

## Evaluation of Salt Tolerance in Bread Wheat (*Triticum aestivum* L.) Genotypes during Early Ontogenesis

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### Abstract

The influence of different concentrations of sodium chloride on the growth and development of bread wheat seedlings has been investigated. Seven productive bread wheat (*Triticum aestivum* L.) genotypes (Gobustan, Leyagatli, Murov-2, Sheki-1, Mirbashir-128, Aghali, Bezostaya) were used as the investigation material. To study the effect of salt on bread wheat genotypes and their morphological growth, seeds were germinated in aqueous solutions of NaCl (0, 150, 200 mM) as an experimental variant and distilled water as a control using the paper roll method. Ten seeds of the each sample were kept on wet filter paper, at 20-22°C temperature, in the dark for 3 days and then germinated under 12h/12h (light/dark) photoperiod for 7 days. During 10 days, the response of wheat seedlings to salt stress, growth dynamics of the above- and underground organs (roots and seedlings) were studied and the varieties were compared according to the morphometric parameters. Germination energy and germination percentage were determined in 50 seeds of each variant of the studied genotypes on the 3<sup>rd</sup> and 7<sup>th</sup> day after germination, respectively. We found that 150 and 200 mM concentrations of NaCl have an inhibitory effect on the germination of seeds, growth of seedlings and root hairs of the studied bread wheat varieties. Mirbashir-128 was the most salt-tolerant genotype which could be used for developing more tolerant genotypes in breeding programs.

**Keywords** bread wheat, germination, influence, salinity, seedlings

### Introduction

The increasing demand of the world population for cereals can be met at the expense of enlarging cultivation areas and raising the productivity of main cereals including bread wheat (*Triticum aestivum* L.). One of the major factors limiting the growth, development and productivity of wheat is soil salinization. Wheat grain quality deteriorates and the productivity declines under salinity [1-2]. Depending on the accumulation of different sodium salts, sulfate, chloride or mixed salinity may occur. Chloride salinity has the most adverse effect on the plant growth and development. Chloride salinity leads to a sharp decline in the water potential of soil and consequently, absorption of water by root hairs becomes difficult. Moreover, chloride ions entering the plant violate the cell ultrastructure, especially causing alterations in chloroplast membranes. The accumulation of other vital cations, especially K<sup>+</sup> and Ca<sup>2+</sup> is prevented by Na<sup>+</sup> ions in the cells [3-4]. The investigations revealed several mechanisms by which plants respond to salinity conditions like some mechanisms provide tolerance against damaging factors, while others provide reparation of the damage [5]. Currently, extensive researches at different levels are being carried out on improving the plant tolerance against adverse biotic and abiotic factors of the environment. One of the methods suitable to overcoming the negative effects of salinity is the use of salt-tolerant wheat varieties. Creation of such forms and their cultivation will contribute to the decrease in the production loss.

The aim of the research was the assessment of salt-tolerance among bread wheat genotypes at

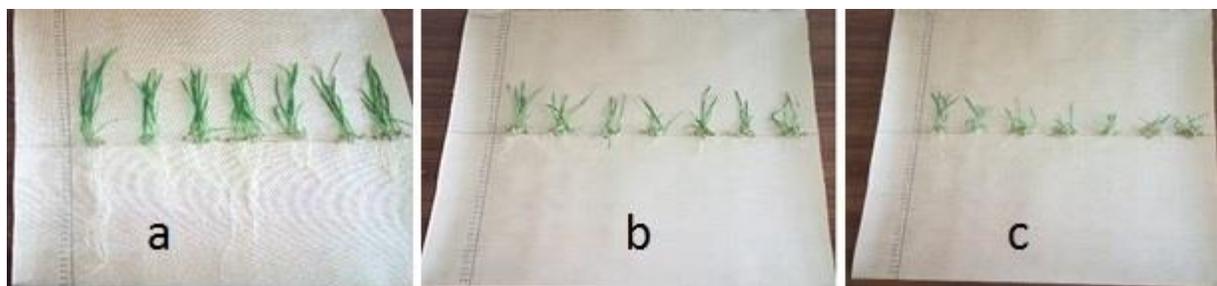


Figure 1. (a, b, c). The effect of different salt concentrations on bread wheat varieties: a-control; b-150 mM NaCl; c- 200mM NaCl

germination stage.

**Methodology**

Seven productive bread wheat (*T. aestivum* L.) genotypes (Gobustan, Leyagatli, Murov-2, Sheki-1, Mirbashir-128, Aghali, Bezostaya) were used in the experiment. For the diagnostics of bread wheat genotypes and to study their morphological properties (effect on the root system and seedlings), seeds were germinated in NaCl solution (experimental variant) and distilled water (control) using the paper roll method [6-7].

Screening of the studied wheat genotypes for salt tolerance was performed using aqueous solutions of NaCl (0, 150, 200 mM). Ten seeds of each sample

were kept on wet filter paper, at 20-22°C temperature, in the dark for 3 days and then germinated under 12h/12h (light/dark) photoperiod for 7 days. The response of the wheat seedlings to salt stress, growth dynamics of the above- and underground organs (roots and seedlings) were recorded for 10 days and the varieties were compared according to the morphometric parameters (Figure 1). In 50 seeds of each variant of the studied genotypes, germination energy and germination percentage were determined on the 3<sup>rd</sup> and 7<sup>th</sup> day, respectively following the germination [8]. Analysis of variance and student test were used to test the variation in the effect of different

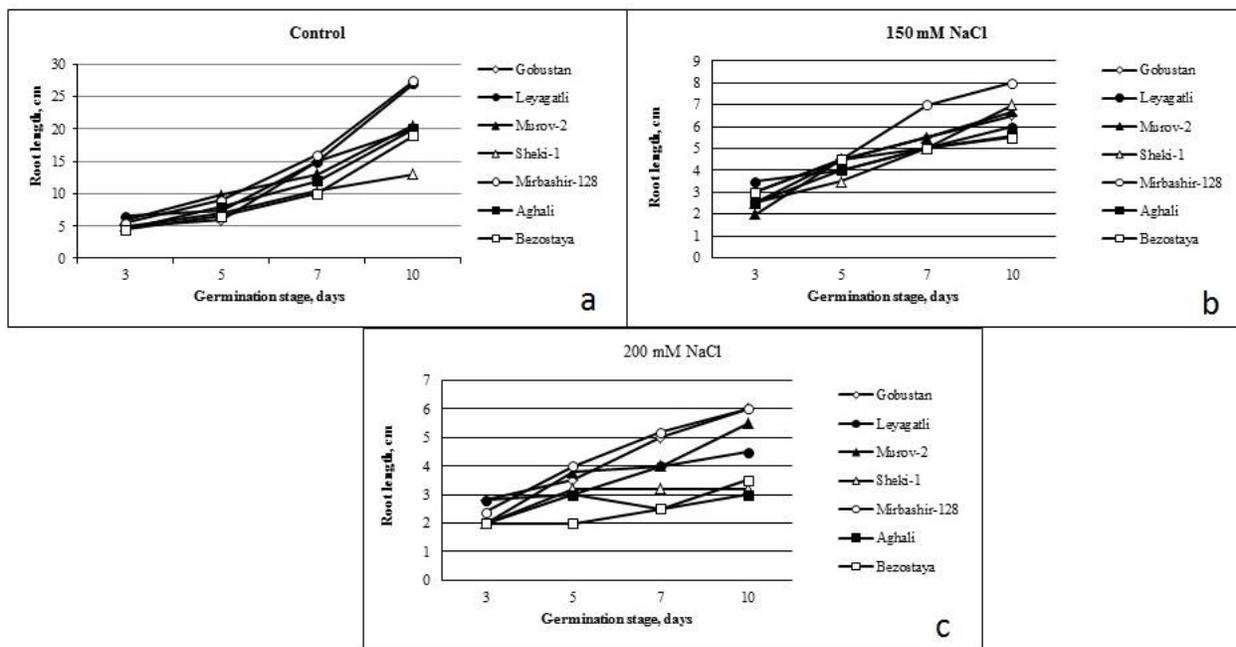


Figure 2. (a, b, c). Dynamics of the growth (development) of roots of different wheat genotypes cultivated at different NaCl concentrations during 10 days.

**Table 1 Salt tolerance characteristics of bread wheat**

Varieties	Seedling length, %		
	Control	150 mM	200 mM
Mirbashir-128	100	78	50
Gobustan	100	72	50
Leyagatli	100	57	50
Murov-2	100	70	41
Sheki-1	100	70	32
Aghali	100	53	35
Bezostaya	100	51	26

salt dosages and the response of varieties to salt stress.

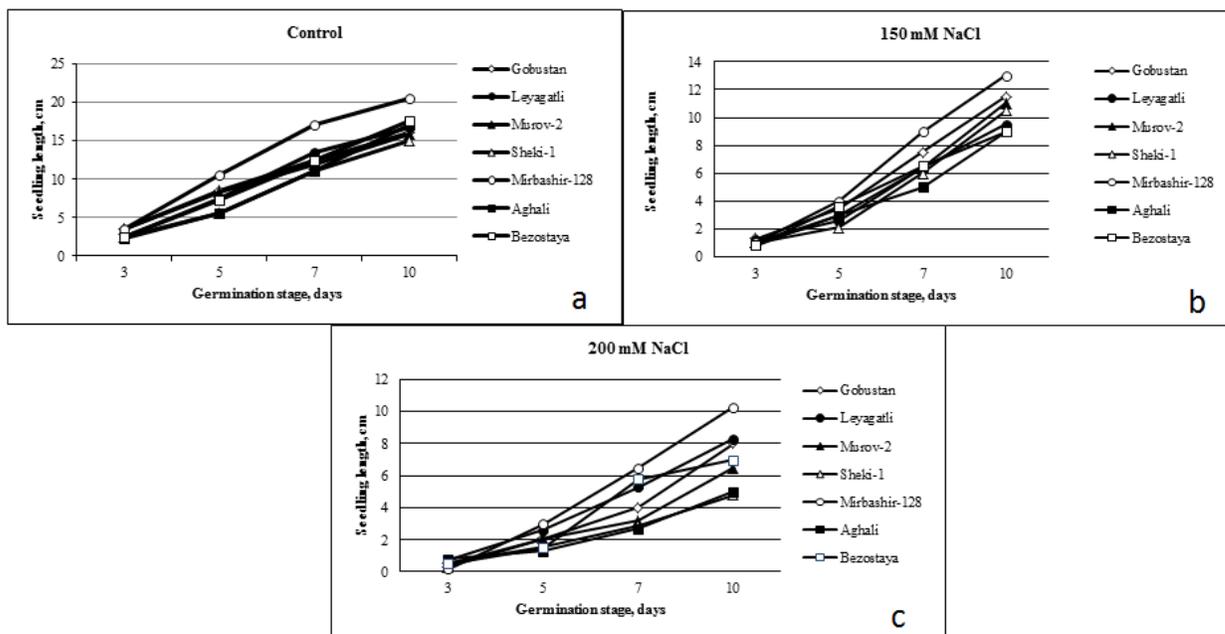
**Results and Discussion**

Diagnostics of the bread wheat genotypes showed different germination ability in the experimental variants of the tested samples. The germination energy decreased from 60% to 40% and from 90% to 70% under chloride salinity and in the control variants, respectively. A relatively less (33%) germination energy was observed only for the Murov-2 variety, cultivated in 200 mM concentration of NaCl. However, all the studied varieties showed maximum germination percentage in both the variants. Due to the general plant

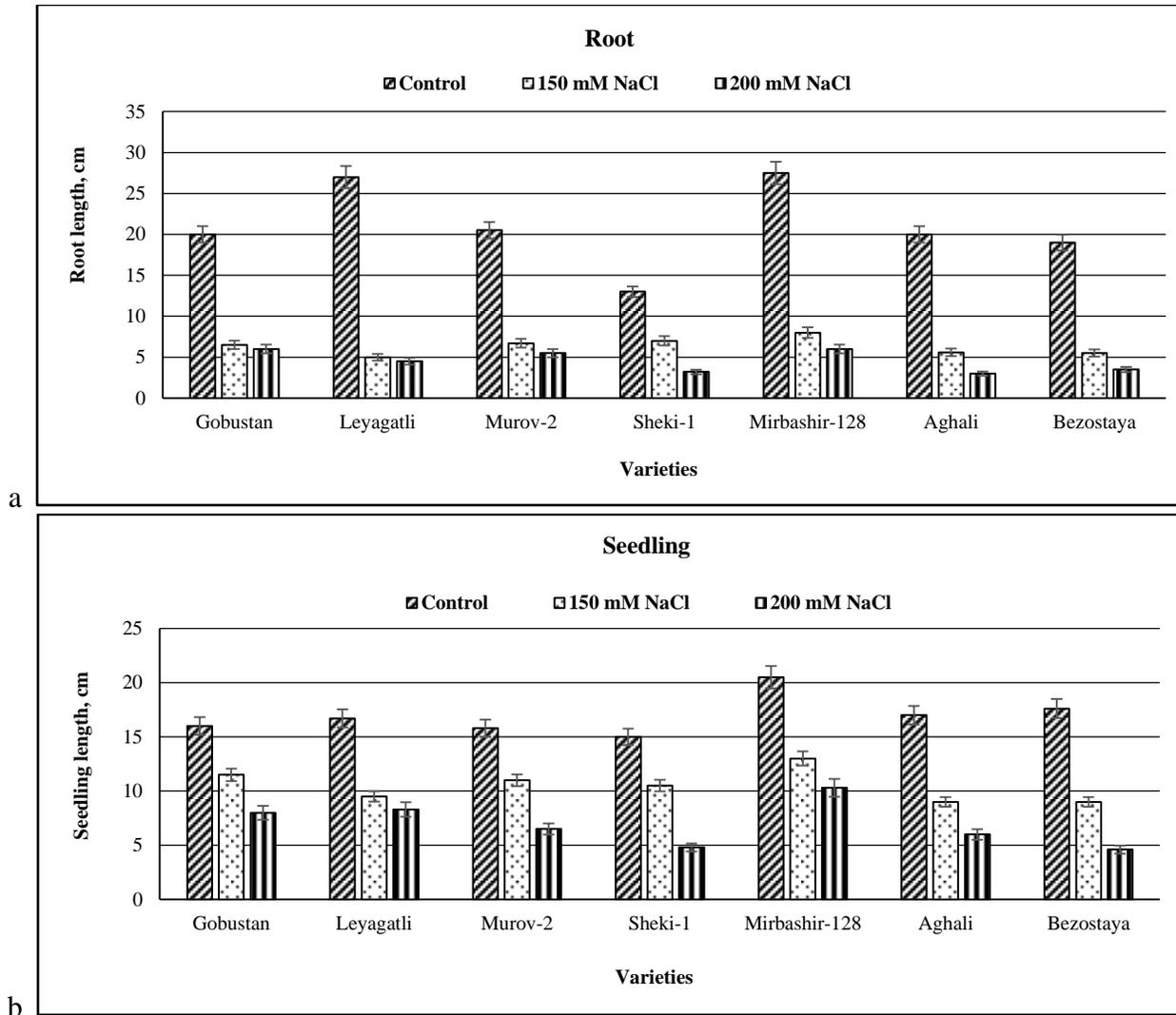
tolerance, alterations in the linear parameters of the growth processes express salt-tolerance of the varieties more correctly as compared to the seed-germination parameters. The lag in the plant development under adverse environment, caused by the suppression of the cell pressure and especially cell tension, may be considered as a plant protective reaction. Tolerant genotypes adapt quickly to stress conditions and restore their development [7]. The degree of the salt-tolerance is determined according to the alterations of the selected parameters under salt stress compared with the control variant.

The ratio of the length of the experimental and controlled seedlings was accepted in percentage as the salt-tolerance parameter (tolerance coefficient) of the sample. The samples with tolerance coefficient exceeding 90% are highly tolerant, plants with the coefficient less than 60% are sensitive forms and moderately tolerant plants have tolerance coefficient values between 90% and 60% [6]. The wheat varieties used in our experiment were moderately tolerant and sensitive according to their characteristics found in the germination phase (Table 1).

As seen in table 1, Murov-2, Sheki-1, Aghali and Bezostaya varieties are sensitive, while the Mirbashir-128, Gobustan and Leyagatli



**Figure 3. (a, b, c). Dynamics of the growth (development) of seedlings of different wheat genotypes cultivated at different NaCl concentrations during 10 days.**



**Figure 4.** Average lengths of root hairs (a) and seedlings (b) of 10 day old wheat varieties exposed to various concentrations of NaCl.

varieties are moderately tolerant at 200 mM salt concentration. Mirbashir-128 was distinguished by its relatively high parameters at 150 mM NaCl. Ten days old seedlings of bread wheat varieties grown in water and at different salt concentrations have been compared in Figure 1.

As seen in figure 1, a lag in the growth of the seedlings and the root system occurred in all the samples with the increasing salt concentrations. At the same time, various salt concentrations differently influenced the varieties. At 150 and 200 mmol NaCl concentrations, the highest parameters for coleoptile and root growth were observed in the Mirbashir-128 variety. The Layegatli and Gobustan varieties were moderately tolerant, and the

tolerance of Murov-2, Sheki-1, Aghali and Bezostaya were relatively less. The comparison of the influence of various concentrations of NaCl on the growth of the seedlings and roots showed that under salinity, root system is affected first and then, aboveground organs are damaged. According to some reports, it may be attributed to the differences in the salt tolerance of different plant organs [9]. The general development of the root system is known to be closely related to some important plant parameters [7]. Therefore, it would be advisable to observe the dynamics of the development of roots and seedlings under stress.

We studied the dynamics of the development of roots and seedlings of wheat plants grown at

different salt concentrations at early stages of ontogenesis (Figures 2 and 3). Dynamics of the growth of bread wheat roots grown under different salt concentrations during 10 days has been presented in figure 2. The study of the root system of bread wheat genotypes showed a decrease in the growth rate of all the genotypes. The Aghali, Sheki-1 and Bezostaya varieties were less tolerant, the tolerance of Murov-2 and Leyaqetli was moderate, while Mirbashir-128 and Gobustan showed higher salt tolerance (Figure 2).

Growth (development) dynamics (Figure 3) of bread wheat seedlings related to the salt concentrations during 10 days showed that all the wheat genotypes developed normally in the germination phase and the development rate decreased with the increasing salt concentrations, relative to the control. A sharp difference between the experimental and control variants was observed on the 3rd day of the germination. The Murov-2, Sheki-1, Aghali and Bezostaya genotypes were less developed as compared to the Mirbashir-128, Gobustan and Leyaqetli genotypes. However, normal development continued in all the varieties at all the salt concentrations. Diagrams presented in figure 4 (a, b) shows the parameters (root and seedling lengths) of bread wheat varieties exposed to various concentrations of NaCl for 10 days.

Negative effects of the salt have been observed in the germination phase of the all the studied varieties. As seen in the figures, based on the morphometric traits, the most salt-tolerant genotype was Mirbashir-128, while Sheki-1 was relatively less tolerant.

It can be concluded that 150 and 200 mM concentrations of NaCl have an inhibitory effect on the germination of seeds, growth of seedlings and root hairs development of the studied bread wheat varieties. The most salt-tolerant genotype among the studied ones was Mirbashir-128, which could be used for developing more salt tolerant genotypes.

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