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苏北滩涂水稻微咸水灌溉模式及土壤盐分动态变化

Irrigation regime and salt dynamics for rice with brackish water irrigation in coastal region of North Jiangsu Province

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中文摘要:

为研究微咸水灌溉对水稻水分利用效率和土壤盐分动态的影响，利用田间试验资料对 SWAP （Soil-Water-Atmosphere-Plant）模型进行了率定和验证。用验证认可的模型模拟并分析了水稻生育期水盐运移规律和水稻水分利用效率，并预测了长期微咸水灌溉对土壤盐分的影响。结果表明：1.5 mg/cm3矿化度微咸水足量灌溉可以获得较高的产量和水分利用效率；各微咸水处理在60～90 cm土层均出现不同程度的盐分累积现象，具体累积深度和土壤盐分浓度与灌水量和灌水矿化度有关；采用1.5 mg/cm3矿化度微咸水进行微咸水长期灌溉研究，10 a的模拟结果显示此灌溉制度不会引起0~100 cm 土层土壤次生盐渍化。该研究为滨海地区微咸水合理利用提供了理论依据。

英文摘要:

Abstract: Soil salinity and the shortage of fresh water resource are the major factors to limit sustainable development of agriculture industry in the newly reclaimed coastal tidal flat soil in northern Jiangsu Province. The results from previous investigation demonstrate that this area has saline water resources with a shallow groundwater table. Rice as a moderate salt-tolerant crop is cultivated widely in this area. Thus, an experiment has been conducted to evaluate the effects of irrigation water with different salt concentration on soil salinity, grain yield and water use efficiency in the region. Field experiments always are time-consuming and expensive. Whereas, simulation models play an increasingly important role in predicting long-term effects of saline water irrigation on soil salinity and crop production. The objective of this paper was to use SWAP model to evaluate the effects of irrigation water with different salt concentration on rice water use efficiency and the dynamic of soil salt concentration in a paddy field based on a field experiment results. Rice was grown on a sandy loam soil and surfaced irrigated with three water quantities (V1, V2 and V3) and five different salt concentrations (C, M1, M2, M3, Ma and Mb), respectively. SWAP model was calibrated and validated based on the field experiments. Model simulation results agreed well with the observed values. For example, the root mean squared error (RMSE) for the salt concentration were 0.60 mg cm-3 from simulation and 0.50 mg/cm3 from the experiment, and the simulated and observed values distributed along the 1:1 line. For the grain yield, most of the relativity error (RE) values were less than 10%. Furthermore, the water use efficiency (WUE) and dynamics of soil water and salt for rice were analyzed based on SWAP simulation results. The results showed that the grain yield and WUE increased with the increase of irrigation water quantity, but the effect of irrigation quality on grain yield and WUE was not as obvious as irrigation quantity. And the high rice yield and WUE were obtained under sufficient irrigation amount with 1.5 mg/cm3 salt concentration, i.e. MaV3 treatment. The soil salt was accumulated at 60- 90 cm soil depth for all the irrigation treatments, and the depth for soil salt accumulation was related to irrigation water quantity and quality. The highest salt concentration was 8.94 mg/cm3 occurred at 85 cm soil depth for M3V3 treatment. Even so, the soil still was considered as non-salinized soil based on the saline soil classification standard for coastal regions in China. The degree of soil salinity was not increased after the brackish water irrigation and the main outflow of soil salt was through deep percolation. Finally, the validated model was used to predict the soil salt concentration distribution characteristics under optimal irrigation treatment for long-term brackish water irrigation. Ten-year simulation showed that the with 1.5 mg/cm3 salt concentration, the water irrigation would not result in soil secondary salinization for 0-100 cm soil depth. The study provided useful information for utilization of local slight saline water.

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