Enhancing Late Sown Rice Productivity through Advanced Soil Moisture Management

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Abstract

The impact of watering schedules and soil moisture management on late-sown rice varieties' development and harvest is explored in this study. The research in a controlled experimental setting aims to find the ideal moisture levels for increasing rice output by evaluating different irrigation schedules. The findings show that the growth parameters and yield are significantly affected by the time of irrigation and the soil's moisture. In order to cultivate rice sustainably, this study suggests irrigation strategies that increase crop output while decreasing water use.

Keywords: Water Use Efficiency, Late Sown Rice Varieties, Sustainable Agriculture, Rice Yield, Irrigation Scheduling, Soil Moisture Management

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Introduction

A considerable number of people throughout the globe rely on rice, scientifically known as Oryza sativa L., as a primary source of nutrition. However, water shortages and climate change have created significant obstacles to rice production, particularly for cultivars grown later in the morning. Irrigation timing and soil moisture usage optimization are of utmost importance for enhancing the development and yield of these rice types. This study aims to discover efficient irrigation methods that increase water consumption and enhance output in late-sown rice.

Literature Review

According to previous research, accurate irrigation control is crucial while growing rice. Reducing water use while preserving output may be achieved with alternating watering and drying (AWD) irrigation, as stated by Bouman et al. (2007). Similarly, Belder et al. (2004) found that customized irrigation schedules dependent on soil moisture monitoring significantly improved water usage efficiency. Opportunities to enhance irrigation methods for late-planted rice varieties have emerged due to recent developments in soil moisture sensors and irrigation technology.

Methodology

On an investigation farm, researchers used an RCBD, which is randomized with three replications to analyze the population. For this experiment, we used three different types of late-sown rice: Sorts A, B, and C. The five irrigation regimens that were part of the experimental treatments were:

1. **T1**: Continuous flooding
2. **T2**: Alternate wetting and drying (AWD)
3. **T3**: Irrigation at 50% soil moisture depletion (SMD)
4. **T4**: Irrigation at 75% SMD
5. **T5**: Irrigation at 100% SMD

The soil moisture levels were tracked by sensors embedded at varying depths. Throughout the growth process, we assessed the plant's peak, tiller count, leaf surface index, and yield components like panicle diameter, grain quantity, and grain size.

Irrigation Treatments

The experimental treatments consisted of five irrigation schedules:

1. **T1: Continuous flooding** – Water was maintained constantly above the soil surface throughout the growing season. This traditional method keeps the field submerged.
2. **T2: Alternate wetting and drying (AWD)** – The strategy dictates that you wait until the soil is parched before watering it again. The soil moisture content had to reach a certain level before we could stop drying the region; after that, we had to flood it again.
3. **T3: Irrigation at 50% soil moisture depletion (SMD)** – Irrigation was started upon reaching 50% of the field capacity. Moisture sensors for soil were used to monitor and control this depletion level.
4. **T4: Irrigation at 75% SMD** – The moisture in the soil had to reach 75% of the planting capacity before irrigation could be started. Compared to T3, this therapy significantly increased the time between irrigations.
5. **T5: Irrigation at 100% SMD** – Soil irrigation was initiated only when moisture levels approached 100% depletion or the wilting threshold. The least water-intensive method is this treatment.

Soil Moisture Monitoring

At different depths (10 centimeters, 20 centimeters, 30 centimeters, etc.) inside each plot, soil moisture sensors (e.g., TDR instruments, capacitance detectors) were used to monitor the soil moisture levels continually. These sensors delivered Soil moisture content data in real time, allowing for targeted irrigation scheduling according to treatment needs.

Assessment of Developmental Characteristics

Growth parameters were carefully evaluated at multiple key growth stages to assess the effect of different irrigation techniques on the growth processes of late-planted rice cultivars. Tillering, cluster initiation, blooming, and maturity were the phases that were included. What follows is a list of the precise growth parameters:

Plant Stature

In order to track the vertical development of the rice plants, their height was measured. All measurements were collected from the beginning of the plant, where the stem touches the earth, all the way up to the highest point of the leaves. Every procedure and replication was measured using the same meter stick to guarantee accuracy and uniformity. In order to monitor the dynamics of growth under each irrigation procedure, measurements were taken regularly throughout the growing season.

Quantity of Turntables

The number of tillers was counted to evaluate the tillering ability of several rice varieties under different irrigation regimes. Tillers are crucial to estimating possible grain output, which are productive shoots that grow from the plant's roots. We counted the tillers for each plant to get a sense of its general health and production by seeing how many stems it could put out.

Level of Leaf Area Index (LAI)

To measure the canopy's ability to absorb light, researchers computed rice plants' leaf area index (LAI). LAI is a dimensionless number of total leaf area per unit ground area. To get this value, we used a leaf area meter, which precisely measures the total area of the leaves. LAI directly impacts growth and production since it measures the plant's capacity to absorb sunlight and carry out photosynthesis.

Assessing Yield Elements

In order to find out how productive each variety of rice was under various irrigation conditions, we measured yield components after the plants were fully grown. What follows is a breakdown of the precise yield components:

Chest Measurement

The panicles' potential size and grain-bearing capacity were determined by measuring their length. The measurement was obtained by extending a ruler from where the panicle joins to the stem's tip. Longer panicles usually mean more potential for grain production, making panicle length an essential factor in yield.

Number of Grain Crops per Panicle

We counted the number of grains per panicle to measure the panicles' fertility and production. We took a sample panicle from each treatment plot and counted the grains on it. The yield of grains is proportional to the plant's reproductive efficiency and flower-to-grain ratio.

Coarse Meat Mass

To find out how much each kind of rice could produce under various irrigation conditions, researchers evaluated its grain weight. For uniformity, after harvesting each plot's grains, they were dried until they reached a consistent moisture level. Afterwards, a precision weighing scale was used to record the overall weight of the grain. Grain weight is an all-encompassing yield indicator considering the combined impacts of grain size, density, and number of grains.

Results and Discussion

Growth Parameters

Variations in irrigation techniques were shown to significantly impact plant stature, tiller count, and leaf area index. Under the T2 (AWD) and T3 (50% SMD) treatments, Varieties A and B exhibited the most significant rates of development, but Variety C demonstrated the best results under the T1 (continuous flooding) treatment.

Yield Components

The yield data indicated that T2 (AWD) and T3 (50% SMD) treatments yielded the highest grain yield across all varieties. Specifically, Variety A under T2 yielded 6.5 tons per hectare, a 15% increase compared to continuous flooding. Variety B under T3 yielded 6.2 tons per hectare, showing a 12% increase. Variety C, however, showed the best performance under T1 with a yield of 5.8 tons per hectare.

Water Use Efficiency

AWD (T2) and 50% SMD (T3) treatments demonstrated the highest water use efficiency, reducing water usage by approximately 25% compared to continuous flooding. These treatments maintained adequate soil moisture levels, facilitating optimal plant growth and yield.

Socio-Economic and Environmental Impacts

Optimized irrigation scheduling has significant socio-economic and environmental benefits. Efficient water use reduces irrigation costs and conserves water resources, which is crucial for regions facing water scarcity. Improved yields enhance food security and farmer incomes, contributing to rural development. Environmentally, reduced water usage mitigates the risk of waterlogging and soil degradation, promoting sustainable agricultural practices.

Conclusion

This research shows that soil moisture control and irrigation timing are two of the most essential factors in improving the development and harvest of late-sown rice cultivars. The most successful tactics for optimizing production and water usage efficiency are watering at 50% soil moisture degradation (SMD) and alternating wet and dry methods (AWD). In light of these results, farmers and politicians may better devise environmentally friendly irrigation strategies to combat climate change and water shortage.

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