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Development and evaluation of integrated water and nitrogen model for maize

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Abstract

Maize (*Zea mays* L.) is an important food crop for irrigated regions in the world. Its growth and production may be estimated by different crop models in which various relationships between growth and environmental parameters are used. For simulation of maize growth and grain yield, a simulation model was developed (Maize Simulation Model, MSM). Dynamic flow of water, nitrogen (N) movement, and heat flow through the soil were simulated in unsteady state conditions by numerical analysis in soil depth of 0–1.8 m. Hourly potential evapotranspiration [$ET_p(t)$] for maize field was estimated directly by Penman–Monteith method. Hourly potential evaporation [$E_p(t)$] was estimated based on $ET_p(t)$ and canopy shadow projection. Actual evaporation of soil surface was estimated based on its potential value, relative humidity of air, water pressure head and temperature at soil surface layer. Actual transpiration ($T_a(t)$) was estimated based on soil water content and root distribution at each soil layer. Hourly N uptake by plant was simulated by N mass flow and diffusion processes. Hourly top dry matter production ($HDMA^{j+1}$, where j is number of hours after planting) was estimated by hourly corrected intercepted radiation ($RSLT^{j+1}$) by plant leaves [determined from leaf area index (LAI^{j+1})] with air temperature, the maximum and minimum plant top N concentration and the amounts of nitrogen uptake. The value of LAI^{j+1} at each hour was estimated by the accumulated top dry matter production at previous hour using an empirical equation. Maize grain yield was estimated by a relationship between harvest index and seasonal plant top dry matter production. The model was calibrated using data obtained under field conditions by a line source sprinkler irrigation. When the values of water and nitrogen application were optimum, grain yield (moisture content of 15.5%) was 16.2 Mg ha^{-1}. Model was validated using two independent

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