Ecofarming
e-Magazine for Agriculture and Allied Sciences
http://www.ecofarming.rdagriculture.in
e-ISSN: 2583-0791

Enhancing Water Use Efficiency

in Field Crops via Diverse Agronomic Strategies

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Received: May, 2024; Accepted: May, 2024; Published: July, 2024

Introduction

Improving water use efficiency in agriculture is essential due to declining irrigation sources, rising energy costs, increasing global demand for food, feed, and fiber, and the expansion of production into more arid regions. In India, field crop yields have decreased due to increasing water scarcity, with irrigation efficiency as low as 30-40%, resulting in significant water loss. Irrigation farming, the largest consumer of water, is often criticized for inefficient water use. Additionally, the lack of new agricultural land to meet the growing population's needs exacerbates the problem, as irrigation must increasingly compete with other interests for limited water resources. To address these challenges, enhancing yields and water use efficiency in water-limited environments is crucial. This can be achieved through various water economization practices such as precise irrigation scheduling based on pan evaporation rates, optimized land configuration, crop selection, intercropping, moisture conservation techniques, and the use of transpiration suppressants. By adopting these strategies, farmers can sustain water resources and improve crop productivity, ensuring long-term agricultural sustainability.

Water Use Efficiency (WUE)

It a measure of how effectively water is used by plants to produce biomass or yield. It is often expressed as the ratio of the amount of crop produced (e.g., grain, fruit, biomass) to the amount of water used, either through irrigation or natural rainfall. In essence, it quantifies the productivity per unit of water consumed.

Importance of WUE

With increasing pressure on freshwater resources due to population growth and climate change, optimizing WUE is essential for sustainable agriculture (Kilemo 2022). Economic Benefits: Higher WUE can lead to reduced water costs and increased profitability for farmers. Efficient water use helps minimize the environmental footprint of agriculture by reducing water withdrawal from natural ecosystems and lowering the risk of soil salinization and nutrient leaching.

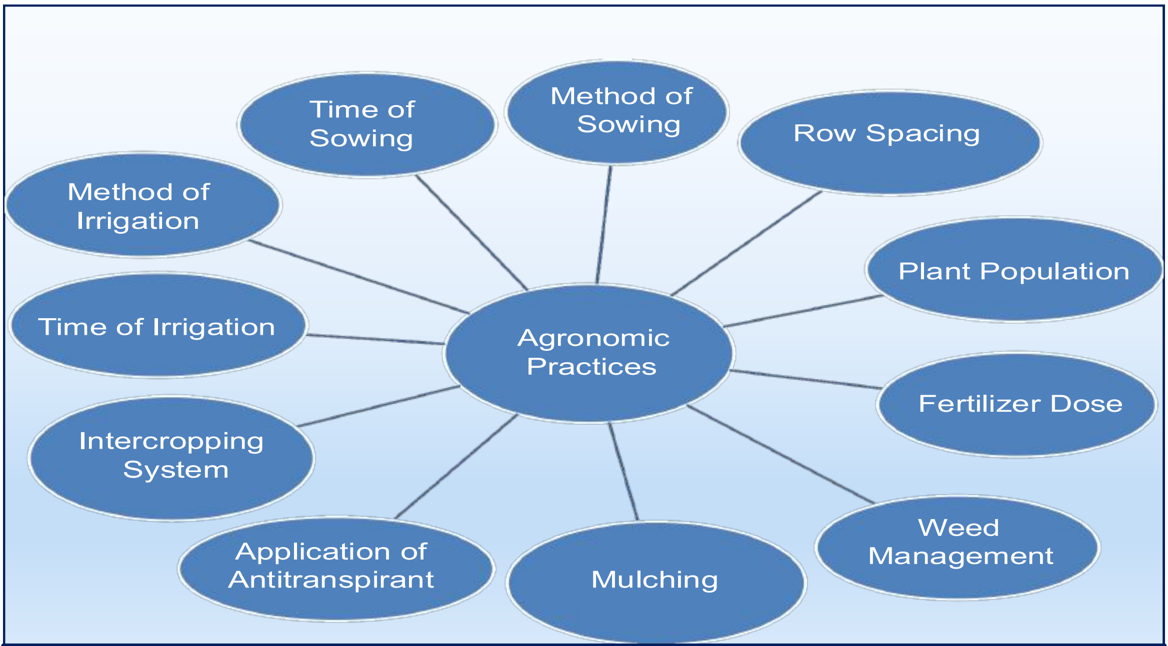
Factors Influencing WUE

1. **Crop Type:** Different crops have varying intrinsic WUE based on their physiological and morphological characteristics.
2. **Climate:** Temperature, humidity, and solar radiation directly affect plant transpiration rates and thus influence WUE.
3. **Soil Properties:** Soil texture, structure, and organic matter content determine water retention and availability to plants.
4. **Agronomic Practices:** Irrigation methods, fertilization, crop rotation, and soil

5. management practices all play a critical role in determining WUE.

Agronomic Practices to Enhance WUE

1. Precision Irrigation: Techniques like drip and sprinkler irrigation deliver water directly to the plant roots, minimizing losses due to evaporation and runoff.
2. Soil Moisture Conservation: Practices such as mulching, cover cropping, and conservation tillage help retain soil moisture.
3. Drought-Resistant Varieties: Developing and using crop varieties that are genetically predisposed to use water more efficiently or withstand periods of low water availability.
4. Optimized Fertilization: Proper nutrient management ensures that plants have the necessary resources to maintain growth and productivity with less water.
5. Crop Rotation and Diversification: These practices improve soil health and structure, enhancing the soil's capacity to retain water.



Different Agronomic Practices

Technological Advancements

Technologies that allow for the monitoring of soil moisture and crop water status in real-time, enabling precise irrigation scheduling (El-Naggar *et al.*,2020). Software tools that integrate various data sources to provide farmers with recommendations on the optimal use of water resources.

Case studies

Duran et al. (2012) conducted research in the trial area of Konya Seker Inc. in Konya-Alakova between 2008 and 2009. They found that using the drip irrigation method for potato production saved nearly 20% of irrigation water compared to the sprinkler irrigation method. They concluded that the application area of the drip irrigation method should be extended to better utilize limited water resources. Hari Ram *et al.* (2013) carried out a field experiment over three years (2008-09, 2009-10, and 2010-11) to study the effect of four irrigation treatments applied at critical growth stages and four rates of rice straw mulching on the grain yield and water use efficiency of wheat in Northwest India. They recorded the highest water use efficiency with two irrigations applied to wheat under 6 t ha^{-1} of rice straw mulch.

Conclusions

It is evident that enhancing water use efficiency (WUE) in field crops is not the result of a single agronomic practice but rather a combination of appropriate strategies. Early sowing extends the productive phase, leading to higher WUE and grain yield, whereas delayed sowing reduces WUE due to a disproportionate decline in grain yield compared to water use. While increased irrigation levels boost total water use and yield, mulching decreases total water use while increasing yield and WUE in wheat. Expanding the use of drip irrigation is essential for effective water use in low rainfall areas. Manual weed control improves WUE by reducing weed density and associated water loss, thereby increasing grain yield. Rice husk mulch, compared to polyethylene mulch, effectively conserves water while maintaining comparable growth and yield in wheat under subtropical conditions. Additionally, grain yield and WUE are higher with bed planting in three rows of wheat, and higher planting density reduces soil water evaporation.

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