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ECOPHYSIOLOGICAL EFFECTS OF WATER DEFICIENCY ON COTTON VARIETIES

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Abstract
The following article deals with the data from a comprehensive study of the ecophysiological effects of water deficiency on cotton varieties. The ecophysiological features of drought adaptation of medium-fiber Bukhara-6, Aqdarya-6, Bukhara-8, C-6524 and Bukhara-102 cotton varieties studied in the conditions of vegetation and field experiments with different soil moisture levels. Levels and forms of drought adaptation and tolerance during the ontogeny of cotton varieties were analyzed comparatively.

Keywords cotton varieties, water deficiency, drought, adaptation, tolerance levels, tolerance forms, ontogeny, moisture levels productivity, yield, fiber quality.

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INTRODUCTION

Global climate change is causing an increase in air temperature in the biosphere, and hot winds caused by a sharp drop in relative humidity in the summer months are causing atmospheric and soil drought. At the present time, when the water problem is serious, it is important to introduce water-saving agro-technologies, as well as to develop methods of growing cotton varieties that are resistant to soil and atmospheric drought and have a high efficiency of water use [1,2].

The strongest negative impact of uncomfortable environmental factors, such as the atmosphere and soil drought falls on the water demanding in critical period of cotton, in the flowering stage. At the same time, the lack of water in the soil and high air temperatures together adversely affect the physiological and biochemical processes bring to a decrease of yield and quality of cotton plants. Therefore, it is important to zoning cotton varieties that are resistant to such adverse abiotic factors based on specific soil and climatic conditions [3,4].

The negative impact of drought can be reduced to some extent by providing cotton varieties with sufficient mineral fertilizers, timely agro-technical processing, and the organization of crop rotation. It is also possible to increase the resistance of plants to the adverse effects of adverse factors by applying the method of electrification.

The main problem is that the soil and climatic conditions of cotton growing areas in our country are very different. The potential of cotton varieties planted in a particular ecological zone also varies depending on the level of agro-technical processing. One of the urgent problems is the scientific substantiation of the degree of soil drought tolerance of medium-fiber cotton varieties and their protective adaptive properties in the soil and climatic conditions of the middle and lower regions of the Zarafshan region.

One of the main reasons for the decline in productivity in botany is the effect of various abiotic stressors, among which the main factors are drought and salinity. Drought is one of the strongest environmental stresses in the world, which reduces crop yields, and research in this area is of great scientific and practical importance [5,6,7].

The study and discovery of abiotic resistance mechanisms of plants in the world is one of the current theoretical and scientific problems that we are forcing nowadays. The need for such work is explained by the fact that the action of stressors requires the activation of various physiological and biochemical mechanisms to overcome the stress that occurs in plants [8, 9, 10].

Improving the agro-ameliorative condition of irrigated lands of the country, improving the applied agro-technical measures, creating and implementing varieties of agricultural crops adapted to abiotic stressors, scientifically substantiating physiological and biochemical properties of cotton varieties and their specific adaptation reactions certain results were achieved.

Subjects of the research

Bukhara-6, Aqdarya-6, Bukhara-8, C-6524 and Bukhara-102 varieties of medium-fiber cotton were used.

Methods of the research

The vegetative experiments focused on a broader study of the physiological and biochemical processes that take place in cotton varieties under conditions of moderate humidity (70 percent) and drought (30 percent). Physiological, morphological, biochemical, biometric, statistical, comparative analysis, phenological, plasmolytic, gasometric and other plant physiology and biochemistry research methods were used.

The soil of the experimental field belongs to the meadow-alluvial type, the depth of groundwater is 2-3 meters. Based on the pre-irrigation soil moisture, volumetric weight, and moisture capacity, the degree of moisture depletion in the soil was determined and irrigation standards were set.

The experimental sites were divided into 3 sections. The experiments were performed in four repetitions. The experiments were carried out on the basis of agronomic techniques adopted on farms. Fertilizers were applied during plowing, along with planting, and during plant growth (3 times). The total amount of fertilizers applied per hectare is: nitrogen-250, phosphorus-175, potassium-100 kg. Phenological observations, calculations and research on plant growth and development were carried out in accordance with the methods of UzPITI.

Determination of all physiological parameters and phenological observations were carried out in the experiments at the stages of flowering, flowering and budding of cotton. For research, a fourth leaf developed from the third part of the main stem was taken.

RESULTS OF THE RESEARCH AND ITS DISCUSSION

The climate of Uzbekistan is sharply continental, in summer the air temperature is the highest (40-45^{0}C) and its relative humidity is the lowest. In summer (June, July, August), very little rainfall and sometimes hot winds (garmsel) in turn lead to water shortages in the soil, resulting in a sharp decrease in the photosynthetic potential of cotton and other agricultural crops [11].

The dependence of the reaction of cotton varieties to soil drought on the characteristics of the variety, the level of water supply to the physiological and biochemical processes of plants, as well as the impact on yield and quality were determined. Daytime and residual water deficiency, leaf water potential, cell sap osmotic pressure, protoplasm viscosity, cell dehydration, and heat resistance levels were observed to be significantly lower in all cotton varieties grown under moderate soil moisture than in plants grown in soil drought conditions.

Soil drought has led to a relative increase in the amount of bound water in all cotton varieties, water deficiency in the leaves, protoplasmic viscosity, and dehydration and heat resistance of leaf cells. It was noted that the value of physiological and biochemical indicators of drought tolerance is highest in varieties resistant to drought. A rapid method for determining the amount of residual water deficiency and diffusion resistance, leaf binding water and bound chlorophyll in the leaves was developed and proposed to determine the resistance level of the cotton plant to soil water deficiency.

According to the results of the study, by planting drought-resistant varieties Bukhara-6, Bukhara-102 and Bukhara-8 in arid areas with high temperatures and water deficiency, it is possible to obtain high and quality crops and save irrigation water.

Changes in water balance in the body of plants are directly related to soil moisture levels, which in turn has led to varying degrees of change in physiological parameters. Variations in physiological and biochemical parameters of cotton were noted to varying degrees depending on soil moisture levels. Decreases in water potential, transpiration rate, starch, total and metabolic water, total chlorophyll levels, leaf levels, and photosynthesis rate were noted, especially in soil drought conditions. At the same time, a sharp increase in some indicators was observed. Similar correlations were observed in limited variants of soil moisture levels.

The change in the parameters studied in plants under adequate humidity was different. Soil drought firstly affects to the water balance of cotton, and changes in water balance in later stages affect the course of all physiological processes to varying degrees. At the same time, a sharp increase in the value of some physiological and biochemical indicators characterizing the drought tolerance of cotton varieties in particular was noted.

During the experiments, a decrease in the rate of transpiration in all varieties under the influence of drought and an increase in the water-retaining properties of the leaves were noted. A decrease in the total amount of water in the leaves and an increase in the amount of water bound at the same time were observed.

Daytime and residual water deficiency in the leaves and high concentrations of cell sap were found to be high under the influence of drought. Based on the results of vegetation and field experiments, it was scientifically substantiated that cotton varieties Bukhara-6, Bukhara-102, Bukhara-8 have low water potential and high resistance of leaf cells to dehydration and heat.

Under the influence of drought, a decrease in the amount of chlorophyll and a decrease in the intensity of photosynthesis were observed in all studied varieties compared to moderate humidity. At the same time, it was noted that the amount of chlorophyll bound in drought-resistant varieties Bukhara-6, Bukhara-8 and Bukhara-102 has increased.

The following changes in physiological and biomic parameters of drought-resistant Bukhara-6 were noted. That is, a slowing of transpiration rate and a decrease in water potential, an increase in total and metabolic water, an increase in total chlorophyll and photosynthesis rate, an increase in proline content, water retention properties, and an increase in bound water. Decreases in diurnal and residual water deficits, increased amounts of bound chlorophyll and cell sap concentration, osmotic pressure, and increased protoplasmic viscosity were noted. A slowing of respiratory rate, an increase in the amount of free amino acids, an increase in the amount of phenolic compounds were detected. In contrast to the drought-tolerant Akdarya-6 variety, the interrelated increase or decrease of the above indicators was scientifically proved.

The growth and development of cotton varieties is directly related to the water supply of the plants. In our experiments, it was noted that drought has a negative impact on plant growth and development, expansion of leaf surfaces and pure productivity of photosynthesis, and growth processes in general. As a result, partial shedding of crop organs and leaves was observed. The weight of cotton in one bowl, the yield and its quality decreased.

Among the studied varieties, Bukhara-6, Bukhara-102, Bukhara-8 was found to have a higher level of drought tolerance than other varieties. Experiments have shown that these varieties have the ability to use water efficiently for their growth and development. For these varieties, the mode of moderate watering is 1–2–1. In this irrigation regime, high yields and quality of these varieties were observed.

The levels of resistance and (anatomical, physiological, biochemical, habitual) forms of drought-tolerant varieties (cell, tissue, ontogenetic) were developed based on the results obtained from the studies the followings:

Among the forms of resistance during research are: anatomical - a decrease in the number of leaf cells, a decrease in leaf surface, thickening of leaves;

Physiological - the occurrence of imbalances in the water balance of plants, a decrease in the intensity of transpiration, water retention of leaves increase in metabolic water, decrease in metabolic water and increase in the amount of bound water, increase in diurnal and residual water deficiency, increase in cell sap concentration and osmotic pressure, increase in protoplasm viscosity and elasticity, decrease in water potential, increase in cell dehydration and heat resistance, decrease in total chlorophyll content an increase in the amount of chlorophyll, a decrease in the rate of photosynthesis and an increase in respiration;

Biochemical - an increase in the amount of free amino acids and proline, an increase in mono- and disaccharides, especially maltose, a decrease in the amount of starch, a decrease in total phenols;

Habitual - a decrease in the length of the main stem and branches, shedding of fruiting bodies, activation of the opening of the cocoons, shortening of the growing season, net productivity of photosynthesis, decrease in the weight and quality of biological and economic yields, etc.

Based on the results obtained during the experiments, the laws of protective adaptation of cotton to drought at the cellular, tissue and ontogenetic levels were determined. Physiological and biochemical comparative characteristics of drought adaptation have been developed based on the mechanisms of physiological adaptation of cotton to drought , as reduction of water consumption, accumulation of low molecular weight osmotic protectors, changes in metabolism increased water use efficiency.

CONCLUSION

Based on the above data, in the years of water scarcity, atmospheric and soil drought, the use of a rapid method of increasing resistance to drought has led to an increase in drought tolerance, yield and quality of cotton varieties. It was recommended to sow Bukhara-6, Bukhara-102, Bukhara-8 varieties of cotton, which are drought-resistant, high yield and high quality, in order to obtain high-quality yields in cotton farms of drought-prone areas. High-quality yields of Bukhara-6, Bukhara-102 and Bukhara-8 cotton varieties were determined in 1-2-1, C-6524, Akdarya-6 sorts 1-3-1 irrigation, and the yield of cotton variety Bukhara-6 in the sort 38.4– 40.7, Bukhara-102 varieties 37.5–38.5 and Bukhara-8 varieties 35.3–36.4 quintal, based on which the fiber quality meets international standards.

A rapid method for determining the resistance of cotton plants to soil water scarcity has been developed and put into practice. It is recommended to plant drought-resistant and high-yielding varieties of cotton Bukhara-6, Bukhara-102 and Bukhara-8 in order to obtain high-quality crops in cotton farms located in the middle and lower regions of the Zarafshan region, where soil drought was observed.

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