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DETERMINATION OF CROP WATER REQUIREMENTS AND IRRIGATION SCHEDULING FOR VIRAMGAM REGION USING CROPWAT

[1]Gaurav Prajapati, [2]Rita Jadav
[1]PG scholar, [2]Associate professor
[1] Civil engineering
[1]L.D.College of engineering, Ahmedabad, India

Abstract : This study has been undertaken to investigate the requirement of water for crops and optimum allocation of water. India is a tropical country so that amount of rainfall is variable, also population is increasing day by day so water demand is increasing. With increase of population food demand is also increased hence we need to improve food production to meet the demand of country. Agriculture is the main source of food, so to increase the yield of crops it is necessary to apply the required amount of water to the crop at required time. To achieve we can use modern technique to determine water requirements of crops and to prepare irrigation schedule. CROPWAT is a tool developed by FAO to compute crop water requirements and to prepare irrigation schedule. For this study, study area is taken viramgam region of Ahmedabad district.in this region the yield of crop cotton decreased during last two years so our aim is to provide CWR computation and irrigation schedule to improve this yield.

Index Terms **– Cropwat, climwat, crop water requirement, irrigation schedule, cotton, Ahmedabad, Gujarat, India**

I. INTRODUCTION

Water and food are the basic need of human being. With the increase of population the requirements of water and food both increased hence to meet this demand optimum use of the resources are required. India is a country where most of the populations are employed in the agriculture sector hence it is utmost necessary to improve the production of crops for the sustainable development of the country. India is a water scarce country hence wasteful use of water by the farmers must be avoided. By the use of modern technology we can supply the required amount of water at the required time to crop to increase the yield of crop and also to reduce the loss of water and conserve the resources. By the over irrigation it will adversely affect the soil and leads to reduction in yield hence must be avoided.

CROPWAT is a modern tool that is developed by land and water division of FAO (Food and agriculture organization) it required basic data as input like climatic data, rainfall data, soil data and crop data. By using penman monteith equation it gives output as CWR (crop water requirement) and irrigation schedule.

For this study we have chosen viramgam region of Ahmedabad district. Climatic and rainfall data collected from climwat 2.0 also developed by FAO , soil data taken from Regional cotton research station, viramgam , crop data taken from Crop Evapotranspiration Guidelines for Computing crop water requirement. Irrigation and Drainage Paper No. 56. (FAO).

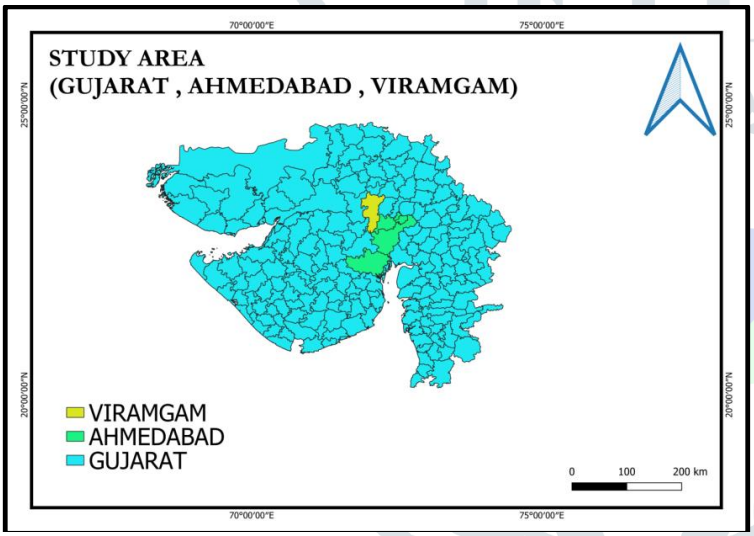
The results show that a total Irrigation requirement of cotton is 453.9 mm. From the present study, it is concluded that Reference Crop Evapotranspiration, Effective Rainfall, Crop water requirement and Irrigation water requirement can be estimated using CROPWAT 8.0 Software with the input of climatic data like maximum and minimum temperature, relative humidity, wind speed and sunshine hours and rainfall.

II. STUDY AREA AND DATA COLLECTION

- For the study Viramgam taluka of district Ahmedabad has been taken as the study area.
- District: Ahmedabad
- Sowing time: July end to August 15th
- Crop Survey: Ahmedabad district major area is V-797 belt, in very small area sowing of Shankar-6 is done .

Soil properties	value
pH	**7.69**
EC	**0.40**
Nitrogen (organic carbon %)	**0.56**
Available Phosphorus (kg/ha)	**27.05**
Available potash (kg/ha)	**498.82**

- Viramgam has semi-arid climate with an annual average rainfall of 715 mm distributed over 36 rainy days.
- Rains come from southwest monsoon, which breaks in June and dissipates in September with July and August as the main wet months.
- The temperature is the highest in May-June and lowest in December-January.
- Maximum temperature ranges from 24.3^0 to 43.9^0 C and the minimum temperature up 2^0 C in January-February



III. METHODOLOGY

Cropwat is a piece of software designed for the calculation of the right amount of water needed for the irrigation of crop fields. The calculation strategy is based on two publications of the same developer: the "Crop Evapotranspiration" guide that presents a procedure for the calculation of the efficient quantity of crop water, and "Yield response to water", which presents an analysis on crop yield as a result of water use.

In this we have used cropwat 8.0 to determine crop water requirements of cotton crop and preparation of irrigation schedule. This software uses penman monteith equation to compute reference evapotranspiration.

$$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

Where:
ET_0= reference evapotranspiration [mm day-1],
R_n = net radiation at the crop surface [MJ m-2 day-1],
G = soil heat flux density [MJ m-2 day-1],
T = mean daily air temperature at 2 m height [°C],
u_2 = wind speed at 2 m height [m s-1],
e_s = saturation vapour pressure [kPa],
e_a = actual vapour pressure [kPa],
$e_s - e_a$ = saturation vapour pressure deficit [kPa],

Δ = slope vapour pressure curve [kPa °C-1],
γ = psychrometric constant [kPa °C-1].

- The crop evapotranspiration under standard conditions, denoted as ETc, is the evapotranspiration from disease-free, well-fertilized crops, grown in large fields under optimum soil water conditions and achieving full production under the given climatic conditions. The values of ETc and CWR (Crop Water Requirements) are identical, whereby Etc refers to the amount of water lost through evapotranspiration and CWR refers to the amount of water that is needed to compensate for the loss.

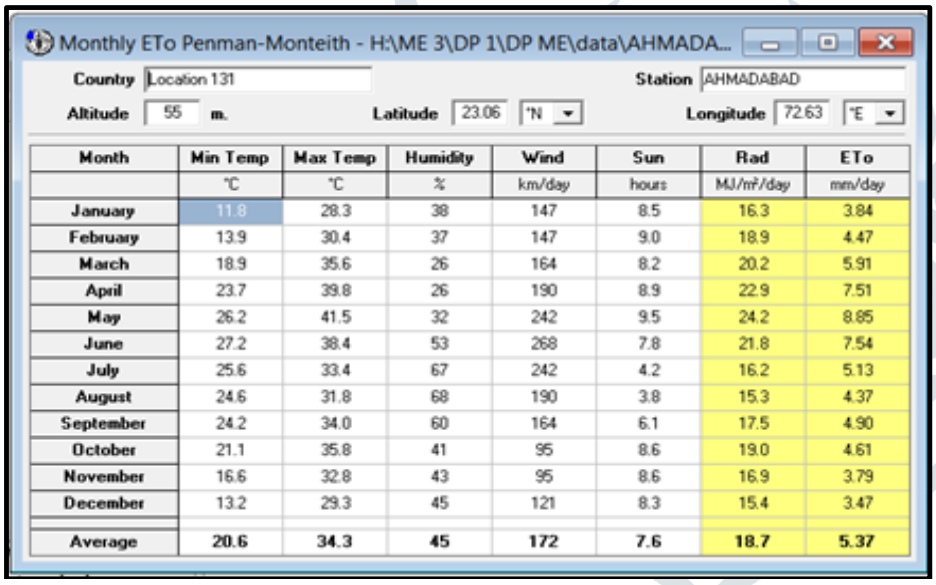
ETc = ETo x Kc
Where:
ETc = Crop evapotranspiration (mm/day)
ETo = Reference crop evapotranspiration (mm/day)
Kc = Crop coefficient

- Once the crop water and irrigation requirements have been calculated, the next step is the preparation of field irrigation schedules. Three parameters have to be considered in preparing an irrigation schedule:

1) The daily crop water requirements
2) The soil, particularly its total available moisture or water-holding capacity
3) The effective root zone depth

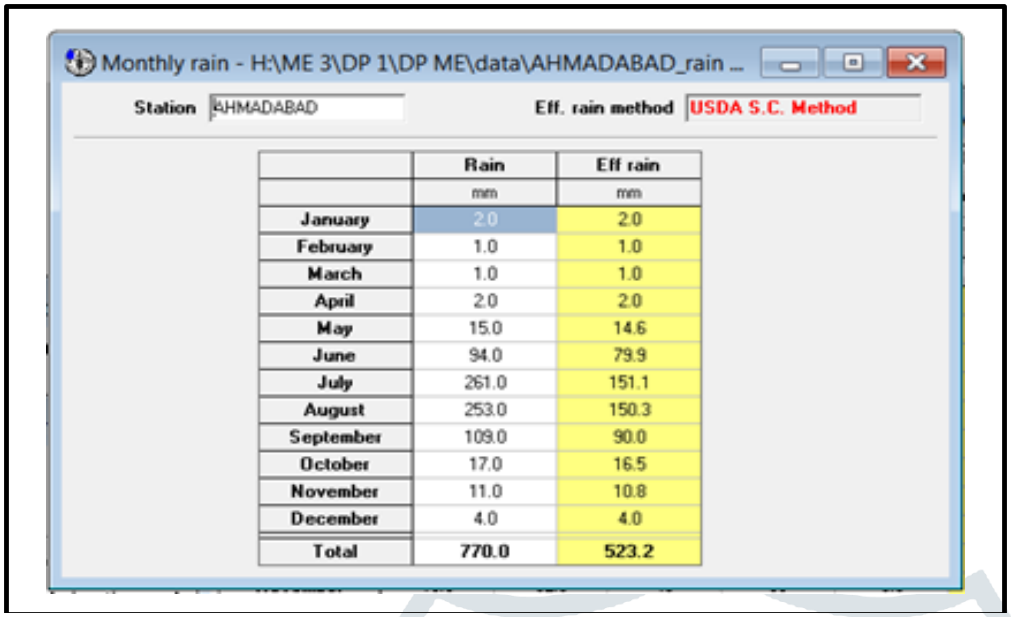
IV. RESULTS AND ANALYSIS

STEP 1: CLIMATE DATA INPUT AND COMPUTATION OF REFERENCE EVAPOTRANSPIRATION USING PENMAN MONTEITH EQUATION



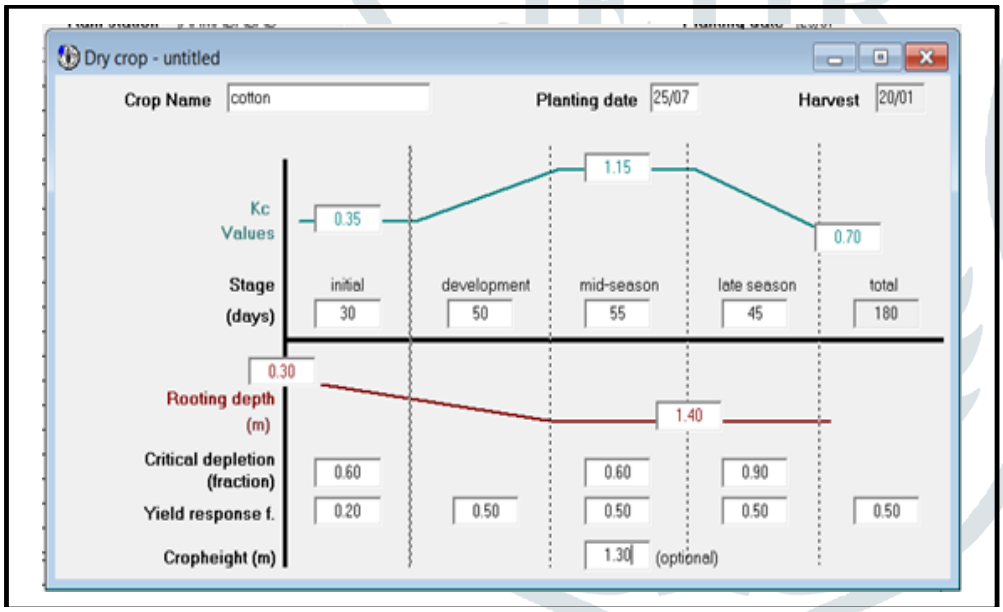
Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	11.8	28.3	38	147	8.5	16.3	3.84
February	13.9	30.4	37	147	9.0	18.9	4.47
March	18.9	35.6	26	164	8.2	20.2	5.91
April	23.7	39.8	26	190	8.9	22.9	7.51
May	26.2	41.5	32	242	9.5	24.2	8.85
June	27.2	38.4	53	268	7.8	21.8	7.54
July	25.6	33.4	67	242	4.2	16.2	5.13
August	24.6	31.8	68	190	3.8	15.3	4.37
September	24.2	34.0	60	164	6.1	17.5	4.90
October	21.1	35.8	41	95	8.6	19.0	4.61
November	16.6	32.8	43	95	8.6	16.9	3.79
December	13.2	29.3	45	121	8.3	15.4	3.47
Average	20.6	34.3	45	172	7.6	18.7	5.37

STEP 2: RAINFALL DATA INPUT AND COMPUTATION OF EFFECTIVE RAINFALL USING USDA SOIL CONSERVATION SERVICE METHOD

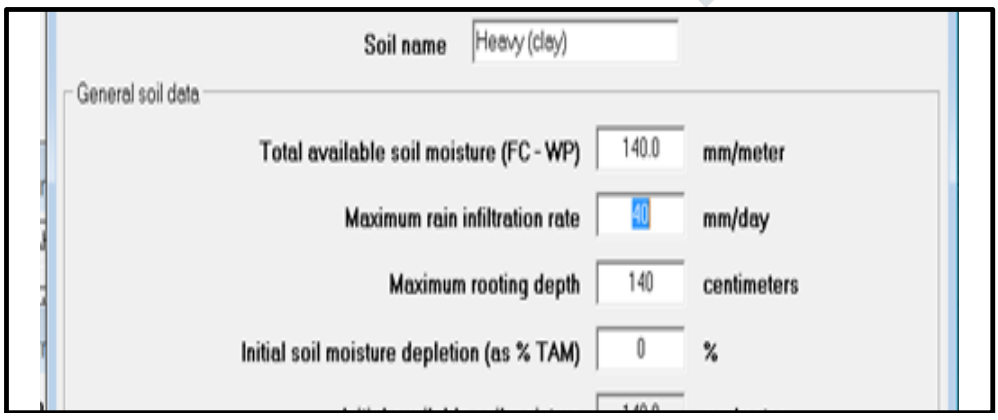


	Rain	Eff rain
	mm	mm
January	2.0	2.0
February	1.0	1.0
March	1.0	1.0
April	2.0	2.0
May	15.0	14.6
June	94.0	79.9
July	261.0	151.1
August	253.0	150.3
September	109.0	90.0
October	17.0	16.5
November	11.0	10.8
December	4.0	4.0
Total	770.0	523.2

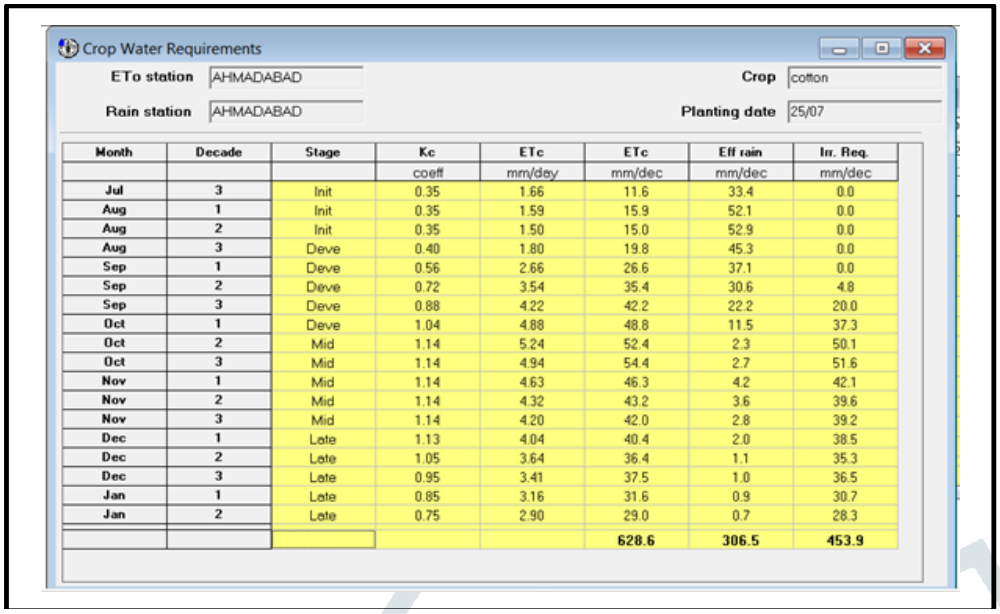
STEP 3: COTTON CROP DATA INPUT



STEP 4: SOIL DATA INPUT



STEP 5: COMPUTATION OF CROP EVAPOTRANSPIRATION AND ICWR (IRRIGATION CROP WATER REQUIREMENT) USING CROP COEFFICIENT, REFERENCE EVAPOTRANSPIRATION AND EFFECTIVE RAINFALL DATA



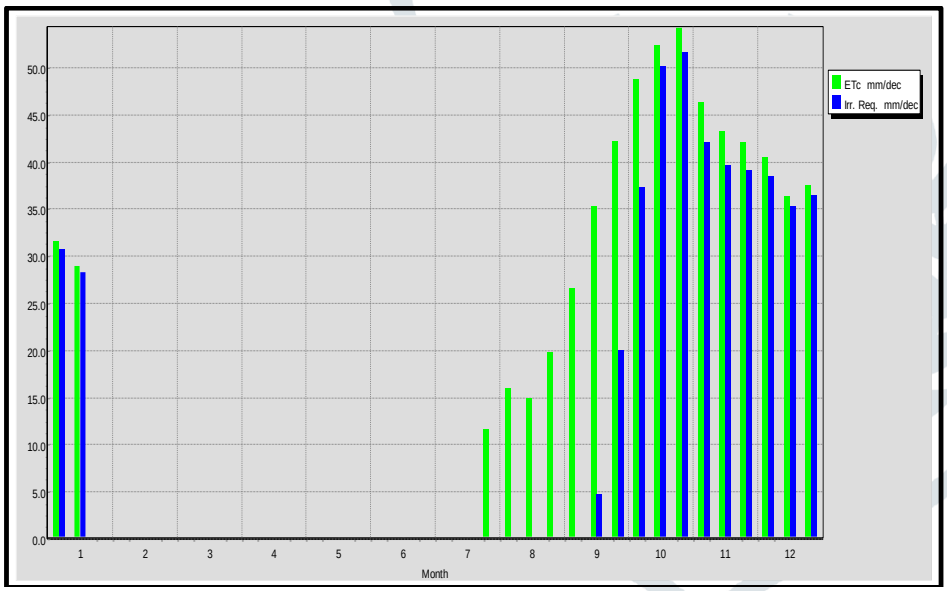
Crop Water Requirements

ETo station: AHMADABAD Crop: cotton

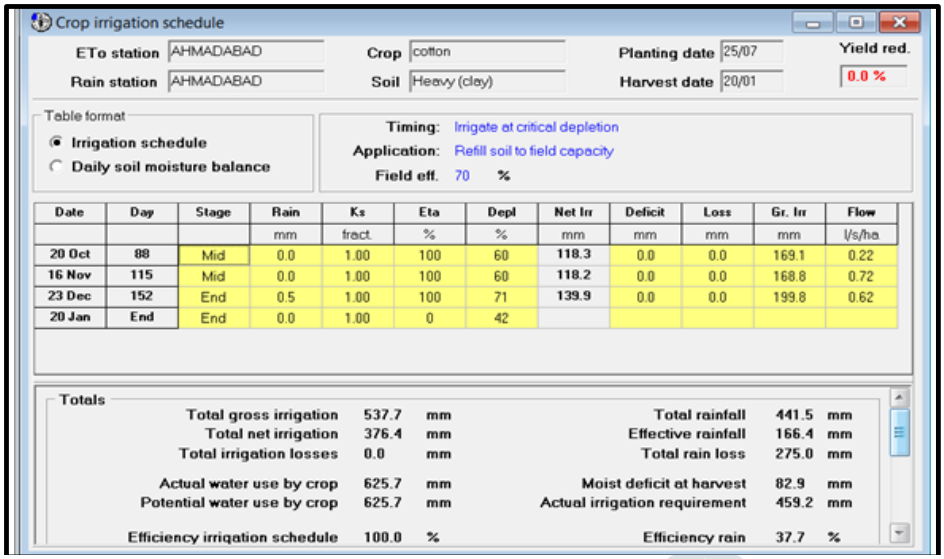
Rain station: AHMADABAD Planting date: 25/07

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/dey	mm/dec	mm/dec	mm/dec
Jul	3	Init	0.35	1.66	11.6	33.4	0.0
Aug	1	Init	0.35	1.59	15.9	52.1	0.0
Aug	2	Init	0.35	1.50	15.0	52.9	0.0
Aug	3	Deve	0.40	1.80	19.8	45.3	0.0
Sep	1	Deve	0.56	2.66	26.6	37.1	0.0
Sep	2	Deve	0.72	3.54	35.4	30.6	4.8
Sep	3	Deve	0.88	4.22	42.2	22.2	20.0
Oct	1	Deve	1.04	4.88	48.8	11.5	37.3
Oct	2	Mid	1.14	5.24	52.4	2.3	50.1
Oct	3	Mid	1.14	4.94	54.4	2.7	51.6
Nov	1	Mid	1.14	4.63	46.3	4.2	42.1
Nov	2	Mid	1.14	4.32	43.2	3.6	39.6
Nov	3	Mid	1.14	4.20	42.0	2.8	39.2
Dec	1	Late	1.13	4.04	40.4	2.0	38.5
Dec	2	Late	1.05	3.64	36.4	1.1	35.3
Dec	3	Late	0.95	3.41	37.5	1.0	36.5
Jan	1	Late	0.85	3.16	31.6	0.9	30.7
Jan	2	Late	0.75	2.90	29.0	0.7	28.3
					628.6	306.5	453.9

GRAPHICAL REPRESENTATION OF COMPARISON OF CROP EVAPOTRANSPIRATION AND IRRIGATION CROP WATER REQUIRENMENTS

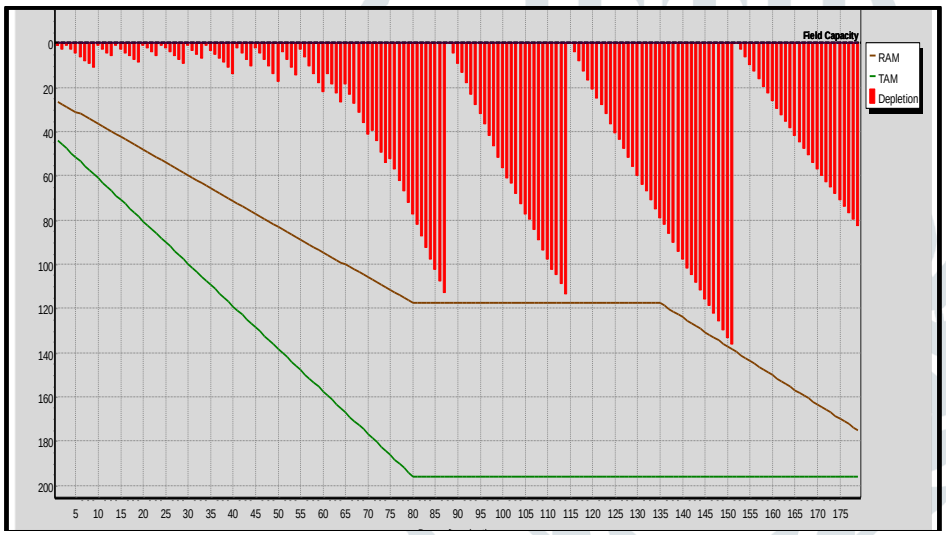


STEP 6: PREPARATION IRRIGATION SCHEDULE AT CRITICAL DEPLETION BASED ON IRRIGATION REQUIREMENTS



Date	Day	Stage	Rain	Ks	Eta	Depl	Net Irr	Deficit	Loss	Gr. Irr	Flow
			mm	fract.	%	%	mm	mm	mm	mm	l/s/ha
20 Oct	88	Mid	0.0	1.00	100	60	118.3	0.0	0.0	169.1	0.22
16 Nov	115	Mid	0.0	1.00	100	60	118.2	0.0	0.0	168.8	0.72
23 Dec	152	End	0.5	1.00	100	71	139.9	0.0	0.0	199.8	0.62
20 Jan	End	End	0.0	1.00	0	42					

GRAPHICAL REPRESENTATION OF IRRIGATION SCHEDULING AT CRITICAL DEPLETION



- Average value of reference evapotranspiration as per penman monteith equation : 5.37 mm/day
- Average value of radiation : 18.7 MJ/m^2 /day
- Step 5 shows computation of crop water requirement of cotton. The results show that a total Irrigation requirement of cotton is 453.9 mm
- Irrigation is applied at critical depletion and it refills soil to field capacity. Field efficiency is considered as 70%. Step 6 shows computation of Irrigation scheduling. As per irrigation scheduling carried out by CROPWAT it shows that gross irrigation requirement is 537.7 mm and net irrigation requirement is 376.4 mm. Fig. 10 shows the irrigation scheduling for cotton at critical depletion.
- Irrigation is applied at fixed depletion and it refills soil to field capacity. Field efficiency is considered as 70%. Step 7 shows computation of Irrigation scheduling. As per irrigation scheduling carried out by CROPWAT it shows that gross irrigation requirement is 660.6 mm and net irrigation requirement is 462.4 mm. Fig.11 shows of Irrigation scheduling
- Irrigation is applied at user defined interval and it refills soil to field capacity. Field efficiency is considered as 70%. Step 8 shows computation of Irrigation scheduling. As per irrigation scheduling carried out by CROPWAT it shows that gross irrigation requirement is 660.6 mm and net irrigation requirement is 462.4 mm. Fig. 12 shows of Irrigation scheduling

V. CONCLUSION

- From the present study, it is concluded that Reference Crop Evapotranspiration, Effective Rainfall, Crop water requirement and Irrigation water requirement can be estimated using CROPWAT 8.0 Software with the input of climatic data like maximum and minimum temperature, relative humidity, wind speed and sunshine hours and rainfall.

- The simulation results analysis suggests that crop water requirements of cotton crop is 453.9 mm/Dec and Irrigation is applied at critical depletion and it refills soil to field capacity. Field efficiency is considered as 70%. As per irrigation scheduling carried out by CROPWAT it shows that gross irrigation requirement is 537.7 mm and net irrigation requirement is 376.4 mm.

- The use of modern scientific tools like CROPWAT can assess the water requirement of crops with large accuracy and suggest the crop pattern and crop rotation which can be readily acceptable to farmers.

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