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A Very Simple Model for Yield Prediction of Rice under Different Water and Nitrogen Applications

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The ability to accurately model crop water and nitrogen requirements can improve irrigation and nitrogen application management. Forecasting of rice yield at the time of planting, under different irrigation and nitrogen application management programmes, is possible with a rice yield simulation model calibrated for the study area. In this study, a very simple model (VSM) was developed for simulation of rice grain and biomass yields under different irrigation and nitrogen application management strategies. The model assumes a triangular pattern for leaf area changes and proportionately of biomass accumulation to the intercepted solar radiation. The model can provide the grain and biomass yields based on maximum leaf area index, harvest index, and light use efficiency. These parameters were estimated by multiple regression equations. Nitrogen application rate, seasonal amount of applied irrigation water, plant population, maximum applied water in flood irrigation, and mean daily solar input before and after flowering are model inputs. Furthermore, the transplanting, flowering, and harvest dates should be specified. The model was calibrated for a lowland local rice cultivar (Champa-Kamfiroozi) in the Kooshkak area (semi-arid climate), Fars province, I.R. of Iran, with data from an experiment with five irrigation treatments and three nitrogen application rates in two consecutive years. The model produced good estimates of dry matter and grain yields. The accuracy of the model was verified with independent data from other experiments in the study area and in the northern parts of Iran with sub-humid climate.

1. Introduction

The application of computer models in agriculture is rapidly increasing. Crop growth models are powerful tools to improve an understanding of global climate change and to predict crop yield changes caused by these changes and other environmental inputs, *i.e.* water and nitrogen applications. Crop yield depends on interaction between soil, water, plant, and atmosphere as a continuum system. Simulation of plant-growth stages and consequently forecasting the crop yield permits better planning and more efficient management of crop production processes (*e.g.* Farshi *et al.*, 1987; Pang & Letey, 1998; Zand-Parsa *et al.*, 2005).

Nitrogen (N) and water are two of the main factors limiting the realisation of yield potentials (Kropff *et al.*, 1993; Cassman *et al.*, 1997). Computer model applications could facilitate irrigation water management by making frequent field visits and measurement less essential. Several crop growth and water balance models have been developed with different levels of complexity depending on specific requirements (Whisler *et al.*, 1986; Singels & De Jager, 1991a, 1991b, 1991c; Smith, 1992; Kropff *et al.*, 1994; Annandale *et al.*, 1999; Crosby, 1996; Benade *et al.*, 1997; Schapendonk *et al.*, 1998, Yin *et al.*, 2000; Ziaei & Sepaskhah, 2003; Lisson & Robertson, 2003).

Close correlations are commonly found between crop yields and N application rates (Novoa & Lomis, 1981; Sinclair & Hoire, 1989; Muchow *et al.*, 1990) and between crop yield, with N application rates, and irrigation water (Zand-Parsa & Sepaskhah, 2001; Pirmoradian *et al.*, 2004). Zand-Parsa *et al.* (2005) developed a multi-component model for maize growth and simulated hourly maize dry matter production. Zand-Parsa and Sepaskhah (2001) determined the

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