Using the AquaCrop Model to Optimize Deficit Irrigation Scheduling of Cotton in Uzbekistan

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INTRODUCTION

The global water demand for irrigated agriculture is growing against limited fresh water resources. To mitigate the ill-effects of climate change on water resources availability as well as to fulfill water needs by ecosystems, challenging water management is desired. Uzbekistan is the 3rd biggest exporter of cotton in the world with 1.3 million hectare area of cotton cultivation mainly irrigated from Amu and Syr Darya rivers. Inefficient and over irrigation for crop production has been the present and past experience in the region. The excessive irrigation application partially contributes to the shallow groundwater table in this region. The existing irrigation norms do not incorporate the deficit irrigation strategies which are needed and will become even more important in the future due to variability of water resources in Amu Darya and Syr Darya rivers. Khorezm region, having faced droughts in the last decade, needs efficient irrigation system as well as plans to exercise deficit irrigation for coping the worst scenarios of future incase of water deficiency. For the development of soil conditions based optimal and deficit irrigation schedules, AquaCrop, a rather simple alternative model with expectedly appropriate results and manageable data, was parameterized first time for Khorezm region. This study derives the optimal and deficit irrigation schedules for cotton with AquaCrop model while considering the groundwater contribution by using the HYDRUS-1D model.

STUDY REGION

This study was carried out at the Cotton Research Institute (CRI) in Khorezm, Uzbekistan. Khorezm region is famous for its arid climate, shallow groundwater table and large irrigation network with low irrigation efficiency where the annual evapotranspiration by far exceeds the annual precipitation.

MATERIALS AND METHODS

The meteorological data was collected from the meteo station based at the CRI while the soil profile data was taken from the GIS laboratory of the German-Uzbek project in Urgench. Groundwater contribution was quantified by using the HYDRUS-1D model. The determined capillary rise contribution was used as a pseudo-precipitation into the AquaCrop model. The choice of AquaCrop is because of its less data requirements and realistic output. AquaCrop was simulated and optimal irrigation schedule was determined. The respective yield and biomass response and deficit irrigation strategies were derived in two ways:

1) Proportionally reduced water supply (RWS) of 40, 50 and 60%,

2) Water stress at a certain crop growth stage.

RESULTS

1. The groundwater contribution to the total ET_c of cotton was 24 % in silt loam and 31% in sandy loam soils.

2. Yield and biomass reduction versus proportionally RWS of 40, 50 & 60%:

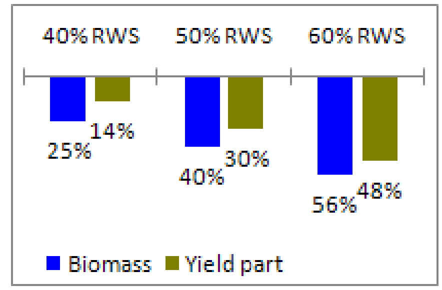


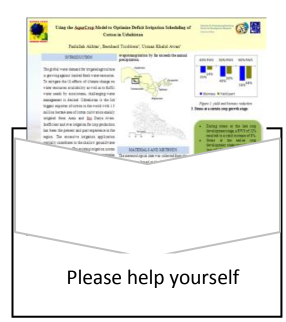
Figure 1: yield and biomass reduction

3. Stress at a certain crop growth stage:

- During stress at the late crop development stage, a RWS of 12% resulted in a yield increase of 8%.
- Stress at the earlier crop development stage caused a yield loss of 17%.
- Water stress at the late ripening stage, no yield loss was observed.

CONCLUSIONS

Among these two deficit irrigation methods, proportionally RWS of 20% of is a low risk choice with negligible yield loss. The deliberate stage specific deficit irrigation practice is risky incase of temporal unavailability of irrigation water supply. AquaCrop simulates achievable yields and its results are close to reality. It is suggested that AquaCrop could be used to simulate different irrigation scenarios for decision making in irrigation schemes operation.



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