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EFFICIENCY OF DRIP IRRIGATION TECHNOLOGY FOR MAIZE CULTIVATION

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Abstract: This article investigates the efficiency of drip irrigation technology for maize cultivation under the meadow-serozem soil conditions of Buka District, Tashkent Region, Uzbekistan. A comparative analysis of drip irrigation and conventional furrow irrigation methods was conducted. The study evaluated maize phenological development, biometric characteristics, irrigation regimes, irrigation water use efficiency, and yield performance.The research results demonstrated that the seasonal irrigation requirement under drip irrigation was 4,125.5 m³/ha, providing a water saving of 17.4% compared with traditional furrow irrigation. In addition, the actual maize yield reached 135 centners per hectare (13.5 t/ha), which was 42.1% higher than that of the control treatment. The findings confirmed that drip irrigation technology improves plant growth and development, enhances the rational use of water resources, and ensures higher crop productivity.The obtained results can serve as a scientific basis for improving maize cultivation technologies on irrigated lands of the Chirchik–Ohangaron Valley and for promoting the wider adoption of water-saving irrigation practices in regions with limited water resources.

Keywords: maize, drip irrigation, furrow irrigation, irrigation norm, water-saving technology, phenological observations, yield, water use efficiency, meadow-serozem soils.

Abstract: This article examines the efficiency of drip irrigation technology for maize cultivation under meadow gray soil conditions of Buka district, Tashkent region. A comparative analysis of drip irrigation and traditional furrow irrigation methods was conducted. Phenological development, biometric characteristics, irrigation regimes, water use efficiency, and yield performance of maize were evaluated. The research results showed that the seasonal irrigation rate under drip irrigation was 4125.5 m³/ha, providing a water saving of 17.4% compared to furrow irrigation. In addition, the actual maize yield reached 135 centners/ha, which was 42.1% higher than that of the control treatment. The study confirmed that drip irrigation technology improves plant growth and development, enhances the efficient use of water resources, and ensures higher crop productivity. The obtained results can serve as a scientific basis for improving maize cultivation technologies on irrigated lands of the Chirchiq–Ohangaron Valley.

Keywords: maize, drip irrigation, furrow irrigation, irrigation rate, water-saving technology, phenological observations, yield, water use efficiency, meadow gray soils.

Introduction

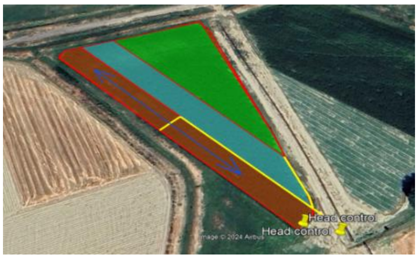
Uzbekistan is facing serious challenges in water resource management due to climate change, population growth, and the intensive use of water resources in agriculture. The Chirchik–Ohangaron Valley is one of the major centers of irrigated agriculture in the country. Irrigation water in this region is mainly supplied from the Chirchik, Ohangaron, and Syrdarya rivers. However, the limited availability of water resources and the increasing impacts of climate change have made efficient water management a critical issue.Meadow-serozem soils are widely distributed throughout the Chirchik–Ohangaron Valley. These soils are generally fertile but have a relatively low capacity for retaining moisture and nutrients. Drip irrigation technology can improve water and nutrient use efficiency in such soils by delivering water and fertilizers directly to the plant root zone, thereby enhancing crop productivity.Maize is one of the important agricultural crops cultivated in the Tashkent region, and increasing its productivity contributes significantly to regional food security. Drip irrigation technology has the potential to reduce water consumption by 30–50%, which is particularly important under conditions of increasing water scarcity.Recognizing the strategic importance of water-saving technologies, the Government of Uzbekistan has adopted a number of policy measures aimed at promoting their widespread implementation. The Presidential Resolution No. PQ-250 establishes measures for the development of water-saving technologies in agriculture, the introduction of drip irrigation systems, and the provision of state support mechanisms. The resolution emphasizes the expansion of drip irrigation practices in farms, reduction of water consumption, and improvement of land and water resource efficiency [1].Furthermore, Presidential Decree No. PF-130 outlines priorities for deepening reforms in the agricultural sector, promoting efficient water resource management, and expanding the application of modern agricultural technologies. The decree places particular emphasis on increasing agricultural productivity through the implementation of water-saving irrigation methods [2].In addition, Presidential Decree No. PF-6024, dated July 10, 2020, “On Measures for the Efficient Use of Water Resources and the Development of the Irrigation Sector,” identifies the large-scale adoption of water-saving technologies, including drip irrigation systems, as one of the key priorities for agricultural development. This decree is aimed at ensuring rational water use, improving irrigation system efficiency, and achieving high crop productivity under conditions of water scarcity [3].Therefore, studying the effectiveness of drip irrigation technology for maize cultivation under the meadow-serozem soil conditions of the Chirchik–Ohangaron Valley is of both scientific and practical importance. The results of this research can contribute to the improvement of irrigation practices, enhancement of water use efficiency, and sustainable agricultural production in the region.

Relevance of the Research Topic

Under conditions of increasing global climate change and growing water scarcity, the efficient use of available water resources through the widespread adoption of water-saving irrigation technologies has become an urgent issue. At the same time, ensuring high productivity of maize, one of the major agricultural crops cultivated in Uzbekistan, remains a priority for achieving sustainable agricultural development and strengthening food security. Therefore, the study of innovative irrigation methods aimed at improving water use efficiency and increasing crop yields is of considerable scientific and practical importance.

Research Object

The research was conducted on a 1-hectare experimental field equipped with a drip irrigation system at the "Shukrullo Yasmina Agro" farming enterprise located in Buka District, Tashkent Region, Uzbekistan. The drip irrigation system, irrigation regime, and yield performance of maize were selected as the main objects of the study.



Scientific Novelty

For the first time under the meadow-serozem soil conditions of the Chirchik–Ohangaron Valley, and in the context of global climate change and increasing water scarcity:

Scientific Novelty

For the first time under the meadow-serozem soil conditions of the Chirchik–Ohangaron Valley and in the context of global climate change and increasing water scarcity:

- The optimal irrigation regime for maize under drip irrigation conditions, including the number, timing, and application rates of irrigations, was developed;
- The effective technical parameters of drip irrigation for maize cultivation, including emitter discharge rates and the spacing between emitters and drip laterals, were determined;
- The effects of the optimal irrigation regime and drip irrigation system parameters on maize productivity were evaluated and scientifically substantiated.

Analysis and Results

Maize is one of the most important food, feed, and industrial crops in the world. It is distinguished by its high yield potential, adaptability to diverse soil and climatic conditions, and substantial grain and green biomass production. At present, countries such as the United States, China, Brazil, and Argentina are among the leading producers of maize worldwide. Therefore, the application of water-saving technologies is of great importance for obtaining high and stable maize yields under conditions of water scarcity.Numerous studies on drip irrigation of maize have been conducted by international researchers. For example, Frederick R. Lamm (USA) reported that the application of drip irrigation technology in maize production can reduce water consumption by 30–40% while increasing crop productivity [4]. Research conducted by Derrel L. Martin and co-authors demonstrated that drip irrigation significantly improves water use efficiency [5]. Similarly, the Chinese scientist Kang Shaozhong proved that drip irrigation under water-deficit conditions positively affects maize growth and grain yield.Several studies have also been carried out by Uzbek researchers on the effectiveness of water-saving irrigation technologies [6]. In particular, Matyakubov B.Sh. and Khamidov A.M. (2025) found that drip irrigation of cotton under the conditions of Khorezm Region resulted in water savings of 1,998–2,256 m^3/ha and increased yields from 35.7 to 40.2 centners per hectare [7]. Dostov Jahongir (2024) reported water savings of 977.9–1,442.0 m^3/ha and additional yield gains when drip irrigation was applied to soybean crops [8]. Likewise, Khamidov Akhror (2024) observed water savings of 2,328–2,890 m³/ha in cotton cultivation, accompanied by yield increases of up to 4.4 centners per hectare.These studies demonstrate that water-saving technologies, particularly drip irrigation, play a significant role in improving water use efficiency, increasing crop productivity, and enhancing the economic efficiency of agricultural production [9]. Therefore, investigating the effectiveness of drip irrigation for maize cultivation under the meadow-serozem soil conditions of the Chirchik–Ohangaron Valley is of considerable scientific and practical importance.In the experimental field, the maize hybrid "GreenLife PL-700" (dent type) was planted according to a 180-cm row-spacing scheme. Drip irrigation pipelines were installed in alternate furrows with a spacing of 1.8 m between laterals. The distance between emitters was 30 cm, and each emitter wetted a soil area with a radius of approximately 40–50 cm. The total experimental area covered 1 hectare and was divided into five plots of 0.2 hectares each.The results of the experiment demonstrated the high agrobiological and water-use efficiency of drip irrigation technology in maize cultivation.

Table 1. Phenological observations conducted on the 1-hectare maize experimental field.

№	Phenological Stage	Duration (days)	Start Date	End Date
1	Seedling Emergence Stage	49	11 april	29 may
2	Leaf Development Stage	14	30 may	12 jule
3	Intensive Vegetative Growth Stage	7	13 jule	19 jule
4	Tasseling Stage (Panicle Emergence)	7	20 jule	26 jule
5	Flowering Stage (Pollination)	7	27 jule	03 july
6	Silking Stage (Female Flower Emergence)	14	04 july	17 july
7	Grain Formation Stage	21	18 july	07 august
8	Дон тўлиш боскичи	14	08 august	21 august
9	Grain Filling Stage	7	22 august	28 august
10	Maturity Stage (Full Ripening)	7	29 august	04 september

During the research period, the pre-irrigation soil moisture content was maintained at 60–70–60% of the field moisture capacity (FMC). This moisture regime created favorable conditions for the growth and development of maize plants.According to the phenological observations, the total growing period of maize lasted 147 days. All developmental stages, from seedling emergence to physiological maturity, occurred within their expected timeframes. In particular, maintaining adequate soil moisture during the intensive vegetative growth, tasseling, and flowering stages enhanced the physiological activity of the plants and promoted their normal

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Drip Irrigation (Pre-irrigation soil moisture	Irrigation No.	Irrigation Date	Irrigation Duration (h)	Irrigation Rate (m³/ha)
60% 70 60 %	Drip Irrigation			

development.

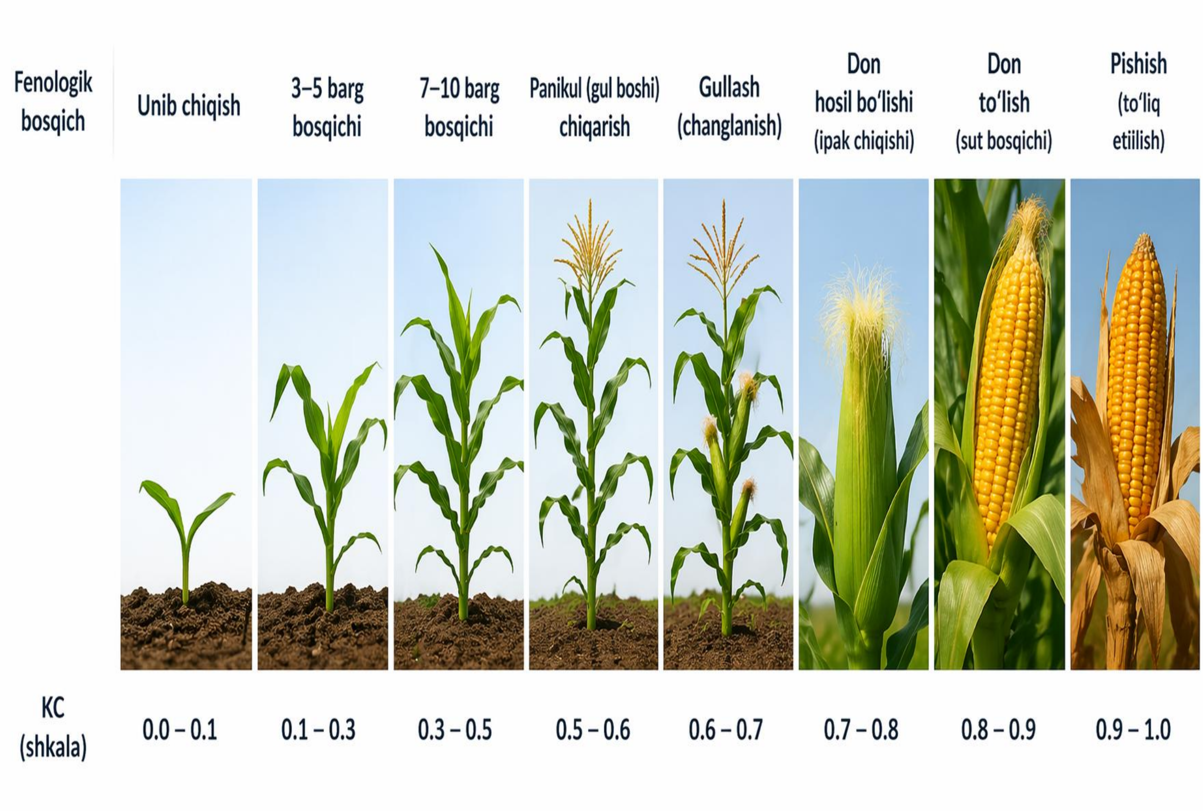

Figure 1. Growth and Development Process of Maize

The drip-irrigated treatment exhibited superior growth characteristics compared with the control (furrow-irrigated) treatment. As of June 1, the average plant height under drip irrigation reached 110.8 cm, which was 24.6 cm higher than that recorded under furrow irrigation. This advantage was maintained throughout the subsequent stages of crop development.During August, the average plant height in the drip-irrigated treatment reached 223.3 cm, whereas the corresponding value in the control treatment was 198.5 cm. These results indicate that drip irrigation improved the availability of water and nutrients to the plants, thereby enhancing vegetative growth and overall crop performance.The formation of yield components also differed significantly between the experimental treatments. Under the drip irrigation treatment, an average of 1.8 ears per plant was formed, whereas only 1.2 ears per plant were observed in the control (furrow-irrigated) treatment. Similarly, the grain weight per ear was higher under drip irrigation, reaching 180 g, compared with 150 g in the control treatment.These results indicate that drip irrigation created more favorable conditions for plant growth and reproductive development. The improved availability of water and nutrients throughout the growing season enhanced ear formation and grain filling processes, ultimately contributing to higher yield potential

Table 2. Irrigation Regime of Maize under Drip Irrigation Technolog

Pre-tasseling growth period (60% of field moisture capacity)	1	05.06	5,3	190,4
	2	09.06	5,4	192,7
	3	13.06	5,5	194,6
	4	17.06	5,6	196,8
	5	21.06	5,7	198,5
	6	25.06	5,8	199,8
Period from tasseling to milk–wax maturity (70% FMC)	7	29.06	7,5	265,3
	8	03.07	7,6	267,8
	9	07.07	7,7	269,4
	10	11.07	7,8	271,6
	11	15.07	7,9	273,5
	12	19.07	8,0	274,9
	13	23.07	8,1	276,8
	14	27.07	8,2	279,2
Full maturity period (60% FMC)	15	31.07	5,4	190,7
	16	05.08	5,5	192,4
	17	10.08	5,6	194,8
	18	15.08	5,7	196,3
Total	18	05.06–15.08	118,3 h	4125,5 м³/га
Control (Furrow Irrigation)				
60 70 60 %	1	10.06	28,4	1187,5
	2	04.07	31,2	1298,6
	3	27.07	33,8	1464,3
	4	18.08	25,3	1042,7
Total	4	10.06–18.08	118,7 h	4993,1 м³/га

This result can be explained by the greater allocation of photosynthetic products to grain formation under drip irrigation conditions. Water use efficiency was also evaluated during the study. The seasonal irrigation norm under the drip irrigation treatment was 4,125.5 m³/ha, whereas 4,993.1 m³/ha of water was applied under conventional furrow irrigation. Consequently, the adoption of drip irrigation resulted in water savings of 867.6 m³/ha, which accounted for 17.4% of the total irrigation water applied in the control treatment.The amount of water required to produce one centner of grain yield was also calculated. Under drip irrigation conditions, water consumption per centner of yield was:

4,125.5 ÷ 135 = 30.6 m³/centner

In the control treatment, the corresponding value was:

4,993.1 ÷ 95 = 52.6 m³/centner

Thus, the amount of water required to produce one centner of maize grain was reduced by 41.8% under drip irrigation compared with furrow irrigation. These findings demonstrate the high efficiency of drip irrigation technology from the perspective of water conservation and agricultural productivity. The results confirm that drip irrigation not only increases crop yield but also significantly improves water-use efficiency under the meadow-serozem soil conditions of the study area.

Table 3. Yield Performance of Maize under Different Irrigation Methods

Indicator	Value	
	Drip Irrigation	Furrow Irrigation
Plant population density (thousand plants/ha)	90	75
Number of ears per plant (ears plant^{-1})	1,8	1,2
Weight of one ear (g)	180	150
Actual grain yield (centners/ha)	135	95

The actual grain yield obtained under the drip irrigation treatment reached 135 centners per hectare, whereas the control treatment produced 95 centners per hectare. The difference in yield amounted to 40 centners per hectare, corresponding to a 42.1% increase over the control. This result can be attributed to the maintenance of optimal soil moisture and nutrient availability within the root zone under drip irrigation conditions.The economic analysis also confirmed the advantages of the proposed technology. Increased crop productivity combined with reduced water consumption lowered production costs and improved the efficiency of land and water resource utilization. The adoption of drip irrigation technology resulted in additional grain yield and enhanced the economic performance of farming enterprises.

Conclusion

The results of the study demonstrated that the application of drip irrigation technology for maize cultivation under the meadow-serozem soil conditions of Buka District, Tashkent Region, is highly effective. Maintaining pre-irrigation soil moisture at 60–70–60% of field moisture capacity created favorable conditions for plant growth, development, and the formation of yield components.According to the research findings, the seasonal irrigation norm under drip irrigation amounted to 4,125.5 m³/ha, which was 867.6 m³/ha, or 17.4%, lower than that of conventional furrow irrigation. This indicates a substantial improvement in the efficiency of water resource utilization.The biometric characteristics of maize were also superior under drip irrigation conditions. Plant height, crop development, and yield component formation were significantly higher than those observed in the control treatment. This can be explained by the uniform supply of water and nutrients to the crop root zone throughout the growing season.Yield analysis revealed that the actual grain yield under drip irrigation reached 135 centners per hectare, compared with 95 centners per hectare under furrow irrigation. Consequently, drip irrigation increased grain yield by 40 centners per hectare, representing a 42.1% increase over the conventional irrigation method.Thus, the scientific results obtained in this study confirm that drip irrigation technology is an effective approach for maize cultivation under the meadow-serozem soil conditions of the Chirchik–Ohangaron Valley. The technology provides significant water savings, improves crop growth and development, and ensures higher and better-quality yields. The findings may serve as a scientific basis for improving maize production technologies and developing practical recommendations for the efficient use of irrigation water resources in the region.

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