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Maize Yield Response to Deficit Irrigation using the AquaCrop Model under Shallow Groundwater Conditions in Uzbekistan

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Abstract

Maize is one of the most widely consumed cereal crops grown worldwide under different environmental conditions. The growing global population puts more strain for increased cereal production in the next decades to feed this population which greatly drive the global water demand for different purposes. Meanwhile humankind has to cope with the predicted impacts of future climate change on water resources availability especially in the arid and semi-arid regions. Irrigated agriculture is hence under high pressure to increase the water use efficiency during these conditions. For this purpose several techniques and models have been developed to simulate the current and future scenarios for future planning and management of the water resources. AquaCrop, is among such models which reliably simulates achievable yields of major crops as a function of water consumption under rainfed, supplemental, deficit, and full irrigation conditions, with comparatively less data demand. In this study, carried out in Khorezm province of Uzbekistan, the AquaCrop model was used to derive the optimal and deficit irrigation schedules for maize crop. Groundwater levels in the region are shallow. We used Hydrus-1D model to simulate the capillary rise. Later capillary rise contribution was introduced into the AquaCrop model. Hence, together with optimal irrigation schedule, deficit irrigation strategies were derived as proportionally reduced water supply (RWS) of 20, 40, 50 and 60% throughout the crop growth and as a stress introduced at specific crop growth stages. The results show that proportionally RWS of 20, 40, 50 and 60% resulted into 3, 20, 30 and 45% yield reduction respectively. In these simulations, 20% proportional reduction in irrigation water application led to a negligible 3% yield loss. During stress at the late yield formation stage, at least 25% of the optimal supply can be saved easily for almost no yield loss. It means that deficit irrigation is more feasible in the late yield formation stage rather than vegetative stage. This study is unique due to the fact that capillary rise contribution quantified by Hydrus-1D model has been introduced into AquaCrop. This way it overcomes the missing consideration of capillary rise contribution by the standard version of AquaCrop model.

Keywords: AquaCrop, capillary rise, deficit irrigation, shallow groundwater