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Effects of Abiotic Factors on the Ecophysiology of Cotton Plant

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ABSTRACT

Background: During the experiments, medium-fibre cotton varieties Bukhara-8, Omad and S-4727, as well as different types of saline meadows - alluvial, red-brown and desert-sandy soil types were used. Objective: To verify the scientific substantiation and production of physiological and ecological features of the Bukhara oasis in different saline meadows as alluvial, grey-brown and desert-sandy soil types, reflecting the effect of salinity and moisture levels on the valuable characteristics of cotton varieties are considered as the aim of the investigation.

Method: The experiments were carried out in the fields of meadow-alluvial, red-brown and desert-sand types. Along with several indicators that determine the growth and development of cotton, depending on soil types and salinity levels, an increase in total water content in leaves, respiration rate, cell sap density, plant water deficit, and protoplasmic viscosity was found.

Result: Growth in height, expansion of leaf surface, number of joints, joint length, yield, fibre yield, fibre length, decrease in weight of 1000 seeds were detected. Recommendations for the production of scientifically based ecophysiological features of the impact of salinity and moisture levels on the valuable traits of cotton varieties Bukhara-8, Omad and S-4727 in the conditions of saline meadows of all levels of the Bukhara oasis - alluvial, grey-brown and desert-sandy soils.

Conclusion: Based on the data obtained, it was noted that all indicators of Bukhara-8 variety are higher than S-4727 and Omad varieties.

Key Words: Abiotic factors, Cotton varieties, Soil salinity, Respiration, Photosynthesis rate, Protoplasmic viscosity, Water deficiency, Pure productivity of photosynthesis, Adaptation

INTRODUCTION

The main tasks of land reclamation in the world are to increase soil fertility by reducing salinity, to obtain high and quality crops from crops and to develop protected lands. Systems of reclamation measures are different for regions with different natural conditions, which requires the development of science-based measures and in-depth study of soil properties.^{1,2} The rational and efficient use of land in the field of agriculture has always been a major issue in the world. This is especially due to the steady increase in population and demand for food. The search for non-traditional methods and sources of increasing water resources, irrigation of crops grown in the irrigated area from planned water resources, timely and proper implementation of saline soils and other agro-ameliorative methods, scientific-practical bases of water use, norms and technologies are being created.^{3,4}

In Uzbekistan, it is important to accelerate agricultural production gradually, rational use of land resources, development of solutions to problems related to increasing the productivity of plants per hectare of irrigated land, and its economic efficiency as well. In this regard, one of the important tasks is to maintain soil fertility and to increase it regularly from year to year.^{5,6}

It has a great scientific and practical substantiation of the issues against saline soils, improvement of the ameliorative and ecological condition of irrigated lands, as well as scientific substantiation of physiological and ecological features of the Bukhara oasis, reflecting the effect of salinity and moisture levels on valuable traits of cotton varieties in soil salinity and different soil types.^{7,8}

As a result of salinization processes observed in different regions of the country and different soils, leading to disruption

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of the agronomic structure of soils, the yield and quality of cotton is being declined. Therefore, nowadays one of the demanding direction is the creation of a scientific basis for the efficient use of water in the conditions of soil salinity and water scarcity.

MATERIALS AND METHODS

Subjects of the research

Bukhara-8, Omad and C-4727 medium-fibre cotton varieties, as well as alluvial, grey-brown and desert-sandy soil types with different levels of salinity were used during the research.

Procedure

The experiments were conducted in the scientific laboratory and training field of Bukhara State University and the fields of farms of Karakul and Jondor districts. The experiments were carried out in meadow-alluvial, red-brown and desert-sandy fields. The depth of groundwater was 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.

In all field experiments, soil water deficit was studied and irrigation was carried out by determining soil moisture before irrigation, its volumetric weight and field moisture capacity. All experiments were performed under 70 per cent humidity conditions where soil moisture was moderate. In some experiments, soil moisture was kept at 70-75-70, 65-70-65, 60-65-60 per cent of the total moisture capacity. Seeds were planted in rows at 60 cm intervals.

During our research, salt regimes were studied in the Bukhara oasis, taking into account the formation of medium, strongly saline soils and the specificity of the processes of salt accumulation in saline soils. Also, during the experiments, agrochemical, agrophysical properties and other indicators of meadow-alluvial, grey-brown and desert-sandy soils, which are widespread in the Bukhara oasis, were identified. Soil salinity levels were also taken into account during field experiments.

The influence of agro-ecological factors on the growth and development of certain physiological parameters, growth and development of cotton varieties was determined using generally accepted methods in the field of plant physiology and biochemistry and soil science. Phenological observations, calculations and research on plant growth and development were carried out following the methods of UzPITI.

Determination of all physiological parameters and phenological observations were carried out in the experiments during the stages of budding, flowering and germination of cotton.

A fourth leaf developed from the third part of the main stem was used for the study. In the laboratory, the valuable economic characteristics of each variety of plants as fibre yield, fibre length, the weight of a thousand seeds and other indicators were determined.

In the Bukhara oasis, the mechanical composition, salinity and other indicators of the most common and varying degrees of salinity meadow-alluvial, grey-brown and desert-sandy soil types were determined.

RESULTS

Salinization processes in soils with different mechanical composition, distributed in irrigated micro and nano relief forms were observed in the form of seasonal staining and permanent staining, as well as total salt content (dry residue), HCO_3^- , Cl^- , SO_4^{2-} ions, Ca^{++} , Mg^{++} and Na^+ cations and easily soluble salts (MgSO_4 , Na_2SO_4 , NaCl), formed from their compounds, differ in composition and amount. The pH indication of soils has low-alkaline, fluctuating around 7.21–7.43 on the soil horizon. The total amount of carbonates in the soil profile was 6.78–9.67%.

In former irrigated meadow-alluvial soils, humus content in the topsoil is 1.09-1.39%, and in the middle and lower horizons the quantity does not exceed than 0.93-0.47%. The amount of nitrogen in the soil profile was also 0.098-0.044% and it was noted that the amount of humus gradually decreased from the upper layer to the lower horizon. An increase in total water content was found in all three varieties studied with increasing salinity in the environment. The value of this indicator peaked, especially in strongly saline conditions.

The experiments were carried out in three different soil conditions, as meadow-alluvial, red-brown and desert-sandy soils during the budding and flowering stages of cotton varieties. It was found that the value of this indicator varies depending on the soil type. It was observed that the total amount of water in all three varieties increased from the stage of flowering to the stage of flowering. It was noted that the total amount of water in cotton varieties grown in meadow-alluvial soil conditions is higher than in cotton varieties grown in brown and desert-sandy soils.^{2,3}

The rate of photosynthesis is one of the most important physiological processes, and plant growth and development, total photosynthetic productivity, biological and economic yield, and yield and its quality depend on the value of this process. From the data obtained during the experiments, it was found that soil salinity has a negative effect on the rate of photosynthesis. The effect of soil salinity levels on the rate of photosynthesis was studied in three different soil conditions during the mowing and flowering stages

of cotton varieties. With the increase in salinity levels, a decrease in the value of this indicator was also observed during the flowering and flowering stages of the three varieties. It was noted during the experiments that the value of this indicator has the lowest value in strongly saline soils compared to non-saline soils.^{4,6,7}

The rate of photosynthesis in Bukhara-8 cultivars grown in meadow-alluvial soils is 1.33 g in non-saline soils, 1.45 g in the flowering stage, 1.28 g in weakly saline soils, 1.37 g in flowering, 1.21 g in moderately saline soils, 1.33 in flowering, 1.12 g during mowing in strongly saline soils, and 1.24 g during flowering. The rate of photosynthesis of Omad cultivar grown in meadow-alluvial soils is 1.15 g in non-saline soil during mowing, 1.25 g in the flowering stage, 1.06 g in low salinity soil, 1.18 g in flowering, 1.00 g in medium saline soil, 1.10 g in flowering, in strongly saline soils it was 0.65 g during mowing and 0.86 g during flowering. The rate of photosynthesis of C-4727 cultivated in meadow-alluvial soils is 1.24 g in non-saline soils during mowing, 1.34 during flowering, 1.17 g in low salinity soils, 1.28 g in flowering, 1.10 g in medium saline soils, 1.22 in flowering, and it was 0.90 g at the time of mowing in strongly saline soils and 1.10 g at the stage of flowering.

A similar correlation was observed in the red-brown and desert-sandy soils. However, the photosynthesis rate of cotton varieties grown in meadow-alluvial soils was higher in all three varieties than in these soils. Experiments have shown that the rate of photosynthesis of cotton varieties grown on light brown soils is higher than the rate of photosynthesis of cotton varieties grown on desert-sandy soils. In the non-saline variants of desert-sandy soils, the net productivity of photosynthesis at the mating stage of Bukhara-8 variety was 6.9, at the flowering stage 8.3, at the mowing stage of Omad variety 5.6, at the flowering stage 6.6, at the mowing stage C-4727 was 5.8, and flowering was 7.1 at the stage. Similar correlations were found in weak, moderate, and strongly saline conditions of meadow-alluvial, grey-brown, and desert-sandy soils, but it was noted that the value of the net productivity of photosynthesis was higher in meadow-alluvial soils. In our study, it was found that the net productivity of photosynthesis in all three species decreases with increasing salinity compared to non-saline variants. A sharp decrease in the value of this indicator was observed in all varieties, especially those grown in strongly saline desert-sandy soils. Luckily, a sharp decline in the pure productivity of photosynthesis was noted.

During the field research, the effect of soil moisture levels and soil types on the yield of cotton varieties was studied. It was noted that the yield of cotton varieties studied was higher than the variants grown in meadow-alluvial soils, grey-brown and desert-sandy soils, depending on soil types and soil moisture level and salinity. A decrease in yield

weight was observed following the decrease in moisture level. Especially in the variants with soil moisture 60-65-60, a sharp decrease in yield was noted. Yield in all varieties was high in 70-75-70 percent humidity. The lowest results in terms of yield of cotton varieties were recorded in the conditions of humidity of 60-65-60% of desert-sandy soils.

In pasture-alluvial soils, the yield of Bukhara-8 cotton variety ranges from 39.2 to 37.6 with a decrease in moisture levels; the Omad variety 36.0-34.0; the C-4727 weighed 37.4-35.5 quintals. Yields of Bukhara-8 cotton variety in red-brown soils range from 38.2 to 35.9 with a decrease in moisture levels; the Omad variety 35.3-33.2; the C-4727 weighed 36.6-34.3 quintals. In desert-sandy soils, the yield of Bukhara-8 cotton variety is 36.9-33.0 with a decrease in moisture levels; the Omad variety 33.5-31.2; the C-4727 weighed 34.8-32.9 quintals. Under moderately saline conditions, the yield of all cotton varieties decreased to varying degrees depending on moisture levels.⁸

At different levels of humidity with moderate soil salinity, crop quality indicators were higher in meadow-alluvial soils than in brown and desert-sandy soils. In the above three different soil types, high results on this indicator were recorded in cotton varieties Bukhara-8 and C-4727.

DISCUSSION

Moderate leaching of strongly saline soils has led to a sharp reduction in the amount of dry residue, Cl^- and SO_4^- ions in the soil layer and groundwater, according to the study. As a result, toxic salts such as NaCl , Na_2SO_4 and MgSO_4 in strongly saline soils were washed away to groundwater and the area of saline soils distributed in the field experimental plots was reduced by 80-90%. The salinity of Bukhara-8, Omad and C-4727 cultivars studied in different saline soils of the Bukhara oasis, as well as the level of growth and development, the amount of dry residue, is 0.35-0.50%, Cl^- ion 0.007-0.015% and SO_4^- a decrease of 0.010-0.550% was observed.

The effect of soil types and salinity levels on some ecophysiological characteristics of cotton varieties studied in different saline soils was found to vary within varieties. It was noted that depending on soil types and salinity levels, the total amount of water in the leaves, the rate of respiration, the density of cell sap, the lack of water in plants, an increase in protoplasmic viscosity. The value of all indicators studied was found to be higher in all (weak, moderate, strong) saline options compared to the non-saline options. Variations in the value of physiological parameters to varying degrees depending on the biological characteristics of the varieties have been scientifically substantiated.

CONCLUSION

Soil salinity levels in all studied varieties led to a slowdown in photosynthesis intensity and photosynthesis net productivity value depending on soil types. It was observed that the value of the studied physiological parameters of cotton varieties differs in the cross-section of varieties depending on soil types, soil salinity levels and stages of development. Based on the data, it was noted that all physiological parameters of Bukhara-8 variety are higher than C-4727 and Omad varieties. In the Bukhara oasis irrigated meadow-alluvial, red-brown and desert-sandy soils, the valuable features of cotton varieties studied in different salinity soils differ in height, growth, leaf surface expansion, the number of joints, joint length, yield, fibre yield, fibre length, 1000 seed weights were found to vary depending on soil salinity and moisture level.

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