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THE IMPLEMENTATION OF SPRINKLER IRRIGATION TECHNOLOGY IN THE CULTIVATION OF SECONDARY MILLET CROPS

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ABSTRACT

This study investigated the effect of sprinkler irrigation technology on the yield and water consumption of repeated wheat crops. The results showed that sprinkler irrigation increased yield by 15% compared to conventional irrigation and reduced water consumption by 25%. Additionally, the average grain weight improved. The study confirms the importance of implementing sprinkler irrigation technology for efficient cultivation of repeated wheat crops and conservation of water resources.

Keywords: repeated wheat, sprinkler irrigation, yield, water saving, technology.

INTRODUCTION

Secondary wheat crop (Triticum aestivum L.) is one of the main food and industrial crops cultivated in the irrigated regions of Uzbekistan. This crop not only serves as the primary staple food for the population but also plays an important role in supplying the domestic market and supporting the country's agricultural exports. The productivity of secondary crops largely depends on the level of water availability, and water shortages in irrigated areas have a negative impact on crop development [1]. As a result, yield decreases, grain quality deteriorates, and opportunities for exporting agricultural products may be limited.

Traditional irrigation methods, including canal and furrow irrigation systems, often operate inefficiently. A significant portion of water is lost through evaporation, fails to reach deeper soil layers, or does not adequately supply moisture to the crop root system. Consequently, crop productivity declines and the efficient use of water resources is constrained [2]. In addition, conventional irrigation methods may disrupt soil structure, alter mineral nutrient balance, and cause environmental problems [3]. Water deficiency reduces the crop's stress tolerance and increases its susceptibility to diseases and pests.

In this context, **sprinkler irrigation technology** provides an opportunity to ensure stable and uniform water distribution in secondary wheat cultivation. This technology is implemented through water droplets or sprinkler systems, maintains consistent soil moisture, promotes the development of a strong root system, and improves grain quality [4]. Sprinkler irrigation not only significantly reduces water consumption but also increases crop yield, reduces stress during growth stages, and enhances resistance to diseases. Moreover, this technology contributes to environmental sustainability by maintaining soil moisture balance and preserving fertile soil layers [5].

Along with the implementation of sprinkler irrigation, the development of strategies for efficient water resource management and the application of practical recommendations become a pressing task. In this regard, the widespread adoption of innovative irrigation technologies in agriculture, the development of recommendations based on experimental results, and the organization of training programs for farmers contribute to sustainable development and environmental safety.

Today, ensuring sustainable agricultural development in regions with limited water resources is a critical challenge. Insufficient water supply poses a particularly serious risk for secondary crops, as they are cultivated multiple times within a single growing season, thereby increasing water demand. From this perspective, the introduction of efficient irrigation systems is essential not only

for increasing yields but also for preserving crop quality, protecting soil resources, and ensuring environmental sustainability.

Objective: The main objective of this study is to systematically investigate the impact of sprinkler irrigation technology on yield and water consumption in secondary wheat cultivation, as well as to identify opportunities for efficient water resource utilization. The results of the study will help develop recommendations for optimizing irrigation systems, ensuring adequate water supply during different growth stages of the crop, and increasing productivity.

Hypothesis: The primary hypothesis of this study is that sprinkler irrigation technology increases yield, improves grain quality, and significantly reduces water consumption compared to traditional irrigation methods. Additionally, by ensuring optimal water supply at different growth stages, this technology has a positive effect on all phases of crop development.

The implementation of sprinkler irrigation not only improves the quality and quantity of agricultural products but also promotes efficient water use and environmental sustainability. Therefore, the large-scale application of this technology and the development of scientifically grounded recommendations represent an important step toward strengthening agricultural sustainability and ensuring food security in the country.

METHODS

At present, Uzbekistan is considered one of the regions with limited water resources; therefore, the introduction of efficient irrigation technologies is of great importance for ensuring agricultural sustainability and strengthening food security. Secondary wheat (Triticum aestivum L.) is one of the main food and industrial crops cultivated in the irrigated areas of Uzbekistan. This crop not only serves as the primary staple food for the population but also plays an important role in supplying the domestic market and supporting agricultural exports. The productivity of secondary crops largely depends on the level of water availability, and water shortages in irrigated regions have a negative impact on crop development [6].

Under traditional irrigation methods, a large portion of water is lost through evaporation, fails to reach deeper soil layers, or does not adequately supply moisture to the crop root system. This situation leads to reduced yields, deterioration of grain quality, inefficient use of water resources, and negative effects on soil structure. In this regard, sprinkler irrigation technology provides an opportunity to ensure stable and uniform water distribution for crops. This technology is implemented through water droplets or sprinkler systems, maintains consistent soil moisture, promotes strong root system development, and improves grain quality.

The study was conducted in the Fergana Valley during 2025–2026. The experiment was established on an area of 0.5 hectares, and locally bred varieties of secondary wheat were used [7]. The soil was classified as chernozem, and the main macroelements—nitrogen, phosphorus, and potassium—were determined in accordance with standard agronomic requirements. Soil moisture and structure created favorable conditions for crop root development. Sprinkler irrigation was applied as the irrigation system, and water consumption, yield, grain weight, and crop resistance to diseases and pests were regularly monitored. In addition, the physicochemical properties of the soil and macroelement content were also systematically assessed.

The study was carried out in the Fergana Valley between 2025 and 2026, a region well known for its intensive agricultural production and favorable climatic conditions for cereal cultivation. Conducting the experiment in this area allowed the researchers to evaluate the effectiveness of modern irrigation technology under realistic field conditions typical of the region.

The experimental field covered a total area of 0.5 hectares, which provided sufficient space to organize treatment plots and obtain reliable data while maintaining effective control over agronomic

practices. Locally bred varieties of secondary wheat were selected for the study because they are well adapted to regional environmental conditions, including temperature fluctuations, soil characteristics, and water availability. Using local varieties also increased the practical relevance of the research findings for farmers in the area.

The soil of the experimental site was classified as chernozem, a soil type recognized for its high natural fertility, good structure, and strong moisture-retention capacity. Prior to planting, the levels of essential macroelements—nitrogen (N), phosphorus (P), and potassium (K)—were analyzed according to standard agronomic procedures. These nutrients play a crucial role in plant development: nitrogen supports vegetative growth, phosphorus promotes root formation and energy transfer, and potassium enhances plant strength and resistance to environmental stress. Ensuring balanced nutrient availability helped create optimal conditions for crop growth.

The soil's favorable moisture content and well-structured profile further supported healthy root development, allowing plants to efficiently absorb both water and nutrients. Such conditions are particularly important for secondary wheat, which often has a shorter growing period and therefore requires efficient resource utilization.

Sprinkler irrigation was implemented as the primary watering method throughout the experiment. This technology was chosen for its ability to distribute water uniformly across the field, prevent excessive water loss, and maintain consistent soil moisture levels during critical growth stages. Regular monitoring was conducted to measure key performance indicators, including total water consumption, crop yield, average grain weight, and the plants' resistance to common diseases and pests. Tracking these variables made it possible to evaluate not only productivity but also crop health and stability.

In addition to plant-related observations, the physicochemical properties of the soil—such as pH, organic matter content, and nutrient dynamics—were systematically assessed during the study period. Monitoring these parameters helped determine how irrigation practices influenced soil quality and long-term fertility.

The results of the study showed that a 15% increase in yield indicates optimal moisture supply during different growth stages of the crop achieved through sprinkler irrigation. Adequate moisture during the flowering and grain-filling stages, in particular, contributed to improved grain quality. The increase in grain weight demonstrates enhanced stress tolerance of the crop and more efficient uptake of nutrients. Moreover, improved mechanical strength of the crop reduced grain losses during harvesting.

A 25% reduction in water consumption highlights one of the most significant advantages of sprinkler irrigation. Under traditional irrigation methods, a large proportion of water is lost through surface evaporation or percolation into deeper soil layers. In contrast, sprinkler irrigation ensures uniform water distribution and stable moisture conditions throughout all growth stages, creating opportunities to increase yield while conserving resources. Water savings not only enhance productivity but also reduce energy and financial costs associated with water delivery and irrigation operations.

Furthermore, the results indicate that sprinkler irrigation contributes to increased resistance of crops to diseases and pests. Stable moisture supply enhances stress tolerance and limits the development of diseases [8]. From this perspective, sprinkler irrigation serves not only as a means of increasing yield but also as a strategic tool for maintaining crop health and reducing disease incidence.

Overall, the study demonstrates that the application of sprinkler irrigation technology in secondary wheat cultivation has clear advantages over traditional irrigation methods. These findings provide a basis for developing practical recommendations for agricultural producers, defining

strategies for water conservation, and increasing crop productivity. In addition, the results can serve as a scientific foundation for improving the effectiveness of sprinkler irrigation technology in other irrigated regions where secondary crops are cultivated in the future [9].

RESULTS

The experiment was divided into two groups. In the control group, traditional irrigation methods were applied, in which water was supplied through furrows or canals, resulting in partial water loss due to surface evaporation. In the experimental group, sprinkler irrigation technology was implemented, and water was evenly distributed over the field using a sprinkler system. This system helped maintain constant soil moisture, ensured stable development of the crop root system, and improved grain quality.

During the study, key agronomic indicators such as yield, average grain weight, and water consumption were systematically measured in both the experimental and control groups. Yield was assessed in kilograms per hectare (kg/ha) to determine the overall productivity of the crop, while the average grain weight was recorded in grams to evaluate grain quality and development. Water consumption was calculated in cubic meters per hectare (m^3/ha), allowing for an accurate assessment of irrigation efficiency and resource utilization.

All collected data were subjected to comprehensive statistical analysis using Analysis of Variance (ANOVA) and independent sample t-test methods. These statistical tools enabled the researchers to determine the reliability of the results and to identify whether the observed differences between the experimental and control groups were statistically significant rather than due to random variation. Such an approach ensured the scientific validity of the findings and provided a strong basis for drawing conclusions about the effectiveness of the applied treatment or technology.

Based on the results, it was demonstrated that sprinkler irrigation technology provides opportunities to increase the yield of secondary wheat crops, reduce water consumption, and improve grain quality. This study serves as a basis for developing practical recommendations aimed at saving water resources and improving the efficiency of agricultural production in the region.

The research results showed that sprinkler irrigation technology has a clear positive effect on increasing the yield of secondary wheat and reducing water consumption. In the experimental group, where sprinkler irrigation was applied, crop yield was significantly higher compared to the control group. Under traditional irrigation conditions, the average yield was 4,500 kg/ha, whereas under sprinkler irrigation it reached 5,200 kg/ha, representing an increase of approximately 15%. This difference was especially evident during the mid-growth and flowering stages of crop development, indicating the direct impact of stable moisture supply on productivity.

In addition, the average grain weight also showed a noticeable improvement. In the control group, the average grain weight was 39.5 g, while in the sprinkler-irrigated group it increased to 41.2 g. This result indicates improved crop quality and better grain development. The increase in grain weight is associated with stable moisture availability during the growing season, which enhanced root system efficiency, nutrient uptake, and crop stress tolerance. Adequate moisture during the flowering and grain-filling stages, in particular, contributed to increased grain density and the formation of high-quality yields.

A significant difference was also observed in water consumption. Under traditional irrigation, average water use amounted to 6,000 m^3/ha, whereas under sprinkler irrigation it decreased to 4,500 m^3/ha. This result indicates a reduction in water consumption by approximately 25%. Water savings not only contributed to increased yields but also significantly improved economic efficiency, as efficient water use reduces production costs and enhances the sustainability of agricultural practices.

The analyses showed that sprinkler irrigation technology ensures stable moisture supply at different growth stages, increases crop stress tolerance, and reduces susceptibility to diseases and pests. Moreover, efficient water distribution helps maintain soil moisture balance, protects soil structure, and reduces the formation of dry surface areas.

Furthermore, observations revealed that under sprinkler irrigation conditions, the crop developed a deeper and more advanced root system, enabling efficient nutrient uptake and improved water-use efficiency even during drought and stress periods. This contributes to long-term soil fertility preservation and enhanced crop stability [8].

Overall, the results of the study indicate that sprinkler irrigation technology in secondary wheat cultivation:

- ✓ significantly increases crop yield;
- ✓ improves grain quality and increases average grain weight;
- ✓ reduces water consumption and ensures efficient use of water resources;
- ✓ enhances stress tolerance by providing optimal water supply at different growth stages;
- ✓ helps maintain soil moisture balance and ensures environmental sustainability.

The overall findings of the study demonstrate that the application of sprinkler irrigation technology in secondary wheat cultivation offers several important agronomic and environmental advantages.

First, the technology significantly increases crop yield. By distributing water evenly across the field, sprinkler irrigation ensures that all plants receive sufficient moisture, which supports uniform growth and higher productivity compared to traditional irrigation methods.

Second, it improves grain quality and increases the average grain weight. Adequate and timely water supply during critical growth stages—such as flowering and grain filling—promotes better nutrient absorption and photosynthesis, resulting in fuller and heavier grains.

Third, sprinkler irrigation reduces overall water consumption while ensuring efficient use of available water resources. Because water is applied in controlled amounts, losses due to runoff, deep percolation, and over-irrigation are minimized. This is particularly important in regions where water resources are limited.

Additionally, the technology enhances plant stress tolerance. Consistent soil moisture helps crops better withstand environmental stresses such as heat and temporary drought, preventing growth interruptions and protecting yield potential.

Finally, sprinkler irrigation contributes to maintaining soil moisture balance and supports environmental sustainability. Proper water management helps prevent soil degradation, reduces the risk of salinization, and promotes long-term agricultural productivity without placing excessive pressure on natural resources.

In this study, the effectiveness of using various biopreparations during irrigation was also investigated. The main control variant involved irrigation using only drainage water. In other experimental variants, different biopreparations were applied together with drainage water irrigation, including Nano-silicon biopreparation and AMINOSID Universal Si biopreparation [10].

The crop selected for the experiment was millet (Saratovskaya–853). Nutrient application rates during irrigation were as follows: nitrogen (N) 150 kg/ha, phosphorus (P) 100 kg/ha, and potassium (K) 60 kg/ha.

According to the experimental results, when the Nano-silicon biopreparation was applied, crop productivity reached approximately 70–75–65% relative to the pre-irrigation CHDNS (standard control yield of deep-rooted cereal crops). This indicates that biopreparations have a positive effect on improving crop nutrition and increasing productivity.

Statistical analyses confirmed that these differences were significant at the $p < 0.05$ level, clearly demonstrating the effectiveness of sprinkler irrigation technology. The results provide a foundation for developing practical recommendations aimed at water conservation, yield improvement, and high-quality grain production in the region. Moreover, the study offers important scientific and practical outcomes for sustainable water resource management and improving the economic efficiency of agricultural production.

The findings also align with the results of other researchers, confirming that sprinkler irrigation effectively distributes water and positively influences crop growth. For example, international agricultural research has shown that sprinkler irrigation promotes deeper root system development and improves nutrient uptake. Our study confirms these findings: water supplied through the sprinkler system was evenly distributed across different soil layers, supporting stable root development. In turn, a well-developed root system enhances the crop's ability to absorb water and nutrients, enabling the maintenance of productivity even under stress conditions.

DISCUSSION

An increase in yield by 15% indicates that sprinkler irrigation provided optimal moisture to the crop at various growth stages. In particular, adequate soil moisture during flowering and grain-filling stages contributed to improved grain quality. Sufficient water availability during these critical periods enhances photosynthesis, increases biomass accumulation, and leads to higher grain weight. The increase in grain weight reflects the crop's enhanced stress tolerance and efficient nutrient uptake. Furthermore, this outcome improves the mechanical stability of the crop, reducing grain loss during harvesting, which translates into significant economic benefits for farmers.

A reduction in water consumption by 25% highlights one of the key advantages of sprinkler irrigation. In conventional irrigation methods, a large portion of water is lost through surface evaporation or fails to reach deeper soil layers, resulting in low efficiency. Sprinkler irrigation, on the other hand, ensures even water distribution and maintains stable soil moisture throughout all growth stages, which enhances yield and conserves resources [11].

Water savings not only increase yield but also reduce energy and financial costs, as traditional irrigation requires additional labor, equipment, and energy. Sprinkler irrigation minimizes these demands and improves the overall efficiency of agricultural production. Thus, this technology supports effective water resource management, improves yield and grain quality, and contributes to environmental sustainability.

Moreover, the study results indicate that sprinkler irrigation enhances crop resistance to diseases and pests. This effect is primarily related to controlled soil moisture and environmental conditions. Stable moisture availability increases crop stress tolerance and helps limit disease development. From this perspective, sprinkler irrigation serves not only as a tool for yield improvement but also as a strategic approach for maintaining crop health and reducing disease incidence.

The findings also demonstrate that sprinkler irrigation facilitates the efficient use of water resources and promotes ecological sustainability. Water conservation enhances economic efficiency and strengthens agricultural sustainability in the region. Optimal water management reduces soil erosion, preserves soil structure, and maintains agricultural ecosystems in irrigated areas. Furthermore, large-scale implementation of this technology is an effective tool for consistently improving both the quality and quantity of agricultural products.

Overall, the study shows that the application of sprinkler irrigation technology in secondary wheat cultivation has clear advantages over traditional irrigation methods. These results provide a scientific basis for developing practical recommendations for agricultural producers, formulating

strategies for water conservation and yield improvement, and may also serve as a reference for extending sprinkler irrigation to other irrigated regions where secondary crops are grown.

REFERENCES

1. Research and methodological manuals published by the Ministry of Agriculture of the Republic of Uzbekistan (e.g., methodological materials on “Evaporation and Sprinkler Irrigation Technology”).
2. Scientific journals: *Agronomy Research, Uzbek Journal of Agricultural Science* on Triticum aestivum L. irrigation technologies.
3. Theses and dissertations from higher education institutions in Uzbekistan in the field of agriculture.
4. Ahmadov, A. A. (2026). *Effect of sprinkler irrigation on yield and water consumption of secondary wheat: Fergana Valley experiment (2025–2026)* [Research report]. Fergana: Uzbekistan Scientific Research Institute of Agriculture.
5. Kuznetsov, V. I., & Smirnova, N. P. (2019). Эффективность дождевального орошения озимой пшеницы в условиях ограниченного водоснабжения. *Vestnik Sel’skokhozyaystvennoy Nauki*, 12(4), 45–52.
6. Ivanov, A. S. (2020). Современные технологии орошения зерновых культур в Центральной Азии. *Agroengineering*, 15(2), 10–18.
7. Petrov, M. V., & Lebedev, Yu. A. (2018). Влияние капельного орошения на качество зерна пшеницы. *Selskoe Khozyaystvo: Nauka i Praktika*, 7(3), 34–40.
8. Keller, J., & Bliesner, R. D. (1990). *Sprinkler and trickle irrigation.* New York: Van Nostrand Reinhold.
9. Postel, S. (2000). Entering an era of water scarcity: The challenges ahead. *Ecological Applications*, 10(4), 941–948.