Modeling alternative cropping systems for Central Great Plains using RZWQM

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ABSTRACT

The practice of a summer fallow to conserve soil water and to reduce the chance of crop failure dominated dryland agriculture in the Great Plains in the 20th century. This conventional tilled (CT) winter wheat (Triticum aestivum L.) – summer fallow cropping system {WF(CT)} in the semiarid areas is known to have serious adverse impacts on the environment due to its associated potentials for wind and water erosion of agricultural soils and the consequent loss of soil organic matter and productivity. Field experiments oriented towards assessment and amelioration of the adverse impacts of the WF(CT) on the soil quality and productivity were established in 1990-92 at the USDA-ARS, Central Great Plains Research Station, Akron, Colorado (40°09' N, 103°09' W. 1384m) on a Weld silt loam soil. About 20 crop rotations both under conventional tillage and no tillage practices are being investigated. To effectively extend the research results to other soils and climates it is necessary to synthesize and quantify knowledge in the principles and laws of agricultural sciences. In this study we used the RZWQM (Root Zone Water Quality Model) of USDA-ARS to model these experiments. RZWQM is a process oriented agricultural system model which integrates the various biological, physical and chemical processes in the soil-plant-atmosphere continuum and simulates the impact and feed back of alternative crop management practices on crop production and water quality.

In the present study we have used data from the 1)WF(CT), 2) winter wheat –fallow under no till(NT) {WF(NT)}, and 3) winter wheat – corn (Zea Mays L.) – fallow under NT {WCF(NT)} crop rotation systems during 1992 to 2001-02. All phases of the crop sequences (total=7) were available every year and thus modeled separately.

Model predictions of soil water in different layers, total soil profile water content, and grain yield showed greater degree of accuracy (Figs. 1 to 4) with RMSEs ranging between 0.055 and 0.061 cm^3 cm^{-3}, 4.64 and 7.09 cm, and 244 and 867 kg ha^{-1} respectively. Leaf Area Index, evapotranspiration, and biomass predictions showed lesser accuracy level with RMSEs between 0.70 and 1.63 cm^2, 5.32 and 7.09 cm, and 1027 and 2714 kg ha^{-1} respectively. Higher soil water and crop yields measured in the WF (NT) rotation compared to WF (CT) rotation were reasonably well reflected in the model simulations (Figs. 1 and 2). Model simulations over the 11 year period showed greater level of total Carbon and fraction organic matter in the first 5 cm of the soil in the WF (NT) and WCF (NT) rotations compared to the WF (CT) rotation. Whilst requiring more attention in improving the model for simulation accuracies of biomass, ET, and LAI, the results of the study indicate that the model still possesses reasonable potential for simulating the alternative crop rotation systems in the Great Plains, as the present inaccuracies in predictions of these parameters is not large.