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INFLUENCE OF SODIUM CHLORIDE ON PHYSIOLOGICAL AND BIOCHEMICL CHARACTERISTICS OF WHEAT GENOTYPES

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ВЛИЯНИЕ ХЛОРИДА НАТРИЯ НА ФИЗИОЛОГИЧЕСКИЕ И БИОХИМИЧЕСКИЕ ХАРАКТЕРИСТИКИ ГЕНОТИПОВ ПШЕНИЦЫ

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Abstract. The effect of sodium chloride on physiological and biochemical parameters of wheat genotypes was studied. Wheat plants were grown in pots in soil with the addition of 0.5% sodium chloride. To create new salt-tolerant wheat varieties, a comparative analysis of morphophysiological and biochemical parameters of plants was carried out. Morphological and physiological parameters such as growth, chlorophyll and carotenoid content, photochemical activity of chloroplasts and PSII activity were studied in wheat plants. The effect of salt on the amount of chlorophyll a, chlorophyll b and carotenoids, which are the main physiological parameters, is manifested differently in both plants. When studying the salt tolerance of plants, differences were found in the relative amount of chlorophyll (a+b), carotenoids, as well as the photochemical activity of chloroplasts and the efficiency of PS 2. Among the varieties, according to all morphophysiological and biochemical indicators, the soft wheat variety Mirbashir 128 turned out to be the most resistant to the effects of salt.

Аннотация. Изучено влияние хлорида натрия на физиологические и биохимические показатели генотипов пшеницы. Растения пшеницы выращивали в горшках в почве с добавлением 0,5% хлорида натрия. Для создания новых солеустойчивых сортов пшеницы был проведен сравнительный анализ морфофизиологических и виохимических показателей растений. У растений пшеницы были изучены такие морфофизиологические показатели, как рост, содержание хлорофилла и каротиноидов, фотохимическая активность хлоропластов и активность ФСII. Влияние соли на количество хлорофилла a, хлорофилла b и каротиноидов, которые являются основными физиологическими показателями, проявляется по-разному у обоих растений. При изучении солеустойчивости растений выявлены различия в относительном количестве хлорофилла (a+b), каротиноидов, а также фотохимической активности хлоропластов и эффективности ФС 2. Среди сортов по всем морфофизиологическим и биохимическим показателям наиболее устойчивым к действию соли оказался сорт мягкой пшеницы Мирбашир 128.

Keywords: wheat, salt, chlorophyll, enzyme, activity, photosystem 2, tolerance.

Ключевые слова: пшеница, соль, хлорофилл, фермент, активность, фотосистема 2, устойчивость

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Salinity is one of the abiotic stress factors decreasing plant productivity. The salinization of soils over time is particularly dangerous. The limitation of agricultural and fertile lands is an obstacle to meeting the food requirements of the population [1].

In particular, the rapid growth of the population and the need in ensuring food security make more urgent the development of salt-tolerant varieties capable to grow in saline soils, and their extensive use. According to rough estimates, 521,700 hectares of plains in the Azerbaijan Republic were in a saline state in [2].

In 2007, this parameter increased to 661.9 thousand hectares and accounted for 46.6 % of the land. One of the most effective measures taken to achieve high productivity under stress is the development of plants capable to adapt to salinity. The expression of genes regulating stress tolerance increases under high salt concentrations and ensures salt tolerance of plants [3].

Salts in the soil water may inhibit plant growth for two reasons. Firstly, the presence of salt in the soil solution reduces the ability of the plant to take up water and this leads to reductions in the growth rate. This is referred to as the osmotic or water-deficit effect of salinity. Secondly, if excessive amounts of salt enter the plant in the transpiration stream, there will be injury to cells in the transpiring leaves and this may cause further reductions in growth. This is called the salt specific or ion-excess effect of salinity [4].

These salinity reduces water potential and causes ion imbalance or distur bances in ion homeostasis and toxicity; this altered water status leads to initial growth reduction and limitation of plant productivity. The detrimental effect is observed at the whole plant level as death of plants or decrease in productivity. Salt stress affects all the major processes such as germination, growth, photosynthetic pigments and photosynthesis, water relation, nutrient imbalance, oxidative stress, and yield.

According to some authors, developing more plastic wheat varieties, suitable for the regions of the republic is required because of the disturbance of ecological balance and the presence of abiotic stress factors. Therefore, stress tolerance in plant breeding is of great importance. Currently, in our country, extensive research has been carried out on salt-tolerance of local wheat varieties as well as brought from abroad [5].

Thus, numerous studies conducted in the world and in our country showed the perspectives of the development of the wheat varieties adapted to salinity.

The purpose of the research was to study the effect of sodium chloride on the physiologicaj and biochemicaal characteristics of wheat genotypes, to identify varieties tolerant to salinity.

Materials and methods

The object of the study was wheat seeds Mirbashir 128, (*Triticum aestivum*) and Vuqar (*Triticum durum*). Plants were grown in pots under normal soil conditions and under conditions of 0.5% sodium chloride.

In two-week-old plants, growth, the amount of photosynthetic pigments, the photochemical activity of chloroplasts, and the activity of photosystem 2 were measured. 0.1 g of leaf samples taken from plants grown under both normal and saline conditions were homogenized using a pestle and mortar in 96% alcohol by adding $CaCO_3$, centrifuged at 200 g, and a pure extract of chlorophyll pigments was obtained. The optical density of a solution of chlorophyll in alcohol was measured on an SP-2000 spectrophotometer at 665, 649, 440 nm, and the amounts of chlorophyll and carotenoids were determined by Wintermans [6].

The photochemical activity of chloroplasts was measured on the polarography OH-103 by oxygen evolution using the Clark electrode. Potassium ferricyanide was used as an electron acceptor.

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The effisience of photosystem II (PSII) was established based on Fv/Fm using a photosynthesis analyzer (PAM Germany):

$$F_v = F_m - F_0,\ Y = F_v / F_m;$$

where F_0 — fluorescence of leaves illuminated after dark treatment, F_m — fluorescence of light-saturated leaves.

Peroxidase and catalase activity were determined using special methods [6, 7].

Statistical analysis. Data analysis and statistical analysis were conducted using Microsoft Excel. Statistical analysis was performed with the aid of the Statgraphics Plus 5.1 statistical package. The means of values were compared by Duncan's multiple range test (p=0.05).

Results

Morphophysiological characteristics of wheat plants exposed to salt action are shown in Tables 1.

Table 1

EFFECT OF NaCl (0.5%) ON MORPHOPHYSIOLOGICAL CHARACTERISTICS OF WHEAT GENOTYPES*

Genotype	*Variants*	*Plant growth, cm*	*Chl (a+b), mg/g fresh weight*	*PS 2 activity, Mkmol O_2 / mg chl h*	*Carotenoids, mg/g fresh weight*	*F_v/Fm*
Vugar	Control	16±2	3.2±0,5	55±2.5	0.8±0.01	0.75
	NaCl	9±1	1.9± 0,2	20±1.4	0.4±0.02	0.62
Mirbashir-128	Control	15±2	3.5±0,6	56±3.1	0.9±0.03	0.75
	NaCl	11±1	2.7±0,5	35±2.2	0.6±0.01	0.66

Note: * Each value represents the mean ±SD (standard deviation) for the mean n=3 independent experimets p=0,05.

When measuring growth, it turned out that under saline conditions, the growth of Vugar plants was inhibited by 50%, while growth inhibition in the Mirbashir-128 variety was 26,6%, The content of chlorophyll in the Vugar variety decreased by 40%, while in the Mirbashir-128 variety it decreased by 22,8%, The activity of PS 2 in the variety Vugar decreased by 63,6%, in the variety Mirbashir-128 — 37,5%, The same pattern was observed in the content of carotenoids in the work of PS 2, Apparently, this is due to the fact that Mirbashir-128, as bread wheat, contains the D genome, which affects the tolerance of this variety to the action of salts. The activity of peroxidase and catalase enzymes under salt conditions are shown in Tables 2 and 3.

Table 2

ACTIVITY OF THE GUAIACOL-DEPENDENT PEROXIDASE ENZYME IN WHEAT GENOTYPES UNDER SALT CONDITIONS (MMOL/|MIN-

Varieties of wheat	*Control*	*0,5 % NaCl*
Mibashir-128	30±2	45±5
Vugar	25±3	30±4

Table 3

ACTIVITY OF THE CATALASE ENZYME IN WHEAT GENOTYPES UNDER SALT CONDITIONS (MMOL/MIN)

Varieties of wheat	*Control*	*0,5 % NaCl*
Mibashir-128	35±2	47±5
Vugar	28±3	33±4

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As can be seen from Tables, the activity of peroxidase and catalase under the influence of salt increases in both wheat genotypes. However, in the Mirbashir-128 wheat genotype, the activity increases more than in the Vugar wheat genotype.

Discussion

Salinity could affect chlorophyll concentration of leaves through inhibition of synthesis of chlorophyll or an acceleration of its degradation. Impairment of the carboxylation capacity, which in turn inhibits electron transport, is indicated by the measurements of chlorophyll fluorescence. A reduced quantum yield may result from a structural impact on PS II although some authors [7] found PS II to be highly resistant to salinity stress. Salinity has been concluded to affect reaction centers of PS II either directly or via an accelerated senescence. High external salt concentrations could affect thylakoid membranes by disrupting lipid bilayer or lipid-protein associations and thus, impair electron transport activity. The efficiency of the photochemical conversion of the PS II energy decreased with increasing salt concentrations. Some authors indicate the decrease of the root system function in plants exposed to salt stress. They assumed a more important role of toxic effects of ions [8].

It is known that under the salt stress, the external water potential decreases, the absorption of biogenic metal ions by the roots becomes difficult, and the chlorine and sodium ions have a toxic effect on plant metabolism. These three possible effects of salt stress have a detrimental effect on plant growth, development and yield [9].

Osmotic stress is associated with the accumulation of ions in the soil solution, while malnutrition and the specific effects of ions are associated to the accumulation of ions, mainly sodium and chloride, to toxic levels which inhibits the availability of other important elements such as calcium and potassium. Toxic levels of sodium in plant organs damage biological membranes and subcellular organelles, reducing growth and causing abnormal development before plant death. Several physiological processes, such as photosynthesis, respiration, starch metabolism and fixation of nitrogen also disrupted in salt conditions, which leads to a decrease in crop productivity. In rIn response to this, the plant synthesizes low molecular weight solutes, including soluble carbohydrates for better absorption of water during salinity. Genotypes with a powerful genetic apparatus cope with this task and grow well in salt conditions. In the process of evolution, protective mechanisms against environmental stressors are formed in all organisms, including plants. Therefore, when assessing tolerance to stress factors, it is necessary to consider the individual characteristics of each plant genotype[7, 8].

Conclusions

Among the varieties, the most tolerant to the action of salt according to all morphophysiological and biochemical indicators was the bread wheat variety Mirbashir -28 .

Recommendation: bread variety Mirbashir-128 be used in further breeding work.

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