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RESEARCH ARTICLE

INFLUENCE OF CHLORIDE SALINITY ON GERMINATION, WATER RELATION PARAMETERS AND CHLOROPHYLL CONTENT OF WHEAT GENOTYPES

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ABSTRACT

The effects of different salinity levels on germination of wheat seedlings, water regime and chlorophyll content have been studied. Seeds and seedlings of wheat were grown in NaCl solutions of 0 (control), 100, 150, 200 and 250 mmol L^{-1}concentrations under controlled conditions. The results proved that bread wheat genotypes (*Triticum aestivium L*) Gyrmyzy gul and Gobustan were the most salt tolerant among thestudied genotypes.

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INTRODUCTION

Developing theoretical bases of high productivity of agricultural plants and their application in the practical selectionare the major challenges facing the modern plant physiology.Urgent measures are required to provide sustainable development of agricultural systems and food security,considering recent rapid increasesin the world population, global climatic changes, and a gradual reduce in cultivation fields. Wheat occupies a particular place among agricultural plants due to its nutritional value.Therefore, improving grain yield and quality of wheat plants, selection of new perspective forms adapted to local conditions and applying them in practical selection are of great importance (Abdulbagiyeva *et al*., 2015; Aliyev *et al*., 2002 and Tamrazov *et al*., 2014). As wheat plants are cultivated in every district of Azerbaijan, it is necessary to explore complex soil and climatic conditions of various areas and develop highly productive wheat varieties with good quality, which fit these conditions. Based on traits determining high productivity and quality, wheat genotypes with contrasting morphophysiological properties were selected for producing new hybrid forms and their planting in areas with various ecological conditions was recommended (Abdulbagiyeva *et al*., 2015; Aliyev *et al*., 2002; Cai *et al*., 2008; Hasanova *et al*., 2015 and Tamrazov *et al*., 2014). Salinity is one of the major extreme factors affectingdynamics of wheat development.Salinization retards plant growth and development and limits productivity.Various plants differently respond to salinity.

Wheat can be used in the selection of salt-tolerant varieties because ofhigh inter- and intraspeciesdiversity. From this point of view establishing physiological mechanisms, whichprovide normal growth and development in the selection of productive varieties with high adaptive ability (resistant against salt stress to a certain degree), against various soiland climatic conditions is of great importance. Comparative study of plant life processes would clarify real mechanisms of stress resistance, including salt-tolerance. Excessive accumulation of salt in soil as an extreme factor adversely affects physiological processes occurring in cells. This leads to a decrease in water potential impeding water intake through roots causing water deficiency or osmotic stress in plants.Moreover, excessive accumulation

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of toxic ions such as Na+ and Cl^- has a negative influence on plants. The mentioned factors lead to a weaker water exchange, lower photosynthetic activity, impaired growth and development of the plants, which ultimately result in reduced productivity (Koca *et al*., 2007 and Munns, 2002). The main purpose of the presented research was to evaluate salt tolerance of wheat genotypes at the germination stage and during the normal development phase and to study leaf water regime and photosynthetic pigments under salt stress.

MATERIALS AND METHODS

Durum wheat (*Triticum durum Desf*) genotypes Barakatli-95, Garagylchyg-2and bread wheat genotypes (*Triticum aestivium L*) Gyrmyzy gul and Gobustan were used as the study objects and experiments were conducted under two conditions in parallel.Aqueous NaCl solutions of 0, 100, 150, 200, 250 mmol.L^{-1} were used in both cases. Seeds from every sample were put in Petri dishes, which bottoms were covered withwet filter paperand then placed in the thermostat. Germinationwas performed ata constant temperature of 20°Cin the dark.In the first case, a response of wheat embryo to salt stress was studied at the germination stage. In the second case, salt effects on physiological parameters were analyzed in unstressed control plants in the 14-day-old leaves on the 7th day after the germination. Germination ability, i.e. germination energy was tested after 3 days of cultivation and germination percent after 7 days of cultivation in the unstressed control variants.

Relative water content (RWC) of leaves was determined according to the method of Tambussi *et al.* (2005) using the following formula:

$$RWC= 100\% (M_F -M_D) / (M_T -M_D)$$

where:
M_F – fresh weight
M_T – turgid weight
M_D – dry weight

Chlorophyll was extracted from leaves using 96% ethanol and measured spectrophotometrically (Multiskan GO, Germany) at 665nm (Chl a) and 649 nm (Chl b). The pigment contents (mg/g) were measured by the method of Wintermans *et al.* (2003). Data analysis was carried out according to the statistical procedure described by Gomez and Gomez (1984) and the computer package MSTAT-C (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The final assessment of plant tolerance against stress factors, including salinity is based on plant productivity or the loss of productivity. As the ultimate productivity represents the integration of the levels with different tolerance, two values were used to evaluate plant tolerance: the starting point of productivity loss and the point of the enhancement of

Table 1. Effects of various NaCl concentrations on germination energy and germination percentage of wheat seeds

Wheat genotypes	control		100mM NaCl		150 mM NaCl	
	germination energy, %	germination percentage, %	germination energy, %	germination percentage, %	germination energy, %	germination percentage, %
Barakatli– 95	80	93	70	48	38	20
Garagylchyg-2	76	92	64	36	34	16
Gyrmyzy gul	93	97	75	39	40	8
Gobustan	92	96	50	21	40	5

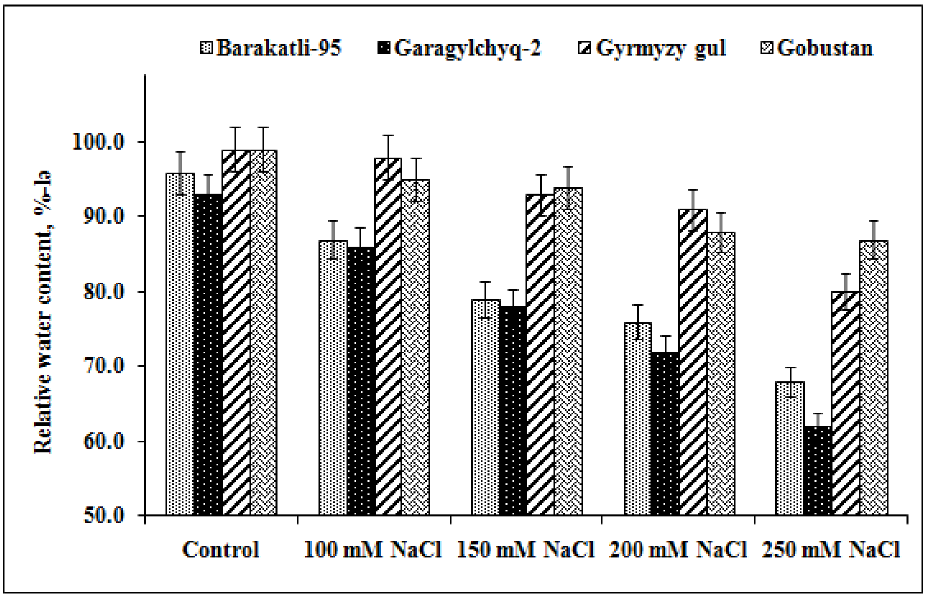

Figure 1. Effects of various NaClconcentrations on relative water content

productivity loss as salt stress intensified (Ayers and Westcott, 1994; Badridze *et al*., 2009). Germination ability is one of the major traits of seed quality. Because sowing norms are established based on germination ability. The purpose of the determination of germination ability is to establish a number of seeds capable of germination (Seyidaliyev *et al*., 2014). First, germination ability of wheat seeds was determinedin the research. The results were presented in Table 1. In control variants germination ability i.e. germination energy and germination percentageof these varieties were found to be 80% and 93% for Barakatli-95;76% and 92% for Garagylchyg-2;93% and 97% for Gyrmyzy gul and 92% and 96% for Gobustan, respectively.

Table 2. Effects of various NaCl concentrations on the chlorophyll content (mg/g)in different wheat genotypes

№	Genotypes	NaCl, mM	Chl_a	Chl_b	Chl_{a+b}
1	Barakatli-95	0	1.503	0.441	1.944
		100	0.815	0.199	1.014
		150	0.749	0.195	0.944
		200	0.659	0.128	0.786
		250	0.633	0.124	0.756
2	Garagylchyg-2	0	1.086	0.297	1.383
		100	0.689	0.151	0.840
		150	0.634	0.159	0.793
		200	0.510	0.092	0.602
		250	0.506	0.090	0.596
3	Gyrmyzy gul	0	1.478	0.560	2.038
		100	1.040	0.418	1.458
		150	0.846	0.312	1.158
		200	0.838	0.308	1.146
		250	0.800	0.312	1.112
4	Gobustan	0	1.280	0.448	1.728
		100	0.632	0.196	0.828
		150	0.498	0.128	0.626
		200	0.420	0.092	0.512
		250	0.396	0.078	0.474

The study of the effects of various NaCl concentrations on 3-day-old seedlings of wheat genotypes showed a decrease in germination energy under stress. Germination energy ofthe highly productive Barakartli-95 was slightly higher (80, 70, 38, 20, 6 %) compared with Garagylchyg-2 (76, 64, 34, 14, 6 %). It should be noted that growth of seedlings of both varieties was observed only at 100 and 150 mM concentrations of salt after 3 days. At all concentrations of NaCl germination energy of the bread wheat genotypes Gyrmyzygul and Gobustan was found to be 85, 75, 40, 15, 5% and 70, 50, 40, 15, 5%, respectively. The development of the seedlings of these varieties after three days became possible at the lowest concentration (100 mM) of NaCl.Effects of various salt concentrations on germination ability and height of seedlings allow us to find coefficient (highly tolerant, moderate, sensitive)of salt tolerance (Belozerova *et al*., 2014 and Ayers, 1994). 7-day-old seedlingsof all the studied varieties grown under normal conditions were exposed to salt stress and the increase in the salt concentration led to the pronounced decrease in RWC determined in 14-day-old leaves (Figure 1).

Thus, depending on the concentrations of NaCl, relative water content for the durum wheat varieties Barakatli-95 and Garagylchyg-2 was found to be 96, 87, 79, 76, 68 % and 93, 86, 78, 72, 62 %, respectively.According to the results Barakatli-95 is more salt-tolerant compared with other studied varieties. As a result of the increase in NaCl concentration,RWC changed and was equal to 99; 98; 93; 91; 80% and 99; 95; 94; 88; 87% forGyrmyzygul and Gobustan, respectively. So there were no marked differences in dynamics of changes of RWC values depending on the salt concentrations between durum and bread wheat genotypes.However, RWC in the Gobustan variety was 7% more than that in the Gyrmyzy gul variety at the high NaCl concentration. Effects of NaCl on the amount of green pigments in leaves of 14-day-old wheat genotypes were also studied (Table 2). Changes in the pigment amounts depending on the salt concentration correlated with the decrease in relative water content. Relative water content is a major parameter of water regime, which is considered to be one of the mechanisms of plant stress tolerance (Sinclair and Ludlow, 1985).

The chlorophyll content decreased in both Barakatli-95 and Garahylchyg-2 varieties compared with control variants and the total chlorophyll contentwas slightly higher in the Barakatli-95 variety. Higher values for the total chlorophyll content were observed in the bread wheat genotype Gyrmyzy gul compared with Gobustan in all variants and a decreasecompared with the control variant occurred in both genotypes depending on NaCl concentrations (Table 2). The results showed different responses of wheat genotypes to the salt effects. It should be noted that degree of salt tolerance is dependent on the growth conditions of the plants. Quantitative indicators of salt tolerance and productivity of different plants vary depending on their biological properties. Therefore not only salt tolerant plants but also plants combined salt tolerance and productivity traits are of great importance for agriculture (Udovenko, 1997). From the biological point of viewstress is considered as any environmental changeadversely affecting and impairing normal development of the plant.During adaptation, plants respond to unfavorable conditions via a number of biochemical and physiological changes (Aliyev *et al*., 2014). Thus, the research has established that salt stress negatively affectsgermination ability, relative water content of leaves and the content of photosynthetic pigmentsof wheat genotypes. The obtained data confirm that plant tolerance to extreme environmental conditions is a result of the complex combination of various physiological adaptive reactions against stress.

Conclusion

According to germination energy, germination percentage and the content of the photosynthetic pigments, bread wheat genotypes (*Triticum aestivium L*) are tolerant to salt stress.

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