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RESEARCH ARTICLE

Estimation of Crop Water Requirement of Sweet corn crop using CROPWAT 8.0 model

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ABSTRACT

Most of the crops are watered through traditional methods of irrigation, which leads to wastage of water. The Crop Water Requirement (CWR) is necessary to design the irrigation system, which is the total quantity of water required for the crop from sowing to harvest.Optimization of water applied to the crop is essential as the yields of the crop are adversely affected either by excess or deficit water supply. CROPWAT 8.0 requires meteorological data as input such as maximum and minimum temperatures, wind speed, relative humidity, and sunshine hours. The soil and crop data were also given as input for calculating the CWR of sweet corn. The meteorological data of the past ten years was collected from the meteorological observatory, which is located at Agricultural College Farm, Bapatla. The average values of the above-said data were calculated for ten years (2012-2021) to estimate the crop water requirement using CROPWAT 8.0. The crop water requirement was estimated as 332 mm using the CROPWAT 8.0 model. It was found to be minimal in the initial stages (15.60 mm/dec) and found to be maximum in the middle stages (64.80 mm/dec), and again at harvesting stage, it started declining (16.70 mm/dec). CROPWAT 8.0 model gives more accurate amount of water needed for the crop, which in turn helps the crop growers to design the appropriate irrigation scheduling.

Keywords: Crop Water Requirement, CROPWAT 8.0 model, sweet corn.

INTRODUCTION

In agriculture, most of the crops are watered through traditional methods of irrigation, which leads to more water wastage. Under the present circumstances of meagre availability of surface water and dwindling ground water sources day by day, the only alternative is to optimise the amount of water applied to the crop to cope up the needs of the food security of growing population by bringing more area under cultivation by way of utilizing the available scarce resources of water judicially.

The Crop Water Requirement (CWR) is necessary to design the irrigation system, which is the total quantity of water required for the crop from sowing to harvest. Several computer models are available to estimate the crop water requirement. CROPWAT 8.0, a computer program developed in the Netherlands, calculates the CWR and Irrigation Water Requirement of various crops under different climatic conditions. The Penman-Monteith method had been recommended by FAO to calculate the crop evapotranspiration (ETc) under different conditions, which give accurate and wider suitability (Patel *et al*., 2017) compared to Penman, BlaneyCriddle and other methods.

The CWR requires the preparation of irrigation

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scheduling, which includes planning and decision-making in the irrigation process. Irrigation scheduling is one of the most important factors in the agricultural sector for achieving sustainable crop productivity. Optimising the water applied to the crop is essential as crop yields are adversely affected by either excess or deficit water supply.

MATERIAL AND METHODS

Experimental site

The field experiment was carried out at the field irrigation laboratory, Department of Soil and Water Engineering, Dr.N.T.R. College of Agricultural Engineering, Bapatla, Bapatla district of Andhra Pradesh state, India. The experiment was conducted on sweet corn crop during *kharif* season of the year 2022. Sowing of Sweet corn crop was done on August 3, 2022. The experimental site is geographically located at latitude of 16°N and longitude of 88°E with an altitude of 6 m above sea level (Fig. 2.1). Bapatla is one of the districts in Andhra Pradesh and it is located in the southeastern part of that state which is very near to the coast of Bay of Bengal and the town experiences hot summer and cool winter. The maximum temperature ranges between 30°C to 40°C in summer and the minimum temperature ranges between 18 °C to 28 °C in winter. The annual precipitation is about 700-1150 mm with an average of 897 mm of which 25% is received during crop growing period of *kharif* 2022. The average relative humidity is 75% and average wind speed is 108 km/day. Mean daily evaporation ranged between 2.59 to 3.32 mm/day during crop growing period.

Collection of Meteorological Data

Many softwares like CRIWAR, CROPWAT, SWATRE, etc., were available to estimate the crop water requirement of the crop. In the present study CROPWAT 8.0 was used to estimate the crop water requirement of the sweet corn. CROPWAT 8.0 requires meteorological data as input such as maximum and minimum temperatures, wind speed, relative humidity and sun shine hours. The soil and crop data were also given as input for calculating the CWR of sweet corn. The meteorological data of the past ten years was collected from the meteorological observatory, which is located at Agricultural College Farm, Bapatla. The average values of the above said data were calculated for ten years (2012-2021) to estimate the crop

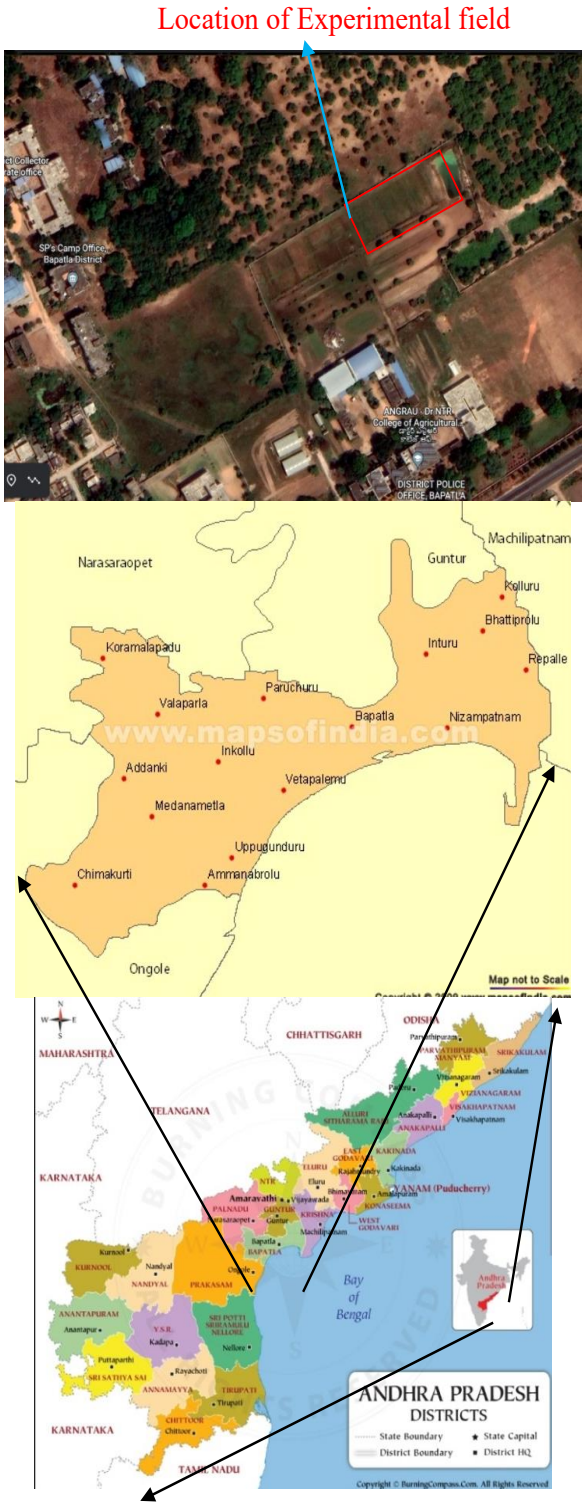
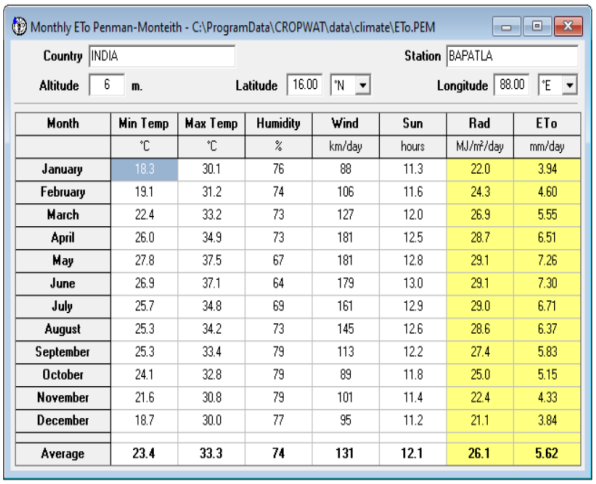


Fig. 2.1 Location of Experimental field

water requirement using CROPWAT 8.0. Input files of CROPWAT 8.0 are shown in Fig 2.2 and Table 2.1. The meteorological data during the crop growing period is presented in the Table 2.2.



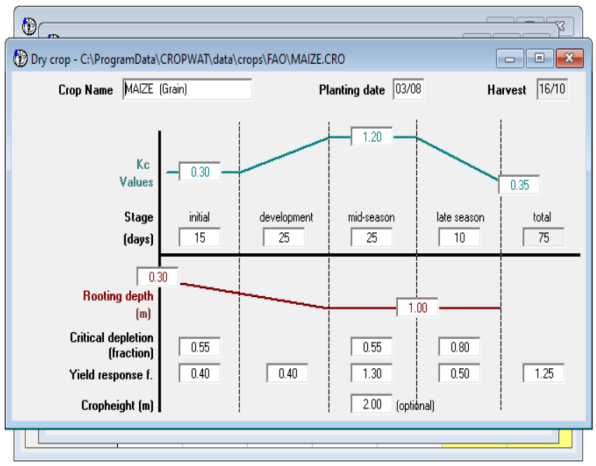


Fig.2.2 Input data files of CROPWAT 8.0

Soil properties of the experimental plot

Soil properties of the experimental plot was collected from the Department of Soil and Water Engineering, Dr. N. T. R. College of Agricultural Engineering, Bapatla where the experiment was carried out. The physical properties such as textural class, hydraulic conductivity (cm/h), bulk density (g/cm^3), field capacity (% vol) and permanent wilting point (% vol) were collected and shown in Table 2.3.

RESULT AND DISCUSSION

Estimation of Crop Water Requirement

Crop Water Requirement of sweet corn was estimated using meteorological data of the past 10 years with the help of CROPWAT 8.0 software. The outcome of the CROPWAT 8.0 was shown in Table 3.1 and these results showed that water required for the crop (crop evapotranspiration) is less during the initial period of crop growing because of less canopy area of the sweet corn crop and it was gradually increases. In the first decade of August it was found as 15.60 mm/dec, on second decade it was 20.40 mm/dec. In third decade, it kept on increasing at 40.30 mm/dec, and in the first decade of September, it was found to be 56.10 mm/dec. It was found to be maximum at second decade of September when there was more canopy area coverage and then decreased until the end of the crop period.

Table 2.1 Average values of past ten years (2012-2021) meteorological data

Month	Min. temp (°C)	Max. temp (°C)	RH (%)	Wind speed (km/day)	Sunshine hours	Rainfall (mm)
January	18.30	30.09	76	88	11.3	0.513
Feburary	19.15	31.19	74	106	11.6	7.467
March	22.44	33.24	73	127	12.0	0.06
April	26.00	34.89	73	181	12.5	5.2372
May	27.76	37.49	67	181	12.8	31.955
June	26.91	37.12	64	179	13.0	68.491
July	25.74	34.79	69	161	12.9	73.461
August	25.31	34.18	73	145	12.6	128.56
September	25.31	33.40	79	113	12.2	152.32
October	24.13	32.80	79	89	11.8	106.629
November	21.61	30.82	79	101	11.4	49.235
December	18.67	30.03	77	95	11.2	11.8753

Table 2.2 Weather parameters recorded during crop growing period (*Kharif*2022)

Month	Average daily Temperature (°C)		Relative Humidity (%)		Average wind speed (km/ day)	Total Rainfall (mm)	Average daily evaporation (mm)
	Max.	Min.	Max.	Min.			
August	34.22	25.54	96.48	64.81	142	123.20	3.32
September	33.90	25.37	98.13	66.30	112	54.90	3.29
October	31.97	23.58	99.58	72.84	88	159.80	2.59

Table 2.3 Physical properties of the experimental soil

Soil depth from surface (cm)	Mineral content (% mass)			Textural class	Hydraulic conductivity (cm/h)	Bulk density (g/cm^3)	Field capacity (% vol)	Permanent wilting point (% vol)
	Clay	Silt	Sand					
0-15	35	10	55	Sandy clay loam	0.94	1.37	21.48	6.73
15-30	35	10	55	Sandy clay loam	0.50	1.57	27.17	9.12
30-45	30	10	60	Sandy clay	0.46	1.53	28.24	10.56
45-60	35	5	60	Sandy clay loam	0.96	1.63	27.69	10.92
60-75	35	5	60	Sandy clay loam	0.96	1.63	27.73	11.61
75-90	30	5	65	Sandy clay loam	0.95	1.67	26.62	10.75

Table 3.1 Crop Evapotranspiration of sweet corn during growing period

Month	Decade	Stage	K_c Coefficient	ET_c mm/day	ET_c mm/dec
August	1	Initial	0.30	1.95	15.60
August	2	Development	0.32	2.04	20.40
August	3	Development	0.59	3.67	40.30
September	1	Development	0.93	5.61	56.10
September	2	Middle	1.11	6.48	64.80
September	3	Middle	1.11	6.23	62.30
October	1	Late	1.04	5.57	55.70
October	2	Late	0.54	2.79	16.70
		Total			332.00

At the harvesting stage, the water needed for the crop was found to be minimum, with a value of 16.70 mm/dec. An Irrigation Schedule was prepared on a daily basis based on the sweet corn crop water requirement, which was calculated by CROPWAT 8.0. Similar findings were observed by Bahadur *et al.*2021, Bhat *et al.*2017, and Roja *et al.*2020.

CONCLUSION

CROPWAT 8.0 model gives more accurate amount of water needed to the crop which in turns helps the crop growers to design the appropriate irrigation scheduling.

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