Biosci. Biotech. Res. Comm. Special Issue No 1:24-32 (2017)

BBRC
Bioscience Biotechnology Research Communications

Assessment of the tolerance of various cultivars of barley towards salinity stress in germination and early growth stages

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ABSTRACT

In order to assess the tolerance of some of barley cultivars towards salinity stress in germination and early growth stages in greenhouse condition an experiment was carried out in Ardabil islamic Azad University research farm in 2015-2016 agriculture year. This research was carried out in 2 factorial designs in completely randomized design with three replications. The first factor included twelve cultivars of barley including Afzal, Nosrat, Valfajr, Kavir, Yousef, Torsh, Sahra, Nimruz, Zehek, Dasht, Bahman and Reyhan 2. The second factor included four levels of salinity of without stress and salinity stresses of 6, 12 and 18 Decisiemens per meter (dS/m). The first experiment was carried out in Petri dishes and characteristics related to germination (including velocity of germination and seedling characteristics) were recorded. In the second experiment, the velocity and percentage of seedling emergence of barley were measured. Characteristics analysis of variance results suggested that salinity stress impact was significant on all characteristics except for percentage of seedling emergence in pots. The difference between barley cultivars was significant, except in weight per hundred seeds, length of coleoptile and percentage of emergence.

KEY WORDS: SALINITY STRESS, BARLEY, ELECTRICAL CONDUCTIVITY, GERMINATION PERCENTAGE

ARTICLE INFORMATION:

**Corresponding Author:*
Received 27th Nov, 2016
Accepted after revision 24th March, 2017
BBRC Print ISSN: 0974-6455
Online ISSN: 2321-4007
Thomson Reuters ISI ESC and Crossref Indexed Journal
NAAS Journal Score 2017: 4.31 Cosmos IF : 4.006

Online Contents Available at: http//www.bbrc.in/

INTRODUCTION

Salinity is one of the main problems in the farms in the world so that millions of tons of salt enters agricultural soils through irrigation, annually. Increase in the concentration of salts in soil solution or irrigation water has been considered one of the oldest agricultural and environmental problems, globally. Presence of high rate of salts in the soil or irrigation water confronts the plant with salinity stress. The saline soils area in Iran is 25 million hectares which is increasing due to the weak management in irrigation (Pakniat *et al.*, 2003). Barley is one of the most important crops and among the small grains, it shows resistance towards heat, base and salt. Barley is significant due to its capacity to grow in less fertile areas which are limited by drought, low temperature and salinity (Mottaki *et al.*, 2004). Germination speed and early growth of barley decrease under salinity stress. The growth differences of barley cultivars under salinity stress shows the genetic difference in the potentials of the cultivars in confronting salinity stress. Since it seems that barley cultivars with higher emergence speeds and better early growth have higher resistance towards salinity, this research tries to study the conditions of germination, emergence and early growth of twelve barley cultivars under salinity stress.

Results from Kholq sima *et al.* (2013) suggested that there is a positive correlation between salinity tolerance in the planet during germination and vegetative growth. Considering the aforementioned requirements, this experiment was carried out in order to study the impact of sodium chloride salinity on germination and determining threshold of salt tolerance in a number of commercial barley cultivars for identification and introduction of the most tolerant cultivar in greenhouse condition. Salinity is among the most serious dangers threatening environment and agriculture in many parts of the world, and it impacts the performance of crops yield in arid and semi-arid regions. Considering the significance of barley in feeding animals and also malting industry in Iran, presence of saline soils and water in Iran proper for planting barley and also presence of various genotypes tolerating salinity, which are introduced recently, make conducting research in this regard inevitable.

MATERIALS AND METHODS

This experiment began in autumn 2015 and continued in spring and summer 2016 in Ardabil islamic Azad University research farm located in Hasan Baruq town (5 km west of Ardabil). Height above sea level was 1,350 meters and the longitude and latitude were 48° 30' E and 38° 15' N, respectively. The climate in which the experiment was carried out was cold semi-arid and the soil in the region was clay loam soils which is poor is organic materials.

EXPERIMENT DESIGN

This research was conducted in 2 factorial designs in completely randomized design with three replications. The first factor included twelve cultivars of barley including Afzal, Nosrat, Valfajr, Kavir, Yousef, Torsh, Sahra, Nimruz, Zehek, Dasht, Bahman and Reyhan 2. The second factor included four levels of salinity of without stress and salinity stresses of 6, 12 and 18 Decisiemens per meter (dS/m). The first experiment was carried out in Petri dishes and characteristics related to germination (including velocity of germination and seedling characteristics) were recorded. In the second experiment, the velocity and percentage of seedling emergence of barley were measured. In this experiment, in order to control the electrical conductivity of water, a saucer was put under each pot so that the water salinity could be measured and the uniformity of salinity during the experiment could be controlled. The seeds were planted in 5-liter plastic pots which were filled with 1:1:1 of sand, agricultural soil and Well-rotted washed farmyard manure. The uniform seeds of all twelve barley cultivars were disinfected by Vitavax fungicide and planted.

SALINITY STRESS APPLICATION PROCESS

Initially, the seeds were irrigated by water every other day until the growth of bushes and reaching stemming and subsequently, salinity stress was applied after the stage of growth through irrigation by NaCl solution (Table 1).

Table 1. How to salinity stress

Growth medium	Normal irrigation	1^{st} irrigation	2^{nd} irrigation	3^{rd} irrigation	4^{th} irrigation	5^{th} irrigation
Without Stress	0mM 250 cc	0 mM 500cc	0 mM 500 cc	0 Mm 500 cc	0 mM 500 cc	0 mM 400 cc
6ds/m	0 mM 250 cc	50 mM 500 cc	50 mM 500 cc	0 mM 400cc	0 mM 500 cc	25 mM 400 cc
12ds/m	0 mM 250 cc	50 mM 500 cc	100 mM 500 cc	50 mM 400 cc	0 mM 500 cc	50 mM 400cc
18ds/m	0 mM 250 cc	50mM 500 cc	100 mM 500 cc	50 mM 500 cc	0 mM 500 cc	75 mM 400cc

MEASURED CHARACTERISTICS

Final Germination Percentage

According to Almadras (1998), final germination percentage (FGP) is calculated through dividing germinated seeds on the total number of seeds and through the following formula:

FGP = Ng/Nt × 100
Ng = the total number of germinated seeds
Nt = the total number of assessed seeds

Coefficient of Velocity of Germination

Coefficient of velocity of germination (CVG) is calculated through counting the number of germinated seeds per day. CVG is calculated through the following formula:

CVG = 100 × ∑Ni/∑NiTi
Ni = the number of germinated seeds per day
Ti = number of days since the beginning of the experiment

Germination Rate Index

Germination rate index (GRI) is calculated by the percentage of the number of germinated seeds per day during the experiment. Germination rate index is calculated through the following formula:

GRI = G1/1+G2/2+...+Gx/x
G1 = percentage of germination on the first day
G2 = percentage of germination on the second day, etc.

Number of Radicles, Length of Radicle and Length of Coleoptile

In order to measure seedling characteristics, 10 seedlings were chosen from each dish and the number of radicles, the length of radicle and the length of coleoptile were measured and their average was recorded as the input for each pot.

Emergence Percentage

Emergence percentage of seedlings in pot is calculated through the following formula:

EP = EN/TN

In which EP is the emergence percentage which is calculated through dividing the number of emerged seeds (EN) on the total number of planted seeds (TN). Notetaking and observation were carried out fifteen days after planting the seeds.

Velocity of Emergence

Velocity of emergence of seedlings in the pot was calculated by the formula presented by Pirasteh-Anisheh *et al*., 2011):

ER = ∑n/Dn

In which: velocity of emergence (ER) is calculated by the total of germinated seeds per day (n) on the number of each day (Dn).

RESULTS AND DISCUSSION

ANALYSIS OF VARIANCE OF CHARACTERISTICS

Analysis of Variance of Germination Characteristics

Results for analysis of variance of the characteristics related to germination are provided in Table 2. As it could be observed from the table, the replication effect is significant in length of radicle and length of coleoptile, emergence percentage and velocity of emergence. Although the experiment was of petri dish and pot, various stories of the seed germinator machine and also places of the pots in the greenhouse as a block, had a significant impact on some of the characteristics. The salinity stress impact was significant on all characteristics except for the seedlings' emergence percentage. The salinity stress impact on this characteristic might be due to the fact that the measurement of this characteristic is carried out before the real salinity of the pot soil reached the target amounts, since electrical conductivity of the pot soil did not reach the target amount by the first irrigation by saline water. The difference between barley cultivars were significant except for the length of coleoptile and emergence percentage which indicates the presence of genetic diversity among the assessed cultivars based on their tolerance of salinity stress.

Table 2. Analysis of Variance of the Characteristics Related to the Germination

Velocity of Emergence	Emergence Percentage	Length of Coleoptile	Length of Radicle	Number of Radicles	GRI	CVG	FGP	Df	Sov
0/209**	156/77*	2/14*	9/53*	824/0^{ns}	107/69^{ns}	43/146^{ns}	333/4^{ns}	2	R
1/265**	17/3^{ns}	4/02**	75/09**	1/34*	4158/7**	2296/47**	1504/9**	3	Salinity Stress
0/081**	37/9^{ns}	0/531^{ns}	7/61**	1/88**	1211/1**	381/80**	1082/3**	11	Cultivar
0/026^{ns}	28/67^{ns}	1/24**	5/463**	0/572^{ns}	191/2*	159/71*	2114/6^{ns}	33	C * S
0/035	41/7	0/488	2/385	0/509	124/4	89/203	163/8	94	E
8/08	6/87	25/5	25/3	15/0	22/8	22/25	16/22		cv%

Results from this research are in accordance with the results from Hang and Redman (1995) and also findings of Kaya *et al.* (2006).

Results from Mohammadi *et al.* (2011) suggested that the effect of salinity, genotypes and their interaction was significant at one percent. The interaction of cultivar × salinity was significant in characteristics of velocity of germination, germination rate index, length of radicles and length of coleoptile which indicates the different reaction of cultivars to the various levels of salinity stress. Also, Dadashi *et al.* (2007) expressed that the majority of measured characteristics in 10 genotypes of barley in both normal condition and salinity stress condition had a significant difference at 1 and 5 percent and this shows that there is a genetic diversity among the 10 genotypes of barley based on their resistance or sensitivity towards stress. Bechini *et al.* (2010) found a considerable genetic diversity among the barley cultivars during studying the salinity stress.

THE IMPACT OF SALINITY STRESS ON GERMINATION CHARACTERISTICS

Final Germination Percentage

As it could be observed from Table 3, by the beginning of salinity stress final germination percentage has initially increase slightly and subsequently, it decreased by the increase in the salinity stress to 12 dS/m. it seems that weak salinity leads to better stimulation of germination. In Maqtuli Chaichi (1999) research, germination percentage mean comparison in various salinity stress levels, the germination percentage decreased, but this decrease was significant in 200 Mmol level, only. Salinity decreases germination in the plant through three main factors including osmotic potential, production of toxic ions and changes in nutrient elements. Decrease in final germination percentage under impact of salinity is reported in alfalfa by Aminpur and Ja'faraqai (1998). In studying the resistance of canola towards salinity, Baybverdi and Tabatabi (2009) expressed that by the increase in salinity, the final germination percentage decreases. The decrease in the number of germinated seeds could be related to the water absorption due to the formation of osmatic potential by the increase in salinity and also sodium toxicity impact on plants metabolic processes which lead to disorder in the seed embryo development and as a result the radicle exist the shell. In Movafeq *et al.* (2012) research, salinity stress decreased the final germination percentage.

Coefficient of Velocity of Germination

As it could be observed in Table 3, coefficient of velocity of germination has not decreased until 6 dS/m level, but by the increase in the stress intensity, it decreased in the next levels. It seems that coefficient of velocity of germination does not show any sensitivity to low levels of stress. Salinity stress decreases the water absorption through osmotic stress and by concentration sodium and chloride ions lead to an imbalance in absorption

Table 3. Impact of Salinity Stress Levels on Characteristics Related to Germination

Velocity of Emergence	Emergence Percentage	Length of Coleoptile	Length of Radicle	Number of Radicles	GRI	CVG	FGP	Salinity Stress Levels
2/50A	93/89A	2/71A	7/19A	4/84AB	57/13A	55/77A	80/89B	Without Stress
2/36B	94/02A	3/09A	7/35A	4/99A	59/10A	50/78A	87/00A	6 ds/m
2/37B	95/00A	2/86A	5/67B	4/63B	41/70B	39/10B	75/33 BC	12 ds/m
2/06C	93/33A	2/29A	4/20C	4/56B	37/82B	36/14B	72/33 C	18 ds/m

Table 4. Cultivars Means Comparison in Without Stress Level

Velocity of Emergence	Emergence Percentage	Length of Coleoptile	Length of Radicle	Number of Radicles	GRI	CVG	FGP	Cultivar
2/42A	86/66A	2/55AB	8/10ABCD	4/44B	46/56DE	52/06BC	70/66 BCD	Afzal
2/53A	91/66A	2/83AB	9/72AB	5/11AB	59/64BCD	47/62BC	89/33 AB	Nosrat
2/49A	91/66A	2/82AB	9/82A	5/11AB	59/17BCD	48/52BC	86/66 AB	Valfajr
2/55A	96/66A	2/55AB	7/99ABCD	4/22B	34/70E	42/69C	58/66 D	Kavir
2/63A	98/33A	2/66AB	8/88ABC	4/22B	79/63A	64/69AB	98/66 A	Bahman
2/46A	95/00A	1/88B	5/72DEF	4/66AB	59/53BCD	49/47BC	84/00 ABC	Zahak
2/50A	95/00A	2/72AB	7/33ABCD	4/99AB	71/28ABC	51/29BC	98/66 A	Dasht
2/46A	95/00A	2/33AB	4/44EF	4/88AB	52/28CDE	50/90BC	77/33 ABCD	Yousef
2/70A	98/33A	3/38A	7/10ABCDE	5/55AB	75/48AB	73/47A	89/33 AB	Sahra
2/45A	96/66A	2/99AB	3/77F	4/21B	39/84DE	43/32C	61/33 CD	Reyhan 2
2/41A	90/00A	2/77AB	6/88BCDE	5/88A	56/83BCD	47/79BC	82/66 ABC	Nimrooz
2/36A	91/66A	2/99AB	6/55CDE	4/77AB	52/63CDE	49/41BC	73/33 BCD	Torsh

of nutrient elements and formation of toxicity (Kaimakanova, 2009). Shamsi Mahmud Abadi (2007) expressed that by the increase in salinity, the seeds are not capable of absorbing water for germination and cell development and on the other hand, the enzymes which are important in plant activation and growth are damaged or activated by dely. Due to the same reason, by the increase in salinity, the velocity of germination is decreased initially and then the germination percentage changes. Through the conducted studies in this experiment, it is concluded that the lack of germination in many of the studied seeds is related to the disorder in water absorption in water absorption due to osmotic potential impact of the salt solution. Also, the toxicity due to the concentration of some ions leads to prevention of germination through forming disorder in metabolism of the embryo.

Germination Rate Index

As it could be observed from Table 3, germination rate index has not decreased until 6 dS/m level, but by the increase in the stress intensity, it decreased in the next levels. It seems that germination rate index decreases in stresses higher than 6 dS/m. Turhan and Ayaz (2004) came to this conclusion that increase in salinity levels decreases the seedling germination by impacting cell division and metabolism of the plant. They also found out that the inhibitory effect of sodium chloride on germination of sunflower seed depends on the absorption of chloride and sodium ions by the hypocotyl.

Number of Radicles

As it could be observed in Table 3, the number of radicles do not have any significant difference both in without stress and 6 dS/m stress. However, by the increase in the stress intensity, the mean decreases. Salinity stress and lack of water and nutrient resources are among the main factors in decreasing yield in crops. Healthy and developed roots increase the water and nutrients absorption and it leads to increase in yield (Rezaatai *et al.*, 2013). The volume of root and the number of root hairs are among the characteristics which are of a great significant in optimal situation (water and nutrients). In optimal situation, the plant tries to absorb water and nutrients by increasing the volume and number of roots in surface layer of the soil, while in stress situation, the length of the roots and the ratio of the length of the roots to the shoots becomes more important (Canbar *et al.*, 2009) In Bechini *et al.* (2010), salinity stress led to a significant decrease in the number of radicles in barley cultivars.

Length of Radicle

As it could be observed from Table 3, in both without stress and 6 dS/m stress, there is no difference between the characteristics and it has decreased in the next stress levels. Hence, the best growth of length of radicle was in without stress and 6 dS/m stress levels. Uniformity and velocity of germination showed a positive and direct relation with the length of radicle and plumula. In Movafeq *et al.* (2013) salinity stress led to a decrease in the length of radicle. In the study of Mohammad Yousefi *et al.* (2011), the length of plumula to radicle had a higher decrease in salinity stress.

Length of Coleoptile

As it could be observed from Table 3, the length of coleoptile has not undergone salinity stress. Hence, it could be concluded that the length of coleoptile has the least sensitivity towards salinity stress. According to Francis *et al.* (1986) and Kaimakanova *et al.* (2009), under salinity stress the ratio of coleoptile elongation decreases by the low water potential of the soil and due to the weakness of coleoptile, the seedling is not established well. Salinity decreases the seedling growth through decreasing the nutrient reserve, and suspends the cell division and damages it by preventing axis development on the cotyledon. Also, under salinity stress, under salinity stress the ratio of coleoptile elongation decreases by the low water potential of the soil (Francis *et al.*, 1986) and as due to the weakness of coleoptile, the seedling is not established well.

Emergence Percentage

As it could be observed in Table 3, there was no significant difference found between the mean of emergence of percentage in the bushes in the pots. Tis is due to the fact that by the first irrigation, the salinity treatment had not reached the targeted limit. The emergence capacity of the seeds, especially in undesirable conditions such as farms, is a significant index of seed vigor. Results from this experiment proves the abovementioned issue. According to Monez and Toaster (2008), salinity decreases the early emergence of the plant through three factors including osmotic potential of the solution, production of toxic ions and changes in nutrient elements balance. In low salinity concentrations, decrease in osmatic potentials is a limiting factor for germination and emergence. However, in high salinity concentrations

Velocity of Emergence

Considering Table 3, the velocity of emergence had the highest mean in without stress level and, the velocity of emergence decreased by the increase in stress and the lowest mean was at 18 dS/m level, which has decreased in this level. Plants from vigorous seeds have a higher velocity of emergence, comparing with plants from weak and worn-out seeds (Wave, 1977).

COMPARISON OF MEANS OF CULTIVARS BASED ON GERMINATION CHARACTERISTICS

Final Germination Percentage

As it could be observed from Table 4, in without stress level, cultivars of Dasht, Bahman, Nosrat, Sahra, Valfajr, Zahak, Nimruz and Yousef with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 6 dS/m (Table 5), cultivar of Kavir had the lowest rate of the characteristics and other cultivars with common letter of A did not show any significant difference. In salinity stress level of 12 dS/m (Table 6), cultivars of Reyhan 2 and Afzal had the lowest rate of the characteristics and other cultivars with common letter of A did not show any significant difference. In salinity stress level of 18 dS/m (Table 7), cultivars of Afzal, Nosrat and Kavir had the lowest rate of the characteristics and other cultivars with common letter of A did not show any significant difference. Results from Mohammadi *et al.* (2011) showed that the genotypes showed a significant difference at one percent in confrontation with salinity stress. Generally said, by the increase in salinity stress level, germination percentage decreased.

Coefficient of Velocity of Germination

As it could be observed from Table 4, in without stress level, cultivars of Bahman and Sahra, with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 6 dS/m (Table 5), cultivars of Dasht, Zahak and Nosrat with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 12 dS/m (Table 6), all 12 cultivars with common letter of A did not show any significant difference. In salinity stress level of 18 dS/m (Table 7), cultivars of Dasht, Valfajr and Afzal with common letter of A did not show any significant difference.

Germination Rate Index

As it could be observed from Table 4, in without stress level, cultivars of Bahman, Sahra and Dasht, with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 6 dS/m (Table 5), cultivars of Sahra, Dasht, Zahak, Nosrat and Afzal with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 12 dS/m (Table 6), cultivars of Bahman, Nimruz, Valfajr, Sahra, Torsh, Yousef and Dasht with common letter of A had the highest rate of the characteristics. In salinity stress level of 18 dS/m (Table 7), cultivars of Valfajr, Dasht, Yousef, Sahra, Bahman and Zahak and Afzal with common letter of A had the highest rate of the characteristics. Decrease in germination could be due to the osmatic effects or the toxicity of salt or a combination of these two factors. In other words, decrease or delay in emergence of seedling might be due to the lack of the seed vigor in overcoming external osmatic potential and also absorption of the required water for the embryo (Khosh kholq *et al.*, 2008).

Number of Radicles

As it could be observed from Table 4, in without stress level, cultivars of Nimruz, Sahra, Nosrat, Valfajr, Dasht, Yousef and Zahak, with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 6 dS/m (Table 5), all cultivars with common letter of A showed no significant difference. In salinity stress level of 12 dS/m (Table 6), cultivars of Afzal, Zahak and Valfajr with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 18 dS/m (Table 7), cultivars of Sahra, Nimruz, Dasht, Zahak and

Table 5. Cultivars Means Comparison in Stress Level of 6 dS/m

Velocity of Emergence	Emergence Percentage	Length of Coleoptile	Length of Radicle	Number of Radicles	GRI	CVG	FGP	Cultivar
2/39AB	88/33A	3/33AB	8/10AB	4/33A	61/14AB	51/65BC	88/00 AB	Afzal
2/63A	93/33A	3/33AB	8/94AB	5/27A	65/80 AB	57/01 A	92/.. AB	Nosrat
2/35AB	98/33A	2/94AB	8/49AB	5/21A	58/96BC	44/96C	88/00 AB	Valfajr
2/15AB	88/33A	2/99AB	9/33A	4/66A	54/71 BC	47/21BC	69/33 B	Kavir
2/30AB	100/00A	2/38B	5/77B	5/05A	54/77BC	49/70BC	94/66 A	Bahman
2/36AB	95/00A	2/88AB	7/72AB	5/11A	65/88A	58/73A	96/00 A	Zahak
2/51A	98/33A	3/66AB	6/32B	4/99A	66/66A	64/30A	86/66 AB	Dasht
2/24AB	91/66A	2/99AB	7/77AB	5/10A	46/23BC	40/85C	81/33 AB	Yousef
2/50A	93/33A	3/22AB	6/77AB	5/22A	67/28A	50/96BC	88/00 AB	Sahra
2/16AB	91/66A	3/99A	7/44AB	5/21A	50/97BC	45/48C	86/66 AB	Reyhan 2
2/49A	98/33A	2/77AB	7/11AB	5/10A	59/62BC	48/07BC	86/66 AB	Nimrooz
2/11B	91/66A	2/55B	4/44C	4/55A	57/64ABC	50/37BC	86/66 AB	Torsh

Table 6. Cultivars Means Comparison in Stress Level of 12 dS/m

Velocity of Emergence	Emergence Percentage	Length of Coleoptile	Length of Radicle	Number of Radicles	GRI	CVG	FGP	Cultivar
2/46A	93/33A	3/55A	6/10A	5/55A	33/10BCD	35/00A	65/33 B	Afzal
2/46A	96/66A	3/27ABC	50/55AB	4/88B	31/20BCD	30/75A	72/00AB	Nosrat
2/22A	88/33A	3/77A	7/33A	4/99AB	49/48AB	43/14A	81/33AB	Valfajr
2/37A	98/33A	3/55A	6/11A	4/55B	27/95CD	31/87A	73/33 AB	Kavir
2/23A	98/33A	2/38 BCD	5/88AB	4/22B	55/94A	44/46A	92/00 A	Bahman
2/49A	95/00A	3/72A	5/88AB	5/22AB	51/26AB	45/53A	88/00 AB	Zahak
2/38A	95/00A	2/88ABC	5/50AB	4/88B	39/19ABC	36/27A	81/33 AB	Dasht
2/36A	95/00A	2/83ABC	5/66AB	4/44B	43/60ABC	38/45A	77/33 AB	Yousef
2/31A	96/66A	2/00CD	4/55AB	4/55B	49/25AB	45/98A	72/00 AB	Sahra
2/31A	96/66A	1/44D	3/10B	3/99B	18/44D	34/76A	38/67 C	Reyhan 2
2/44A	93/33A	2/66A-D	5/99AB	4/11 B	51/68AB	43/89A	82/67 AB	Nimrooz
2/24A	93/33A	2/22BCD	6/44A	4/22B	49/21AB	39/00A	80/00 AB	Torsh

Bahman with common letter of A were in the first group and had the highest rate of the characteristics.

Length of Radicle

As it could be observed from Table 4, in without stress level, cultivars of Valfajr, Nosrat, Bahman, Afzal, Kavir, Dasht and Sahra, with common letter of A were in the first group. In salinity stress level of 6 dS/m (Table 5), except for cultivars of Dasht, Bahman and Torsh, all other cultivars with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 12 dS/m (Table 6), except for cultivar Reyhan 2, all other cultivars with common letter of A were in the first group and had the highest rate of the characteristics. In salinity stress level of 18 dS/m (Table 7), except for cultivars of Nosrat and Kavir, all other cultivars with common letter of A showed no significant difference. In the study of Mohammad Yousefi *et al.* (2011), cultivar mean comparison showed that cultivar of Reyhan had the highest rate in length of radicle and cultivars of Valfajr and Afzal did not have any significant difference.

Length of Coleoptile

As it could be observed from Table 4, in without stress level, all cultivars, except for cultivar of Zahak, had common letter of A and were in the first group. Also, in salinity stress level of 6 dS/m (Table 5), all cultivars, except for cultivars of Bahman and Torsh, had common letter of A and were in the first group. However, cultivars of Reyhan 2, Dasht and Afzal were in the first ranks. In salinity stress level of 12 dS/m (Table 6), cultivars ofZahak, Afzal, Kavir, Nosrat, Dasht, Yousef and Nimruz had the highest and cultivars of Sahra, Reyhan and Torsh had the lowest rate of length of coleoptile. In salinity stress level of 18 dS/m (Table 7), cultivars of Yousef, Sahra and Dasht, had the highest rate of length of coleoptile, although they were in the first group with the next 5 genotypes (with common letter of A).

Emergence Percentage

Considering the lack of significance in difference between the cultivars in this characteristic, there was no

Table 7. Cultivars Means Comparison in Stress Level of 18 dS/m

Velocity of Emergence	Emergence Percentage	Length of Coleoptile	Length of Radicle	Number of Radicles	GRI	CVG	FGP	Cultivar
2/26A	91/66A	2/33ABC	3/88AB	4/22BCD	29/83BCD	39/32ABC	53/33 C	Afzal
2/10A	95/00A	1/11C	2/88B	3/33D	15/29D	23/24C	53/33 C	Nosrat
1/98A	93/33A	2/44AB	4/44AB	4/22BCD	58/18A	49/42AB	85/33 A	Valfajr
2/11A	95/00A	1/11C	2/88B	3/99CD	28/05BCD	30/32C	57/33 BC	Kavir
1/90A	90/00A	2/33ABC	4/32AB	4/55ABCD	42/93ABC	33/36BC	89/33 A	Bahman
1/92A	90/00A	2/44AB	4/99AB	4/88ABC	39/87ABC	35/06BC	86/66 A	Zahak
1/96A	93/33A	2/55AB	3/55AB	5/33A	58/11A	54/51A	82/66 A	Dasht
2/04A	93/33A	3/55A	6/21A	4/44BCD	44/31AB	37/06BC	77/33AB	Yousef
2/21A	93/33A	2/46A	5/16AB	5/82A	43/53AB	37/77BC	80/00 AB	Sahra
2/06A	96/66A	1/66BC	3/99AB	4/44BCD	22/46CD	26/52C	65/33 ABC	Reyhan 2
2/21A	96/66A	1/99BC	3/99AB	5/44AB	35/21BCD	34/30BC	66/66ABC	Nimrooz
2/00A	91/66A	2/55AB	4/22AB	4/10BCD	35/98BC	32/77BC	70/66 ABC	Torsh

significant difference was found between all the stress levels. While showing the negative effect of salinity on the seedling emergence percentage, Taddayon and Emam (2007) reported the highest and lowest seedling emergence percentage in cultivars of Reyhan and Afzal. They attributed this negative effect to the decrease in the soil osmatic potential and presence of high rates of sodium and chloride. Studies have showed that salinity has a considerable inhibitory effect on emergence of the seeds and this inhibitory effect is a significant limiting factor for planting crops in saline lands.

Velocity of Emergence

As it could be observed from Table 4, in without stress level, all cultivars, had common letter of A and there was no significant difference found between the cultivars. In salinity stress level of 6 dS/m (Table 5), cultivars of Nosrat, Dasht and Sahra had the highest velocity of emergence, although they did not have any significant difference with the next 8 cultivars (with common letter of A. In this level, cultivars of Reyhan 2, Kavir and Torsh had the lowest velocity of emergence. In the study of Emam *et al.*, (2013), the highest rate of velocity of emergence in both desirable and saline conditions was related to the cultivar of Nosrat, and it was significantly higher than the other cultivars. In this research, the highest rate of decrease in emergence and velocity of emergence in the seedling under salinity stress was in the cultivar of Shirin, while the lowest rate of decrease in emergence and velocity of emergence in the seedling under salinity stress were in cultivars of Nosrat and Abolfazl, respectively. In salinity stress levels of 12 and 18 dS/M (Table 6 and 7), all 12 cultivars had the common letter of A and there was no significant difference was found among them.

CONCLUSION

Analysis of variance results in characteristics showed that salinity stress effect was significant on all characteristics except for the seedling emergence in the pots. The difference between barley cultivars was significant, except in weight per hundred seeds, length of coleoptile and percentage of emergence, which shows the genetic diversity among the studied cultivars in their resistance towards salinity stress. The interaction of cultivar × salinity was significant in characteristics of seed yield, number of fertile tillers and number of grains per spike, coefficient of velocity of emergence, germination rate index, length of radicle and length of coleoptile, which shows the different reaction of cultivars towards various levels of salinity stress. The significance of the difference between cultivars in measured characteristics show that studied cultivars have difference potentials and it is possible to access genotypes with higher characteristics. Crops are different in their resistance towards various concentrations of salt in their root region. Hence, choosing plants for the maximum production under salinity stress will be among the most significant and useful options (Khan *et al.*, 1992).

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