Original Research Article

Modelling Wheat Productivityunder Deficit Irrigation

Abstract

This research was carried out to simulate wheat growth under deficit irrigation across two cropping years (2020-21 and 2021-22) at Prayagraj, Uttar Pradesh India.Crop growth simulation models are useful for evaluating the impact of water scarcity on crop productivity and crop yield.The AquaCrop model is one of these available options and this model is capable of simulating water productivity, grain yield, biomass yield, and canopy cover. Major inputs for the model in this investigation are climate, soil characteristics, plant attributes, and the management of crop cultivation.The results of the simulation revealed that the model accurately simulates grain yield, water productivity, biomass yield, and canopy coverat different amount of irrigation.The simulated and observed grain yield coefficients of determination (R^2) were 0.96 and 0.95, respectively.The model simulation performed well (RMSE=0.131, NRMSE=3.75) and model efficiency (EF) was 0.99. Simulated and observed water productivity is equivalent at different amount of irrigation regimes. The model simulation performed well (RMSE=0.106 and NRMSE=5.00). Simulated and observed water productivity had EF of 0.99 and R^2 of 0.96.The model simulation of biomass under different amount of irrigation varied between RMSE ranged from 0.492 to 0.857, NRMSE ranged from 9.239 to 17.513 and EF ranged from 0.97 to 0.99. Coefficients of determination (R^2) of simulated biomass yield and observed biomass of all treatments were 0.99. It was determined that the simulated canopy cover for all treatments at different amount of irrigation had successfully adapted to the observed canopy cover.Thus, the RMSE varied from 13.344 to 18.974, the NRMSE from 20.770 to 33.223, and the EF from 0.91 to 0.96 for model simulations treated to various interventions. Coefficients of determination (R^2) of simulated canopy cover for all treatments were 0.97, although R^2 of observed canopy cover for various treatments ranged from 0.88 to 0.92.

Keywords: Wheat, Treatment, Simulation, AquaCrop model.

1. Introduction

Wheat is regarded as one of the world's major grain crops owing to its adaptability to a wide range of agroclimatic and soil conditions.Wheat ranks first among main cereals in terms of worldwide area and production, and it is the primary source of nutrition for around 35 percent of the world's population (Wang et al., 2018).Wheat is the most common source of protein in human diet, containing more protein than maize, rice, and other main grains(Kaisa et al., 2021).The United Kingdom has the greatest average wheat yield (7.9 tonnes per hectare), followed by Germany (7.8 tonnes) and France (7.5 tonnes).It was cultivated on 29.9 million hectares in India, yielding 107 million metric tonnes with an average yield of 3,430 kg per hectare (Government of India, 2019-20).The restricted variables of yield in wheat pose one of the greatest difficulties in wheat farming (Curtis &Halford., 2014).Daily inputs of crop, soil, climatic, and management information go into the AquaCrop model, which then replicates soil water balance and the processes of crop growth (Doorenbos and Kassam., 1979).It is important to note that the AquaCrop model treats soil evaporation and plant transpiration as two distinct processes (Foster et al., 2017).Utilizing a crop-specific water productivity variable that has been corrected for reference evapotranspiration, daily biomass buildup may be estimated throughout a large climatic range (Kukal and Irmark., 2020).A harvest index parameter, which evolves throughout the course of the growing season and responds to abiotic stresses like water and temperature, is then used to determine what fraction of the biomass really becomes harvestable yield.Using AquaCrop, you can model the development, biomass production, and harvest of grassy crops (Steduto et al., 2007).In AquaCrop, the growth of the plant's leaves is measured by the green canopy cover (CC) and not by the Leaf Area Index (Nielsen et al., 2012). The production of above-ground biomass is related to the total quantity of crop transpiration. The proportionate factor is the productivity of biomass water (Mueller et al., 2005).In AquaCrop, biomass water productivity is normalised to account for the influence of climatic variables, making the normalised biomass water productivity applicable to various locations, seasons, and CO_2 concentrations (Raes et al., 2022).The simulated aboveground biomass (B) includes all photosynthetic products absorbed by the crop during the growing season.Harvest Index (HI) is the fraction of aboveground biomass that may be used to produce a harvestable good, and it is used to calculate crop yield (Steduto et al., 2012).When running a simulation, the real harvest index is calculated by applying an adjustment factor based on the stress impact to the reference Harvest Index.

2. Materials and Methods

The parameters of AquaCrop were determined and its performance validated using pooled data of wheat crop for two cropping years (2020-21 and 2021-22) in Prayagraj, Uttar Pradesh India.Experiments in the field were carried out at Irrigation Research Centre, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. Prayagraj is situated at 25.45 degrees North latitude and 81.84 degrees East longitude, and it is situated at the confluence of the Yamuna and Ganga rivers.The experimental design was a randomized complete block with three replication and five levels of irrigation included: however for the remaining treatment the irrigation amount to reduce by 0%, 20%, 40%, 60%, and 80% of 66 mm as designed depth of irrigation and irrigation was scheduled on the basis of limiting soil water conditions.The version of AquaCrop 6.1 wasused in this study.

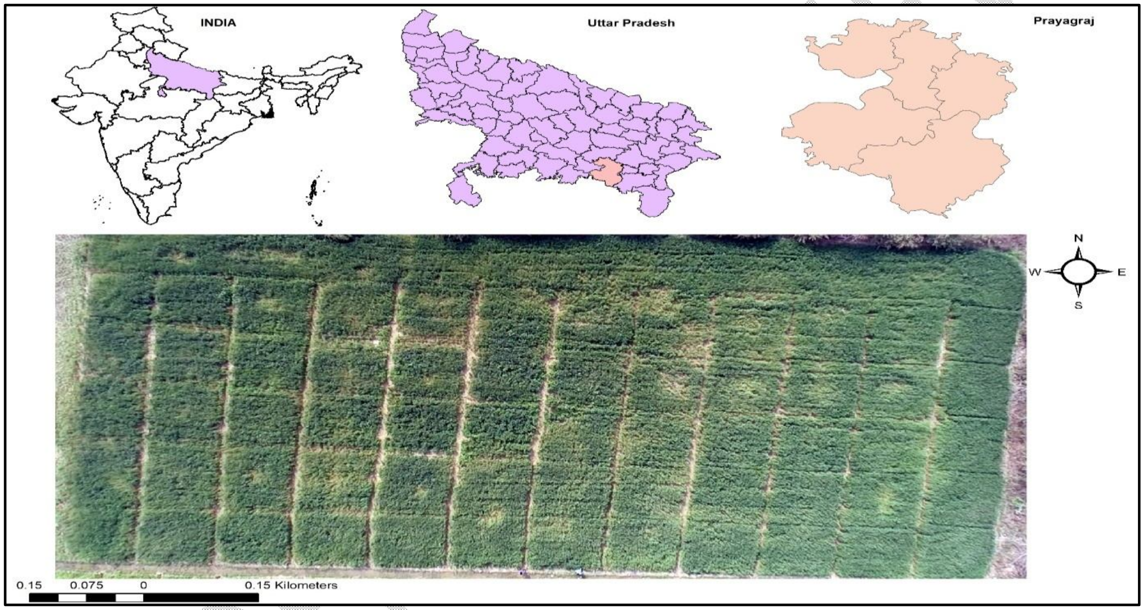

Fig. 1. Location of field experiment site at Irrigation Research Centre SHUATS, Prayagraj

2.1 Irrigation scheduling based upon limiting soil water conditions

2.1.1 Soil moisture content: Irrigation was scheduled on the basis of limiting soil water conditions. Soil moisture content is often evaluated in a laboratory by comparing the soil's weight after being oven-dried with its weight when it was first wet. Using this method, we were able to determine the soil's moisture content as a fraction of its dry weight: (AACC, 1995).

$$MC(\%) = \frac{(W2-W3)}{(W3-W1)} \times 100 \qquad (1)$$

Where, MC is the soil moisture content (%), W1 is the weight of tin (g), W2 is the weight of moist soil + tin (g), and W3 is the weight of dry soil + tin (g)

2.1.2 Total available water: Total available water refers to the quantity of water that may be used by plants. Actually, it's the soil moisture differential between the field capacity and the permanent wilting point(Allen et al., 1998). The total available water was determined using the formula below.

$$TAW = 1000\ [(\theta_{FC} - \theta_{WP})] \times Z_r \quad (2)$$

Where, TAW is the total available water (mm), θ_{FC} is the moisture content at field capacity (%), θ_{WP} is the moisture content at permanent wilting point (%), and Z_r is the effective root zone depth, (m).

2.1.3 Readily available water: The readily available water is the fraction of TAW that a crop may take from the root zone without suffering from water stress(Allen et al., 1998).

$$RAW = p\ TAW \quad (3)$$

Where, RAW is the readily available soil water in the root zone (mm), p is the average fraction of total Available Water.

2.1.4 Calculate the net depth of irrigation: After the calculating of total available water (TAW), the maximum permissible depletion (p) in percentage was used in the following equation to determine the net depth of irrigation (Allen et al., 1998).

$$IW = p\ TAW \quad (4)$$

Where, IW is the net depth of irrigation to be used for a single irrigation (mm),p is the maximum allowable depletion (%) and TAW is the total available water (mm). Using data from FAO-56, maximum allowable depletion (p) for wheat crop is equal to 0.55.Table 1 shows the irrigation level, depth of irrigation, number of irrigations, and total amount of water applied in each treatment.

Table 1.Irrigation details of deficit irrigation

Treatments	Level of irrigation	Depletion (%)	Depth of irrigation (mm)	No. of irrigation	Total applied of water (mm)
T_1	1	0	66	6	396
T_2	0.8	20	52.8	6	316.8
T_3	0.6	40	39.6	6	237.6
T_4	0.4	60	26.4	6	158.4
T_5	0.2	80	13.2	6	79.2

2.2 Model parameters and input data

2.2.1 Weather data

AquaCrop needs daily readings of lowest and maximum temperatures, wind velocity, relative humidity, precipitation, and solar radiation (Raes et al., 2009, Steduto et al., 2009).The weather data, which prevailed during the two-wheat crop growing seasons, November 2020 to April 2021 and November 2021 to April 2022, are presented in Table 2.

Table 2. Average monthly weather data during crop growing season(2020-21 and 2021-22)

Weather data 2020-21						
Month	**T. max (^{0}C)**	**T. min (^{0}C)**	**Mean RH (%)**	**Sunshine (hour)**	**Wind speed (Km/h)**	**Rainfall (mm)**
November	32.21	13.59	74.35	8.41	1.11	0.80
December	26.76	9.56	80.90	7.91	1.01	18.40
January	22.29	9.15	78.90	2.99	0.98	7.00
February	30.13	11.26	67.70	8.18	1.03	5.20
March	36.21	19.52	60.40	9.21	1.17	2.80
April	41.99	20.08	52.30	9.15	1.53	0.00

Weather data 2021-22						
Month	**T. max (^{0}C)**	**T. min (^{0}C)**	**Mean RH (%)**	**Sunshine (hour)**	**Wind speed (Km/h)**	**Rainfall (mm)**
November	29.62	15.14	74.76	8.69	1.03	0.00
December	24.76	11.12	81.22	5.22	1.03	1.20
January	20.49	9.08	85.77	3.36	1.04	57.20
February	27.91	13.20	68.19	8.27	1.37	0.00
March	35.44	19.46	59.18	8.97	1.32	0.00
April	42.15	23.73	59.03	8.75	1.53	0.00

Source: Department of Forestry and Environment at Prayagraj, Uttar Pradesh

2.2.2 Wheat growth measurements

The canopy's growth phases and aboveground biomass were observed over the (2020-21 and 2021-22) growing seasons. The plants were filmed at their current development stage before being mowed down. Time to emergence, maximum canopy cover, the onset of senescence, and maturity are some of the general development phases that must be determined for AquaCrop. Table 3 shows the findings of field measurements used to determine emergence time, maximum canopy cover, and the onset of senescence for use in AquaCrop simulations.

Table 3.Wheat growth parameters used in AquaCrop 6.1 model

Parameter	Calibrated Value
Number of plants per hectare	1000000
Time to reach maximum canopy cover	70 DAS
Initial canopy cover	1.50%
Maximum canopy cover	97%
Canopy growth coefficient	11.10%
Canopy decline coefficient	9.17%
Time to start senescence	90 DAS
Time to reach flowering	84 DAS
Length of flowering stage	15 days
Time from sowing to emergence	7 days
Time from sowing to reach maturity	130 days
Minimum effective rooting depth	0.30 m
Maximum effective rooting depth	1.0 m
Time from sowing to maximum root depth	40 days
Building up of harvest index	28 days
Reference harvest index	50%

2.3 Calibration of AquaCrop

Input variables for each simulation run included things like weather, soil type, irrigation frequency, planting date, and plant density. Calibration runs were used to collect crop data and/or adjust the model. For the calibrations, we compared the actual biomass production to the predicted value we calculated using the seed yield, the water productivity, and the canopy cover.

2.4 Model description

The goal of AquaCrop is to model the biomass and yield of field crops under varying water stress conditions. The following formula is a useful method for determining the yield response to water of fields, vegetable, and tree crops under varying irrigation regimes (Doorenbos and Kassam, 1979).

$$(\mathrm{Y_x} - \mathrm{Y_a})/\mathrm{Y_x} = \mathrm{k_y}(\mathrm{ET_x} - \mathrm{ET_a})/\mathrm{ET_x}\ (5)$$

Where, Y_x and Y_a are the maximum and actual yields. ET_x and ET_a stand for maximum and actual evapotranspiration, respectively. $K_y$denotes the proportionality factor between relative yield decline and relative evapotranspiration reduction. The following processes are sequentially simulated by the model with a daily time step:

(A) Simulation of crop development: In crop growth simulations, canopy expansion is separated from root zone expansion. AquaCrop describes crop growth using canopy cover instead of leaf area index(Geerts et al., 2009 and farahani et al., 2009).

$$CC = 1 - exp^{(-065LAI)}(6)$$

Where, CC represents the canopy cover (%)and LAI is the leaf area index.

(B) Simulation of crop transpiration: To calculate crop transpiration, first multiply the evaporating power of the atmosphere, which is denoted by ET_0, by a crop coefficient, which is denoted by K_{cb}, and then take into account water stresses, which are denoted by Ks.

$$Tr = Ks\left(Kcb_x\ CC^*\right)ET_o(7)$$

(C) Simulation of above ground biomass: The aboveground biomass production for each day of the crop cycle is calculated by multiplying the water productivity by the crop transpiration-to-reference evapotranspiration ratio (Tr/ET_0) for that day. Within AquaCrop, this is simulated by considering a temperature stress coefficient denoted by (Ks_b):

$$B = Ks_b WP^* \sum_i \frac{Tr_i}{ETo_i}(8)$$

(D) Partitioning of biomass into yield: The yield (Y) is calculated by multiplying the simulated above-ground biomass (B) by the adjusted harvest index, which is as follows:

$$Y = f_{HI}\, HI_o\, B \quad (9)$$

Where, HI is the harvest index and f_{HI} is a multiplier that takes into consideration the stresses that change the harvest index from its reference value.

(E) Water productivity: The correlation between crop yield and the quantity of water utilised in agricultural production is known as water productivity.

$$\text{WP (Kg m}^{-3}\text{)} = \frac{\text{Grain yield}}{\text{Total amount of water supplied}} \quad (10)$$

2.5Model validation

Adjusting for the parameters of the calibration procedure, the AquaCrop validation procedures used five treatments from the wheat crop field experiment for the two crop years (2020-21 and 2021-22). Simulations of canopy cover and above-ground biomass at different post-sowing times, grain yield, biomass, and water productivity were all used to verify the AquaCrop model.

2.6Evaluation of model performance

A model's performance must be reviewed so that a final value can be provided for the model's capacity to replicate an observed variable, the impact of calibrating model parameters can be assessed, and findings may be compared to previous reports (Krause et al., 2005).

(I) Coefficient of determination (R^2): The Square of the Pearson correlation coefficient is the coefficient of determination (R^2). Its value is between 0 and 1, with higher numbers suggesting more agreement.

$$R^2 = \left[\frac{\sum(O_i - \overline{O})\,(P_i - \bar{P})}{\sqrt{\sum(O_i - \bar{O})^2 \sum(P_i - \bar{P})^2}}\right]^2 \quad (11)$$

In this equation, O_i and P_i are the observations and predictions, respectively; $\bar{O}$ and $\bar{P}$ are their means (Krause et al., 2005).

(II) Root mean square error (RMSE): The root mean square error (RMSE) is a widely used statistical metric that computes the average size of the difference between predictions and observations (Krause et al., 2005).

$$RMSE = \sqrt{\frac{\sum(P_i - O_i)^2}{n}} \quad (12)$$

Where, n is the number of observations, and Pi and Oi are the predicted and observed values, respectively.

(III) Normalized root mean square error (NRMSE): Numerous statistical methods were used to evaluate the congruence between the simulated and actual results. Root-mean-square error normalisation was used to assess model performance (Rinaldy et al., 2003).

$$NRMSE = \frac{1}{\bar{O}}\sqrt{\frac{\sum(P_i-O_i)^2}{n}}\times100 \qquad (13)$$

The NRMSE of a simulation is deemed outstanding when it is less than 10%, acceptable when it is between 10% and 20%, fair when it is between 20% and 30%, and poor when it is more than 30%.

(IV) Nash-Sutcliffe model efficiency coefficient (EF): Quantifying the residual variance in proportion to the variance of the observations can be done with the use of the Nash-Sutcliffe model efficiency coefficient (Nash and Sutcliffe., 1970). The model and the data perfectly match with an EF of 1.

$$EF = 1 - \frac{\sum(P_i-O_i)^2}{\sum(O_i-\bar{O})^2} (14)$$

3. Result and Discussion

In this section of the research, we attempt to determine how much water must be applied and at what intervals so that extra water does not drain but instead return to the root zone when deficit irrigation is administered.Thus, the irrigation leads along with maximum allowed depletion (MAD), percentage of thresholds, depth of irrigation (mm), irrigation frequency, and total quantity of water provide a standard for deficit irrigation in wheat.At the study site, the soil water availability for sandy loam was determined to be 120 millimetres. It was determined that the soil moisture content at field capacity was 35%.Wheat is considered to have a depletion fraction of 0.55, with a maximum rooting depth of 1.5 to 1.8 metres.In the 1st treatment, the depth of irrigation continues at 66 mm, however in the 2nd, 3rd, 4th, and 5th treatments, the depth of irrigation is 52.8 mm, 39.6 mm, 26.4 mm, and 13.0 mm, respectively.The highest total water applied to wheat was 396 mm in the 1st treatment, followed by 316.8 mm in the 2nd treatment, 237.6 mm in the 3rd treatment, 158.4 mm in the 4thtreatment, and 79.2 mm in the 5th treatment.

3.1 Simulation of grain yield

Table 4 and Fig. 2 provide the findings of the model simulation for wheat grain yield.

Table4.Simulated grain yield and observed grain yield of wheat

Treatment	Observed grain yield (t/ha)			Simulated grain yield (t/ha)		
	2020-21	2021-22	pooled	2020-21	2021-22	Pooled
$T_{1(396mm)}$	4.60	4.26	4.43	4.86	4.28	4.57
$T_{2(316.8mm)}$	4.33	4.24	4.29	4.46	4.25	4.36
$T_{3(237.6mm)}$	3.13	3.43	3.28	3.23	3.62	3.43
$T_{4(158.4mm)}$	2.53	3.36	2.95	2.63	3.47	3.05
$T_{5(79.2mm)}$	2.13	2.84	2.49	2.38	2.93	2.66
RMSE	0.131					
NRMSE (%)	3.75					
EF	0.99					

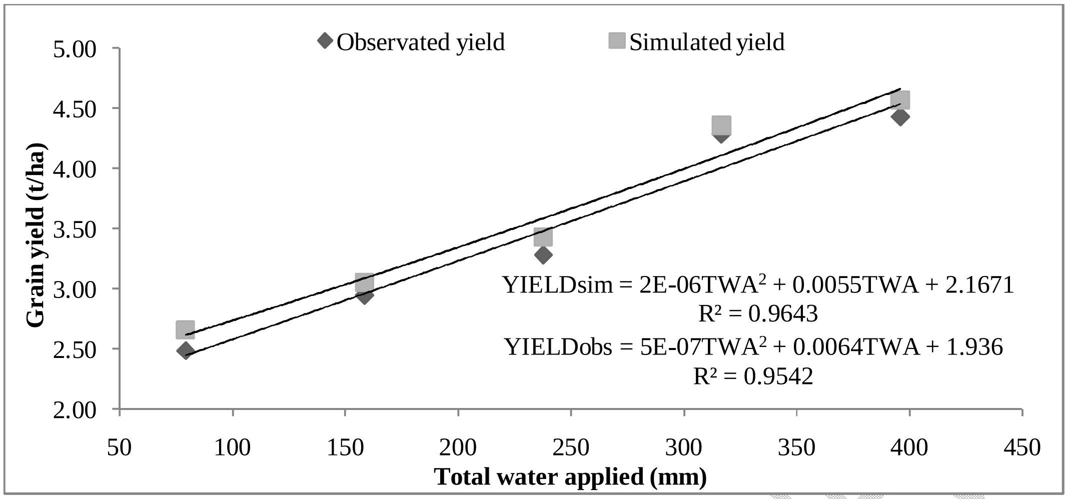

Fig. 2. Evaluation of Simulated grain yield and observed grain yield in wheat

Simulated grain yields in all treatments with various amount of irrigation depth had good agreement with observed grain yields. As a result, the model simulation performed very well (RMSE=0.131 and NRMSE=3.75). The model efficiency (EF) was 0.99 and coefficient of determination (R^2) of simulated and observed grain yield were 0.96 and 0.95.

3.3Simulation of water productivity

Table 5 and Fig. 3 exhibit the outcomes of the model simulation for the water productivity of wheat.

Table 5. SimulatedWP and observed WP of wheat

Treatment	**Observed WP (Kg/m^3)**			**Simulated WP (Kg/m^3)**		
	2020-21	**2021-22**	**pooled**	**2020-21**	**2021-22**	**Pooled**
$T_{1(396mm)}$	1.16	1.08	1.12	1.23	1.08	1.15
$T_{2(316.8mm)}$	1.37	1.34	1.35	1.41	1.34	1.37
$T_{3(237.6mm)}$	1.32	1.44	1.38	1.36	1.52	1.44
$T_{4(158.4mm)}$	1.60	2.12	1.86	1.66	2.19	1.93
$T_{5(79.2mm)}$	2.69	3.59	3.14	3.00	3.70	3.35
RMSE		0.106				
NRMSE		5.00				
EF		0.99				

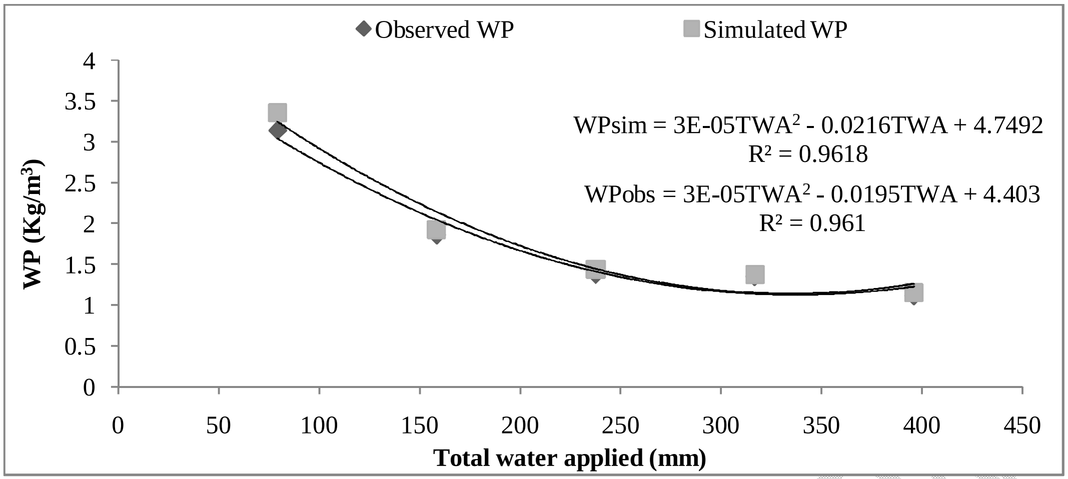

Fig. 3. Evaluation of Simulated WP and observed WP in wheat

Simulated water productivity matches observed water productivity well in all treatments with various amount of irrigation. The model simulation therefore performed quite well (RMSE=0.106 and NRMSE= 5.00). Between simulated and observed water productivity, the model efficiency (EF) was 0.99 and coefficient of determination (R^2) of simulated and observed water productivity were 0.96 and 0.96.

3.4 Simulation of biomass

Table 6 and Figs. 4 to 8 show results of model simulation for wheat biomass.

Table 6.Pooled data of simulated biomass and observed biomass (t/ha) of wheat

DAS	T_1(396mm)		T_2(316.8mm)		T_3(237.6mm)		T_4(158.4mm)		T_5(79.2mm)	
	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated
20	0.57	0.40	0.55	0.39	0.53	0.39	0.51	0.39	0.49	0.39
30	1.23	1.05	1.23	1.04	1.21	1.04	1.18	1.04	1.16	1.04
40	1.77	1.87	1.76	1.87	1.73	1.86	1.69	1.86	1.65	1.86
50	2.95	2.67	2.93	2.66	2.88	2.65	2.82	2.64	2.75	2.64
60	3.56	3.75	3.51	3.74	3.46	3.72	3.38	3.71	3.31	3.71
70	4.81	4.65	4.68	4.63	4.61	4.60	4.51	4.59	4.41	4.59
80	5.93	5.89	5.85	5.86	5.76	5.83	5.63	5.81	5.51	5.81
90	7.12	7.73	7.02	7.69	6.91	7.65	6.55	7.62	6.42	7.63
100	8.42	9.57	8.19	9.52	8.05	9.46	7.84	9.44	7.63	9.44
110	10.25	11.12	9.95	11.05	9.76	10.99	9.51	10.95	9.33	10.95
120	11.96	12.05	11.86	11.97	11.22	11.89	10.95	11.85	11.17	11.76
RMSE	0.492		0.575		0.654		0.789		0.857	
NRMSE	9.239		11.01		12.833		15.9.3		17.513	
EF	0.99		0.99		0.98		0.982		0.97	

According to the findings, simulated biomass in all treatments influenced by limiting soil water conditionsadapts well to observed biomass. So that model simulation under different treatments varied between RMSE ranged from 0.492 to 0.857, NRMSE ranged from 9.239 to

17.513 and EF ranged from 0.97 to 0.99. Coefficients of determination (R^2) of simulated biomass yield and observedbiomass yield of all treatments were 0.99.

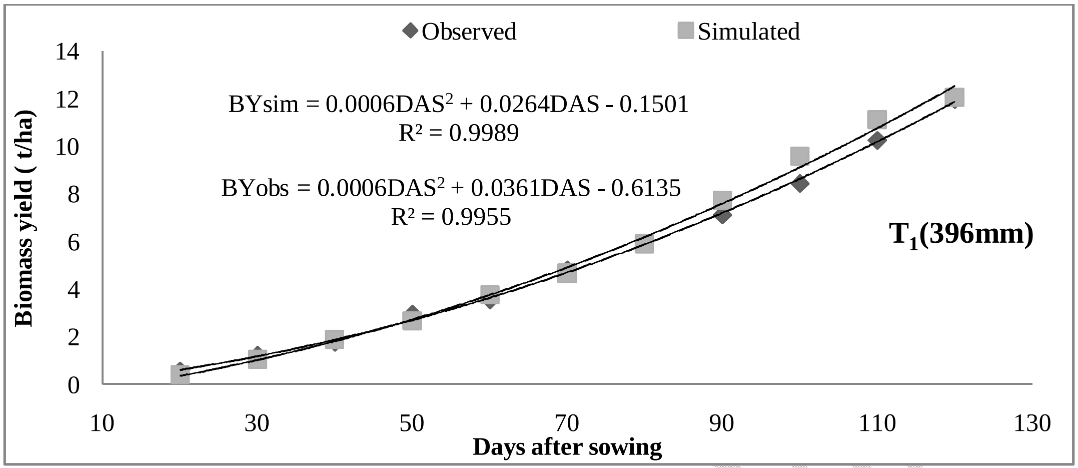

Fig. 4.Evaluation of Simulated and observed biomass yield in wheat of T_1(396mm)

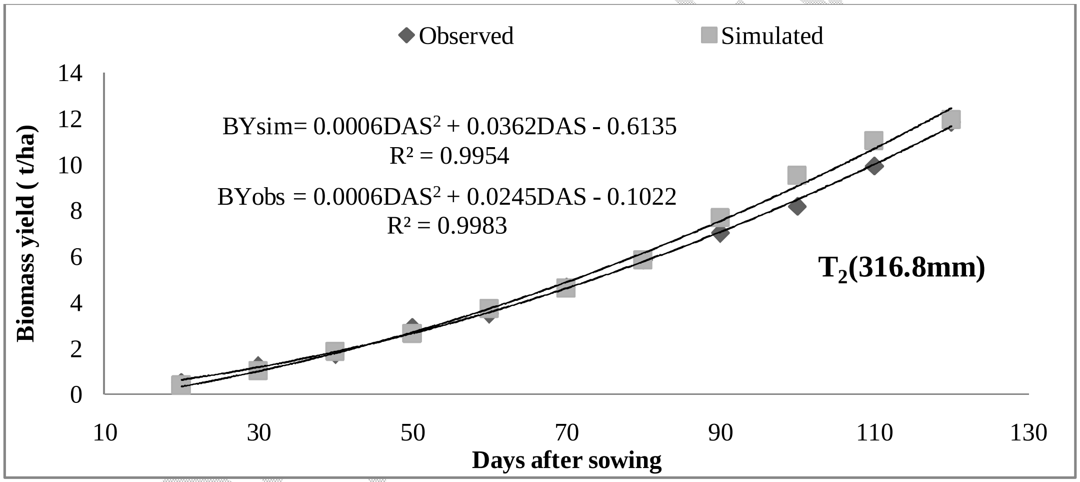

Fig. 5.Evaluation of Simulated and observed biomass yield in wheat of T_2 (316.8mm)

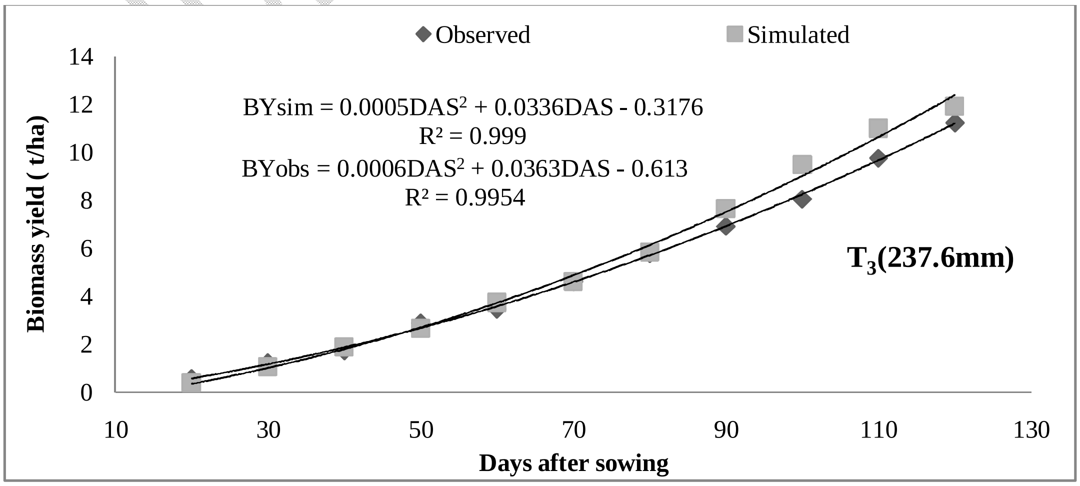

Fig. 6.Evaluation of Simulated and observed biomass yield in wheat of T_3 (237.6mm)

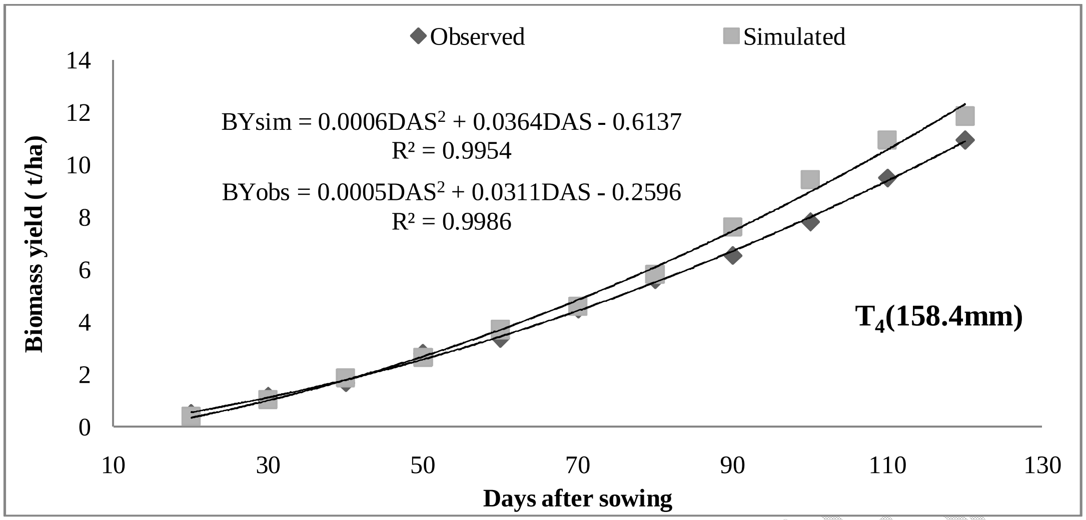

Fig. 7.Evaluation of Simulated and observed biomass yield in wheat of T_4 (158.4mm)

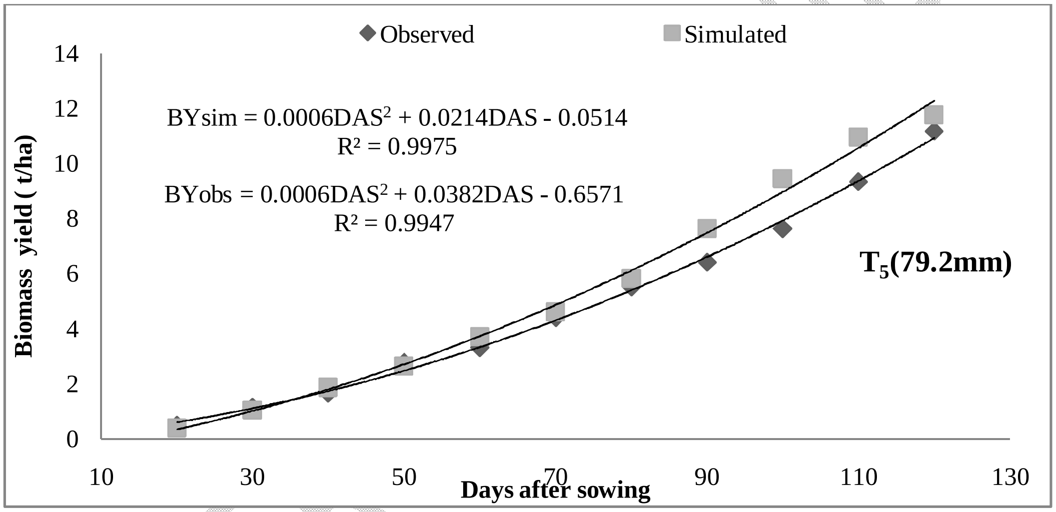

Fig. 8.Evaluation of Simulated and observed biomass yield in wheat of T_5 (79.2mm)

3.5 Simulation of canopy cover

The simulated results of the wheat canopy cover are shown in Table 7 and Figs. 9–13. The results show that under limiting soil water conditions, the simulated canopy cover of all treatments agrees well with the observed canopy cover.So that model simulation under different treatments varied between RMSE ranged from 13.344 to 18.974, NRMSE ranged from 20.770 to 33.223 and EF ranged from 0.91 to 0.96. Coefficients of determination (R^2) of simulated canopy cover of all treatments were 0.97 and Coefficients of determination (R^2) of observedcanopy cover of various treatments ranged from 0.88 to 0.92.

Table 7.Pooled data of simulated canopy cover and observed canopy cover (%) of wheat

DAS	T_1(396mm)		T_2(316.8mm)		T_3(237.6mm)		T_4(158.4mm)		T_5(79.2mm)	
	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated
20	8.64	15.50	7.98	15.50	7.38	15.50	8.82	15.45	9.23	15.45
30	24.97	37.10	23.29	37.00	20.45	36.80	21.27	36.75	18.94	36.75
40	43.71	70.30	40.82	69.70	35.05	69.10	35.01	68.80	33.77	68.80
50	87.66	85.60	85.19	84.80	85.01	84.00	81.72	83.55	81.46	83.55
60	94.57	92.00	93.75	91.10	93.06	90.20	91.77	89.70	90.93	89.70
70	97.21	94.70	97.21	93.70	96.62	92.80	96.24	92.30	95.18	92.30
80	93.47	96.20	92.66	95.20	91.34	94.20	90.78	93.70	89.02	93.70
90	82.90	96.70	81.63	95.70	79.00	94.70	77.94	94.20	74.45	94.20
100	72.91	90.20	67.43	89.30	64.38	88.30	62.72	87.85	58.36	87.85
110	53.29	76.50	47.73	75.50	46.52	74.60	42.41	74.15	42.41	74.15
120	47.39	45.20	42.39	44.40	37.42	43.50	34.46	43.05	34.46	43.05
RMSE	13.344		15.243		16.973		17.669		18.974	
NRMSE	20.77		24.656		28.45		30.22		33.223	
EF	0.964		0.95		0.936		0.927		0.913	

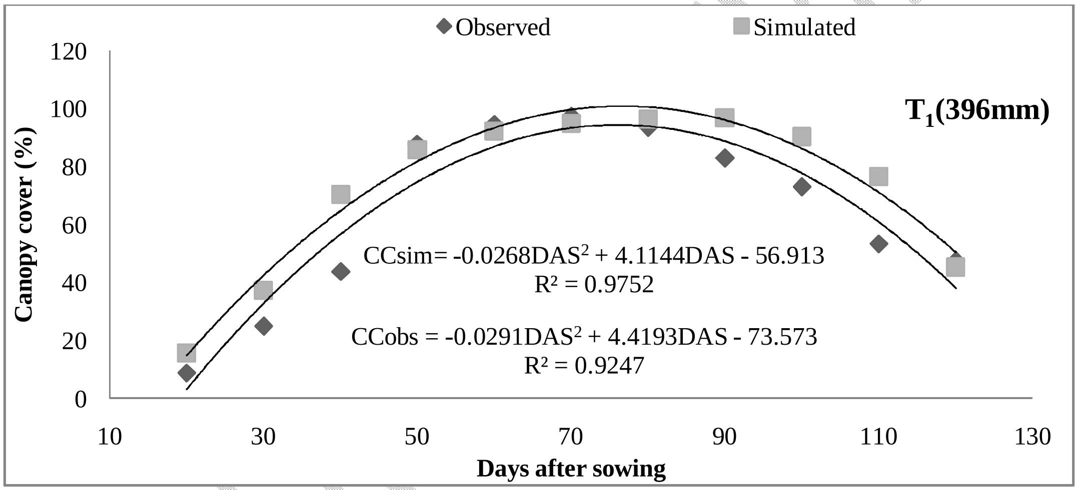

Fig. 9. Evaluation of Simulated and observed canopy cover in wheat of T_1 (396 mm)

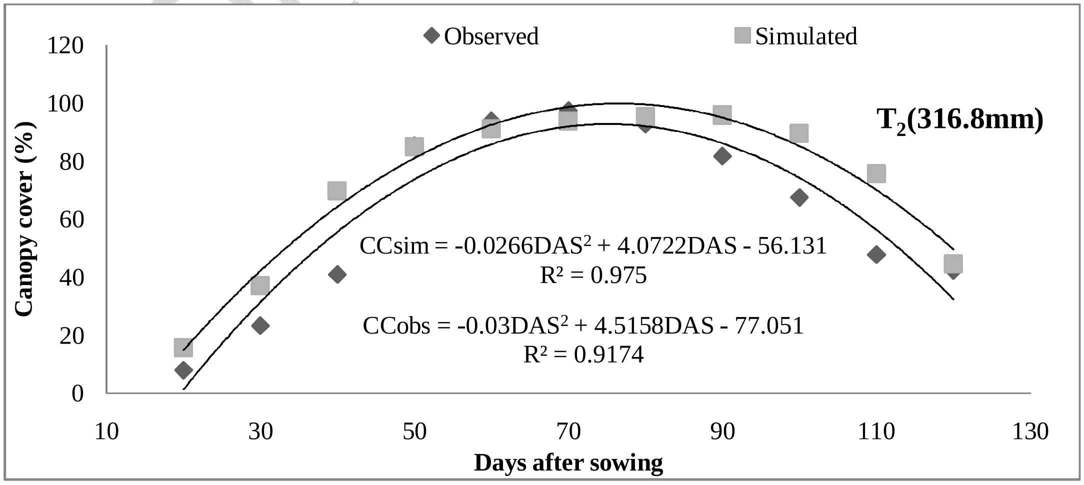

Fig. 10.Evaluation of Simulated and observed canopy cover in wheat of T_2 (316.8 mm)

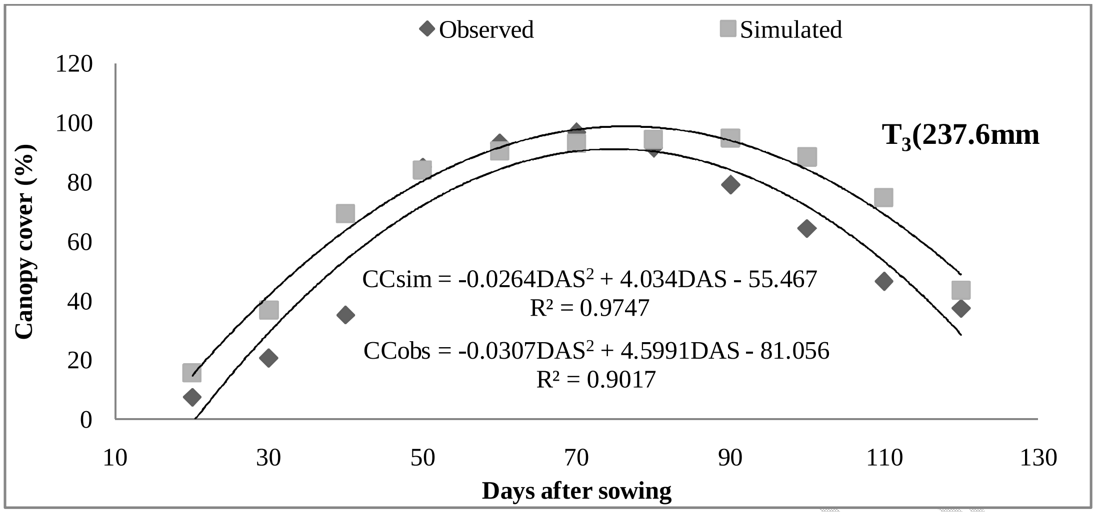

Fig. 11.Evaluation of Simulated and observed canopy cover in wheat of T_3 (237.6 mm)

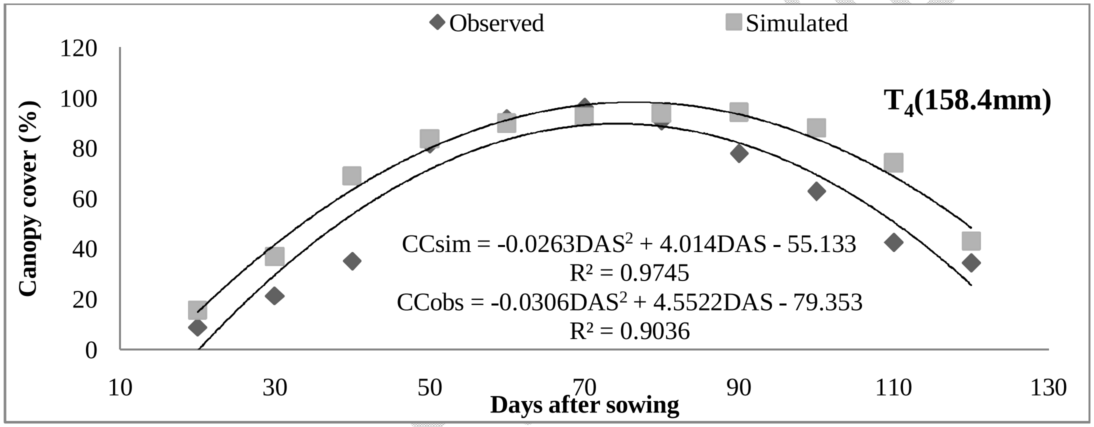

Fig. 12. Evaluation of Simulated and observed canopy cover in wheat of T_4 (158.4 mm)

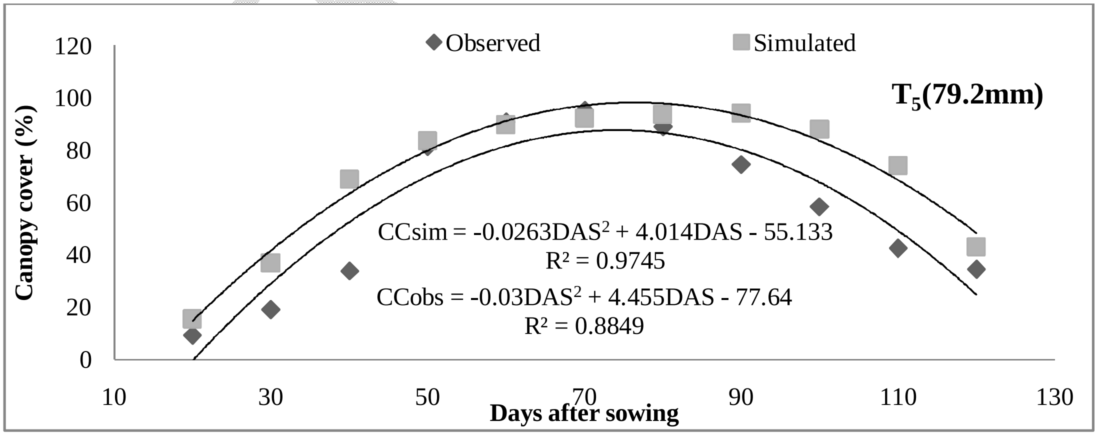

Fig. 13. Evaluation of Simulated and observed canopy cover in wheat of T_5 (79.2 mm)

Conclusion

The AquaCrop model was validated, with the findings demonstrating that it accurately simulated biomass yield, water productivity, grain yield, and canopy cover.The coefficient of determination (R^2) of the simulated and observed grain yield was 0.96 and 0.95 respectively, while the RMSE and NRMSE were 0.131 and 3.75, respectively. The coefficients of determination (R^2) of simulated and observed water productivity were 0.96 and 0.96 respectively and the model simulation worked admirably (RMSE=0.106 and NRMSE= 5.00).The ease of use of AquaCrop is mostly attributable to the fact that it only requires a minimal number of input data, all of which are either publicly accessible or can be quickly gathered.Projective studies, such those examining the consequences of climate change in the future, are ideal applications for AquaCrop models.By comparing predicted yields with observed yields in a specific field, farm, or region, aqua-crop models may help determine what variables are limiting crop production and water productivity. It works well for hypothetical circumstances, such those brought on by climate change in the future.

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