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The Effect of Drought and Salinity Stresses on Seed Germination of *Alyssum hamalocarpum* in Iran's Arid Lands

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Abstract The current study aimed to investigate the effect of two abiotic stresses including salinity and drought on seed germination characteristics of Allyssum hamalocarpum in vitro. The experiment was designed as factorial completely randomized with four replications. Treatment included five levels of drought i.e. 0, – 0.19, – 0.25, – 0.41 and – 0.99 Mpa and five levels of salinity including 0, 50, 100, 150 and 200 mmol/L NaCl. Polyethylene glycol and NaCl were used to create various levels of drought and salinity stresses, respectively. Data were analyzed with One-way ANOVA and means with significant difference were separated with Duncan test at %95 confidence level. Seed germination characteristics of A. hamalocarpum were affected ($P<0.05$) by various levels of drought and salinity stresses. Germination percentage and rate, radicle length, plumule length, radicle and plumule dry matter mass were decreased ($P<0.05$) as stresses increased. A. hamalocarpum seeds tolerated drought level up to – 0.25 Mpa. However, germination percentage and rate reduced at drought level greater than – 0.25 Mpa. It was concluded that seed germination characteristics of A. hamalocarpum can be more affected by salinity stress than drought stress. This indicates that A. hamalocarpum is more sensitive to salinity stress than drought stress.

Keywords: Medicinal plant, abiotic stress, grassland, Cruciferae family, Polyethylene glycol.

Introduction

Recognition, domestication and studying the principles underlying the cultivation of medicinal plants of grasslands in farming ecosystem is one of the significant issues in agricultural and natural resources sciences. *A. hamalocarpum* of *cruciferae* family, is a 5-10 cm annual, its fruit is of *silicule* type, its egg is wide and pointed, without winged fur and it's red when ripe (Mozaffarian, 1996). The seeds form the medicinal part of the plant that are round, wide, gray, and they have a thin mucilage cover that is visible on the sides of the seed as short winged and white. *A. hamalocarpum* strengthens the hearts and facilitates digestion in Gastrointestinal tract. In the past medicine, *A. hamalocarpum* used to be applied as expectorants and anti-inflammatory drugs. This plant is originally grown in Iranian dry regions. Since the *A. hamalocarpum* seed germination is slow, its direct cultivation is not recommended. One of the barriers to the development and

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cultivation of medicinal plants in the country is its weak and sporadic existence in the soils of dry regions especially when there are nonliving environmental stresses such as salinity and drought. Salinity stress and dry stress are among the most important environmental stresses of salinity and dry stresses (Alizadeh, 2002). A problem that exists in both humid and dry climates becomes more significant by increase in aquatic cultivation (Saboulz, 1994). Dry stress affects the different aspects of plant growth and decreases and delays seed germination, decreases growth in aerial organs and decrease in the production of dry material. In arid and half-arid areas, dry stress and water shortage affects plant growth. It is reported that the resistance of plants against environmental stresses in several life cycles is different generally in most plants, the first stage in development is considered the most sensitive developmental stage (Salami *et al.*, 2006). Forbearance against drought is important at this stage for the sustainability of the plants because weak seed germination and slower growth of the plant (Giahcheh) leads to the weak sustainability and sometimes the destruction of the crop (Soltani *et al.*, 2006). In arid and semi-arid areas that are often exposed to drought stress, seed germination seems problematic (Ashraf *et al.*, 2006). Such stress can decline germination in seeds by confining water absorption, diminishing supply materials of the seed, and disrupting the synthesis of the preserved proteins (Ramagupal, 1990). Drought stress occurs for a plant when the amount of received water by the plant is less than its loss. This may happen as a result of excessive water loss or the reduction in absorption or both of them (Kouchaki and Alizadeh, 1995).

Salinity stress, second to drought stress, is regarded as one of the main barriers to the production of medicinal plants in many areas especially arid areas. Today, soil and water salinity is considered as one of the obstacles and limitations of utilizing resources in efficient production of crops. From among all the cultivable lands in the country, only 8.1 million hectares are (faryab) and about 50% of lands are affected by different types of salinity of the soil. The most sensitivity to salinity in life cycle of the plants is observed during seed germination and at the beginning of the growth of the seed (Maghtouli and Chaeechi, 1999). Salinity stress affects the germination and growth of the seeds by reducing water potential and toxicity of certain ions such as Sodium, Chlorine and also reducing nutritional ions required by the plant such as calcium and potassium (Ghaderi *et al.*, 2011). Generally, seed germination is considered as the most sensitive stage in most plants. Salinity affects the germination process through reduction of water absorption rate or increase in the extrusion of ions which might change hormone and enzyme activities (Catalan *et al.*, 1994). The seeds of the plants in salinity environments are exposed together to heat, salinity, and drought stress which causes growing plant loss. Investigating the effect of salinity and drought on the rate and the percentage of seed germination and also the growth of plant in most plants has indicated that salinity and drought stress in seed germination phase is a reliable test for evaluating the resistance of many species in such a way that salinity and drought can lower the rate and percentage of seed germination and also reduce plant growth (Irannezhad *et al.,* 2009).

Numerous studies have been conducted on the reaction of some medicinal plants against salinity and drought stresses in seed germination stage and also the phase of plant growth (Bornet *et al.*, 2005). The deterrent effects of environmental stress on seed germination have been reported in all these experiments (Hosseini and Rezvani-moghadam, 2006).

Hosseini and Rezvani-moghadam (2006) studied *Plantago ovate* affected by salinity and drought stress and revealed that by the increase in these two stresses, the rate and percentage of seed germination, the length of radicle and plumule was lessened. Moreover, Dashti *et al.* (2006) studied the effect of salinity and drought stresses on seed germination of *Althea officinalis* and found out that the rate and percentage of seed germination was significantly lessened by the increase in salinity levels. Gholami *et al.* (2009) evaluated the seed germination indices of *Viciamonantha* and found that the rate and percentage of seed germination, the length of the radicle and the plumule was reduced. Boroumand *et al.* (2005) observed in their experiments on the seed germination of *Carumcopticume, Foeniculum and Anethum graveolens* that the rate of seed germination, length of the radicle and plumule lessened as a result of implementing the salinity and drought stress in different temperatures. *Anethum graveolens dhi* was the least resistant plant against temperature changes and osmotic potential. Ramazani *et al.* (2009) evaluatd the effect of salinity and drought stresses on the seed germination and the growth of *Capparis spinosa* and revealed that seed germination and the growth significantly decreased by the increase in the density of salinity and drought stresses. *Capparis spinosa* germinated up to the density equal to 1.2 Mpa and germination was ceased with a high-density but the growth of the plant was ceased with the density equal to 1 Mpa. In addition to this, Hassani (2005) studied the effect of water stress of Poly Ethylene glycol on seed germination of *Ocimum basilicum* and also Salami *et al.* (2006) studied the effect of salinity stress on the seed germination of the seeds of medicinal plants called *Cuminum cyminum* and *Valeriana officinalis* and they stated that the increase in salinity and drought stress in these plants may lead to the reduction of the percentage of seed germination, the rate of germination, the length of the radicle, the length of the plumule, the weight of dry radicle and dry plumule.

Resistance against drought and salinity, especially in the phase of germination and growth should always be taken into consideration in choosing plants for cultivation. Since the conventional evaluations in field conditions are on one hand time-consuming and on other hand affected by numerous uncontrollable factors such as soil, climate, farming operations, therefore it is necessary to provide quick and somewhat exact plant reactions to salinity drought using an experimental method in controlled conditions (Bloom, 1984). Despite the studies conducted regarding the reaction of medicinal plants to environmental stresses, no studies are done so far on the amount of resistance of *A. hamalocarpum* against common abiotic stresses in the country especially salinity and drought stresses. Hence, regarding the broadness of lands affected by salinity and drought stresses in Iran and considering the improvement of qualitative indices of many medicinal plants in average stress conditions, the objective of this research is to study the effects of different salinity and drought stress levels on seed germination of *A. hamalocarpum***.**

Materials and methods

In order to study the effect of salinity and drought stress on the seed germination features of *A. hamalocarpum*, two separate experiments were conducted with a completely incidental framework repeated four times in the laboratory of cultivation and reproduction of grassland plants in the water and soil college of the University of Zabol in 2013. *A. hamalocarpum* seed was purchased from Pakan Institue of Isfahan. In the first experiment, Polyethylene glycol 6000 was applied based on Mitchel Kaufmann's (1973) formula to create drought stress levels (-0.25, -0.41, and -0.99 Mpa). In the second experiment, certain amounts of sodium chloride were utilized in order to create salinity stress level of zero, 50, 100, 150, and 200 mill mules over liter sodium chloride. When the healthy seeds were separated from small and dried up seeds, they were disinfected by 3% sodiumhypochlorite solution and then it was washed by distilled water. (Aminifar *et al.*, 2010). Cultivation in petri dishes having 6 centimeters diameter and the length of 1.5 centimeters and to each one 7 milliliters poly ethylene glycol and sodium chloride were added with a certain potential. Twenty five infected seeds on Whatman filter paper were placed inside petri dishes and they were transferred into a germinator with ±25˚Cwith 16 hours exposure to light and 8 hours exposure to darkness (Draper *et al.*, 1985). The counting of germinated seeds began from the third day after cultivation up to fourteen days at a certain hour and the evaporated water from the surface of petri dishes was replaced with distilled water. The standard for germination was uprooting the two millimeter radicle. At the end of fourteenth day the length of the radicle and the plumule, the dry weight of the plant (radicle and plumule) was measured. In order to measure the dry weight of the samples, first the sample of each treatment was selected, separated and then washed with distilled water and was placed for forty eight hours in an oven with 80℃ (Catalan et al., 1994), then the dry weight was measure by a digital scale. The germination percentage and rate were calculated separately for each treatment base on the relations (1) and (2) (Ista, 2002).

$$GP=100\times(ni/s) \quad (1)$$

GP is the percentage of germination, *ni* represents germinated seeds, ti is the time and S equals the total number of seeds.

$$GR = \sum ni/ti \qquad (2)$$

In this relation, GR stands for germination rate, it equals the number of the days after germination, and ∑n is the total number of germinated seeds in the test period.

Data analysis was conducted using SPSS (V.16) and SAS (V.9.1) and comparing the means of traits was done by Compare Means Duncan test**.**

Results and Discussion

Salinity drought

Analysis of variance indicated that the different drought treatments carried out are significantly different regarding germination percentage, rate, the length of the radicle and plumule, the weight of the radicle and plumule ($p<0.05$). (Table 1). Comparing the means for the measured traits revealed that seed germination percentage followed a similar reductive procedure with the reduction of potential osmosis. The second level of drought stress (-0.25 Mpa) included the highest percentage of germination (60.75%) but there was no significant difference with the control treatment and it was placed in one group (Table 2). By the growing stress level, seed germination percentage was lessened so that the third level (-0.41 Mpa) and fourth level (-0.99 Mpa) indicated a significant difference with the control treatment and they were place in separate groups. The lowest percentage level belonged to the fourth drought level (12.33%) (Table 2) (Fig. 1). Hosseini and Rezvani-moghaddam (2006) studied the effect of drought stress on seed germination of *Plantago psyllium* and Hassani (2005) studied the effect of aquatic stress of poly ethylene glycol on the traits of *Ocimum basilicum* and they pointed out the reduction of seed germination percentage by the increase in drought stress that is in line with the results of this study. The seeds should absorb enough water for the germination process, the existing solutions such as poly ethylene glycolin in the cultivation environment can reduce water absorption by the seed, reduce the hydrolization of material supplies of the seed, and consequently stop or delay the germination process. Drought stress and limited water absorption by the seed is probably the main cause of the reduction in germination rate through affecting the transfer of seed supplies and the synthesis of the protein in the embryo. (Kaboli *et al.*, 2001).

Table 1. Analysis of variance (square means) of seed germination traits of *Allyssumhamalocarpumin* in different drought levels.

Resources of changes	Degree of freedom	Germination percentage	Germination rate	Length of plumule	Length of radicle	Weight of plumule	Weight of radicle
treatment	3	17128.22**	5.40**	0.398*	8.33**	0.0006*	0.00058**
Error	44	24366.25	8.39	1.424	8.75	0.0005	0.00038
Total	47	41497.47	13.79	1.822	17.09	0.0011	0.00096

** level of significance $p<0.01$
*Level of significance $p<0.05$

Table 2. Comparing the means of the seed germination traits of *Alyssum hamalocarpum* affected by different drought levels.

Source of changes	Germination percentage	Germinate rate of the seed (per day)	Length of the plumule (cm)	Length of the radicle (cm)	Dry weight of the radicle (gr)	Dry weight of the(gr)
Control	53.33 a*	0.89ab	0.691ab	1.13 a	0.004ab	0.016 a
-0.25Mpa	60.75 a	1.10 a	0.812 a	1.75 b	0.005 a	0.018 a
-0.41 Mpa	32.67 b	0.58 b	0.693ab	1.15 a	0.002bc	0.011ab
-0.99 Mpa	12.33 c	0.22 c	0.555 b	0.57 c	0.0007 c	0.002 b

* The means in each column including at least one common letter show no significant difference.

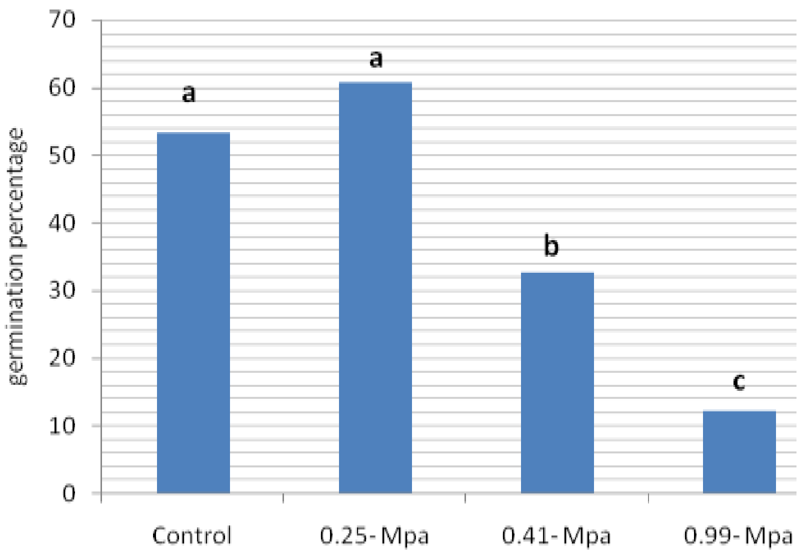

Fig. 1. The effect of drought treatments on the seed germination of *Alyssum hamalocarpum.*

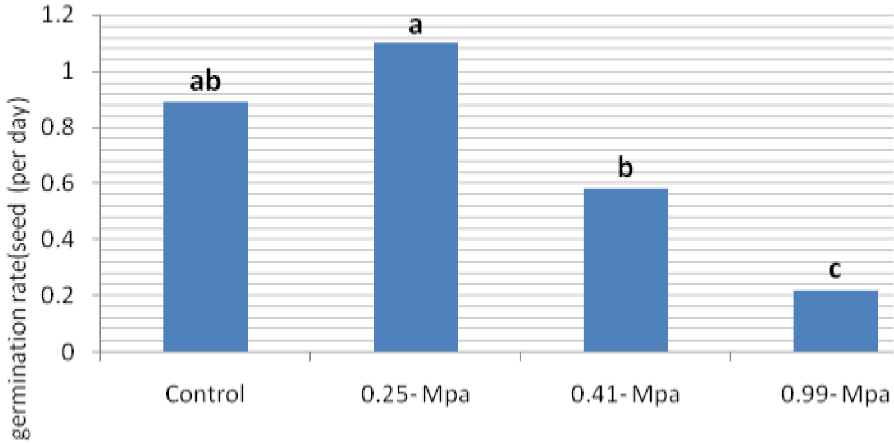

Fig. 2. The effect of drought treatments on the germination rate of *Alyssum hamalocarpum*

Comparing germination rate of the seeds denotes on the maximum germination rate of 1.1 seed in a day in the drought stress that was - 0.25 Mpa that were note significantly different from the control treatment. The minimum germination rate 0.22 seeds in a day had to do with the fourth drought treatment (Fig. 2) which represented the diminishing procedure of germination rate while the drought stress level increased (Table 2). The findings by Gholami *et al.* (2009) on the *Vicia monantha* and also Ramezani *et al.* (2009) studies on *Capparis spinosa* demonstrates decrease in seed germination rate by the increase in drought levels that are in line with the findings of this study. If water absorption is interrupted by the seed, the metabolic activities of germination occurs gradually in the water and therefore the period of emergence of the radicle from the seed will be longer and thereby the germination rate will be lessened (Mir *et al.*, 1989).

The length of the radicle and the plumule is also reduced by the increase in drought stress level. The maximum radicle and plumule length belongs to the treatment -0.25 Mpa (second treatment) and the minimum radicle and plumule length has to do with the treatment -0.99 Mpa (fourth treatment). Zero treatments (control), -0.25 and -0.41 Mpa regarding the plumule length were not significantly different from zero treatments (control) and -0.41 Mpa regarding the radicle length. The reduction rate of radicle length ranged from the maximum amount of -0.25 Mpa (second treatment) to the minimum amount of -0.99 Mpa (fourth treatment) was equal to 1.18 centimeters and the decrease in the length of the plumule ranged from the maximum amount in the second treatment to the minimum amount in the fourth treatment was equal to 0.25 centimeter (Table 2). Other researchers such as Boroumand *et al.* (1384), Dashti *et al.* (1386) reported the decrease in the length of radicle and plumule due to the increase in drought stress. In addition, Katergi *et al.* (1994) mentioned that low water absorption by the seed in stress conditions may cause the secretion of the hormones and the activities of enzymes and consequently disrupting the growth process in the radicle and plumule in such a way that germinated seeds have shorter plumules and radicles in environments that are under stress.

The dry weight of the radicle and the plumule also reduce by the increase in drought stress. The treatment -0.25 Mpa (second treatment) respectively had the maximum dry weight of the radicle and the plumule which did not have any significant different with the control treatment and -0.41 Mpa (third treatment) was not significantly different regarding the weight of the plumule. The minimum radicle and plumule weight had to do with the treatment -0.99 Mpa (fourth treatment) having 0.0007 and 0.002 grams weight (Table 2). Dry weight loss of the radicle and plumule was quite normal by the increase in drought which was also reported by Gholami *et al.* (2009), Boroumand *et al*. (2009) and Ramezani *et al.* (2009). Osmotic potential loss disrupts the growth process in the radicle and plumule that might lead to weight loss in the radicle and plumule (Redman *et al.*, 1994).

Correlation coefficient results demonstrated that all the seed germination traits under study affected by drought stress had a positive and significant correlation. The maximum correlation was between germination rate and germination percentage that was equal to 0.99 (Table3). The number of germinated seed at a certain time augmented by the increase in germination rate of the seeds, therefore, if germination rate grows in a treatment, it can be mentioned that more seeds germinated and as a consequence germination percentage rises.

Table 3. Correlation coefficient figures among related traits with different drought levels in *Alyssum hamalocarpum.*

Germination traits	**Germination percentage**	**Germination rate**	**Length of plumule**	**Length of radicle**	**Dry weight of plumule**	**Dry weight of radicle**
Germination percentage	1					
Germination rate	0.99**	1				
Length of plumule	0.59*	0.58*	1			
Length of radicle	0.76**	0.76**		1		
Weight of plumule	0.96**	0.97**	0.56*	0.68**	1	
Weight of radicle	0.95**	0.96**	0.57*	0.73**	0.89**	1

**Level of significance p<0.01
*Level of significance p<0.05

Salinity stress

The results indicated that the effect of different salinity levels as well as drought on germination traits of *A. hamalocarpum* was significant ($p<0.05$) (Table 4).

Table 4. *Alyssum hamalocarpum* in different salinity levels.

Sources of changes	Degree of freedom	Germination percentage	Germination rate	Length of radicle	Length of plumule	Weight of radicle	Weight of plumule
Treatment	4	23264.00**	6.58**	12.53**	4.42**	0.00058*	0.0008**
Error	55	16549.33	5.97	6.42	3.68	0.0004	0.0004
Total	59	39818.33	12.55	18.96	8.11	0.0009	0.0010

**Level of significance $p<0.01$
*Level of significance $p<0.05$

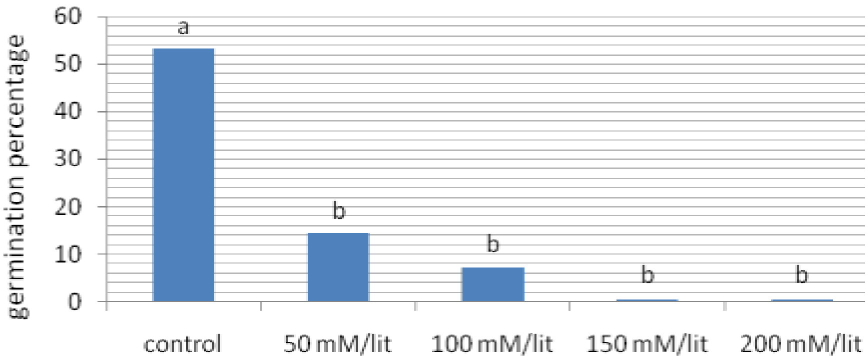

Fig. 3. The effect of salinity treatments on seed germination of *Alyssum hamalocarpum*.

There was a decrease in germination percentage by the reduction of water potential and also by the increase in its salinity so that increase in salinity reduced germination from 53.33 percent in the control treatment to 0.66 percent and in salinity treatment it was 200 mill mules of sodium chloride per liter (Fig. 3).Germination percentage from the control treatment up to 200 mill mule reduced to 52.72%. Also, there was a significant difference between germination percentage and all salinity levels. In addition, stress levels of 50, 100, and 150 mill mule per a liter of sodium chloride revealed 72, 86, and 98 percent reduction in germination (Table 4). Rezaei and Alinejad (1383) by an experiment on the effect of salinity stress on the germination of *Cuminum cyminum*, Dashti *et al.* (1386) by a similar experiment on *Althaea officinalis* indicated that the more the salinity level the less will be the germination percentage and it was in line with the results of this study. Reduction in the germination of the seeds affected by salinity stress can be as a result of direct effect of sodium chloride on the growth of the embryo (PuljakevMeyber *et al.,* 1994). Salinity affect seed germination and reduces it through toxic effects of ions such and sodium and chlorine (Zoo, 2001).

Seed germination rate also followed a process of drastic changes. Hence, control treatment with the maximum germination speed of 0.89 seed per day demonstrated a significant difference with other treatments (Fig. 4). The minimum germination rate was related to the treatment of 200 mill mule per s liter of sodium chloride that indicated a decrease of 98 percent in comparison with the control treatment (Table 5). DavazdahEmami, (2003) studied the effect of salinity on the germination of *Matricariachamomilla*, Plantagoovate, Rubiatinctorum, *Salvia officinalis, Melissa officinalis, Foeniculum vulgare, Pimpinella anisum, Trachyspermum ammi, Borago officinalis*, and *Hyssopus officinalis* and reported that increase in water salinity reduced germination rate of the seeds which was compatible with the results of this study. In addition, Hosseini and Rezvani-moghaddam, (2006) studied the effect of salinity on the germination of *Plantago ovate* and reported that increase in the salinity levels can reduce germination rate. Salinity stress affects seed germination rate through reducing the water absorption rate as a result of osmotic effect and increase in the exit of ions by changes in hormone and enzyme activities (Hang and Redman, 1995).

Table 5. Comparing the means of seed germination traits of *Alyssum hamalocarpum*affected by different salinity levels.

Source of changes	**Germination percentage**	**Seed germination rate per day**	**Length of plumule (cm)**	**Length of radicle (cm)**	**Dry weight of radicle (gram)**	**Dry weight of plumule (gram)**
Control	53.33 [a*]	0.89 [a]	0.69 [a]	1.13 [a]	0.004 [a]	0.016 [a]
50Mill mule per a liter of sodium chloride	14.66 [b]	0.26 [b]	0.59 [a]	0.95 [a]	0.001 [b]	0.005 [b]
100Mill mule per a liter of sodium chloride	7.33 [b]	0.13 [b]	0.19 [b]	0.29 [b]	0.002[ab]	[b]0.002
150Mill mule per a liter of sodium chloride	0.66 [b]	0.012 [b]	0.04 [b]	0.05 [b]	0.000 [b]	[b]0.000
Mill mule 200 per a liter of sodium chloride	0.61 [b]	0.011 [b]	0.06 [b]	0.05 [b]	0.000 [b]	[b]0.000

*In each column the means having at least one common letter do not show a significant difference

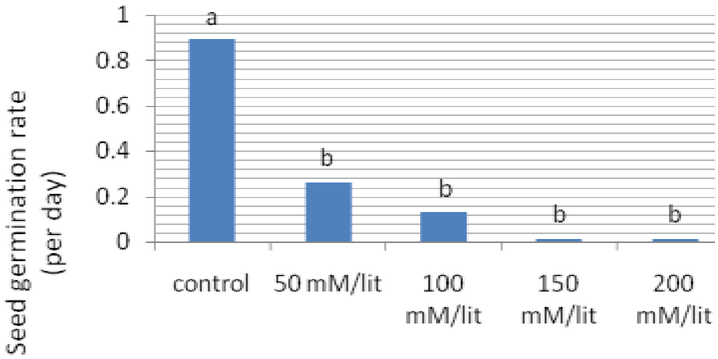

Fig. 4. The effect of salinity treatments on the germination rate of *Alyssum hamalocarpum*.

The increase in salinity levels reduce the length of the radicle and that of the plumule. The was no significant difference regarding the length of radicle of the control treatment with a level of 50 mill mule per a liter of sodium chloride but this difference was significant compared with other salinity levels ($p<0.05$). The maximum radicle length belonged to the control treatment (1.3 centimeters) and the least was related to the treatment of 200 mill mule per a liter of sodium chloride that indicated 95 % decline compared to the control treatment (Table 5). Regarding the length of the plumule, there was a significant difference between the control treatment and the levels of 100, 150, and 200 mill mule per a liter of sodium chloride. The maximum length of the plumule in the control treatment (0.69 centimeters and the minimum length of plumule in the treatment of 150 mill mules per a liter of sodium chloride was observed (Table 5). The reduction of the length of radicle and plumule as a result of increase in salinity level was also reported by Rezaei and Alinejad (2005), Hosseini and Rezvani-moghaddam (2006), and Yazdani-biooki *et al.* (2011) that are in line with the present study. Normally, the reduction in the length of the radicle and plumule in sodium chloride solution occurs because of the toxicity of ions and their negative effects on cell membrane (Salami *et al.*, 1385).Salinity stress prevents the decomposition of preserved supplies in the seed through reduction of water absorption and also through disrupting the secretion of enzymes such as amylase and lipase. Hence, the required energy for the exit of radicle and plumule and their growth is not provided (Ni yu *et al*., 1995).

The weight of the radicle and that of the plumule is reduced by the increase in salinity levels ($p<0.05$). Dry weight of the radicle in the control treatment revealed no significant difference with the treatment of 100 mill mules per a liter of sodium chloride, but the difference was significant with the other levels of salinity and regarding the dry weight of the plumule, there was also a significant difference between control treatment and all salinity levels. In addition, the maximum dry weight of the radicle (0.004 gr) and the plumule (0.016 gr.) was belonged to control treatment. The reduction in the dry weight of radicle and plumule from the control treatment to the level of 200 mill mules per a liter of sodium chloride was equal to 100 percent (Table 5). The reduction in the dry weight of the radicle and the plumule appears to be normal by the increase in salinity. This was also reported by Salami *et al.*, (2006) and Yazdani-biooki *et al*. (2011). The decrease in osmotic potential and the toxicity effect of ions , disrupts the growth of radicle and plumule by increase in salinity levels and will consequently lead to weight loss in radicle and plumule (Redman *et al.*, 1994).

The correlation coefficient results demonstrated that there was a positive correlation among the measured traits of salinity stress ($p<0.05$). The maximum correlation was between seed germination rate and seed germination percentage (0.98**) (Table 6). So, the increase in germination rate led to the increase in germination percentage in a certain time.

Table 6. Correlation coefficient figures between the traits related to different salinity levels in *Alyssum hamalocarpum.*

Germination traits	Germination percentage	Germination rate	Length of plumule	Length of radicle	Dry weight of plumule	Dry weight of radicle
Germination percentage	1					
Germination rate	0.98**	1				
Length of plumule	0.58**	0.56**	1			
Length of radicle	0.75**	0.72**		1		
Dry weight of plumule	0.71**	0.70**	0.53*	0.73**	1	
Dry weight of radicle	0.80**	0.79**	0.56*	0.70**	0.89**	1

**Level of significance $p<0.01$
*Level of significance $p<0.05$

This study reports that the environmental stresses such as salinity and drought stress have a negative effect on the seed germination traits of *A. hamalocarpum.* Generally, an increase in drought and salinity stress levels reduces the germination traits and the growth of *A. hamalocarpum.* This is mainly caused by the reduction in water potential and the toxicity of certain ions such as sodium and chlorine and also reduction of required nutritional ions of the plants such as calcium and potassiumas a result of salinity stress and the reduction of water absorption as a result of reduction in osmotic potential. In dry and hot areas, a delay in seed germination of this plant in spring leads to drought stress and reduces the number of germinated seeds. Besides, an increase in temperature and water evaporation amount the upper layer of the soil will be salinity and exposes the seed to salinity stress that causes delay in seed germination. A delay in seed germination caused by salinity and drought stresses may reduce the germination rate and the plant might fail to be green and sustainable.

Conclusion

According to the findings of the study, *A. hamalocarpum* reveal better reactions against salinity stress in drought stress condition regarding their germination and primary growth. This can occur as a result of more toxicity in sodium chloride salinity than applying poly ethylene glycol solution. In general, *A. hamalocarpum* endures drought stress less than -0.25 Mpa but seed germination is reduced by the increasing drought stress. It is sensitive to salinity stress and seed germination is significantly reduced. Therefore, according to the sensitivity level of this plant to salinity stress, it is recommended that the cultivation of this plant be prevented in areas with high amount of soil salinity.

Finally, what seems prominent is that the present study was conducted in vitro and the results are mostly applicable in controlled conditions in vitro. In order to make sure of the reaction of this plant against salinity and drought stresses after seed germination phases, it is necessary to conduct this study in vivo to be able to have an appropriate and exact evaluation of the resistance of this plant.

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