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论文

利用RZWQM-ERES模拟华北平原农田土壤水分动态及其对作物产量的影响

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摘要：

农业系统模型是农业生产多元目标优化管理的重要工具，但由于系统模型过程复杂，参数众多，校正和验证工作一直是模型研究的重点和难点。本文对RZWQM (Root Zone Water Quality Model)与CERES (Crop Environment Resource Synthesis)的结合模型RZWQM-CERES模拟土壤水分及作物产量进行了参数优化和验证，结果表明，RZWQM-CERES在禹城站和栾城站模拟不同灌溉处理土壤贮水量与测定值呈相似的变化趋势，均方根差(RMSE)分别为2.38~2.70 cm及3.49~3.73 cm；作物产量模拟结果与实测值对土壤水分的响应趋势一致($R^2 = 0.83^{***}$，$n = 22$)，其中在禹城站模拟小麦和玉米产量的RMSE分别为550 kg hm^{-2}和580 kg hm^{-2}，栾城站模拟小麦产量的RMSE为670 kg hm^{-2}。以上结果表明RZWQM-CERES可作为华北平原模拟和分析土壤水分对作物产量影响的有效工具。本文初步建立了一套适合华北平原作物生产的模型参数，为利用RZWQM-CERES建立农田水分优化调控策略奠定了基础，并探讨了模型评价过程中应注意的问题。

关键词： RZWQM-CERES 华北平原 模型参数 土壤水分 作物产量

Simulating Soil Water Dynamics and Its Effects on Crop Yield Using RZWQM-CERES in the North China Plain

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Abstract:

Agricultural system model is an important tool for optimizing multi-objective managements and decisions in agriculture. However, due to the complex process with multiple parameters in the model, calibration and validation for system model are difficult. In the paper, the hybrid model RZWQM (Root Zone Water Quality Model)-CERES (Crop Environment Resource Synthesis) was calibrated and validated for simulating soil water dynamics and crop yield under various irrigation levels at Yucheng and Luancheng Experimental Stations in the North China Plain. The results showed that the root mean standard error (RMSE) and mean relative error (MRE) of simulated soil water storage in the 0–120 cm layer across different treatments at Yucheng Experimental Station ranged from 2.38 to 2.70 cm and from 2.8 to 3.3%, respectively. The RMSE and MRE of simulated leaf area index across treatments were ranged from 0.43 to 0.73 and from –12.8 to 4.2%, respectively, and the RMSE and MRE of simulated grain yield ranged from 550 to 580 kg ha^{-1} and from –0.6 to 7.6 %, respectively. At Luancheng Experimental Station, the RMSE and MRE of simulated soil water storage in the 0–120 cm layer ranged from 3.49 to 3.73 cm and from –0.6 to 10.0 %, respectively. The RMSE and MRE of simulated grain yield were 670 kg ha^{-1} and –6.6%, respectively. Generally, the simulated and measured grain yields showed similar responses to soil water changes across the irrigation treatments ($R^2 = 0.83^{***}$, n =22). Above results indicate that RZWQM-CERES can be used as a tool to simulate and investigate the effects of soil water on crop yield in the wheat-maize cropping system in the areas. The reasonable model parameters established for the cropping system are the basis of model application for optimizing multi-objective managements and decisions in agriculture. The model parameterization, model mechanism and its flexibility were also discussed.

Keywords: RZWQM-CERES North China Plain model parameterization soil water crop yield

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