Moderation of Hydrothermal Regime in Improving Water and Crop Productivity

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ABSTRACT

Agriculture needs to moderate the hydrothermal regime in order to increase crop productivity and water use efficiency. This entails controlling temperature and water availability to establish ideal growing conditions for crops. By employing a combination of agronomic practices, such as conservation tillage, mulching, precision irrigation, and soil amendment strategies, farmers can mitigate the adverse effects of extreme hydro-thermal conditions, including droughts and waterlogging. Farmers can improve agricultural resilience against climate instability, stabilize yields, and conserve water resources by regulating the hydrothermal environment. So, putting hydrothermal moderation measures into practice is essential for both food security and sustainable agriculture.

INTRODUCTION

There is a great potential to improve crop and water productivity by moderating hydrothermal regimes, especially through strategic water management techniques. Hydro-thermal regimes, characterized by the intricate balance between water availability and temperature fluctuations, significantly impact agricultural productivity. Hydro-thermal regimes play a critical role in determining soil moisture availability, soil temperature conditions, and water distribution within agricultural ecosystems, all of which directly influence plant growth, water use efficiency, and ultimately crop productivity. They directly affect various physiological processes in plants, including photosynthesis, transpiration, nutrient uptake, and reproductive development, all of which ultimately impact crop growth, yield, and quality. Crop productivity is significantly influenced by hydro-thermal regimes, which encompass the interplay of water availability and temperature dynamics within agricultural ecosystems (Esaulko et al. 2022). Water productivity, which refers to the amount of crop yield or economic output generated per unit of water used, can be enhanced by effectively managing hydro-thermal regimes. Effective management of hydro-thermal regimes is essential for enhancing water productivity in agriculture. By implementing appropriate techniques and strategies to optimize soil moisture, regulate soil temperature, improve water use efficiency, and enhance nutrient availability, farmers can achieve higher crop yields and economic returns per unit of water used, contributing to sustainable water management and food security.

Need for moderation of hydrothermal regime:

The moderation of the hydrothermal regime, which includes managing both soil moisture and temperature, is crucial for ensuring optimal conditions for plant growth, soil health, and overall ecosystem functioning.

- **Soil Structure and Health:** Moderating soil moisture levels helps maintain soil structure, porosity, and nutrient availability, promoting healthy root development and microbial activity.

- **Seed Germination and Plant Growth:** Soil temperature profoundly influences seed germination, root growth, and plant development. Moderating soil temperature within optimal ranges promotes faster and more uniform germination, enabling plants to establish healthy root systems and access water and nutrients efficiently.

- **Nutrient Cycling and Availability:** Soil moisture and temperature regulate microbial activity, decomposition rates, and nutrient cycling processes in the soil. Moderating the hydrothermal regime helps maintain a balance between microbial activity and nutrient availability, ensuring a steady supply of nutrients for plant uptake and growth.

- **Water Conservation and Irrigation Efficiency:** Moderating soil moisture levels helps reduce water loss through evaporation and runoff, maximizing water use efficiency and minimizing the need for irrigation (Benjamin and Nielsen 2004).

- **Climate Resilience and Adaptation:** Moderating the hydrothermal regime becomes increasingly important for building resilience and adaptation in agricultural systems. Balanced soil moisture and temperature regimes enhance the resilience of crops and soil ecosystems to extreme weather conditions.

Approaches to moderate hydrothermal regime:

Managing the hydrothermal regime, which encompasses soil moisture and temperature dynamics, involves employing various approaches to mitigate extremes and promote optimal conditions for plant growth and ecosystem health.

1. **Mulching:**

- Mulch acts as a protective barrier, shielding the soil from direct sunlight and wind, thereby preserving moisture and moderating soil temperature.
- Research has shown that mulching can significantly improve water retention in the soil, especially during dry periods, promoting more stable soil moisture conditions (Bhattarai et al. 2019).

2. **Cover Cropping:**

- The dense foliage of cover crops shades the soil surface, reducing solar radiation and evaporation, which helps maintain soil moisture levels.
- Cover crops can increase water infiltration rates, reduce runoff, and regulate soil temperature, creating a more favourable hydrothermal regime for subsequent crops (Basche and DeLonge 2014).

3. **Contour Farming:**

- By following the contour lines of the land, contour farming helps to trap and retain water, minimizing soil moisture loss and preventing waterlogging in low-lying areas.
- Contour farming can effectively stabilize soil moisture levels, reduce soil erosion, and enhance water availability for plant growth.

4. **Efficient Irrigation Techniques:**

- Adopting efficient irrigation techniques, such as drip irrigation, sprinkler irrigation, or precision irrigation, can help optimize water use efficiency.

5. **Soil Conservation Practices:**

- Implementing soil conservation practices, such as reduced tillage or conservation tillage, helps maintain soil structure, organic matter content, and moisture retention capacity.
- Reduced tillage minimizes soil disturbance, reducing the risk of soil compaction and erosion, while also preserving soil moisture.
- Conservation tillage involves leaving crop residues on the soil surface, which acts as a natural mulch, protecting the soil from erosion and preserving moisture.

Effect of moderation of hydrothermal regime on water productivity:

1. **Soil Moisture Availability:**

- Adequate soil moisture is essential for plant growth, as it facilitates nutrient uptake, photosynthesis, and transpiration. Optimal soil moisture levels ensure efficient water use by crops, maximizing water productivity.
- Excessive soil moisture, caused by poor drainage or over-irrigation, can also decrease water productivity by promoting waterlogging and nutrient leaching (Lobell et al. 2008).

2. **Irrigation Management:**

- Effective irrigation management practices, such as scheduling irrigation based on soil moisture levels and crop water requirements, are crucial for optimizing water productivity.
- Precision irrigation techniques, such as drip irrigation or micro-sprinklers, deliver water directly to the root zone of

plants, minimizing water losses through evaporation and runoff.

- Implementing deficit irrigation strategies, where water is applied at levels below crop water requirements during non-critical growth stages, can enhance water productivity by promoting efficient water use and stress-induced physiological responses in crops.

3. Soil Conservation Practices:

- Mulching reduces evaporation, minimizes soil temperature fluctuations, and preserves soil moisture, leading to improved water retention and utilization by crops.

- Cover cropping increases organic matter content, enhances soil structure, and reduces erosion, contributing to more favourable hydrothermal conditions for plant growth and water productivity.

- Conservation tillage practices, such as no-till or reduced tillage, help conserve soil moisture, reduce soil erosion, and enhance water infiltration, ultimately improving water productivity in agricultural systems.

4. Climate Resilience:

- Maintaining optimal soil moisture and temperature conditions can enhance crop resilience to water stress and temperature extremes, minimizing yield losses and preserving water productivity.

- Implementing climate-smart agricultural practices, such as crop diversification, agroforestry, and integrated water management, can help mitigate the impacts of climate change on water productivity and agricultural sustainability (Lobell et al. 2008).

5. Soil Temperature Effects:

- Soil temperature influences water productivity by affecting evapotranspiration rates, nutrient availability, and plant growth and development.

- Managing soil temperature through shading, mulching, or crop selection can help mitigate the adverse effects of temperature extremes on water productivity and crop performance.

CONCLUSION:

The hydrothermal regime is a fundamental aspect of soil and ecosystem functioning, with far-reaching implications for agriculture, biodiversity conservation, and climate change adaptation. Main factors impacting these regimes are soil structure, texture, organic matter, bulk density, porosity, soil colour etc. Understanding and managing these regimes is essential for sustaining healthy ecosystems and ensuring food and water security in a changing climate. Soil management practices like mulching, tillage, irrigation, intercropping, planting density etc. have significant potential to moderate the hydrothermal regimes.

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