MAUSAM, **53**, 2 (April 2002), 127-132

551.5 : 63

A study of agrometeorological parameters for the Kharif maize at Anand (Gujarat)

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(*Received 5 November 1998, Modified 26 September 2001*)

सार - इस शोध-पत्र में आनंद (गुजरात) में वर्ष 1989, 1990 और 1991 की अवधि में खरीफ की फसल में मक्का की उपज के दौरान पाई गई विभिन्न ऋतु जैविक अवस्थाओं में वाष्पीकरण, वाष्पन-वाष्पोत्सर्जन तथा संभाव्य वाष्पन-वाष्पोत्सर्जन के व्यवहार पर अध्ययन किया गया है। यह देखा गया है कि फसल में दाना तैयार होने की अवस्था के दौरान वाष्पन-वाष्पोत्सर्जन और संभाव्य वाष्पन-वाष्पोत्सर्जन अधिकतम होता है तथा फसल की कटाई के दौरान फसल से संबंधित सापेक्षिक वाष्पन-वाष्पोत्सर्जन न्यूनतम पाया गया है। फसल की ऋतु में यह मात्रा 0.84 पाई गई है। इस शोध-पत्र में संभाव्य वाष्पन-वाष्पोत्सर्जन और सापेक्षिक वाष्पन-वाष्पोत्सर्जन का आकलन करने के लिए समाश्रयण निदर्शों को विकसित करने का प्रयास किया गया है।

ABSTRACT. A study was conducted on the behaviour of evaporation, evapotranspiration and potential evapotranspiration in different phenological phases, during the years 1989, 1990 and 1991 for Kharif Maize crop at Anand (Gujarat). It has been noticed that evapotranspiration and potential evapotranspiration attained maximum values in grain phase. In harvesting phase relative evapotranspiration and crop coefficient had lowest values. The seasonal crop coefficient was obtained 0.84. An attempt has been made in this paper to develop the regression models to estimate potential evapotranspiration and relative evapotranspiration.

Key words – Maize, Evapotranspiration, Potential evapotranspiration, Relative evapotranspiration, Leaf area index.

1. Introduction

Maize [*Zea mays* L.] is reported to grow well in the regions where the natural vegetation is of tall grasses. This shows a preference of the crop for a high soil water status. Because of lack of photo-respiration, maize is one of the best trappers of solar radiation under good moisture supply. It is also suited for maximisation of yield in assured rainfall zones where it can be sown to an initial high population density and thinned in mid - season for harvesting green cobs. The availability of short duration hybrids have increased the versatility and potential of maize being fitted into a wide variety of cropping practices and rainfall situations.

Evaporation (EP), Evapotranspiration (ET), Relative Evapotranspiration (RET = ET/EP), Potential Evapotranspiration (PET) and Crop Coefficient (KC = ET/PET) in relation to different phonological phases of kharif maize crop [Variety - Ganga Saphed 2] for the years 1989, 1990 and 1991 were studied from the data generated at Auxiliary Evapotranspiration (AET) Observatory, situated in Gujarat Agricultural University, Anand [Lat 22° 35′ N Long.72° 55′ E] in Gujarat State. During the course of study, Leaf Area Indices [LAI] and Leaf Area Duration [LAD] have also been computed. An attempt has been made in this paper to develop the regression models to estimate PET and RET.

2. Materials and methods

2.1. ET data were recorded daily at 0730 hours IST, from the gravimetric lysimeters, installed at AET observatory, Anand. Care had been taken to ensure that there was (*i*) maize of the same variety, stand and age for the lysimeter crop, (*ii*) no non-cropped area around the lysimeters, (*iii*) proper alignment of the field and tank rows, (*iv*) no difference in cultural treatments between the lysimeters and field crop. The spacing adopted was 60 cm between rows and 20 cm between plants in rows.

2.2. The soil at Anand is sandy loam, alluvial in origin belonging to Entisols [type : Ustorthents] having Nitrogen 1090 kg/ha, pH 7.75 and Bulk density

TABLE 1

Kharif maize (Variety - Ganga Saphed 2) at Anand (Gujarat)

	1989		1990		1991	
	Lysimeter		Lysimeter		Lysimeter	
	L1	L2	L1	L2	L1	L2
Date of sowing	11 July '89	11 July '89	7 July '90	7 July '90	22 July '91	22 July '91
Date of harvesting	11 Oct '89	11 Oct '89	8 Oct '90	8 Oct '90	3 Nov '91	3 Nov '91
Irrigation(mm)	30	30	0	0	177	192
Rain (mm) (During crop season)	508.5		1078.8		565.5	
Total of weekly mean relative humidity = Σ RH	1059.71		1177.45		1106.43	
Grain yield (Average from L1 &L2)	4749.0 (kg/ha)		6553.0 (kg/ha)		5286.0 (kg/ha)	
Total ET (mm) = Σ ET	466.2		451.4		517.6	
Total PET (mm) = Σ PET	550.6		549.9		612.1	
Total EP (mm) = Σ EP	439.3		406.3		487.3	
Seasonal mean RET = Σ ET/ Σ EP	1.06		1.11		1.06	
Seasonal mean KC = Σ ET/ Σ PET	0.85		0.82		0.85	

1.5 gm/cm^3. The crop durations were 93, 94 and 105 days in the years 1989, 1990 and 1991 respectively. For all these three years the basal dose of 16gms of Diammonium phosphate [N:P:K = 20: 50: 0 kg/ha] was applied in each lysimeter. For top dressing 10 gms of urea was applied in each lysimeter at 26, 16 and 35 days after sowing in the years 1989, 1990 and 1991 respectively.

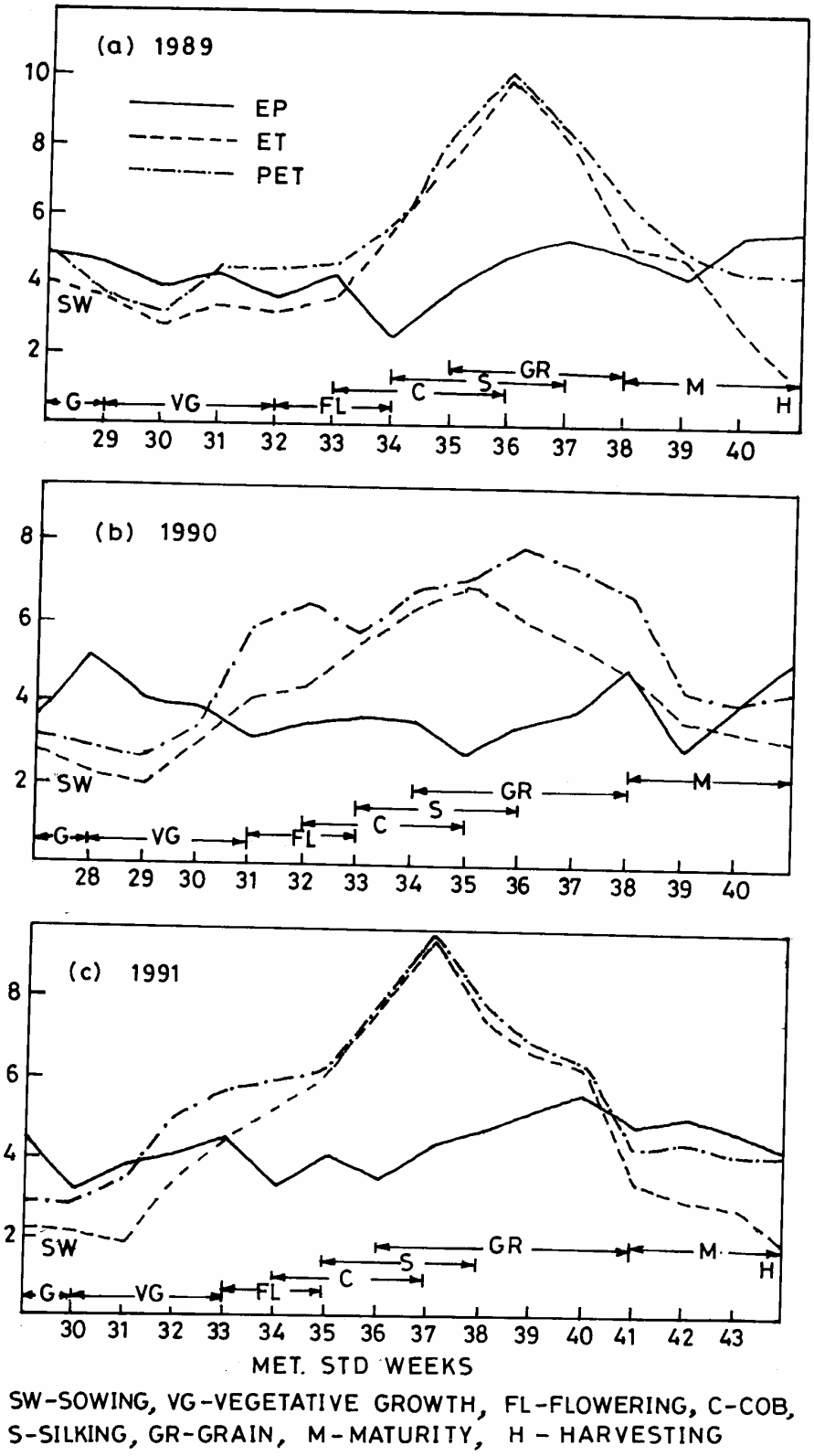
2.3. The values of Pan Evaporation (EP) and Rainfall (RFL) were recorded daily at 0830 hours IST. The other meteorological data were recorded daily at 0700 and 1400 hours LMT. The Leaf Area Indices (LAI) were computed once in a week. The values of PET were computed by Penman's method.

2.4. The correlation coefficients [CC] were computed between the weekly means of EP, ET, PET, RET, LAI and the weekly means of other meteorological parameters. The statistical significance at 5% level of highest cc, obtained for all the parameters, was tested by applying r^2 [r = regression coefficient] test. Only those parameters, satisfying this criteria were retained for further studies. The details of sowing, harvesting, irrigation, rain, grain yield, Σ RH (RH = Weekly mean of mean relative humidity), Σ EP, Σ ET, Σ PET, seasonal mean RET, seasonal KC are indicated in Table 1. The values of EP, ET and PET in different phenological phases for the years 1989, 1990 and 1991 are shown in Fig. l. In Table 2, the values of RET and KC at the exit of different phenological phases for the years 1989, 1990 and 1991 are shown. The relation between (*i*) ET and PET (*ii*) LAI and RET are indicated in Figs. 2 and 3 respectively.

3. Results and discussions

3.1. *Evapotranspiration (ET), Potential evapotranspiration (PET) and Evaporation (EP)*

From Fig. 1, it is noticed that ET and PET decrease from sowing phase to the emergence of vegetative growth phase. From vegetative growth phase, both ET and PET start increasing in flowering phase, cob phase, silking phase and finally attain maximum values grain phase. The high values of ET (9.37mm) and PET (9.55 mm) in 1991 are also affected by high value of hours of bright sunshine (10. 5). Thus ET and PET have



Figs. 1(a-c). Weekly mean of EP, ET and PET

TABLE 2

Relative evapotranspiration (RET = ET/EP) and crop coefficient (KC = ET/PET) at the exit of different phenological phases for kharif maize at Anand (Gujarat)

Exit of phenological phase	1989		1990		1991	
	RET	KC	RET	KC	RET	KC
Germination	0.78	0.98	0.84	0.78	0.67	0.79
Vegetative growth	0.89	0.76	0.96	0.70	0.99	0.76
Flowering	1.99	0.99	1.49	0.96	1.49	0.99
Cob	2.05	0.99	2.57	0.98	2.17	0.98
Silking	1.54	0.98	1.75	0.78	1.59	0.95
Grain	1.04	0.81	0.98	0.71	0.70	0.79
Harvesting	0.22	0.68	0.63	0.53	0.45	0.59

higher values in the 8th week after sowing. From the emergence of maturity phase till harvesting phase, ET and PET start decreasing.

EP is maximum in harvesting phase. However, a high value of EP (554 mm) is recorded in grain phase in the year 1991 due to high value of hours of bright sunshine (10.11) in that period. EP is minimum in cob phase. However in the year 1991, a lowest value of EP (3.21 mm) has been recorded in germination phase, due to least value of hours of bright sunshine (0.90) during that period.

3.2. *Relative evapotranspiration (RET) = ET/EP and crop coefficient (KC) = ET /PET*

From Table 2, it is observed that the values of RET have increased from germination phase to vegetative growth phase. However, in the same period, KC values have decreased. RET values then start increasing in flowering phase and attain maximum value at the end of cob phase. KC values also start increasing in flowering phase and remain almost constant till the end of cob phase. Both RET and KC, start decreasing from silking phase. This fall continues in grain phase and finally, both RET and KC attain least values at the exit of harvesting phase. The seasonal mean relative evapotranspiration for the years 1989, 1990 and 1991 is 1.08. The seasonal mean crop coefficient for these years has been computed as 0.84.

3.3. *Relation between evapotranspiration (ET) and potential evapotranspiration (PET)*

By analysing the weekly mean values of ET and PET, the correlation coefficient (cc) between them was found to be 0.98. The regression equation has been obtained as

$$Yi = 0.5774 + 1.0238\ (Xi) \qquad (1)$$

where,

Yi = Estimated value of PET in the i^{th} week.

Xi = Observed value of ET in the i^{th} week.

The relation between ET and PET has been shown in Fig. 2.

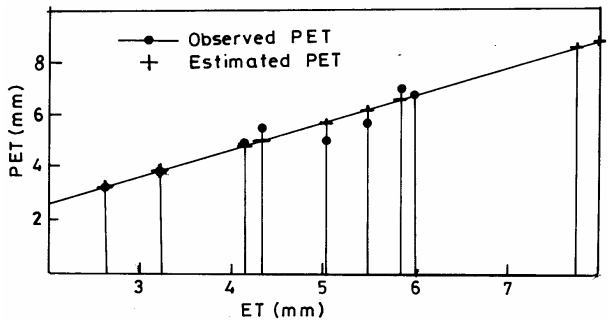


Fig. 2. Relation between ET and PET

3.4. *Leaf area index (LAI) and RET*

The ratio between the area of the surface of given leaves and ground area covered is referred as Leaf Area

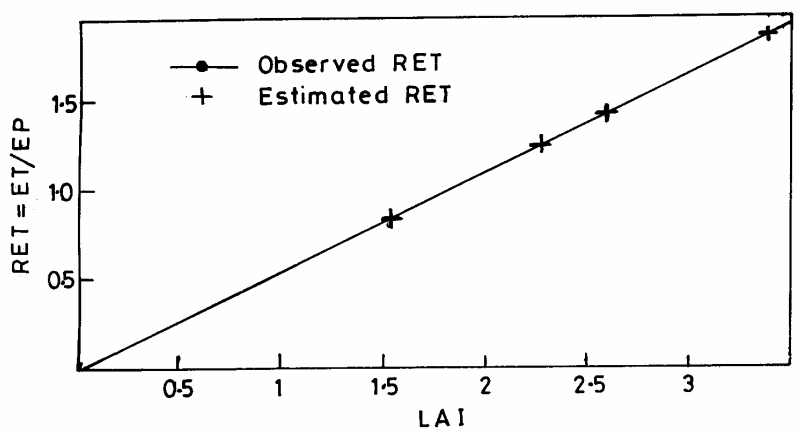


Fig. 3. Relation between LAI and RET

Index. The growth form of maize is such that the optimum LAI is obtained very early in its life cycle and maintained till harvest. It is noticed that the average of weekly values of LAI for the years 1989, 1990 and 1991 reduced from 3.39 to 2.60 in flowering to cob phase.

In grain phase, this value still reduced to 2.28 and finally reaching to 1.55 in maturity phase. The average of weekly values of RET for the years 1989, 1990 and 1991, during flowering, cob, grain and maturity phases of maize have been calculated as 1.87, 1.47, 1.25 and 0.84 respectively.

A one to one correspondence has been noticed between LAI and RET. The CC between them is found as 0.99. Thus the regression equation has been obtained as

$$Yi = 0.0250 + 0.5632\ (Xi) \qquad (2)$$

where,

Yi = Estimated value of RET in the i^{th} week.

Xi = Observed value of LAI in the i^{th} week.

The relation between LAI and RET has been shown in Fig. 3.

3.5. *Leaf area duration (LAD)*

LAD is the measure of the ability of the plant to produce and maintain Leaf Area. LAD is expressed in days or weeks.

$$LAD = LAI \times M$$

where

LAI = Mean Leaf Area Index

M = Number of weeks in the crop growth period/season.

The mean LAI's for the years 1989, 1990 and 1991 have been computed as 2.74, 2.24 and 2.26 respectively. The number of weeks in the crop growth period for these 3 years are 3 each respectively. Hence LADs for the years 1989, 1990 and 1991 are 8,7 and 7 weeks respectively. The mean approximate value of LAD is 8 weeks.

3.6. *Yield*

From Table 1 it is observed that the crop sown in the year 1990 produced the highest yield (6553 kg/ha) followed by 1991 (5386 kg/ha) and 1989 (4749 kg/ha) sown crops. This may be due to early sowing of crop, early application of urea for top dressing and higher rainfall in that year as compared to the other two years.

4. Conclusions

(*i*) ET and PET start increasing in flowering phase and attain maximum values in grain phase.

(*ii*) RET and KC have minimum values in harvesting phase.

(*iii*) The seasonal crop coefficient for kharif maize crop is 0.84.

(*iv*) PET can be estimated with the knowledge of ET.

(*v*) RET can be obtained if LAI is known.

(*vi*) LAD for kharif maize crop is 8 weeks.

(*vii*) Early sowing of the crop, early application of urea for top dressing and higher rainfall increase the grain yield.

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