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Rate of Photosynthesis and Features of Adaptation to Salinity of Cotton Varieties in Saline Soil Conditions

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Abstract:
This article presents information on the effect of salinity on the rate of photosynthesis of cotton varieties grown over large areas of Uzbekistan. It was found that the rate of photosynthesis of the studied cotton varieties depends on the level of salinity. It was noted that the Bukhara-8 cotton variety is more resistant to salinity than the S-6524 variety. According to the scientific results obtained, salinity sharply reduced the rate of photosynthesis of both varieties. Among the studied varieties, it was found that the rate of photosynthesis in the Bukhara-8 variety is higher than in the S-6524 variety.

Keywords: cotton varieties, soil salinity, photosynthesis rate, productivity, endurance.

Introduction

One of the main challenges facing world agriculture is that by 2050, more than 70 per cent of additional food products will need to be produced for another 2.3 billion people worldwide [1,2].

Due to natural causes and certain farming methods, the proportion of agricultural land with high salinity is increasing rapidly worldwide [3,4,5].

Global climate change, salinization of irrigated areas, and problems related to population growth and the expansion of saline areas threaten public health, national economy, and ecology. In this regard, one of the urgent scientific problems is to study the salt tolerance mechanisms of plants and to reveal them. Deepening the knowledge in this field creates the necessary conditions for the development of methods of selection, transgenesis and the use of physiologically active substances in increasing the salt tolerance of plants [6,7].

Unfavorable abiotic factors affect the growth and development of plants, which leads to a significant decrease in productivity [8,9].

Salinity has a negative effect on the plant's photosynthesis process and photosynthesis apparatus. There are several reasons for the decrease in photosynthesis during salinity. First, a decrease in water potential, loss of turgor of oral cells and, as a result, a decrease in carbon dioxide absorption, etc.

Various forms of abiotic stress, including salt stress, accelerate the production of CFS. Therefore, excessive concentration of sodium chloride causes osmotic stress, which is manifested by the slowing down of photosynthesis, the activation of respiration in the light, and the increase in the production of CSF [10,11,12,13].

Soil salinity levels are one of the adverse factors that reduce plant growth and development,

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enzyme activity, and photosynthesis rate, negatively affecting agricultural production [15,16,17].

The development of cotton cultivation in areas with saline soil is very difficult. An increase in soil salinity has a negative effect on the germination, growth and development of cotton seeds. In this case, all the physiological processes in the cotton plant, including water balance, assimilation of mineral nutrients, photosynthesis, etc., change dramatically. As a result, the overall photosynthetic productivity of cotton, including the weight of the biological and economic harvest, decreases, and its quality deteriorates.

Accumulation of salts in cells poisons the protoplasm and slows down all synthetic processes, photosynthesis and protein synthesis. Ammonia is released from the breakdown of proteins. As a result, ammonia accumulates in tissues and poisons them. Plants adapted to saline soil are less affected. Under the influence of salinity, the physical and chemical properties of the colloids of cotton cells, and the processes of substance exchange change [18,19].

Therefore, according to the sources of scientific literature mentioned above, the problems of soil salinity are one of the unpleasant environmental problems. Salinity has a negative effect on all physiological, biochemical, morphological and anatomical characteristics of plants, and at the last stage reduces the biological and economic yield of plants and their quality. Salinity affects plant growth and development in a variety of ways. First, there are changes in the water exchange of plants, as a result of which the speed of photosynthesis slows down, and the amount of water in the tissue and cells decreases. In addition, soil salinity affects the biochemical composition of plants, including the concentration of proteins, amino acids, sugars, carbohydrates and other compounds.

Soil salinity is a major abiotic stress that limits plant growth and productivity in major areas of the world, and it has negative effects on flora. The question of adaptation or resistance of plants to salt stress is related to the complex physiological characteristics and the activity of metabolic processes. Under the influence of salinity, harmful salts accumulate in the cells and tissues of plants, which have a negative effect on all its osmotic properties. According to the given data, one of today's problems is to increase the tolerance and resistance of plants to soil salinity levels and their resistance to such adverse environmental factors.

It is known that as a result of the effect of salinity on plants, the growth and development of plants slow down and overall productivity decreases. The main reason for this may be a change in the relationship between the processes of photosynthesis and respiration in plants. As a result of these processes, the plant should not only be supplied with energy but also with metabolites necessary for various biosynthetic processes, which are the main criteria for growth, development and productivity.

In a saline environment, the rate of photosynthesis in plants slows down, and the overall photosynthetic activity of plants decreases [20,21,22].

Research Objects and Methods

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Bukhoro-8 and S-6524 varieties, which belong to the group of medium-fibre cotton varieties, were used as the object of research. Currently, these varieties are planted in large areas in several regions of our republic. During the experiments, grassland-alluvial soils common in the region were used. Such soils form the main areas of the Bukhara region.

Before carrying out the experiments, fields with non-saline, weak, medium and strong salinity were determined.

Soil salinity levels were also taken into account when conducting field experiments.

In the text and tables of the work, variants with weak soil salinity-experiment-1; abbreviated as medium-salinity-variants-experiment-2 and high-salinity-variants-experiment-3.

In the experiments, the water deficit of the soil was studied by determining the soil moisture before irrigation, its volumetric weight and field moisture capacity, and irrigation was carried out. All experiments were conducted under conditions of 70 per cent humidity with moderate soil moisture. The seeds were sown in rows at an interval of 60 cm. The average number of bushes in experimental areas was 90-95 thousand per hectare. The area of the experimental sites was 0.5 hectares, and the total amount of fertilizers applied per hectare was 225 kg of nitrogen, 170 kg of phosphorus and 90 kg of potassium. All observations, measurements and research work on the growth and development of plants were carried out in accordance with the methods of UzPITI.

In the conducted experiments, the rate of photosynthesis, which characterizes adaptation and resistance of plants to adverse factors, salinity, was studied: The rate of photosynthesis was determined by the half-leaf method.

Results and Discussion

The processes of photosynthesis and respiration in plants largely depend on the type of salinity in the soil. The rate of photosynthesis and respiration in cotton grown in sulfate salinity is much higher than in chloride salinity. Depending on the salinity, the amount of chlorophyll in the leaves changes dramatically, as does the rate of photosynthesis.

The main function of chloroplasts is to participate in the process of photosynthesis. Salinity, in turn, has a negative effect on the photochemical activity of chloroplasts. As a result, the synthesis of chlorophyll slows down and the overall productivity of plants decreases.

The amount of salts in the soil has a negative effect on the rate of photosynthesis, as a result, the accumulation of dry matter in cotton and the rate of photosynthesis are also slowed down. The rate of accumulation of dry matter by plants is one of the characteristics of cotton's salt tolerance. In conditions of soil salinity, the rate of accumulation of dry matter is higher in cotton varieties and species that are resistant to salt than those that are not resistant.

Sufficient water supply of plants has a positive effect on the rate of photosynthesis. Being in a turgor state of cells ensures the active functioning of plastids. Otherwise, the rate of photosynthesis and overall photosynthetic productivity of plants will decrease.

The rate of photosynthesis was studied in the tillering, flowering and boll stages of Bukhara-8 and S-6524 cotton varieties.

According to the data obtained on the speed of photosynthesis, the value of this indicator

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was found to be different depending on the soil salinity levels, growth and development stages of cotton.

Photosynthesis increased rapidly in all control options, and a decrease in the value of this indicator was found in both varieties in weak, medium and strong soil salinity conditions. In all variants of both cultivars, the rate of photosynthesis was low in the tillering stage, its rate was much higher in the flowering stage, and its rate decreased relatively when going to the flowering stage. At the flowering stage of the Bukhara-8 variety, the rate of photosynthesis was 2.26 g/m2 hour. Also, in an experiment-1 variant of this variety, the rate of photosynthesis was 94.2 per cent compared to the control. Also, the value of this indicator was 84.9 per cent in the experiment-2 option and 74.7 per cent in the experiment-3 option.

At the flowering stage of cotton variety S-6524, the rate of photosynthesis in the experiment-1 variant was 84.9 per cent compared to the control. In the experiment-2 variant, the rate of photosynthesis decreased to 75.6% compared to the control, and in the experiment-3 variant of this variety, the rate of this indicator decreased to 61.0%.

Also, in both cultivars, the rate of photosynthesis slowed down with increasing salinity. The rate of accumulation of dry matter by plants can be considered as one of the characteristics of their salt tolerance and adaptation.

In a highly saline environment, chlorophyll breaks with chloroplast proteins. As a result, the green colour of the leaves disappeared and yellow spots were formed, and it was found that the amount of chlorophyll and, in turn, the rate of photosynthesis decreased in the cotton varieties grown in saline environments.

Based on the obtained data, it was found that the rate of photosynthesis in both studied varieties is different depending on the salinity level of the soil, the stages of growth and development of the varieties, and the biological and individual properties of the varieties.

With increasing salinity, the rate of photosynthesis slowed down in both cultivars. Differences were also found between the varieties according to the value of this indicator. In conditions of soil salinity at different levels, a high rate of photosynthesis was observed in the Bukhoro-8 variety.

In general, according to the obtained data, the rate of photosynthesis in the section of varieties was directly related to their growth and development stages and soil salinity levels. Under natural conditions, even the accumulation of harmless salts increases the osmotic pressure of the soil solution. As a result, physiological drought is observed in the soil, which makes it difficult for plants to be supplied with water. In such conditions, although there is enough water in the soil, plants cannot meet their water needs. Therefore, it is important to study the degree of tolerance of cultivated and promising cotton varieties to one or another level of salinity.

Conclusions

It was found that the rate of photosynthesis of cotton varieties depends on the level of soil salinity. Among the studied varieties, it was found that the Bukhoro-8 variety of cotton is more resistant to soil salinity than other varieties, and the S-6524 variety is not resistant to

salinity. Soil salinity dramatically reduced the photosynthetic rate of both cotton cultivars studied.

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