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論文の内容の要約

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学位論文名	Applicability of the AquaCrop model for simulating the growth of winter wheat and cotton under a semi-arid climate in Uzbekistan

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Introduction: Human actions have a significant impact on the hydrological cycle, resulting in an escalation of global water scarcity. This effect is particularly pronounced in developing societies, where the expansion of irrigated agriculture places additional strain on water resources. An illustrative case can be observed in Uzbekistan, where the agricultural sector alone accounts for a staggering 92% of total water withdrawal, primarily due to inadequate precipitation levels. Uzbekistan's population has doubled in the three decades following its independence in 1991, intensifying the urgency to enhance water management. Addressing the intertwined challenges of water scarcity, soil salinity, and subpar agricultural output becomes imperative. To tackle these issues concurrently, the utilization of advanced tools like crop models proves highly promising. A notable example is the AquaCrop model, which presents an effective framework for optimizing water consumption across diverse environmental and crop scenarios, particularly in regions constrained by water availability.

Literature review: Developed by the Food and Agricultural Organization (FAO), the AquaCrop model adeptly balances simplicity with precision. Notably, this model necessitates fewer input parameters compared to its counterparts, streamlining its practical application. Across empirical evidence, the AquaCrop model has demonstrated its capability to faithfully replicate essential growth aspects such as biomass accrual, canopy expansion, and crop yield. This holds true for a diverse array of crops, including winter wheat (*Triticum aestivum*) and cotton (*Gossypium hirsutum L.*), encompassing a spectrum of environmental conditions.

Nonetheless, it is important to acknowledge that the subset of investigations validating AquaCrop within arid or semiarid climates for winter wheat and cotton has yielded a

wide array of calibrated parameter values. This variance prompts inquiries into the relevance and transference of these previously affirmed datasets to the specific context of Uzbekistan.

Materials and methods: Our research aims to evaluate the AquaCrop model's suitability for simulating winter wheat and cotton growth in Uzbekistan's unique climate. We meticulously calibrated the model using first-year data and validated it using second-year data from two semi-arid sites: Karshi district (2010-2012) for winter wheat and Kibray district (2021-2022) for cotton. This approach ensures accurate representation of growth dynamics and cultivar response under local conditions.

Results and discussion: AquaCrop simulations revealed winter wheat encountering low-temperature stress, in contrast to field observations. This implies potential cold stress tolerance in the cultivar, necessitating laboratory experiments for accurate parameter derivation. Conversely, AquaCrop consistently overestimated cotton yield, as it doesn't account for the yield-reducing effect of repeated high temperatures in arid and semiarid environments. Additionally, investigating various irrigation methods on canopy growth, biomass, and yield indicated minimal divergence in model simulations due to proactive water addition based on predefined soil moisture thresholds. During the validation phase, the AquaCrop model effectively simulated canopy cover, biomass, and grain yield for winter wheat. However, validation outcomes for cotton simulations exhibited varying degrees of performance across treatments, ranging from moderate to high. A notable challenge stemmed from substantial year-to-year fluctuations in maximum canopy cover, a factor not presently integrated into the calibration procedure. This absence resulted in an underestimation of both canopy cover and biomass in cotton simulations.

Conclusions: In summary, the AquaCrop model demonstrates encouraging performance in simulating winter wheat and cotton growth under Uzbekistan's semi-arid conditions. However, refinement is essential to enhance its accuracy for cotton, involving the inclusion of temperature stress and seasonal variation. Continuous model improvements tailored to Uzbekistan's unique climate and cultivation context can pave the way for effective water management, fostering sustainable agriculture and mitigating water scarcity concerns.