THE EFFECT OF RESOURCE-SAVING IRRIGATION ON WINTER WHEAT YIELD AND WATER USE EFFICIENCY: A FIELD STUDY

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https://doi.org/10.5281/zenodo.18655518

Abstract

Efficient use of water in agriculture has become increasingly important due to growing water scarcity and the need for sustainable crop production. This study examines the impact of resource-saving irrigation strategies on the yield and water use efficiency of winter wheat based on field experiments. Three different irrigation regimes were tested, including conventional irrigation, moderate deficit irrigation, and regulated deficit irrigation applied at critical growth stages. The findings indicate that optimizing irrigation can maintain or slightly increase grain yield while significantly improving water use efficiency, demonstrating that resource-saving approaches can support both productivity and sustainability in irrigated wheat cultivation.

Keywords: winter wheat, irrigation regime, water use efficiency, deficit irrigation, sustainable agriculture

1. Introduction

Water scarcity poses a major challenge to modern agriculture, particularly in regions where irrigation is essential for crop production. Winter wheat is a staple crop highly dependent on soil moisture during key growth stages, and traditional irrigation often results in overuse of water and decreased soil quality. Resource-saving irrigation, including deficit and regulated irrigation, aims to provide water according to the physiological needs of the crop, thereby minimizing waste and improving water productivity. This study aims to explore the effects of such irrigation strategies on the yield and water use efficiency of winter wheat under field conditions.

2. Materials and Methods

The field experiment was carried out in a representative irrigated farmland area characterized by medium loam soil with good water-holding capacity and adequate fertility. The experimental site was prepared according to standard agronomic practices, including plowing, harrowing, and basal fertilization prior to sowing. Winter wheat seeds of a locally adapted variety were sown at the recommended density and row spacing to ensure uniform plant establishment.

Three different irrigation treatments were applied to evaluate the impact of water-saving strategies on crop performance. The first treatment involved conventional irrigation, where soil moisture was maintained at a high level throughout the growing season. The second treatment applied moderate deficit irrigation, in which water was supplied at slightly lower levels than full crop water requirements, allowing mild water stress during non-critical growth stages. The third treatment followed a regulated deficit irrigation approach, in which water was

applied only during critical periods of wheat development, such as tillering, heading, and grain filling, while non-critical stages experienced controlled moisture reduction.

The experimental design was a randomized block design with multiple replications for each irrigation treatment to reduce variability due to soil heterogeneity and microclimatic differences. Soil moisture content was regularly monitored using standard methods at different soil depths to ensure precise irrigation scheduling. Crop growth and development parameters were carefully observed throughout the season, including plant height, number of productive stems, spike development, leaf condition, and general plant vigor.

Irrigation volumes were determined according to treatment protocols, and water was applied using surface irrigation techniques commonly practiced in the region. Fertilization, pest control, and other agronomic interventions were applied uniformly across all treatments to ensure that differences in crop performance could be attributed primarily to irrigation regime. Data on seasonal water consumption and crop development were systematically recorded to allow assessment of the effects of different irrigation strategies on water use efficiency and productivity.

3. Results

The experiment showed that the choice of irrigation regime had a clear impact on winter wheat performance. Moderate deficit irrigation produced yields comparable to or slightly higher than conventional irrigation, while regulated deficit irrigation maintained good productivity with reduced water input. Overall, water-saving irrigation reduced total water consumption while sustaining crop development and grain formation. The results highlight that careful management of irrigation timing and amount can optimize the balance between yield and resource use, demonstrating the potential of deficit and regulated irrigation strategies in practical agriculture.

4. Discussion

These findings suggest that winter wheat can tolerate moderate water stress without significant yield loss, which can improve water productivity and soil health. Over-irrigation in conventional regimes may reduce nutrient uptake and create temporary waterlogging, whereas deficit irrigation encourages deeper root growth and more efficient resource utilization. The study emphasizes that the selection of irrigation strategy depends on whether the priority is maximum yield or maximum water conservation. Applying resource-saving irrigation aligns with sustainable agriculture goals, enabling farmers to maintain productivity while reducing environmental impacts associated with excessive water use.

5. Conclusion

Field trials indicate that resource-saving irrigation strategies are effective in enhancing water use efficiency of winter wheat without compromising yield. Moderate deficit irrigation emerged as the most effective approach for balancing productivity and water conservation. Implementing such strategies in irrigated wheat production can contribute to sustainable farming practices, ensuring that limited water resources are used more efficiently while supporting food security in water-scarce regions.

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