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EXTENDED ABSTRACT

Predicting Biomass and Grain Yield in Canola Under Different Water Regimes and Fertilizers Using AquaCrop Model

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Introduction

The AquaCrop model improves farm management practices, including plant density, planting time, and chemical fertilizers. It also simulates crop yield, soil water content, soil salinity, and water productivity. One of the applications of this model is the assessment of rainfed production during the long term, the effect of low fertilization, the productivity of real water on the farm, and the analysis of future climate scenarios. The disadvantages of this model include the lack of calibration of the amount and time of fertilization and the lack of consideration of plant diseases and weeds (Raes et al., 2009). The AquaCrop model is suitable for simulating different water and nitrogen managements on yield (Khoshravesh et al., 2012). Ebrahimi, Rezaverdinejad and Majnooni Heris (2015) evaluated the AquaCrop model under different irrigation and nitrogen fertilizer managements for estimating maize grain yield and biomass in Shiraz. This model predicted the grain yield of maize with high precision and biomass obtained in all treatments was more than the estimated values. Alishiri, Paknejad and Aghayari (2014) in simulating sugarbeet growth under different irrigation regimes and nitrogen fertilizer concluded that the highest error in performance simulation was in the treatment that had the highest fertilizer stress. The purpose of this study was to calibrate and validate the AquaCrop model for estimating the crop grain yield (GY) and biomass (B) of Canola under different irrigation regimes and pure nitrogen fertilizer levels in loamy soils in Gazvin, Iran, for two years.

Methodology

This study was conducted for performance evaluation of the AquaCrop model to predict grain yield and biomass of Canola in Gazvin for two years. The experiment was a randomized complete block based on factorial design with three replications. Irrigation treatments were in the main plots as the main factor in three levels of normal irrigation, irrigation cutoff in the stem elongation stage, and irrigation cutoff at flowering stage. Nitrogen fertilizer treatments were as sub plots in 5 levels of 0, 40, 80, 120 and 160 kg per ha. For climate information, the daily data from the Qazvin Meteorological Station were used and the reference evapotranspiration was calculated based on the FAO Penman-Monteith method using the ET_O Calculator software (Allen et al., 1998). To compare the simulation and measured values of biomass and yield, the statistical indices of determination coefficient (R^2), normalized root mean square errors

(NRMSE), relative error (RE), coefficient of residuals (CRM), and compatibility (d) were used (Morisi et al., 2007; Singh, Tripathy and Chopra, 2008; Willmott, 1982).

Results and Discussion

The main economic field crop products are the final biomass and grain yield for which the crop growth models try to arrive at satisfactory and acceptable simulations. Based on the results in Table 1 and 2, the normalized root mean square error of calibration and validation were, respectively, 8.95 and 11.78 percent for grain yield prediction and 12.87 and 12.08, respectively, for biomass. Also, the determination coefficient of calibration and validation for maize grain yield were calculated to be 0.89 and 0.87, respectively, These figures were 0.79 and 0.84, respectively, for maize biomass.

Table 1- Statistical parameters of the evaluation model for total irrigation and fertilizer levels (Canola grain yield)

Statistical index	*NRMSE (%)*	*CRM (-)*	*NSE (-)*	*d (-)*	*R^2 (-)*
Calibration	8.95	-0.018	0.88	0.997	0.89
Validation	11.78	0.053	0.86	0.994	0.87

Table 2- Statistical parameters of the evaluation model for total irrigation and fertilizer levels (Canola biomass)

Statistical index	*NRMSE (%)*	*CRM (-)*	*NSE (-)*	*d (-)*	*R^2 (-)*
Calibratio	12.87	-0.037	0.62	0.994	0.79
Validation	12.08	0.078	0.74	0.995	0.84

It is proved that AquaCrop has an acceptable performance in simulating final grain yield of canola (Zeleke et al., 2011), wheat (Khorsand et al., 2014; Zhang et al., 2013; Andarzian et al., 2011), barley and teff (Araya et al. 2010a,b), and maize (Abedinpour et al., 2012; Hsiao et al., 2009; Heng et al., 2009). Araya et al. (2010a, b) reported a deviation for grain yield of -5.6 to 14.6% for barley and -22.5 to 8.5% for teff. Zeleke et al. (2011) used the AquaCrop model for the calibration and testing of canola. The compatibility and deviation percentages were of 0.97, 0.95 and 1.2%, -9.7%, respectively and percentages of deviations in the calibration and validation for GY were 4.7% and -2.1. Andarzian et al. (2012) reported that the AquaCrop model predicted biomass values at harvest quite well. The calculated values of statistic indices NRMSE, compatibility and R^2 were 4.4%, 0.97 and 0.95, and these statistical indices for grain yield were 5%, 0.97 and 0.95, respectively. The AquaCrop model could satisfactorily predict top-weight biomass and grain yield of wheat under Ahvaz conditions. Zhang et al. (2013) in their model represented a compatibility and an RMSE of 0.5 to 1.44 (ton ha-1), 0.95 to 0.98 and 0.16 to 0.38 (ton ha-1), 0.22 to 0.89, respectively, for wheat grain yield and biomass simulation. The AquaCrop model (the NRMSE at the range of less than 10%) simulated grain yield of winter wheat for Roshan and Ghods varieties more accurately than the FAO agro-hydrological (the NRMSE at the range of 10 to 30%) model (Khorsand et al., 2014).

Conclusions

The data of field experiments on Canola were used to calibrate and validate the AquaCrop model in a semi-arid region of Gazvin, Iran. The results shows that this model can predict canola grain yield and biomass with an appropriate precision and can determine the optimization strategies for the improvement of water productivity and nitrogen fertilizer in maize used in the province of Gazvin. Because of the simplicity and the limited parameterization of AquaCrop in comparison with other crop growth models, it is obvious that the calibrated model is a reliable tool for a vast range of water management strategies, crop yield, and biomass prediction scenarios under water-saving irrigation managements in semi-arid regions of Iran. The results of previous studies demonstrated that simulation models can be applied as a useful and valid tool for predicting grain yield, biomass, canopy cover and water movement through soil profiles (Khorsand et al., 2014).

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