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Estimation of evapotranspiration by WTGROWS model

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ABSTRACT

A field experiment with wheat crop was laid out in strip plot design with treatments of dates of sowing and four irrigation levels replicated thrice on loamy sand soils of Agronomy Farm, B A college of Agriculture, Gujarat Agricultural University, Anand campus during *rabi* 2000 and 2001. The estimated volumetric ET values by gravimetric method before and after each irrigation were compared with the simulated values by WTGROWS. The pooled RMSE was 2.9 per cent of the observed mean ET. The index of agreement was 0.96 during both the years. Relatively lower value of MBE in relation to MAE during both the years revealed underprediction by the model within the limit of ± 15 per cent.

Key words: WTGROWS, evapotranspiration.

The robustness of WheaT GROwth Simulator (WTGROWS)- a mechanistic crop growth simulation model (Aggarwal *et al*., 1994) was tested across the country in estimation of wheat yields. The model has a soil water balance sub model attached to it to simulate water uptake and to determine water stress. Potential evaporation and transpiration are computed by Penman's approach and by SUEVTR subroutine of MACROS, respectively. Hence, an effort was made to compare the seasonal changes in the observed and model simulated evapotranspiration (ET) as ET is a weather driven phenomenon. Moreover estimation of ET aids in judicious scheduling of irrigation in wheat crop.

MATERIALS AND METHODS

A field experiment was carried out for two consecutive years during *rabi* 2000 and 2001 to generate necessary data to estimate ET using WTGROWS model under Anand conditions. The field experiment was laid out in strip plot design with treatments on three dates of sowing and four irrigation levels replicated thrice on loamy sand soils of Agronomy Farm, B A college of Agriculture, Anand Agricultural University. The main treatments were three dates of sowing D_1, D_2, and D_3 at

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an interval of two weeks from I[st] Nov to 30[th] Nov. The sub plot treatments were irrigation levels ranging between three irrigations in I_1 and six irrigations in I_4 coinciding with critical stages of crop growth. The sub plot treatmental details were: I_1 - CRI, BT, and ML, I_2 - CRI, TL, FL and DS, I_3 -CRI, TL, BT, FL and ML and I_4 - CRI, TL, BT, FL, ML and DS (CRI - Crown Root Initiation, TL - Tillering, BT - Booting, FL - Flowering, ML - Milking and DS - Dough stage). The wheat variety GW – 496 was used for the present investigation.

The profile soil moisture content upto 45 cm depth was determined by gravimetric method before and after each irrigation and converted into volumetric content. The difference in soil moisture content were taken as observed ET. These values were compared with the simulated ET output soil water balance model of WTGROWS for all the treatments under study during both the years.

Correlation (r) and regression coefficients (R) were determined to evaluate the association between the measured and modelled values of ET. Besides, the test criteria such as suggested by Willmott (1982) were also followed while evaluating the performance of the model. They are: mean absolute error (MAE) mean bias error (MBE), root mean square error (RMSE), index of agreement (D) and error per cent. These were calculated as follow.

$$MAE = \sum_{i=1}^{n} [Pi - Oi] / n$$

$$MBE = \sum_{i=1}^{n} (Pi - Oi) / n$$

$$RMSE = \left[\sum_{i=1}^{n} (Pi - Oi)^2 / n \right]^{1/2}$$

$$D = 1 - \left[\sum_{i=1}^{n} (Pi - Oi) / \sum_{i=1}^{n} (|P'i| + |O'i|)^2 \right]$$

$$0 \le (D) \le 1$$

where ,

$$P'i = Pi - \overline{P}, O' = Oi - \overline{O}$$

Error % ={(simulated – observed) / observed} x 100

RESULTS AND DISCUSSION

The range of the measured ET during *rabi* 2000 was 235 to 405 mm and the same during *rabi* 2001 was 228 to 402 mm. The corresponding values as simulated by WTGROWS ranged from 177 to 415 mm in the year 2000 and 195 to 413 mm in 2001. The highest and the lowest values of measured and modeled ET were observed in the

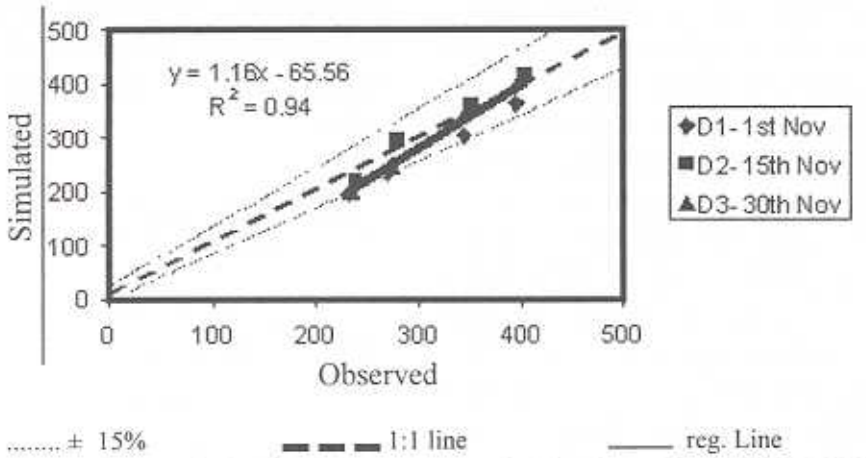

Fig 1: Comparison of simulated evapotranspiration (mm) by WTGROWS with that observed in wheat, pooled 2000 and 2001

treatments D_2I_4 and D_1I_1, in respect of the data pooled over the two seasons (Fig.1).. The results on ET here (Table 1) were observed to be comparable with those reported by Sahu (1977), Mehta (1980), Shekh (1985), Savani (1985) and Vadodaria (2001) who also estimated ET in wheat under Anand conditions under different irrigation levels. The correlation and regression coefficients between the observed and simulated values of ET were positive during both the years and also in case of data pooled over the seasons and were statistically significant (Table 1).

The pooled RMSE was 9 mm, which was 2.9 per cent of the observed mean ET. The index of agreement was 0.96 during both the years. Relatively lower value of MBE in relation to MAE during both the years revealed underprediction by the model. Underestimation of ET by the model was noticed in all the treatments of the first date of sowing and in three irrigation treatments of all the dates of sowing of pooled data over the seasons (Table 2). A little overestimation of ET by the model was found in case of the treatments involving five and six irritations for the second and third date of sowing and also in case of four irrigations for the second date of sowing. This overestimation and /or underestimation of simulated total ET was also reflected in the time course of cumulative ET.

Table 1: Test criteria adopted in evaluation of WTGROWS with respect to evapotranspiration (mm)

Parameter	2000	2001	Pooled
Observed ET	316	312	314
S D ±	67	66	67
Simuleted ET	302	297	299
S D ±	79	80	80
r	0.97 **	0.96 **	0.97 **
R^2	0.95 **	0.94 **	0.94 **
MAE	22	23	23
MBE	-15	-14	-15
RMSE	9	10	9
% of observed. RMSE	2.8	3.2	2.9
Index of Agreement (D)	0.96	0.96	0.96

Table 2: Error per cent in WTGROWS simulated evapotranspiration (Pooled, 2000 and 2001) from observed in wheat

Treatments	Error per cent			
Dates of sowing	I_1	I_2	I_3	I_4
D_1-1st Nov	-15.77	-12.62	-11.63	-8.10
D_2-15th Nov	-9.41	4.82	1.71	2.35
D_3-30th Nov	-13.68	-9.51	1.73	2.63

The trend of cumulative ET, during both the years, showed a steady increase up to flowering and subsequently at a slower rate just as was the case with respect to dry matter production. Relatively lower value of MBE in relation to MAE during both the years revealed underprediction by the model of course within the limit of ± 15 per cent.

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