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WATER DEFICIENCY EFFECTS ON GROWTH AND YIELD OF COTTON VARIETIES

Adizova Khamida Rakhimovna
Lecturer, Bukhara State University, Bukhara, Uzbekistan
E-mail: h.r.adizova@buxdu.uz

Abstract
This study investigates the physiological and biochemical indicators that determine the tolerance levels of selected medium-fiber cotton varieties to soil water deficiency. The relationship between these indicators and the specific varietal characteristics of cotton was established. Results showed that the studied cotton varieties exhibit a high degree of adaptability and resistance to water scarcity, particularly under soil drought conditions. These findings emphasize the importance of selecting appropriate cotton varieties to maintain optimal growth, leaf area development, and yield performance in water-limited environments, thereby contributing to sustainable cotton production.

Keywords: Cotton varieties, water deficiency, salinity, growth, leaf area, productivity, biological yield, economic yield.

Introduction

Cotton production is one of the leading sectors of the national economy, as cotton raw material is used to produce nearly a hundred widely consumed goods. Consequently, the demand for cotton raw materials is steadily increasing both domestically and internationally. This growing demand necessitates improvements in both the total yield and the quality of cotton produced. It is important to note that during the Soviet era, cotton production primarily developed through extensive methods, which involved increasing total yields by expanding cultivation areas. This expansion often led to the exploitation of lands with unfavorable reclamation conditions and the reduction of areas allocated to other agricultural crops, resulting in cotton monoculture dominance. As a consequence, soil fertility declined, and its physical and chemical properties deteriorated. Additionally, the efficiency of irrigated water use decreased significantly.

Currently, addressing these challenges and ensuring the sustainable development of cotton production requires a shift toward intensive production methods. This means increasing the total yield and improving its quality by maximizing productivity from existing agricultural lands. To achieve this, it is crucial to develop agrotechnical measures tailored to the morphological and biological characteristics of cotton varieties. Proper crop rotation practices, efficient use of local and mineral fertilizers, measures to combat soil erosion, restoring and enhancing soil fertility, improving soil reclamation conditions, and maintaining ecological balance are of great importance.

In Uzbekistan's cotton-growing regions, climatic conditions during the summer months (June, July, and August) are characterized by minimal precipitation and, at times, hot winds (garmsel), which contribute to severe soil water deficiency. Such adverse environmental factors coincide with the critical flowering stage of cotton, during which water scarcity and high air temperatures negatively impact physiological and biochemical processes within the plant. These stressors ultimately reduce both yield and fiber quality. Therefore, it is essential to select and cultivate cotton varieties that demonstrate resilience to these unfavorable conditions, taking into account local soil and climatic characteristics [1-3].

Given the current global water scarcity issues, the efficient use of water resources, especially freshwater sources, is of paramount importance. Introducing drought-resistant cotton varieties that maintain high biological and economic yields offers significant potential for water conservation. Furthermore, global climate change has intensified the negative impacts of atmospheric and soil drought on agricultural crops, including cotton. The reduction of water resources necessitates a deeper and more comprehensive study of the ecophysiological aspects of drought tolerance in cotton varieties [4-6].

One approach to mitigating the effects of drought is artificial irrigation. However, even irrigation cannot completely eliminate the adverse effects of drought on plants. During intervals between irrigation (particularly in June and July), high air temperatures and low relative humidity accelerate water evaporation from plant tissues and the soil surface. This leads to drying of the soil's upper layers and a reduction in turgor pressure within cotton cells, resulting in visible wilting during midday hours [7-9].

Thus, studying the protective adaptive characteristics of cotton under soil drought conditions and identifying varieties with superior drought resistance holds significant scientific and practical relevance. Such research will contribute to the development of sustainable cotton production systems that optimize water use and maintain high yields despite challenging environmental conditions.

Materials and Methods

Research Objects: The research focused on medium-fiber cotton varieties, including Bukhara-6, Bukhara-102, Bukhara-8, Okdaryo-6, and C-6524. Laboratory and field experiments were conducted using several physiological methods commonly applied in plant physiology research.

Results and Discussion

Ensuring that cotton varieties receive sufficient mineral and organic fertilizers, applying agrotechnical treatments in a timely manner, and implementing proper crop rotation can significantly mitigate the negative effects of drought [10-12]. In drought-sensitive plants, photosynthesis is negatively affected even under mild drought conditions, with severe impacts observed in drought-intolerant species and varieties. Data on photosynthesis under water-deficient conditions revealed that CO_2 diffusion becomes more active in many plants under moderate water stress. However, prolonged drought leads to a decline in photosynthetic activity, often due to increased stomatal resistance resulting from water loss [8].

Among various environmental factors, the water supply level strongly influences chloroplast function, as water is directly involved in photosynthesis. The stability of water content in chloroplasts under drought conditions determines the weight of the final yield. Moreover, chlorophyll is highly sensitive to water deficiency. Since photosynthesis is a complex process involving multiple enzymatic systems, drought can affect different stages of this process. Notably, the negative impact of drought on photosynthesis productivity in plants is not solely related to stomatal closure [13-16].

Numerous scientific studies have investigated the impact of drought on photosynthetic intensity. In many cases, reduced photosynthesis under drought conditions is attributed to stomatal closure. Additionally, temperature effects should also be considered, as drought combined with high temperatures can further influence photosynthesis. Interestingly, mild and short-term drought may partially stimulate photosynthesis, while prolonged and severe drought significantly reduces it [17-19].

Under drought conditions, the synthesis of photosynthetic products slows down, leading to increased sugar accumulation in leaves. Yield reduction in such conditions is often caused more by slowed growth processes than photosynthesis depression. While many physiological processes continue, plant growth halts [20].

Plant adaptation to adverse environmental factors occurs in three stages: excitation, resistance, and exhaustion. Prolonged exhaustion results in plant death. Reduced soil moisture slows water movement in the soil, initially slowing plant growth, which becomes the primary reason for yield reduction under drought conditions [21].

Compared to stems and leaves, roots are less sensitive to drought. Root growth continues under water-deficient conditions until soil moisture drops to the wilting point. Studies on cereal crops have shown that atmospheric drought slows cell elongation and leaf tissue differentiation, while soil drought primarily affects cell elongation.

In vegetative experiments, the growth dynamics of various cotton varieties were examined throughout their growth and development stages (budding, flowering, and boll formation). The response of plant growth to drought and their adaptive characteristics are key indicators in studying drought tolerance. The length of the main stem, directly linked to plant growth intensity, was analyzed. Growth is an irreversible process involving the formation of new cells, tissues, and plant organs, as well as increases in cell volume.

Under water-deficient conditions, slowed growth correlates with reduced photosynthetic intensity and increased respiration, leading to higher material consumption. Changes in these processes significantly impact plant productivity. Variations in drought tolerance among plant varieties should be considered when studying growth responses. Different organs and tissues exhibit varying levels of resistance, which influences overall growth reactions.

The experiments assessed the impact of two moisture levels on the growth dynamics of cotton varieties. In both moderate and limited moisture conditions, all cotton varieties exhibited the highest growth rates from the budding to boll formation stages. However,

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under limited moisture conditions, growth rates were considerably lower compared to plants grown under moderate moisture.

Overall, the growth dynamics of all studied varieties varied depending on water availability and development stages. Differences among varieties were linked to their individual biological and physiological characteristics. Bukhara-6, Bukhara-102, and Bukhara-8 varieties showed relatively lower sensitivity to soil drought compared to other varieties.

Additionally, the experiments revealed changes in leaf surface area depending on drought conditions. Leaf surface development, a crucial indicator of plant physiological processes such as photosynthesis, transpiration, respiration, mineral nutrition, and water balance, significantly affects yield and quality. The leaf surface area varied depending on the biological characteristics of the varieties and water availability. Excessively small or large leaf areas can lead to yield reduction. Optimal leaf surface development is essential for achieving high yield and quality.

Under severe drought conditions, the leaf surface area, stem growth, and dry matter accumulation in cotton plants were reduced by 80-85% compared to plants grown under moderate moisture. Previous studies have shown that leaf surface formation rates are directly influenced by drought and high temperatures. Under limited moisture conditions (30% moisture), all cotton varieties exhibited reduced leaf surface areas, with variations linked to the biological characteristics of each variety. The highest leaf surface area values were observed during the boll formation stage under moderate moisture conditions (70% soil moisture). Thus, soil drought negatively impacted leaf surface development and slowed plant growth. Among the studied varieties, Bukhara-6 and Bukhara-102 exhibited the least reduction in leaf surface area under drought conditions, while Okdaryo-6 and C-6524 showed the most significant reductions.

Conclusion

The impact of stress factors on plants varies across different growth and developmental stages. Plants exhibit the highest level of stress tolerance during dormancy, while the lowest tolerance is observed in young seedlings. As plants continue to grow and develop, their tolerance levels progressively increase until they reach the maturation stage.

Based on the conducted research, the key physiological and biochemical indicators determining the drought tolerance levels of certain cotton varieties under soil water deficiency were identified. The findings scientifically substantiate that these indicators are directly related to the specific varietal characteristics of the cotton plants.

The studied cotton varieties demonstrated a high degree of adaptability and drought tolerance, particularly under conditions of soil drought. Notably, these varieties were found to grow and develop well, producing relatively high and quality yields in the arid soil-climatic conditions of the Bukhara region.

Understanding the developmental phases, ensuring their proper progression, and recognizing conditions that may alter the normal rhythm of plant development are critical. Such knowledge is essential for accurately assessing the state of cotton plants

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and implementing appropriate agrotechnical measures tailored to specific environmental conditions.

References

1. Ergashovich, K. A., Toshtemirovna, N. U., Rakhimovna, A. K., & Abdullayevna, F. F. (2020). Effects of microelements on drought resistance of cotton plant. *International Journal of Psychosocial Rehabilitation*, *24*(2), 643-648.
2. Kholliyev, A. E., Norboyeva, U. T., Kholov, Y. D., & Boltayeva, Z. A. (2020). Productivity of cotton varieties in soil salinity and water deficiency. *The American Journal of Applied sciences*, *2*(10), 7-13.
3. Ergashovich, K. A., Toshtemirovna, N. U., Rakhimovna, A. K., & Abdullayevna, F. F. (2020). Effects of microelements on drought resistance of cotton plant. *International Journal of Psychosocial Rehabilitation*, *24*(2), 643-648.
4. Ergashovich, K. A., Toshtemirovna, N. U., Raximovna, A. K., & Abdullaevna, F. F. (2022). The properties of cotton resistance and adaptability to drought stress. *Journal of Pharmaceutical Negative Results*, *13*(4), 958-961.
5. Kholliyev, A. E Teshaeva D. R. Adaptation Characteristics of Autumn Wheat Variieties to Salinity Stresses Ra journal of applied research.- 2022.- Volume 08.- -Issue 03.P.-209-213. ISSN:2394-6709.
6. Kholliev A.E.,Danabaev A.B.Khudoyshukrov Sh.J.Bobayarov K.J.Productivity of Thin Fiber Cotton Varieties Under Conditions of Stress Factors. босмаTexas Journal of Agriculture and Biological Science .-2023.-Volume 14.-P.- ISSN: 2771-8840.
7. Kholliyev A. E., O.T. Jurayeva. The effect of moisture levels on productivity indicators of sorghum varieties in the conditions of Bukhara region. The American journal of Agriculture and Biomedical engineering (ISSN – 2689-1018) volume 06 issue03. P- 13-19. (SJIF.2024. №23).
8. Kholliyev A.E., Teshayeva D. R. Soil salinity and water exchange of autumn wheat varieties //Debats Scientifiques Et Orientations Prospectives Du Developpement Scientifique: Sur Les Materiaux la I Conference Scientifique Et Pratique Internationale.-Paris, 2021.-Volume 2.- P.-144-145. ISBN 978-617-7991-06-8.
9. Norboyeva U.T., Kholliyev A.E. Salinification influence on physiology of water exchange in cotton plant varieties (*Gossypiym Hirsutum*L.) //The Way of Science. International scientific jornal. – Volgograd: №7(41), 2017. –С. 16-18.
10. Norboyeva U.T., Kholliyev A.E. Soil salinity and saline tolerance of the sorts of cotton//Mechanisms of resistance of plants and microorganisms to unfavorable environmental. – Irkutsk, July 10-15, 2018.(PART I). –С.567- 570.
11. Norboyeva U.T., Kholliyev A.E. Water interchange and saline tolerance of the sorts of cotton.//Mechanisms of resistance of plants and microorganisms to unfavorable environmental. –Irkutsk, July 10-15, 2018. (PART I). –С.563-566.
12. Norboyeva U.T., Kholliyev A.E. Physiology, Productivity and Cotton Plant Adaptation under the Conditions of Soil Salinity. International Journal of Recent

Technology and Engineering (IJRTE) // Volume-8, Issue-2.S3, July 2019. – P. 1611– 1613.

13. Norboyeva U.T., Kholliyev A.E.Regulation of the water balance of the cotton varieties under salting conditions// ACADEMICIA: An International Multidisciplinary Research Journal. Vol. Issue 8, August 2019. – P. 5-9.
14. Kholliyev A.E., Norboyeva U.T., Boltayeva Z.A., Adizova Kh.R. 11.Ecophysiological effects of water deficiency on cotton varieties //Journal of Critical Reviews. Vol 7, Issue 9, 2020.- P. 244-246.
15. Kholliyev A.E., Norboyeva U.T., Boltayeva Z.A. Productivity of cotton varieties in soil salinity and water deficiency //The American Journal of Applied Sciences. Vol 02, Issue 10- 2020.- P. 7-13.
16. Kholliyev A E, Norboyeva U T, Boltayeva Z A, Adizova Kh R 2020 Ecophysiological effects of water deficiency on cotton varieties //Journal of Critical Reviews. Vol 7, Issue 9.- pp. 244-246.
17. Kholliyev A E, Norboyeva U T, Boltayeva Z A 2020 Productivity of cotton varieties in soil salinity and water deficiency//The American Journal of Applied Sciences.Vol 02, Issue10.-pp.7-13.
18. Kholliyev A E, Norboyeva U T, Fayziyeva F F, Adizova Kh R The properties of cotton resistance and adaptability to drought stress//Journal of Pharmaceutical Negative Results. Vol.13, Issue 4-2022.-pp. 958-961.
19. Norboyeva U T, Kholliyev A E 2019 Physiology, Productivity and Cotton Plant Adaptation under the Conditions of Soil Salinity. International Journal of Recent Technology and Engineering (IJRTE) // Volume-8, Issue-2.S3, July. – pp. 1611–1613.
20. Kholliyev A E, Norboyeva U T and others. 2021 Effects of Abiotic Factors on the Ecophysiology of Cotton Plant. International Journal of Current Research and Review.-Vol.13.-Issue04.-pp-4-7.
21. Норбоева У.Т., Холлиев А.Э. Физиологические особенности солеустойчивости и адаптации сортов хлопчатника //-Issues of modern education in the condition of globalization, Volume 2, Moscow, 2017.-№2. –С.175-178.