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LYSIMETRIC ESTIMATION OF EVAPOTRANSPIRATION AND SCHEDULING IRRIGATION FOR COTTON

The crop factor (KC value) for winter irrigated cotton at Coimbatore was estimated with 10 years data on evapotranspiration (ET) from lysimeter and pan-evaporation data (PAN) from an open pan evaporimeter. The KC values were 0.81, 1.10 and 0.57 respectively for vegetative, flowering and bolling and harvest stages. The mean daily and monthly ET values were furnished for the crop period (August-January). A model on irrigation schedules based on weekly ET, rainfall anticipated at 50 per cent probability in conjunction with the net waterholding capacity of the soil was computed. The consumptive use of cotton was 616 mm including the contribution from the anticipated rainfall of 213 mm. The model is useful for scheduling irrigations in the winter combodia cotton tracts of Tamil Nadu.

2. The criteria of soil water availability alone may not be adequate in estimating the water needs of crops as the consumptive use of a crop depends on its growth characteristics and atmospheric parameters. A knowledge on the evapotranspiration (ET) would be useful in scheduling irrigation. Measurement of ET through lysimeters was more accurate and dependable (Misra and Ahmed 1987). The consumptive use of hybrid cotton in Maharashtra was 774 mm (Khade *et al.* 1988). An integrative approach of estimated ET with anticipated precipitation provided accurate irrigation requirement in the Delta Region of Missippi (Pote and Wax 1987). The values of crop factor (KC values) for cotton were reported to range from 0.22 to 0.95 during the vegetative phase, 0.96 to 1.93 during flowering and bolling period and 0.85 to 0.70 during the harvesting period (Misra and Ahmed 1987). The present study was taken up to compute the ET and crop factors for cotton during different phenophases from the data collected from lysimeter and to schedule irrigation with ET, soil water availability and anticipated rainfall at 50 per cent probability.

3. *Materials and methods*—The ET data were collected from a weighing type of lysimeter at Tamil Nadu Agricultural University, Coimbatore (11° N, 78°E, 427 m, m.s.l.) by the India Meteorological Department for a period of 10 years (1976-1986). The cotton varieties used were MCU-5 (5 years) and MCU-9 (5 years) with same duration and plant type. The values of crop factor were calculated from the daily ET data and open PAN evaporation (From USWB, A class open pan evaporimeter) for different growth phases of cotton and also for months (cropping period).

Based on the data on ET and PAN evaporation, a model to work out the water requirement of cotton in conjunction with soil moisture holding capacity and anticipated rainfall was projected as suggested by Misra and Ahmed (1987). The data on 50 per cent rainfall probability computed by Kulandaivelu and Kempuchetty (1980) were used. The soil type is red loam (field capacity 23% and permanent wilting point 11%) and net available water holding capacity is assumed to be 100 mm per metre depth. Depth of irrigation

(50 mm) was adopted as suggested by Khade *et al.* (1988).

The dates of sowing, harvest and total crop duration are furnished in Table 1.

4. *Results and discussion* — The crop coefficient value (KC) is taken as the ratio between crop ET and PAN evaporation. The KC values computed for different growth phases of the cotton crop are furnished in Table 2. There was an increase in KC values from vegetative to flowering and boll development period and declined during the harvesting stage. During the vegetative phase, the ET was 0.87 times of PAN because cotton being a slow growing crop, the foliage coverage was less and more soil surface area was exposed for solar radiation. Conversely, during the flowering and boll development period, the ground coverage by canopy was more than 90 per cent with increased leaf area for transpiration. In the harvest stage due to leaf senescence and fall the transpiration might have been reduced. The mean ET values during vegetative, flowering and harvesting periods were respectively 208, 292 and 116 mm.

The mean daily and monthly ET, PAN and KC values are furnished in the Table 3. The highest ET per day was observed during the month of September followed by August, whereas, the least was in the month of December. The PAN per day was the highest in the month of August and September. The lower PAN values from October to December was due to the prevalence of monsoonic weather with lower temperature and increased relative humidity.

Irrigations were scheduled based on the mean ET values for a cotton crop sown during middle of August in conjunction with soil moisture holding capacity and rainfall anticipated at 50 per cent probability level (Table 4). After life irrigation, based on the ET values and anticipated rainfall during the 33rd and 34th standard weeks of August, the crop requires irrigation only during the end of August (35th standard week). The anticipated rainfall during the 1st and 2nd week of September is very meagre and the ET is also high (72 mm). The crop requires irrigation at the beginning of 3rd week of September (38th standard week). During the flowering and boll development stage from 4th week of September (39th standard week) to 1st week of December (48th standard week) the crop requires only three irrigations as the quantity of rainfall is 185 mm which helps to maintain the soil moisture well below the level of 75 per cent depletion. The crop requires only one irrigation during the harvesting stage in the third week of December (51st standard week). In all the crop requires eight irrigations including the first and life irrigations. The consumptive use of water for winter cotton is worked out to be 616 mm and the contribution from rainfall is 213 mm and the balance of 400 mm has to be supplemented through irrigation.

Based on KC values, and when the PAN values are known which could be computed from climatological data, the ET of the crop can be calculated with the relationship ET=KC×PAN. From the ET and the anticipated rainfall the water requirement can be arrived at for a region.

TABLE 1

Total duration of the crop

	Variety	Date of sowing	Date of harvest	Duration (days)
(1)	MCU-5	17 Oct 75	30 Apr 76	194
(2)	,,	7 Oct 76	5 Apr 77	179
(3)	,,	8 Aug 77	20 Feb 78	195
(4)	,,	9 Aug 78	8 Feb 79	183
(5)	,,	6 Aug 79	26 Feb 80	204
(6)	MCU-9	8 Aug 81	15 Feb 82	191
(7)	,,	23 Aug 82	15 Mar 83	204
(8)	,,	27 Aug 83	6 Mar 84	191
(9)	,,	29 Sep 84	4 Apr 85	187
(10)	,,	23 Aug 85	10 Mar 86	198

TABLE 2

Crop coefficients, ET and PAN evaporation

Crop growth stages	Duration (days)	Total ET (mm)	Total PAN (mm)	KC= ET/ PAN	CV(%) ET	CV(%) PAN
Vegetative	0–42	208.2	256.2	0.81	35.5	39.5
Flowering and boll development	43–110	292.3	264.5	1.10	21.0	16.0
Picking	111–165	115.6	200.7	0.57	39.0	13.5

TABLE 3

Monthly ET, PAN and KC values

	ET (mm/ day)	PAN (mm/ day)	KC	PAN for the month (mm/ month)	ET (mm/ month)	CV(%) ET	CV(%) PAN
Aug	4.52	6.20	0.73	192.2	140.1	54.2	56.5
Sep	5.08	5.65	0.89	169.5	150.6	16.8	22.6
Oct	4.37	3.74	1.17	135.5	135.5	24.4	20.5
Nov	4.41	3.68	1.19	132.3	132.3	24.8	14.0
Dec	2.93	2.90	1.01	90.8	91.8	15.6	13.3
Jan	3.63	5.01	0.72	155.3	112.5	31.4	17.0

TABLE 4

Irrigation schedules for cotton based on weekly ET and rainfall

	Std. week	Dates	Rainfall (mm)	ET (mm)	Soil water balance (SWB=RF+I—ET) (mm)		Irrigation (mm)
			Vegetative phase				
Aug	33	13-19	5.1	30.6	100-30.6	69.4	
	34	20-26	3.6	34.6	72-34.6	37.4	
	35	27-2	1.5	37.6	39.9-37.6	2.3	50
Sep	36	3-9	0.3	35.4	52.6-35.4	17.2	50
	37	10-16	6.6	34.6	73.8-34.6	39.2	
	38	17-23	8.1	35.4	47.3-35.4	11.9	50
			Flowering and boll development phase				
	39	24-30	6.0	32.6	70.9-32.6	38.3	50
Oct	40	1-7	6.9	31.2	45.2-31.2	14.0	
	41	8-14	18.6	31.0	82.6-31.0	51.6	
	42	15-21	30.3	30.0	81.9-30.0	51.9	
	43	22-28	39.9	30.8	91.8-30.8	61.0	
Nov	44	29-4	34.8	29.9	95.8-29.9	65.9	
	45	5-11	10.2	29.0	76.1-29.0	47.1	
	46	12-18	17.5	28.8	62.1-28.8	33.3	
	47	19-25	13.8	26.5	47.1-26.5	20.6	50
	48	26-2	6.0	22.5	76.6-22.5	54.1	
			Picking phase				
Dec	49	3-9	4.0	20.5	58.1-20.5	37.6	
	50	10-16	—	20.9	37.6-20.9	16.7	50
	51	17-23	—	23.4	66.7-23.4	43.3	
	52	24-31	—	25.4	43.3-25.4	17.9	
Jan	1	1-7	—	25.4	—	—	
	2	8-14	—	—	Completion of harvest	—	
Total			213.2	616.1			300

SWB — Soil water balance, RF — Rainfall at 50% probability, ET — Evaporation, I — Irrigation.

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