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Hydroclimatic impacts in agriculture in the U.S.: an integrated assessment of the prospective implementation of deficit irrigation strategies.

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The spatial and temporal variability of climate, land use, and population growth rates put immense pressure on agriculture and food security. Non-irrigated fields in the U.S Corn Belt have suffered from episodic water stress, which is expected to occur more frequently for future growing seasons. Therefore there is a need to develop and analyze implementation approaches of climate-resilient irrigation practices.

The present study focuses on the effect of irrigation application in the extensive agricultural productivity of the U.S. Corn Belt, thus a spatiotemporal analysis was performed involving statistical analysis and crop-irrigation modeling of 17 counties across the Corn Belt in order to evaluate the impacts of hydroclimatic parameters (temperature, evapotranspiration, and precipitation) on the plant physiology and total seasonal yields throughout the growing season in a daily time step. The model developed and implemented was the Deficit Irrigation Toolbox (DIT) based on the OCCASION methodology [Schütze and Schmitz (2010), Grundmann et al. (2012)] with the objective to achieve precise scheduling of irrigation systems taking into account the response of the crop to water stress within two periods: a historic period from 1981 to 2010 and a future period from 2041 to 2069. The irrigation strategies analyzed with DIT were: (1) no irrigation (rain-fed), (2) full irrigation, (3) full irrigation with a threshold, (4) deficit irrigation with constant irrigation in a fixed schedule, (5) deficit irrigation based on a decision table of initial soil moisture, water availability, and phenological stages, and (6) deficit irrigation with Global evolutionary Technique for Optimal Irrigation Scheduling (GET-OPTIS) [Schütze et. al (2011)].

The results show extensive warming in the temperature occurred during the growing season of the historic period, additionally, temperatures are projected to increase at a similar magnitude for future growing seasons. Precipitation increased in the early stage but decreasing in the late stage of the growing season and this variability is projected to increase in the future. Higher temperature and evapotranspiration extremes imply higher risks yield reduction especially for non-irrigated sites, consequently, the simulations indicate that deficit irrigation optimization strategies have a great potential to increase the water and yield productivity for future growing seasons, where the deficit irrigation based on the decision table showed the higher achievable yields followed by the scheduling made by GET-OPTIS. The model accuracy and efficiency were evaluated by comparing simulated and recorded distributed datasets of total yields from irrigated and rain-fed fields.

The present proposal aims to better understand the contributions of atypical weather to crop production and implications for future management options by enhancing the usability of climate information and the modeling of different irrigation strategies.