



Optimization of irrigation schedule based on the response relationship of water consumption and yield for winter wheat in North China Plain

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ABSTRACT

It is very important for regional agricultural sustainable development by researching the relationship between water consumption and yield, determining the reasonable irrigation threshold and proposing the optimal irrigation schedule. The Aquacrop model was verified by the measured data, and then, the variations of water consumption, yield, and water productivity for winter wheat under various irrigation schedules in North China Plain were analyzed by this model. Meanwhile, the irrigation thresholds under the highest yield and the highest water productivity were determined. Finally, the optimal irrigation schedules for the winter wheat were proposed after taking irrigation water use productivity (IWP) and water consumption productivity (WP) as the objective, respectively. The results show that (1) the determination coefficient (R^2) > 0.747 between the simulated and observed values of the soil water content and canopy cover, and the Nash efficiency coefficient (EF) > 0.482, and R^2 > 0.865 between the simulated and observed values of the biomass and yield, and EF > 0.864, so the model can simulate the soil water content, canopy cover, crop biomass, and final yield accurately. (2) When irrigation amount ranged from 150 to 400 mm, the water consumption increased along with the increase in irrigation amount. When the irrigation amount reached 400 mm, the water consumption remained unchanged. (3) When the irrigation amount ranged from 150 to 300 mm, the yield and WP increased with the increase in irrigation amount, and the increasing trend of the yield and the WP slowed down and even reduced when the irrigation amount exceeded 300 mm. (4) Optimization of irrigation schedule in various hydrological years shows that after taking the maximal IWP as the objective, the yield reached 3,821–5,959 kg hm⁻² with the irrigation frequency of two times, and the optimal irrigation amount of 140–220 mm. After taking the maximum WP as the objective, the yield reached 6,727–6,926 kg hm⁻² with irrigation frequency of three times, and the irrigation amount of 240–330 mm. For the areas with the shortage of water resource such as North China Plain, this study may provide theoretical basis for irrigation water management of winter wheat.

Keywords: Aquacrop; Water consumption; Productivity; Optimization of irrigation schedule; Winter wheat

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