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

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INTRODUCTION

Uzbekistan owns around 1.3 million hectare of irrigated land in the Aral Sea Basin, one of the higher consumers of water from Amu Darya and Syr Darya rivers. This region with shallow groundwater table is known for excessive irrigation water supply as well as inefficiency at the irrigation network. The irrigation norms in practice don't integrate the changing water availability conditions due to climate change in the Amu Darya basin. The existing irrigation norms leave no voids for practicing deficit irrigation strategies in the region too. The major crops of this country are cotton, rice, maize and wheat. From the production point of view, maize holds about 4th position among the cereals grown in Uzbekistan. By using AquaCrop model the optimal and deficit irrigation schedules under shallow groundwater condition were derived in this study. While considering the shallow groundwater conditions, the capillary rise contribution to the crop root zone was estimated by using the HYDRUS-1D model.

EXPERIMENTAL SITE

This study was carried out at the Cotton Research Institute (CRI) in Khorezm province of Uzbekistan. CRI provides control conditions for experimental purposes.

Fig. 1: Location of the research site in Urgench, Khorezm

CLIMATE CONDITION

The climatic conditions of Khorezm has been identified as continental, with cold winters and hot dry and long summers. The mean annual temperature in Khorezm is 12.1°C while the annual estimated potential annual evapotranspiration is about 1500 mm

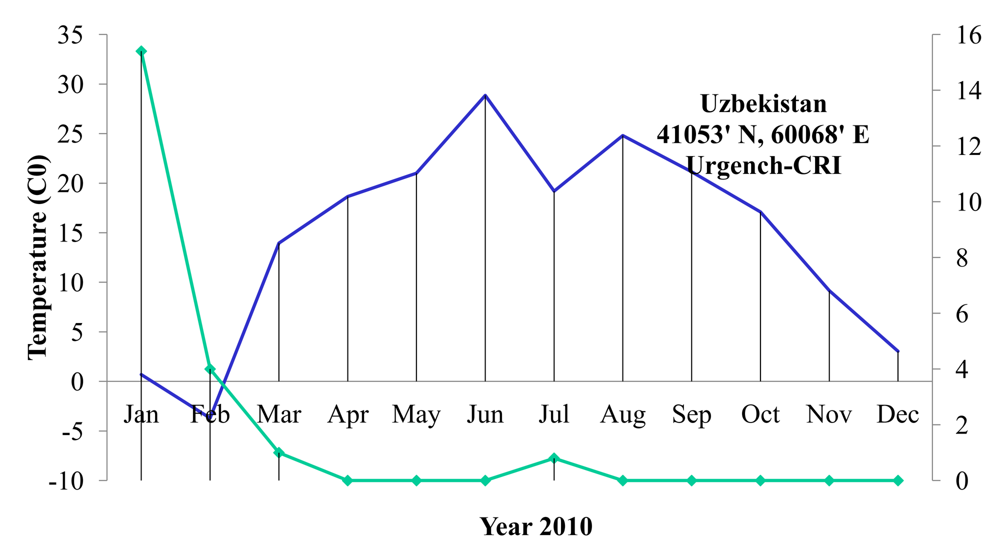

Fig. 2: Climate diagram of CRI, Urgench

RESULTS

- AquaCrop simulation showed that proportionally reduced water supply of 20, 40, 50 and 60% would result in a yield reduction of 3, 20, 30 and 45% respectively.

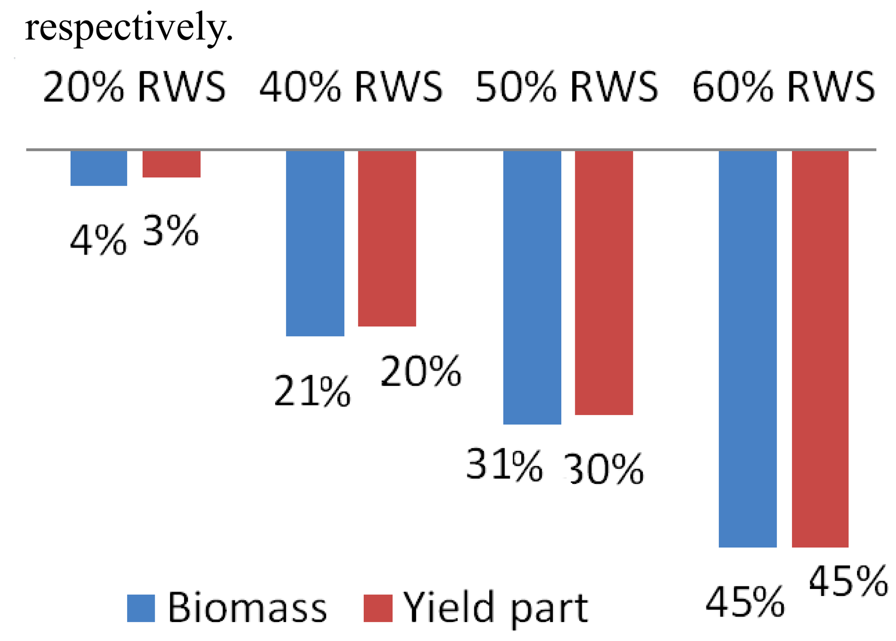

Fig. 3: Yield and biomass response to proportional deficit irrigation

- The yield loss in this case can be further minimized by increasing the application efficiency during the irrigation events throughout the crop growth period.

The average groundwater level during the cropping season of maize was 1.38m added around 10% of soil moisture through the capillary rise contribution to ET_c of maize in sandy loam soils

- 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. During stress at the flowering stage, the maximum corn yield loss of 12% was observed.

MATERIALS AND METHODS

Research fields were equipped with observation wells to monitor GW levels. Soil samples were taken fron 0-30, 30-60, 60-90 and 90-120 cm below the soil surface.

Fig. 4: Soil sampling at various depths

The meteorological data was collected at the meteorological station located at the Cotton Research Institute in Urgench. The soil relevant data was taken from the GIS laboratory of the ZEF/UNESCO project in Urgench. HYDRUS-1D model was used for the quantification of groundwater contribution.

Fig. 5: On-farm phenological measurements for the parameterization of the AquaCrop Model

The estimated capillary rise contribution due to shallow groundwater level was used as a pseudo-precipitation into the AquaCrop model. AquaCrop was simulated to derive the optimal and deficit irrigation schedules.

Using two different deficit irrigation strategies during these simulations, the respective yield and biomass response was analyzed: 1) Proportionally reduced water supply (RWS) of 20, 40, 50 and 60%, 2) stress introduction during a specific crop growth stage.

ACKNOWLEDGEMENTS

This research was conducted under the ZEF/UNESCO project 'Economic and Ecological Restructuring of Land- and Water Use in the Region Khorezm (Uzbekistan) funded by Ministry for Education and Development Research (BMBF), Germany (Project Number 339970D). The first author was supported through a grant by the German Academic Exchange Service (DAAD). Thanks to the Center for International Migration and Development (CIM/GIZ) for their financial assistance and facilitation of this networking trip..

GERMAN-UZBEK KHOREZM PROJECT
Zentrum für Entwicklungsforschung
Center for Development Research
University of Bonn
UNESCO
SPONSORED BY THE Federal Ministry of Education and Research
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