2004

Test of the Hybrid-Maize Model for Simulation of Soil Moisture Dynamics and Maize Response to Water Deficit

Haishun S. Yang
University of Nebraska-Lincoln, hyang2@unl.edu

Achim R. Dobermann
University of Nebraska-Lincoln, adobermann2@unl.edu

Kenneth G. Cassman
University of Nebraska-Lincoln, kcassman1@unl.edu

Kenneth G. Hubbard
University of Nebraska-Lincoln, khubbard1@unl.edu

Timothy J. Arkebauer
University of Nebraska-Lincoln, tarkebauer1@unl.edu

See next page for additional authors

Authors

Haishun S. Yang, Achim R. Dobermann, Kenneth G. Cassman, Kenneth G. Hubbard, Timothy J. Arkebauer, Shashi Verma, and Daniel T. Walters

Proceedings of the 2004 Biological Systems Simulation Conference. March 8-10, 2004, Gainesville, Florida. pp83-84.

Test of the Hybrid-Maize Model for Simulation of Soil Moisture Dynamics and Maize Response to Water Deficit

H.S. Yang[1]; A. Dobermann[1]; K.G. Cassman[1]; K.G. Hubbard[2]; T. Arkebauer[1]; S. Verma[2]; D. Walters[1]

[1] *Department of Agronomy and Horticulture, University of Nebraska – Lincoln*
[2] *School of Natural Resources, University of Nebraska – Lincoln*

The Hybrid-Maize model (Yang et al, 2004), which has been validated under optimal water conditions, was evaluated for its ability to simulate soil moisture dynamics in the root zone and effects of water deficits on maize development and final yields (Fig. 1). The experimental data for this evaluation were obtained from ongoing field studies of the Carbon Sequestration Program (CSP) at the University of Nebraska. The studies include three cropping systems, each located in a quarter-section field (57 ha), two of which are irrigated by central-pivots and the third is rainfed. One irrigated field is in continuous maize and the other two are maize-soybean rotation. In each field, detailed micro-meteorological measurements were made, and soil moisture is continuously monitored at 10, 25, 50 and 100cm depths year around. Maize crop phenological development, leaf area expansion and aboveground biomass were measured nine times each growing season from 2001-2003, and final grain yield and stover biomass were measured at physiological maturity.

The simulation of soil water balance in Hybrid-Maize is patterned after Ohm's law (Driessen and Konijn, 1992). The demand for water evaporation from soil surface and evapotranspiration (ET) through crop is determined by three input weather variables (air humidity, temperature and potential ET) and total leaf area. The resistance to water flux through soil is determined by soil water content and soil physical and hydrologic properties. The entire soil rooting depth is divided into 10-cm layers, except the thin uppermost layer of dry soil (self-mulching) whose thickness varies with soil moisture status and tillage method. As crop development proceeds, rooting depth increases linearly and the water uptake weighting factor of each layer decreases exponentially until shortly after silking when root growth ceases. Water stress occurs when soil water supply falls below maximum ET, and photosynthesis is reduced proportionally. Soil water balance and water stress is computed on a daily time step.

The model evaluation focuses on two aspects: (1) Hybrid-Maize simulation of water balance in the rooting zone throughout the growing season, and (2) the effect of water stress on maize crop development and final grain and stover yields. Preliminary results indicate reasonable agreement between model simulation of grain yield for both irrigated and rainfed systems. Details of the test will be reported along with discussion for strategies for model improvement.

References

Driessen, P.M. and Konijn, N.T. 1992. Land-Use Systems Analysis. Wageningen Agricultural University.

Yang, H.S., Dobermann, A., Lindquist, J.L., Walters, D.T., Arkebauer, T., and Cassman, K.G. 2004. Hybrid Maize - A maize simulation model that combines two crop modeling approaches. Field Crops Res. In Press.

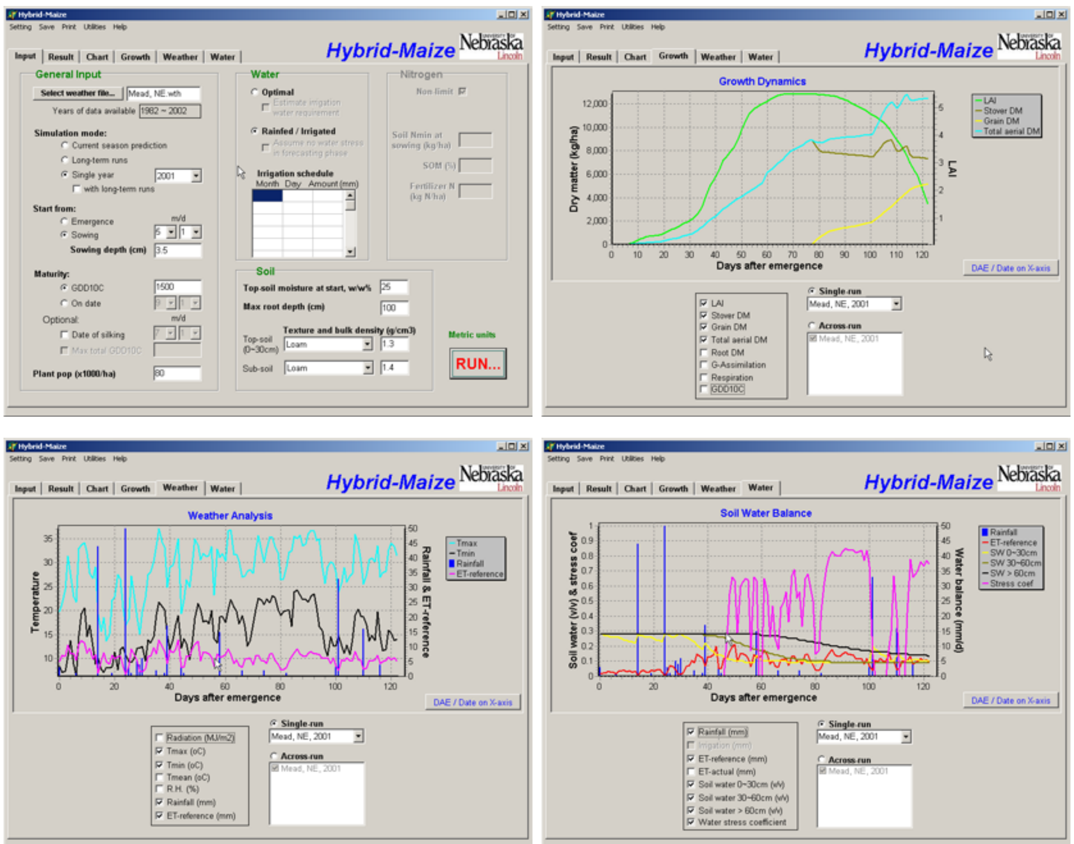

Fig. 1. Screen shots of the Hybrid-Maize simulation of soil water dynamics and water stress effects on maize crop growth under rainfed conditions in Mead, NE. Top left: model input page; top right: development of leaf area, stover biomass and grain filling; bottom left: weather conditions including temperature, rainfall and potential evapotranspiration; bottom right: water input (rain and irrigation), soil water dynamics at three depths, and water stress on maize. The X-axis in these graphs is days after emergence.