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基于SWAP模型的春小麦咸水非充分灌溉制度优化

Optimization of irrigation scheduling under deficit irrigation with saline water for spring wheat based on SWAP model

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中文摘要:

为探讨石羊河流域春小麦适宜的咸水非充分灌溉制度，该文利用2008年、和2009年的田间试验资料对SWAP模型进行了率定和验证，并应用模型模拟了不同水文年型、不同灌水方案对土壤水盐平衡、作物产量和水分利用效率的影响。结果表明：咸水灌溉时，适宜的非充分灌溉能够提高作物产量和水分利用效率，土体盐分增加量明显降低；而咸水灌溉时最大产量及对应的灌水量随灌水矿化度的增大而降低。春小麦最优灌水方案为：1）25%降水年型（丰水年），灌水矿化度0.7、3、6 g/L的最优方案均为灌3次水，灌溉定额322 mm；2）50%降水年型（平水年），灌水矿化度0.7、3、6 g/L的最优方案均为灌3次水，灌溉定额分别为328、287、246 mm；3）75%降水年型（枯水年），灌水矿化度0.7和3 g/L的最优方案为灌4次水，灌溉定额分别为440和396 mm，灌水矿化度6g/L对应的最优方案为灌3次水，灌溉定额352mm。该文提出的灌溉方案对于该地区咸水资源的高效利用具有一定的指导意义。

英文摘要:

Abstract: Overexpansion of irrigation in the Shiyang River basin (102° 52′ E, 37° 52′ N) has produced negative effects such as decrease of fresh water resources, deterioration of water quality and increase in soil salinization. With the limit of the fresh water resource, saline ground water has to be widely used for wheat production, but at the same time, soil salinization should be avoided. In order to investigate the most applicable deficit irrigation schedule with saline water for spring wheat in the Shiyang River Basin, the agro-hydrological Soil-Water-Atmosphere-Plant (SWAP) model was used to evaluate the effect of various irrigation schedule on water and salt balance in soil, crop yield and water use efficiency for the different hydrological years. An irrigation experiment was set up with water quantity of 375, 300 and 225 mm in combination with irrigation water salt concentrations of 0.7, 3, and 6 g /L in 2008 and 2009. In total, there were nine irrigation treatments. Experimental data in 2008 was used for SWAP model calibration while data in 2009 was used for the model validation. The validated SWAP model was then used to simulate soil water content, soil salt concentration and crop relative yield. Based on the meteorological data of 1951 to 2010, sufficient and deficit irrigation schedule for 25%, 50% and 75% hydrologic year was set up and simulated by use of the SWAP model. The simulated results indicated that appropriate deficit irrigation was beneficial for increasing crop yield, water use efficiency and decreasing soil salinity when saline water was used. However, the maximum yield and the corresponding irrigation water quantity in saline irrigation decreased with the increased of water salinity. The simulated results also indicated that the optimal irrigation schedule of spring wheat was 1) three times of irrigation were needed with the total irrigation water of 332 mm for three water qualities of 0.7, 3 and 6 g salt/L at the hydrologic years of 25%; 2) three times of irrigation were needed with the total amount of 328, 287 and 246 mm water for water salt concentrations of 0.7, 3 and 6 g /L, respectively at the hydrologic year of 50%; and 3) four times of irrigation were needed with the total amount of 440 and 396 mm water for 0.7 and 3 g salt/L water quality, and three times of irrigation with 352 mm water for water quality of 6 g salt/L at the hydrologic year of 75%. Winter irrigation was suggested from this study for water storage and salt leaching in this area.

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