A FALLOW-WHEAT SYSTEM SIMULATION MODEL

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Simulation models of cropping systems are an important tool for experimentation for a wide range of reasons. One important reason is the formalisation of our understanding of crop response in conservation tillage systems. Such a model can explore the strategic and tactical management options that offer prospects of how to systematically increase production and profitability.

MATERIALS AND METHODS

A fallow-wheat system model was developed using six sub-models, viz. soil water, soil carbon, soil nitrogen, crop biomass, crop nitrogen and phenology. Two further submodels, environment and management, provided input data and controls for model operation. The model contained a total of 27 state variables. The model is an extension of a previously published model (1) that now includes crop response to nitrogen and the alternative fallow management techniques of stubble mulching and reduced tillage. The integration interval remains at one day. The soil nitrogen submodel is primarily driven by the decomposition of organic matter between four state variables, surface crop residues, fresh organic matter, microbial biomass and stable humus. Mineralisation and/or immobilisation is controlled by the corresponding C:N ratios. Within the crop, N is distributed between roots, above-ground and grain components according to demand, but not below predefined lower limits. Crop growth is determined as a function of transpiration efficiency adjusted for temperature extremes and nitrogen deficiency. LAI is determined as the product of above-ground biomass and leaf area ratio, modified to account for N deficiency. The phenology submodel provides the framework for the partitioning of growth to roots, above-ground biomass, dead biomass and grain.

The model was validated on data from a fallow-wheat cropping system, using measurements of soil water, soil nitrogen, crop biomass and yield taken from a range of tillage treatments.

RESULTS AND DISCUSSION

Total soil water was simulated well (R^2=0.95; RMSE=0.02 Mg/m^3) with a generally good characterisation of the soil water profile. Total soil mineral nitrogen was simulated with less accuracy than soil water (R^2=0.61; RMSE=1.84 g/m^3). The simulation of biomass followed the general pattern observed throughout the season (R^2=0.77; RMSE=1655 kg/ha). Grain yield was simulated with less accuracy than biomass (R^2=0.42; RMSE=756 kg/ha). This was largely because grain number was poorly simulated (R^2=0.07; RMSE=1425/m^2). Simulated grain size (R^2=0.61; RMSE=5.6 mg) was more accurate than grain nitrogen concentration (R^2=0.29; RMSE=0.31% N). There was no evidence of bias between various tillage methods tested in the simulations.

REFERENCES

1. O'Leary, G.J., Connor, D.J. and White, D.H. 1985. Agric. Systems 17, 1-26.