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Estimation of Crop Water Requirement and Irrigation Scheduling Using CROPWAT 8.0

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ABSTRACT: The estimation of crop water requirements is crucial for irrigation planning and management. The study was carried out for three different regions Rajkot, Banaskatha, and Anand located in Gujarat state of India. The selection is made for crops based on the actual production in those regions such as wheat, cotton and groundnut in Rajkot, Wheat, Potato and Bajra in Banaskatha and wheat, tobacco and rice in Anand. By using 10 years IMD climatic data, the reference crop evapotranspiration crop water requirement, and irrigation requirement were determined using CROPWAT 8.0. The tool CROPWAT 8.0 is based on Pen-man monteith approach. The study shows that wheat crop having same planting date at all stations but vary in the results because of different climate and soil conditions. And Irrigation is not required for Bajra crop as rainfall suffice the crop water requirement. Irrigation scheduling was done using two approach namely irrigate at critical depletion approach and irrigate at user defined interval approach. Irrigation is started on 7th day of planting the crop and irrigation interval has been taken 15 days for irrigate at user defined interval approach. Irrigate at critical depletion approach is recommended for crops as its yield reduction is 0% except for some crops like wheat in Banaskatha and Anand, rice in Anand. Because these crops require less water in irrigation with yield reduction is zero in user defined intervals approach.

KEYWORDS: Reference crop evapotranspiration, crop coefficient, CROPWAT 8.0, pen-man monteith approach, crop water requirement, irrigation water requirement

I. INTRODUCTION

Population growth and changing lifestyles have increased the water demand, largely for irrigation in both urban and rural areas. India has 18% of the world’s population, and 4% of the world’s freshwater, out of which 80% is used in agriculture. The amount consumed in surface and groundwater in India, however, is just 48%. India is an agriculture-based country where more than 70% population depends on agriculture and is highly susceptible to the problem of water scarcity and high climatic variability. So, water resource managers must carefully consider how to best utilize the available resources for possible advantages because land and water resources in any nation won’t vary greatly over time. Irrigation scheduling ensures that water is supplied according to crop requirements and is consistently available to the crop.

The significance of irrigation scheduling is that it enables the irrigator to apply the exact quantity of water to achieve the target. This increases irrigation efficiency. A critical element is the precise measurement of the quantity of water supplied or the depth of application.

Uniform water distribution across the field is important to achieve the maximum advantages from irrigation scheduling or management. Precise water application prevents over or under irrigation. Over irrigation wastes energy, water, and labor; remove crucial nutrients below the root zone, which is out of reach of plants; and reduces soil aeration, and thus crop yields. Under irrigation poses stress to the crop and causes a reduction in yield. Appropriate irrigation scheduling will improve financial gain by maximizing crop yield and quality, decreasing water lost through deep percolation and runoff, optimizing pumping costs; and improving water use efficiency. Irrigation scheduling is the procedure used by irrigation system managers to determine the correct frequency and period of watering.

II. STUDY AREA AND DATA COLLECTION

The location of study area has been described in the table as follows:

SR.No.	NAME	LATITUDE	LONGITUDE	ALTITUDE
1	Rajkot	22.30 °N	70.78 °E	138m
2	Banaskatha	24.34 °N	72.34 °E	252m
3	Anand	22.57 °N	72.93 °E	39 m

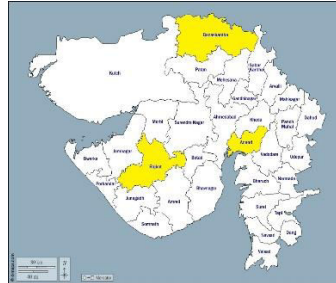


Fig. 1: Study area location

DATA COLLECTION:

This is the most important aspect of the research. India's meteorological department (IMD) provided the meteorological data. And The crop and soil data were collected from Food and Agriculture Organization (FAO). Soil type data were collected from the Commissionerate of agriculture (govt. of Gujarat).

Table 2: Data Requirement For The Study

CLIMATE	CROP	SOIL
Min.&Max temp.	Planting Date	Soil type
Humidity	Length of each stage	Saturation capacity
Windspeed	Critical depletion	Field capacity
Sunshine		Wilting point
Radiation		

Table 3: Crop coefficient

Sr. No.	CROP	Kc ini	Kc mid	Kc end
1	Wheat	0.70	1.15	0.25
2	Groundnut	0.40	1.15	0.60
3	Cotton	0.35	1.20	0.60
4	Potato	0.50	1.15	0.75
5	Bajra	0.30	1.00	0.30
6	Tobacco	0.50	1.15	0.80
7	Rice	0.80	1.15	0.85

III. METHODOLOGY

CROPWAT was created by the FAO's Division of Land and Water Development to make irrigation planning and management easier. The CROPWAT tool is developed for both monitoring and controlling irrigation systems and is a useful tool for determining evaporation standards, agricultural water needs, and the need for irrigation schemes. This tool is designed on the basis of Pen-man monteith method. Irrigation methods can be changed, irrigation schedules can be set for a variety of water supply conditions, and production can be evaluated for both rain-fed and irrigation water deficiency scenarios with the use of these tools.

Irrigation engineers, agro scientists, agriculture researchers, and water resources engineers can use CROPWAT as a practical tool for examining and managing irrigation pressures. Water is used by plants to cool themselves, and the weather is the driving force behind this process. Even in the same environment and atmosphere, various crops require varying quantities of water. The program provides a superb user experience with its various graphics and configurable



menus. The data collection (climate and cropping pattern), as well as the outcomes (crop water need and soil moisture deficit), are both readily graphed and printed.

- 1) Estimation of reference crop evapotranspiration by Pen-man monteith method

$$ET_o = \frac{0.408\Delta (R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

- 2) By using crop coefficient Etc is determined,

$$ETC = KC * ETO$$

- 3) Then irrigation water requirement is determined

Irrigation water requirement=Crop water requirement-Effective rainfall

IV. RESULTS

Table 4 Result Data Of Wheat

Sr No	Station	CropWater Requirement	IrrigationWater Requirement
1	Rajkot	454.4	434.6
2	Banaskatha	382.1	378.7
3	Anand	359.8	356.4

Table 5 Result Data of All Crops Except Wheat

Sr no	Station	Crop name	Planting date	Crop water requirement	Irrigation water requirement
1.	Rajkot	Cotton	15/06	608.6	285.0
		Groundnut	15/06	474.5	134.1
2.	Banaskatha	Potato	05/11	411.4	410.5
		Bajra	20/06	348	32.2
3.	Anand	Tobacco	10/08	377.2	247.8
		Rice	15/06	729.3	586.3

Table 6 Result Data Of Irrigation Scheduling With Critical Depletion Approach

Sr. No.	Station	Crop	Gross Irrigation	Net Irrigation	Yield reduction(%)
1	Rajkot	Wheat	617.5	432.2	0.0
		Cotton	291.6	204.1	0.0
		Groundnut	145.4	101.8	0.0
2	Banaskatha	Wheat	443.0	310.1	0.0
		Potato	546.2	382.3	0.0
		Bajra	0.0	0.0	0.0
3	Anand	Wheat	258.7	181.1	0.0
		Tobacco	353.5	247.5	0.0
		Rice	720.3	504.2	0.0



Table 7 Result Data Of Irrigation Scheduling With User Defined Interval Approach

Sr. No.	Station	Crop	Gross Irrigation (mm)	NetIrrigation(m m)	Yield reduction(%)
1	Rajkot	Wheat	576.0	403.2	0.6
		Cotton	145.7	102.0	1.7
		Groundnut	147.5	103.3	2.4
2	Banaskatha	Wheat	331.5	261.0	0.0
		Potato	438.1	306.7	10.2
		Bajra	117.3	82.1	0.0
3	Anand	Wheat	319.4	223.6	0.0
		Tobacco	285.5	199.9	0.5
		Rice	585.2	409.6	0.0

V. CONCLUSION

The study shows that wheat crop having same planting date at all stations but vary in the results because of different climate and soil conditions. And Irrigation is not required for Bajra crop as rainfall suffice the crop water requirement. Irrigate at critical depletion approach is recommended for crops as its yield reduction is 0% except for some crops like wheat in Banaskatha and Anand, rice in Anand. Because these crops require less water in irrigation with yield reduction is zero in Irrigate at user defined intervals approach. By comparing both approach in irrigation scheduling, wheat in Rajkot shows 0.6% yield reduction when irrigate at user defined interval approach is adopted. The result of cotton and groundnut crop shows 1.7% and 2.4% yield reduction respectively with user defined intervals approach. Potato crop in Banaskatha depicts 10.2% yield reduction. In Anand region, the result of tobacco crop shows 0.5% yield reduction with adopting the same approach

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