

**EFFECT OF IRRIGATION REGIMES ON THE GROWTH, DEVELOPMENT  
DYNAMICS AND YIELD OF COTTON**

**Qodirov Zayniddin Zaripovich**

*PhD in Agricultural Sciences, Associate Professor, Bukhara State Technical  
University*

*E-mail: zayniddin91@gmail.com*

**Ulmasov Suxrobbek Xurshid o‘g‘li**

*Master’s student, Bukhara State Technical University*

*E-mail: suxrobbekolmasov@gamil.com*

**Muxlisa Zuvaydillayeva**

*Student, Bukhara State Technical University*

*E-mail: MuxlisaZuvaydillayeva@gmail.com*

**Abstract**

This article analyzes the relationship between the growth and development dynamics of cotton (*Gossypium hirsutum* L.) variety “Bukhara-10” during the vegetation period (plant height, fruiting branches, yield components, and number of bolls) and final yield under different irrigation regimes in saline-prone meadow-alluvial soils of the Bukhara region. Field experiments conducted in 2025 included 4 treatment variants with 3 replications and were evaluated based on phenological observations carried out on June 1, July 1, August 1, and September 1. The results demonstrated that differences associated with irrigation regimes emerged from the early stages of vegetation and progressively increased in a cumulative manner throughout plant development. The treatment maintaining pre-irrigation soil moisture at 70–80–65% of field capacity (FC) and applying drip irrigation according to the 3–11–1 schedule showed the highest performance: by September 1, plant height reached 102.8 cm, the total number of bolls was 14.6 per plant, and the number of opened bolls reached 9.9 per plant, resulting in the highest yield of 49.3 centners/ha (statistically significant according to LSD analysis), which was 28.7% higher than the control treatment (38.3 centners/ha). The findings indicate that growth indicators recorded during the early vegetation stages can serve as reliable predictors of final cotton yield.

**Keywords**

cotton, irrigation regime, phenological observations, growth and development dynamics, yield components, number of bolls, plant density, yield productivity, drip irrigation, LSD (Least Significant Difference), Bukhara-10 variety.

**Introduction:** Cotton productivity is a complex indicator formed as a result of the combined influence of numerous agrobiological factors, and its formation process continues throughout the entire vegetation period of the crop. Therefore, evaluation of final yield should be based not only on harvesting outcomes but also on phenological observations conducted at different growth stages, including changes in plant height, fruiting branches, yield components, and boll formation dynamics. Such an approach has important scientific

and practical significance for understanding crop development patterns and predicting final productivity. In particular, it enables the early assessment of irrigation regime efficiency and provides opportunities for timely implementation of necessary agronomic adjustments. Rational use of water resources and improvement of irrigation technologies have been identified as priority areas in the agricultural sector of the Republic of Uzbekistan in accordance with the Presidential Resolution No. PQ-4087 dated December 27, 2018, Presidential Decree No. PF-6024 dated July 10, 2020, Presidential Resolution No. PQ-107 dated April 1, 2023, and the Resolution adopted on February 5, 2026. These policy directions emphasize the importance of introducing water-saving technologies and increasing agricultural productivity under conditions of limited water availability. The purpose of this study was to investigate the growth and development dynamics of the cotton variety “Bukhara-10” under different irrigation regimes at four vegetation stages (June 1, July 1, August 1, and September 1), to determine the relationship between these dynamics and final yield performance, and to provide a scientific basis for identifying the most optimal irrigation regime.

**Materials and Methods:** The study was conducted in 2025 on the fields of the “Sherzod Toshev” farm located in the Bukhara region under conditions of meadow-alluvial soils with medium loamy texture. The groundwater table was situated at a depth of 1.9–2.2 m, with groundwater mineralization ranging from 1 to 3 g/L. Field experiments were carried out using the cotton variety “Bukhara-10” and included 4 treatment variants arranged in 3 replications. Variant 1 (control) involved conventional furrow irrigation with pre-irrigation soil moisture maintained at 70–75–65% of field moisture capacity (FMC), following an irrigation schedule of 1–3–1. Variants 2, 3, and 4 were established using drip irrigation technology. Pre-irrigation soil moisture levels were maintained at 70–75–65%, 70–80–65%, and 80–80–65% of FMC, respectively. The irrigation schedules were arranged as 3–11–1 for Variants 2 and 3, and 4–11–1 for Variant 4. Phenological observations were carried out for each treatment and replication at four vegetation stages—June 1, July 1, August 1, and September 1. Observations included plant height, number of true leaves, number of fruiting branches, number of yield components, and number of bolls. Prior to harvesting, actual plant density was determined. Final yield was calculated based on the harvested cotton yield obtained from each replication. Statistical evaluation of the experimental data was performed using analysis of variance (ANOVA) according to the methodology of B.A. Dospekhov, and treatment differences were assessed using the Least Significant Difference (LSD) test.

**Results and Discussion:** According to the phenological observations recorded on June 1, the average plant height of cotton in the control treatment was 18.7 cm, while the number of true leaves reached 7.8 per plant. In the treatments where drip irrigation technology was applied, plant height ranged from 19.5 to 21.5 cm and the number of true leaves varied between 8.2 and 8.5 per plant. Compared with the control, plant height increased by 0.8–2.8 cm and the number of true leaves increased by 0.4–0.7 leaves. These results indicate that differences associated with irrigation regimes began to emerge from the earliest stages of vegetation, although the magnitude of differences remained relatively limited at this stage.

Observations conducted on July 1 showed further differentiation among treatments. In the control treatment, cotton plant height reached 66.2 cm, the number of fruiting branches was 9.4 per plant, and the number of yield components was 8.8 per plant. Under drip irrigation conditions, plant height ranged from 69.4 to 70.4 cm, the number of fruiting branches reached 10.7–12.0 per plant, and yield components increased to 12.6–13.4 per plant. Thus, within one month, differences relative to the control expanded to 3.2–4.2 cm in plant height, 1.3–2.6 branches in fruiting branch formation, and 3.8–4.6 units in yield components. These findings confirm that the effect of irrigation regimes intensified cumulatively throughout the vegetation period. The observations recorded on August 1 demonstrated more pronounced differences in both vegetative and generative development of plants. In the control treatment, plant height reached 97.4 cm, the number of fruiting branches was 11.9 per plant, yield components amounted to 13.5 per plant, and the number of bolls reached 9.5 per plant. In drip-irrigated treatments, these indicators increased to 99.3–99.8 cm, 14.7–16.2 branches, 19.6–20.8 yield components, and 13.6–14.3 bolls per plant, respectively. The greatest difference was observed in the number of yield components (6.1–7.3 units), indicating that this growth stage plays a decisive role in determining crop yield formation potential. Final observations conducted on September 1 revealed substantial treatment effects on crop performance. In the control treatment, plant height reached 99.3 cm, the total number of bolls was 10.7 per plant, and the number of opened bolls was 6.4 per plant. In drip-irrigated Treatments 2 and 4, plant height increased to 101.2–103.5 cm, the total number of bolls reached 14.1–14.3 per plant, and opened bolls reached 9.3–9.9 per plant. The highest indicators were recorded in Treatment 3, where pre-irrigation soil moisture was maintained at 70–80–65% of field moisture capacity (FMC). Under these conditions, plant height reached 102.8 cm, the total number of bolls was 14.6 per plant, and opened bolls reached 9.9 per plant. The actual plant density determined before harvesting ranged from 90.3 to 93.7 thousand plants per hectare across all treatments. The control treatment averaged 90.6 thousand plants/ha, while Treatments 2, 3, and 4 recorded 92.1 thousand plants/ha (1.7% higher than control), 93.4 thousand plants/ha (the highest value, 3.1% higher), and 92.8 thousand plants/ha (2.4% higher), respectively. Improved plant survival under drip irrigation conditions can be explained by better soil water–air balance, more stable moisture conditions within the root zone, and enhanced resistance of young plants to environmental stress factors.

Observation Parameters	Dates /	Treatment 1 (Control)	Treatment 3 (70–80–65%)	Difference (3–1)
June 1, Plant Height, cm		18,7	~21,5	+2,8
Plant Height (cm) on July 1		66,2	~70,4	+4,2
Plant Height (cm) on August 1		97,4	~99,8	+2,4
Plant Height (cm) on September 1		99,3	102,8	+3,5

Observation Parameters	Dates /	Treatment 1 (Control)	Treatment 3 (70–80–65%)	Difference (3–1)
Yield Components (units per plant) on August 1		13,5	~20,8	+7,3
Total Bolls (number per plant) on September 1		10,7	14,6	+3,9
Opened Bolls (number per plant) on September 1		6,4	9,9	+3,5
Plant Density (thousand plants per hectare)		90,6	93,4	+2,8

Table 1. Changes in Growth and Development Parameters Throughout the Vegetation Period under Control and Treatment 3 Conditions

Yield data obtained from the replications showed that productivity in Treatment 1 ranged from 37.9 to 38.6 centners/ha (average 38.3 centners/ha), in Treatment 2 from 44.1 to 45.1 centners/ha (average 44.5 centners/ha), in Treatment 3 from 49.1 to 49.6 centners/ha (average 49.3 centners/ha), and in Treatment 4 from 46.7 to 46.9 centners/ha (average 46.7 centners/ha). According to the results of analysis of variance (ANOVA) and the Least Significant Difference (LSD) test, the differences among treatments were statistically significant, confirming that the observed variations were not random but directly associated with the applied irrigation regimes. Analysis of data collected throughout the vegetation stages demonstrated that Treatment 3 (pre-irrigation soil moisture maintained at 70–80–65% of field moisture capacity and irrigation schedule 3–11–1) produced the highest values for all growth and development indicators during the entire growing period. This treatment also achieved the highest final yield (49.3 centners/ha). The results indicate a direct relationship between the superiority in the number of yield components observed on August 1 (by 7.3 units), the greater number of opened bolls recorded on September 1 (by 3.5 bolls), and the final yield increase of 11.0 centners/ha (28.7%) compared with the control treatment. Although Treatment 4 (pre-irrigation soil moisture maintained at 80–80–65% of field moisture capacity) produced results comparable to Treatment 3 in terms of plant height and plant density (plant height reaching up to 103.5 cm), it remained inferior regarding the number of yield components and boll formation, resulting in a lower final yield (46.7 centners/ha). These findings suggest that excessive moisture may stimulate vegetative growth, particularly stem elongation, but does not contribute to the formation of generative organs (yield components and bolls) as effectively as the irrigation regime applied in Treatment 3, ultimately limiting yield performance.

**Conclusion:** The conducted research demonstrated that the growth and development dynamics of cotton throughout the vegetation period differ depending on the irrigation regime from the early growth stages, and these differences intensify cumulatively toward the end of the growing season, becoming one of the key factors determining final yield

performance. The treatment in which pre-irrigation soil moisture was maintained at 70–80–65% of field moisture capacity (FMC) and drip irrigation was applied according to the 3–11–1 schedule ensured the highest values throughout the vegetation period in terms of plant height, number of fruiting branches, yield components, number of bolls, and plant density. As a result, this treatment achieved the highest final yield of 49.3 centners/ha, representing a 28.7% increase compared with the control treatment (38.3 centners/ha), with statistically significant differences confirmed by the Least Significant Difference (LSD) test. In particular, the superiority observed in the number of yield components on August 1 (by 7.3 units) was directly reflected in the greater number of opened bolls recorded on September 1 (by 3.5 bolls), which ultimately contributed to higher final productivity. These findings indicate that phenological observations conducted during the flowering and boll formation stage (approximately around August 1) can be effectively used for early assessment of irrigation regime performance and for timely adjustment of agronomic practices when necessary. Therefore, for cultivation of the cotton variety “Bukhara-10” under meadow-alluvial soil conditions of the Bukhara region, it is recommended to maintain pre-irrigation soil moisture at 70–80–65% of field moisture capacity and to apply drip irrigation technology according to the 3–11–1 irrigation schedule.

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