551.573 : 633.18 : 631.5

STUDIES ON EVAPOTRANSPIRATION AND CROP COEFFICIENTS OF DIFFERENT DURATIONS OF RICE FOR SUSTAINABLE CROP GROWTH

1. Water is a limiting factor in the expansion of irrigation areas (Erie *et al.* 1981) and for efficient irrigation water management, a knowledge of the water requirement, in general and evapotranspirational losses, in particular is vital (Tripathi *et al.* 1987), especially in Chhattisgarh region of Central India, where the irrigation is very limited and it is dependent on the rainfall in the catchment area. In Chhattisgarh region of Madhya Pradesh, rice is the predominant crop and different varietal recommendations are made for different soil types, like early duration varieties for light soils and uplands, medium duration varieties for medium soils and late maturity varieties for lowlands and heavy soils.

1.1. Accurate measurement of evapotranspiration helps in managing water for irrigation and developing sound agronomic and irrigation practices too (Tomar and O'Toole 1980). However, measurement of evapotranspiration by lysimeters is a cumbersome process. Based on the need and other objectives, several researchers designed various kinds and sizes of lysimeters to measure the ET rates of different crops (McIlroy and Summer 1961, Denmead *et al.* 1966, Namker *et al.* 1978). In India, volumetric lysimeters are used for measuring the evapotranspiration of rice and irrigated crops (Venkatraman 1961).

2. The non-weighing lysimeters (volumetric) used in the present study were designed by India Meteorological Department. Two field tanks of size 1.2 × 1.2 × 0.9 m are sunk in the middle of a well- exposed field of size 60 × 40 m. Evapotranspiration of rice crop during different years was measured daily at 0730 hr (IST) and weekly totals were worked out. In the study period of 14-years, rice genotypes of three different maturity groups were taken under irrigated conditions. Correlation coefficients were worked out between weekly ET values during different years with corresponding weekly averages of some important weather parameters.

TABLE 1

Pattern of weekly ET, EP and crop coefficients of (ET/EP) rice crop of different durations

Week No. from sowing	Rice Crop duration								
	Early			Medium			Late		
	ET (mm)	EP (mm)	ET/EP	ET (mm)	EP (mm)	ET/EP	ET (mm)	EP (mm)	ET/EP
1.	18.2	21.2	0.86	22.4	17.6	1.27	16.9	23.2	0.73
2.	25.7	26.8	0.96	36.7	28.6	1.20	41.7	27.3	1.52
3.	32.5	30.9	1.05	31.4	22.6	1.38	41.7	24.0	1.73
4.	28.5	20.8	1.37	36.7	24.8	1.47	43.4	22.1	1.95
5.	33.6	21.6	1.55	38.0	24.9	1.52	36.4	21.9	1.66
6.	43.2	28.2	1.53	40.6	26.5	1.53	30.7	21.2	1.45
7.	41.1	28.6	1.43	44.9	24.9	1.80	39.4	24.7	1.59
8.	44.7	31.7	1.41	45.7	26.4	1.73	36.0	22.0	1.63
9.	43.3	31.4	1.38	43.4	26.5	1.63	36.0	26.7	1.35
10.	37.8	26.6	1.42	44.3	25.9	1.71	42.6	26.5	1.61
11.	38.5	27.9	1.37	45.3	27.0	1.68	36.3	28.2	1.28
12.	25.9	26.4	0.98	42.9	26.3	1.63	45.3	24.3	1.86
13.	24.3	25.5	0.95	40.5	26.3	1.54	44.5	25.2	1.76
14.	23.6	25.3	0.93	36.4	24.3	1.50	43.3	26.2	1.65
15.	-	-	-	30.6	22.3	1.37	45.3	22.1	2.00
16.	-	-	-	26.5	20.1	1.32	35.8	22.9	1.56
17.	-	-	-	20.6	21.8	0.94	34.2	20.5	1.66
18.	-	-	-	-	-	-	25.3	20.2	1.25
19.	-	-	-	-	-	-	24.2	22.2	1.09
20.	-	-	-	-	-	-	26.2	25.8	1.01
21.	-	-	-	-	-	-	24.8	22.5	1.10
Total	460.9	372.9	1.23	626.9	416.8	1.50	750.0	496.8	1.51

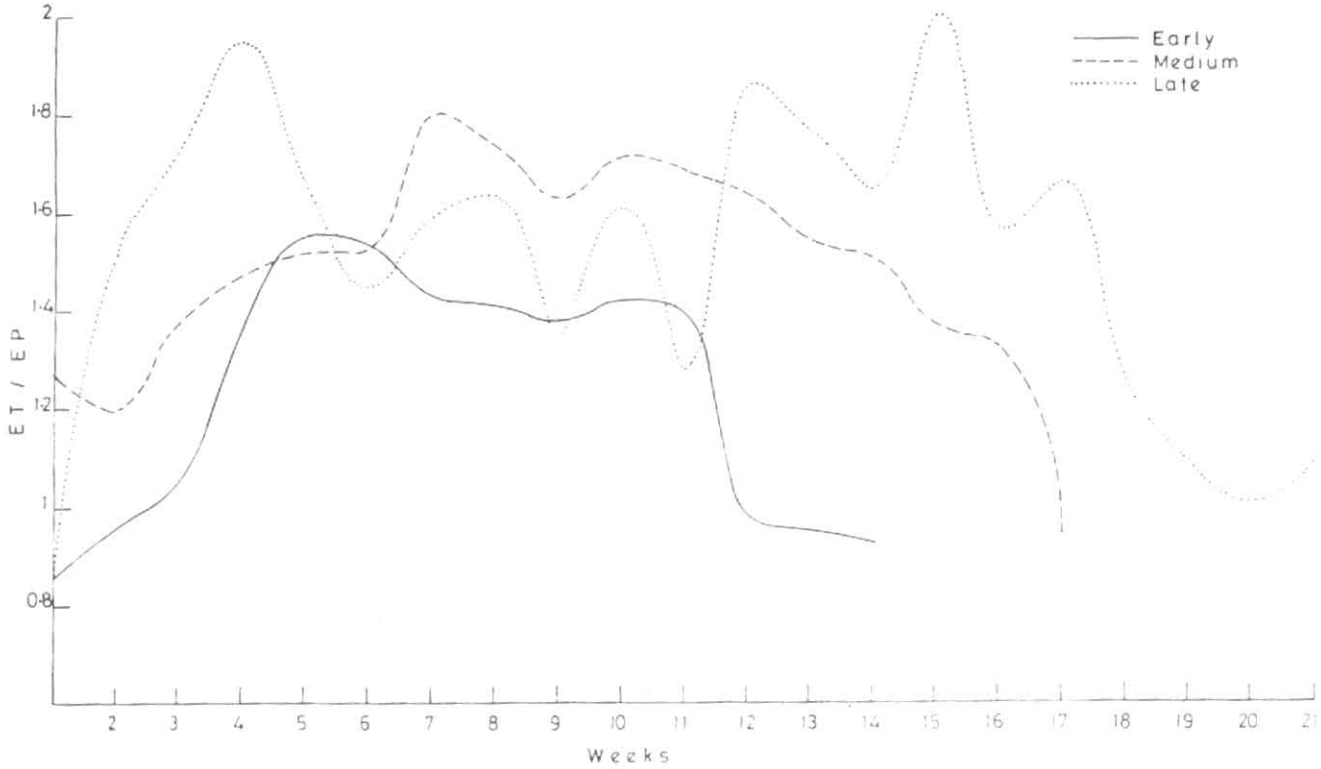

Fig. 1. Pattern of crop coefficients for rice genotypes of three different durations under Raipur conditions

3. The corresponding values of pan evaporation (EP) were also averaged for three different durations, *i.e.*, early, medium and late maturity varieties. The values of ET, EP and corresponding crop coefficients (ET/EP) for each of the weeks starting from sowing are shown in Table 1. It can be well observed that larger the duration of crop, greater are the evapotranspirational losses. The average crop coefficient values of these three groups of rice durations were worked out as shown in this table.

3.1. However, there was an inter-annual variability of these crop coefficient values. This clearly indicates that the evapotranspirational demand of the crop doesn't remain the same throughout the crop growing period and it fluctuates depending upon leaf surface area and its development and also on the vegetative/reproductive growth of the crop.

3.2. The weekly values of the crop coefficients in respect of early, medium and late maturity varieties are shown in Fig. 1. The peak values of the crop coefficients for all these varieties occurred during vegetative and reproductive stages. This indicates the higher water demand is at these stages which is true for most of the crops. The values of ET during 4 main crop growth stages, *viz.*, seedling (establishment), vegetative, reproductive and maturity stages and their corresponding duration at different growth stages were also worked out and are shown in Table 2.

TABLE 2

Evapotranspiration during major growth stages of rice of different durations

Crop stage	Early		Medium		Late	
	Duration (Weeks)	ET (mm)	Duration (Weeks)	ET (mm)	Duration (Weeks)	ET (mm)
Seedling (Establishment)	2	43.9	3	90.5	3	100.3
Vegetative	5	178.9	6	249.3	8	300.8
Reproductive	4	164.3	5	209.4	6	248.2
Maturity	3	73.8	3	77.7	4	100.7
Total	14	460.9	17	626.9	21	750.0

3.3. The ET values during reproductive stage varied from 164.3 mm for early duration, 209.4 mm for medium duration varieties to 248.2 mm for late duration varieties. The ET loss during maturity period is 73.8 mm for early, 77.7 mm for medium and 100.7 mm for late maturing varieties.

3.4. Based on the mean ET values for different duration of rice crop sown in June/July in conjunction with soil moisture holding condition and rainfall anticipated in coming weeks at or above 75% probability level, irrigations will be scheduled in the stress conditions. This can be done according to the water requirement of rice at crucial phenophase stages in a particular region. The weekly rainfall probabilities can be worked out at assured probability levels based on historic database of rainfall combined with weekly forecasts issued through National Centre for Medium Range Weather Forecasting (NCMRWF), New Delhi in which the quantum of daily rainfall alongwith the probabilities are specified. Based on this, crucial life saving irrigation scheduling can be planned on the basis of water reserves and water requirement in rice area on micro-regional basis.

3.5. Correlation coefficients were worked out between the weekly ET and corresponding weather parameters like maximum and minimum temperatures, wind speed, sunshine hours and pan evaporation for each year from 1979 to 1992. Evapotranspiration was significantly correlated with single or two weather parameters in few years. This infers that in some years depending upon the set of environmental conditions, only few weather parameters became significant. The significant correlations obtained in individual years were due to the fluctuation of weather parameters within critical limits. For example in 1980, ET was significantly correlated with minimum temperature and open pan evaporation because these factors fluctuate within critical limits. While in 1982 it was highly significantly correlated with pan evaporation because of only this factor being critical. This needs some more experimentations under control conditions keeping some of the factors constant.

4. The peak rates of evapotranspiration occur during the vegetative and reproductive stages. The ET values in most of the years did not correlate with different weather parameters indicating that these non-significant parameters were not in critical limits and subsequently different years have different sets of environmental conditions. These evapotranspiration studies will greatly help in determining the water requirement of crop and on this basis, the water reserves in a particular region can be efficiently utilized and life saving irrigations can well be planned.

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