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Evaluation of FAOAqua Crop model for wheat under different irrigation regimes

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Abstract: The experiment was conducted at the research farm of the Water Technology Centre, IARI, New Delhi during *rabi* seasons of 2010-11and 2011-12. Irrigation treatments include irrigation applied at 50% deficit (W_1) and 25 % deficit (W_2) and full irrigation (W_3) under recommended fertilization levels with split doses of N-fertilizer. Full irrigation treatment was based on irrigations to meet the soil moisture deficit up to the field capacity (FC) level and deficit irrigation treatments of 25% and 50% were imposed with respect to the full irrigation.The model was calibrated with experiment generated data sets of *rabi* 2010-11 and validated using the data set of *rabi* 2011-12. It was observed that the validated model performed well for grain yield prediction with absolute prediction error of 2.9%, 0.91% and 7.85% for full, 25% deficit and 50% deficit irrigation levels, respectively. Also, for prediction of biomass yield the prediction error ranged from 11.81% to 28.96% for all three irrigation treatments. Moreover, the validated model was observed to predict the water productivity with absolute prediction errors of 43.57%, 13.87% and 12.8% for full, 25% deficit and 50% deficit irrigation treatment levels, respectively. Nonetheless, it was observed from this study that the AquaCrop model can be used to simulate the grain and biomass yield for wheat crop with acceptable accuracy under different irrigation regimes in a semi-arid enviroment.

Keywords: AquaCrop model, Calibration, Irrigation regimes, Validation, Wheat crop

INTRODUCTION

Crop growth simulation models of varying complexity have been developed for predicting the effects of soil, water and nutrients on grain and biomass yields and water productivity of different crops. AquaCrop, a crop water productivity model developed by the Land and Water Division of FAO and released for use during 2009 (Steduto *et al.*, 2009), was used to simulate yield response to water of several herbaceous crops. The AquaCrop model has been parameterized and validated for simulating yield, biomass and water productivity of different crops. Mkhabela and Bullock (2012) evaluated AquaCrop for wheat crop grown at five different experimental sites in Canadian Prairies. They reported that the difference between observed and simulated grain yield was only 3% and the difference between observed and simulated total soil water content was 2%. They concluded that the AquaCrop can be a valuable tool for simulating both wheat grain yield and soil water content on the Canadian Prairies, particularly considering the fact that the model requires a relatively small number of explicit and mostly intuitive input data, which can be readily available or easily collected. Salemi *et al.* (2011) used the AquaCrop model for simulating the grain yield and water productivity of winter wheat grown in the Gavkhuni River Basin (GRB), central Iran under deficit irrigation condition. It was observed that the water productivity for wheat was in the range of 0.91 to 1.49 kg m^{-3} and its maximum value was for the crop grown under 40% deficit irrigation treatment. Andarzian *et al.* (2011) evaluated AquaCrop model for its ability to simulate wheat yield under full and deficit water conditions in a hot dry environment in south of Iran. The AquaCrop model was able to accurately simulate soil moisture content of root zone, crop biomass and grain yield, with normalized root mean square error (RMSE) less than 10%. Xiangxiang *et al.* (2013) evaluated AquaCrop model for simulating the impact of irrigation regimes on the biomass and grain yield of wheat. The model was calibrated and validated using the experimental data of wheat grown during the period from 2006 to 2011 in the *Changwu* Agri-ecological station at Loess Plateau of Shaanxi Province, China. The model simulated results for soil moisture in the root zone depths were in line with the observed values with R^2 varying from 0.88 to 0.95 for different irrigation treatments. Moreover, the comparison of model simulated and observed grain yield under the single irrigation, double irrigation, triple irrigation and quadruple irrigation treatments resulted in R^2 of 0.80, 0.98, 0.99, and 0.77, respectively. Abedinpour *et al.* (2012) evaluated AquaCrop for simulating the grain yield and water

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productivity of *Kharif* Maize in a semi-arid environment of Northern India. It was observed that the prediction error in simulation of grain and biomass yield under all irrigation and nitrogen levels ranged from a minimum of 0.47% to 5.91% and maximum of 4.36% to 11.05%, respectively. The model prediction error in simulating the water productivity (WP) varied from 2.35% to 27.5% for different irrigation and nitrogen levels. Over all, the FAO AquaCrop model predicted maize yield with acceptable accuracy under variable irrigation and nitrogen levels. Singh *et al.* (2013) calibrated and validated FAO AquaCrop model for 10 wheat cultivars experimented in West Bengal and reported that the model performed well with minimal input data in prediction of wheat yield. Iqbal *et al.* (2014) simulated the soil moisture, grain and biomass yield of winter wheat in the Northern China Plain region and concluded that the model can be used with reliable degree of accuracy. Kumar *et al.* (2015) compared AquaCrop and SWAP model for prediction of grain yield of salt-tolerant and salt non-tolerant wheat cultivars in the semi-arid region of India and suggested use of AquaCrop model which requires less input data as compared to SWAP , but could predict the crop growth and yield parameters at par with SWAP model.

Keeping this in view, a study was undertaken to evaluate the water driven crop growth model AquaCrop (Ver. 4.0 released in June 2012) for predicting the grain and biomass yield of *rabi* (winter) wheat using the experimental data of WTC farm, IARI, New Delhi, India.

MATERIALS AND METHODS

Site description: The experiment was undertaken in the experimental farm of Water Technology centre (WTC), IARI for wheat experiment of *rabi* 2010-11 and 2011-12. The field is located at 77^o 9' 36.5''E longitude and 28^o 37' 55.2'' N latitude having an average elevation of 230 m above mean sea level (amsl). Surface irrigation facility with ground water is available in the farm, which provides assured irrigation during the crop growth period. Water available for irrigation in the farm was of salinity less than 1 dSm^{-1}, hence the salinity stress was also not considered in the AquaCrop model to simulate the growth and yield of wheat. Climate data during the experiment period for calibration and validation of AquaCrop model was acquired from the automatic weather station located within the IARI farm. The rainfall, maximum and minimum temperature and relative humidity variations as observed during the experiment period for 2010-11and 2011-12 is shown in Table 1. The daily rainfall and maximum and minimum temperature during crop growth for the year 2010-11 and 2011-12 have been depicted in Figs. 2 and 3, respectively.

Field layout and experiment details: The data on growth and yield parameters of wheat crop, soil and irrigation scheduling, soil moisture and other input parameters required for model calibration and validation were obtained from the field experiments conducted in the research farm of Water Technology Centre (WTC), IARI, New Delhi, India during the *rabi* (post-monsoon winter) seasons during years2010-2011 and 2011-2012.The design of experiment with different irrigation and N-fertilization treatment is shown in Fig. 1. The field experiment was laid in randomized block design comprised of three regimes of irrigation *i.e*. W_1:50% deficit irrigation (DI), W_2: 25% DI and W_3:full irrigation pertaining to crop water requirement and four nitrogen fertilizer treatments including the recommended application of 50% basal and 50% at crown root initiation (CRI) stage and split-N doses as basal, at CRI and at heading stage amounting to the total recommended dose of 120 kg ha^{-1} of nitrogenous fertilizer. Moreover, the experimental data pertaining to the recommended N-fertilization was used for calibration and validation of AquaCrop model due to limitation of AquaCrop model in handling the split-N fertilization at different growth stages of crop. Wheat cultivar HD2894 was sown with row spacing of 20cm in the plot of 6 × 3.5 m size. Plot to plot spacing was maintained at 2m and replications were separated by 2.75m in the entire experiment (Fig.1). The physical and chemical properties of soil of the experiment are presented in table 2.

Moreover, due to non-availability of any module in AquaCrop to simulate different split N-fertilization treatments imposed at different growth stages, the recommended fertilization level without any fertility stress was simulated in this study. Reference evapotranspiration (ETo) was estimated using modified Penman-Monteith formulae and used in AquaCrop as one of the input climatic parameter. The data on initial condition, soil, climate and crop growth obtained from field were used in AquaCrop model to generate crop yield, biomass and water productivity (WP).Two deficit levels of irrigation water *i.e*. 50% DI(W_1), 25% DI(W_2) and full irrigation (W_3) pertaining to crop water requirement based on soil moisture deficit criterion was taken.

Measured quantity of irrigation water based on soil moisture content was directly applied to the furrows using HDPE pipes to eliminate conveyance loss of water. The harvesting was done during the maturity stage with grain moisture content of about 13-15%.Crop growth parameters *viz*. above ground biomass, leaf area index and plant height were measured at different growth stages under different irrigation treatments.

Irrigation scheduling in the experiment: All experimental plots were irrigated using surface method of irrigation. Irrigation water depths indicated by the soil moisture deficit (SMD) in each treatment was calculated using soil moisture content before irrigation, root zone depth of plant and bulk density of soil using the Equation 1

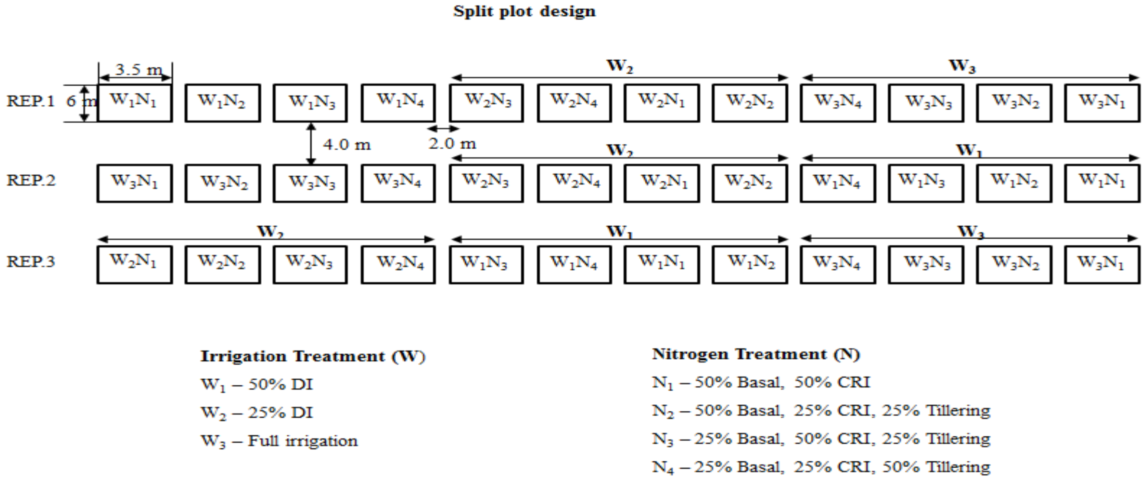

Fig. 1. *Layout of the experimental field for rabi2010-11 and 2011-12.*

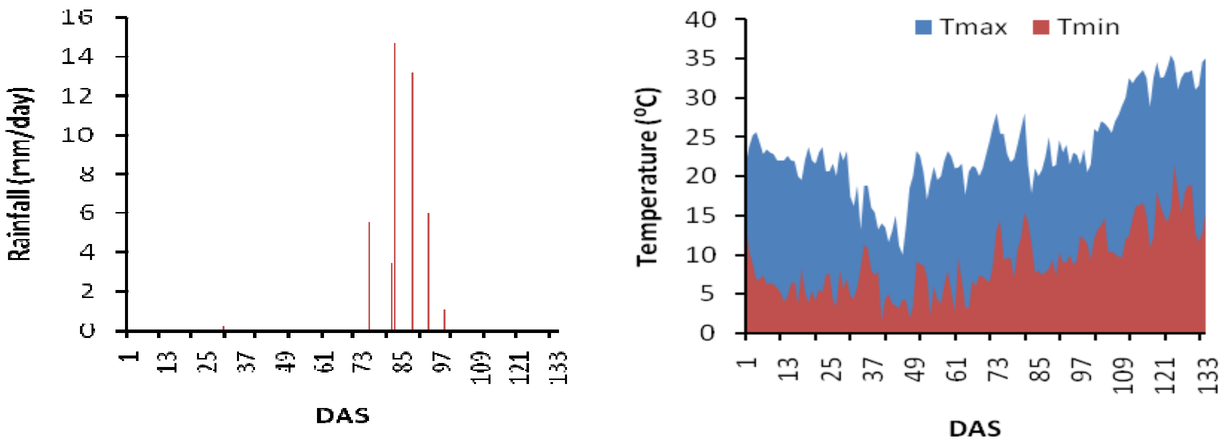

Fig. 2. *Weather parameters during the crop growth period in rabi2010-11.*

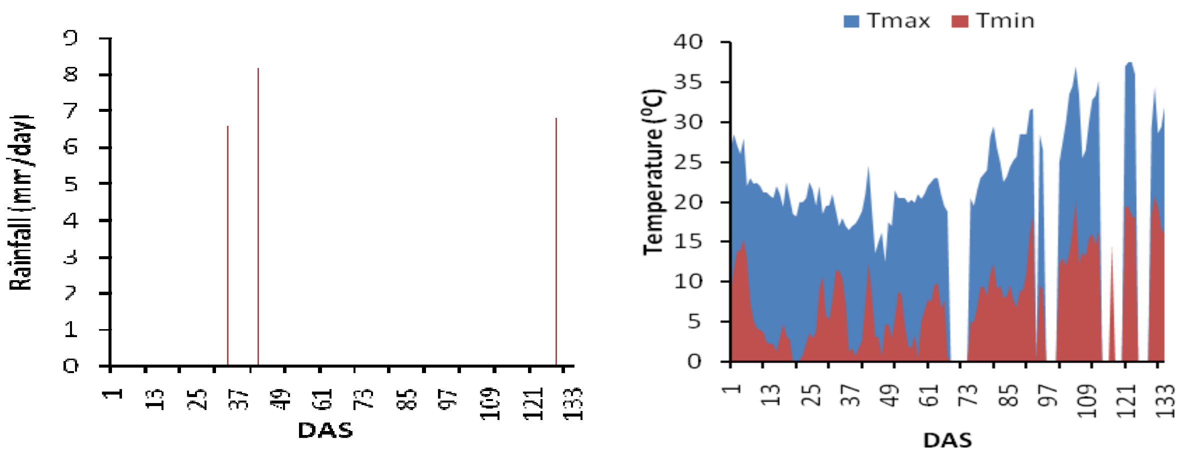

Fig. 3. *Weather parameters during the crop growth period in rabi2011-12.*

$$SMD = (\theta_{Fc} - \theta_i) \times D_{RZ} \times B_d \times f \quad (1)$$

Where,

SMD: soil moisture deficit (mm), θ_{Fc}: soil water content at field capacity (%), θ_i: soil water content before irrigation (%), D_{RZ}: root zone depth (mm), Bd: bulk density of soil (gcm^{-3}) and f: coefficient of each treatment. The coefficient of each treatment *viz.* f(W3) = 1 (full irrigation up to FC without any deficit),f(W2) = 0.75 (25% DI), f(W3) = 0.50 (50% DI) were used for different treatments to estimate the quantity of irriga-

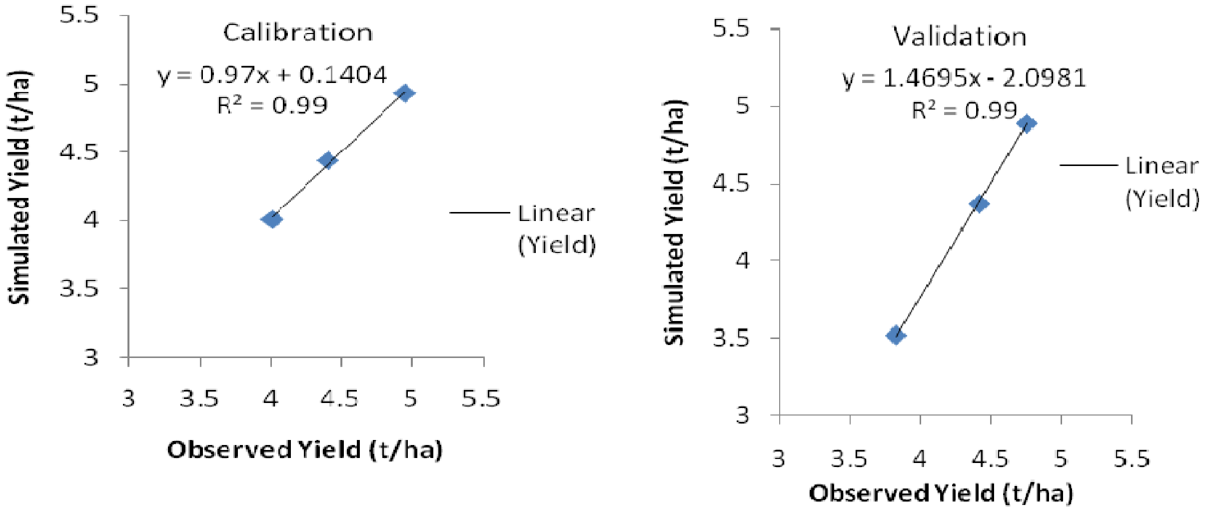

Fig. 4. *Model calibration and validation results for grain yield under three different irrigation regimes during rabi 2010-11.*

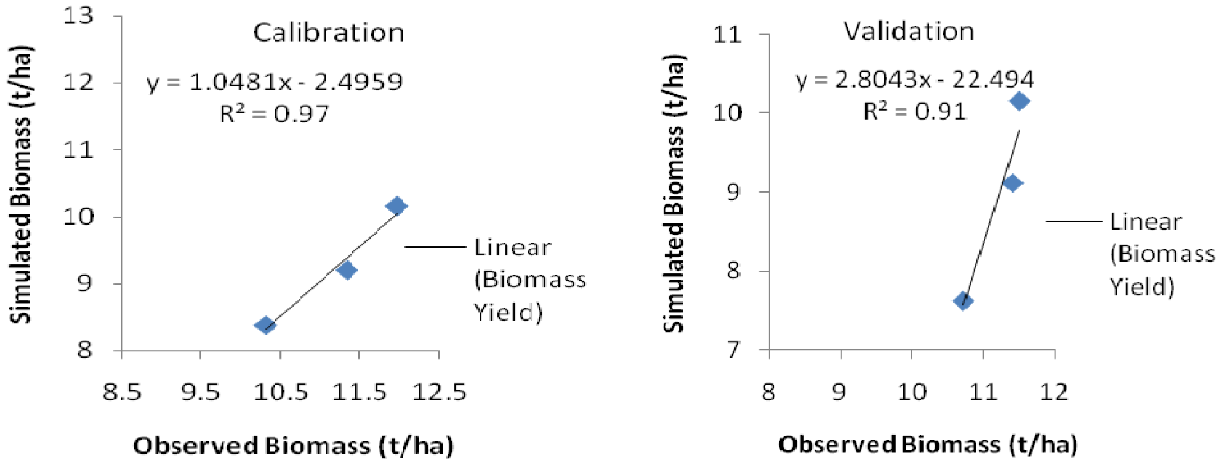

Fig. 5. *Model calibration and validation results for biomass yield under three different irrigation regimes during rabi 2011-12.*

Table 1. Climatic parameters during entire crop growing season of 2010-11 and 2011-12.

Weather parameters months	Temperature (^{0}C) (max)		Temperature (^{0}C) (min)		Rainfall (mm)		Mean RH (%)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
December	21.05	22.13	5.89	5.03	0.25	0	67	59.33
January	18.37	18.7	5.68	5.45	0	14.8	67	63.02
February	23.19	22.96	9.96	7.83	37.88	0	70	50.1
March	29.88	30.18	13.74	13.26	0.86	0	61.5	48.67
April	34.66	34.9	17.32	18.85	0	6.8	44.5	45.74
Mean	25.43	25.774	10.52	10.084	38.99	21.6	62	53.372

Table 2. Soil physical and chemical properties of experimental field.

Soil depth (cm)	B_d (g/cm^3)	F_C (w/w)	PWP (w/w)	Ks (cmd^{-1})	EC (dsm^{-1})	pH
0-15	1.41	21.3	9.5	24.7	0.24	7.7
15-30	1.43	22.8	10.2	26.2	0.34	8.1
30-45	1.39	24.1	13.7	18.6	0.35	8.01
45-60	1.37	24.9	14.7	19.1	0.37	8.05
60-90	1.36	26.3	15.0	19.5	0.38	8.5

B_d: Bulk Density, Ks: Saturated Hydraulic conductivity, F_C: Field Capacity, PWP: Permanent Wilting Point, EC: Electrical Conductivity

Table 3. Different agronomic practices of the experiments during *rabi* season of 2010-11and 2011-12.

Agronomic practices	2010-11	2011-12
Sowing date	25.11.10	02.12.11
Pre sowing fertilization (kg ha^{-1})	P_2O_5;60, K_2O;40	P_2O_5;60, K_2O;40
Irrigation supplies	4	4
Total water used (mm) (W_1, W_2, W_3)	179, 242, 306	165, 227, 289
Harvest date	07.04.11	15.04.12
Length of growing season	134	136

Table 4. Crop parameters with unit and their specific value used in experiment.

Parameters	Value			Unit
	FI	25% DI	50% DI	
Base temperature	0.0	0.0	0.0	^{0}C
Upper temperature	39	39	39	^{0}C
Canopy growth coefficient	14.7	14.4	14.3	%/day
Canopy decline coefficient	11.3	14.3	15.2	%/day
Canopy expansion threshold (P_{upper})	0.20	0.19	0.20	% of TAW
Canopy expansion threshold (P_{lower})	0.74	0.50	0.50	% of TAW
Canopy expansion shape factor	3	3	3	Unit less
Stomatal closure threshold (P_{upper})	0.65	0.65	0.65	% TAW
Stomatal closure shape factor	2.5	2.5	2.5	Unit less
Early canopy senescence threshold (P_{upper})	0.70	0.70	0.70	% of TAW
Early canopy senescence shape factor	2.5	2.5	2.5	Unit less
Maximum basal crop coefficient (K_{cb})	1	1	1	Unit less
Time from sowing to emergence	6	6	6	Days
Time from sowing to maximum canopy	50	50	50	Days
Time from sowing to senescence	117	117	117	Days
Time from sowing to maturity	133	133	133	Days
Duration of flowering	7	7	7	Days
Time from sowing to maximum root depth	85	85	85	Days

FI: Full Irrigation, DI: Deficit Irrigation, TAW: Total Available Water

Table 5. Observed and simulated grain yield (t/ha), water productivity (kg/m^3) and biomass (t/ha) of wheat cultivar HD-2894.

Irrigation regimes	Calibration (2010-11)						Validation 2011-12					
	Yield (ton/ha)		WP (kg/m3)		Biomass		Yield (ton/ha)		WP (kg/m3)		Biomass(ton/ha)	
	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated
Full Irrigation	4.95	4.93	1.42	2.01	11.96	10.15	4.75	4.89	1.40	2.01	11.51	10.15
25% DI	4.4	4.44	1.59	1.93	11.33	9.20	4.41	4.37	1.73	1.97	11.42	9.12
50% DI	4.01	4.01	1.79	1.87	10.31	8.38	3.82	3.52	2.11	1.84	10.72	7.62

Table 6. Prediction error of yield, water productivity and biomass of wheat during calibration and validation.

Irrigation regimes	Grain Yield P_e(±%)		WP P_e(±%)		Biomass P_e(±%)	
	Calibration	Validation	Calibration	Validation	Calibration	Validation
Full Irrigation	0.42	2.95	41.55	43.57	15.13	11.81
25% (DI)	0.89	0.91	21.38	13.87	18.81	20.16
50% DI	0.05	7.85	4.47	12.80	18.73	28.96

DI: Deficit Irrigation

Table7. Model Efficiency (ME) and Mean Absolute Error (MAE) of modeled grain yield, water productivity and biomass yield of wheat during calibration and validation.

Output	ME		MAE	
	Calibration	Validation	Calibration	Validation
Yield	0.99	0.99	0.02	0.16
WP	-5.85	-0.99	0.34	0.37
Biomass	-7.32	-4.85	1.96	2.26

ME: Model Efficiency, MAE: Mean Absolute Error tion water.

Estimation of crop evapotranspiration: Soil water budget method was used to estimate actual crop evapotranspiration (ETa). The components of water balance equation within the soil profile up to root zone depth were measured using Equation (2)

$$ET_c = P + IR + C_p - D_p - R_o \pm \Delta W \quad (2)$$

Where,

ET_c is crop evapo-transpiration (mm), P is precipitation (mm), IR is total irrigation depth (mm), C_p is capillary contribution from ground water table to the crop root zone (mm), D_p is deep percolation losses (mm), R_o is runoff (mm) and Δ W is the change in soil water content (mm). The basins in the experimental plots were closed by bunds and the water table depth was 4 m below the ground surface. Therefore, the surface runoff and the vertical upward seepage or the capillary flow to the root zone was assumed negligible in the calculation of ET using Equation 2. Besides this, the drainage below root zone, after a number of soil-water content measurements, was considered to be negligible. So the Equation 2 was reduced to:

$$ETc = P + IR \pm \Delta W \quad (3)$$

Input data for the AquaCrop model: Operation of AquaCrop model requires input data consisting of climatic parameters, crop, soil and field and irrigation management data.

Climate data: The climate data required for AquaCrop model are daily rainfall, minimum and maximum air temperature, reference crop evapotranspiration (ETo), and mean annual carbon dioxide concentration (CO_2). ETo was estimated by ETo calculator using the daily maximum and minimum temperature, wind speed at 2 m above ground surface and hours of bright sunshine.

Crop data: In AquaCrop, the crop file contained 13 phenological crop growth stages with canopy and root development, evapotranspiration, water, fertility, and temperature stress parameters. The list of crop parameters with unit and their value used in this experiment is presented in Table 4.

Soil parameters: Soil parameters of experiment site required for AquaCrop model as input data are number of soil horizons, soil texture, field capacity (FC), permanent wilting point (PWP), saturated hydraulic conductivity (Ksat), volumetric water content at saturation (sat) and initial soil moisture content and its salinity. The experiment site did not contain any impervious or restrictive soil layer to obstruct the expansion of root growth. The curve number (CN) of the site was used to estimate surface runoff from rainfall that occurred during the experiment.

Irrigation and field management parameters: Irrigation and field management during the experiment are two important components considered in the AquaCrop model. In full irrigation treatment, water was applied up to field capacity level when soil moisture in the root zone approached 50% of total available water (TAW). In the deficit irrigation treatments (*i.e.* 75and 50% of full irrigation or 25 and 50% deficit irrigation, respectively), depths of irrigation in different plots were reduced to 75and 50% of the full irrigation. The field management components were the fertility level and height of bunds to eliminate surface runoff. In this study there was no limit of fertility and 0.1m bund height was considered. The details of agronomic practices during the crop growing season have been listed in Table 3.

Calibration of AquaCrop model: Calibration of the AquaCrop model was accomplished by using the observed values from the field experiment of wheat during 2010-11 *rabi* season as model input and then simulating the model to predict the output *viz.* the grain and biomass yield and water productivity (WP). Subsequently, the predicted output values of these parameters were compared with the observed wheat grain yield, biomass and water productivity of the experimental plot. The difference between the model predicted and observed values of experiment was minimized by using trial and error approach in which one specific input variable was chosen as the reference variable at a time and adjusting only those parameters that were known to influence the reference variable the most. The procedure is repeated several times to arrive at the closest match between the model simulated and observed value of the experiment for each irrigation regimes.

Validation of AquaCrop model: Calibrated AquaCrop model was validated using the weather and the irrigation depth information during the wheat growing period of *rabi* 2011-12 to predict the grain yield, biomass and water productivity of wheat. Further, the AquaCrop model simulated values were compared with the observed values of the experiment and the model validation performance statistics were estimated.

Model evaluation criterion: The goodness of fit between the simulated and observed values was verified by using the prediction error statistics. The prediction error (P_e) and mean absolute error (MAE) was used as the error statistics to evaluate both the calibration and validation results of the model. The model efficiency (ME) (Nash and Sutcliffe, 1970) shows efficiency of the model in simulation of the parameters and coefficient of determination (R^2) determines the discrepancy between simulated and observed values. These error statistics were used to evaluate the predictive power of the model. In this study, the model output in terms of prediction for grain and biomass yield besides water productivity during harvest was considered for evaluation of the model. The model evaluation parameters are given by:

$$P_e = \frac{(S_i - O_i)}{Oi} \times 100 \quad (4)$$

$$MAE = \frac{\sum |S_i - O_i|}{n} \quad (5)$$

$$ME = 1 - \frac{\sum_{i=1}^{N} (Oi - Si)^2}{\sum_{i=1}^{N} (Oi - \bar{O})^2} \quad (6)$$

Where, S_i and O_i are predicted and actual (observed) data, $\bar{O}$is mean value of O_i and N is the number of observations. Model efficiency (ME) and R^2 approaching one and Pe and MAE close to zero are indicators for better model performance.

RESULTS AND DISCUSSION

AquaCrop model calibration and validation results: Calibration of the AquaCrop model was accomplished by using the observed values from the field experiment during *rabi* 2010-11 as model input parameters and then operating the model to obtain the simulated output in terms of grain yield, biomass and water productivity. The calibrated model parameters are presented in Table 4.The model predicted outputs were compared with the observed grain yield, water productivity and biomass under different irrigation regimes. Observed and model simulated grain yield, water productivity and biomass yield during calibration and validation are presented in Table 5. It was observed from Table 5 that the grain yield varied from 4 to 4.95 ton/ha during the model calibration and 3.82 to 4.75 ton/ha during the validation of the AquaCrop model under different irrigation regimes. The model prediction error was estimated and presented in Table 6. It was observed from Table 6 that the grain yield prediction when compared with validation data set of *rabi* 2011-12 and calibrated using the *rabi* 2010-11 data set resulted in absolute prediction error of 2.95%, 0.91% and 7.85% for full, 25% deficit and 50% deficit irrigation levels, respectively. Water productivity varied from 1.84 to 2 kg/m^3 during calibration and validation process. Water productivity under full irrigation (W_3) treatment was the lowest whereas that for 50% DI the WP was the highest for both the calibrated and validated model simulations. It was observed from Table 6 that the calibrated model while simulating the water productivity resulted in an absolute prediction error of 41.55%, 21.38% and 4.47% for full, 25% deficit and 50% deficit irrigation regimes, respectively. The model validation results indicated that for full, 25% and 50% deficit irrigation levels the prediction error varied from 12 to 44%. However, the model performed well in predicting water productivity for 50% deficit irrigation treatment when compared with other irrigation treatments. The reason for poor prediction of water productivity by AquaCrop model can be attributed to the difference in the estimation procedure of water productivity used in the model simulation process and as estimated using the experiment data. Similar results were also reported by Abedinpour *et al.* (2012), Iqbal *et al.* (2014), Kumar *et al.* (2014) and Kumar *et al.* (2015) in which the model performed better for prediction of grain and biomass yield as compared to the water productivity.

Above ground biomass yield varied from 10.31 to 11.96 t/ha and 10.42 to 11.51t/ha during *rabi* 2010-11 and 2011-12 growing seasons, respectively. The full irrigation treatment produced highest above ground biomass compared to other irrigation regimes. It was observed that the model predicted biomass yield by validated AquaCrop model was with prediction error of 11.81%, 20.16% and 28.96% for full, 25% DI and 50% DI, respectively (Table 6). The model efficiency (ME) and mean absolute error (MAE) of model prediction for grain yield, water productivity and biomass yield is presented in Table 7. It was observed from Table 7 that the ME is 0.99 for both calibration and validation for grain yield, varied from -5.85 and -0.99 for WP during calibration and validation, respectively. Also, the comparison of model simulated and observed biomass yield resulted in ME of -7.35 and -43.85 for calibrated and validated model, respectively. It was also observed that the model was validated for grain and biomass yield under all irrigation regimes with prediction error statistics $0.16 < MAE < 2.26$ t ha^{-1} (Table 7). Moreover, the model simulated and observed grain and biomass yield for both calibration and validation processes is shown in Figs 4 and 5, respectively. It was observed that the R^2 for grain yield was 0.99 for both calibration and validation (Fig. 4), whereas for biomass yield the R^2 was 0.97 and 0.91 during model calibration and validation processes, respectively (Fig. 5).

Similarly, the model prediction error for water productivity was13.9 and 12.8% under 25% and 50% deficit irrigation regimes, respectively. However, the model prediction error was 43.6% for full irrigation treatment. The difference in AquaCrop model simulated water productivity and the water productivity estimated using the experiment data as mentioned above was due to the fact that the AquaCrop model estimates the water productivity as a ratio of grain yield to the total crop evapotranspiration during the growing period. Whereas, in the field experiment, the sum of irrigation water supplied to the field using the soil moisture deficit criterion and the effective rainfall during the growing season accounts for the total water used and the water productivity is estimated by dividing the grain yield with the total water use. The AquaCrop model considered the total crop evapotranspiration during the growing period of wheat to be the total water used for crop growth and subsequently, the grain yield was divided with the total crop evapotranspiration for estimating water productivity. The total crop evapotranspiration during the crop growing period was less than the sum of irrigation water applied and the effective rainfall during the growing season. Therefore, water productivity was observed to be more as simulated by AquaCrop model when compared with the experiment data, which is basically due to the difference in the computation of total water as estimated in AquaCrop model and analyzing the data acquired from the field experiment. Therefore, the comparison of water productivity between the AquaCrop model simulated and observed values indicated higher prediction error. Nonetheless, it was observed that the model performed well for prediction of grain and biomass yield but failed to predict the water productivity for all irrigation regimes when compared with the observed data generated from the field experiment.

Conclusion

It was observed that the AquaCrop model could simulate the grain and biomass yield of wheat with prediction error ranging from 0.91 to 7.85% and 11.81 to 28.96%, respectively under three irrigation regimes. Experiment generated data of *rabi* 2010-11 and 2011-12 and AquaCrop model simulated results revealed that wheat grain yield and above ground biomass were significantly affected under full and deficit irrigation regimes. However, the AquaCrop model prediction for grain yield of wheat was better under full irrigation and 25% deficit irrigation with prediction error of 2.95 and 0.91% as compared to the 50% deficit irrigation treatment with prediction error of 7.85%. Similarly, for biomass yield, the model performed well with prediction accuracy of 11.81% under full irrigation as compared to deficit irrigation regimes. However, the model failed to predict the water productivity in line with the experimental results. Nonetheless. it can be recommended from this study that the AquaCrop model,which requires less model input data in comparison to other crop models can be used for prediction of wheat grain and biomass yield with acceptable accuracy under variable irrigation regimes in a semi-arid environment as that of the experiment region.

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