iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** IV **Month of publication:** April 2022

DOI: https://doi.org/10.22214/ijraset.2022.42068

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com

FAO-CROPWAT 8.0 Used for Analysis of Water Requirements and Irrigation Schedule in the Kutch Region of Gujarat

Poojaba Jadeja[1], Milan. K. Chudasama[2]
[1]*P.G. Scholar, Department of Civil Engineering, SSEC, Bhavnagar, Gujarat, India*
[2]*Assistant Professor, Department of Civil Engineering, SSEC, Bhavnagar, Gujarat, India*

Abstract: Water is an important input for agriculture so this valuable resource is designed properly and deliverable. Reasonable information on evapotranspiration, crop water requirements, and net irrigation requirements is required for effective planning of this resource. To use optimum amount of water for crops and reduce irrigation quantity, some form of irrigation scheduling should be used by the farming community. Unscientific and injudicious application of groundwater in this region resulted in depletion of the groundwater table. To achieve effective utilization of the groundwater resources, there is a need to estimate the crop water requirement for different crops at different management levels to accomplish effective irrigation management. Crop water requirements of different crop in districts of* Kutch *was calculated using FAO CROPWAT 8.0 a computer simulation model. The simulation study was conducted with the objectives of determining irrigation water requirement and irrigation scheduling for some major crops. The Penman - Monteith method was used for evapotranspiration calculation in the model. The model predicted the daily, decadal as well as monthly crop water requirement at different growing stages of crops.
Keywords: crop water requirement, irrigation scheduling, CROPWAT 8.0

I. INTRODUCTION

Water is becoming valuable to its growing demand in agricultural activities [1] Water demand is rising gradually as the crop yield is a serious problem throughout the world, particularly in developing countries, owing to population growth, rapid urbanization, and irrigation activities [1], [4]. The causes for this are the lack of adequate water management and water resources conservation. It is compulsory to apply significant approaches that help rise water efficiency [2]. Water is an important input for agriculture so that this valuable resource is designed properly and deliverable [2], [8]. Reasonable information on evapotranspiration, crop water requirements, and net irrigation requirements is required for effective planning of this resource [6]. The water demand for crops differs significantly between crops to crops, even during the entire growing season of a single crop. A major part of a hydrological cycle is evapotranspiration [7], [8]. It is also the transport of water from crop and soil surface to the environment through evaporation [7]. The type of vegetation under various weather conditions vary in evapotranspiration [4]. As the E^{To} rises, the need for crop water will also significantly raise, eventually affecting the production of a crop. It is quite tough to achieve this issue owning to a restricted resource of water [3], [4]. The water requirement can be calculated by the estimated process, where the calculation of the water requirement of the crop (E^{Tc}) is equivalent to the E^{To} value multiplied by the crop coefficient (Kc) [3], [4]. Globally, the Penman-Monteith equation is one of the most accurate and detailed techniques for calculating evapotranspiration and crop water requirements [2], [5], [6].

In CROPWAT 8.0, the Penman-Monteith equation is used to evaluate the potential evapotranspiration [1]. Temperature, wind speed, humidity, solar radiation and ambient temperature are the main determiners of the potential evapotranspiration rate in the Penman-Monteith equation. With model CROPWAT 8.0 we can detect crop water requirements throughout the growing period by rainwater and irrigation on the field [3] [5], [7]. Crop water requirements (CWR) relates to the quantity of water needed to cover losses of evapotranspiration from the cultivated field over a certain period [1]. The requirements of crop water are normally expressed in mm/day, mm/month or mm/season. The only way to improve agriculture is through the provision of modern, adequate irrigation strategies and improved water management practices [6]. Taking into consideration the current water situation throughout the world is an important technique for choosing proper water use CROPWAT is an FAO developed window-based model for determining the E^{To} for accurate irrigation scheduling and design [3], [5], [6]. The Penman-Monteith Equation of FAO is the basis of this application to determine E^{To}, which will also be useful for increasing crop production [1], [2], [4], [6]. This research aims to estimate the crop water requirement for the various crops in the Kutch district using CROPWAT 8.0 [4].

II. STUDY AREA

Kachchh district (also spelled as Kutch) is a district of Gujarat state in western India, with its headquarters (capital) at Bhuj. Covering an area of 45,674 km², it is the largest district of India. In Kachchh district three areas are covered in this work (Bhuj, Mundra and Anjar).

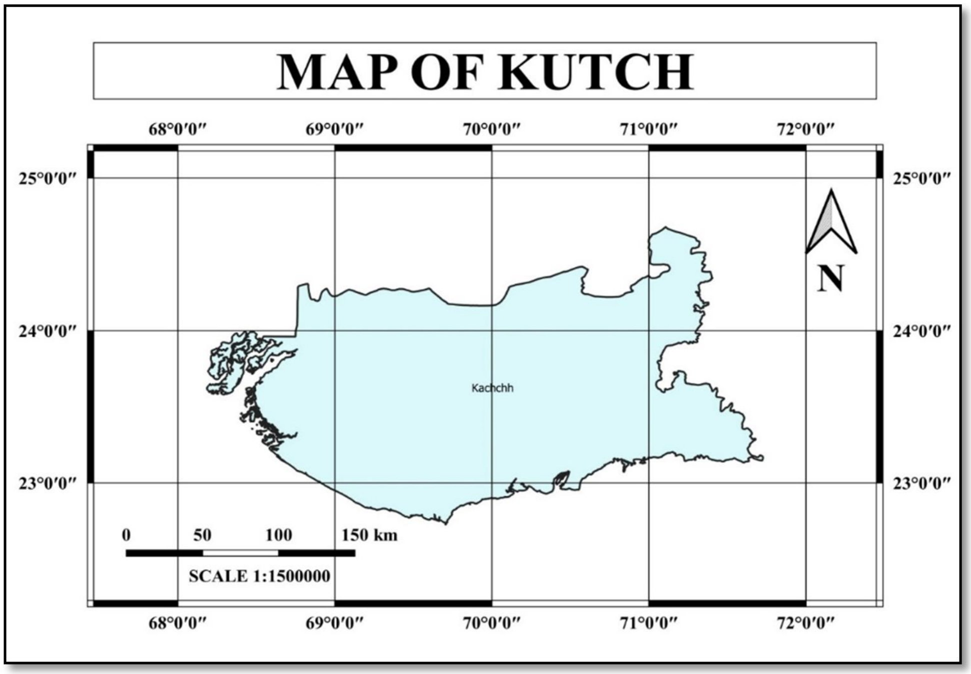


Figure 2.1: Map of Study Area (Kutch)

III. METHODOLOGY

A. CROPWAT

The document shows in a practical way the use of CROPWAT 8.0 design and management of irrigation schemes, taking the user, with the help of an actual data set, through the different steps required to calculate evapotranspiration, crop water requirements, scheme water supply and irrigation scheduling. To learn about how the software works and the main calculation procedure, users are invited to read the context specific help available in the software.

CROPWAT is a decision support system developed by the Land and Water Development Division of FAO for planning and management of irrigation. CROPWAT is meant as a practical tool to carry out standard calculations for reference evapotranspiration, crop water requirements and crop irrigation requirements, and more specifically the design and management of irrigation schemes. It allows the development of recommendations for improved irrigation practices, the planning of irrigation schedules under varying water supply conditions, and the assessment of production under rain fed conditions or deficit irrigation.

CROPWAT is a computer program that uses the FAO Penman-Monteith method to calculate reference evapotranspiration (E^{To}), crop water requirements (E^{TC}) and irrigation scheduling (FAO 1992). The program allows for the development of irrigation schedules under various management and water supply conditions and to evaluate rain-fed production, drought effects and efficiency of irrigation practices (FAO 2002). CROPWAT is helpful to agro-scientists, agro-researchers and water resources engineers as a practical tool to carryout standard calculations for evapotranspiration and management of if irrigation schemes. Plants use water for cooling purposes and the driving force 'of this process is prevailing weather conditions. Under the same climate and atmosphere, different crops have different water use requirements.

Following features are included in CROPWAT

1) Monthly, decade and daily input of climate data.
2) Possibility to estimate climate data in the absence of measured value.
3) Decade and daily calculation of crop water requirements based on update calculation algorithms including adjustment of crop-coefficient value.

4) Calculation for dry crops and for paddy and upland rice
5) Daily soil water balance output tables.
6) Easy saving and retrieval of session and of user defined irrigation scheduling.
7) Graphical presentation of input data and calculation results. Easy import/export of data and graphics through clipboard or ASCII text file.
8) Extensive printing routines.
9) Context-sensitive help system.

IV. DATA REQUIRED

A. *Reference Crop Evapotranspiration (E^{To})*

Evaporation and transpiration occur simultaneously and there is no easy way of distinguishing between the two processes. Apart from the water availability in the top soil, the evaporation from a cropped soil is mainly determined by the fraction of the solar radiation reaching the soil surface. This fraction decreases over the growing period as the crop develops and the crop canopy shades more and more of the ground area. When the crop is small, water is predominately lost by soil evaporation, but once the crop is well developed and completely covers the soil, transpiration becomes the main process. In Figure the partitioning of evapotranspiration into evaporation and transpiration is plotted in correspondence to leaf area per unit surface of soil below it. At sowing nearly 100% of ET comes from evaporation, while at full crop cover more than 90% of ET comes from transpiration.

B. *Penman-Monteith Method*

In 1948, Penman combined the energy balance with the mass transfer method and derived an equation to compute the evaporation from an open water surface from standard climatological records of sunshine, temperature, humidity and wind speed. This so-called combination method was further developed by many researchers and extended to cropped surfaces by introducing resistance factors. One can interpret the equation as the maximum water which could be evapotranspiration due to the solar and wind energy within the system, at given air and surface characteristics. The resistance nomenclature distinguishes between aerodynamic resistance and surface resistance factors. The surface resistance parameters are often combined into one parameter, the 'bulk' surface resistance parameter which operates in series with the aerodynamic resistance. The surface resistance, describes the resistance of vapor flow through stomata openings, total leaf area and soil surface. The aerodynamic resistance, describes the resistance from the vegetation upward and involves friction from air flowing over vegetative surfaces. Although the exchange process in a vegetation layer is too complex to be fully described by the two resistance factors, good correlations can be obtained between measured and calculated evapotranspiration rates, especially for a uniform grass reference surface.

The Penman-Monteith form of the combination equation,

$$\boxed{ET_0 = \frac{0.408\Delta(R_n - H_s) + \gamma\frac{900}{T+273}x_2(P_s - P_a)}{\Delta + \gamma(1 + 0.34x_2)}}$$

where,

- ET_0 = reference evapotranspiration
- R_n = net radiation at crop surface
- H_s = soil heat flux density
- T = mean daily air temperature at 2m height
- P_s = saturation vapour pressure
- P_a = actual vapour pressure
- Δ = slope vapour pressure curve
- γ = psychrometric constant.

C. Crop Coefficient

The Crop coefficient (k_c) integrates the effect of characteristics that distinguish a specific crop from the Reference crop. According to the Crop coefficient approach, Crop evapotranspiration under standard conditions (E^{Tc}) is calculated by multiplying the Reference evapotranspiration (E^{To}) by the suitable k_C. The Crop coefficient is influenced mostly by crop type and to a minor extent by climate and soil evaporation and varies over the crop growing Stages, since ground cover, Crop height and leaf area change as the crop develops. CROPWAT 8.0 requires k_c values for initial stage, mid-season stage and at harvest. k_c values during the development and late season stages are interpolated.

D. Crop Evapotranspiration

Crop evapotranspiration is calculated by multiplying E^{To} by k_c a coefficient expressing the difference in evapotranspiration between the cropped and reference grass surface. The difference can be combined into one single coefficient, or it can be spilt into two factors describing separately the difference in evaporation and transpiration between both surfaces. The selection of the approach depends on the purpose of the calculation, the accuracy required, the climate data available and the time step with which the calculation are executed. E^{Tc} is determined by the crop coefficient approach whereby the effects of the various weather condition are incorporated into $E^{To}$and the crop characteristics in to the Kc coefficient: $E^{Tc} = k_c * E^{To}$

E. Calculation Procedure for crop Evapotranspiration E^{Tc}:

Identifying the crop growth stages, determining their lengths, and selecting the corresponding k_c coefficients. Adjusting the selected k_c coefficient for frequency of wetting or climate condition during the stage. Constructing the crop coefficient curve. Calculating E^{Tc} as the product of E^{To} and K.

F. Crop Water Requirement

The amount of water required to compensate the evapotranspiration loss from the cropped fields is defined as crop water requirement. Although the values for Crop evapotranspiration under standard condition (E^{Tc}) and crop water requirement are identical crop water requirement refers to the amount of water that needs to be supplied while crop evapotranspiration refers to the amount of water that is lost through evapotranspiration.

G. Irrigation Scheduling

Irrigation scheduling is required when rainfall is insufficient to compensate for the water lost by evapotranspiration and apply water at the right period and in the right amount by irrigation. The Irrigation requirement expressed in mm and computed over a certain period of time, expresses the difference between the Crop evapotranspiration under standard conditions (E^{Tc}) and the Effective Rainfall contributions over the same time step. Irrigation requirement indicatively represents the fraction of the crop water requirements that needs to be satisfied through irrigation contributions in order to guarantee to the crop optimal growing conditions.

V. DATA COLLECTION

A. Meteorological Data

Meteorological data of 17 years was collected from State Water Data Centre located in Gandhinagar. Meteorological parameters used for calculation of E^{To}, are latitude, longitude and altitude of the station, maximum and minimum temperature (C°), maximum and minimum relative humidity (%), wind speed (km/day) and sunshine hours which was collected and the average values have been fed to the model. Rainfall data collected from the same station is also fed to the software which will generate the effective rainfall data.

B. Crop Data

Major crops grown in this region are Wheat, millets and pulses and commercial crops like cotton, castor and groundnut. CROPWAT requires the crop data like, crop coefficient, Kc values (initial, mid and late growth stages), rooting depth, length of plant growth stages, critical depletion and yield response factor which were taken from FAO Irrigation and drainage paper 56. The yield response factor (Ky) is the ratio of relative yield reduction to relative evapo-transpiration deficit that integrates the weather, crop and soil conditions that make crop yield less than its potential yield in the face of deficit evapotranspiration. Sowing and harvesting date were taken according to the guide from agricultural operations over this area.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com

C. Soil Data

Soil type in this area is black clayey soil and loamy (medium textured). The software needs some general soil data like total available soil moisture, maximum rain infiltration rate, maximum rooting depth, initial soil moisture depletion and initial available soil moisture. Thise6 information obtained from FAO manual 56.

VI. RESULT AND DISCUSSION

A. Bhuj

Table 6.1: Climate characteristics, rainfalls, and E^{To} of Bhuj area obtained using CROPWAT software

Month	Min temp	Max temp	Humidity	Wind	Sun	Radiation	E^{Tc}
	°C	°C	%	m/s	hours	MJ/m^2/day	mm/day
January	15.1	26.5	42	1.5	9.7	17.7	3.59
February	17.2	28.5	46	1.6	10.0	20.2	4.25
March	20.8	31.9	51	1.7	10.6	23.6	5.31
April	23.8	33.8	62	2.2	10.9	25.8	6.22
May	26.3	33.3	71	3.7	9.8	24.7	6.38
June	27.5	32.9	74	4.3	8.6	22.9	6.12
July	26.9	30.5	80	4.2	7.8	21.6	5.18
August	25.9	29.4	83	3.7	7.5	20.8	4.59
September	25.4	30.5	78	2.5	8.2	20.6	4.63
October	24.1	33.5	60	1.8	10.0	20.9	5.06
November	20.9	31.6	48	1.4	9.8	18.2	4.18
December	16.6	27.9	42	1.2	9.8	17.1	3.37
Average	22.5	30.9	61	2.5	9.4	21.2	4.91

Table 6.2: Daily and Decadal Crop Water Requirement of cotton in the Bhuj area

Month	Decade	Stage	k_c	E^{Tc}	E^{Tc}	Eff Rain	Irr. Req
			Coeff	mm/day	mm/dec	mm/dec	mm/dec
May	1	Init	0.35	2.21	22.1	0.0	22.1
May	2	Init	0.35	2.23	22.3	0.0	22.3
May	3	Deve	0.35	2.21	24.3	0.1	24.2
June	1	Deve	0.45	2.81	28.1	0.2	27.9
June	2	Deve	0.61	3.74	37.4	0.3	37.1
June	3	Deve	0.77	4.46	44.6	0.9	43.7
July	1	Deve	0.93	5.09	50.9	1.9	49.1
July	2	Mid	1.08	5.61	56.1	2.6	53.5
July	3	Mid	1.14	5.68	62.5	2.2	60.2
August	1	Mid	1.14	5.45	54.5	1.8	52.7
August	2	Mid	1.14	5.23	52.3	1.6	50.7
August	3	Mid	1.14	5.24	57.7	1.4	56.2
September	1	Mid	1.14	5.26	52.6	1.3	51.3
September	2	Late	1.09	5.06	50.6	1.2	49.4
September	3	Late	0.96	4.59	45.9	0.8	45.0
October	1	Late	0.83	4.12	41.2	0.3	40.9
October	2	Late	0.69	3.58	35.8	0.0	35.8
October	3	Late	0.58	2.81	19.7	0.0	19.7
					758.8	16.8	742.0

Table 6.3: Total gross net irrigation and rain efficiency - cotton

Total gross irrigation	957.9 mm	Total rainfall	17.0 mm
Total net irrigation	670.5 mm	Effective rainfall	16.4 mm
Total irrigation losses	0.0 mm	Total rain loss	0.7 mm
Actual water used by the crop	755.9 mm	Moist deficit at harvest	209.1 mm
Potential water used by the crop	755.9 mm	Actual irrigation requirement	739.6 mm
Efficiency irrigation schedule	100%	Efficiency rain	96.1%

Table 6.4: Irrigation schedules for cotton crop as per the CROPWAT model

Date	Day	Stage	Rain (mm)	k_s fraction	E_{ta} (%)	Depletion (%)	Net Irrigation	Deficit (mm)	Loss (mm)	Gross Irrigation (mm)
05 May	5	Init	0.0	1.00	100	65	48.0	0.0	0.0	68.6
01 June	32	Dev	0.0	1.00	100	66	98.0	0.0	0.0	140.0
01 July	62	Dev	0.0	1.00	100	66	152.7	0.0	0.0	218.2
01 Aug	93	Mid	0.0	1.00	100	67	186.7	0.0	0.0	266.7
06 Sept	129	Mid	0.0	1.00	100	66	185.1	0.0	0.0	264.4
27 Oct	End	End	0.0	1.00	0	75				

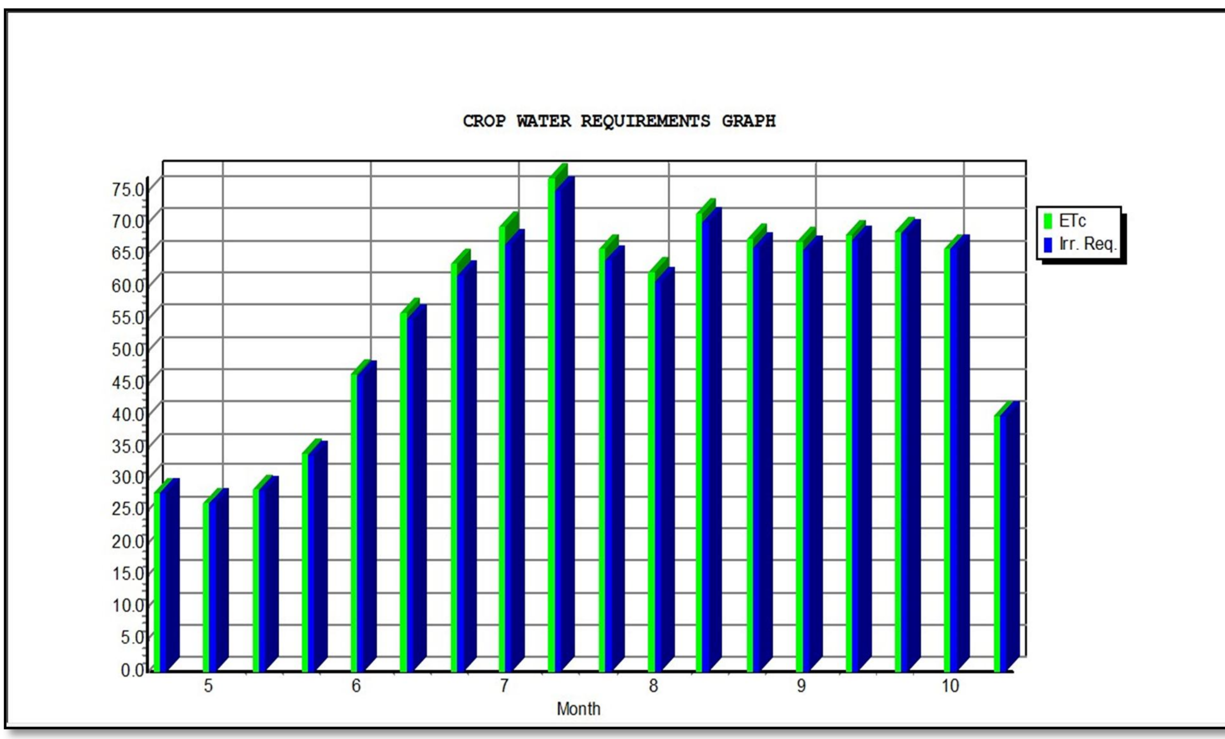


Fig 6.1: crop water requirement of cotton crop (Bhuj)

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com

B. Mundra

Table 6.5: Climate characteristics, rainfalls, and E^{To} of Mundra area obtained using CROPWAT software

Month	Min temp	Max temp	Humidity	Wind	Sun	Radiation	E^{To}
	°C	°C	%	m/s	hours	MJ/m²/day	mm/day
January	14.9	27.0	38	1.5	9.7	17.9	3.72
February	17.0	29.5	38	1.6	10.1	20.6	4.49
March	20.7	33.6	40	1.7	10.6	23.7	5.69
April	23.6	35.9	51	2.2	11.0	26.0	6.83
May	26.1	35.1	65	3.7	10.5	25.8	7.16
June	27.5	33.9	70	4.3	9.1	23.6	6.67
July	26.8	31.1	78	4.2	7.8	21.6	5.39
August	25.8	30.0	82	3.7	7.4	20.6	4.68
September	25.2	31.5	75	2.5	8.3	20.8	4.88
October	24.0	34.7	51	1.8	10.1	21.2	5.43
November	20.8	32.3	39	1.4	9.8	18.4	4.39
December	16.4	28.3	38	1.2	9.6	17.1	3.47
Average	22.4	31.9	55	2.5	9.5	21.4	5.23

Table 6.6: Daily and Decadal Crop Water Requirement of cotton in the Mundra area

Month	Decade	Stage	k_c	E^{Tc}	E^{Tc}	Eff Rain	Irr. Req.
			Coeff	mm/day	mm/dec	mm/dec	mm/dec
May	1	Init	0.35	2.47	24.7	0.0	24.7
May	2	Init	0.35	2.51	25.1	0.0	25.1
May	3	Deve	0.35	2.46	27.0	0.1	26.9
June	1	Deve	0.45	3.10	31.0	0.3	30.7
June	2	Deve	0.61	4.10	41.0	0.5	40.5
June	3	Deve	0.77	4.83	48.3	1.0	47.3
July	1	Deve	0.93	5.43	54.3	1.8	52.6
July	2	Mid	1.09	5.89	58.9	2.4	56.5
July	3	Mid	1.15	5.93	65.2	2.1	63.1
Aug	1	Mid	1.15	5.58	55.8	1.7	54.1
Aug	2	Mid	1.15	5.27	52.7	1.5	51.2
Aug	3	Mid	1.15	5.39	59.3	1.3	57.9
Sep	1	Mid	1.15	5.54	55.4	1.1	54.3
Sep	2	Late	1.10	5.38	53.8	0.9	52.9
Sep	3	Late	0.97	4.92	49.2	0.6	48.6
Oct	1	Late	0.84	4.46	44.6	0.2	44.4
Oct	2	Late	0.71	3.91	39.1	0.0	39.1
Oct	3	Late	0.60	3.06	21.4	0.0	21.4
					806.9	15.8	791.2

Table 6.7: Total gross net irrigation and rain efficiency – cotton

Total gross irrigation	1282.6 mm	Total rainfall	16.0 mm
Total net irrigation	897.8 mm	Effective rainfall	16.0 mm
Total irrigation losses	0.0 mm	Total rain loss	0.0 mm
Actual water used by the crop	803.9 mm	Moist deficit at harvest	30.1 mm
Potential water used by the crop	803.9 mm	Actual irrigation requirement	787.9 mm
Efficiency irrigation schedule	100 %	Efficiency rain	100 %

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com

Table 6.8: Irrigation schedules for cotton crop as per the CROPWAT model

Date	Day	Stage	Rain (mm)	k_s fraction	E_{ta} (%)	Depletion (%)	Net Irrigation	Deficit (mm)	Loss (mm)	Gross Irrigation (mm)
05 May	5	Init	0.0	1.00	100	67	49.3	0.0	0.0	70.4
29 May	29	Init	0.0	1.00	100	66	92.8	0.0	0.0	132.6
26 June	57	Dev	0.0	1.00	100	66	143.5	0.0	0.0	205.0
25 July	86	Mid	0.0	1.00	100	67	187.0	0.0	0.0	267.1
29 Aug	121	Mid	0.0	1.00	100	67	186.9	0.0	0.0	267.0
17 Oct	170	End	0.0	1.00	100	85	238.3	0.0	0.0	340.4
27 Oct	End	End	0.0	1.00	0	11				

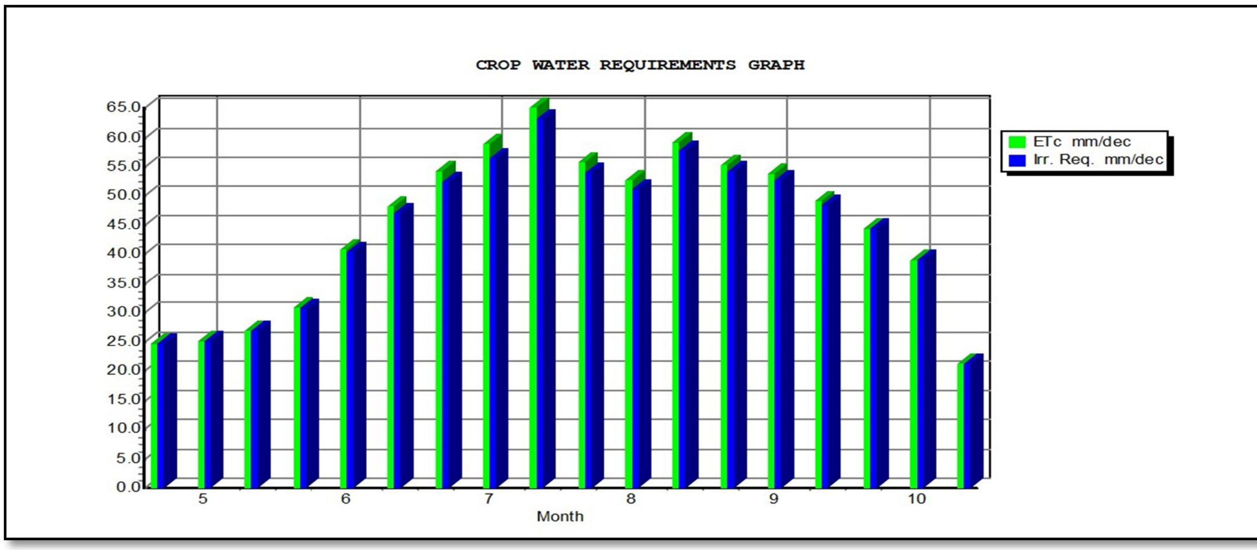


Fig 6.2: crop water requirement of cotton crop (Mundra)

C. Anjar

Table 6.9: Climate characteristics, rainfalls, and E^{To} of Anjar area obtained using CROPWAT software

Month	Min temp	Max temp	Humidity	Wind	Sun	Radiation	E^{To}
	°C	°C	%	m/s	hours	MJ/m^2/day	mm/day
January	14.4	26.7	39	1.5	9.7	17.7	3.62
February	16.6	29.8	36	1.6	10.1	20.4	4.49
March	20.7	34.6	33	1.7	10.7	23.7	5.86
April	23.8	37.9	41	2.2	11.1	26.1	7.35
May	26.2	37.6	57	3.7	10.9	26.4	8.14
June	27.6	35.4	66	4.3	9.5	24.2	7.30
July	26.8	31.9	76	4.2	7.9	21.8	5.66
August	25.7	30.7	80	3.7	7.2	20.3	4.83
September	25.1	32.5	71	2.5	8.6	21.2	5.19
October	23.9	35.3	47	1.8	10.1	21.0	5.55
November	20.3	32.1	40	1.4	9.8	18.2	4.32
December	15.7	27.9	41	1.2	9.6	16.9	3.36
Average	22.2	32.7	52	2.5	9.6	21.5	5.47

Table 6.10: Daily and Decadal Crop Water Requirement of cotton in the Anjar area

Month	Decade	Stage	k_c	E^{Tc}	E^{Tc}	Eff Rain	Irr. Req
			Coeff	mm/day	mm/dec	mm/dec	mm/dec
Apr	2	Init	0.35	2.57	5.1	0.0	5.1
Apr	3	Init	0.35	2.66	26.6	0.0	26.6
May	1	Init	0.35	2.80	28.0	0.0	28.0
May	2	Deve	0.35	2.96	29.6	0.0	29.6
May	3	Deve	0.48	3.84	42.3	0.1	42.1
Jun	1	Deve	0.65	4.94	49.4	0.3	49.2
Jun	2	Deve	0.82	5.95	59.5	0.4	59.1
Jun	3	Deve	0.98	6.61	66.1	0.9	65.2
Jul	1	Mid	1.13	7.03	70.3	1.6	68.7
Jul	2	Mid	1.17	6.61	66.1	2.1	63.9
Jul	3	Mid	1.17	6.28	69.1	1.9	67.2
Aug	1	Mid	1.17	5.88	58.8	1.5	57.3
Aug	2	Mid	1.17	5.52	55.2	1.4	53.9
Aug	3	Mid	1.17	5.70	62.7	1.2	61.5
Sep	1	Late	1.09	5.54	55.4	1.2	54.3
Sep	2	Late	0.96	4.97	49.7	1.0	48.6
Sep	3	Late	0.82	4.37	43.7	0.7	43.0
Oct	1	Late	0.69	3.78	37.8	0.2	37.6
Oct	2	Late	0.56	3.31	16.6	0.0	16.6
					892.0	14.5	877.5

Table 6.11: Total gross net irrigation and rain efficiency – cotton

Total gross irrigation	1167.8 mm	Total rainfall	14.6 mm
Total net irrigation	817.5 mm	Effective rainfall	14.6 mm
Total irrigation losses	0.0 mm	Total rain loss	0.0 mm
Actual water used by the crop	888.7 mm	Moist deficit at harvest	196.7 mm
Potential water used by the crop	888.7 mm	Actual irrigation requirement	874.1 mm
Efficiency irrigation schedule	100 %	Efficiency rain	100 %

Table 6.12: Irrigation schedules for cotton crop as per the CROPWAT model

Date	Day	Stage	Rain (mm)	k_s fraction	E_{ta} (%)	Depletion (%)	Net Irrigation	Deficit (mm)	Loss (mm)	Gross Irrigation (mm)
23 Apr	5	Init	0.0	1.00	100	68	50.1	0.0	0.0	71.6
14 May	26	Init	0.0	1.00	100	67	87.7	0.0	0.0	125.3
8 June	51	Dev	0.0	1.00	100	67	134.0	0.0	0.0	191.4
1 July	74	Dev	0.0	1.00	100	66	173.3	0.0	0.0	247.6
29 July	102	Mid	0.0	1.00	100	67	187.2	0.0	0.0	267.4
31 Aug	135	Mid	0.0	1.00	100	66	185.1	0.0	0.0	264.5
15 Oct	End	End	0.0	1.00	0	70				

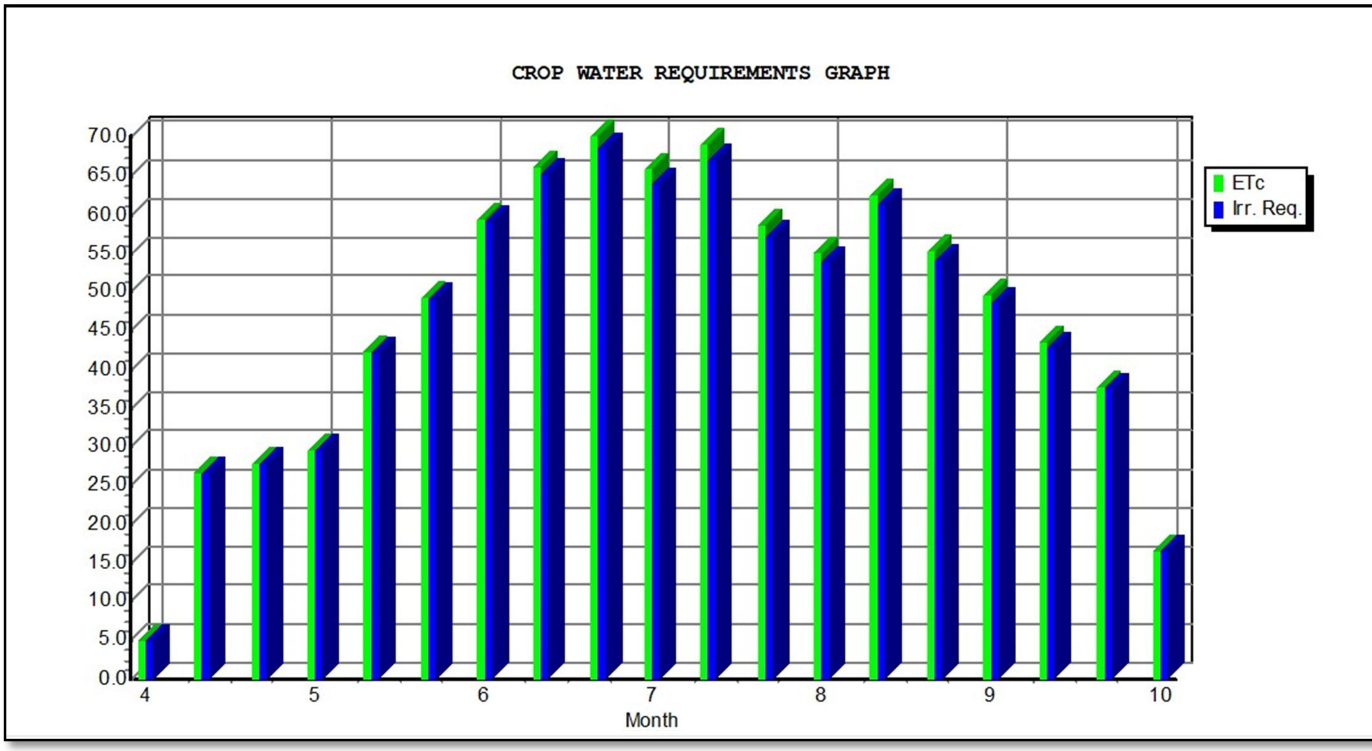


Fig 6.3: crop water requirement of cotton crop (Anjar)

VII. CONCLUSION

It has been concluded from the study that by putting the meteorological data like Temperature (maximum and minimum), rainfall, wind speed, relative humidity, and sunshine hours into the CROPWAT model the Effective rainfall, Reference evapotranspiration, Irrigation water requirement, and Crop water requirement can be determined. CROPWAT is an easy, meaningful, and workable model for the assessment of Effective rainfall, Reference evapotranspiration, Irrigation water requirement, and Crop Water Requirement. The texture of soil from the research was black clayey soil.

From the result the average water requirement for cotton crop in Bhuj, Mundra and Anjar will be 758.8, 806.9 and 892.0 mm per decade respectively. While the irrigation water requirement will be 742.0, 791.2 and 877.5 mm per decade respectively.

REFERENCES

[1] A.V. Memon, S. Jamsa, Crop Water Requirement and Irrigation scheduling of Soybean and Tomato crop using CROPWAT 8.0, International Research Journal of Engineering and Technology (IRJET).

[2] Anshu Gangwar, Tejram Nayak, Rajkumar Manojkumar Singh, Ashutosh - Singh Estimation of Crop Water Requirement Using CROPWAT 8.0 Model For Bina Command, Madhya Pradesh Art, Indian journal of Ecology.

[3] K.Saravanan and R.Saravanan. Determination of Water Requirements of Main crops in the Tank Irrigation Command area using CROPWAT 8.0. International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS), 2014, Vol 1, No.5, 266-272.

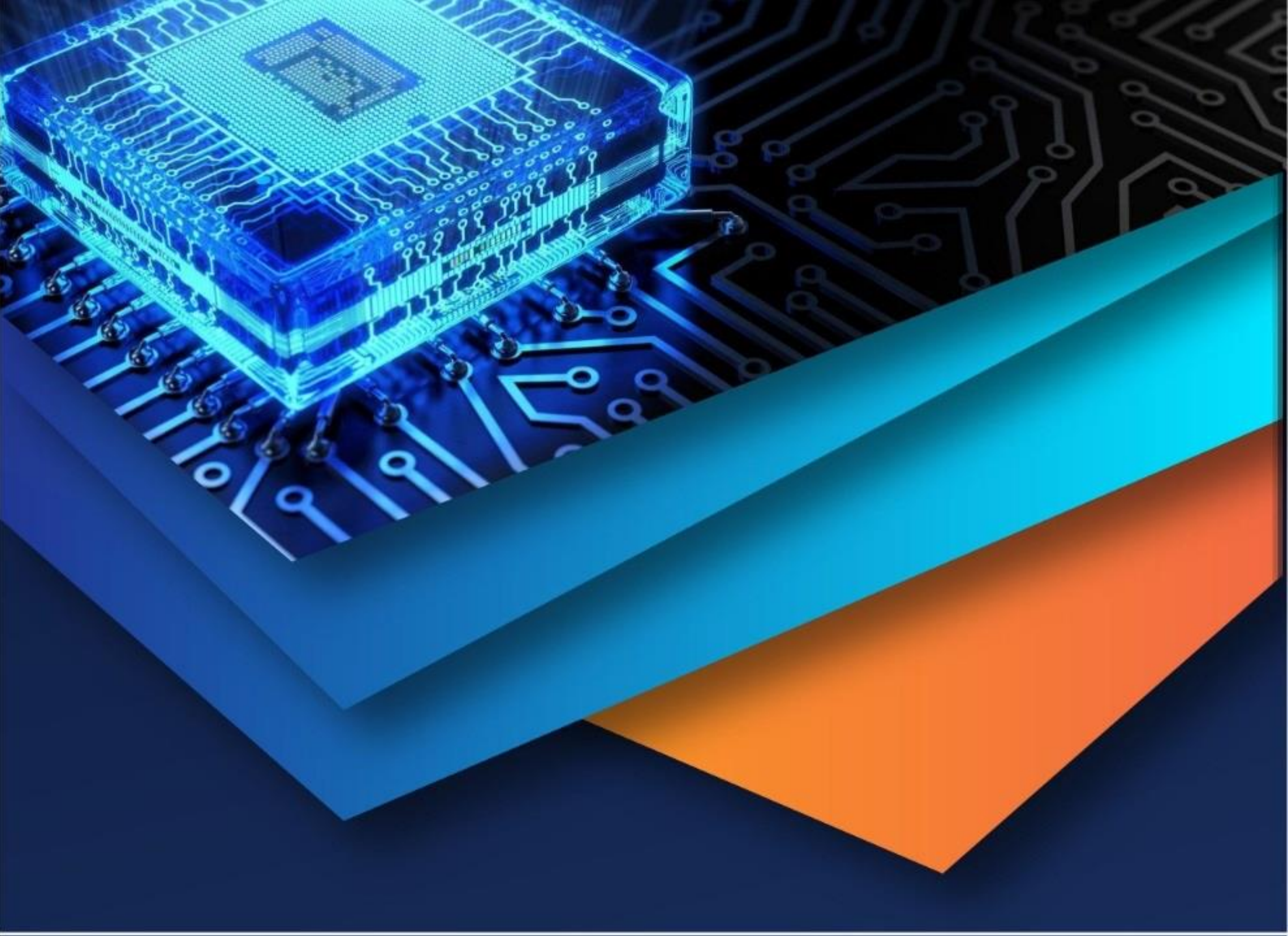
[4] Muhammad Jalal Khan, Abdul Malik, Mujibur Rahman, Muhammad Afzaal and Shahi Mulk. Assessment of Crop Water Requirement for Various Crops in Peshawar, Pakistan Using CROPWAT Model. Irrigation Drainage Sys Eng, Volume 10:9, 2021.

[5] Nilkanth Herbha, Hardik Vora, A. N. Kunapara, Simulation of Crop Water Requirement and Irrigation Scheduling for Maize Crop Using FAO-CROPWAT 8.0 in Panchmahal Region of Middle Gujarat, Trends in Biosciences 10(46), 9387-9391, 2017.

[6] Roja, M. (2020). Estimation of Crop Water Requirement of Maize Crop Using FAO CROPWAT 8.0 Model. Indian Journal of Pure & Applied Biosciences, 8(6), 222–228. https://doi.org/10.18782/2582-2845.

[7] Sonu Kumari, Irrigation Scheduling Using CROPWAT. International Journal of Creative Research Thoughts (IJCRT) IJCRTICCC036.

[8] Vijendra Shantaram, Baviskar,J.B.Patel, S.R.Takale,M.S. Shitap,V.J.Patel and G.R.Maruthi Sankar. Efficient irrigation management for enhancing productivity and profitability of wheat under semi-arid inceptisols in Gujarat. Indian Journal of Soil Conservation, 45(2): 183-191, 2017.



10.22214/IJRASET

INDEX COPERNICUS 45.98

ISRA JIF IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR: 7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY