groundnut 347 to 402, for cotton 603 to 666 and for rice 606 to 625 mm at seven agricultural research stations representing five different agroclimatic zones of Gujarat State. The reference crop evapotranspiration was estimated by using Radiation method. The water requirement values for the crops was found to be the lowest at Junagadh in South Saurashtra and the highest at Sardar Krushinagar in North Gujarat agroclimatic zones. Water requirement for each growth stage of the crops are also estimated and discussed.

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INTRODUCTION

The water requirements during the crop growth period in any given season and region is useful for day to day work on the farm and enable the soil moisture deficit to be kept within acceptable limits. The pattern of crop water requirement is essential to make the best use of the available rainfall.

A wide range of crops as diverse as pearlmillet to rice are generally taken up in all the agroclimatic zones of the Gujarat State. However, the agroclimatic information especially in the format useful for improving the cropping pattern and developing production technology is lacking. Keeping these points in view, seasonal water requirement of the major kharif crops with particular reference to phenological stages were computed and presented in this paper.

MATERIALS AND METHODS

Daily meteorological data between 1958 to 1989 recorded at agrometeorological observatories in respect of seven agricultural research stations representing five agroclimatic zones of the Gujarat State (Fig. 1) have been utilized in this study. Reference crop evapotranspiration (ETo) was computed by using Radiation method (Doorenbos and Pruitt, 1979) as follows :

$$ETo = C\ (W.\ Rs.)\ mm/Day$$

Where ETo = Reference crop evapotranspiration in mm/day

Rs = Solar radiation equivalent to evaporation in mm/day

W = Weighting factor reflecting the effect of temperature and altitude of the station

C = Is the adjustment factor reflecting the effects of mean relative humidity and day time wind at 2 m height above the soil surface.

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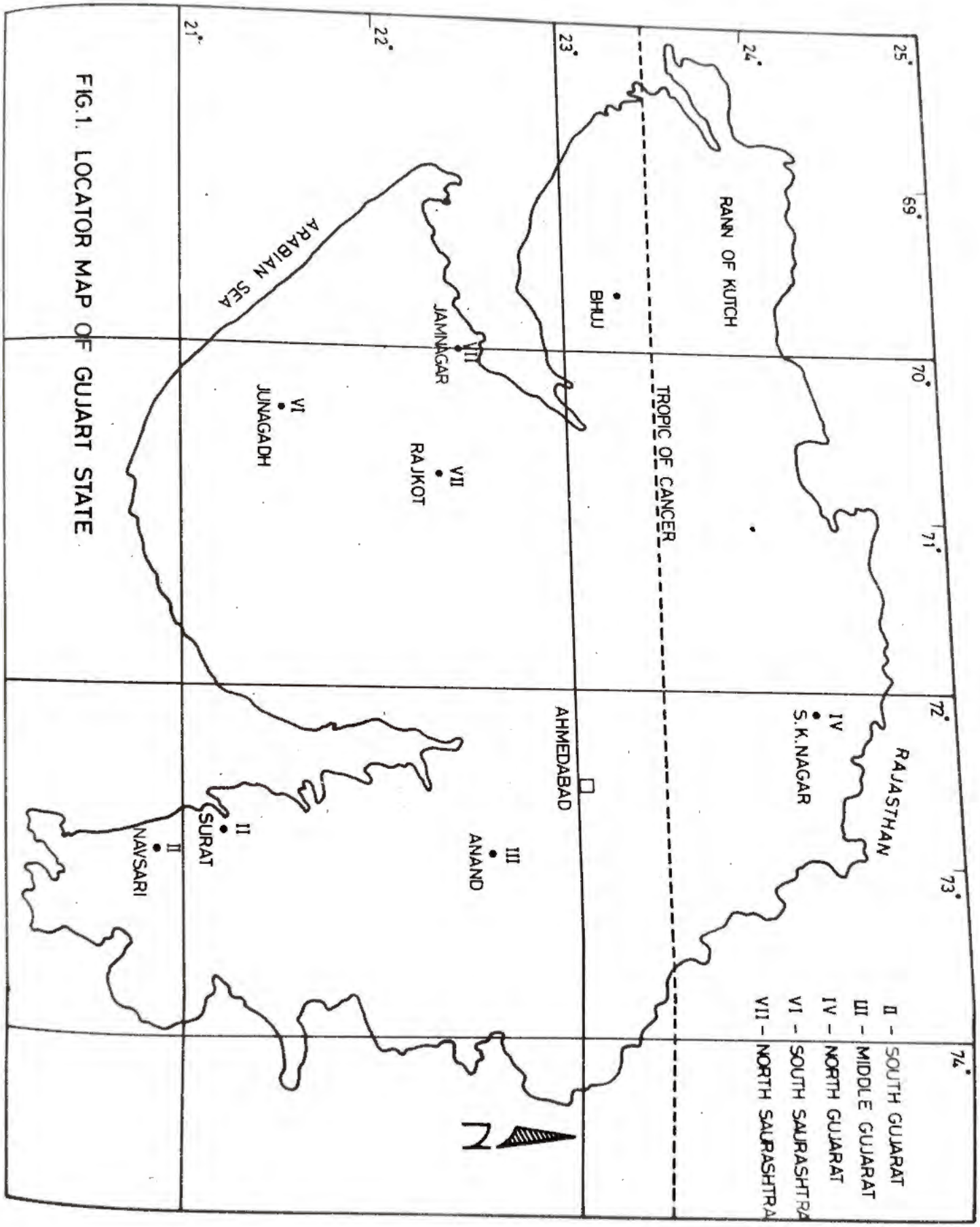

FIG.1. LOCATOR MAP OF GUJART STATE

FIG-1

Solar radiation (Rs) values were estimated by using the relationship, Rs.=Ra (0.42 + 0.30 n/N).

The weekly crop coefficients for individual crops except sorghum (Rathore, 1986) were adopted from Doorenbos and Kassam (1986). The water requirement of each crop for all the seven stations were computed on weekly basis for individual years. These weekly values were used to estimate water requirement for individual growth phases and for the whole season.

The crop life period for pearlmillet, sorghum, groundnut, rice and cotton was considered as 13, 14, 16, 16 and 22 weeks at all the stations.

RESULTS AND DISCUSSION

Rainfall and water requirement during cropping season

The total amount of precipitation received during the length of growing season and water requirements for each crop and for each kharif season was worked out and the average values for individual crops at each station are estimated and the average values for individual crops at each station are presented in Table 1. The choice of the starting period for accumulation of rainfall was based on the method proposed by Frere and Popov (1979) namely; the week at the beginning of the monsoon season when rainfall exceeded the estimated water requirement of the particular crop under consideration.

It is seen from the Table that the average rainfall corresponding to different cropping seasons was different, for example, for pearlmillet crop it ranged from 460 mm at Rajkot to 722 mm at Junagadh. This reflects a wide variation in seasonal rainfall in different agroclimatic zones of Guarat State.

The coefficient of variation of rainfall in the crop periods was higher of the order of 44 to 53% at Rajkot and Junagadh stations followed by Jamnagar, Anand and Surat (37 to 43%). At S. K. Nagar station both the seasonal rainfall and the CV were the lowest (18 to 23%) signifying relatively higher reliability of a low amount of rainfall at the station.

A similar trend in case of water requirement of crops was observed even though the duration of crops at different stations was considered same. The seasonal crop water requirements for pearlmillet ranges from 292 to 336 mm at different stations. Of all the stations considered, the water requirement for the four crops studied are the lowest at Junagadh station and at SK Nagar in North Gujarat region, the requirements are the highest. The seasonal water requirements reported here for pearmillet, sorghum and groundnut crops are lower than those estimated by Raheja (1961) and Gopani(1963) for Gujarat State. The differences are attributable to the fact that they employed pan-evaporation or penman methods for this purpose, which was found to give over estimation in some regions. For sorghum (Rathore, 1989), groundnut (Reddy, 1988), for cotton (Kaliappa *et al.*, 1974 and Doorenbos and Pruitt, 1979) at different localities reported values in the range commensurate with the values obtained in the present investigation.

The average seasonal rainfall exceeded the mean water requirement of crops at all the stations except for cotton at Jamnagar and Rajkot.

Phenophasic water requirement of kharif crops

Water requirement for each growth stage of the crops under study for seven stations are presented in Table 2. The duration of the crop phase and the crop coefficient for the phase being same for a crop at all the stations, the water requirement values were found to differ at different stations. For example, for sorghum crop, the water requirement for 2 weeks duration of sowing and establishment stage (i.e. stage I) ranged from 38 mm at Junagadh to 43 mm at

TABLE 1

Mean seasonal rainfall (mm) and water requirement (mm) for major kharif crops in Gujarat State.

Station	Pearlmillet		Sorghum		Groundnut		Cotton		Rice	
	Rainfall	WR	Rainfall	WR	Rainfall	WR	Rainfall	WR	Rainfall	WR
Anand	701	312	724	355	696	372	777	623	755	608
	(40)	(15)	(41)	(9)	(37)	(8)	(43)	(6)	(42)	(7)
Jamnagar	524	332	542	375	544	394	553	666	---	---
	(39)	(9)	(41)	(1)	(40)	(1)	(42)	(1)		
Junagadh	722	292	743	329	765	347	910	603	---	---
	(44)	(4)	(44)	(4)	(44)	(4)	(52)	(4)		
Navsari	---	---	1337	357	1471	372	1485	628	1471	606
			(23)	(5)	(33)	(4)	(37)	(5)	(33)	(6)
Rajkot	460	328	501	370	491	386	592	662	---	---
	(46)	(9)	(47)	(10)	(47)	(9)	(53)	(9)		
SK Nagar	474	336	487	380	504	402	---	---	---	---
	(18)	(8)	(23)	(7)	(22)	(6)				
Surat	---	---	1079	370	1123	388	1138	635	1122	625
			(40)	(1)	(39)	(2)	(38)	(1)	(38)	(2)

CV % is shown in paranthesis, WR = Water requirement.

TABLE 2

Mean phenqphasic water requirements (mm) of major kharif crops in Gujarat State.

Station	*Pearlmillet*				*Sorghum*				*Rice*		
	I	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*	*I*	*II*	*III*
Anand	40	105	60	107	40	74	125	116	381	80	147
	(15)	(16)	(16)	(10)	(15)	(16)	(14)	(11)	(8)	(11)	(8)
Jamnagar	43	109	66	114	43	77	130	125			
	(9)	(4)	(7)	(4)	(7)	(5)	(5)	(2)			
Junagadh	38	96	60	98	38	67	117	107			
	(12)	(7)	(7)	(5)	(11)	(8)	(5)	(5)			
Navsari	---	---	---	---	42	75	127	113	385	75	146
					(10)	(7)	(8)	(4)	(6)	(5)	(8)
Rajkot	43	109	64	112	43	77	128	122			
	(11)	(10)	(14)	(9)	(11)	(11)	(12)	(10)			
SK Nagar	41	103	71	121	41	71	139	129			
	(12)	(11)	(16)	(10)	(12)	(12)	(14)	(7)			
Surat	---	---	---	---	39	75	137	120	402	81	142
					(15)	(4)	(1)	(2)	(2)	(3)	(3)

TABLE -2 **(Contd.)**

Station	Groundnut				Cotton				
	I	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*	*V*
Anand	81	99	94	98	29	90	340	136	28
	(15)	(15)	(13)	(9)	(11)	(27)	(7)	(8)	(10)
Jamnagar	82	103	103	106	29	89	377	141	30
	(4)	(4)	(4)	(2)	(6)	(4)	(1)	(2)	(1)
Junagadh	72	94	86	95	26	77	329	139	32
	(8)	(5)	(6)	(7)	(9)	(6)	(5)	(6)	(9)
Navsari	79	101	92	100	28	84	348	138	39
	(7)	(8)	(6)	(8)	(11)	(13)	(4)	(9)	(16)
Rajkot	82	102	98	104	30	87	369	145	31
	(11)	(11)	(11)	(12)	(13)	(12)	(10)	(9)	(4)
SK Nagar	81	106	105	110	---	---	---	---	---
	(10)	(12)	(12)	(6)	---	---	---	---	---
Surat	82	108	100	98	29	90	361	129	26
	(3)	(2)	(2)	(2)	(7)	(2)	(2)	(2)	(3)

Rajkot. The similar trend can be observed for other stages and for other crops also. The values were comparatively less for the stations like Anand, Surat, Navsari and Junagadh because the seasonal rainfall in these stations were higher (Table 1) as compared to other stations like Jamnagar, Rajkot and SK Nagar. The coefficient of variation worked out considering the water requirement at individual growth stage of different crops show that, generally it is of the order of 10 to 15 per cent. The CV at Surat station is the lowest, while it is highest at the Anand station. Thus the water requirement and the rainfall pattern during the growth period of the crops will help in planning the cropping pattern of a region.

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