IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 19, Issue 6 Ser. I (Nov. – Dec. 2022), PP 25-31
www.iosrjournals.org

Irrigation Water Management of Mallour Distributary in Ambala

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Abstract: *Estimation of crop water requirement is necessary in the purpose of irrigation scheduling and optimal use in water management. In this study crop water requirements and irrigation scheduling of kharif season is estimated for the command area of Mallour distributary in Ambala at Haryana. Paddy and wheat are the major crops in the study area of Ambala region. The duration of paddy crop is 120 days. The cropwat model was developed by the Food and Agriculture Organisation (FAO) is used for calculating the crop water requirement (CWR) and scheduling of irrigation. Meteorological data from 1981 to 2019 were obtained from the Nasa Power Generation and soil data were obtained from the FAO 56 paper. The rainfall characteristics is estimated with climatological data and it is observed that the average annual precipitation is almost 773.56 mm where the total rainfall was 630 mm occurs during the monsoon season. The main usage of cropwat model was to estimate the reference evapotranspiration (ETo), evapotranspiration (ETc), and irrigation water requirements (IWR). The results showed that the average seasonal ETc for 2016 to 2019 is 788.60 mm for paddy crop. The lowest monthly ETo (138.43 mm) was noticed in January and the highest (225.71 mm) was noticed in June. The estimated irrigation requirement for paddy are 291.2mm respectively.*

Date of Submission: 01-11-2022 Date of Acceptance: 12-11-2022

I. Introduction

Water is life." Life can't be supported on the planet without water. It is vital for all the essential exercises for example, food, environment, development, and assembling businesses. It has a critical impact on the nation's monetary growth and general prosperity. The UN has said that "water is a social and social great, not simply a financial item." Developing populace in the mix with reasonable advancement endeavours is encountering expanding weight on water assets. The inconsistent dispersion of water assets over the long haul and space and their adjustment through human use and abuse are reasons for water deficiencies in numerous world pieces. According to the Land Use Statistics 2014-15, the complete topographical region of the nation is 328.7 million hectares, of which 140.1 million hectares is the revealed net planted zone and 198.4 million hectares is the gross edited zone with a trimming power of 142%. The actual zone planted works out to be 43% of the absolute geological region. The actual flooded zone is 68.4 million hectares. Because of these conditions, rural efficiency is restricted by the factors associated with ecology, such as temperamental water supply, wordy downpours, and helpless soils. Roundabout occasions may even now be lost to the climate because of environmental factors, for example, temperature. One significant course through which water is lost to the environment is vanishing, driven by air temperatures. In plants, in any case, water is likewise lost through happening. It is regularly hard to isolate dissipation and happen; consequently, water lost through the two cycles is named evapotranspiration. Water lost through this cycle might be recharged by precipitation or water system to meet the yield water needs. There are a few different ways to decide how much water should be applied to plants at a specific point as expected. Both immediate and backhanded field estimations can be used. It is regularly troublesome and expensive to quantify ETc straightforwardly. To get around impediments related to direct field estimations in certain regions, demonstrating the paces of reference evapotranspiration (ETo) and harvest evapotranspiration/crop water necessities (ETc/CWR) has been utilized to design water system and the powerful designation of water assets [1]. Crop water requirement (CWR) is defined as the water depth consumptively used by crops without loss of irrigation water. The crop water requirement depends upon evapotranspiration, crop type, and its characteristics, climate condition, soil characteristics. In India, the irrigation projects have been planned with simpler assumption (delta method) to define crop water requirement. However, crop water needs vary with space and time, as the demand for evapotranspiration tends to vary with the local environment, soil characteristics and crop variety. Over the period various methods and models are being developed and applied for estimating crop water requirement and proper management of irrigation projects. Various researchers have applied Cropwat model, developed by Food and Agriculture Organization (FAO), for estimating the crop water requirement.

The researchers have carried out the study of soil moisture depletion in root depth in high density apple orchard of Jammu and Kashmir and observed the maximum depletion of 16 cm in crop root zone. The crop coefficient value had been modified by the local agro climatological condition and adopted the methodology obtained by Food and Agriculture Organisation (FAO). The cropwat model was used for estimating the crop water requirement in high density area of apple crop for evaluating the irrigation scheduling [2]. The another researcher had been carried out the study for irrigation requirement of coconut to improve the water and crop productivity in Kerala The researcher observed that the quantity of water requirement of palm tree is varied between 115 to 200 litres per day (LPD)[3]. The researchers have carried out the study on grapes crop water requirement evaluated by the cropwat model. The researchers observed that the cropwat model gives the better result and directly affect the crop productivity and water use efficiency. The productivity of crop is increased up to 42% and enhanced the water use efficiency (WUE) up to 25% [4]. The main source for calculating the CWR is crop evapotranspiration (ET_o) multiply by a crop coefficient (Kc) value of required water by crop [5]**.** The study was carried out for estimating the actual evapotranspiration (AET) of the Shipra river basin in Madhya Pradesh by using cropwat model. The major crop in kharif season is soyabean, sorghum and in rabi season is wheat and gram. The kc value was obtained by the guideline of Irrigation Department. The maximum Et value was observed in the month of May (288 mm) and minimum was month of November (34 mm**)** respectively [6]**.** In this study the Irrigation Water requirement of Mallour Distributary in Ambala is estimated using Cropwat model for increasing overall efficiency of the system.

II. Study area and Data

The command area of Mallour Distributary is located at latitude 30º 20’ 59.14" N and longitude 76º 50’ 01.26" E in the Ambala district of Haryana. The altitude is 301 m high from mean sea level. The Ambala district receives irrigation water from the Narwana Branch; which is carrying the water from the Bhakra mainline and it is the lifeline of irrigation and other systems in Ambala district. The off taking of Narwana Branch from BML is at RD 158000/L with carrying capacity is 4022 cusecs (general supply is 3900 cusecs). The Narwana branch is enters to Ambala in Haryana through Punjab Portion at RD 160765. A cross regulator is fixed for diverting the water from SYL Canal at RD 166500 of the Narwana branch for the regulation of the other canal systems. The index map of the study area is shown in figure 1. The Gross Command Area (GCA) is 6299 ha and Cultivable Command Area (CCA) is 5799 ha respectively The command area of the study area during kharif seasons of 2016 to 2019 is 2485acre, 2493acre,2567 acre, and 2546 acre respectively. The length of the Mallour distributary is 9.52 km. The off taking RD of Mallour Distributaries is 166465/R of Narwana Branch with design discharge of 35.09 cusecs in Kharif and 14.06 cusecs in Rabi season. The irrigation is primarily supplied from surface water through canal irrigation systems. The various crops grown in these area: Rice, Wheat, Sugarcane, Pulses, Onion, and Potatoes, etc. However, rice and wheat are the two major crops of this region. The various varieties of rice cultivated in these area are 11 - 21, 30 nos’, PR14, Cauvery hybrid, 2355 hybrid, and in wheat 2967, 187, 2733, 222, etc**.** The seasonal water requirement of the paddy crop is 450 – 700 mm/total growing period and total growing period of paddy crop is 90 – 150 days.

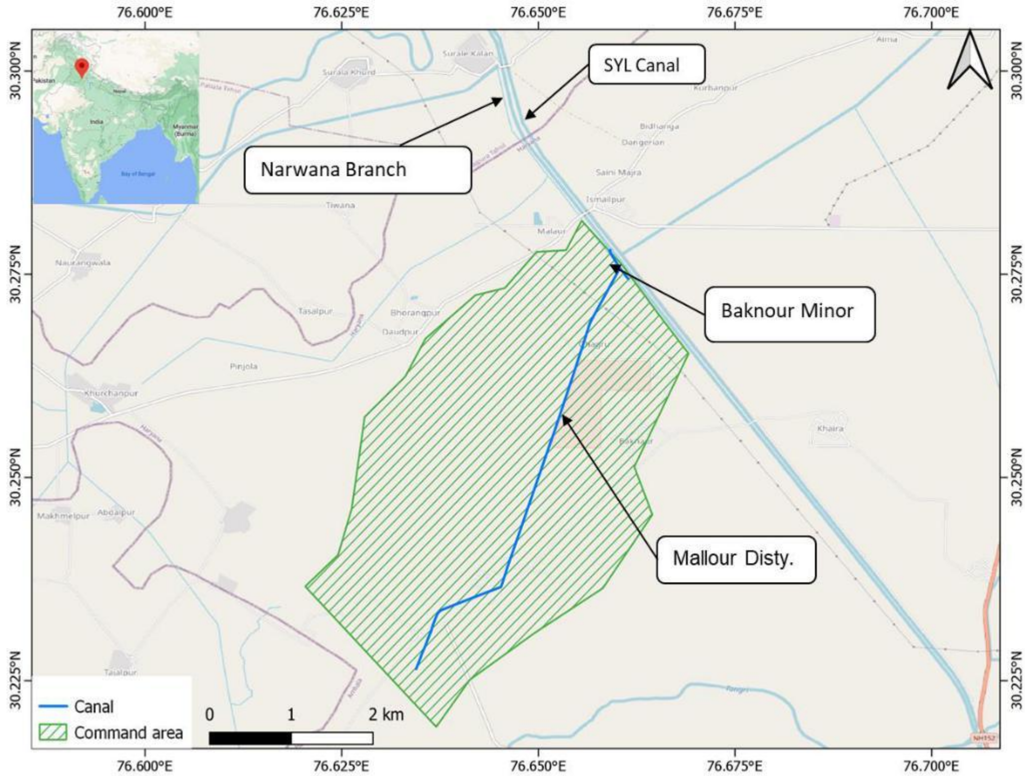

Fig. 1 Index map of the study area

The meteorological data like minimum and maximum air temperature, relative humidity, sunshine hours, and wind speed etc. for the area are obtained from NASA Power Generation Centre. Soil characteristics are taken from Food and Drainage Organization and crop calendar is obtained from the Irrigation Department of Ambala, Haryana. In addition to this historical water supply to the Mallour distributary is also obtained from the Irrigation Department of Ambala, Haryana for the period 2016 to 2019.

III. Methodology

The methodology in this study is shown in Fig. 2. The various hydro meteorological data are collected for estimation of irrigation requirement. Various meteorological data like minimum and maximum air temperature, relative humidity, sunshine hours, and wind speed etc. are required for calculating the reference evapotranspiration (ET_o). There are various methods for calculating the ET0 are Blaney Criddle, Thornthwaite, Penmen Monteith, Hargreaves, etc. The CROPWAT model is used for estimating ET0 and crop water requirement for various crops from meteorological, rainfall, soil and crop data. The CROPWAT, a product bundle created by the United Nations Food and Agriculture Organization (FAO), utilizes soil water planning in the root zone, in which real evapotranspiration count additionally assessed by ET0 with Kc and Water pressure coefficient (Ks), and the Penman-Monteith condition suggested by FAO in 1998, was utilized to figure ET0. It demonstrated higher exactness and more extensive reasonableness in the application. Subsequently, the CROPWAT model was utilized to perceive crop water shortages in fields to appraise the spatial circulation of evapotranspiration and to plan water system schedules. The CROPWAT model suitable accounts for crop coefficients, seepage, and the development of the soil water at the maximum root profundity[7]**.** The detail procedure was adopted by cropwat model for estimating the crop water requirement can be found in the manual [8]. Field application efficiency and convenience losses are added to estimate irrigation requirements and required supply at head regulator of Mallour distributary. Further, the actual irrigation supplied during the Kharif season of 2016-2019 are also analyzed for estimating irrigation efficiency.

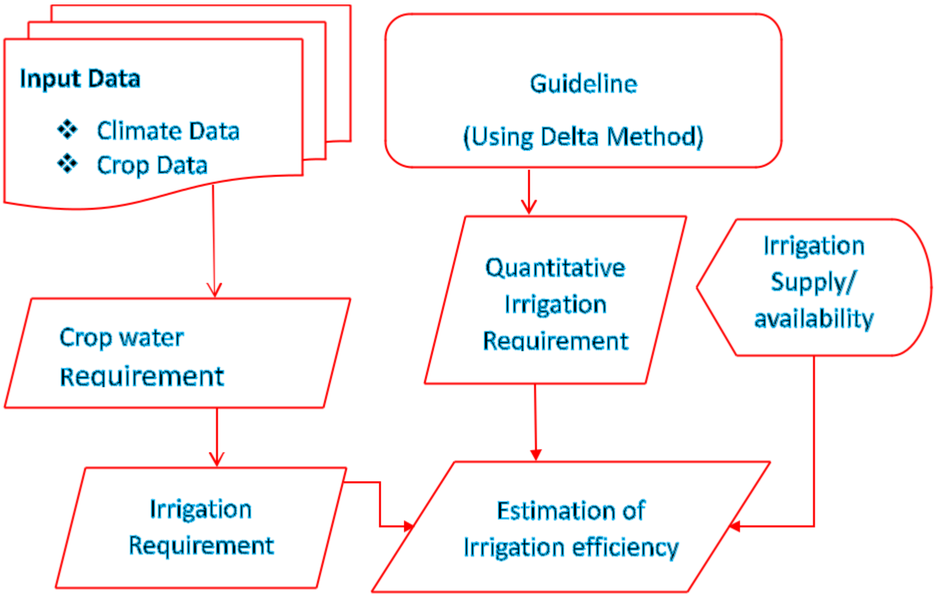

Fig. 2: Flow chart showing general methodology

IV. Results and Discussion

The estimated rainfall characteristics are shown in figure 3. It is observed that the average annual precipitation is 773.56 mm where the total rainfall was 630 mm occurs during the monsoon season. The dependable rainfall is estimated using webull approach. The 75% dependable rainfall is observed in 1984 with annual rainfall of 647.92mm and monsoon rainfall of 499.81 mm. The ET0 is estimated using cropwat model with input data like minimum and maximum temperature, wind speed, relative humidity,sun shine hours, solar radiation. The Monthly variation of these climatic factors is shown in Figure 4. The maximum ETo value is observed in the month of June is 7.44 mm/day and minimum in the month of January is 1.84 mm/day respectively. Effective rainfall is expressed as a part of precipitation which is effectively used by the crop after various losses due to surface runoff and percolation. Here, USDA Soil Conservation Service method was selected for estimating effective rainfall. The effective rainfall is estimated to be about 70 % of the precipitation i.e. 656.7 mm per annum out of the total annual rainfall 938.0 mm in the study area. The estimated monthly evapotranspiration and effective rainfall are shown in Table

1. The maximum rainfall and maximum effective rainfall occurred in July (151.4 mm) followed by August (150.1 mm) and September (129 mm) months. The minimum effective rainfall occurred during November with 6.9 mm. The crop duration is for 120 days. The nursery for transplanting is prepared in about 579.9 ha, which is generally irrigated from the groundwater source through tube wells. After computing ET0 and effective rainfall the crop water requirement and irrigation requirement are estimate from the soil characteristics and crop characteristics.The computed irrigationrequirement for paddy crop in 10-daily period is shown in Table 2. The soil moisture retention during paddy crop period is shown in Figure 5. The irrigation requirement is very high during the initial stage for field preparation in the month of June. During developmental stage the irrigation requirement is low as most of the water requirement is met by rainfall in month of July, August and September. Again irrigation requirement is high during late stage for flowring and maturing of crop.

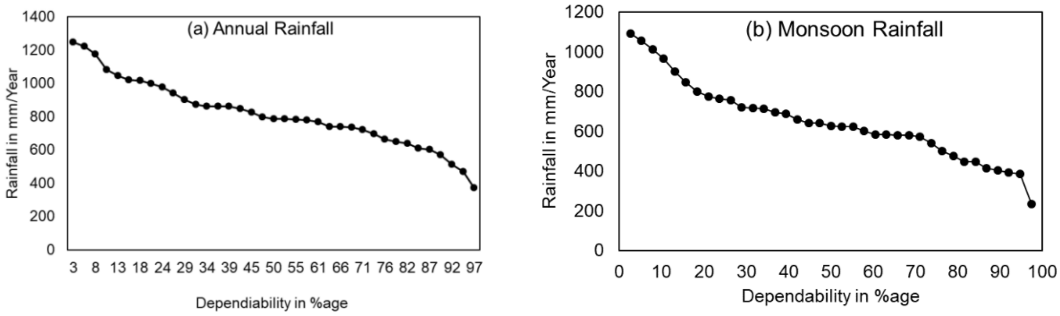

Fig 3: Rainfall Characteristics

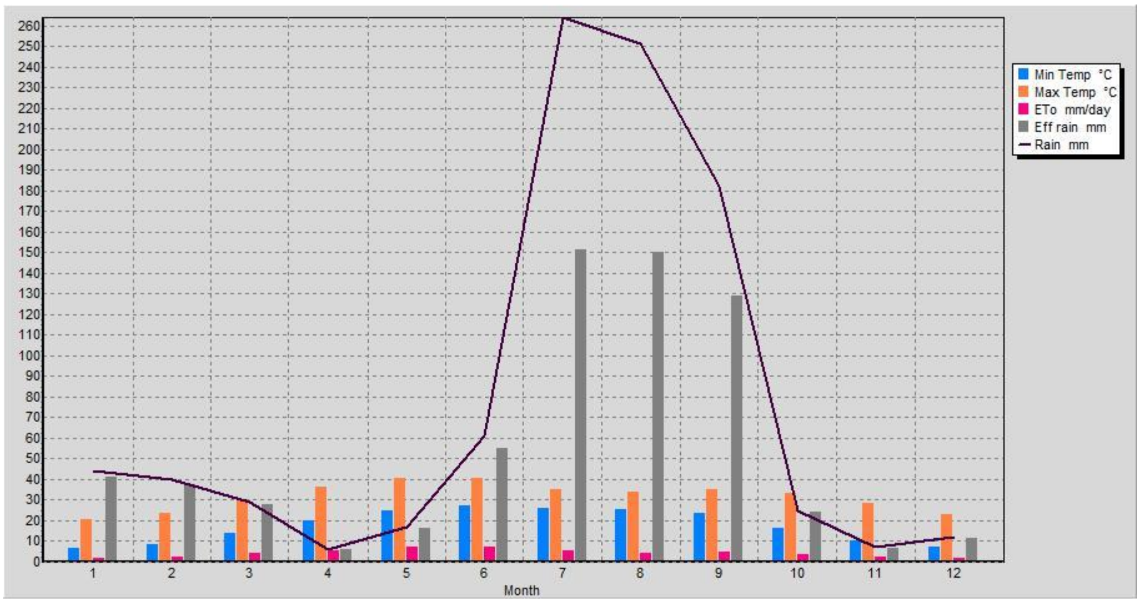

Figure 4: Monthly variation of climatic factor

Table 1 : Monthly Rainfall and Evapotranspiration

Month	Rain (mm)	Eff Rain (mm)	ET0 (mm/day)
January	44	40.9	1.84
February	40	37.4	2.71
March	29	27.7	4.09
April	6	5.9	5.67
May	17	16.5	6.97
June	61	55	7.44
July	264	151.4	5.25
August	251	150.1	4.46
September	182	129	4.57
October	25	24	3.68
November	7	6.9	2.68
December	12	11.8	1.87

Table 2: 10-daily irrigation requirement for paddy crop

Month	Decade	Stage	Kc	ETc	ETc	Eff Rain	Irr. Req.
	coeff	mm/day	mm/dec	mm/dec	mm/dec	Mm/dec	mm/dec
Jun	1	Init	1.05	7.86	7.9	1.2	7.9
Jun	2	Init	1.05	8.13	81.3	15.6	65.6
Jun	3	Init	1.05	7.26	72.6	27.3	45.3
Jul	1	Deve	1.05	6.21	62.1	42.8	19.3
Jul	2	Deve	1.07	5.49	54.9	55.1	0
Jul	3	Deve	1.09	5.36	59	53.4	5.6
Aug	1	Deve	1.11	5.19	51.9	50.8	1.1
Aug	2	Mid	1.14	4.96	49.6	50.9	0
Aug	3	Mid	1.14	5.06	55.7	48.3	7.4
Sep	1	Mid	1.14	5.26	52.6	48	4.6
Sep	2	Mid	1.14	5.34	53.4	47	6.4
Sep	3	Mid	1.14	4.96	49.6	34	15.6

Oct	1	Late	1.12	4.46	44.6	16.9	27.7
Oct	2	Late	1.07	3.92	39.2	3.9	35.4
Oct	3	Late	1.01	3.36	37	3.3	33.7
Nov	1	Late	0.96	2.88	17.3	2.1	15.5
Total					**788.6**	**500.5**	**291.2**

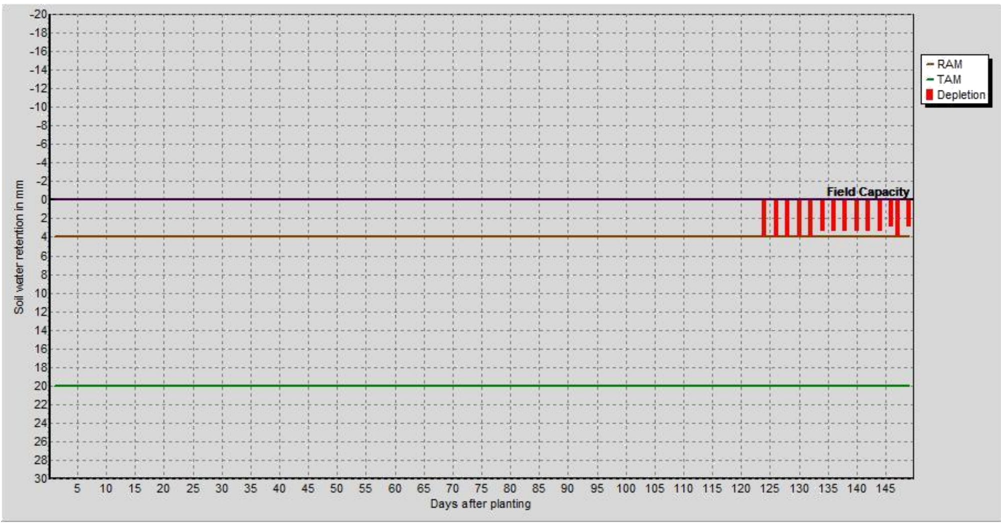

Fig. 5 Soil moisture variation in paddy field

The irrigation water supplied at design efficiency of 60%. The actual irrigation supplied (flow rate) in Kharif season is shown in Figure 6. The total volume of irrigation water was 1.63 MCM, 1.87 MCM, 1.84 MCM and 2.03 MCM respectively. The estimated total water requirement for the Kharif season is in the order of about 8.67 Mcm. The estimated irrigation water requirements of paddy crop during 2016 to 2019 are 2.92 MCM, 2.93 MCM, 3.02 MCM, and 3.00 MCM respectively. The balance water requirement is met by the ground water source.

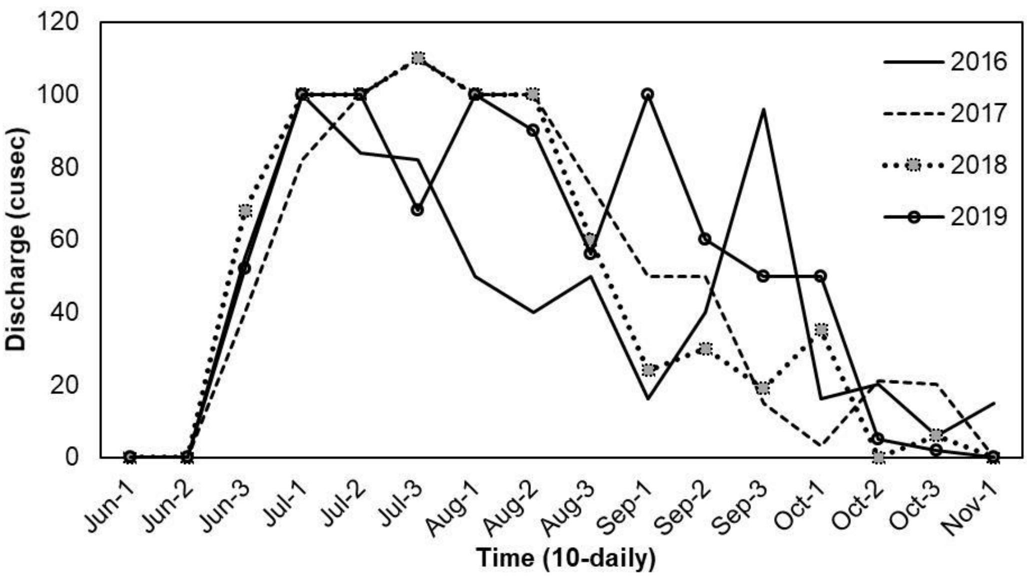

Figure 6: Irrigation supplied during Kharif season (2016 to 2019)

V. Conclusion

In this study crop water requirements and irrigation scheduling of kharif season for the command area of Mallour distributary in Ambala at Haryana is carried out using CROPWAT model, developed by the Food and Agriculture Organisation. Paddy is the major crop cultivated in the Kharif season. The duration of paddy crop is 120 days and Cultivable Command Area is 5799 ha. Meteorological data from 1981 to 2019 were obtained from the Nasa Power Generation and soil data were obtained from the FAO 56 paper. It is observed that the average annual precipitation is about 773.56 mm out of which about 630 mm occurs during the monsoon season. USDA Soil Conservation Service method is used for estimating effective rainfall. The effective rainfall is estimated to be about 70 % of the precipitation i.e. 656.7 mm per annum out of the total annual precipitation 938.0 mm in the study area. The maximum precipitation and maximum effective rainfall occurred in July (151.4 mm) followed by August (150.1mm and September (129 mm) months. The cropwat model was used for estimating the reference evapotranspiration (ETo), evapotranspiration (ETc), and irrigation water requirements (IWR). It is observed that the irrigation requirement is very high during the intial stage for field prepration in the month of June and low during developmental stage as most of the water requirement is met by rainall in month of July, August and September. Again irrigation requirement is high duirng late stage for flowring and maturing of crop. The results showed that the average seasonal ETc for 2016 to 2019 is 788.60 mm for paddy crop. The estimated irrigation requirement for paddy are 291.2mm. The estimated irrigation water requirement of paddy crop during 2016 to 2019 are 2.92 MCM, 2.93 MCM, 3.02 MCM, and 3.00 MCM respectively. However, total volume of irrigation water was 1.63 MCM, 1.87 MCM,1.84 MCM and 2.03 MCM respectively. The balance water requirement is generally met from the ground water source. It is observed that the irrigation water supply is not adequate and in future it is planned to diversify the cropping pattern and increase irrigation efficiency to reduce dependency on groundwater.

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Vikrant Chaudhary, et. al. “Irrigation Water Management of Mallour Distributary in Ambala”. *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, 19(6), 2022, pp. 25-31.