Using RZWQM to Simulate Water, Nitrogen, and Planting Date Effects on Corn, Soybean, and Winter Wheat Production in Northeast Colorado

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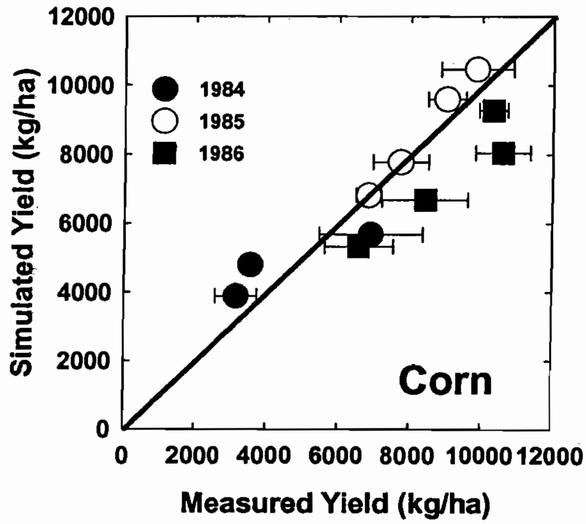
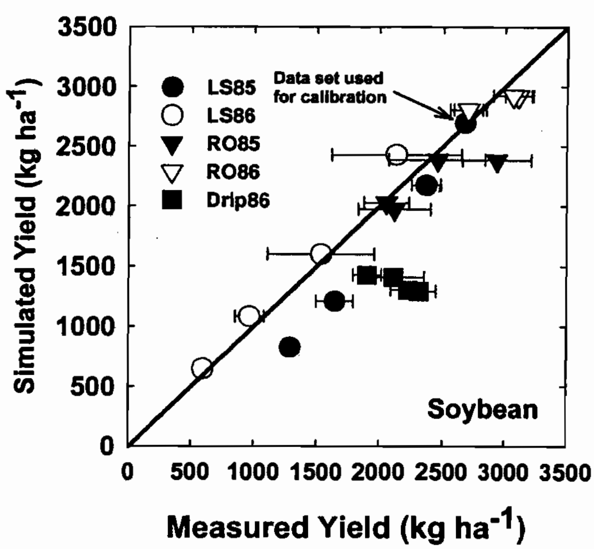
The USDA-ARS Central Great Plains Research Station is charged with the development of integrated cropping systems and technologies for maximum utilization of soil and water resources for western Nebraska, southeastern Wyoming, eastern Colorado, and western Kansas. The region encompasses a number of soil types and climates, with precipitation increasing from 12 inches in the west to 22 inches in the east and pan evaporation increasing from 49 inches in the north to 68 inches in the south (May-Oct). In order to extend the results of cropping systems research from experiments conducted in Akron, CO to the larger central Great Plains region, systems models must be used. These models must be calibrated and validated for the soils and climates of the central Great Plains. As a starting point in using RZWQM for dryland systems analysis in the central Great Plains, we evaluated the model for corn, soybean, and winter wheat production under a variety of available moisture, planting date, and fertility conditions using data collected at Akron, CO.



Simulating Water Stress Effects on Corn and Soybean

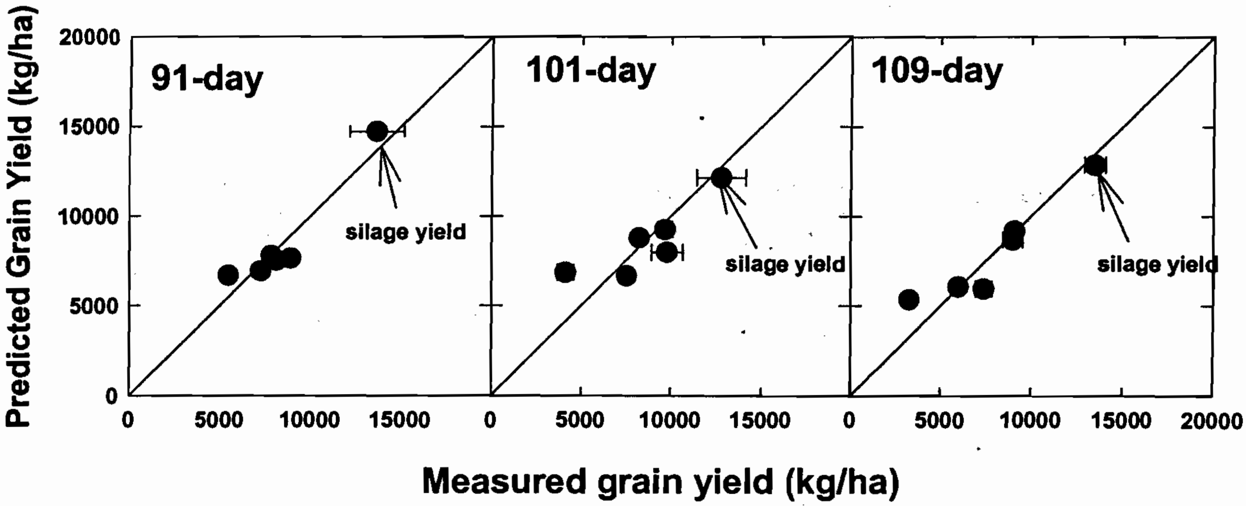
The ability of RZWQM to accurately simulate the effect of varying levels of water availability on dry matter production, crop water use, and grain yield was evaluated for corn and soybean utilizing data acquired under a gradient irrigation system, a drip irrigation system, and under a rainout shelter where plots were flood irrigated. Corn data were collected over a 3-yr period with three water levels in one year and four water levels in the other two years. The model was calibrated with soil water, leaf area, plant height, aboveground biomass, evaportranspiration, and grain yield data from the lowest water level in one year, and evaluated with the remaining seven data sets. Corn leaf area index was predicted well in one year, but the model underestimated maximum LAI and all values during the second half of the growing season in another year. RZWQM tended to overpredict available soil water throughout the growing season and underpredict crop water use. Yields over the 3-yr period were well predicted over a range of 3000 to 11000 kg/ha.

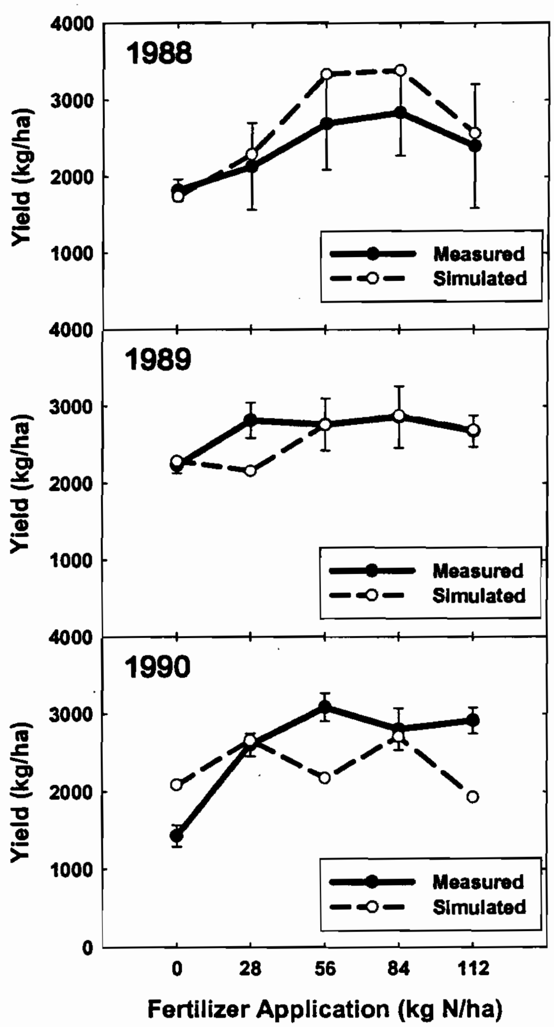
The water fitness parameter adequately quantified water stress in soybean such that both water use and yield were reduced under water limiting conditions. RZWQM simulations of soybean yield were generally well correlated with measured yields over a range of 500 to 3000 kg/ha.



Planting Date Effects on Corn

The ability of RZWQM to accurately simulate planting date effects on corn water use and yield was tested using data from a 2-yr experiment in which 91-day, 101-day, and 109-corn hybrids were planted in late April, mid-May, and mid-June under full irrigation. Water use was consistently overpredicted for the 91-day hyrid, while water use for the other two hybrids was sometimes under and sometime over-predicted. The model simulated corn yields reasonably well, but





the yield depression resulting from the latest planting date was underpredicted in one year. In the other year the rate of yield loss between the first and second plantings was well predicted by RZWQM.

Nitrogen Stress Effects on Winter Wheat

The ability of RZWQM to accurately simulate nitrogen fertility stress in winter wheat was tested using data from a 3-yr experiment in which dryland winter wheat was grown under five nitrogen fertilizer application rates (0, 28, 56, 84, 112 kg N/ha). Wheat water use from spring green-up to harvest was severely underestimated in all three years. The increase in water use measured with the first one or two additions of nitrogen fertilizer was not simulated well. The biomass response to nitrogen fertilizer was underestimated in two of three years. The biomass response to nitrogen fertilizer was underestimated in two of three years. The yield response to nitrogen fertilizer was overestimated in the near-average precipitation year. In the two drier years, simulated yields tracked modeled yields fairly closely, or underestimated yield.

Using the calibrated model and the long-term Akron weather record showed very little benefit of fertilization rates greater than 56 kg/ha. RZWQM can be a useful tool for modeling corn, soybean, and winter wheat production, although work should continue to improve simulations of winter wheat.