RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 13 | Issue 1 | April, 2020 | 56-61

ISSN–0974–2662 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/13.1/56-61**

Estimate the irrigation water requirements of existing and other high value crops in the Appapuram Channel Command using 'AquaCrop' Model

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Received : 29.11.2019; **Revised :** 12.02.2020; **Accepted :** 27.02.2020

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■ **ABSTRACT :** This study was carried out to determine the total water requirement needed for 10000 hectares of rice, cotton, maize, chillies, black gram, green gram, sugarcane and other crops are commonly grown in the area, which are being cultivated in appapuram channel command of Krishna Western Delta (KWD) in *Kharif* and *Rabi* seasons, respectively. In KWD, water is supplied continuously until about 10 days before harvesting. Water is required to bring the fields to saturation, and to establish a layer of water in the fields to facilitate land preparation, Saturation of water, effective rainfall, evapotranspiration and seepage percolation will be calculated for determination of crop water requirement during the pre-saturation and normal growth periods. The computer simulation model AquaCrop was applied to estimate crop water requirements and yield of rice, cotton chilli, and maize green gram and block gram crops grown in both the seasons. The decennial meteorological data for years 2000-2015. The study showed that the total of 1010, 656.0, 573.3, 816.2, 672.2 mm and 552.2 mm of irrigation water for paddy maize blackgram chilli, cotton, and green gram crops during *Kharif* and *Rabi* seasons, respectively which clearly show that there is a misutilization of canal water and non-utilization of ground water to the extent recommended hence the area under cultivation is also lower than the actual potential.

■ **KEY WORDS :** AquaCrop Model, CROPWAT, Water requirement, Grain yield

■ **HOW TO CITE THIS PAPER :** Kishan, K. and Hema Kumar, H.V. (2020). Estimate the irrigation water requirements of existing and other high value crops in the Appapuram Channel Command using 'AquaCrop' Model. *Internat. J. Agric. Engg.*, **13**(1) : 56-61, **DOI: 10.15740/HAS/IJAE/13.1/56-61.**

resources. All this can be achieved by using appropriate tools to predict water productivity under different irrigation regimes or deficit irrigation approaches for different crops (Sarangi, 2010).

METHODOLOGY

The command area of Appapuram channel, which branches form Commamuru branch canal (Krishna Western main canal) near Sangam Jagarlamudi lock is selected as the study area. Field visits were made to study the actual cropping pattern existing in the command. Interaction meetings and interviews with the farmers, WUA members were conducted to collect the information to the nearest possibility to the ground truth. It spreader over 10000 ha and is on an average 6 m above the mean sea level. The Appapuram channel has nine branches hydraulic particulars of Appapuram main channel and its distributaries.

Though the crops like paddy, cotton, maize, chillies, black gram, and green gram and sugarcane are commonly grown in the area, for the past three years, farmers were growing paddy, in *Kharif* and maize, blackgram in *Rabi* seasons, respectively. The model CROPWAT was run to calculate the effective rainfall which is an important parameter for calculating crop irrigation requirement. The canal water release data for 10 years (2005-2015) were collected from Irrigation and Command Area Development (I & CAD) Department at Bapatla and analyzed for further investigation. The details of crops grown in the command, climate, soil data etc. collected are used to assess the net irrigation requirement in the distributary using Aqua Crop 4.0 Model.

The effective precipitation is one of the water inputs to the soil root zone. For irrigation purpose the effective rainfall is defined as the part of total precipitation during the crop growing period that is available to meet the evapotranspiration needs of that crop. USDA Soil Conservation Service Method (USDA-SCS Method) is used by the crop model for calculating the effective rainfall. The net irrigation requirement for crops grown in the distributory is computed by the Aqua Crop 4.0 Model.

Aqua Crop 4.0 is a crop water productivity model developed and modified by the Land and Water Division of FAO (2012) to simulate yield response to water. Aqua Crop is a general model, as it is widely used for a wide range of herbaceous crops, including forage, vegetable, grain, fruit, oil, and root and tuber crops. It simulates yield response to water of herbaceous crops and is particularly suited to address conditions where water is

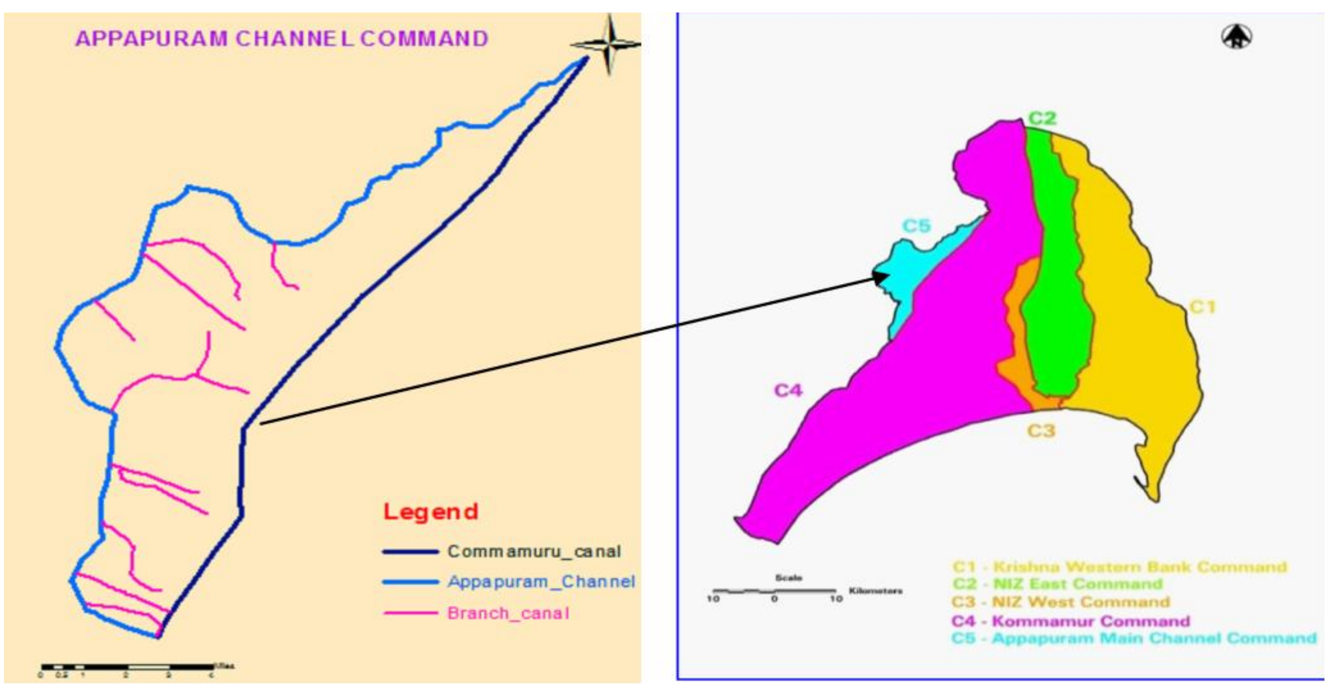

Fig. A : Map showing appapuram channel command area

a key limiting factor in crop production. Aqua Crop attempts to balance accuracy, simplicity and robustness. It uses a relatively small number of explicit and mostly-intuitive parameters and input variables requiring simple methods for their determination. Its main applications include assessing water-limited, attainable crop yields at

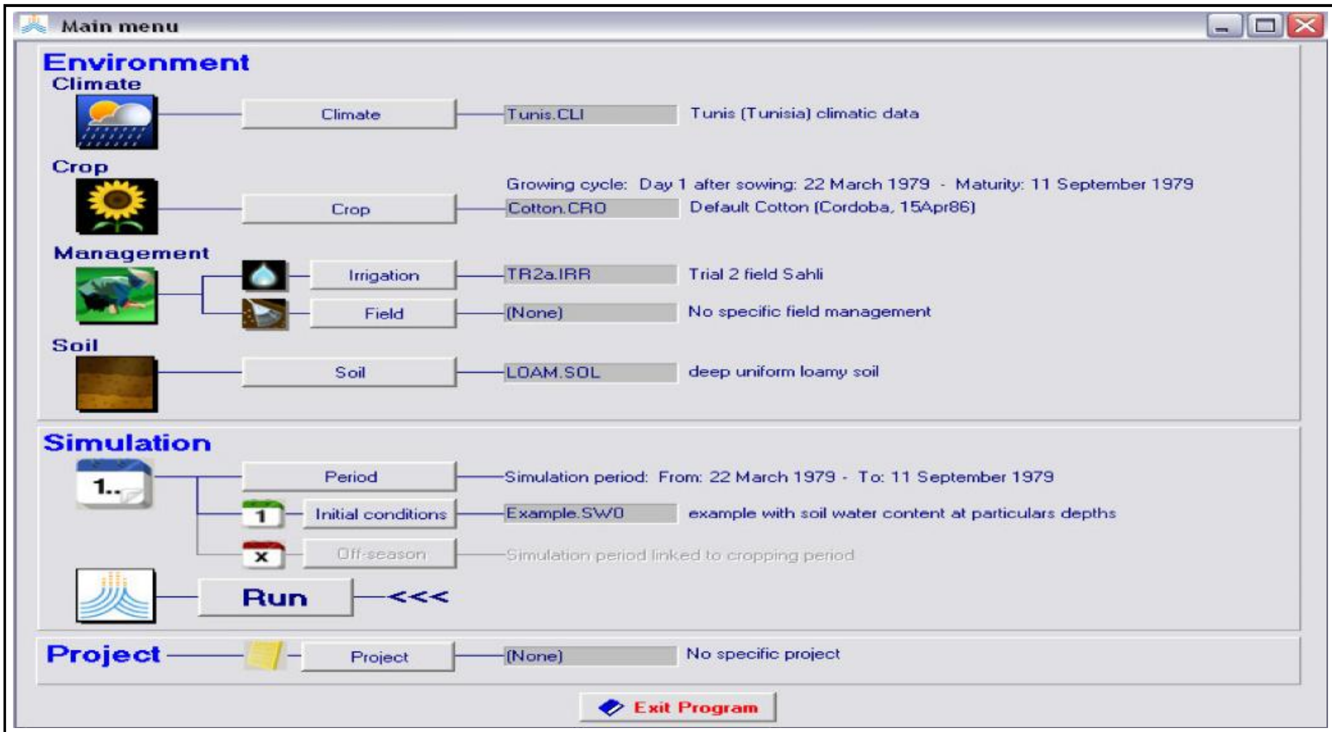

Fig. B : Main menu of Aqua Crop 4.0 model

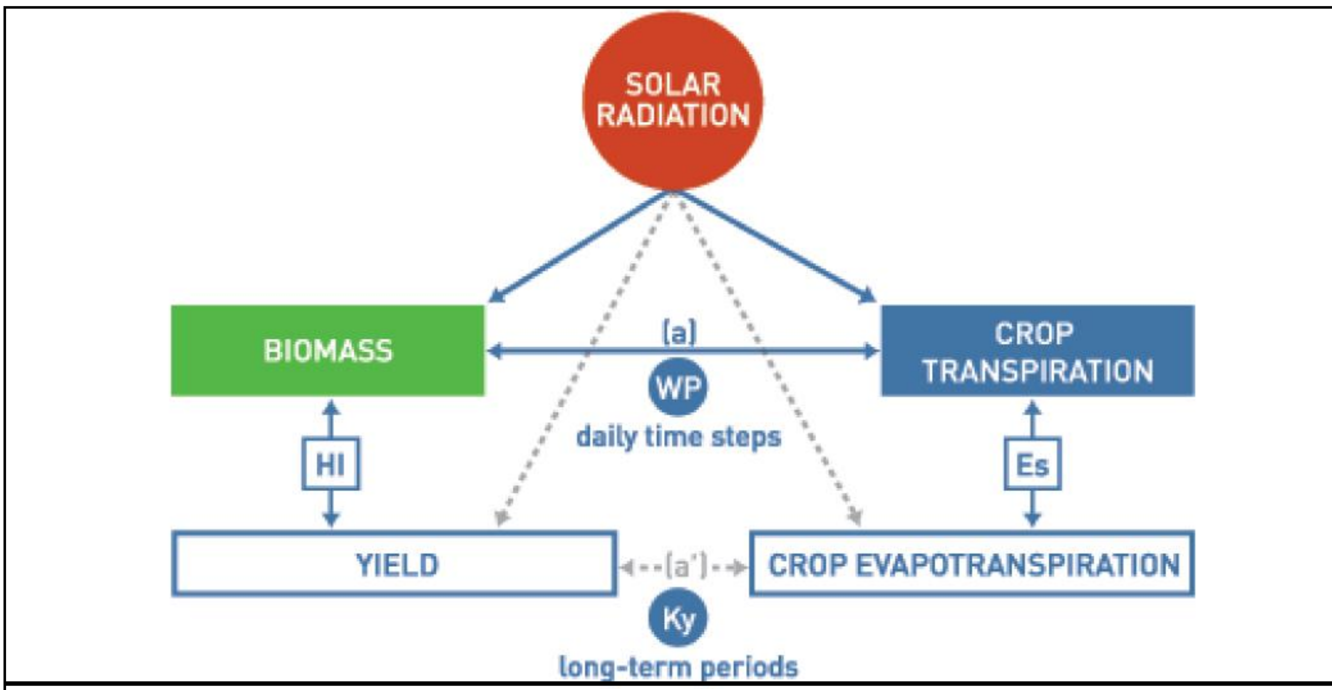

Fig. C : Schematic representation aqua crop 4.0 model

a given geographical location, assessing rain fed crop production on the long term and developing irrigation schedules for maximum production and for different climate scenarios and for optimizing a limited amount of water available.

Aqua Crop uses a relative small number of explicit parameters and largely intuitive input variables, either widely used or requiring simple methods for their determination. Input consists of five components such as weather data, crop and soil characteristics, and field and irrigation management practices that define the environment in which the crop will develop.

RESULTS AND DISCUSSION

The model calculated the effective rainfall in mm for each month taking the average monthly rainfall values for the study area. The weather data fed in the model was used to calculate the effective rainfall duly deducting the evapotranspiration and infiltration and deep percolation losses.

The total annual rainfall of the study area was plotted for 15 years is presented in Fig. 1.The rainfall data for the period of 15 years (2000-2015) were collected from RARS, Lam in Guntur district. The season wise rainfall (2000-2015) of this station is shown in Fig. 2.

From the Fig. 2, it could be observed that the during the *Kharif*, there is more rainfall than the other two seasons. This information was utilized in the estimation of irrigation water requirements of different crops finally in formulating the constraints also.

Effective rainfall is one of the important water input to root zone to meet the evapotranspiration needs of the crop. The calculations were performed through CROPWAT model by feeding the rainfall and other meteorological parameters on mean monthly basis. The model was run for multiple crops and multiple crop periods (2000-2015) successively.The USDA soil conservation service (SCS) method was used by the model to calculate the daily effective rainfall and is represented in Fig. 3. This information is used in feeding in Aqua Crop model for predicting the yield levels of different crops of the study area.

The computer simulation model AquaCrop was applied to estimate crop water requirements and yield of rice, cotton chilli, and maize green gram and block gram crops grown in both the seasons. The decennial meteorological data for years 2000-2015 The study showed that the total of 1010, 656.0, 573.3, 816.2, 672.2 mm, and 552.2 mm of irrigation water for paddy maize blackgram chilli, cotton, and green gram crops during *Kharif* and *Rabi* seasons, respectively

On the basis of last three year records obtained from agriculture department and information collected from farmers. The study showed total yield 5.5, 1.5, 4.1, 4.0, 1.0 and 1.0 t/ha of yield for rice cotton maize chilli, maize, green gram and black gram crops during *Kharif*

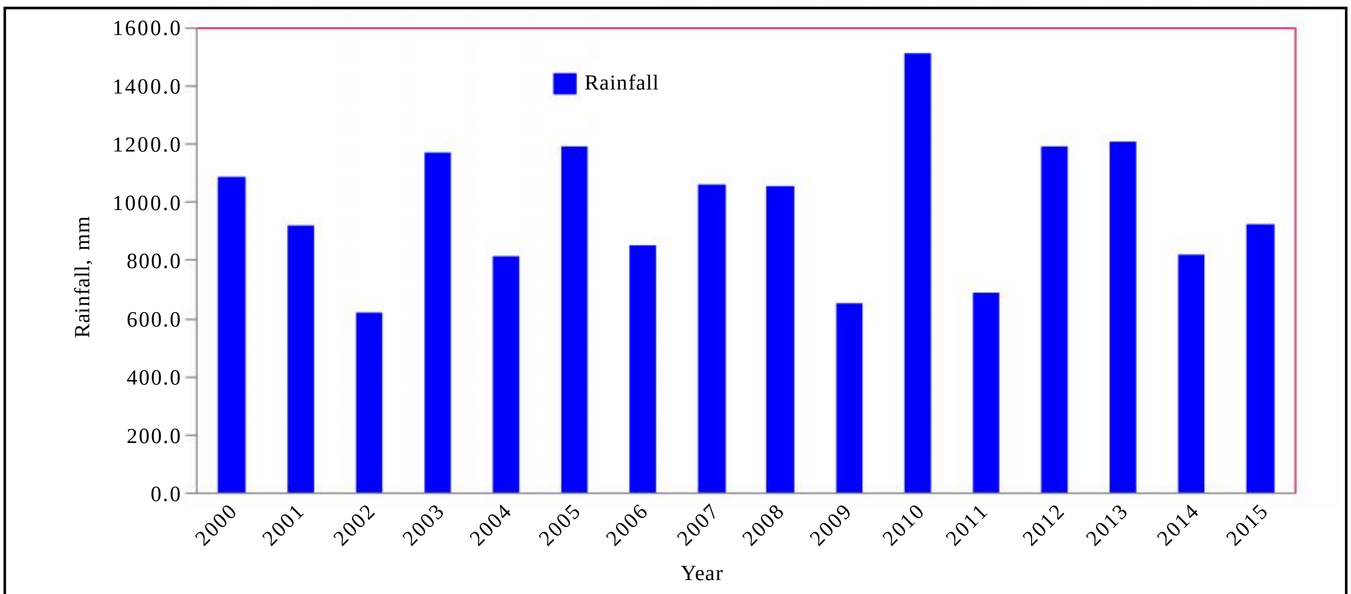

Fig. 1 : Annual rainfall in appapuram channel command (2000-2015)

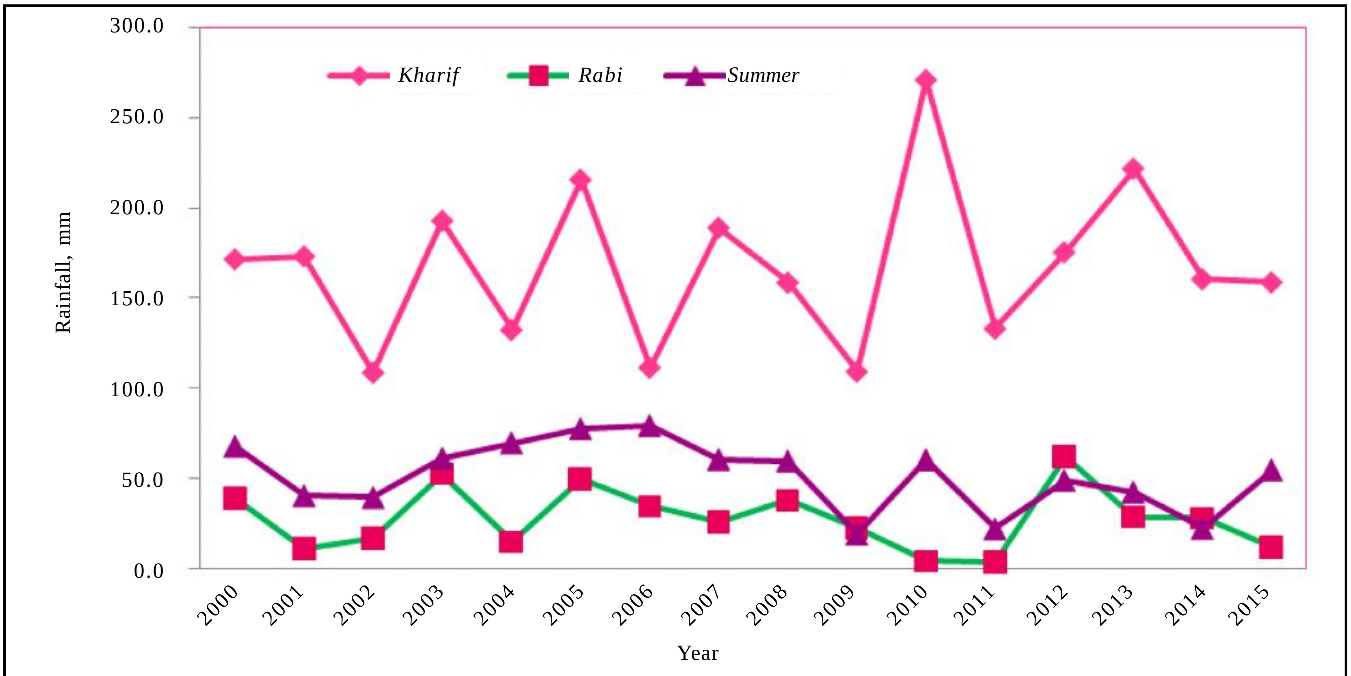

Fig. 2 : Seasonal rainfall in appapuram channel command (2000-2015)

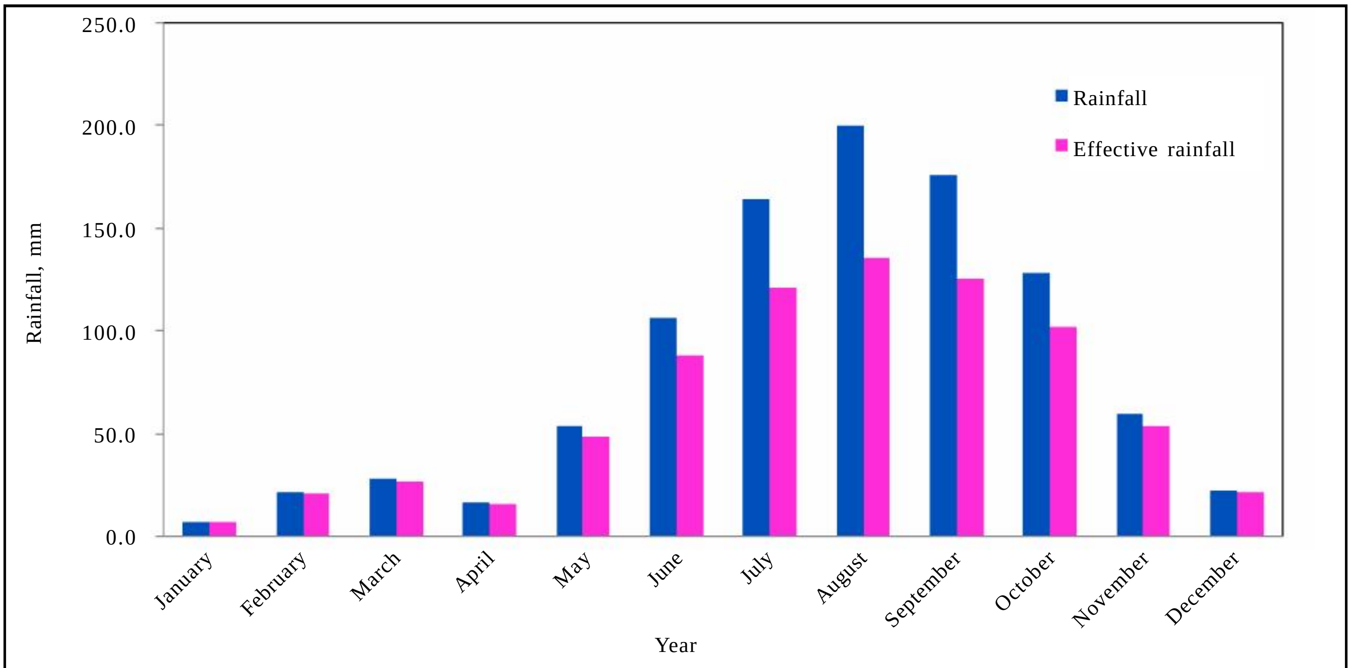

Fig. 3 : Monthly and effective rainfall in the study area

and *Rabi* seasons, respectively.

Conclusion:

The computer simulation model AquaCrop was applied to estimate crop water requirements and yield of rice, cotton chilli, and maize green gram and block gram crops grown in both the seasons. The AquaCrop model predicts yield of a crop through crop physiological

Table 1 : Estimated monthly irrigation water requirement of different crops

Sr. No.	Month	Paddy (mm)	Maize (mm)	Blackgram (mm)	Chilli (mm)	Cotton (mm)	Green gram (mm)
1.	January	0.0	107.5	0.0	103.0	103.0	0.0
2.	February	0.0	114.9	0.0	110.1	110.1	0.0
3.	March	0.0	150.3	131.5	144.0	0.0	131.5
4.	April	0.0	171.7	150.3	0.0	0.0	150.3
5.	May	0.0	0.0	161.4	0.0	0.0	161.4
6.	June	0.0	0.0	130.1	0.0	0.0	109.0
7.	July	250	0.0	0.0	0.0	0.0	0.0
8.	August	220	0.0	0.0	0.0	0.0	0.0
9.	September	210	0.0	0.0	120.4	120.4	0.0
10.	October	180	0.0	0.0	113.7	113.7	0.0
11.	November	150	0.0	0.0	118.0	118.0	0.0
12.	December	0.0	111.6	0.0	107.0	107.0	0.0
		1010	656.0	573.3	816.2	672.2	552.2

Table 2 : Average yield of different crops in command area

Sr. No.	Crop	Yield(t/ha)
1	Rice	5.5
2	Cotton	1.5
3	Chilli	4.1
4	Maize	4.0
5	Greengram	1.0
6	Blackgram	1.0

responses based on different irrigation regimes and rainfed situations. The model have been successfully calibrated and validated for different crops and vegetables. The salinity module of AquaCrop is under development and can provide the crop response under irrigated saline environment. The AquaCrop model is useful for developing irrigation strategies under water deficit situations. Similar work related to the present investigation was also carried out byArya *et al.* (2010); Ahmadi *et al*. (2015); Bhandarkar *et al*. (2004); Srinivasulu *et al.* (2003) and Zhiming *et al*. (2007).

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