

COSSMO: A COMBINATION CROP GROWTH AND WATER MANAGEMENT MODELING SYSTEM

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INTRODUCTION

Controlled-drainage/subirrigation (CDSI) is a management scheme by which the water table below the crop root zone is managed (by adding or removing water) to provide an optimum soil water environment. Since crop growth is affected by water management strategies, a method is needed to predict the crop response to these various strategies. Improper management can lead to plant injury by allowing either too much or too little water to reach the plant's roots, thereby reducing yields. The water management model DRAINMOD (Skaggs, 1978) was developed as a design and management tool for use with CDSI systems in humid regions. A limiting aspect of DRAINMOD is the inability to simulate crop growth directly.

In order to determine the potential benefits of managing soil water conditions with a CDSI system, a method for evaluating the effects of various irrigation strategies on crop growth is needed. Many efforts have been made to enable DRAINMOD to simulate crop growth (Sabbagh et al., 1991; Brink, 1986; Evans, 1991). This presentation describes an attempt to add crop growth capabilities to DRAINMOD by developing an "expert simulation system", COSSMO (COMbined SUBirrigated SOYbean MOdel), to link DRAINMOD with the crop growth model SOYGRO. This presentation also indicates the results of validating the COSSMO system with soil, weather data, and observed yields from studies in North Carolina. Simulation results from COSSMO are also compared to simulation results from SOYGRO stand-alone.

METHODS

The two models, DRAINMOD 3.4 and SOYGRO 5.4, simulate water table management and soybean crop growth, respectively. The SOYGRO model was modified to accept upward water movement from a water table from DRAINMOD and to account for crop stress from possible root flooding. The DRAINMOD model was enhanced to accept evapotranspiration and effective rooting depths from SOYGRO and to incorporate a

feedback control loop (Perry et al., 1990). An expert system, COSSMO, was developed to obtain various model input from the user, execute the two models in an iterative fashion, and provide output information to the user. The two models were able to share data by the use of data swap files. Perry et al. (1990) described the development and code verification in detail. However, no validation was performed.

In order to validate the modeling system, sixty-five sets of field data from the Tidewater Research Station near Plymouth, North Carolina were obtained. For each year, variety, and study combination, actual field drainage system parameters were used in the COSSMO simulations (Table 1). Four soybean varieties (Bragg, Davis, Forrest, and Ransom) grown in the North Carolina studies were used in the validation simulations. A Portsmouth fine sandy loam soil (fine sandy over sandy or sandy - skeletal, mixed, thermic Typic Umbraquult) was used in all simulations. Complete soil properties measured at the Tidewater station were reported by Gilliam et al. (1978) and Skaggs (1978). The reader is referred to Evans et al. (1991) for detailed information on the field and system characteristics.

Rainfall and temperature data were obtained from weather records collected by a weather station at the site. Solar radiation was not available for the Tidewater station, therefore monthly mean daily insolation values were obtained (de Jong, 1973) and converted to solar radiation values.

Once the necessary data files were generated, COSSMO simulations were run using a row spacing of 91.4 cm (36 inches) and a plant spacing of 7.6 cm (3 inches). The SOYGRO model was executed stand-alone using the same soil, weather, and variety information.

RESULTS AND DISCUSSION

A predetermined "allowable" range of error of 670 kg/ha (10 bu/ac) overprediction to 340 kg/ha (5 bu/ac) underprediction was assumed to gauge resulting predicted yields. This range is based on a ± 340 kg/ha (5 bu/ac) allowable range (17 % of maximum yield). The additional

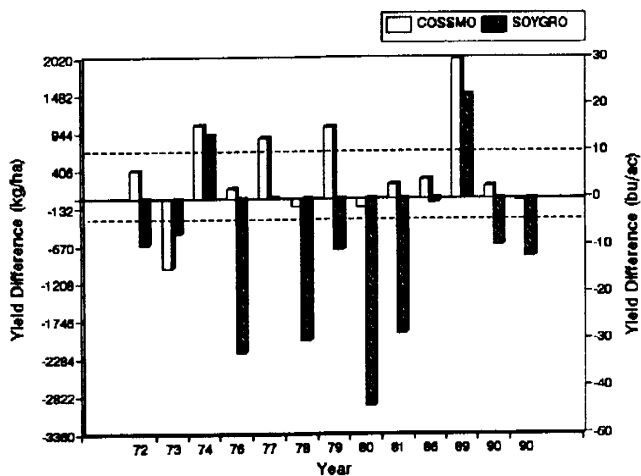


Figure 2. Difference between predicted and observed soybean yield for Ransom variety.

as compared to SOYGRO differences (mean of -690 kg/ha (-10 bu/ac), sample standard deviation of 1170 kg/ha (17.5 bu/ac)) indicated that the combination of DRAINMOD and SOYGRO represented the soil-water interactions associated with a drainage system better than SOYGRO alone did.

This preliminary validation, while limited in soil types, indicated COSSMO has the potential to become a tool for evaluating water management effects on crop growth. Further validation is needed under a variety of soil conditions before a general release of COSSMO is feasible. Efforts are underway to obtain additional data for further validation.

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