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Irrigation management of crops rotations in a changing climate

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Due to climate change we cannot continue to perform irrigation systems design and irrigation management based only on historical records of weather stations, assuming that the statistical parameters of the meteorological data remains unchanged in time, being necessary to take into account the climatic data relative to climate change scenarios. For the Mediterranean basin the various climate models indicate an increase in temperature and a reduction in precipitation and a more frequent occurrence of extreme events which will increase the risk of crop failure. Thus, it is important to adopt strategies to ensure the sustainability of irrigated agriculture in a changing climate. A very interesting technique to achieve this is the adoption of crops rotations, since they increase the heterogeneity of farming systems distributing the risk between crops and minimizing costs. This study aims to evaluate the impact of climate change in the irrigation requirements of crop rotations for the Alentejo region in the South of Portugal, and the ability of crops rotation to reduce these impacts and stabilize crops production. The IrrigRotation software was used to estimate the water requirements of two crop rotations used in the Alentejo region, Sunflower-Wheat-Barley and Sugar beet-Maize-Tomato-Wheat. IrrigRotation is a soil water balance simulation model, continuous in time, based on the dual crop coefficients methodology, which allows to compute the irrigation requirements of crop rotations. The climate data used were the observed data of the Évora and Beja weather stations (1961-90), the A2 and B2 scenarios of the HadRM3P model and the A2 scenarios of the HIRHAMh and HIRHAMhh models (2071-2100). The consideration of a set of climate change scenarios produces as a result a range of values for the irrigation requirements which can be used to define safety margins in irrigation design. The results show that for the Beja clay soils, with high values of soil water storage capacity, the crops rotations can decrease the water deficit of the rainfed crops cultivated after the irrigated crops. This is due to the storage of water in the deepest soil layers during the irrigated crops with shallow roots that increase the available soil water at the planting date of the wheat crop. For the soils with small water storage capacity and small depth, such as the Évora silt-clay-sandy soil, it was not observed the benefic effects of crops rotation in the reduction of the water deficit of the rainfed crops. The results obtained for the several climate change scenarios (2071-2100) show an increase in irrigation requirements between 13% and 70%, with the higher values corresponding to the Autumn-Winter crops (sugar beet), due to the combined effect of an increased evapotranspiration and a reduced precipitation during the crop cycle. The irrigation requirements for the peak period increased between 10% to 46%. For the climate change scenarios it was also found an increased risk of crop failure for the rainfed crops, with a water deficit value for the wheat ranging between 32% to 59%, and for the barley ranging between 34% to 45%.

Keywords: Crops Rotation, Soil water balance, Irrigation, Climate change, Model