551.573 : 551.579.5 : 633.17/.18

WATER USE MODELLING OF PEARL MILLET

Plants respond to the tune of weather. The response changes gradually during the growth periods of annual crops, but the process is the function of biometeorological time (Robertson 1977). Such functional relationship is worked out by many workers [Baier (1973), Lomas (1976)]. The information on soil moisture availability and the root zone activity pertaining to varied crops are available [Peck *et al.* (1958), Baier (1969), Sarma & Ghildiyal (1977), Russell (1980), Ramana Rao *et al.* (1983)]. Similarly the vital functions of a crop can be identified through evapotranspiration (ET) [Hillel *et al.* (1969), Raghavendra Rao (1971), Kadam *et al.* (1978), Baier (1977, 1979)]. Such crop weather relations are under investigation through crop-weather modelling. However, Stanely *et al.* (1981) inferred that the ability to simulate the crop phenophase trends under the non-limiting soil moisture potential is an important component in the development of realistic models.

The investigation is made at Agricultural Research Station, Perumallapalli (Tirupati) of Andhra Pradesh Agricultural University. The period of investigation is considered into four separable crop phenophases : (*i*) seedling, (*ii*) vegetative, (*iii*) reproductive and (*iv*) maturity, during kharif 1978-79. The soil moisture estimates are made by gravimetric method at four depths of 10, 20, 30 and 40 cm among pearl millet field. Simultaneously the readings on weather elements such as, air and soil temperatures, open pan evaporation, relative humidity total sunshine hours and wind speed are recorded.

Diurnal ET of pearl millet is estimated from the data thus obtained. Multiple regression models of pearl millet ET and its prediction with the weather parameters are tried by computer means. Out of the four models, the model pertaining to vegetative phase of pearl millet had a significant correlation ($r = 0.57$). The correlation coefficient values (r) attempted for all the models and the ranges of the weather elements used in the analysis are furnished in the Table 1. The reason for the said behaviour of the results might be due to poor soil moisture retentivity and high atmospheric evaporative demand. But in case of vegetative phase the self mulching action of the crop could mask the high evaporation (EO) demand of the atmosphere. In addition to the crop morphological modifications could increase the root catchment area during moisture stress condition [Peck (1958), Baier (1969, 1977), Raghavendra Rao (1971), Sarma & Ghildiyal (1977), Kadam *et al.* (1978), Russell (1980) and Ramana Rao (1983)]. On the whole the inadequate moisture condition of pearl millet environment might be the possible reason to obtain the poor fit values among the models except at vegetative phase.

To examine the possibility in improving the ET models from the available data, stepwise multiple regression is used to eliminate the weather elements which had poor relation with the process of ET. The results of Table 2 indicating the seedling phase of pearl millet had shown a trend of positive relation as noticed in steps III, IV and V. But in vegetative phase similar trends could be observed among all the steps except in step II. However, step IV and V had given high correlation coefficient values ($r = 0.70$ and 0.75). During the reproductive phase similar trend is continued except in step III. At maturity phase the inclination of positive trend is there among the steps, II, III and IV.

On examination the results indicate that in general where there is high rate of ET there its relation with weather elements is more pronounced and identified as noticed in the case of vegetative and reproductive phases of pearl millet. This phenomenon may be due to considerable morphological changes and the speed of crop cover involving intense physiological activity of the crop. However, a high positive relation is observed with the weather elements such as (*i*) Relative humidity, wind speed and total sunshine hours, and (*ii*) wind speed and total sunshine hours compared with the other combinations.

TABLE 1

Ranges of parameters for the pearl millet phenophases, 1978-79

Phases	Evapo-transpiration Y_1 (mm)	Air temperature X_1(°C)	Soil temperature X_2(°C)	Pan evaporation X_3(mm)	Relative humidity X_4 (%)	Wind velocity X_5(km/day)	Total sunshine X_6(hr)
Seedling	3.2-3.4 (r=0.24)	28.0-30.5	27.7-30.2	1.7-11.3	71-92	8.7-28.6	7.7-11.5
Vegetative	4.0-1.9 (r=0.57)	27.0-30.5	30.0-34.0	3.1-12.3	77-92	7.2-19.5	0.0-10.4
Reproductive	2.5-2.5 (r=0.33)	26.0-32.5	29.0-31.1	3.5-11.5	78-93	8.5-20.1	1.9-10.7
Maturity	2.6-2.2 (r=0.19)	26.0-29.8	27.7-33.0	4.8-10.0	78-93	4.5-17.4	0.6-10.5

TABLE 2

Stepwise multiple regression results

Step	Variables	*r* value
	I. Seedling phase	
I	AT, ST, EO, RH, WS, SSH	0.47
II	ST, EO, RH, WS, SSH	0.40
III	EO, RH, WS, SSH	0.57
IV	RH, WS, SSH	0.55
V	WS, SSH	0.52
	II. Vegetative phase	
I	AT, ST, EO, RH, WS, SSH	0.64
II	ST, EO, RH, WS, SSH	0.46
III	EO, RH, WS, SSH	0.58
IV	RH, WS, SSH	0.70
V	WS, SSH	0.75
	III. Reproductive phase	
I	AT, ST, EO, RH, WS, SSH	0.71
II	ST, EO, RH, WS, SSH	0.71
III	EO, RH, WS, SSH	0.33
IV	RH, WS, SSH	0.70
V	WS, SSH	6.67
	IV. Maturity phase	
I	AT, ST, EO, RH, WS, SSH	0.34
II	ST, EO, RH, WS, SSH	0.50
III	EO, RH, WS, SSH	0.51
IV	RH, WS, SSH	0.50
V	WS, SSH	0.46

AT : Air mean temperature **ST** : Soil mean temperature
EO : Pan evaporation **RH** : Relative humidity
WS : Windspeed **SSH**: Total sunshine hours

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