Biosystems Engineering (2006) **95** (4), 583–596
doi:10.1016/j.biosystemseng.2006.08.003
SW—Soil and Water

Water Budget Approach to quantify Cowpea Yield using Crop Characteristic Equations

A.R. Sepaskhah; Sh. Rezaee-pour; A.A. Kamgar-Haghighi

Department of Irrigation, Shiraz University, Shiraz, I.R. of Iran; e-mail of corresponding author: sepas@shirazu.ac.ir

(Received 24 December 2005; accepted in revised form 10 August 2006; published online 17 October 2006)

Crop growth and yield as influenced by various environmental parameters are modelled for better planning and more efficient management of the crop production process. Many of the models currently used have complex input requirements. The objective of this study was to use soil water budget and simple relationships for evapotranspiration partitioning, leaf area index determination, and the transpiration functions for dry matter and for harvest index to develop a model for growth and yield production of cowpea under soil water stress conditions. The Food and Agriculture Organisation (FAO)–Penman and FAO–Penman–Monteith methods were used to estimate the reference crop potential evapotranspiration E_{To} and the results of the soil water balance accordingly were compared. The model was calibrated by a set of data from which the above relationships were derived and then validated very well with another set of data obtained from an experiment in the same area but in a different year. It was concluded that the FAO–Penman method for estimation of reference crop potential evapotranspiration is superior to FAO–Penman–Monteith method in the study area. The model is also capable of estimating dry matter production during the growing season. Furthermore, it was shown that the model can be successfully applied for farm irrigation management and scheduling. It was indicated that the optimum irrigation interval was 7 days with the amount of applied water of 5 cm for each irrigation event.

1. Introduction

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 (Pang & Letey, 1998; Ziaei & Sepaskhah, 2003; Pirmoradian & Sepaskhah, 2006; Sepaskhah *et al.*, 2006). There are many possible applications of growth and water balance models to water and other input management (Hoogenboom, 2000; Horie *et al.*, 1992). Among different models for crop growth and yield simulation, Paz *et al.* (1998), using a soyabean model, showed that yield variability correlated with variability of simulated water stress.

Many of the models currently applied in precision agriculture have complex input requirements and are more detailed than necessary for certain applications. The soil water balance is the basis for simple models in which the evapotranspiration partitioning to evaporation and transpiration is based on the leaf area index and soil water stress (Sepaskhah & Ilampour, 1995) and leaf area index is also dependent on the crop evapotranspiration (Sepaskhah & Ilampour, 1995). Furthermore, in simple models, total dry matter production is linearly related to seasonal transpiration (de Wit, 1958; Arkley, 1963; Bierhuizen & Slatyer, 1965; Tanner, 1981; Tanner & Sinclair, 1983). In simple models, grain yields can be obtained by multiplication of total dry matter production by harvest index H_I. However, the H_I was reported to be dependent on transpiration (Sepaskhah & Ilampour, 1995).

The objective of this study was to use soil water budget and simple relationships for evapotranspiration partitioning, leaf area index determination and harvest index–transpiration function to develop a model for growth and yield prediction of cowpea under soil water stress conditions.