Original Article

The Properties of Cotton Resistance and Adaptability to Drought Stress

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Abstract

The article presents data obtained based on the study of physiological and biochemical processes of drought tolerance of cotton varieties and physiological indicators of protective adaptation. The study aims to determine the degree and form of protective adaptation of cotton varieties to soil drought based on the physiological and biochemical properties of water exchange, as well as to develop methods to increase drought tolerance. To obtain a high and high-quality yield in cotton farms located in the middle and lower regions of the Zarafshan oasis (Uzbekistan) and in areas where drought is observed, drought-resistant and adaptive features, the possibility of growing varieties of Bukhara-6, Bukhara-102, Bukhara-8 cotton with high yield and quality, as well as conclusions, suggestions and recommendations.

Keywords: Cotton, Drought, Stress, Diffusion Resistance, Transpiration, Metabolic and Bound Water, The Cell Sap, Water Deficiency, Endurance, Adaptation.

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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. In the current period of serious water problems, 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 adverse environmental factors, such as the atmosphere and soil drought, falls on the water-demanding-critical period of cotton, i.e. the flowering stage. At the same time, due to the lack of water in the soil and high air temperatures together adversely affecting the physiological and biochemical processes that take place in the cotton, the yield and its quality decrease. Therefore, it is important to zoning cotton varieties that are resistant to such adverse factors based on specific soil and climatic conditions [3,4,5].

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 electrification method [6,7].

The urgency of the above problem is that the soil and climatic conditions of the 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 current problems is the scientific substantiation of the degree of soil drought tolerance of medium-fibre cotton varieties and their protective adaptive properties in the soil and climatic conditions of the middle and lower regions of the Zarafshan oasis [8,9,10].

Research is being conducted around the world on the selection of varieties with high yield and quality and drought tolerance, including based on the following priorities: the creation of cotton varieties with beneficial economic characteristics, resistance to adverse environmental factors; increase in the adaptive capacity of cotton; development of scientifically based recommendations for planting in areas with water shortages with different soil and climatic conditions; identification of drought and salt-tolerant genotypes based on selection and molecular methods; development of methods to increase the resistance of plants through the use of biologically active substances and trace elements [11,12].

Bukhara-6, Aqdarya-6, Bukhara-8, S-6524 and Bukhara-102 varieties of medium fibre cotton were used as the object of research. The study aims to determine the degree and form of protective adaptation of cotton varieties to soil drought based on the physiological and biochemical properties of water exchange, as well as to develop methods to increase drought tolerance.

Research tasks are seed germination rate under different soil moisture conditions, amount of water forms in leaves, transpiration rate, leaf diffusion resistance, diurnal and residual water shortages, water potential and turgor resistance of leaves, determination of proline and carbohydrate content in leaves, the number of chlorophylls and the degree of their binding to protein-lipid compounds, photosynthesis and respiratory rate, determination of the number of free amino acids and phenolic compounds and the growth of cotton varieties of soil drought, determine the impact on development and productivity, as well as to study and apply the effect of the electrification method on the yield and its quality to increase the drought resistance of cotton.

Materials and Methods

The soil of the experimental field belongs to the alluvial meadow type, the depth of groundwater is 2-3 meters. Based on the pre-irrigation soil moisture, bulk density, and moisture capacity, the degree of moisture deficiency 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 based on agro-techniques adopted on farms. Fertilizers were given during ploughing, along with planting, and during plant growth (3 times). The total amount of fertilizers applied per hectare is nitrogen-250, phosphorus-175, and potassium-100 kg. Phenological observations, calculations and research work on plant growth and development were carried out in accordance with the methods of the Uzbek Cotton Research Institute (UzCRI). Determination of all physiological parameters and phenological observations were carried out in the experiments during the stages of weeding, flowering and germination of cotton. A fourth leaf developed from the third part of the main stem was taken for the study.

Physiological and biochemical processes of drought tolerance of cotton varieties and indicators of protective adaptive properties were determined using methods generally accepted in plant physiology and biochemistry.

Results and Discussion

During scientific studies, the diffusion resistance of cotton leaves under conditions of varying soil moisture levels was studied during the mowing, flowering, and budding stages of the plant. Diffusion resistance of leaves is an indicator of plant photosynthetic productivity, which is inextricably linked with transpiration intensity and is one of the protective adaptive reactions of plants to drought [13,14].

The diffusion resistance of the leaves increased in all variants of the cotton from the combing to the budding stage. As the soil moisture level decreased, the diffusion resistance of the leaves also became higher. It was observed that the value of diffusion resistance was higher in the experimental variant with 30% soil moisture than in the other variants.

Leaf diffusion resistance increased by 27.2% in the experimental variant with 50% soil moisture and 57.1% in the experimental variant with soil moisture at 30% compared to the control stage. In the flowering stage, it was 13.2 and 38.6 per cent, respectively, and in the flowering stage, it was 20.3 and 39.8 per cent. Carbohydrate metabolism plays an important role in increasing the resistance of plants to drought and high temperatures. During the experiments, the amount of glucose, sucrose, maltose and starch in the flowering stage of the cotton plant was determined. Under moderate soil moisture conditions, a decrease in glucose content compared to other options was observed, and under the influence of drought, a sharp increase in glucose content was observed.

In the variant with 30% soil moisture, glucose levels were found to be 147.5% higher than the control. In the context of soil drought, sucrose was 140.2% higher than the control. In particular, in the variant with soil moisture of 30%, the value of maltose reached 284.6% compared to the control.

The decrease in soil moisture level also led to a decrease in the amount of starch. Soil moisture was higher in the moderate variant than in both experimental variants. The reduction in starch content in the variant with 50% soil moisture compared to the control was 68.3%, and in the variant, with 30% soil moisture was 49%. Taking into account the sum of the detected carbohydrates, it was noted that their content increased by 127.3% compared to the control in the conditions of soil drought. In the variants with soil moisture of 70 per cent, the total water content in all-cotton varieties, including free water, was also high, but the amount of bound water was low. At 30 per cent humidity, the opposite was true.

In all cotton varieties, a decrease in total and metabolic water content, and an increase in the amount of bound water, from mowing to weaning under two different humidity conditions were found. Under conditions of limited humidity (30 per cent), there are significant differences in the amount of bound water compared to varieties in moderate humidity (70 per cent). Differences were also observed in the cross-section of varieties in terms of the amount of water-bound. Especially Bukhara-6, Bukhara-102 varieties differ from other varieties due to the high amount of bound water.

In addition to the daytime water shortage in the leaves of cotton varieties, residual water deficiency was also studied during vegetation experiments. Looking at the data obtained on the amount of residual water, it was observed that its value depends on the level of soil moisture and the stages of development of varieties. It was found that the value of residual water deficiency was high in all varieties under conditions of limited soil moisture (30 per cent). It was noted that the value of this indicator varies across varieties. In the conditions of soil drought, the value of residual water shortage was the highest in the varieties Aqdarya-6 and S-

6524, and the lowest in the varieties Bukhara-6 and Bukhara-102. For invariants with moderate soil moisture levels, the value of this indicator decreased. It was noted that the concentration of cell sap of Bukhara-6, Bukhara-102 and Bukhara-8 varieties is higher than in other varieties under both humidity conditions. Such a feature may be one of the protective properties aimed at providing plants with more water even in adverse conditions. A decrease in soil moisture level affected an increase in osmotic pressure in the cells. In all varieties from the beginning to the end of the vegetation was observed a different increase in the value of this indicator.

The amount of chlorophyll and the degree of its binding to protein-lipid compounds were also studied, and it was noted that the total and bound chlorophyll content is higher in Bukhara-6, Bukhara-102 and Bukhara-8 varieties in soil drought conditions. Based on the results of laboratory, vegetative and field 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 - reduction of water consumption, accumulation of low molecular weight osmoprotectants, changes in metabolism, increased water use efficiency.

Due to the positive effects of electrification on the physiological and biochemical and water exchange processes, it was found that due to the increase in water storage, reduction of diurnal and residual water shortages, drought tolerance of cotton, yield and its quality increased in soil moisture deficiencies. and a rapid method for determining diffusion resistance, bound water in leaves, and amount of bound chlorophyll were developed.

To obtain a high and high-quality harvest in cotton farms located in the middle and lower regions of the Zarafshan oasis (with arid soil), drought-resistant and high-yielding cotton varieties Bukhara-6, Bukhara-102 and Bukhara-8 have been introduced. A rapid method for determining the resistance of a cotton plant to soil water scarcity has been developed and recommended for use. The use of electro-ignition methods to increase the drought tolerance, yield and quality of cotton varieties has been introduced. The scientific significance of the results of the study serves to develop the physiological and biochemical basis of adaptation of cotton varieties to different types of cellular, tissue and ontogenetic levels of protective responses and adaptation to soil drought, depending on the degree of soil drought. Drought-resistant varieties Bukhara-6, Bukhara-102 and Bukhara-8 were planted in arid areas with high temperatures and water shortages.

Conclusion

The laws of protective adaptation of cotton to drought at the cellular, tissue and ontogenetic levels were determined, physiological, biochemical, habitual forms of drought tolerance of varieties depending on soil moisture level were scientifically based and on this basis a model of drought-tolerant cotton varieties was created.

Physiological and biochemical comparative characteristics of drought adaptation have been developed based on the mechanisms of cotton adaptation to drought - reduction of water consumption, accumulation of low molecular weight osmoprotectants, changes in metabolism, and increased water use efficiency.

The reaction of cotton varieties to soil drought depends 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.

All cotton varieties grown under conditions of moderate soil moisture were observed to have significantly lower daytime and residual water shortages, leaf water potential, the osmotic pressure of cell sap, protoplasm viscosity, cell dehydration, and heat resistance than plants grown under soil drought conditions. Soil drought has led to a relative increase in the amount of bound water in all-cotton varieties, water scarcity 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 in the leaves, the amount of bound water in the leaves, and the amount of bound chlorophyll was developed and proposed to determine the degree of resistance of the cotton plant to soil water deficiency. In years of water scarcity, and atmospheric and soil drought, the use of environmentally friendly electrification methods 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, to obtain high and high-quality crops in cotton farms in drought-prone areas. High-quality and high-quality yields in Bukhara-6, Bukhara-102 and Bukhara-8 cotton varieties were determined in the order of 1-2-1, S-6524, Akdarya-6 varieties in the order of 1-3-1 irrigation, and cotton yield in Bukhara-6 variety were 38.4–40.7, Bukhara-102 variety 37.5–38.5 and Bukhara-8 variety 35.3–36.4 quintals, based on which the fibre quality meets international standards.

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