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Estimation of yield and dry matter of winter wheat using logistic model under different irrigation water regimes and nitrogen application rates

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Estimation of yield and dry matter of winter wheat using logistic model under different irrigation water regimes and nitrogen application rates

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Complex simulation models need considerable input data that may be unavailable. In this study, based on growing degree days, a simple and empirical logistic model was used to predict top dry matter (DM) and grain yield (GY) of winter wheat in a semiarid area. For calibration and validation of the model, winter wheat cv. Shiraz was cultivated for two growing seasons (2009–2010 and 2010–2011) under different levels of irrigation water and nitrogen application rates. The coefficients of the logistic model and the harvest index were related to the seasonal amount of applied water (I) plus rainfall (R) and applied nitrogen plus residual soil mineral nitrogen ($N + N_r$) with good accuracy in 2009–2010. The values of DM were estimated using the developed empirical logistic model during the growing season in 2010–2011. Results also indicated that there was a good agreement between the measured and predicted GY in 2010–2011 with fair accuracy. Therefore, it is concluded that the presented model is appropriate for prediction of DM and GY of winter wheat at the study region.

Keywords: logistic model; winter wheat; top dry matter; grain yield; growing degree days

Introduction

Crop simulation models offer a powerful tool to predict crop growth and yield in different environmental conditions. Such models help to manage resources, maximizing returns to producer and reducing negative impacts on water quality. They can be used to optimize the fertilizer and irrigation management (Pang & Letey 1998; Pirmoradian & Sepaskhah 2006; Sepaskhah et al. 2006, 2011; Zand-Parsa et al. 2006). Depending on the scientific discipline, there are different types of models, ranging from very simple models that are based on one equation to extremely advanced models that include thousands of equations (Hoogenboom 2000). Although, model users would like to be able to simulate the complete soil–plant–atmosphere continuum, they normally have very difficult time in obtaining the input parameters required to simulate these processes (Hunt & Boote 1998). Computer modelers have a tendency to request input information for their simulation models that, in many cases, is not available. The lack of adequate input data made users of crop models to use simpler models with fewer required input data.

Simple mathematical models such as Chapman–Richards and Gompertz equations were often used to show growth dynamics, plant height and biomass accumulation (Overman et al. 1988a, 1988b; Prasad et al. 1992; Weiner et al. 1998; Birch 1999; Jean & Sheng 2005; Liu & Peng 2006). The logistic model is one of the most frequently used

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