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Assessment of Aquacrop Model for Irrigated Cotton under Deficit Irrigation in Semi-Arid Tropics of Maharashtra

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Predicting attainable yield under water limiting condition is an important goal in rainfed agriculture. Proper irrigation planning is not only essential for water saving but also for yield enhancement and it is only possible when an accurate and reliable decision-making tool has been adopted. AquaCrop is one of the models extensively used for irrigation planning purposes. To evaluate the performance of the model, the present experiment entitled on "Assessment of AquaCrop model for irrigated cotton under deficit irrigation in semi-arid tropics of Maharashtra'' was carried out at Department of Irrigation and Drainage Engineering, CAET, Parbhani. The experiment was conducted in such a way that AquaCrop model was calibrated for the year 2009-2010 and it was validated for the year 2010-2011. Part of the obtained field data *i.e.* data for full irrigation treatment (100% ET_c) for the year 2009-2010 was used for calibration of the model, while the data of 2010-2011 was used to validate the model. AquaCrop version 6.1 was used in the study. There was a close match between observed and simulated canopy cover. It was supported by high value of R^2_{NS} (0.97). Another statistical parameter CRM having value of -0.045, indicates that the model overestimates the canopy cover. The high value of Nash Sutcliffe coefficient (R^2_{NS}) value as 0.81 shows close match between observed and simulated yield. The CRM (Coefficient of Residual Mass) between observed and simulated yield was also as low as -0.060, indicating that the model overestimated the yield**.** Considering overall acceptability of validation results, it was concluded that the model performs well with relatively high validity.

Introduction

Cotton is known as "white gold" in India since it is the most valuable cash crop. Cotton is one of India's most important cash crops, contributing significantly to the country's economic development. Cotton farming is an essential aspect of Indian agriculture since it provides a wide range of livelihood and employment opportunities. Cotton is the most important cash crop for contributing significantly to export earnings. Cotton farming employs over 6 million farmers directly and indirectly engages approximately 40 to 50 million people involved in cotton cultivation, cotton trade, and cotton processing. Cotton fibre is a unique fibre that serves as a raw resource for the textile industry, with an annual economic impact of at least $600 billion. Genetic diversity and its history in receiving lint cotton and cotton yield sustainability, as well as a history of bio-based extra qualities like demonstration and change in numerous biochemical, physiological, morphological, and genetically relevant traits. It is grown on roughly 10.31 million hectares of land in the country, accounting for 30 % of global cotton production and 30 % of global cotton area. Cotton is produced throughout the world at a rate of precisely 25 million tonnes per year. India is the world's second-largest cotton producer, after China, and the world's second-largest cotton exporter, after the United States. Over the last five years, global cotton production has expanded dramatically. A total of 25,185,000 metric tonnes (148 million bales, 170 kg each bale) were produced in 2010. Brazil (2027 kg/ha) is the most productive of the six major cotton-growing countries, followed by China (1311 kg/ha), the United States (945 kg/ha), Uzbekistan (859 kg/ha), Pakistan (684 kg/ha), and India (478 kg/ha).

AquaCrop is a new water productivity model developed by the Food and Agriculture Organization (FAO) (Raes*et al*. 2009; Steduto*et al*. 2009). The newly created approach is user-friendly and focused on practitioner-end users. The model achieves an ideal balance of output accuracy, robustness, and simplicity while requiring a small number of parameters. It has a water-driven growth engine that transforms daily transpiration (Tr) to daily biomass production (B), a conservative (almost constant) parameter particular to a crop species, using daily reference evapotranspiration (ETo) and normalised water productivity (NWP).

Water stress is activated in the model by the soil water content in the root zone, which includes three stress response functions: canopy growth decrease, stomatal closure, and canopy senescence acceleration. A dynamic harvest index (HI), which develops during the yield development stage until reaching a maximum value, is used to model the partition of biomass into yield. Depending on the timing and intensity of the stress, as well as the crop growth pattern, water stress can either increase or reduce the HI value (Steduto*et al.* 2009).

The FAO project's goal is to calibrate AquaCrop for each major crop species in terms of all of its important factors, known as conservative parameters that are related across a wide range of conditions independent of location and may be used with a variety of cultivars. The user must specify the location, cultivar, meteorological data, irrigation events, and planting density. Only for cotton has a precise and wide calibration of the conservative parameters been achieved (Heng*et al.* 2009; Hsiao *et al.* 2009). Single location data sets were used to perform initial parameterization for cotton (Farahani*et al*., 2009). To undertake a fuller parameterization of this crop, data from additional places with different climatic and soil characteristics is required. Earlier studies on cotton responses to deficit irrigation have been published (Dagdelen*et al*. 2006; Basal *et al*., 2009). It's difficult to anticipate the output while using deficit irrigation. The modelling approach has the advantage of allowing the field findings to be applied to settings that were not evaluated in the field. It is beneficial in terms of providing practical suggestions for bettering irrigation management alternatives. Before they can be used to solve practical problems, the models must be calibrated using field and laboratory data. As a result, our goal is to calibrate and evaluate the AquaCrop model for full and deficit irrigation of cotton in Maharashtra's semi-arid region.

The FAO AquaCrop model is user-friendly software that maintains an optimal mix of accuracy, robustness, and simplicity while requiring a very small amount of input data. The model is based on input from multiple sources, including soil (percentage of sand, clay, and loam), weather (air temperature, reference evapotranspiration, and rainfall), crop (initial, final, and rate of change in per cent canopy cover, biomass water productivity, harvest index, and typical management conditions such as irrigation).The AquaCrop model represents an effort to incorporate current knowledge of crop physiological responses into a tool that can predict the suitable yield of a crop based on the water supply available.

Materials and Methods

Location of Study area

The experimental field of AICRP on Water Management is located in central campus of University at Parbhani. Geographically Parbhani is situated at an altitude of 409 m above mean sea level in the central India and intersected by 76° 47' East longitude and 19° 26' North latitude. Experimental field was fairly uniform and levelled.

Crop

The cotton (Bt.Bunny), now a popular variety having good fiber quality and free from soil bacterial infection was selected for present study.

The crop is well adapted to black cotton soils, red sandy loams and lateritic soils. It requires a mean annual temperature of over 16°C and annual rainfall of at least 50cm distributed throughout the growing season. A daily minimum temperature of 16°C is required for germination and 21°C to 27°C for proper vegetative growth.

Brief description AquaCrop model

AquaCrop model is grounded on crop growth engine which is essentially water driven, in which, the crop growth and production are driven by the amount of water used through consumptive use. The complexity of crop responses to water shortfalls led to the use of empirical production functions as the most applied choice to evaluate crop yield response to water.

Among empirical function approaches, FAO Irrigation and Drainage Paper No. 33 (Doorenbos *et al.,* 1979) signified an important cause to determine the yield response to water of the field, vegetable and tree crops, through the following equation:

$$\left(1-\frac{Y_a}{Y_x}\right)=k_y\left(1-\frac{ET_a}{ET_x}\right) \quad \text{---- (2.1)}$$

where

Y_x and Y_a - Maximum and actual yield,

ET_x and ET_a - Maximum and actual evapotranspiration, and

k_y - Crop yield factor

Continuous alteration of above relationship by FAO experts resulted in AquaCrop model. It differs from the main existing models for its balance between robustness, accuracy and simplicity.

AquaCrop develops from the previous Doorenbos and Kassam (1979) approach by separating (i) the final yield (Y) into biomass (B) and harvest index (HI) and (ii) the ET into soil evaporation (E) and crop transpiration (Tr). The separation of ET into soil evaporation (E) and crop transpiration (T_r) avoids the confusing effect of the non-productive consumptive use of water (E). This is important particularly during imperfect ground cover.

The separation of final yield (Y) into biomass (B) and harvest index (HI) permits the discrepancy of the basic functional relations between environment and biomass (B) from those between environment and HI. These relations are in fact basically different and their use evades the confounding effects of water stress on biomass (B) and on harvest index (HI). The changes defined led to the following equation at the core of AquaCrop growth engine:

$$B = WP \sum T_r \quad \text{----- (2.2)}$$

Where,

T_r - Crop transpiration, mm

WP - Water productivity parameter, g m^{-2}

The canopy signifies the source for actual transpiration that gets translated in a relative amount of biomass produced through the water productivity parameter (WP) (Eq. 3.3). The harvestable portion of such biomass (yield) is then determined via harvest index (HI) as below.

$$Y = HI \times B$$ ----- (2.3)

Even though AquaCrop practices HI parameter, it does not calculate the separating of biomass into various organs (e.g. leaves, roots etc.), *i.e.*, biomass production is decoupled from root deepening and canopy expansion.

AquaCrop differentiates four major crop types on the basis of their harvestable yields: forage crops, root and tuber producing crops, fruit or grain producing crops and leafy vegetable producing crops.

The canopy is a vital feature of AquaCrop through its expansion, ageing, conductance and senescence, as it regulates the amount of water transpired, which in turn determines the amount of biomass produced.

The canopy development is expressed through the portion of green canopy ground-cover (CC). For non-stressed conditions, the expansion from emergence to full canopy development follows the exponential growth during the first half of the full growth and follows an exponential decline during the second half (Fig 3.16).

After full development, the canopy can have a variable duration period before incoming the senescence stage. Being canopy development expressed through CC and not via leaf area index (LAI) is one of the distinguishing features of AquaCrop. Relations for estimation of crop canopy for initial, development and decline stage areas given below:

$$CC = CC_o e^{CGC.t}$$ ---- (2.4)

$$CC = CC_x - (CC_x - CC_o)\, e^{CGC.t}$$ ---- (2.5)

$$CC = CC_x \left[1 - 0.05\left(e^{\frac{CDC.t}{CCx}} - 1\right)\right]$$ ---- (2.6)

where,

CC - Canopy cover at time t

CC_o - Initial size of the canopy (at t = 0) in fraction

CGC - Growth rate of the canopy in fraction per day

CC_x- Maximum coverage for optimal growing conditions

CDC - Canopy decline coefficient (in fraction per day reduction)

t - Time from the onset of senescence

The standardization of WP for climate in AquaCrop is based on the atmospheric evaporative demand as well-defined by ET_0. The aim is to make the WP value in the model precise for each crop appropriate to varied site and seasons, including future climate situations. The equation for calculating normalized water productivity (WP) is as given below:

$$WP = \frac{B}{\left[\sum \frac{T_r}{ET_o}\right]}$$ ----- (2.7)

where,

B - Biomass yield (B)

T_r - Transpiration

ET_o - Reference evapotranspiration

Data collection and input data parameters

AquaCrop model has a structure that overarches soil-plant-atmosphere continuum. For assessing crop water productivity of irrigated cotton, AquaCrop requires following data which were collected and processed as per requirement of model.

Weather data

Weather data for the period 2nd June 2009 to 31st January 2010, and 3rd June 2010 to 27thJanuary 2011was obtained from Meteorological Observatory, VNMKV, Parbhani. It comprised of maximum and minimum temperature (^oC), mean daily relative humidity (%), daily sunshine hours (hr), wind speed (ms^{-1}), rainfall (mm) and evaporation ($mmday^{-1}$).

Crop data

Crop-specific parameters required by AquaCrop model are plant density, yield, biomass, harvest index (HI), effective rooting depth, crop growth stages and green canopy cover (CC), while required user-specific parameters are crop cultivar, timing of crop cycle, water management and agronomic practices. The data was obtained from two years field experiment conducted during the period 2nd June 2009 to 31st January 2010, and 3rd June 2010 to 27th January 2011.

Soil data

The soil data obtained from the physicochemical analysis of soil samples of experimental plots were used to characterize the soil.

Model setup

The model was setup using creating file menus. Using these menus input files for new climate, crop, irrigation management, soil profile, ground water and field data were created.

Climate file

Climate file consists of creating a temperature file, ET_o file, rain file and CO_2 file. While creating ET_o, rain or temperature file, the type of data (daily, 10-daily or monthly data) and time range was specified.

Crop file

While creating a crop file, type of crop (fruit/grain producing crops, leafy vegetable crops, roots and tubers, or forage crops) and parameters such as planting method, cropping period and length of growing cycle were specified. With the help of this information AquaCrop generates a complete set of required crop parameters. These included the planting dates, seedling emergence, duration of the various cabbage physiological periods from sowing date and harvesting dates. Plant population is based on the recommended plant spacing for the site. The parameters are displayed and the values can be adjusted in the crop characteristics menu.

Soil profile file

To create a soil profile file, soil characteristics *viz.* soil type, number of horizons and their thickness were specified. With the help of this information AquaCrop generates a complete set of soil profile parameters. The parameters are displayed and the values can be adjusted in the soil profile characteristics menu.

Irrigation file

Type of irrigation file was specified first from the listed below, while creating an irrigation file:

Net irrigation water requirement

Irrigation schedule

Generation of irrigation schedule

Subsequently in accordance to irrigation file specified, the following required information was also specified:

The allowable depletion when determining the net irrigation requirement

The time, application depth and the irrigation water quality of the successive irrigation events

The irrigation water quality, time and depth criteria to generate irrigation events

Groundwater file

While creating groundwater file, type of file (from listed below) was specified first.

Constant depth and water quality or

Variable depth or water quality.

Subsequently, the depth and quality of the groundwater for various moments (if variable) in the season were specified in the Groundwater characteristics menu.

After creation of various files, sowing or planting date, simulation period and corresponding initial and off-season conditions were specified. The characteristics can be updated in the project characteristics menu.

Field data file

When creating a field data file, the observed green canopy cover (CC) on particular dates as obtained from field experiment data was specified in the field data menu.

Calibration and validation of model

Part of the obtained field data *i.e.* data for full irrigation treatment (100% ET_c) for the year 2009-2010 was used for calibration of the model, while the data of 2010-2011 was used to validate the model. AquaCrop version 6.1 was used in the study. The model was calibrated and validated by varying following parameters manually:

Harvest index

Water productivity (WPb)

AquaCrop version 6.1 was used in the study.

Output extraction

Simulation results are stored in a set of output files. The output files with daily data contain information on the crop development and production.

Model Performance

In addition to qualitative assessment with graphical displays using observed and simulated data set, the model simulation results were evaluated quantitatively using various statistical measures described below. Various performance measures were used in reference to the conclusion of Yapo *et al.,* (1998) that any single performance measure may not adequately measure the ways in which model fails to match the important characteristics of target data. In accordance to the recommendation of ASCE (1993) task committee Nash Sutcliffe coefficient and a dimensionless statistical measure *i.e.* coefficient of residual mass were used to judge the performance of the model.

Nash-Sutcliffe coefficient of efficiency

Nash-Sutcliffe coefficient of efficiency (R^2_{NS}) is used to assess predictive power of hydrological models. R^2_{NS} is described by following formula (Nash and Sutcliffe, 1970)

$$R^2_{NS} = 1 - \frac{\sum (Q_O - Q_S)^2}{\sum (Q_O - Q_{av})^2} \quad \ldots\ldots (3.8)$$

Where,

Q_o - observed values

Q_s - simulated values

Q_{av}- mean of observed values

Nash-Sutcliffe coefficient of efficiency can range from -∞ to 1. R^2_{NS} value of 1 therefore indicate perfect fit. An efficiency of zero indicates that the model predictions are as accurate as the mean of observed data. Closer the model efficiency to 1, more accurate is the model. Model efficiency less than 0.7 correspond to a very poor fit (Coulibaly *et al.*, 2000).

Coefficient of Residual Mass (CRM)

Coefficient of Residual Mass (CRM) is a dimensionless statistical performance criteria as described below.

$$CRM=\frac{\left[\sum_{i=1}^{n}O_i-\sum_{i=1}^{n}S_i\right]}{\sum_{i=1}^{n}O_i} \quad \text{.... (3.9)}$$

Where,

O_i - Observed value at time i

S_i - Simulated value at time i

This criterion indicates the overall under or over-estimation of the ordinates. For a perfect model, the value of CRM is zero. A positive value of CRM indicates the tendency of model to underestimate the observed ordinates, whereas the negative value indicates a tendency to overestimate the observed ordinates.

Results and Discussion

Crop Growth Modelling

Calibration of AquaCrop model

Calibration is required in crop simulation models to estimate model parameter values for various crops, cultivars, and ecosystems. Calibration of the model aids in the reduction of parameter uncertainty. The AquaCrop model was calibrated using experimental data from the first crop period (2nd June 2009 to 31st January 2010). This was done using irrigation level I_4, which represents full irrigation treatment (100 percent of ETc). AquaCrop was manually calibrated by changing model parameters. The canopy cover, growth, and decline coefficients; crop coefficient for full canopy transpiration; water productivity (WP); soil water depletion thresholds for inhibition of leaf growth, stomata conductance, and canopy senescence acceleration; and coefficients for adjusting the harvest index (HI) in relation to inhibition of leaf growth and stomata conductance. These parameters are presumed to be applicable to a wide range of conditions and not specific for a given crop cultivar. The crop characteristics required by the model were adjusted for the cultivar under this study using measured data based mainly on green canopy cover. The performance of model was judged by comparing observed values of yield of cotton with simulated outputs. The performance of model was discussed in the following sections**.** AquaCrop model was set up as per procedure described and providing initial values for the following parameters.

Canopy cover

Canopy parameters such as initial canopy cover, canopy size of sowing seedling, number of days to recover maximum canopy size and canopy cover decline etc. were adjusted manually during the calibration process. Table 4.2 presents the observed and simulated canopy cover.

Temporal variation of observed and simulated canopy cover is presented in Fig 3.1, while Fig 3.2 shows comparison of observed and simulated canopy cover. There was a close match between observed and simulated canopy cover (Fig 3.1).

It was supported by high value of R^2_{NS} (0.97). Another statistical parameter CRM having value of -0.045, indicates that the model overestimates the canopy cover.

Table.1 Conservative and cultivar specific parameters

Description	Value
Base temperature °C	10
Upper temperature °C	30
Crop type	Root and tuber crop
Date of sowing	02-06-2009
Date of harvesting	20-10-2009
Growing cycle, Days	140

Table.2 Observed and Simulated canopy cover during calibration

Day after sowing	Canopy cover, percent	
	Observed	Simulated
20	0.65	0.80
40	19.6	25.2
60	42	47
80	67	75
100	65	63
120	62	60
140	60	58
R^2_{NS}	0.97	
CRM	-0.045	

Table.3 Observed and simulated yield for calibration period

Sr.No.	Treatments	Observed Yield, t ha^{-1}	Simulated Yield, t ha^{-1}
1	I_4= Drip irrigation at 100 per cent ETc	2.95	3.05

Table.4 Calibrated model parameters

Description	Measure
A) Canopy cover	
Initial canopy cover (CC_o), %	0.10
Mode of planting	Sowing
Canopy size of transplanted seedling, cm^2 $plant^{-1}$	5.00
Maximum canopy cover, %	98
Plant density, plant ha^{-1}	2.0
Canopy decline	Very slow
Day 1 to recovery, days	7
Day 1 to maximum canopy, days	65
Senescence, days	110
Root system	Deep rooted crop
Maximum effective depth, m	2.0
B) Harvesting index, %	19
C) Water productivity (WP_b), gm^{-2}	15

Table.5 Statistical analysis of validated results for yield

Sr.No.	Crop season	Treatments	Yield, t ha^{-1}	
			Observed	Simulated
1	Validation 2009	I_1= Drip irrigation at 0.3 ETc	2.58	2.72
2		I_2= Drip irrigation at 0.5 ETc	2.65	2.83
3		I_3= Drip irrigation at 0.7 ETc	2.74	2.93
4	Validation 2010	I_1= Drip irrigation at 0.3 ETc	2.49	2.64
5		I_2= Drip irrigation at 0.5 ETc	2.72	2.98
6		I_3= Drip irrigation at 0.7 ETc	2.74	2.94
7		I_4= Drip irrigation at 1.0 ETc	2.81	3.06
		R^2_{NS}	0.81	
		CRM	-0.060	

Fig.1 Observed and simulated canopy cover for calibration period

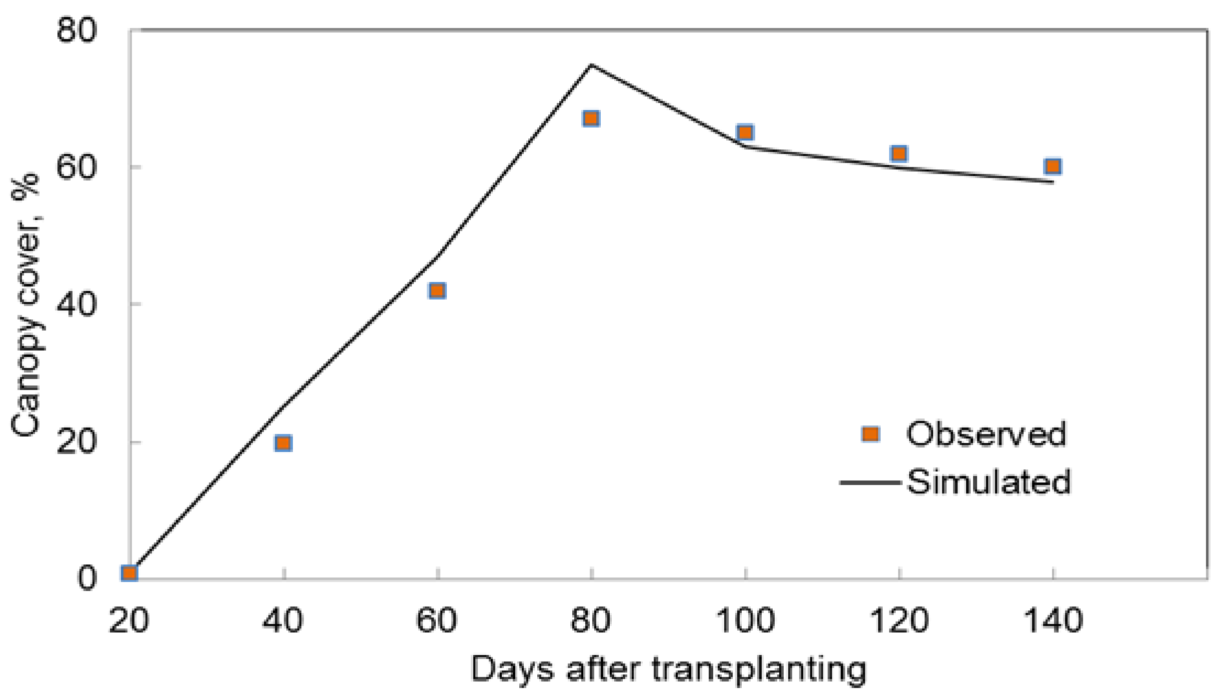


Fig.2 Comparison between observed and simulated canopy cover during calibration

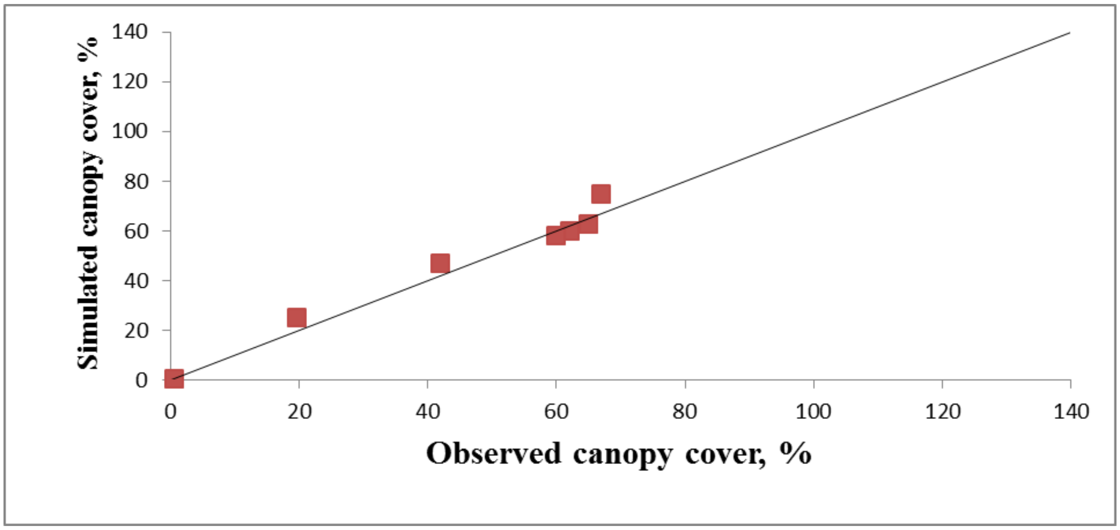


Fig.3 Model generated transpiration, canopy cover and soil moisture in the root zone for drip irrigation at 1.0 ET_C (I_4) for 2009: Calibration period

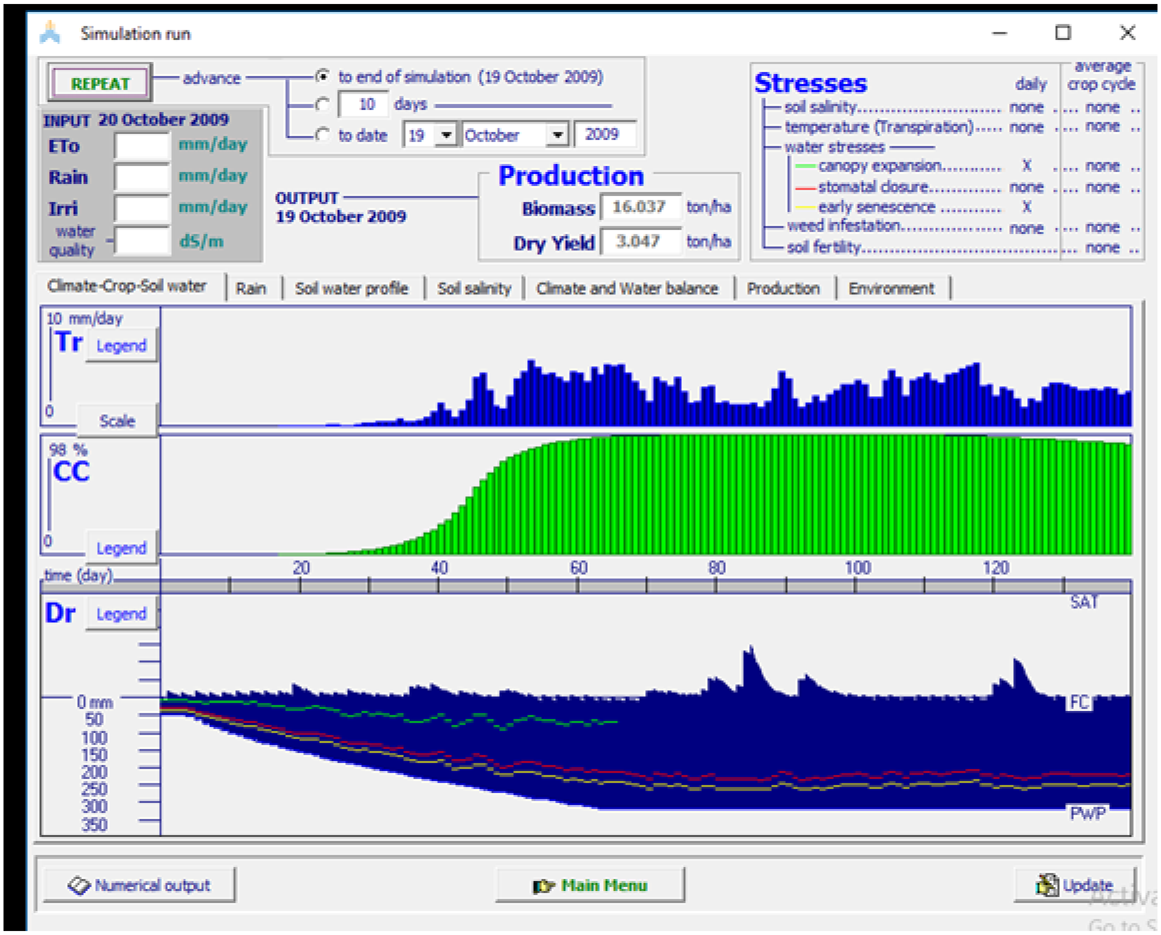
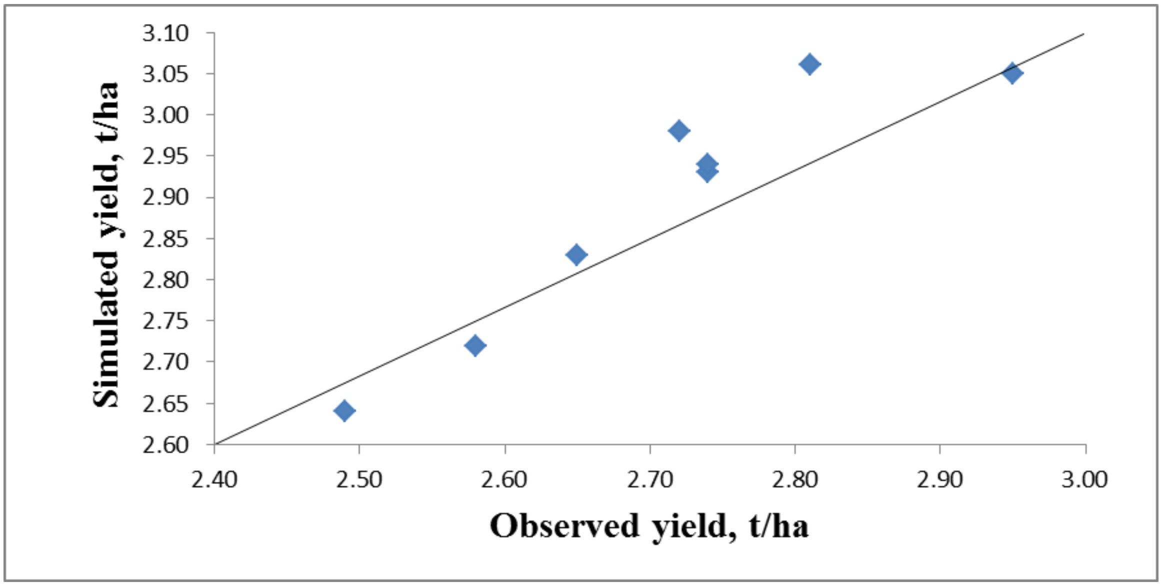


Fig.4 Comparison between observed and simulated yield during validation



The scatter plot shown in Fig.3.2 indicates that although the canopy lies on both sides of 1:1 line, there is slightly overestimation**.**

Yield of cotton

After adjusting the canopy, harvesting index and water productivity were varied manually.

Figure 3.3 shows the model-generated transpiration, canopy cover, and soil moisture in the root zone with a drip irrigation level of 1.0 ETc (I_4 for 2009) throughout the calibration period. It reveals that during the crop growing season, soil moisture in the root zone was at field capacity. Soil moisture was within available water capacity during the crop period. The canopy cover and transpiration requirement were found to be well matched. During the calibration period, the cotton yield was found to be 2.95 t ha^{-1}. The model predicted a yield of 3.05 t ha^{-1} with a harvesting index of 19 % and a water productivity of 15 gm^{-2}. The observed and predicted values of canopy cover and cotton production matched well, indicating that the model calibration was excellent. R^2_{NS} and CRM statistics were also acceptable. As a result, the AquaCrop model setup was considered as calibrated. Calibrated model parameters are presented in Table 3.4

Model validation

The AquaCrop model was validated without making any additional changes to the calibrated model parameters. The model was verified for the remaining treatments (I_1, I_2, and I_3) of the first crop season from 2nd June 2009 to 31st January 2010, as well as all treatments (I_1 to I_4) of the second crop season from 3rd June 2010 to 27th January 2011. The cumulative yield for validation period for each treatment was simulated with model and presented in Table 3.5. It also presents the results of statistical tests for validation period.

The results in Table 3.5 show that for various deficit and full irrigation treatments, the simulated and actual yields of cotton matched well. The yield of cotton varied between 2.58 to 2.49 t ha^{-1}. It was revealed that the average deviation between observed and simulated yield was 6.2 percent.

The high value of Nash Sutcliffe coefficient (R^2_{NS}) value as 0.81 shows close match between observed and simulated yield. The CRM (Coefficient of Residual Mass) between observed and simulated yield was also as low as -0.060, indicating that the model overestimated the yield similar to that calibration. The value of CRM is zero in a perfect model. The comparison of observed and simulated values of yield for validation period is presented in Fig.3.4

As simulated values lie on both side of 1:1 line, it is cleared that the model does not overestimate or underestimate the parameters consistently. Considering overall acceptability of validation results, it was concluded that the model performs well with relatively high validity.

Summary

AquaCrop can be used as a planning tool to assist in management decisions for both irrigated and rainfed agriculture. AquaCrop is a crop water productivity and yield response model developed by the FAO. The AquaCrop model is user-friendly software that maintains an optimal mix of accuracy, robustness, and simplicity while requiring a very small amount of input data. The model is based on input from multiple sources, including soil (percentage of sand, clay, and loam), weather (air temperature, reference evapotranspiration, and rainfall), crop (initial, final, and rate of change in per cent canopy cover, biomass water productivity, harvest index, and typical management conditions such as irrigation).

The AquaCrop model represents an effort to incorporate current knowledge of crop physiological responses into a tool that can predict the suitable yield of a crop based on the water supply available.

In view of the above the research project entitled, "Assessment of AquaCrop model for irrigated cotton under deficit irrigation in semi-arid tropics of Maharashtra" was carried out at Department of Irrigation and Drainage Engineering, CAET, Parbhani. The experiment was conducted in such a way that AquaCrop model was calibrated for the year 2009-2010 and it was validated for the year 2010-2011. Simulation studies were also performed with a crop growth simulation model to predict crop canopy cover, soil moisture and yields. The AquaCrop Model is used in this work to simulate cotton crop growth under various irrigation levels. Part of the obtained field data *i.e.* data for full irrigation treatment (100% ET_c) for the year 2009-2010 was used for calibration of the model, while the data of 2010-2011 was used to validate the model. AquaCrop version 6.1 was used in the study. The model was calibrated and validated by varying following parameters manually:

Harvest index

Water productivity (WPb)

Weather data for the period 2nd June 2009 to 31st January 2010, and 3rd June 2010 to 27th January 2011 was obtained from Meteorological Observatory, VNMKV, Parbhani. It comprised of maximum and minimum temperature (^{o}C), mean daily maximum and minimum relative humidity (%), daily sunshine hours (hr), wind speed (ms^{-1}), rainfall (mm) and evaporation (mmday^{-1}).

The plots under 100% ETc(I_4) a full irrigation treatment of the first experiment (2009) during which crop was almost under non-stress conditions were used to provide necessary information for the calibration of AquaCrop, while the data of all other treatments in both the experiments were used in validating the model. The results of the field investigation and the simulation studies are summarized below.

The following conclusion could be drawn from the results of the study.

Considering overall acceptability of validation results in terms of statistical parameters, it was concluded that model performs well with relatively high validity and field experiment results verified results of AquaCrop model.

As potential of AquaCrop model in predicting yield of cotton in response to water for Marathwada region is verified, it confirmed the capability of AquaCrop model. It is therefore recommended to use this model to improve yield of cotton in response to water.

Overall, the observed and simulated results for cotton were good with R2NSand RMSE. Respecting the simplicity and small number of parameters in AquaCrop compared to other different models, we can recommend that, the calibrated model (V 6.1) could be used as a decision support tool for predicting cotton yield under different water management strategies.

References

Ahmadi, S. H., Mosallaeepour, E., Kamgar-Haghighi, A. A., & Sepaskhah, A. R. (2015). Modeling Maize Yield and Soil Water Content with Aquacrop Under Full and Deficit Irrigation Managements. *Water Resource Managemen.* 29 (8), 2837- 2853.

Andarzian, B., Bannayan, M., Steduto, P., Mazraeh, H., Barati, M. E., Barati, M. A., & Rahnama, A. (2011). Validation and testing of the AquaCrop model under full and deficit irrigated wheat production in Iran. *Agricultural Water Management*.100 (1), 1–8.

Araya, A., Keesstra, S. D., & Stroosnijder, L. (2010). Simulating yield response to water of Teff (Eragrostis tef) with FAO's AquaCrop model. *Field Crops Research*.116 (1–2), 196–204.

Araya A, Habtu S, Hadgu KM, Kebede A and Dejene T (2010). Test of AquaCrop model in simulating biomass and yield of water deficient and irrigated barley (*Hordeum vulgare*).*Agricultural Water Management*, 97: 1838–1846.

Abedinpour M, Sarangi A, Rajput TBS, Singh, Man, Pathak H, Ahmad T (2012). Performance evaluation of AquaCrop model for maize crop in a semi-arid environment. *Agricultural Water Management*, 110: 55–66.

Abedinpour, M., Sarangi, A., Rajput, T. B. S. and Singh, M. 2014. Prediction of maize yield under future water availability scenarios using the AquaCrop model. *Journal of Agricultural Science*, 152: 558-574.

Antony E. and Singandhupe R.B. 2004. Impact of drip and surface irrigation on growth, yield and WUE of capsicum (*Capsicum annuum* L.). *Agricultural Water Management* 65:121-132.

Babel, M. S., Deb, P., & Soni, P. (2019). Performance Evaluation of AquaCrop and DSSAT-CERES for Maize Under Different Irrigation and Manure Application Rates in the Himalayan Region of India. *Agricultural Research*, 8 (2): 207–217.

Briddon, R. W., & Markham, P. G. (2000). Cotton leaf curl virus disease. *Virus Research*. 71(1–2), 151–159.

Blessing Masasi., Saleh Taghvaeian., Prasanna H. Gowda., Gary Marek., Randy Boman. (2020). Validation and application of AquaCrop for irrigated cotton in the Southern Great Plains of US.*Irrigation Science*. https://doi.org/10.1007/s00271-020-00665-4

Coulibaly P, Anctil F, and Bobee B (2000). Daily reservoir inflow forecasting using artificial neural networks with stopped training approach. *J. Hydrol.*, 230: 244-257. deficit irrigation. *Journal of Horticulture Science*, 4: 138–146.

Dağdelen, N.Başal, H.Yilmaz, E. (2008). Different drip irrigation regimes affect cottonyield, water use efficiency and fiber quality in western Turkey. agricultural water management. 96, 111–12

Doorenbos J, Kassam AH, and Bentvelsen CIM (1979). Yield response to water, Rome. Food and Agriculture Organization of the United Nations.

Heng LK, Hsiao T, Evett S, Howell T, and Steduto P (2009). Validating the FAO AquaCrop Model for Irrigated and Water Deficient Field Maize. *Agron. J.* 101, 488-498.

Hsiao, T. C., Heng, L., Steduto, P., Rojas-Lara, B., Raes, D., & Fereres, E. (2009). Aquacrop-The FAO crop model to simulate yield response to water: III.Parameterization and testing for maize. *Agronomy Journal*, 101(3): 448–459.

Yapo PO, Gupta HV, and Sorooshian S (1998). Multi-objective global optimization for hydrologic models, *J. Hydrol.*, 204: 83–97.yield of tomato. *Journal ofAgriculture Research and Technology*, 37 (2): 189-192.

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