THE RESPONSE OF SEED GERMINATION TO SALINITY IN BARLEY (*Horduem Vulgare* L.)

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Master Thesis

Field crops

Supervisered: Prof. Dr. Mehmet Aycicek

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This Master Thesis on..... by the following jury members

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PREFACE

I would like to thank (Allah) for giving me the power to start and complete this work. I would like to express my sincere thanks to Prof. Dr. Mehmet AYÇİÇEK for his longanimity and right orientation during this study. I would like to thank Assoc. Prof. Dr. Hasan KILIÇ, Asst. Prof. Dr. Mustafa OKANT, Assoc. Prof. Dr. Kağan KÖKTEN, Asst Prof. Veysel TURAN and Asst. Prof. Erdal ÇAÇAN. A special thank also goes to Res. Ass. Senem SABANCI for her encouragement to me in this work. I appreciate the delight I earned from the University of Bingol, College of agriculture and the department of Field crops. Finally, I would like to thank my family especially my aunt for their support. I dedicate this work to my wife and son.

Rezheen Sedeeq

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LIST OF SYMBOLS

µM	:	Micrometre
Ca	:	Calcium
$CaCl_2$	:	Calsium chloride
°C	:	Celsius degree
Cl	:	Chloride
Cm	:	Micrometre
dS m^{-1}	:	decisiemens per metre
EC	:	electrical conductivity
g	:	Gram
K	:	Potassium
KCl	:	Potassium chloride
L	:	Litre
mM	:	Millimolar
mg	:	Mili gram
NaCl	:	sodium chloride

THE RESPONSE OF SEED GERMINATION TO SALINITY IN BARLEY (*Hordeum vulgare* L.)

ÖZET

Bu çalışmanın amacı çimlenme döneminde NaCl stresinin dokuz farklı arpa çeşidi (*Hordeum vulgare* L.) tohumları üzerine etkileridir. Saf su kullanıldığı kontrol ile birlikte dört farklı doz (50, 100, 150 ve 200 mM) kullanılmıştır. Sonuçlar göstermiştir ki; tuzluluk artıkça bütün parametreler azalmıştır, ancak doz ve çeşit interaksiyonunda çimlenme hızı ve oranında önemli bir fark olmamıştır. Genel olarak ölçülen bütün parametrelerle ilgili olarak diğer çeşitlerle kıyaslandığında Şahin-91, Olgun, Karatay-94 ve Aydan Hanım çeşitleri tuza toleranslı olduğu gözlenmişti.

Anahtar kelimeler: Arpa, çimlenme, tuzluluk.

THE RESPONSE OF SEED GERMINATION TO SALINITY IN BARLEY (*Hordeum vulgare* L.)

ABSTRACT

The aim of the study was to realize the response of seeds of nine different barley cultivars (*Hordeum vulgare* L.) to NaCl stress during the germination period. Four levels of salinity (50, 100, 150 and 200 mM) with the control which was distilled water as a control were used. Result shown that there was a significant reduction in all parameters with increasing salinity levels, however there was not any significant differences in germination speed and rate when varities interacted with concentrations. Generally it has been observed that Şahin-91, Olgun, Karatay-94 and Aydan Hanım varieties are the most tolerance to salinity compared to other varieties with regards to all tha parameters that has been measured.

Keywords: Barley, seed germination, salinity.

1. INTRODUCTION

Barley is scientifically named *Hordeum vulgare* L. conv hexastichon (six rows) and *Hordeum vulgare* L. conv distichon (two rows) which belongs to family Poaceae (Gramineae). The chromosome number of barley is 2n = 14. Barley is one of the most important cereals and ranks 4th after maize, rice and wheat, while it is fifth among the cereals for producing the dry matter in the world, thus barley is considered to be an important source of food (Yousofinia et al. 2012). Barley is one of the most resistant crops to salinity (Ceccarelli et al. 1987). As reported by (Bagwasi 2015) salinity is the amount of soluble salt in water or soil. Salinity is abiotic stress affects nearly one billion hectares of the agricultural land area around the world (FAO 2007). One of the factors for determining the success of plant emergent is salinity. Therefore an experiment on toleration to NaCl in germination stage is very important to determine the lowest limit of salinity for this stage (Yousofinia et al. 2012). Salinity directly affects the yield production in most crop cereals. The common salt is NaCl which causes salinity; however some plants have the ability to adapt to this unfavorable stress (Munns and Tester 2008). In plant Na and Cl are increase and other minerals nutrients decrease such as Ca, K and nitrate inside the plant (Frike et al. 2004). Barley is accounted as the tolerant species to salinity in cereal crops (Belaid and Morris 1991).

It seems that every stage has special genes which regulate the salinity in the plant (Mano and Takeda 1997). Germination and early growth have the different tolerant level in same genotypes under saline treatment and there is no link between germination and vegetative growth to salinity tolerance (El Madidi et al. 2016). It appears that each stage of barley cultivars is best to test to identify total salt tolerant in the same plant (Huang and Redmann 1995).

Imbibition is the first and most important stage in seed germination, salinity is one of the important factors that have effects on the amount of water that absorbent by seed. (Al Fakhry and Khalaf 1983). A constant germination and establishing of plants based on the quality of planted seeds and seeds surrounding conditions (Acquaah 2002). The process of seed germination from imbibition to emergence of radicle and plumle is very substantial for establishing the new plant, it may be influenced by high concentration of NaCl in irrigated water (Anbumalarmathi and Mehta 2013 and Rahman et al. 2008). In addition to decreasing the seed germination it has been proved that salinity also delays the germination (Bagwasi 2015). Germination is a vital stage of production in most cereals. Osmotic is the only factor that reduces the germination ratio in salinity environment (Zhang et al. 2010). The most strengent and liability to risk in plant life is seed germination (Bagwasi 2015). Divergence in the levels of salinity may restricted seed germination, in some situation it is give rise to death of seeds (Ramoliya et al. 2003 and Radic et al. 2005)

It is found that the most sensitive stage to saline is germination stage (Movafegh et al. 2012).Barley cultivars were sensitive to osmotic stress during germination stage (Huang and Redmann 1995). Germination ratio is decreased for three genotypes of barley when treated with salt stress (Wu et al. 2013). (Yousofinia et al. 2012) found that salinity decrease ratio of germinated seed and delay the seed germination. It is revealed that the ratio and percentage germination of barley was decreased sharply under salt stress (Ahmad et al. 2006) (100 mM) of NaCl inhibited growth of germination in compare to (50 mM) of NaCl (Demirkiran et al. 2013). (Al-Karaki 2001) concluded that ion toxicity in did not affect germination while eternal osmotic or internal osmotic affected germination in salt stress.

In addition, salinity affects early growth stage after germination and especially leaves part as the photosynthesis is placed. The shoot was more sensitive to salinity than root in wild and cultivated barley (Degl'Innocenti et al. 2009). At seedling stage barley protect shoot from accumulating NaCl and use Na and Cl to regulate osmotic stress at the leave (Pérez-López et al. 2014). Salinity had a huge effect on iron uptake in young plant barley (Gene) was induced in cell wall proteins under salt stress and led to an increase of proline transport in the apical region of the root in barley (Ueda et al. 2007).In seedling stage

there was a different level of tolerance among to accessions tested under salt stress (Nevo and Chen 201k0). It is suggested that salinity in alkaline soil lead to reduce iron uptake by plant due to silent phytosiderophore release (Yosfi et al. 2007).

2. LITERATURE REVIEWS

Seeds of six cultivars of barley were exposed to saline irrigation during germination in a study by Hussain et al. (1997). With increasing EC of water that has been used for irrigation to 9.26 dS m^{-1} the seed germination gave rise to decrease 24% to %35, the reduction ratio was 28-47% when the EC is raised to 13.4 dS m^{-1}. The decreasing of germination was 30-53% when EC was 16.28 dS m^{-1}. in addition to germination saline water also affected on plant height and the number of tillers in plant, in which they decrees with increasing the concentration of NaCl.

According tk8o Adjel et al. (2013) experiment on twelve barley genotype to find out their response to salinity stress in germination stage, they found that there is a drastic reduction in root length, length of coleoptile germination percentage, germination speed in sensitive cultivars.

Mer et al. (2000) applied four different crops (wheat, barley, gram, and brassica) into an experiment in a greenhouse to determine their reaction to salinity. The result showed that barley was the most resistant to high concentration of NaCl during seed germination and early seedling growth stage. While the other plant (mustard, gram and wheat) they were resistance to low concentration of NaCl in water only. Combustion symptoms on the leaves of barley was evident in high concentration level of NaCl.

As reported by Othman et al. (2006) when salt sensitivity were assessed to twelve genotypes of barley in an experiment during germination. 30 seeds were taken from each genotype and placed in Petri dishes, with using different concentrations of NaCl (100, 200, 300 mM) and control which means 10.6, 19.0, 27.0 and 0.05 dS m^{-1} (control) as an electrical conductivities. Seed germination percentage was diminished rapidly with increasing NaCl. At the most elevated level (300 mM) germination was significantly decreased.

The study was conducted in the laboratory by Al-Seedi (2008) to investigate the effect of saline water on seed germination of barley. The concentrations that have been used were (3, 6, 9, 12 and 15 dS m^{-1}) of NaCl with distilled water as a control. It has been observed any alleviation in concentration (15, 12, 9 and 6 dS m^{-1}) caused increasing of germination percentage (8%, 5%, 3%, and 2%) respectively, the radicle and shoot length, dry weight of shoots and radicle were decreased also.

It has been disclosed by El Goumi et al. (2014) that the Length of shoot and root, germination percentage, and dry weight even wet weight of (shoot and root) were significantly reduced by increasing the concentration of NaCl when Three cultivars of Moroccan barley have interacted with five different concentrations of NaCl including water as a control (5, 10, 15, 20 g/L and 0 g/L).

Aharizad et al. (2013) used seeds of 20 barley in an experiment to evaluate the tolerance to salinity during germination stage, the experiment was conducted in the laboratory. Length of seminal root and Coleoptiles were measured, with increasing levels of salinity these measurements were decreased. It has been observed that high concentration of NaCl in water affected root growth more than growth of shoots.

Dadashpour (2012) made a study to realize the Influence of different concentration's and different source of salt on seed germination of pumpkin were evaluated. The sources of salt were (KCl, CaCl2 and NaCl), the concentrations were (0, 1, 3, 5, 7 and 9 dS m^{-1}). While the salinity level of water is more than (5 dS m^{-1}), Germination percentage, the length of root and shoots and weight (wet and dry) of shoots and root tip to decrease.

According to the result of a study that conducted by Bagwasi (2015), with testing three cultivars of barley and three cultivars of wheat by exposing these cultivars to different salinity level (4, 8, 12, 16 and 20 dS m^{-1}) and filtered water as a control at high levels of salinity, the germination rate of wheat was more than barley and barley was more sensitive to salinity compared to wheat in the germination stage.

Abdi et al. (2016) made a study to investigate the reaction of seven varieties of barley to five levels of salinity. The experiment was regulated in the laboratory for seven days, at

the end, it has been observed that the emergence of coleoptile is more effective to salinity than the breaching of radicle. Generally by increasing the salinity level, the germination rate was decreased.

Naseri et al. (2012) conducted this experiment to test the response of three varieties of barley to six concentrations of NaCl (0, 3, 6, 9, 12 and 15 ds m^{-1}). The highest percentage of germination, length of primary root and wet weight of primary root was recorded in the control (0 dS m^{-1}) and the lowest was reported in (15 dS m^{-1}).

Muhammad and Hussain (2012) made a laboratory experiment in order to define the response of wheat to salinity stress. He applied seven genotypes of wheat and five concentration of NaCl 0.02 as a control, 2, 4, 6 and 8 dS m^{-1}. the percentage of germination affected significantly by increasing NaCl level, but the variations between different levels of NaCl were non-significant.

Atabayeva et al. (2013) reported a significant reduction in biomass and growth of the plant contrariwise to the proportion of (exodermis root/endodermis root) is increased in a few varieties, when some varieties of barley exposed to salinity in a hydroponic experiment.

Kılıç et al. (2007) infused the seeds of barley (Bülbül-89) in 3 µM 24-epibrassinolide for 24 hours in a study to improve the inhibitory impact of salinity. The result shown that the pretreatment of seeds was prosperous in improving the inhibitory of seeds to salinity on germination percentage, elongation of radicle and wet weight, however for coleoptile elongation it was not successful.

Hussain et al. (2013) exposed seeds of three cultivars of wheat to three concentrations of NaCl (6.8, 13.2 and 19.0 dS m^{-1}) with control which it was a (distilled water) in petri dishes. Piecemeal reduction in germination and early growth were reported.

Idilkut (2013) utilized four concentrations (0, 25, 50, 100 mM) in a study, to investigate their effect on seed germination in maize. The highest (root and shoot length, germination rate, and germination speed) were reported in (0) concentration.

Akbarimoghaddam et al. (2011) performed a study to appreciate the impact of NaCl on six varieties of bread wheat during germination. The germination was reduced and delayed, the length of root and shoot also decreased by increasing the level of salinity from (0) to (12.5) dS m^{-1} respectively.

Atak et al. (2006) organized a research on triticale, three registered cultivars of triticale k8and six levels of salinity (2.4, 4.2, 5.9, 7.7, 10.6 and 13.2 dS m^{-1}) has been utilized in the research. The results shown that Final germination percentage of triticale doesn't effect by different level of salinity, while germination time decreased with increasing salinity.

A laboratory experiment was done by Akbari et al. (2007) to determine the effect of salinity on germination of bread wheat. The result indicates that germination percentage, a length of radicle and hypocotyl and dry weight of hypocotyl were diminished when NaCl concentration was increased.

Groundnut was tested to salinity stress by Ambede et al. (2012) in Maseno University, Kenya. The seeds of two varieties of groundnut were irrigated with saline water, the concentrations were (0 (control), 6.96, 12.93, 19.89 and 25.86 dS m^{-1}). In general a saline water reduced seed germination comparing to the control. As well the effect of NaCl was visible on root length.

El-Tayeb (2005) aimed in his study to realize the Impact of dipping grain of barley in 1 mM salicylic acid. Five concentration of NaCl were used (0, 50, 100, 150 and 200 mM) in this experiment, the result was non-significant in which the germination was decreased by increasing salinity level.

The response of four genotypes of sweet sorghum to salinity tolerance was tested by Almodares et al. (2007). The concentrations of NaCl were (0, 100, 200, 300 mM). There was a significant reduction in germination percentage for all the genotypes, and at 200 mM level and above one of the cultivars didn't germinate.

Bağcı et al. (2003) made a hydroponically experiment was conducted to investigate the salt tolerance of eight genotypes of barley. Hoagland solution were used as a nutrient solution with five concentrations of NaCl (3.4, 59.3, 133.3, 216.6 and 314.5 mM). An obviously decline was observed in germination percentage at (216.6 and 314.5 mM), increasing salinity gave rise to decrease the shoot length and weight.

This study was accomplished by Taghipour and Salehi (2008) at Azad University of Miyaneh, Iran. The effect of salinity on the dry and wet weight of root and shoot, shoot length, and leaf area were studied. There was a significant reduction in all parameters when salinity concentration increased.

Yousofinia et al. (2012) exposed four cultivars of barley to three concentrations of NaCl (0, 50, 100 mM) in a research to investigate their resistance to salinity during germination. The extreme germination percentage was reported in (0) concentration, while the lowest percentage of germination reported in (100 mM).

Tavili and Biniaz (2009) performed a study to estimate the salt resistance during germination stage, 25 seeds of each (*Hordeum vulgare*) and (*Hordeum bulbosum*) were planted in Petri dishes. Eight concentrations (0, 60, 120, 180, 240, 300, 360 and 420 mM) of three kinds of saline solutions (CaCl2, KCl and NaCl) were prepared. By increasing the level of salinity the germination of seed decreased, and also high salinity level influenced the mean time of germination negatively. It has appeared that (*Hordeum bulbosum*) is more sensitive to salt than (*Hordeum vulgare*).

The study was implemented in College of Sciencek, Al-Mustansiriya University, Baghdad, Iraq by AL-Saady (2015). Four concentrations of NaCl (40, 80, 120 and 160 mM) and filtered water as a control were used to realize their effects on wheat during the germination phase. Compared to the control, the reduction ratio of germination percentage was (10.11, 22.54, 27.82 and 34.44%) by (40, 80, 120 and 160 mM) respectively. furthermore the reduction ratio of the germination speed was (7.14, 14.58, 32.74 and 38.10%) under (40, 80,120 and 160 mM) respectively Comparing to control.

The purpose of the experiment is to obtain rice response to salinity during germination. Eight genotypes of rice and two concentrations of NaCl and distilled water were used (0, 100, 200 mM). Generally, salinity negatively affected on germination percentage and germination speed, with increasing salinity the speed and percentage of germination decreased (Ghoneim et al). (2015).

According to Läuchli and Grattan (2007) most of the studies mentioned that plants during vegetative and early seedling growth phase are particularly susceptible to NaCl comparing to germination phase. This has been found by Maas et al. (1983) in corn.

3. MATERIAL AND METHOD

The experiment was organized in the laboratory of the Department of Field Crops, Faculty of Agriculture, University of Bingol. Complete Randomized Design (CRD) was used in this experiment with three replications.

3.1. Material

3.1.1. Seeds

Seeds of barley cultivars

Şahin-91 : 2 rows, alternative

Karatay-94 : 2 rows, alternative

Olgun : 6 rows, winterweight

Aydan Hanım : 2 rows, winterweight

Kral-97 : 6 rows, alternative

İnce-04 : 2 rows, alternative

Tarm-92 : 2 rows, alternative

Bülbül-89 : 2 rows, alternative

Çetin-2000 : 6 rows, winterweight

3.1.2 Preparation of sodium chloride solution

Four different concentrations of NaCl were prepared: (50, 100, 150, and 200 mM) by dissolving NaCl in filtered water in addition to (0) concentration which was distilled water as a control.

3.2. Method

All the seeds have been sterilized bye (sodium hypochloride % 5) solution, subsequently, the seeds washed with filtered water, and it has been putted in Petri dishes (9 cm diametre) with double-layer filter paper (each Petri 20 seed) the seeds placed between two filter papers.

3.2.1. Measurements

3.2.1.1. Germination speed

When the radicle emergence from the seeds it deemed a germinated seed. The number of germinated seeds till the 4^{th} day were counted. Germination speed is the number of germinated seeds till the 4^{th} day divided by the total number of seeds that sown*100 (Sağsöz 1995).

3.2.1.2. Germination rate

The number of germinated seeds till the 7^{th} day divided by the total number of seeds that sown*100 (Sağsöz 1995).

3.2.1.3. Leaf and root length

The length of leaf and root were measured in (cm) after 7 days from the beginning of an experiment.

3.2.1.4. Leaf and root fresh weight

The fresh weight of root and leaf were measured in (g) by using sensitive balance after 7 days from the beginning of an experiment.

3.2.1.5. Leaf and root dry weight

The roots and leaves were dried by putting the matter in an oven for 48 hours at (68) °C, after that the dry matter were weighed with sensitive balance.

3.3. Statistical analysis

(SAS) program was used for data analysis.

4. RESULT AND DISCUSSION

The results of ANOVA belong to the effects of different salt concentrations on some barley cultivars during the germination are presented in Table 1. As it can be seen on the table, the differences in germination speed, germination rate, firs leaf length, first root length, fresh leaf weight, fresh root weight, dry leaf weight and dry root weight were found significant statistically (P0.001). While the interactions between the varieties and the salt concentrations were non-significant, in the germination speed and germination rate. However, the important differences such as the dry leaf weight and root length 0.05, wet root weight and dry root weight 0.01, fresh leaf weight and leaf length 0.001 are found to be significant differences.

Table 1. The mean square values of the examined features in the experiment conducted using nine different barley cultivars and five different salt concentration

Source	DF	GS	GR	LL	RL	FLW	FRW	DLW	DRW
Varieties	8	8191.99	9495.83	7.02	19.91	0.068	0.036	0.00034	0.0005
Concentrations	4	3589.16	3902.50	327.98	235.0	0.481	0.147	0.00375	0.0018
Interaction (V*C)	22	190.37	160.20	2.41	2.17	0.0061	0.005	0.00005	0.00006
Error	100	137.01	98.92	0.50	1.25	0.0017	0.002	0.00003	0.00003
Total	134								

4.1. Germination speed

The values of the varieties and salt concentrations obtained through the analysis of variance conducted in terms of the germination speed are presented in Table 2, Table 3 and Table 4 respectively.

Table 2. Germination speed values of variance analysis results of the germinated barley cultivars with different salt concentrations

Source	DF	SS	MS	F value	
Varieties	8	75966.66	9495.83	95.99	***
Concentrations	4	15610.00	3902.50	39.45	***
Interaction (V*C)	22	3524.56	160.20	1.62	ns
Error	100	9892.09	98.92		
Total	134	104993.33			

***: Statistically significant at the level of 0.001, ns: Non Significant

Table 3. Germination speed values of the barley cultivars

Number	Varieties	Mean
1	Şahin-91	88.66 a
2	Karatay-94	72.00 b
3	Olgun	70.33 b
4	Aydan Hanım	68.33 b
5	Kral-97	58.00 c
6	İnce-04	55.33 c
7	Tarm-92	32.33 d
8	Bülbül-89	24.00 e
9	Çetin-2000	13.00 f

LSD (0.05) = 7.20

Table 4. Germination speed values obtained in different salt concentrations applied to barley cultivars

Number	Salt Concentrations	Mean
1	C_O (Control)	71.11 a
2	C_1 (50 mM)	56.85 b
3	C_2 (100 mM)	54.63 b
4	C_3 (150 mM)	45.55 c
5	C_4 (200 mM)	39.63 d

LSD (0.05) = 5.37

The differences between varieties in terms of germination speed was found to be statistically significant at the 0.001 level. The highest speed of germination among varieties found in Şahin-91 (88.66%) and the lowest in Çetin-2000 (13.00%). Karatay-94 is 72.00%, Olgun 70.33%, Aydan Hanım 68.33%, Kral-97 58.00%, İnce 55.33%, Tarm-92 is 32.33% while Bülbül-89 has had a germination speed projected at 24.0%.

The control application resulted the highest germination speed in the study, it has been found that raising doses that applied to the study gave rise to reduce the germination speed and this collapse was also observed to be statistically significant (Table 2. Germination Speed). During the control application when the germination speed are determined as %71.11 it was observed that the values have resulted as follows %56.85, %54.63, %45.55 and %39.63 respectively once the salt concentrations increased.

The results obtained from our study that when salt concentrations are increased the germination is negatively affected are similarly found in the researches conducted by Huang and Redmann (1995), Naseer et al. (2001), El-madidi et al. (2004), Ahmad et al. (2006), Naseri et al. (2012) as well as Adjel et al. (2013). Movafegh et al. (2012) while using three varieties of barleys in the salinity tolerance experiment, they found that statistically the germination rate of the varieties are significantly affected by the salinity level; they stated that the lowest germination rate is obtained with using the highest level of salinity.

Ghoulam & Fares (2001), stated that the low dosages of salt concentrations are delaying the germination while the high dosages reduce the rate of germination. Salt stress is negatively affecting almost all the stages of the development such as germination, seed viability, seedling formation, vegetative growth, flowering and seed formation, consequently it decreases the economic productivity and the quality of the product (Rogers et al. 1995); different researchers found that the most affected development stage from the salt stress is germination stage (Baldwin et al. 1996; Katembe 1998).

Al-Karaki (2001) in his research to determine the salt tolerances at germination stages conducted for six varieties of barley, found that similarly like in many other types of plants increasing salt concentrations in barley results in reducing the germination speed and power. The researcher concluded that the decrease in the germination is resulted from the insufficient absorption of the water in more salty solutions rather than the toxic effect of NaCl.

According to (El-Madidi et al. 2004) the increased salt concentration in five local varieties and four breeding varieties has reduced the germination rate significantly, while

in another study it was found that the local varieties are more tolerant to saltiness at germination stages as compared to those at breeding program.

Salinity tolerance has been tested in other studies on different genus of plants as well; Saboora et al. (2006) in their study conducted on nine different wheat varieties found that the germination rate is decreased significantly by increasing salinity.

In our study, the variance differences related to the interaction of variety * salt concentration in terms of germination speed was found to be non-significant statistically. This situation shows that different doses of salt concentrations does not affect the germination speed of varieties, and that all the varieties are similarly affected in regard of this feature. The results obtained in the studies conducted by El-Maididi et al. (2004) and Movafegh et al. (2012) are supporting our research results; however, Yousufinia et al. (2012), Adjel et al. (2013) in their studies determined that the genetic responses of salinity in terms of germination ratios are different.

4.2. Germination rate

The difference in terms of germination rate values of nine different barley varieties used in our study and the effect of different salt concentrations on the germination rate of the varieties found to be statistically significant level 0.001; while the interaction related to variety * salt concentration found to be non-significant statistically (Table 5, 6 and 7).

Table 5. Shows the variance analysis results related to germination rate values of barley cultivars that were germinated at different salt concentration

Source	DF	SS	MS	F value	
Varieties	8	65535.92	8191.99	59.79	***
Concentrations	4	14356.66	3589.16	26.20	***
Interaction (V*C)	22	4188.27	190.37	1.39	ns
Error	100	13701.72	137.01		
Total	134	97782.59			

***: Statistically significant at the level of 0.001, ns: Non Significant

Table 6. The values of the germination rate of barley cultivars

Number	Varieties	Mean
1	Şahin-91	92.00 a
2	Olgun	83.33 b
3	Karatay-94	80.66 b
4	Aydan Hanım	79.00 b
5	Kral-97	66.33 c
6	İnce-04	61.00 c
7	Tarm-92	46.66 d
8	Bülbül-89	44.00 d
9	Çetin-2000	19.33 e

LSD (0.05) = 8.47

Table 7. The germination rate values obtained from different salt concentrations applied to barley cultivars

Number	Salt Concentrations	Mean
1	C_O (Control)	74.81 a
2	C_1 (50 mM)	72.59 ab
3	C_2 (100 mM)	67.59 b
4	C_3 (150 mM)	54.25 c
5	C_4 (200 mM)	48.70 c

LSD (0.05) = 6.32

As in germination speed, similarly in germination rate as well the highest value found in Şahin-91 variety (%92.00), and the lowest value in Çetin-2000 variety (%19.33). While Olgun, Karatay, Aydan Hanım, Kral-97, İnce, Tarm-92 and Bülbül-89 found to have %83.33, %80.66, %79.00, %66.33, %61.00, %46.66 and %44.00 germination rate respectively.

Different salt concentrations found to have statistically significant effect on the germination rate; the increased doses of salt concentrations statistically have decreased the values of germination rate of varieties at a significant level (0.001). Accordingly, the germination rate which was %74.81 during the control application. The others was found to be %72.59, %67.59, %54.25 and %48.70 respectively after the increase of salt concentration.

4.3. The first leaf length

In this study where nine different barley cultivars were germinated with four different salt concentrations against the control, the differences among varieties, concentrations and varieties*concentrations was statistically significant at 0.001 level. (Table 8.)

Table 8. Variance analysis results of the first leaf length values of barley cultivars germinated at different salt concentrations

Source	DF	SS	MS	F value
Varieties	8	56.20	7.02	13.91 ***
Concentrations	4	1311.93	327.98	649.22 ***
Interaction (V*C)	22	53.07	2.41	4.78 ***
Error	100	50.51	0.50	
Total	134	1471.72		

***: Statistically significant at the level of 0.001

Table 9. The first leaf length value of the barley cultivars

Number	Varieties	Mean
1	Olgun	7.58 a
2	Şahin-91	7.46 a
3	Karatay-94	7.41 a
4	Kral-97	7.34 a
5	İnce-04	6.78 b
6	Aydan Hanım	6.40 bc
7	Tarm-92	6.35 bc
8	Çetin-2000	6.23 c
9	Bülbül-89	5.64 d

LSD (0.05) = 0.51

Table 10. The first leaf length values obtained at different salt concentrations applied to barley cultivars

Number	Salt Concentrations	Mean
1	C_O (Control)	10.92 a
2	C_1 (50 mM)	8.59 b
3	C_2 (100 mM)	7.74 c
4	C_3 (150 mM)	4.76 d
5	C_4 (200 mM)	1.97 e

LSD (0.05) = 0.38

Table 11. Interaction values of salt concentrations * varieties in terms of first leaf length

Variety * Concentrations	Mean
Şahin-91*C_0	11.70 a
Olgun* C_0	11.66 a
İnce-04*C_0	11.33 ab
Karatay-94 * C_0	11.23 ab
Çetin-2000* C_0	10.90 ab
Tarm-92* C_0	10.90 ab
Kral-97* C_0	10.73 abc
Karatay* C_{50}	10.36 bc
Olgun* C_{50}	10.36 bc
Bülbül-89* C_0	10.23 bcd
Aydan Hanım* C_0	9.66 cde
Olgun* C_{100}	9.13 def
Şahin-91*C_{100}	9.06 ef
Şahin-91*C_{50}	8.94 efg
Kral-97* C_{100}	8.66 efgh
İnce-04* C_{100}	8.56 efgh
Kral-97* C_{50}	8.53 fgh
Çetin-2000*C_{50}	8.46 fghi
Karatay* C_{100}	8.26 fghij
İnce-04* C_{50}	8.26 fghij
Aydan Hanım* C_{50}	7.86 ghijk
Aydan Hanım* C_{100}	7.80 hijk
Bülbül-89* C_{50}	7.43 ijk
Tarm-92* C_{100}	7.20 jk
Tarm-92* C_{50}	7.10 k
Çetin-2000* C_{100}	5.63 l
Kral-97* C_{150}	5.63 l
Şahin-91*C_{150}	5.60 l
Olgun* C_{150}	5.43 l
Karatay* C_{150}	5.40 l
Bülbül-89* C_{100}	5.40 l
İnce-04* C_{150}	4.7 ln
Aydan Hanım* C_{150}	4.53 lm
Çetin-2000* C_{150}	4.53 lm
Tarm-92* C_{150}	3.63 mn
Bülbül-89* C_{150}	3.40 n
Kral-97* C_{200}	3.16 no
Tarm-92* C_{200}	2.93 nop
Aydan Hanım* C_{200}	2.16 opq
Şahin-91*C_{200}	2.03 pqr
Karatay* C_{200}	1.78 qr
Bülbül-89* C_{200}	1.73 qr
Çetin-2000* C_{200}	1.63 qr
Olgun* C_{200}	1.30 qr
İnce-04* C_{200}	1.03 r

LSD (0.05) = 1.10

The highest value in respect to the first leaf length resulted from the germination is 7.58 cm which is obtained from Olgun variety, while Bülbül-89 variety found to have the lowest value of leaf length with 5.64 cm.

Şahin-91, Karatay-94and Kral-97 varieties which are in the same statistical group of Olgun valued as 7.46, 7.41 and 7.34 cm leaf length respectively. The leaf lengths in İnce variety 6.78 cm, Aydan Hanım variety 6.40 cm, Tarm-92 variety 6.35 cm while in Çetin-2000 variety it was measured as 6.23 cm (Table 9).

The effect of increasing salt concentration on the first leaf length compared to control was found to be statistically significant (Table 8), while the increased salt concentrations observed to have an impact on the first leaves in varieties by reducing the leaf length. The first leaf length measured under control application is found 10.92 cm while the leaf length in the increased salt concentration recorded as 8.59 cm, 7.74 cm, 4.76 cm respectively and the lowest value In the experiment was reported when (200mM) salt concentration used resulted as 1.97 cm.

The interaction variance of variety * salt concentration statistically significant (Table 8). The barley cultivars used in the experiment affected by salt concentrations at different degrees, i.e. the varieties are not similarly reacting to the increased salt concentration and this is an important indication. Şahin-91 variety with the control dose application has had the highest leaf length, while the sensitive variety which had the lowest leaf length (1.03 cm) observed to be the most varieties affected by salt concentration (table 11).

4.4. First Root Length

According to the variance analysis results the difference between the varieties and salt concentrations in terms of root length are at 0.001 level; while the interaction between variety*salt concentration was statistically significant at 0.05 level (table 12).

Table 12. Variance analysis results of first root length values of barleys germinated at different salt concentrations

Source	DF	SS	MS	F value
Varieties	8	159.35	19.91	15.89 ***
Concentrations	4	940.00	235.00	187.45 ***
Interaction (V*C)	22	47.95	2.17	1.74 *
Error	100	125.36	1.25	
Total	134	1272.67		

***: Statistically significant at the level of 0.001, *: Statistically significant at the level of 0.05

Table 13. First root length values of barley cultivars

Number	Varieties	Mean
1	Olgun	10.36 a
2	Karatay-94	9.04 b
3	Kral-97	8.97 b
4	Tarm-92	8.58 bc
5	İnce-04	8.31 bcd
6	Şahin-91	8.02 cd
7	Aydan Hanım	7.58 d
8	Çetin-2000	7.56 d
9	Bülbül-89	6.26 e

LSD (0.05) = 0.81

Table 14. First root length values obtained at different salt concentrations applied to barley cultivars.

Number	Salt Concentrations	Mean
1	C_O (Control)	12.31 a
2	C_1 (50 mM)	9.05 b
3	C_2 (100 mM)	9.00 b
4	C_3 (150 mM)	6.71 c
5	C_4 (200 mM)	4.41 d

LSD (0.05) = 0.60

Table 15. Interaction values of salt concentration * variety in terms of first root length

Variety * Concentrations	Mean
Olgun*C_0	15.56 a
Karatay*C_0	13.83 ab
Tarm-92*C_0	13.73 b
Şahin-91*C_0	12.73 bc
İnce-04*C_0	11.33 cd
Olgun*C_{100}	11.30 cd
Aydan Hanım*C_0	11.23 cd
Olgun*C_{50}	11.13 cd
Kral-97*C_0	10.96 de
Çetin-2000*C_0	10.86 def
Bülbül-89*C_0	10.56 defg
Kral-97*C_{100}	10.53 defg
İnce-04*C_{50}	10.40 defgh
Karatay*C_{100}	10.06 defghi
İnce-04*C_{100}	9.86 defghij
Kral-97*C_{50}	9.73 defghijk
Karatay*C_{50}	9.33 efghijkl
Tarm-92*C_{50}	9.13 fghijklm
Tarm-92*C_{100}	9.10 ghijklm
Şahin-91*C_{100}	8.70 hijklmn
Çetin-2000*C_{50}	8.63 ijklmn
Olgun*C_{150}	8.53 ijklmn
Aydan Hanım*C_{50}	8.26 jklmno
Aydan Hanım*C_{100}	8.03 klmno
Kral-97*C_{150}	8.03 klmno
Karatay*C_{150}	7.96 lmno
Şahin-91*C_{50}	7.86 lmno
Çetin-2000*C_{100}	7.56 mnop
Bülbül-89*C_{50}	7.03 nopq
Şahin-91*C_{150}	6.70 opqr
Çetin-2000*C_{150}	6.53 opqr
Aydan Hanım*C_{150}	6.10 pqrs
Tarm-92*C_{150}	6.00 pqrst
İnce-04*C_{150}	6.00 pqrst
Bülbül-89*C_{100}	5.86 pqrstu
Kral-97*C_{200}	5.60 qrstuv
Olgun*C_{200}	5.30 qrstuv
Tarm-92*C_{200}	4.96 rstuvw
Bülbül-89*C_{150}	4.60 stuvw
Aydan Hanım*C_{200}	4.30 tuvw
Çetin-2000*C_{200}	4.20 uvw
Şahin-91*C_{200}	4.10 vw
Karatay*C_{200}	4.00 vw
İnce-04*C_{200}	3.96 vw
Bülbül-89*C_{200}	3.26 w

LSD (0.05)=1.73

In our study, the highest root length with 10.36 cm in germinated seeds found in Olgun variety, the lowest root length 6.26 cm found in Bülbül-89 variety. Varieties that are located in the same statistical group have had their roots lengths as Karatay-94 variety 9.04 cm, Kral-97 variety 8.97 cm, Tarm-92 variety 8.58 cm and İnce-04 variety 8.31 cm. Şahin-91 (8.02 cm), Aydan Hanım (7.58 cm) and Çetin-2000 (7.56 cm). varieties have been identified to have the lowest root length among the other varieties after Bülbül-89 variety.

Increased salt concentration has decreased the root length and this decrease was found to be statistically significant (Table 12). Highest root length in the control application which constitute a statistical group by itself found as (12.31 cm), while the decreased root length obtained from the increased salt concentration found as 9.05 cm, 9.00 cm, 6.71 cm and 4.41 cm respectively.

Varieties showed different reactions in terms of root length due to the increased salt concentrations, this case in which interaction variance of variety * salt concentration was at 0.05 level was introduced to be statistically significant (table 12). The highest root length (15.56 cm) was obtained from the variety number 6 in control application which is by itself is a statistical group; the root lengths in the varieties number 9, 3, 4, 5, 1 and 2 which have lowest root lengths showed the highest reaction to the highest salt concentration are determined as 4.30, 4.20, 4.10, 4.00, 3.96 and 3.26 cm respectively.

In the studies conducted by El-Madidi et al. (2004) in which nine different barley varieties were used, it was determined that the increased salt concentration has decreased the root and shoot length. Similar results that support our study in terms of first leaf and first root length were obtained by Degl' Innocenti et al. (2009), Yousufinia et al. (2012), Naseer et al. (2001), Movafegh et al. (2012), Huang and Redmann (1995), Naseri et al. (2012), Adjel et al. (2013) and Ahmad et al. (2006).

Waisel (1972), determined that the reason behind the influence of the root and shoot lengths from the increased salt concentrations is either because of the water absorption, or the reason is the toxic effect of NaCl the metabolic production is significantly influenced

by the high salt stress and the response to the metabolic requirements of the young tissues are limited.

The effects of increased salt concentration in germination on the first leaf and first root lengths are tested in different genus of plants as well. Atak et al. (2006), determined that the increased salt concentrations in triticale plant resulted in reducing shoot and root lengths of the varieties, and this reduction although is not significant for the length of the shoot but its statistically significant for the length of the root. While Saboora et al. (2006) determined that in nine different varieties of barley the first leaf and root lengths are negatively affected by the increased salt concentrations, and when compared to root development the first leaf length is affected more than the root.

In our study, the important interaction between the first leaf and first root lengths obtained through applying increased salt concentration and the varieties, has similarities with the results obtained from the studies conducted by Ahmad et al. (2006) and Yousofinia et al (2012). El-Maididi et al. (2004) in their study determined that the interaction is only important at the root length, while Movafegh et al. (2012) in their study they found that the interaction in terms of the mentioned components is insignificant. In a study in which triticale plant was used it was determined that the reaction of the varieties to the salt concentration in terms of root length found to be statistically significant.

4.5. Fresh leaves weight

Verities in terms of fresh leaf weight, salt concentrations and varieties*concentrations are found to be different statistically and significant at 0.001 level (Table 16).

Table 16. Variance analysis results of fresh leaf weight values of germinated barley cultivars at different salt concentrations

Source	DF	SS	MS	F value
Varieties	8	0.54	0.068	39.15 ***
Concentrations	4	1.92	0.481	274.88 ***
Interaction (V*C)	22	0.13	0.0061	3.52 ***
Error	100	0.17	0.0017	
Total	134	2.78		

***: Statistically significant at the level of 0.001

Table 17. Fresh leaves weight values of barley cultivars

Number	Varieties	Mean
1	Karatay-94	0.34 a
2	Şahin-91	0.32 ab
3	İnce-04	0.30 bc
4	Aydan Hanım	0.29 bc
5	Kral-97	0.28 cd
6	Olgun	0.25 de
7	Tarm-92	0.24 e
8	Bülbül-89	0.17 f
9	Çetin-2000	0.14 g

LSD (0.05)= 0.03

Table 18. Fresh leaves weight values obtained from barley cultivars at different salt concentrations

Number	Salt Concentrations	Mean
1	C_O (Control)	0.40 a
2	C_1 (50 mM)	0.33 b
3	C_2 (100 mM)	0.30 c
4	C_3 (150 mM)	0.21 d
5	C_4 (200 mM)	0.05 e

LSD (0.05)= 0.02

Table 19. Interaction values of Salt concentration * varieties in terms of fresh leaf weight

Variety * Concentrations	Mean
Karatay*C_0	0.511 a
İnce-04*C_0	0.46 b
Tarm-92*C_0	0.44 bc
Şahin-91*C_0	0.44 bc
Karatay*C_{50}	0.44 bc
Aydan Hanım*C_0	0.42 bcd
İnce-04* C_{100}	0.41 cde
Şahin-91*C_{50}	0.40 cdef
Şahin-91*C_{100}	0.38 defg
Karatay*C_{100}	0.38 defg
İnce-04* C_{50}	0.37 efgh
Kral-97*C_0	0.368 fgh
Aydan Hanım*C_{50}	0.366 fgh
Aydan Hanım*C_{100}	0.360 ghi
Olgun*C_{50}	0.35 ghij
Kral-97*C_{100}	0.34 ghij
Olgun*C_0	0.33 hijk
Bülbül-89*C_0	0.33 hijk
Olgun*C_{100}	0.32 ijkl
Karatay*C_{150}	0.316 ijklm
Kral-97*C_{50}	0.315 jklm
Çetin-2000*C_0	0.29 klmn
Çetin-2000*C_{50}	0.27 lmno
Tarm-92*C_{100}	0.27 mno
İnce-04*C_{150}	0.267 no
Olgun*C_{150}	0.260 no
Şahin-91*C_{150}	0.258 no
Tarm-92*C_{50}	0.256 no
Kral-97*C_{150}	0.248 op
Bülbül-89*C_{50}	0.247 op
Aydan Hanım*C_{150}	0.23 op
Bülbül-89*C_{100}	0.21 p
Tarm-92* C_{150}	0.20 p
Şahin-91*C_{200}	0.13 q
Kral-97*C_{200}	0.12 q
Aydan Hanım*C_{200}	0.10 qr
Bülbül-89*C_{150}	0.073 rs
Çetin-2000*C_{100}	0.070 rst
Karatay*C_{200}	0.047 stu
Tarm-92*C_{200}	0.041 stu
Çetin-2000*C_{150}	0.037 stu
İnce-04*C_{200}	0.026 tu
Çetin-2000*C_{200}	0.025 u
Olgun*C_{200}	0.019 u
Bülbül-89*C_{200}	0.016 u

LSD(0.05)= 0.04

In our study, the highest fresh leaf weight was in Karatay-94variety which was 0.34 g. Şahin-91 variety 0.32g, İnce variety 0.30 g, Aydan Hanım variety 0.29 g, Kral-97 variety 0.28 g, Olgun variety 0.25 g, Tarm-92 variety 0.24 g and Bülbül-89 variety recorded 0.17 g as fresh leaf weight. While the lowest fresh leaf which is located separately in a statistical group was (0.14 g) obtained from Çetin-2000 variety.

In our study in which increased salt concentration effected on the fresh leaf weight of the varieties found to have significantly decreasing influence at a statistical level (table 16), in control application in which the fresh leaf weight is 0.40 g each variety by itself constituted a statistical group separately and has been recorded as 0.33 g, 0.30 g, 0.21 g and 0.05 g respectively.

In the variance analysis conducted for the fresh leaf weight, the reaction of the varieties to salt concentrations (Variety * salt concentration interaction) was found to be statistically significant (Table 16). As variety number 5, 1, 8 and 4 in control application recorded the highest fresh leaf weight (0.51 g, 0.46 g, 0.44 g and 0.44 g respectively); The varieties which had the highest salt concentration and showed the greatest reaction to salt doses application and obtained lowest fresh leaf weight are the varieties number 1 (0.026 g), 3(0.025 g), 6(0.019 g) and 2 (0.016) that are located at the same statistical groups.

4.6. Fresh Root Weight

According to the variance analysis result of the fresh root weight, the varieties, concentrations and interaction of variety*salt concentration interaction was found to be statistically significant; this significance was at 0.001 level at variety and concentration, while at the interaction was found to be 0.05 (Table 20).

Table 20. Variance analysis results of fresh root weight values of barley cultivars germinated at different salt concentrations

Source	DF	SS	MS	F value
Varieties	8	0.29	0.036	16.72 ***
Concentrations	4	0.58	0.147	67.50 ***
Interaction (V*C)	22	0.11	0.005	2.31 **
Error	100	0.21	0.002	
Total	134			

***: Statistically significant at the level of 0.001, **: Statistically significant at the level of 0.01

Table 21. Fresh root weight values of barley cultivars

Number	Varieties	Mean
1	Karatay-94	0.21 a
2	Aydan Hanım	0.17 b
3	Bülbül-89	0.16 b
4	İnce-04	0.15 bc
5	Kral-97	0.13 c
6	Tarm-92	0.12 cd
7	Olgun	0.09 d
8	Şahin-91	0.09 d
9	Çetin-2000	0.05 e

LSD (0.05) = 0.03

Table 22. Fresh root weight values obtained from barley cultivars at different salt concentrations

Number	Salt Concentrations	Mean
1	C_O (Control)	0.23 a
2	C_1 (50 mM)	0.16 b
3	C_2 (100 mM)	0.13 c
4	C_3 (150 mM)	0.10 c
5	C_4 (200 mM)	0.03 d

LSD(0.05)= 0.02

Table 23. Interaction values of salt concentrations * Variety in terms of Fresh root weight

Variety * Concentrations	Mean
Bülbül-89*C_0	0.34 a
Karatay*C_0	0.31 ab
Karatay*C_{100}	0.26 bc
Karatay*C_{50}	0.25 bc
Aydan Hanım*C_0	0.25 bc
Tarm-92*C_0	0.23 cd
Olgun*C_0	0.22 cde
İnce-04*C_{50}	0.22 cdef
Aydan Hanım*C_{50}	0.22 cdef
Karatay*C_{150}	0.21 cdefg
İnce-04*C_0	0.21 cdefgh
Bülbül-89*C_{50}	0.20 cdefghi
Çetin-2000*C_0	0.20 cdefghi
Kral-97*C_0	0.17 defghij
Aydan Hanım*C_{100}	0.16 efghij
Kral-97*C_{150}	0.15 efghijk
Bülbül-89*C_{150}	0.15 efghijk
Şahin-91*C_0	0.15 fghijk
Tarm-92*C_{100}	0.14 ghijk
İnce-04*C_{100}	0.14 ghijk
Aydan Hanım*C_{150}	0.14 hijkl
Kral-97*C_{100}	0.14 hijkl
Tarm-92*C_{50}	0.14 hijkl
Kral-97*C_{50}	0.13 ijkl
Olgun*C_{50}	0.13 ijklm
Şahin-91*C_{100}	0.13 ijklmn
İnce-04*C_{150}	0.12 jklmno
Şahin-91*C_{50}	0.12 jklmno
Bülbül-89*C_{100}	0.11 jklmnop
Aydan Hanım*C_{200}	0.08 klmnopq
Tarm-92*C_{150}	0.07 lmnopqr
Olgun* C_{100}	0.06 mnopqr
İnce-04*C_{200}	0.05 nopqr
Olgun* C_{150}	0.05 opqr
Kral-97*C_{200}	0.05 opqr
Şahin-91*C_{150}	0.04 pqr
Karatay*C_{200}	0.04 pqr
Çetin-2000*C_{50}	0.03 qr
Bülbül-89*C_{200}	0.02 qr
Çetin-2000*C_{150}	0.01 qr
Olgun* C_{200}	0.01 qr
Çetin-2000*C_{100}	0.01 qr
Şahin-91*C_{200}	0.01 qr
Tarm-92*C_{200}	0.008 r
Çetin-2000*C_{200}	0.006 r

LSD (0.05)= 0.07

In our study, Karatay-94 varity has been found to have the highest fresh root weight (0.21 g) among the barley varieties. As the fresh root weight in Aydan Hanım 0.17 g, Bülbül-89 0.16 g, İnce 0.15 g, Kral-97 0.13 g, Tarm-92 0.12 g, Olgun 0.09 g, Şahin-91 0.09 g , the lowest fresh root weight was recorded in the study in Çetin-2000 variety (0.05 g) which is located separately in a statistical group.

In the study which increased salt concentration has statistically decreased the fresh root weight significantly (Table 20.), each variety has constituted a separate statistic group by itself and the highest fresh root weight 0.23 g found with control application, while the lowest fresh root weight (0.03 g) found in the highest dose that was 200 mM Application. In concentrations number 2, 3 and 4 the fresh root weight recorded as 0.16 g, 0.13 g and 0.10 g respectively.

The reaction of the cultivars used in the experiment towards to increased salt concentration has been different (Table 20). The highest fresh root weight were from 2 varieties of control application which constituted a statistical group by themselves, while the lowest fresh root weight were from the variety number 3 and 8 in which the highest doses 0.006 g and 0.008 g used respectively.

4.7. Dry Leaf Weight

In the variance analysis conducted in terms of dry leaf weight, the differences between the varieties and salt concentrations was recorded at 0.001 level found to be statistically significant, while the interaction variance of variety*concentration was at 0.05 level and found to be statistically significant (Table 24).

Table 24. Variance analysis results of dry leaf weight values of barley cultivars germinated at different salt concentrations

Source	DF	SS	MS	F value
Varieties	8	0.0027	0.00034	10.67 ***
Concentrations	4	0.0150	0.00375	115.13 ***
Interaction (V*C)	22	0.0012	0.00005	1.73 *
Error	100	0.0032	0.00003	
Total	134	0.0223		

***: Statistically significant at the level of 0.001, ***: Statistically significant at the level of 0.05

Table 25. Dry leaf weight values of barley cultivars

Number	Varieties	Mean
1	Aydan Hanım	0.0332 a
2	Karatay-94	0.0331 ab
3	İnce-04	0.0298 abc
4	Şahin-91	0.0290 bcd
5	Olgun	0.0272 cde
6	Tarm-92	0.0252 de
7	Kral-97	0.0246 ef
8	Bülbül-89	0.0209 fg
9	Çetin-2000	0.019 g

LSD (0.05) = 0.004

Table 26. Dry leaf weight values obtained from barley cultivars at different salt concentrations

Number	Salt Concentrations	Mean
1	C_O (Control)	0.039 a
2	C_1 (50 mM)	0.034 b
3	C_2 (100 mM)	0.029 c
4	C_3 (150 mM)	0.021 d
5	C_4 (200 mM)	0.009 e

LSD(0.05)= 0.003

Table 27. Interaction values of salt concentrations * Variety in terms of dry leaf weight

Variety * Concentrations	Mean
Karatay*C_0	0.055 a
Karatay*C_{50}	0.046 b
Aydan Hanım*C_0	0.042 bc
İnce-04*C_{50}	0.0423 bcd
Tarm-92*C_0	0.0420 bcde
Şahin-91*C_{100}	0.0420 bcde
Aydan Hanım*C_{100}	0.0406 bcdef
Bülbül-89*C_0	0.038 cdefg
İnce-04*C_0	0.037 cdefgh
Karatay*C_{100}	0.037 cdefgh
Aydan Hanım*C_{50}	0.0363 defghi
Kral-97*C_0	0.0360 defghi
İnce-04*C_{100}	0.0356 fghi
Olgun*C_0	0.0353 fghi
Şahin-91*C_0	0.0350 fghi
Kral-97*C_{50}	0.0343 ghi
Olgun*C_{50}	0.0340 ghi
Çetin-2000*C_0	0.0333 ghij
Tarm-92*C_{50}	0.0323 hijk
Olgun*C_{150}	0.0320 hijk
Çetin-2000*C_{50}	0.0306 ijkl
Olgun*C_{100}	0.0276 jklm
Bülbül-89*C_{50}	0.0276 jklm
İnce-04*C_{150}	0.0263 klmn
Şahin-91*C_{50}	0.0263 klmn
Kral-97*C_{100}	0.0256 lmno
Aydan Hanım*C_{150}	0.0246 lmno
Tarm-92*C_{100}	0.0240 mno
Şahin-91*C_{150}	0.0240 mno
Tarm-92*C_{150}	0.0226 mnop
Aydan Hanım*C_{200}	0.0216 mnop
Kral-97*C_{150}	0.0213 nop
Bülbül-89*C_{100}	0.0196 opq
Şahin-91*C_{200}	0.0176 pqr
Çetin-2000*C_{100}	0.0166 pqr
Bülbül-89*C_{150}	0.0150 qr
Çetin-2000*C_{150}	0.0143 qr
Karatay*C_{150}	0.0143 qr
Karatay*C_{200}	0.0126 rs
İnce-04*C_{200}	0.0073 st
Olgun*C_{200}	0.0073 st
Kral-97*C_{200}	0.0060 t
Tarm-92*C_{200}	0.0050 t
Çetin-2000*C_{200}	0.0040 t
Bülbül-89*C_{200}	0.0036 t

LSD (0.05) =0.006

Aydan Hanım variety which constitute a statistical group by itself had the highest dry leaf weight (0.0332 g) in the study; while the lowest dry leaf weight was recorded in Çetin-2000 variety (0.016 g) which also located separately in a statistical group by itself. The 0thers were as follows Karatay-94 variety 0.0331 g, İnce variety 0.0298 g, Şahin-91 variety 0.0290 g, Olgun variety 0.0272 g, Tarm-92 variety 0.0252 g, Kral-97 variety 0.0246 g and Bülbül-89 variety 0.0209 g.

Like in other features, increased doses of salt concentration has a reducing effect on the dry leaf weight, the highest value of dry leaf weight (0.039 g) found in control application, while the lowest dry leaf weight value (0.009 g) found in the 200 mM salt application with the highest concentration. While the dry leaf weight values obtained from the salt concentration number 2,3 and 4 are recorded as follows 0.034 g, 0.029 g and 0.021 g respectively.

The difference resulting from the reaction of varieties to salt concentrations in terms of dry leaf weight, i.e. the interaction variance of variety*salt concentration found to be statistically significant in our study and the highest dry leaf weight was 0.055 g from variety number 5 in control application, while the lowest dry leaf weight found in varieties number 7, 8, 3 and 2 (0.006 g, 0.005 g, 0.004 g and 0.0036 g respectively) which they constitute a statistical group by their own using the highest salt concentration doses.

4.8. Dry Root Weight

Differences resulting from the varieties and salt concentrations in terms of dry root weight were at 0.001 level, while the differences resulting from the interaction variance between the variety * salt concentration were at 0.01 level and found to be statistically significant (Table 28).

Table 28. Variance analysis results of dry root weight values of barley cultivars germinated at different salt concentrations

Source	DF	SS	MS	F value
Varieties	8	0.0045	0.0005	18.74 ***
Concentrations	4	0.0073	0.0018	61.37 ***
Interaction (V*C)	22	0.0014	0.00006	2.21 **
Error	100	0.0030	0.00003	
Total	134	0.016		

***: statitically siginificant at level of 0.001, statitically siginificant at level of 0.01

Table 29. Dry root weight values of barley cultivars

Number	Varieties	Mean
1	Karatay-94	0.0285 a
2	Aydan Hanım	0.0280 a
3	Tarm-92	0.0199 b
4	Kral-97	0.0198 b
5	Olgun	0.0169 bc
6	Bülbül-89	0.0168 bc
7	İnce-04	0.0158 c
8	Çetin-2000	0.0137 cd
9	Şahin-91	0.0101 d

LSD=0.004

Table 30. Dry root weight values obtained from barley cultivars at different salt concentrations

Number	Salt Concentrations	Mean
1	C_O (Control)	0.03 a
2	C_1 (50 mM)	0.02 b
3	C_2 (100 mM)	0.0174 c
4	C_3 (150 mM)	0.0172 c
5	C_4 (200 mM)	0.007 d

LSD (0.05)= 0.003

Table 31. Interaction values of salt concentrations * Variety in terms of dry root weight

Variety * Concentrations	Mean
Karatay*C_0	0.043 a
Tarm-92*C_0	0.040 ab
Aydan Hanım*C_0	0.039 abc
Aydan Hanım*C_{100}	0.0326 bcd
Karatay*C_{50}	0.0323 cde
Bülbül-89*C_0	0.0313 cdef
Karatay*C_{100}	0.0306 defg
Olgun*C_0	0.0276 defgh
Aydan Hanım*C_{50}	0.0266 defghi
Aydan Hanım*C_{150}	0.0260 defghij
Şahin-91*C_0	0.0253 defghij
İnce-04*C_0	0.0250 defghijk
Kral-97*C_{50}	0.0243 efghijk
Karatay*C_{150}	0.0240 fghijkl
Kral-97*C_0	0.0233 fghijklm
Kral-97*C_{150}	0.0230 ghijklm
Çetin-2000*C_0	0.0226 ghijklmn
Kral-97*C_{100}	0.0226 ghijklmn
Tarm-92*C_{50}	0.0216 hijklmno
İnce-04*C_{50}	0.0213 hijklmnop
Çetin-2000*C_{50}	0.0213 hijklmnop
Tarm-92*C_{150}	0.0186 ijklmnopq
Olgun*C_{50}	0.0183 jklmnopq
Olgun*C_{150}	0.0180 jklmnopq
Bülbül-89*C_{50}	0.0170 klmnopq
Aydan Hanım*C_{200}	0.0160 lmnopqr
Bülbül-89*C_{100}	0.0153 mnopqrs
İnce-04*C_{150}	0.0153 mnopqrs
İnce-04*C_{100}	0.0153 mnopqrs
Tarm-92*C_{100}	0.0146 nopqrs
Bülbül-89*C_{150}	0.0140 opqrst
Olgun*C_{100}	0.0133 pqrstu
Karatay*C_{200}	0.0126 qrstuv
Şahin-91*C_{150}	0.0123 qrstuvw
Çetin-2000*C_{200}	0.0116 qrstuvwx
Çetin-2000*C_{100}	0.008 rstuvwxy
Olgun*C_{200}	0.007 stuvwxy
Bülbül-89*C_{200}	0.006 tuvwxy
Kral-97*C_{200}	0.0056 uvwxy
Şahin-91*C_{200}	0.0050 vwxy
Çetin-2000*C_{150}	0.0043 wxy
Şahin-91*C_{100}	0.0041 xy
Tarm-92*C_{200}	0.0040 xy
Şahin-91*C_{50}	0.037 xy
İnce-04*C_{200}	0.0021 y

LSD(0.05)= 0.008

Like in dry leaf weight Karatay-94 and Aydan Hanım varieties had the highest value of dry root weight 0.0285 g and 0.0280 g respectively and these two varities constituted a statistical group by their own. In our study, the lowest dry root weight was recorded in Şahin-91 variety as 0.0101 g, while the dry root weight of the other varieties were as follows; Tarm-92 variety 0.0199 g, Kral-97 variety 0.0198 g, olgun variety 0.0169 g, Bülbül-89 variety 0.0168 g, İnce variety 0.0158 g and Çetin-2000 variety 0.0137 g.

Again like in all the other features, increased doses of salt concentration had a decreasing effect on the dry root weight of the varieties, this effect at the level of 0.05 found to be significant as well (Table 28.). The highest dry root weight obtained from our study was (0.030 g) which was with control application that's separately located at a statistical group, while the highest dose of salt showed the lowest value of dry root weight (0.007 g). The dry root weights obtained from doses such as 50 mM, 100 mM and 150 mM of salt application were as follows 0.020 g, 0.0174 g and 0.0172 g respectively.

In the study which the reaction of the varieties toward increased salt concentrations in terms of the dry root weight are different, the highest dry weight were obtained from the control applications of varieties number 5, 8 and 9 while the lowest dry root weight value was obtained from the variety number 1 in which the highest dose of salt used.

Decreased values of fresh and dry weights of the first leaf and first roots due to the increased salt concentrations obtained in our study are matching with the studies of Naseer et al. (2001), Elmadidi et al. (2004), Ahmad et al. (2006) and Naseri et al. (2012).

In the salinity studies conducted by Ehret et al. (1990) on both wheat and barley, they found that increased salt concentrations decreased the dry root weight in both genus, and this decrease was higher in wheat than in barley.

In the study conducted by El-madidi et al. (2004) on five local varieties and four varieties at breeding program found that increased salt concentrations decreased the weight of the shoot and dry roots and this decrease was higher in the varieties at breeding program.

In a study with triticale, it was determined that the increased salt concentrations have a negative effect on the shoot and dry root weights of varieties, and this negative effect was found to be statistically significant in dry shoot weight, but not in dry root weight. (Atak et at. 2006).

The statistically significant differences (in terms of first leaf and root weight) emerging from the reaction of varieties to the saltiness obtained in our study are in parallel with the findings of Yousufinia et al. (2012). In the study conducted by Ahmad et al. (2006) on two varieties of barleys, and Adjel et al. (2013) on twelve varieties of barleys, similarly they found that the genotypic response of the barley varieties to saltiness in terms of fresh shoot and root weight was statistically significant. In a different study conducted by El-Maididi et al. (2004) on nine different barley varieties, they determined that the interaction of genotype*treatment is significant for determining the dry root weight, while it is not for dry shoot weight. However, in the study conducted by Movafegh et al. (2012) on three barley varieties determined that the reaction of varieties in terms of root and shoot weight is similar.

Atak et al. (2006) stated in their study conducted on triticale that the reaction of three different varieties to the increased salt concentrations in terms of root and shoot weights are similar.

5. CONCLUSION AND RECOMMENDATION

In our study with three replications, the effects of four different salt concentrations against to control (distilled water) have been examined on nine different barley verities in germination stage. In terms of germination speed, germination rate, first leaf length, first root length, wet leaf weight, wet root weight, dry leaf weight and dry root weight, notable differences were observed in both varieties and concentrations, and it has been deemed to be statistically significant ($P<0.001$). The interaction between varieties and salt concentrations was non-significant in germination speed and germination rate only; the interaction was significant in root length and dry leaf weight at a level of 0.05, interaction was also significant in wet root weight and dry root weight at a level of 0.01; while it was significant in leaf length and fresh leaf weight at 0.001.

Table 32. Mean values over the varieties and ovaer the concentrations

Varieties	Parameters							
	GS	GR	LL	RL	LFW	RFW	LDW	RDW
Şahin-91	88.66 a	92.00 a	7.46 a	8.02 cd	0.32 ab	0.09 d	0.0290bcd	0.0101 d
Karatay	72.00 b	83.33 b	7.41 a	9.04 b	0.34 a	0.21 a	0.0331ab	0.0285 a
Olgun	70.33 b	80.66 b	7.58 a	10.36 a	0.25 de	0.09 d	0.0272cde	0.0169bc
Aydan H.	68.33 b	79.00 b	6.40 bc	7.58 d	0.29 bc	0.17 b	0.0332 a	0.0280 a
Kral-97	58.00 c	66.33 c	7.34 a	8.97 b	0.28 cd	0.13 c	0.0246 ef	0.0198 b
İnce-04	55.33 c	61.00 c	6.78 b	8.31 bcd	0.30 bc	0.15 bc	0.0298abc	0.0158 c
Tarm-92	32.33 d	46.66 d	6.35 bc	8.58 bc	0.24 e	0.12 cd	0.0252 de	0.0199 b
Bülbül-89	24.00 e	44.00 d	5.64 d	6.26 e	0.17 f	0.16 b	0.0209 fg	0.0168bc
Çetin-2000	13.00 f	19.33 e	6.23 c	7.56 d	0.14 g	0.05 e	0.019 g	0.0137cd

The germination speed of nine different barley varieties has been observed to be statistically different from each other (Table 3), the highest germination speed value has been obtained in Şahin-91 variety (88.66%), which forms a statistical group on its own. This assortment has been respectively followed with Karatay-94 (72.00%), Olgun (70.33%), Aydan Hanım (68.33%), and Kral-97 (58.00%), İnce (55.33%), Tarm-92 (32.3% 3) and Bülbül-89 (24.00%) varieties. Çetin-2000 variety, on the other hand, was also on its own in a statistical group and it has been observed to be the variety with the

lowest germination speed in the experiment with 13.00%. In the study, it has been observed that salt concentrations have a statistically different effect on the germination speed of barley varieties, check application which is distilled water against salt concentrations and yielded the highest value of germination speed with 71.11%. Increasing salt concentration caused a significant reduction in germination speed, and this decrease in germination speed has been obviously registered in 150 mM concentration and above. In 50 mM and 100 mM salt concentrations, the germination speed has been observed as 56.85% and 54.63% respectively; while in 150 mM and 200 mM salt concentrations the germination speed values were 45.55% and 39.63% respectively.

In terms of germination rate, significant differences were observed statistically in both varieties and salt concentrations at ($P<0.001$) level. The highest germination rate has been obtained in Şahin-91 variety (92.00%), which again formed a statistical group on its own and got distinctly separated from the varieties, followed by Olgun (83.33%), Karatay-94(80.66%), Aydan Hanım (79.00%), Kral-97 (66.33%), İnce (61.00%), Tarm-92 (46.66%) and Bülbül-89 (44.00%) varieties, again respectively. Similarly to germination speed, Çetin-2000 variety has been also observed to have the lowest value in the study in terms of germination ratio (39.63%). The highest value of germination rate was obtained in check application (74.81%) in our study, and such as in germination speed, increasing salt concentrations negatively affected germination rates too. In 50 mM, 100 mM and 150 mM salt applications, the respective germination rates were 72.59%, 67.59% and 54.25%, while the lowest germination rate has been obtained from the highest dose, 200 mM salt concentration practise (48.70%).

In terms of first leaf length, the differences observed in varieties, salt concentrations and variety*salt concentrations and have been deemed to be statistically significant (Table 8). The primary leaf length that resulted from germination were, in Olgun, Şahin-91, Karatay, and Kral-97 varieties respectively is 7.58 cm, 7.46 cm, 7.41 cm and 7.34 cm, these varieties have been placed within the same statistical group. the primary leaf length in İnce variety 6.78 cm, Aydan Hanım variety 6.40 cm, Tarm-92 variety 6.35 cm and the variety of Çetin-2000 variety 6.23 cm, the lowest leaf length value has been obtained in Bülbül-89 variety with 5.64 cm. versus the control application, increasing salt concentrations had a negative effect on primary leaf length, and the impact that each

application has been placed on its own in a different statistical group was an indication that this reducing effect was distinctive (Table 10). The primary leaf length obtained under control application condition was 10.92 cm, in 50 mM, 100 mM, 150 mM and 200 mM salt concentrations the standing were 8.59 cm, 7.74 cm, 4.76 cm and 1.97 cm respectively. The differences was observed when The varieties interacted with salt concentrations, with regards to primary leaf length (Table 8), the highest primary leaf length has been obtained in Şahin-91 variety under control application same to germination test (11.70 cm). After Şahin-91 the ranking from the top position with regards to primary leaf length, Olgun (11.66 cm), İnce (11.33 cm), Karatay-94 (11.23 cm), Çetin-2000 (10.90 cm), Tarm-92 (10.90 cm) and Kral-97 (10.73 cm) varieties, and these varieties became the prominent varieties that having the highest values under control application. The highest salt concentration application has been observed to be the application that yielded the shortest primary leaf length and the most sensitive variety to the highest (200 mM) salt concentration was İnce variety with a primary leaf length 1.03 cm. This variety has been followed by Olgun, Çetin-2000, Bülbül-89 and Karatay-94varieties which are also highly sensitive to 200 mM salt concentration and placed in the same statistical group and had primary leaf lengths 1.30 cm, 1.63 cm, 1.83 cm and 1.78 cm respectively.

In the study with regard to the first root length, the differences was significant among varieties and among the concentrations in 0.001 level, the variety*concentration interaction was found to be significant in 0.05 level. The highest root length value that resulted from germination was in Olgun variety with 10.36 cm. In terms of first root length Karatay-94and Kral-97 varieties have followed this variety by 9.04 cm and 8.97 cm respectively, and the variety with the shortest root length in our experiment was Bülbül-89 with 6.26 cm. The reduction effected by increasing salt concentrations against control application on the first root length has been deemed to be statistically significant (Table 12), and this effect has become even more obvious after 150 mM salt application. The most distinctive indication of this is that even though 9.05 cm and 9.00 cm root lengths have been obtained respectively from the 50 mM and 100 mM salt concentrations, compared to the 12.31 cm root length obtained by the control application, 6.71 cm and 4.41 cm root lengths have been obtained from the 150 mM and 200 mM salt concentrations. In our study where the reactions of the varieties against salt

concentrations have been different in a statistically significant level (Table 12), the highest first root length have been obtained from the control applications of Olgun (15.56 cm), Karatay-94 (13.83 cm) and Tarm-92 (13.73 cm) varieties; while the lowest first root length have been obtained from Bülbül-89, İnce, Karatay-94and Şahin-91 varieties by 3.26 cm, 3.96 cm, 4.00 cm and 4.10 cm, from the salt dosage application with the highest root length values (200 mM).

The differences in fresh leaf weight between varieties, salt concentrations and variety*concentration interaction variances have been deemed to be statistically significant ($P<0.001$). (Table 16). The highest fresh leaf weights has been obtained from germinated seeds were in Karatay-94 variety, which is on its own in a statistical group, by 0.34 g, Şahin-91 and İnce varieties have been the other two varieties that yielding a value of 0.30 g and above (0.32 and 0.30 respectively). Çetin-2000 variety had the lowest leaf weight among all the varieties in the study (0.14 g). The effect of the increasing salt concentrations on fresh leaf weights has been at a statistically significant level, and each application has been defined as different statistical group on its own. This indicates that the increasing salt amount against control is clearly decreasing the fresh leaf weight. While a fresh leaf weight with 0.40 g has been obtained from the control application, with the increasing salt concentration this value has been respectively obtained as 0.33 g, 0.30 g, 0.21 g and 0.05 g. But in terms of variety*salt concentration, Karatay-94variety has yielded the highest fresh leaf weight in the control application by 0.511 g, again in control application, İnce, Tarm-92 and Şahin-91 varieties had respective fresh leaf weight values of 0.46 g, 0.44 g and 0.44 g also under control application condistion. On the other hand, The lowest fresh leaf weights, have been obtained from Bülbül-89 (0.016 g), Olgun (0.019 g) and Çetin-2000 (0.025 g) varieties, under 200 mM salt concentration, which is the highest dose application.

In our study where in terms of wet root weight, varieties, salt concentrations and variety*salt concentration interaction variance values had statistically significant differences (Table20), the highest wet root weight has been obtained from Karatay-94variety with 0.21 g. This variety has been followed by Aydan Hanım (0.17 g) and Bülbül-89 (0.16 g) varieties, and the lowest wet root weight has been obtained from Çetin-2000 variety with 0.05 g. Similar to fresh leaf weight, increasing salt

concentrations reduced the wet root weight significantly sharp manner, under control condition the wet root weight was 0.23 g, and comparing to the control application, the fresh root weights in 50 mM, 100 mM, 150 mM and 200 mM salt concentrations, where each application was a different statistical group, have been respectively 0.16 g, 0.13 g, 0.10 g and 0.03 g. In our study where in terms of wet root weight, the interaction of barley varieties*salt concentrations were different. The highest value has been obtained from Bülbül-89 variety under control application (0.34 g). Even though the second highest fresh root value has been obtained from Karatay-94variety's (0.31 g) also under control application, Karatay-94variety has been ranked third, in terms of interaction, by a wet root weight of 0.26 g in 100 mM salt application.

With regard to dry leaf weight, the differences between varieties, concentrations and variety*concentration variances have been significant, while this significance in interaction status was variance at a level of 0.05, but the significance level in the others was 0.001. Aydan Hanım variety ranked first with a dry leaf weight of 0.0332 g and this variety has been followed by Karatay-94(0.0331 g) and İnce (0.0298 g) varieties, while the variety with the lowest dry leaf weight has been Çetin-2000 variety by 0.019 g. Our study determined that salt concentrations, has a reducing effect on dry leaf weight, just like other characteristics. In the control application, dry leaf weight value was 0.039 g, increasing salt concentrations made a values to be 0.034 g, 0.029 g, 0.021 g and 0.009 g respectively. In our study where variety*interaction variance was significant, the top two values have been obtained from Karatay-94variety under control and first dose (50 mM) applications by 0.055 g 0.046 g dry leaf weights. On the other hand the lowest dry leaf weights have been obtained from Bülbül-89 (0.0036 g), Çetin-2000 (0.0040 g), Tarm-92 (0.0050 g) and Kral-97 (0.0060 g) varieties from the same statistical group with 200 mM salt concentration application, which is the highest dose.

in terms of dry root weight, the differences in varieties, salt concentrations and variety*salt concentration have been deemed to be statistically significant (Table 28), the highest dry root weight have been obtained from Karatay-94 and Aydan Hanım varieties by 0.0285 g and 0.0280 g. With a dry root weight value of 0.0101 g, Şahin-91 variety has been determined to have the lowest value among all varieties. Salt concentrations against control had reduction effect on dry root weight and this effect has been particularly

distinct in the last dose application (200 mM). In the control application over all varieties, the dry root weight was 0.03 g, and in 50 mM, 100 mM, 150 mM and 200 mM salt concentrations 0.02 g, 0.0174 g, 0.0172 g and 0.007 g dry root weights values have been obtained respectively. Looking at the varieties*salt concentration interactions, Karatay-94and Tarm-92 varieties have been placed top with 0.043 g and 0.040 g dry root weight values under control application respectively, while Aydan Hanım variety under the effect of control and 100 mM salt concentration applications have been registered as a third and fourth highest values with 0.039 g and 0.0326 g respectively. In terms of dry root weight, the most sensitive variety to the highest salt concentration has been İnce variety (0.0021 g).

In our study, when the effects of different salt concentrations (50 mM, 100 mM, 150 mM and 200 mM NaCl against control) examined on some characteristics of some barley varieties during germination period, it has been observed that increasing salt concentrations had a great statistically significant effect ($P<0.001$) reducing all the studied characteristics of the varieties, such as germination speed, germination rate, firts leaf length, first root length, fresh leaf weight, fresh root weight, dry leaf weight and dry root weight. This reduction did not led to changes in germination speed and germination rate values in the varieties, but the variety*salt concentration interaction variance has been deemed to be statistically significant with regard to all other characteristics. In our experiment where Şahin-91 variety provided the highest value in terms of germination speed and germination rate values (88.66% and 92.00%, respectively), Çetin-2000 variety has been observed as the variety to have the lowest value in both aspects (13.00% and 19.33%, respectively). It has been observed that in terms of primary leaf length (7.58 cm) and first root length (10.36 cm), Olgun variety was the predominant one, fresh leaf weight (0.34 g) and wet root weight (0.21 g) values were significant in Karatay-94 variety, while Aydan Hanım yielded highest dry leaf weight value (0.032 g), and Karatay-94 variety yielded highest dry root weight value (0.0285 g). Taking into account in all the characteristics, Şahin-91, Olgun, Karatay-94 and Aydan Hanım varieties have been observed to be the leading ones. When compared to other varieties, these varieties can be defined as a resistance varieties to salinity, which is an important abiotic stress factor, therefore it has been concluded that these varieties can be recommended to sown in areas where salinity is a problem. Furthermore, these varieties are also possible

candidates to be availed of when trying to develop salinity resistant varieties. However, in order to determine salinity resistant varieties, further studies including more and different varieties are needed. In this way it will be possible to have a better idea about the conditions of the varieties and their performances against other varieties.

6. REFERENCES

Abdi, N., Wasti, S., Salem, MB., El Faleh, M., Mallek-Maalej, E., "Study on germination of seven barley cultivars (*Hordeum vulgare* L.) under salt stress", Journal of agricultural science, 8(8): p.88, 2016.

Acquaah, G., "Principles of crop production; theory, techniques, and technology", prentice hall, upper saddle, New Jersey 07458, 2002.

Adjel, F., Bouzerzour, H., Benmahammed, A., "Salt stress effects on seed germination and seedling growth of barley (*Hordeum Vulgare* L.) genotypes", journal of agriculture and sustainability, 3(2): 2013.

Aharizad, S., Zaefizadeh, M., Mehdipour, M., "Salinity tolerance of hull-less barley genotypes in germination stage", 2013.

Ahmad, MSA., Ali, Q., Bashir, R., Javed, F., Alvi, AK., "Time course changes in ionic composition and total soluble carbohydrates in two barley cultivars at seedling stage under salt stress Pak", J. Bot, 38(5): p.1457-1466, 2006.

Akbari, G., Sanavy, SA., Yousefzadeh, S., "Effect of auxin and salt stress (NaCl) on seed germination of wheat cultivars (*Triticum aestivum* L.)", Pakistan journal of biological sciences: PJBS, 10(15): p.2557-2561, 2007.

Akbarimoghaddam, H., Galavi, M., Ghanbari, A., Panjehkeh, N., "Salinity effects on seed germination and seedling growth of bread wheat cultivars", trakia journal of sciences, 9(1): p.43-50, 2011.

Al Fakhry, AQ., khalaf, AS., "Crop seeds production and quality", (first. ed.): university of mousl, Iraq, 1983.

Al-Karaki, GN., "Germination, sodium, and potassium concentrations of barley seeds as influenced by salinity", Journal of Plant Nutrition, 28; 24(3): 511-22, 2001.

Almodares, A., Hadi, MR., Dosti, B., "Effects of salt stress on germination percentage and seedling growth in sweet sorghum cultivars", Journal of Biological Sciences, 7(8): p.1492-1495, 2007.

AL-Saady, HAA., "Germination and growth of wheat Plants (*Triticum Aestivum* L.) under salt Stress", journal of pharmaceutical, chemical and biological sciences, 3(3): 416-420, 2015.

Al-Seedi, SNN., "The effect of salinity on germination, growth characters, and emergence of barley (*Hordeum vulgaris* L). in different soil textures", J. thi-Qar univ, 4(1): p.17-26, 2008.

Ambede, JG., Netondo, GW., Mwai, GN., Musyimi, DM., "NaCl salinity affects germination, growth, physiology, and biochemistry of bambara groundnut", Brazilian journal of Plant Physiology, 24(3): p.151-160, 2012.

Anbumalarmathi, J., Mehta, P., "Effect of salt stress on germination of indica rice varieties", European journal of biological sciences, 6: pp.1-6, 2013.

Atabayeva, S., Nurmahanova, A., Minocha, S., Ahmetova, A., Kenzhebayeva, S., Aidosova, S., Nurzhanova, A., Zhardamalieva, A., Asrandina, S., Alybayeva, R., Li, T., "The effect of salinity on growth and anatomical attributes of barley seedling (*Hordeum vulgare* L.)", African journal of biotechnology, 12(18): p.2366, 2013.

Atak, M., Kaya, MD., Kaya, G., Çikili, Y., ÇİFTÇİ, CY., "Effects of NaCl on the germination, seedling growth and water uptake of triticale", Turkish journal of agriculture and forestry, 30(1): p.39-47, 2006.

Bagwasi, G., "Response of wheat (*Triticum aestivum* L.) and barley (Hordeun vulgare L.) to salinity stress", MSc. Thesis. Univ.of Stellenbosch, Stellenbosch, 2015.

BAĞCI, SA., Ekiz, H., Yilmaz, A., "Determination of the salt tolerance of some barley genotypes and the characteristics affecting tolerance", Turkish journal of agriculture and forestry, 27(5): p.253-260, 2003.

Baldwin, AH., McKee, KL., Mendelssohn, IA., "The influence of vegetation, salinity, and inundation on seed banks of oligohaline coastral marshes", American J. Bot. 83: 470–9, 1996.

Belaid, A., Morris, ML., "Wheat and barley production in rainfed marginal environments of west asia and north africa. problems and prospects", CIMMYT economics working Paper., p: 91, 1991.

Ceccarelli, S., Grando, S., Van leur, JAG., “Genetic diversity in barley landraces from syria and jordan”, Euphytica, 36: 389–405, 1987.

Dadashpour, A., “Impacts of different salt source and concentrations on germination and seedling growth of many pumpkin seeds used as rootstoch in iran”, Genetika, 44(2): p.235-250, 2012.

Degl’Innocenti, E., Hafsi, C., Guidi, L., Navari-Izzo, F., “The effect of salinity on photosynthetic activity in potassium-deficient barley species”, journal of plant physiology, 166(18): p.1968-1981, 2009.

Demirkiran, A., Marakli, S., Temel, A., Gozukirmizi, N., “Genetic and epigenetic effects of salinity on in vitro growth of barley □ □ , genetics and molecular biology, 36(4): p.566-570, 2013.

Ehret, DL., Redmann, RE., Harvey, BL., Cipywnyk, A., “Salinity-induced calcium deficiencies in wheat and barley □ , Plant and soil, 128(2): p.143-151, 1990.

El Goumi, Y., Fakiri, M., Lamsaouri, O., Benchekroun, M., “Salt stress effect on seed germination and some physiological traits in three moroccan barley (*Hordeum vulgare* L.) cultivars”, J. Mater. Environ. Sci, 5(2): p.625-632, 2014.

El-Madidi, SAID., El-Baroudi, BR., Aameur, FB., “Effects of salinity on germination and early growth of barley (*Hordeum vulgare* L.) cultivars”, J. agric. biol, 6: p.767-770, 2004.

El-Tayeb, MA., “Response of barley grains to the interactive e. ect of salinity and salicylic acid”, plant growth regulation, 45(3): p.215-224, 2005.

FAO. 2007. FAO Agristat, www.fao.org (accessed on 12 July 2016).

Fricke, W., Akhiyarova, G., Veselov, D., Kudoyarova, G., “Rapid and tissue-specific changes in aba and in growth rate in response to salinity in barley leaves”, journal of experimental botany, 55(399): p.1115-1123, 2004.

Ghoneim, AM., Ahmad, A., Afzal, M., Ebid, A., “Effect of NaCl induced Stress on germination and seedling growth of various (*Oryza sativa* L) Genotypes”, 2015.

Ghoulam, C., Fares, K., “Effect of salinity on seed germination and early seedling growth of sugar beet (*Beta vulgaris* L.) ”, seed science and technology, 29(2): p.357-364. 2001.

Huang, J., Redmann, RE., “Salt tolerance of Hordeum and Brassica species during germination and early seedling growth”, Canadian Journal of Plant Science, 1; 75(4): 815-9, 1995.

Hussain, G., Al-Jaloud, AA., Al-Shammafy, SA., Karimulla, S., Al-Aswad, SO., “Effect of saline irrigation on germination and growth parameters of barley (*Hordeum vulgare* L.) in a pot experiment”, Agricultural water management, 34(2): p.125-135, 1997.

Hussain, S., Khaliq, A., Matloob, A., Wahid, M.A., Afzal, I., “Germination and growth response of three wheat cultivars to NaCl salinity”, Soil Environ, 32(1): p.36-43, 2013.

Idikut, L., “The effects of light, temperature and salinity on seed germination of three maize forms”, Greener J. Agric. Sci, 3(4): p.246-253, 2013.

Katembe, WJ., Ungar, IA., Mitchel, JP., “Effet of salinity on germination and seedling growth of two Atriplex species”, Ann. Bot. 82: 167–75, 1998.

KILIÇ, S., “Effects of 24-epibrassinolide on salinity stress induced inhibition of seed germination, seedling growth and leaf anatomy of barley”, SDÜ Fen Dergisi, 2(1): 2007.

Läuchli, A., Grattan, SR., “Plant growth and development under salinity stress. In advances in molecular breeding toward drought and salt tolerant crops”, (p. 1-32). springer Netherlands, 2007.

Maas, EV., Hoffman, GJ., Chaba, GD., Poss JA., Shannon MC., “Salt sensitivity of corn at various growth stages”, Irri. Sci. 4: 45 – 57, 1983.

Mano, Y., K. Takeda., “Mapping quantitative trait loci for salt tolerance at germination and the seedling stage in barley”, Euphytica, 94: 263–72, 1997.

Mer, RK., Prajith, PK., H Pandya, D., Pandey, AN., “The effect of salts on germination of seeds and growth of young plants of *Hordeum vulgare*, *Triticum aestivum*, *Cicer arietinum* and *Brassica juncea*”, journal of agronomy and crop science, 185(4): p.209-217, 2000.

Movafegh, S., Razeghi, JR., Kiabi, S., "Effect of salinity stress on chlorophyll content, proline, water soluble carbohydrate, germination, growth and dry weight of three seedling barley (*Hordeum vulgare* L.) cultivars", journal of stress physiology & biochemistry, 8(4): 2012.

Muhammad, Z., Hussain, F., "Effect of NaCl salinity on the germination and seedling growth of seven wheat genotypes", Pak. J. Bot,44(6): p.1845-1850, 2012.

Munns, R., Tester, M., "Mechanisms of salinity tolerance annu. rev", plant biol.. 2;59: 651-81, 2008.

Naseri, R., Emami, T., Mirzaei, A., Soleymanifard, A., "Effect of salinity (sodium chloride) on germination and seedling growth of barley (*Hordeum vulgare* L.) cultivars", international journal of agriculture and crop sciences, 4(13): p.911-917, 2012.

Naseer, S, Nisar A., Ashraf, M., "Effect of slt streson gernation and seedling growthof barley (*Horeum vulgare* L.) ", Pakistan J. Biol, Sci 4(3): 359-360, 2001.

Nevo, E., Chen, G., "Drought and salt tolerances in wild relatives for wheat and barley improvement", Plant, cell & environment, 33(4): p.670-685, 2010.

Othman, Y., Al-Karaki, G., Al-Tawaha, A.R., Al-Horani, A., "Variation in germination and ion uptake in barley genotypes under salinity conditions", World journal of agricultural sciences, 2(1): p.11-15, 2006.

Pérez-López, U., Miranda-Apodaca, J., Mena-Petite, A., Muñoz-Rueda, A., "Responses of nutrient dynamics in barley seedlings to the interaction of salinity and carbon dioxide enrichment", environmental and experimental botany, 99: p.86-99, 2014.

Radic, S., M. Prolic, M., Pavlica, M., Pevalek-Kozlina, B., "Cytogenetic effects of osmotic stress on the root meristem cells of centaurea ragusina L.", environmental and experimental botany, 54(3): p.213-218, 2005.

Rahman, M., Soomro, UA., Zahoor-ul-Haq M., Gul S., "Effects of NaCl salinity on wheat (*Triticum aestivum* L.) cultivars", World Journal of agricultural science 4 (3): 398 – 403, 2008.

Ramoliya, PJ., Pandey, AN., "Effect of salinization of soil on emergence, growth and survival of seedlings of Cordia rothii", forest ecology and management, 176(1): p.185-194, 2003.

Rogers, ME., Noble, CL., Halloran, GM., Nicolas, ME., "The effect of NaCl on the germination and early seedling growth of white clover (*Trifolium repens* L.) populations selected for high and low salinity tolerance", seed science and technology, 23(2): p.277-287, 1995.

Sağsöz, S., "Tohumluk Bilimi", (first. ed.): ATATÜRK University, No: 077, Erzurum, 1995.

Sboora, A., Kiarostami, K., Behroozbayati, F., Hajihashmeri, S., "salinity (NaCl) tolerance of wheat genotypes at germination and early seedling growth", Pak. J. Biol. Sci, 9(11): p.2009-2021, 2006.

Taghipour, F., Salehi, M., "The study of salt tolerance of iranian barley (*Hordeum vulgare* L.) genotypes in seedling growth stages", Bio. Diver. Conser, 172: p.53-58, 2008.

Tavili, A., Biniaz, M., "Different salts effects on the germination of *Hordeum vulgare* and *Hordeum bulbosum*", Pakistan journal of nutrition, 8(1): p.63-68, 2009.

Ueda, A., Yamamoto-Yamane, Y., Takabe, T., "Salt stress enhances proline utilization in the apical region of barley roots", biochemical and biophysical research communications, 355(1): p.61-66, 2007.

Waisel, Y., "Biology of halophytes", (first. ed.): 395p. 1972.

Wu, D., Shen, Q., Cai, S., Chen, Z.H., Dai, F., Zhang, G., "Ionomic responses and correlations between elements and metabolites under salt stress in wild and cultivated barley", Plant and Cell Physiology, 54(12): p.1976-1988. 2013.

Yousfi, S., Mahmoudi, H., Abdelly, C., Gharsalli, M., "Effect of salt on physiological responses of barley to iron deficiency", plant physiology and biochemistry, 45(5): p.309-314, 2007.

Yousofinia, M., Ghassemian, A., Sofalian, O., Khomari, S., “Effects of salinity stress on barley (*Hordeum vulgare* L.) germination and seedling growth”, Int J Agric crop Sci, 4(18): p.1353-1357, 2012.

Zhang, H., Louis, J., Irving ,, Craig, M., Cory, M., Daowei, Z., Peter, K., “The effects of salinity and osmotic stress on barley germination rate: sodium as an osmotic regulator”, Annals of Botany, 106(6): 2016.

BACCKGROUND

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