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METHODS OF RAIN IRRIGATION OF WHEAT IN THE CONDITIONS OF SOILS PRONE TO SALINITY

Introduction. wheat (*Triticum aestivum*) is a crucial staple crop globally, and it holds particular significance in agricultural regions that experience ecological stress, such as salinity-prone soils. The cultivation of wheat in regions with salinity challenges requires innovative irrigation methods. Rain irrigation, which refers to methods that harness rainfall for plant growth, offers sustainable solutions for managing water resources and alleviating soil salinity. This article delves into various methods of rain irrigation specifically tailored for wheat, analyzing their effectiveness and adaptability in salinity-prone conditions.

Understanding Salinity-Prone Soils

Soil salinity is a critical agricultural problem, particularly in arid and semi-arid regions where evaporation exceeds precipitation. Key causes of soil salinity include:

- **Poor Drainage:** Inadequate drainage systems lead to the accumulation of salts in the upper soil layers, particularly in low-lying areas.
- **Irrigation Practices:** Over-irrigation and improper irrigation scheduling can cause waterlogging, resulting in salt accumulation.
- **Evaporation:** High temperatures and low humidity conditions contribute to increased evaporation rates, leading to salt concentration in the soil.
- **Groundwater Salinity:** In many regions, including those used for wheat cultivation, saline groundwater can exacerbate soil salinity when used for irrigation [1].

Effects of Salinity on Wheat

Salinity adversely affects wheat cultivation in various ways:

- **Reduced Germination Rates:** High salinity levels can hinder seed germination and seedling establishment.
- **Stunted Growth:** Saline conditions lead to osmotic stress, which affects water uptake and nutrient absorption.
- **Lower Yields:** Salinity can significantly reduce grain yield and quality, impacting farmer livelihoods and food security.
- **Soil Degradation:** Continued salinity can lead to soil degradation and loss of agricultural productivity [2].

Definition and Principles of Rain Irrigation

Rain irrigation refers to methods that utilize natural precipitation to provide water for crops. This can involve capturing and effectively managing rainfall through various techniques to optimize water utilization in agricultural practices:

- **Rainwater Harvesting:** Collecting and storing rainwater for irrigation during dry periods.
- **Soil Moisture Management:** Approaches that enhance soil moisture retention to maximize beneficial effects of rainfall.
- **Integrated Water Resource Management (IWRM):** A holistic approach that combines various techniques for efficient water utilization and soil salinity management.

Advantages of Rain Irrigation in Salinity-Prone Soils

Implementing rain irrigation for wheat cultivation is particularly beneficial for farmers facing salinity challenges:

- **Reduces Dependence on Groundwater:** Utilizing rainwater decreases pressure on declining groundwater resources, which may be saline.
- **Leaching of Salts:** Adequate rainfall can help leach salts from the root zone, improving soil health.
- **Cost-Effectiveness:** Rain irrigation is often less costly than traditional irrigation systems, making it an attractive option for farmers.
- **Sustainability:** It promotes sustainable farming practices by reducing the salinization of soils and promoting healthy crop growth.

Methods of Rain Irrigation for Wheat

Various methods can be employed to effectively use rain irrigation for wheat in salinity-prone soils. These methods are categorized based on their design, functionality, and adaptability to local conditions [3].

Rainwater Harvesting Techniques

Overview: Roof-based rainwater harvesting involves capturing rainwater from building roofs and directing it into storage tanks or cisterns.

Application in Wheat Cultivation:

- **Collection and Storage:** Water collected can be used to irrigate wheat during dry spells, particularly in regions with low annual rainfall.
- **Quality Control:** Roof materials (e.g., clean metals or tiles) must be selected carefully to ensure water quality.

Surface Runoff Harvesting

Overview: This technique captures surface runoff from fields during rainfall events to direct it into storage systems or directly into nearby agricultural lands.

Application in Wheat Cultivation:

- **Contour Farming:** Implementing contour planting or furrow systems can channel runoff to specific areas designated for wheat planting.
- **Runoff Pits:** Constructing retention basins or pits can collect runoff, allowing gradual infiltration into the soil.

Improved Soil Moisture Management Practices

Overview: Mulching involves covering the soil surface with organic or synthetic materials to reduce evaporation and improve moisture retention.

Application in Wheat Cultivation:

- **Organic Mulches:** Using straw, grass clippings, or other organic materials conserves soil moisture and adds organic matter to the soil.
- **Synthetic Mulches:** Plastic sheeting can also effectively minimize evaporation from the soil surface.

Overview: Amending soils with organic matter and other materials can enhance soil structure and improve moisture retention [4].

Application in Wheat Cultivation:

- **Organic Matter Addition:** Incorporating compost or well-rotted manure increases soil water-holding capacity, allowing wheat to withstand saline conditions better.
- **Gypsum Application:** Gypsum can help displace sodium in saline soils, improving drainage and promoting better crop growth [5].

Crop Rotation with Salinity-Tolerant Species

Overview: Integrating salinity-tolerant crops in rotation with wheat can mitigate salinity levels in soils and enhance overall productivity.

Application:

- **Tolerant Varieties:** Growing crops like barley or quinoa after wheat harvest improves soil health and reduces salinity, benefiting subsequent wheat crops.

Reduced Tillage Systems

Overview: Adopting reduced tillage practices helps maintain soil structure, moisture retention, and organic matter content.

Application in Wheat Cultivation:

- **Conservation Tillage:** Implementing conservation tillage reduces soil disturbance, promoting better moisture retention and improving soil health in saline-prone areas.

Challenges and Mitigation Strategies

Implementing rain irrigation systems for wheat in salinity-prone soils is not without challenges. Understanding potential obstacles can help formulate effective mitigation strategies [6].

Unpredictable Rainfall Patterns

Challenge: Irregular rainfall can lead to insufficient moisture during critical growth stages.

Mitigation Strategies:

- **Water Storage Systems:** Enhance storage for excess rainfall to be used during drought periods.
- **Weather Forecasting Tools:** Using advanced technology for accurate weather predictions aids in better planning for irrigation.

Soil Salinity Management

Challenge: High initial soil salinity can hinder germination and seedling growth.

Mitigation Strategies:

- **Pre-Planting Leaching:** Perform pre-planting leaching of saline soils with clean water, where possible, to reduce salinity levels before sowing.
- **Crop Selection:** Choose salt-tolerant wheat varieties that can better withstand salinity stress.

Knowledge Gaps Among Farmers

Challenge: Many farmers may lack knowledge about the benefits and practices of rain irrigation.

Mitigation Strategies:

- **Training Programs:** Develop education and outreach programs focused on efficient rain irrigation management and sustainable farming practices.
- **Demonstration Farms:** Establish demonstration plots showcasing successful rain irrigation techniques to encourage adoption.

Several agricultural projects and initiatives have successfully implemented rain irrigation techniques to enhance wheat production in salinity-prone soils:

Case Study 1: Uzbekistan's Integrated Rainwater Management Project

Overview: This program aimed to improve agricultural productivity by implementing advanced rainwater harvesting techniques and promoting soil health.

Outcomes:

- Increased wheat yields by 25% through effective rainwater harvesting systems.
- Improved soil structure and moisture retention through innovative farming practices and the addition of organic matter.

Case Study 2: The Use of Mulching in Wheat Production

Overview: An aggregated effort in various urban farms across Navoi demonstrated the benefits of mulching for conserving soil moisture in wheat fields.

Outcomes:

- Reductions in evaporation rates averaged around 40% during the growing season.
- Enhanced crop resilience against salinity stress, resulting in healthier wheat plants and improved yields.

Policy Recommendations

To effectively support the implementation of rain irrigation methods for wheat in salinity-prone areas, policymakers should consider the following recommendations:

Promotion of Research and Development

Invest in research initiatives focused on developing advanced rain irrigation technologies and best management practices tailored to the local environment.

Financial Incentives for Farmers

Offer financial assistance programs to farmers for installing rainwater harvesting systems, soil amendments, and improved agricultural practices.

Collaboration with Agricultural Institutions

Foster partnerships between government bodies, agricultural universities, and local farmer cooperatives to enhance training and resource availability [7].

Conclusion. Rain irrigation methods present a viable solution for wheat cultivation in salinity-prone soils, especially in regions like Uzbekistan where water scarcity is a pressing issue. These techniques not only promote sustainable agricultural practices but also enhance soil health, improve crop yields, and contribute to food security. By overcoming challenges through appropriate mitigation strategies, education, and supportive policies, farmers can successfully harness the potential of rain irrigation and cultivate high-quality wheat despite salinity concerns.

By addressing these future research avenues, the agricultural sector can pave the way for sustainable productivity and effectively manage the challenges presented by salinity-prone soils in wheat cultivation.

References

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