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Water requirements of crops in north coastal Andhra

A. R. SUBRAMANIAM and P. A. NARASIMHA RAJU

Dept. of Meteorology and Oceanography, Andhra University, Waltair

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सार — प्रत्येक फसल के अन्तर्गत पड़ने वाले क्षेत्र और उनकी जल संबंधी आवश्यकताओं को जानते हुए जल स्रोतों में भंडारण और जलाशयों, तालाबों, सरोवरों आदि से वितरण की योजनायें बनाई जा सकती हैं। चूंकि उत्तरी तटीय आंध्र के अधिकांश क्षेत्र में अधिकतर वर्षा होती है। अत: यह आवश्यक है कि सिंचाई सुविधायों के कार्यक्रम बनाने के लिए या फसल के पैटर्न में परिवर्तन करने के लिए फसल के लिए पानी की आवश्यकताओं का आकलन किया जाए। इस अध्ययन के लिए, बलेनी और क्रिडल (1950) की विधि अपनाई गई है क्योंकि केवल वायु तापमान आंकड़ों से मुक्त उपलब्ध जलवायु सम्बन्धी आंकड़ों के क्षेत्रों के लिए इस विधि का सुझाव दिया जाता है। तीन प्रतिनिधि स्टेशनों, कलिंगपट्टनम, विशाखापटणम और अनाकापल्ले को लिया गया है और इस क्षेत्र में उत्पन्न प्रमुख फसलों के लिए जल की सामान्य आवश्यकताओं का आकलन किया गया है।

ABSTRACT. Knowing the area under each crop and their water requirements, it is possible to plan the water resources for storage and distribution from the reservoirs, ponds, lakes etc. Since most of the north coastal Andhra region a rainfed area, it is essential to estimate the water requirement of the crop either to change the cropping pattern or to schedule the irrigation facilities. For this study, Blaney and Criddle (1950) method has been adopted since this method is suggested for area where available climatic data consists of air temperature data alone. Three representative stations, Kalingapatnam, Visakhapatnam and Anakapalle have been taken and estimated the normal water requirements for the principal crops grown in the region.

1. Introduction

North coastal Andhra a rainfed region is under cultivation of various crops like rice, jowar, maize, groundnut, mesta, millets, sugarcane, etc. Since irrigation facilities are poor it is essential to know the water requirements of crops in order to change the cropping pattern and schedule the irrigation potential in the area. The crop water requirements are defined as "the depth of water needed to meet the water loss through evapotranspiration (E_T crop) of a disease-free crop, growing in large fields under non-restricting soil conditions including soil water, fertility and achieving full production potential under the given growing environment" (Doorenbos and Pruitt 1977). The crop water requirements at 3 stations, *viz.*, Kalingapatnam, Visakhapatnam and Anakapalle are estimated and discussed; the guidelines and methodology given by Doorenbos and Pruitt (1977) are followed in this study.

2. Data and methodology

(*i*) *Prediction of reference crop evapotranspiration*— The effect of climate on crop water requirements is accounted by the reference crop evapotranspiration (E_{T0}) which is defined as the rate of evapotranspiration from an extensive surface of 8 to 15 cm tall, green cover of uniform height, actively growing, completely shading the ground and not short of water. Out of four methods, *viz.*, Blaney and Criddle (1950), Radiation — Makkink (1957), Penman (1948) and pan evapotranspiration methods recommended by them, the Blaney and Criddle method has been adopted for the study since this method is suggested for areas where available climatic data consists of air temperature data alone as is the case in the region. Using measured temperature as well as general levels of humidity, sunshine, and wind, a better result can be drawn to obtain evapotranspiration. The relationship recommended representing mean value over the given month is expressed as,

$$E_{T0} = C[P\,(0.467\,T + 8)] \text{ mm/day}$$

where,

E_{T0} is reference crop evapotranspiration in mm/day for month considered,

T is mean daily temperature in °C over the month considered,

P is mean daily percentage of total annual day time hours obtained from the table for given month and latitude,

C is adjustment factor which depends upon relative humidy, sunshine hours and day time wind estimates.

The reference crop evapotranspiration (E_{T0}) can be estimated with the help of Fig. 2 as given by Doorenbos and Pruitt (1977). Information on general monthly or seasonal weather conditions and approximate range of RH (Relative Humidity) minimum, n/N (Actual number of sunshine hours/Possible number of sunshine hours) and U_2 (wind speed) during day time at the two stations, Visakhapatnam and Kalingapatnam — in the region is obtained from the records of India Meteorological Department, Pune and for Anakapalle at Regional Agricultural Research Station.

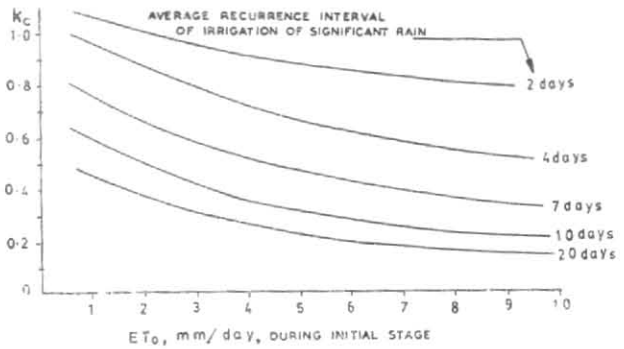

Fig. 1. Average *Kc* values for, initial crop development stage

TABLE 1

Water requirements of crops

Name of the crop	Planting week	Initial stage				Crop development stage				Mid-season stage				Late season stage				Total No. of days	Total crop E_T (mm)
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D		
Kalingapatnam																			
Rice	28	20	0.44	113	50	35	1.00	195	195	40	1.10	203	223	30	0.95	139	132	125	600
Maize (Khar.)	23	20	0.42	114	48	35	0.95	194	184	40	1.04	209	219	30	0.50	147	81	125	532
Jowar	25	20	0.43	112	48	35	0.95	184	175	40	1.00	206	206	30	0.50	141	70	125	499
Groundnut	26	25	0.44	137	60	35	0.85	184	156	45	0.95	221	210	25	0.40	107	43	120	469
Maize (Rabi)	44	20	0.50	90	45	35	0.70	137	94	45	1.05	135	142	30	0.50	112	56	130	337
Sugarcane	30	45	0.52	235	122	125	1.00	507	507	125	1.05	557	585	70	0.70	390	273	365	1487
Visakhapatnam																			
Rice	29	20	0.45	106	48	35	1.00	183	183	40	1.10	211	232	30	1.00	121	121	125	584
Maize (Khar.)	24	20	0.44	112	49	35	0.95	185	176	40	1.05	210	220	30	0.55	149	82	125	527
Jowar	24	20	0.45	112	50	30	0.95	185	173	40	1.00	210	210	30	0.50	128	64	120	497
Groundnut	26	30	0.46	132	61	35	0.85	183	155	45	0.95	230	218	20	0.40	109	44	130	478
Millets	24	15	0.42	84	35	30	0.75	132	99	40	1.05	209	219	20	0.30	119	36	105	389
Mesta	23	20	0.44	112	49	35	0.90	186	167	40	1.00	209	209	30	0.50	155	77	125	502
Anakapalle																			
Rice	28	20	0.45	108	49	35	1.00	182	182	40	1.05	185	197	30	0.95	122	116	125	544
Sugarcane	30	45	0.46	233	107	125	1.00	498	498	125	1.10	537	590	70	0.70	388	271	365	1466
Millets	24	15	0.43	114	49	30	0.70	162	113	40	1.00	203	203	20	0.30	96	29	105	394

A - duration in days; *B* : *Kc* values; C : reference crop *Et* (mm); *D* : crop E_T (mm)

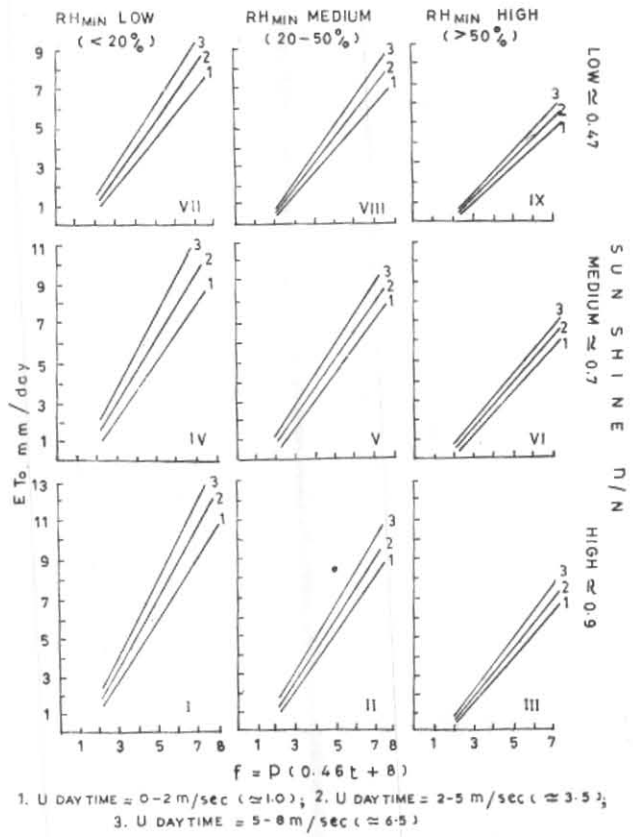

Fig. 2. Prediction of E_{T0} from Blaney-Cridle factor for different conditions

(ii) Selection of crop coefficient — The crop coefficient (K_C) values related to the predicted reference crop evapotranspiration (E_{T0}) to evapotranspiration of disease free crop grown in large fields under optimum soil water and fertility conditions and achieving full production potential under the given growing environment. Therefore E_T crop can be found by E_T crop $= K_C . E_{T0}$. E_T crop is the sum of transpiration by the crop and evaporation from the soil surface. Evaporation is negligible during full ground cover, the evaporation from the soil surface (E soil) may be considerable during early growing period, particularly when the soil surface is wet for most of the time from irrigation and rain. The crop coefficient K_C will vary during different crop stages and hence the following stages of crop development should be taken into account as suggested by Doorenbos and Pruitt and the method of obtaining K_C values is also given under :

(1) Initial stage	Germination and early growth when the soil surface is not or is hardly covered by the crop.
(2) Crop development stage	From end of initial stage to to attainment of effective full ground cover.
(3) Mid-season stage	From attainment of effective full ground cover to time of start of maturity.
(4) Late season stage	From the end of mid season stage until full maturity or harvest.

To evaluate K_C values at different stages of the crop, the information on planting or sowing dates, the total growing season and length of crop development stages have been collected from the district agricultural offices in the region. The K_C values for initial development stage have been taken from the Fig. 1 given by Doorenbos and Pruitt (1977) relating the reference E_{T0} during initial crop stage to the K_C value for an assumed irrigation or rainfall frequency of 7 days. The K_C value for mid-season stage for given climate (humidity and wind) has been selected from the tables given by Doorenbos and Pruitt. For time of full maturity (or harvest within a few days) and for given climate (humidity and wind) K_C value for late season stage is also obtained from the tables. Assuming straight line between K_C value at end of initial to start of mid-season stage, K_C value for crop development stage has been obtained by means of graphical smoothing. Thus, four stages have been taken to indicate the approach of methodology in selecting K_C values.

(iii) Factors effecting E_T crop — E_T crop estimated by the above method refers to E_T of a disease-free crop grown in a very large field not short of water and fertilization. Further the application of such normal data needs careful attention for various factors that can alter the E_T crop. The important factors with E_T crop which get affected (Doorenbos and Pruitt 1977) are variations with time distance, size of irrigation development advection, level of available water, ground water, salinity of water etc.

3. Results and discussion

The estimated normal crop water requiremets for the principal crops grown at Kalingapatnam, Visakhapatnam and Anakapalle are given in Table 1. The crop water requirements for rice are 600 mm, 584 mm and 544 mm at Kalingapatnam, Visakhapatnam and Anakapalle respectively. Water requirement is more for rice during reproductive stage (223 mm) and less during initial stage (50 mm) at Kalingapatnam. E_T of millets at Visakhapatnam and Anakapalle is 389 mm and 394 mm respectively. At Kalingapatnam and Visakhapatnam the E_T is 469 mm and 478 mm for groundnut respectively. The crop water requirements for sugarcane is 1487 mm at Kalingapatnam and 1466 mm at Anakapalle. Water requirement for rice, jowar, maize crops is more at Kalingapatnam than in Visakhapatnam.

Results of the fields observation on a 12 month sugarcane crop conducted at Regional Agricultural Research Station, Anakapalle shows the average value of E_T crop 1588 mm. The crop E_T of sugarcane estimated for Anakapalle is found to be 1466 mm showing there could be 122 mm less in estimated value. In view of the reported field observation, it is necessary to take crop coefficients, 1.1 and 1.2 during crop development and mid-season stage instead of 1.0 and 1.05 to overcome the lower estimated value.

At Kalingapatnam the actual receipt of normal rainfall is 1002 mm whereas the estimated normal requirement of water for sugarcane (12 month crop) is 1487 mm. It is evident that still 485 mm of water has to be supplied through irrigation to survive the crop. For other crops supplimentary irrigation is not necessary since rainfall in the region satisfies the requirement of crops during different phenophases.

Thus the estimated values based on climatic parameters are of considerable practical use for irrigation design where field observations are not available.

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