

SCREENING OF BARBED GOATGRASS (*Aegilops triuncialis* L.) FOR NaCl SALINITY STRESS AT GERMINATION AND EARLY STAGES OF PLANT GROWTH

Gergana DESHEVA, Manol DESHEV, Evgeniya VALCHINOVA,
Albena PENCHEVA, Bozhidar KYOSSEV

Agricultural Academy, Institute of Plant Genetic Resources “K. Malkov”,
2 Druzhba Street, 4122, Sadovo, Bulgaria

Corresponding author email: gergana_desheva@abv.bg

Abstract

The objective of this study was to evaluate the genotypes of barbed goatgrass (*Aegilops triuncialis* L.) for tolerance to NaCl salinity stress at germination and the early stages of plant growth. Seeds from five populations of *Aegilops triuncialis* L. were collected from disparate regions of Bulgaria and subjected to salt stress at six distinct NaCl concentrations (50, 100, 150, 200, 250 and 300 mM). The genotypes exhibited considerable variation for the germination and seedling characteristics examined under both control and salinity-stress conditions. The highest value of the relative injury rate was recorded when seeds were treated with 300 mM NaCl. The application of increasing concentrations of the NaCl prolonged the mean germination time and suppressed the studied germination and seedling traits and had a greater inhibitory effect on shoot growth compared to root growth. Genotype BGR43665 was identified as the most tolerant to salinity stress, when exposed to increasing concentrations of sodium chloride ranging from 50 to 250 mM, on the base of the indices values for Mean productivity (MP), Geometric mean productivity (GMP), Harmonic mean (HM), Stress tolerance index (STI), Yield index (YI), Yield stability index (YSI), Relative stress index (RSI), calculated on the based of shoot dry mass. The average of the summary ranks (ASR) also identified BGR43665 as the best genotype.

Key words: *Aegilops triuncialis* L., germination, early growing stage, salinity, tolerance.

INTRODUCTION

Elevated salinization is identified as a significant detrimental environmental stress, particularly in desert and semi-desert climates, leading to substantial yield losses for a wide range of domesticated plants worldwide. More than 20% of the irrigated area on Earth is damaged by salt, with an increasing trend due to climate change and overexploitation of groundwater resources (Wu et al., 2017; Alam et al., 2021; Pour-Aboughadareh et al., 2023; Fatema et al., 2024; Kotula et al., 2024; Zhou et al., 2024). Salt stress affects almost all plant components and leads to a significant reduction in biomass production and ultimately yield (Seeda et al., 2022). Plants are affected by salt stress in two ways: osmotic stress and ionic stress. Osmotic stress is caused by high salt content in the soil, which reduces water potential and limits the amount of water plants can take up. It leads to dehydration and various physiological responses of plants. Ionic stress

is associated with the accumulation of toxic sodium (Na⁺) and chloride (Cl⁻) ions in plant tissues, leading to disruption of ionic homeostasis and displacement of important potassium (K⁺) ions (Waheed et al., 2024). Plants exhibit adverse responses to salt stress, which can impede nutrient uptake, disrupt ion balance, and hinder growth (Bano et al., 2023). The capacity of plants to withstand excessive salt levels in their environment is variable, and they are typically classified into four distinct categories: salt-sensitive, moderately salt-sensitive, moderately salt-tolerant, and salt-tolerant (Zhou et al., 2024).

It is widely acknowledged that the germination of seeds and the subsequent growth of seedlings represent the most critical yet vulnerable phases in the life cycle of plants. Consequently, the focus of salinity research has been predominantly on these two stages (Ehtaiwwesh & Emsahel, 2020; Dehnavi et al., 2020; Mohammadi et al., 2023; Irik & Bikmaz, 2024). Increasing salinity concentration has

been found to reduce osmotic potential, thereby limiting germination rate, emergence rate and root development. The decrease in total seed germination under salt stress conditions is due to the occurrence of metabolic disturbances expressed in an increase in phenolic compounds. It has been suggested that the decline in total germination percentage is associated with a reduction in water absorption into seeds (Podder et al., 2020). Dehnavi et al. (2020, 2024) noted that, salt stress tolerance at the germination and seedling emergence stages has been shown to determine better plant establishment in saline soils. Ehtaiwesh et al. (2024) observed that the identification of salinity-tolerant crops and their diverse genotypes with the potential to withstand salinity is of paramount importance, given the trends and future demographic projections. Furthermore, the breeding of important crops with the potential to develop salinity-tolerant genotypes can facilitate the efficient use of salt-affected land and saline water resources. The objective of the present study was to evaluate the genotypes of barbed goatgrass (*Aegilops triuncialis* L.) with regard to their tolerance to NaCl salinity stress during the processes of germination and the early stages of plant growth.

MATERIALS AND METHODS

In this investigation, five barbed goatgrass (*Aegilops triuncialis* L.) accessions collected from different locations across the Bulgarian territory were evaluated for their response to NaCl salinity stress under laboratory conditions (Table 1). The effect of six different salt concentrations (50 mM, 100 mM, 150 mM, 200 mM, 250 mM, 300 mM) on seed germination and early seedling characteristics were investigated. Deionized water was used as control. Two replicates of 25 seeds of each treatment were plated for germination on filter paper with 20 ml of the test solutions. The paper with the seeds was placed in plastic bags to keep them moist. Before starting the germination test, the samples were placed for one week on refrigeration at 4°C. Seed germination was at 20±1°C for 8 days. The paper was changed every two days to prevent salt accumulation. Seeds were considered

germinated when the germ was at least 2 mm long. The number of germinated seeds was recorded each day. The following germination characteristics were recorded- germination percentage (G, %), coefficient of velocity of germination (CVG), germination rate index (GRI, % day⁻¹), mean germination time (MGT), and relative injury rate (RIR). CVG was calculated using Kader & Jutzi (2004), GRI and MGT using Kader (2005), and RIR using Li (2008). On day 8, 10 seedlings were randomly selected from each treatment to measure shoot and root length and fresh weight. Dry weight of the shoot and the root were recorded after drying in an oven at 80°C for 24 hours. Seedling height reduction was determined using the method described by Islam & Karim (2010).

To characterize the response of the genotypes at different salinities and to select the most tolerant genotype, the following tolerance and susceptibility indices were calculated using the user-friendly online software iPASTIC: Tolerance Index (TOL), Relative Stress Index (RSI), Mean Productivity (MP), Harmonic Mean (HM), Yield Stability Index (YSI), Geometric Mean Productivity (GMP), Stress Susceptibility Index (SSI), Stress Tolerance Index (STI) and Yield Index (YI) (Pour-Aboughadareh et al., 2018).

Analysis of variance (ANOVA) was used to test the effects of salt concentration, genotype and their interaction on the measured traits. Comparisons of means were made using the Duncan’s multiple range test at the probability level (p < 0.05) using SPSS software.

Table 1. Passport information for the accessions included in the study

Accession number	Species	Origin	Geographical coordinates		
			Latitude	Longitude	Altitude
BGR43679	<i>Aegilops triuncialis</i> L.	BGR	41°51'20"N	26°04'46"N	74
BGR43540	<i>Aegilops triuncialis</i> L.	BGR	41°52'22"N	26°00'15"N	88
BGR43669	<i>Aegilops triuncialis</i> L.	BGR	41°39'29"N	25°38'60"N	342
BGR43307	<i>Aegilops triuncialis</i> L.	BGR	41°37'31"N	25°40'30"N	166
BGR43665	<i>Aegilops triuncialis</i> L.	BGR	41°42'45"N	25°36'20"N	342

RESULTS AND DISCUSSIONS

A two-way ANOVA analysis (Tables 2, 3) showed a significant individual effect of genotype, concentration (dose) and their interaction on the studied germination and seedling characteristics. The study revealed that salt concentration exerted the most substantial effect on the majority of the examined

parameters, with the exception of the germination percentage, where genotype and the applied dose exhibited nearly equivalent impacts on trait expression.

Table 2. Two-way ANOVA on the effect of genotype, concentration and their interaction on the germination characteristic of *Aegilops triuncialis* L

Source of Variation	df	MS	Sign.	η^2 , %
CVG				
Genotype	4	515.21	0.00	7.86
Concentration	6	3276.18	0.00	74.93
Interaction	24	122.77	0.00	11.23
GRI				
Genotype	4	2505.93	0.00	22.90
Concentration	6	4795.16	0.00	65.72
Interaction	24	108.11	0.00	5.93
MGT				
Genotype	4	7.08	0.00	11.73
Concentration	6	20.62	0.00	51.24
Interaction	24	3.27	0.00	32.47
G				
Genotype	4	8126.79	0.00	40.87
Concentration	6	5912.14	0.00	44.60
Interaction	24	313.04	0.00	9.45

G-germination percentage, CVG-coefficient of velocity of germination, GRI-germination rate index, MGT-mean germination time, η^2 -degree of influence of the factors (%), df = degrees of freedom.

Table 3. Two-way ANOVA on the effect of genotype, concentration and their interaction on the seedling characteristic of *Aegilops triuncialis* L

Source of Variation	df	MS	Sign.	η^2 , %
RL				
Genotype	4	8.42	0.00	3.12
Concentration	6	161.56	0.00	89.80
Interaction	24	1.90	0.00	4.22
ShL				
Genotype	4	40.0	0.0	6.7
Concentration	6	341.0	0.0	85.1
Interaction	24	5.1	0.0	5.1
FRW				
Genotype	4	77.18	0.00	3.88
Concentration	6	1103.71	0.00	83.21
Interaction	24	24.82	0.00	7.48
FShW				
Genotype	4	538.19	0.00	3.68
Concentration	6	8268.46	0.00	84.72
Interaction	24	172.04	0.00	7.05
DRW				
Genotype	4	1.73	0.00	10.08
Concentration	6	9.29	0.00	81.12
Interaction	24	0.12	0.00	4.31
DShW				
Genotype	4	9.33	0.00	5.53
Concentration	6	84.40	0.00	75.06
Interaction	24	0.99	0.05	3.53

Root length (RL), Shoot length (ShL), Fresh root weight (FRW), Fresh shoot weight (FShW), Dry root weight (DRW), Dry shoot weight (DShW), η^2 -degree of influence of the factors (%), df = degrees of freedom.

López-Méndez et al. (2024) noted that if the interaction between genotypes and salt is significant, it means that the genotypes respond differently at a given salt concentration. In our study, this is confirmed by the significant differences in the germination percentages of the five *Aegilops* genotypes studied under the

different treatments (Figure 1). Increasing salt concentration resulted in a reduction in germination percentage, but the magnitude of the reduction under high salt stress was much greater than that under low salt stress. At the salinity level of 250 mM NaCl the germination percentage varied between 0% for BGR43669 and BGR43307 and 20% for BGR43665. At the highest concentration of 300 mM NaCl, only abnormal seed germination was recorded, manifested by a poorly developed root system without shoot development (Figure 1).

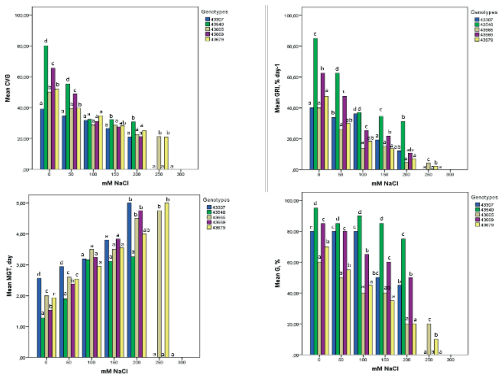


Figure 1. Variation of the germination characteristics (G, %-germination percentage; CVG-coefficient of velocity of germination; GRI, % day⁻¹-germination rate index; MGT, day-mean germination time) of five *Aegilops triuncialis* genotypes treated with different NaCl doses. Bars with different letters in the group are significantly different from each other according to Duncan's Multiple Range Test at $p < 0.05$

The application of increasing concentrations of sodium chloride solutions had a negative effect on CVG and GRI characteristics and positive on the MGT. This is due to the fact that increased salinity levels limit water absorption, which in turn leads to suppression of nutrient assimilation (Podder et al., 2020). Consequently, the germination rate decreases and mean germination time increase in response to increasing salinity. The results of this study are in agreement with the observations documented by Yohannes et al. (2020), Dehnavi et al. (2020), Kundu et al. (2023), Nikolić et al. (2023) and Ehtaiwesh (2024), who conducted their studies on different plant species. Dehnavi et al. (2020) and Kundu et al. (2023) noted that the observed variations among accessions in germination parameters might be attributable to both hereditary factors and specific genetic influences.

The relative injury rate (RIR), utilized in this study as a metric to evaluate the degree of stress experienced by plants under salinity conditions, exhibited significant disparities among genotypes at varying salinity levels. At low concentrations of 50-100 mM NaCl, the coefficient ranged from 0 for BGR43307 (for the two concentrations, respectively) to 0.33 for BGR43665 (at 100 mM NaCl, respectively). In the context of medium salt stress, the lowest RIR was observed for BGR43540, at both 150 and 200 mM NaCl concentrations. The highest RIR values, exceeding 0.80, were attained under conditions of 250-300 mM NaCl treatment, with the exception of BGR43665 at 250 mM NaCl, where an RIR of 0.67 was recorded (Table 4).

Table 4. Variation in the relative injury rate (RIR), root height reduction (RHR, mm) and shoot height reduction (ShHR, mm) of five barbed goatgrass genotypes treated with different NaCl doses

Genotype	RIR	RHR	ShHR
50 mM NaCl			
BGR43679	0.21c	0.09ab	0.29b
BGR43540	0.11abc	0.32c	0.21ab
BGR43669	0.06ab	0.05a	0.15a
BGR43307	0.00a	0.13b	0.26b
BGR43665	0.17bc	0.05a	0.13a
Average	0.11	0.13	0.21
100 mM NaCl			
BGR43679	0.36c	0.15a	0.32ab
BGR43540	0.05a	0.48b	0.52b
BGR43669	0.23b	0.22ab	0.29a
BGR43307	0.00a	0.17a	0.42ab
BGR43665	0.33bc	0.12a	0.33ab
Average	0.2	0.23	0.37
150 mM NaCl			
BGR43679	0.50c	0.52bc	0.70bc
BGR43540	0.11a	0.59c	0.71c
BGR43669	0.30b	0.36a	0.50a
BGR43307	0.38bc	0.41ab	0.59abc
BGR43665	0.33bc	0.33a	0.58ab
Average	0.32	0.44	0.62
200 mM NaCl			
BGR43679	0.71c	0.71b	0.92a
BGR43540	0.21a	0.73b	0.90a
BGR43669	0.41b	0.55a	0.89a
BGR43307	0.44b	0.74b	0.88a
BGR43665	0.67c	0.67b	0.86a
Average	0.49	0.68	0.89
250 mM NaCl			
BGR43679	0.86b	0.93b	0.98a
BGR43540	1.00c	0.89a	1.00a
BGR43669	1.00c	0.90a	1.00a
BGR43307	1.00c	0.92ab	1.00a
BGR43665	0.67a	0.91ab	0.99a
Average	0.9	0.91	0.99
300 mM NaCl			
BGR43679	1	0.96b	1
BGR43540	1	0.89a	1
BGR43669	1	0.89a	1
BGR43307	1	0.94b	1
BGR43665	1	0.94b	1
Average	1	0.92	1

Means within a column that have different superscript letters are significant different from each other according to Duncan's Multiple Range Test at $p < 0.05$.

In earlier studies made by Ali et al. (2019), Yohannes et al. (2020) and Habibi et al. (2021) also noted that RIR increase with increasing concentration of salinity level.

In the initial stages of salt stress, plants exhibit reduced water uptake by their roots and accelerated water loss in their leaves. This phenomenon can be attributed to the elevated salt content in the soil and plants, which exerts pressure and accelerates water loss. According to experts in the field, salt stress can be classified as a form of hyperosmotic stress (Seeda et al., 2022). Salinity has been demonstrated to impede the maintenance of adequate nutrient levels, which are indispensable for the growth of plants. This is attributable to the osmotic and specific ion toxicity effects of salinity. Consequently, salinity imposes limitations on root development and seedling growth (Pour-Aboughadareh et al., 2021; Irik & Bikmaz, 2024). As illustrated in Table 4, there was significant variation in the root and shoot height reductions (RHR, ShHR) of studied genotypes, when treated with different doses of NaCl. The lowest RHR and ShHR were exhibited by BGR 43665 and BGR 43669 at 50 mM NaCl. At the highest salinity stress, the root reduction varied between 0.89 for BGR43540 and BGR43669 to 0.96 for BGR 43679, while the shoot reduction was 1 for all studied genotypes. In general, the reduction in shoot length was greater than the reduction in root length. The similar results were recorded by Chakma et al. (2019); Podder et al. (2020); Habibi et al. (2021); Fatema et al. (2024) for different plant species.

Dry matter production is an important criterion to evaluate salt tolerance in plant since it permits direct estimations of economic returns under specific saline conditions. Tao et al. (2021) found that under salt stress at seedling stage, tolerant cultivars had higher shoot water content, shoot dry weight, and lower stomata density. Therefore, in this study, shoot dry weight data obtained under application of different NaCl salinity stresses were used to calculate 9 indices for screening salt tolerant and susceptible genotype (Pour-Aboughadareh et al., 2019).

In the control variant, shoot dry weight ranged from 4.71 mg/plant for BGR43307 to 7.75

mg/plant for BGR43665. Under salinity stress, shoot dry weight varied between 0 mg/plant for BGR43540, BGR43669 and BGR43307 in the variant with 250 mM NaCl and 6.48 mg/plant for BGR43665 in the variant with 50 mM NaCl. The relative change due to salinity stress demonstrated that the genotypes BGR43665 and BGR43679 exhibited minimal alterations at 50 mM NaCl, with respective reductions of 16.34% and 16.55% compared to the control. At 100 mM to 250 mM NaCl, genotype BGR43665 showed the least significant change compared to the control, in contrast to the other genotypes evaluated in this study (Table 5).

Table. 5 Variation in tolerance and susceptibility indices at different salinity level of five barbed goatgrass genotypes

Genotype	Yp	Ys	RC	TOL	MP	GMP	HM	SSI	STI	YI	YSI	RSI
50 mM NaCl												
BGR43679	5.79	4.83	16.55	0.96	5.31	5.29	5.37	0.62	0.72	1.06	0.83	1.14
BGR43540	6.96	4.08	41.85	2.91	5.51	5.31	5.12	1.56	0.72	0.89	0.58	0.79
BGR43669	6.00	4.25	29.17	1.75	5.13	5.05	4.98	1.09	0.65	0.93	0.71	0.97
BGR43307	4.71	3.25	30.97	1.46	3.98	3.91	3.85	1.16	0.39	0.71	0.69	0.94
BGR43665	7.75	6.48	16.34	1.27	7.12	7.09	7.06	0.61	1.29	1.42	0.84	1.14
100 mM NaCl												
BGR43679	5.79	3.62	37.58	2.18	4.70	4.58	4.45	0.94	0.54	0.97	0.62	1.04
BGR43540	6.96	3.23	53.69	3.74	5.09	4.74	4.41	1.34	0.58	0.86	0.46	0.77
BGR43669	6.00	3.25	45.53	2.75	4.63	4.42	4.22	1.14	0.50	0.87	0.54	0.91
BGR43307	4.71	3.01	36.09	1.70	3.86	3.76	3.67	0.90	0.36	0.81	0.64	1.07
BGR43665	7.75	5.58	27.96	2.17	6.67	6.58	6.49	0.70	1.11	1.49	0.72	1.20
Average	6.24	3.74	40.23	2.51	4.99	4.81	4.65	1.00	0.62	1.00	0.60	1.00
150 mM NaCl												
BGR43679	5.79	2.43	57.99	3.36	4.11	3.75	3.43	1.10	0.36	0.82	0.42	0.89
BGR43540	6.96	2.89	58.52	4.08	4.93	4.49	4.08	1.11	0.52	0.98	0.41	0.88
BGR43669	6.00	3.08	48.61	2.92	4.54	4.30	4.07	0.92	0.47	1.04	0.51	1.08
BGR43307	4.71	2.20	51.15	2.41	3.50	3.29	3.09	0.97	0.28	0.78	0.49	1.03
BGR43665	7.75	4.08	47.31	3.67	5.92	5.63	5.35	0.90	0.81	1.38	0.53	1.11
Average	6.24	2.96	52.72	3.29	4.60	4.29	4.00	1.00	0.49	1.00	0.47	1.00
200 mM NaCl												
BGR43679	5.79	1.00	82.73	4.79	3.40	2.41	1.71	1.04	0.15	0.78	0.17	0.84
BGR43540	6.96	0.79	88.72	6.18	3.88	2.34	1.41	1.12	0.14	0.61	0.11	0.55
BGR43669	6.00	1.25	79.17	4.75	3.63	2.74	2.07	1.00	0.19	0.97	0.21	1.01
BGR43307	4.71	0.71	84.96	4.00	2.71	1.83	1.23	1.07	0.09	0.55	0.15	0.73
BGR43665	7.75	2.70	65.16	5.05	5.23	4.57	4.00	0.82	0.54	2.09	0.35	1.69
Average	6.24	1.29	80.15	4.95	3.77	2.78	2.08	1.01	0.22	1.00	0.20	0.96
250 mM NaCl												
BGR43679	5.79	0.01	99.83	5.78	2.90	0.24	0.02	1.00	0.00	0.50	0.00	0.54
BGR43540	6.96	0.00	100.00	6.96	3.48	0.00	0.00	1.00	0.00	0.00	0.00	0.00
BGR43669	6.00	0.00	100.00	6.00	3.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
BGR43307	4.71	0.00	100.00	4.71	2.35	0.00	0.00	1.00	0.00	0.00	0.00	0.00
BGR43665	7.75	0.09	98.84	7.66	5.92	0.84	0.18	0.99	0.02	4.50	0.01	3.62
Average	6.24	0.02	99.73	6.22	3.13	0.22	0.04	1.00	0.00	1.00	0.00	0.83

Yp- shoot dry weight under control, mg/plant, Ys- shoot dry weight under salinity condition, RC-relative change TOL-Tolerance, MP-Mean productivity, GMP-Geometric mean productivity, HM-Harmonic mean, SSI-Stress susceptibility index, STI-Stress tolerance index, YI-Yield index, YSI-Yield stability index, RSI-Relative stress index.

The TOL index states that genotypes with higher values are more sensitive to stress, while those with lower values are more tolerant (Pour-Aboughadareh et al., 2019). In accordance with these findings, genotype BGR43679 exhibited the greatest tolerance at 50 mM NaCl salinity, while genotype BGR43307 demonstrated the highest tolerance when subjected to increasing concentrations of sodium chloride ranging from 100 to 250 mM, as compared to the other genotypes. Pour-Aboughadareh et al. (2019) noted that

genotypes demonstrating robust performance under both non-stress and stress conditions had high values for the STI, MP, GMP, and HM indices, thus being identified as tolerant. The results of the study showed that genotype BGR43665 demonstrated the greatest salt tolerance when exposed to increasing concentrations of sodium chloride ranging from 50 to 250 mM, as a comparison to the other genotypes. The SSI (Stress Susceptibility Index) is a tool employed to evaluate the severity of genotypes in stress environments, thereby reflecting their vulnerability. Lower SSI values are indicative of genotypes that are more tolerant to stress, and conversely, higher SSI values are indicative of genotypes that are less tolerant to stress (Bhandari et al., 2024). According to this index genotype BGR43540 was identified as the most sensitive genotype, while BGR43665 as the most tolerant to the tested salt doses. The three stability indices (YI, YSI and RSI) used to assess genotypic stability under both stress and non-stress conditions showed that genotypic stability of the studied genotypes decreased with increasing salt stress. According to these indices, the most tolerance genotypes at low salinity stress (50-100 mM NaCl) were BGR43679 and BGR43665, at medium salinity stress were BGR43669 and BGR43669, while for the high stress respectively BGR43679 and BGR43665 (Table 5). Table 6 presents the ranking of the genotypes studied based on the indices calculated for each variant in the experiment. Ranking by different indices for each of the genotypes studied affects its rank differently relative to the whole group, so the average of the summary ranks (ASR) was calculated for all statistics to select potentially the best genotypes. The genotype with a low ASR value is considered as the most superior genotype (Pour-Aboughadareh et al. (2019). Therefore, taking into account the calculated values for ASR, the genotype most tolerant to the studied salinity doses was BGR43665, which exhibited values ranging from 1.09 at 50 mM NaCl to 1.36 at 250 mM NaCl. The most sensitive to NaCl salinity stress was BGR43307.

Table 6. Ranking of studied five barbed goatgrass genotypes on the base of the calculated tolerance and susceptibility indices at different salinity level

Genotype	Yp	Ys	TOL	MP	GMP	HM	SSI	STI	YI	YSI	RSI	SR	ASR	SD
50 mM NaCl														
BGR43679	4	2	1	3	3	2	2	3	2	2	2	26	2.36	0.81
BGR43540	2	4	5	2	2	3	5	2	4	5	5	39	3.55	1.37
BGR43669	3	3	4	4	4	4	3	4	3	3	3	38	3.45	0.52
BGR43307	5	5	3	5	5	5	4	5	5	4	4	50	4.55	0.69
BGR43665	1	1	2	1	1	1	1	1	1	1	1	12	1.09	0.3
100 mM NaCl														
BGR43679	4	2	2	3	3	2	3	2	3	3	3	30	2.73	0.65
BGR43540	2	4	5	2	2	3	5	2	4	5	5	39	3.55	1.37
BGR43669	3	3	4	4	4	4	4	4	3	4	4	41	3.73	0.47
BGR43307	5	5	1	5	5	5	2	5	5	2	2	42	3.82	1.66
BGR43665	1	1	2	1	1	1	1	1	1	1	1	12	1.09	0.3
150 mM NaCl														
BGR43679	4	4	3	4	4	4	4	4	4	4	4	43	3.91	0.3
BGR43540	2	3	5	2	2	2	5	2	3	5	5	36	3.27	1.42
BGR43669	3	2	2	3	3	3	2	3	2	2	2	27	2.45	0.52
BGR43307	5	5	1	5	5	5	3	5	5	3	3	45	4.09	1.38
BGR43665	1	1	4	1	1	1	1	1	1	1	1	14	1.27	0.9
200 mM NaCl														
BGR43679	4	3	3	4	3	3	3	3	3	3	3	35	3.18	0.4
BGR43540	2	4	5	2	4	4	5	4	4	5	5	44	4	1.1
BGR43669	3	2	2	3	2	2	2	2	2	2	2	24	2.18	0.4
BGR43307	5	5	1	5	5	5	4	5	5	4	4	48	4.36	1.21
BGR43665	1	1	4	1	1	1	1	1	1	1	1	14	1.27	0.9
250 mM NaCl														
BGR43679	4	2	2	4	2	2	2	2	2	2	2	26	2.36	0.81
BGR43540	2	3	4	2	3	3	3	3	3	3	3	32	2.91	0.54
BGR43669	3	3	3	3	3	3	3	3	3	3	3	33	3	0
BGR43307	5	3	1	5	3	3	3	3	3	3	3	35	3.18	1.08
BGR43665	1	1	5	1	1	1	1	1	1	1	1	15	1.36	1.21

Yp- shoot dry weight under control, mg/plant, Ys- shoot dry weight under salinity condition, TOL-Tolerance, MP-Mean productivity, GMP-Geometric mean productivity, HM-Harmonic mean, SSI-Stress susceptibility index, Stress tolerance index, YI-Yield index, YSI-Yield stability index, RSI- Relative stress index, SR-sum of ranks, ASR-average sum of ranks, SD-standard deviation.

CONCLUSIONS

Genotype, concentration and their interactions had significant individual effects on the investigated germination and seedling traits of *Aegilops triuncialis* L. The strongest effect on trait expression being exerted by the applied concentration, except for the trait germination percentage where genotype and concentration had almost equal contributions to trait expression. The application of increasing concentrations of the NaCl prolonged the mean germination time and suppressed the studied germination and seedling traits and had a greater inhibitory effect on shoot growth compared to root growth. The genotype BGR43665 was relatively the most tolerant to the application of increasing concentrations of 50 to 250 mM NaCl, The genotype BGR43665 was relatively the most tolerant to the application of increasing concentrations of 50 to 250 mM NaCl, while the highest concentration of 300 mM NaCl had toxic effect on seed germination in all of the studied genotypes.

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