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Research Article

ENVIRONMENTAL MATERNAL EFFECTS ON DROUGHT AND SALINITY TOLERANCE OF IRANIAN KNAPWEED (*CENTAUREA DEPRESSA* M. BIEB.) AT GERMINATION AND SEEDLING GROWTH STAGE

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ABSTRACT
A laboratory experiment was conducted to determine the environmental maternal effects on drought and salinity tolerance of *Centaurea depressa* at germination and emergence stage, as a factorial experiment based on a completely randomized design with four replications. Seeds of two populations (Ahvaz and Karaj) germinated at a range of drought (0, -0.2, -0.4, -0.6, -0.8 and -1.0 MPa) and salinity (0, 100, 200, 300, 400 and 500 mM of NaCl). Results showed that germination percentage, radical and shoot length, and seedling dry weight of both *Centaurea depressa* populations decreased significantly ($P \leq 0.01$), with increasing intensity of drought and salinity, however results showed a greater salinity and drought tolerance of Ahvaz population. Germination percentage of Karaj and Ahvaz population was 0 and 13.5% respectively at -1 MPa osmotic potential and 0 and 8% respectively at 500 mM of NaCl.

***Keywords:** Sodium Chloride, Seedling Dry Weight, Radicle's Length, Shoot's Length*

INTRODUCTION
Weeds biology and its importance in agriculture management during recent years is necessity to consideration. In order to appropriate management and principle control of weeds, recognizing of effectiveness environmental circumstances on weeds biology is indispensable. This knowledge inferred to the importance of weeds seed dynamism in the soil and will improve agricultural operating management (Forcella *et al.*, 1993; Bhowmik 1997). Seed emergence and seedling development is the crucial process in plant growth cycle (Khan and Gulzar, 2003). Weed thriving in the emergence and developing stage can immensely anticipate or distinguish its life in the natural and arable ecosystems. Emergence can be undertaken with different environmental factors like drought and salinity (Chauhan and Johnson, 2007; Chachalis and Ready, 2000; Taylorson, 1987). Thus, recognizing the effectiveness elements on weeds emergence can present effective and novel solutions for their management. Seed emergence and developing is the most sensitive plants growth stage to drought and salinity stress. Usually if the seedling can tolerate the stress, it can cope and pass the other growth stage (Sathiyamoorty and Nukamura, 1995). The environment humidity potential is the effectiveness parameter in water absorption and seed dilation. Drought stress declines the water absorption potential. The seeds of all plants for germination need a minimum water absorption and dilation. To obtain that, it is necessary not to drop the environment potential at the stable level. By declining the osmotic potential, seeds humidity absorption will drop down and subsequently the emergence ability reduced. Soil humidity is determinative and crucial factor for germination and the minimum alter in soil moisture availability can affect impressively on germination among plant species (Keddy and Ellis, 1985). Poly ethylene glycol is the main chemical element, which is used for drought stress treatment because of its passive metabolic characteristic (Hohl and Peter, 1991). Its high molecule weight prevents the water entrance through the seed (Berkat and Briske, 1982).

Salinity is the main environmental factors, which severely threaten the stability of drought and semi-drought region particularly where the rate of evaporation and aspiration is higher than the raining rate (Szaboles, 1994). The salinity is threatened over than the six percent (equivalent of 800 million hectare) of world lands (FAO, 2005). Many of the salty lands due to plants establishment difficulties remain arid for years and years. In salty regions seeds usually expose to thermal, salinity and drought stress simultaneously, which results the higher rate of seeds mortality. Result on different plant germination showed that by increasing the salinity stress radicle length, shoot length and seedling weight significantly reduce compared to weedy check (Khan and Ungar, 2001). Germination and seedling growth reduction in salinity condition might be for lower osmotic potential and declining the seed moisture accessibility, the poisonous ions like Na^+ or Cl^- and some metabolism interference or disequilibrium of nutrition elements (Khan and Ungar, 2001). *Centaurea depressa* is the common weed in cereal farmlands, which leads the great damage to these fields. It is an annual weed with divergent stalk and reproduces by seed. It has duke like and vertical root and light, fragile and sandy soil is its essential needs however; it can adapt and develop in clay and limy soil. Usually it is observed in cereal fields and because of that it is named *Centaurea depressa* (Shoeb *et al.*, 2004).

Kaydan and Yagmur (2008) reported by decreasing osmotic potential, the percentage of germination and *Triticalea* seedling growth will decrease. The drought caused by PEG6000 has more impressive negative effect on germination and seedling growth compared to NaCl. Koocheki and Shahroudi (1996) and Azarnivand and Jafarian (2003) reported the ultimate germination percentage and germination rate in chickpea and two species of *Agropyron* spp. Decline by decreasing the water potential. Nezamabadi *et al*., (2005) found that NaCl solvable at different potentials (-0.4 &-0.8 MPa) significantly decreased the rhizome germination of *Glycyrrhiza glabra* and at level of 1.2 & 1.6 mega Pascal compeletly ceased its germination. Romo and Haferkamp (1987) reported salinity treatments caused by NaCl and CaCl has the same effect on germination and Na ion has the neuter effect on *Kochia prostrate* germination. On the other word the effect of osmotic potential on germination is correlated to the type of ion. Katembe *et al*., (1998) reported the higher densities of NaCl (-1.5 MPa) are more affected on dilation and germination of *Atriplex* compered to Poly ethylene glycol. They also compared *Atriplex* germination at (-0.25 &-1 MPa) NaCl and Poly ethylene glycol. Francois *et al.,* (1984) declared that soil salinity not decreased Sorghum germination at rate of 0.5 percent; however soil salinity at higher levels of 0.5 percent delayed the germination.

Anticipation and prevention of weeds are the main factors in the term of weed management. The investigation of weeds appearance and invasion in the various territories under the different ecological situation, ecological effects on maternal species and generated seeds from the maternal plants are counted as a novelty of the research and this research aimed to cope with these issues.

MATERIALS AND METHODS

Centaurea depressa seeds were randomly gathered from several farms in Karaj and Ahvaz. Then they treated with Carbendazim fungicide at 1 per thousand proportions for 5 minute and rinsed with sterilized water and placed in the room temperature for a while in order to be dried (Pahlevani *et al.,* 2008). The vitality of *Centaurea depressa* seeds was determined with Tetrazolium chloride test. According to this test 50 seeds of each population in four repetitions soaked in Tetrazolium chloride solvable 1% for about 48 hour and settled at 30 °C temperature in darkness (Esno *et al.*, 1996). The seeds which became red were alive. In this experiment the vitality rate of Karaj and Ahvaz population was respectively calculated about 87 and 90% (the statistical difference was insignificant). To determine 1000-grain weight according to ISTA process, one thousands of seeds were randomly selected and their accurate weight was recorded by the sensitive digital scale. The thousand grain weight of Karaj and Ahvaz population was respectively 2.318 and 2.303 g (the statistical difference was insignificant). This experiment conducted as factorial with randomized complete block in four repetitions. The effect of drought stress on seeds germination investigated by solvable at different osmotic potentials at level of (0, -0.2, -0.4, -0.6, -0.8 and -1.0 MPa) was investigated. The mentioned solvable liquids prepared according to 1 equation and the appropriate amount of poly ethylene glycol (PEG 6000) with sterilized water (Michel and Kaufman, 1973).

Equation 1: $S = -(1.18 \times 10^{-2})C - (1.8 \times 10^{-4})C^2 + (2.67 \times 10^{-4})CT + (8.39 \times 10^{-7})C^2T$

S: Solvable potential (MPa), C: Amount of polyethylene glycol 6000 (PEG g/kg Water), T: environment temperature.

The effect of salinity on seeds germination investigated by utilizing NaCl solvable at 0, 100, 200, 300, 400 and 500 mml.

To investigate the ability of seeds germination under different lightning and thermal conditions, in each treatment 50 seeds placed in petri dishes (11 cm length) which contains of sieve paper and 8 ml sterilized water. Then they conveyed to germinator and kept in advised lightning and thermal conditions. After 14 days the percent of germination calculated. The radicles which have 2 mm length were accepted. Ultimately the percent of germination was determined according to the below formula:

$$GP = 100 \times (\frac{N_i}{S})$$

GP: Percentage of germinating. Ni: The number of germinated seeds in ith day, S: Total number of cultivated seeds.

At least, all of the experiments repeated threefold at different times. After initial data analyzing and evaluation of their distribution process, the hypothesis of normal data distribution is investigated. The abnormal data was regulated by logarithmic formula. At least data analysis was done with utilizing the SAS ver. 9.1 Software. The comparison means is assess with Duncan test and graphs were draw with Excel Software.

RESULTS AND DISCUSSION

The Effect of Drought Stress on Germination Behavior of Centaurea Depressa

Result showed reducing of osmotic potential cause reducing of germination percentage, radicle and shoot length and dry seedling weight in both population of *Centaura depressa* in Karaj and Ahvaz. The germination percentage of Karaj and Ahvaz population from 87 & 91.5% (at zero osmotic potential) get to 0 & 13.5% (at-1osmotic potential) respectively (Figure 1-4). Radicle length in Karaj population from 15.25 mm at zero osmotic potential get to 2.32 mm at 0.8 osmotic potential and also at 1 osmotic potential no germination was observed. Also in Ahvaz population the radicle length from 16.5 mm at zero osmotic potential get to 1.87 mm at 1 osmotic potential. This reduction process on shoot length in both populations is observed; so that, in Karaj population the shoot length from 9.87 mm gets to 1.27 and then 0 mm. Whereas, in Ahvaz population this factor from 10.02mm get to 0.87mm. Also the highest dry weight of seedling in both populations (Karaj & Ahvaz) was reported from sterilized water. So that; by declining of osmotic potential, the dry weight of both aforementioned populations reduced. This factor in Karaj from 0.324 gets to 0 g and in Ahvaz it is changed from 0.331 to 0.078 g.

Reddy and Singh (1992) reported-0.1 MPa osmotic potential had the less effect on *Biden spilosa* germination. But at 0.75 MPa osmotic potential, less than 3% of seeds germinated. Result showed that the intensity of drought stress on emergence characteristics affected by characteristic population of *Centaurea depressa*. On the other word maternal environment elements in drought stress can considerably affect on seeds germination characteristics.

Golzardi *et al.,* (2012) in the same study in order to investigate of the maternal environment effect on drought and salinity resistance in germination period of *Cynanchum acutum* L. showed Kerman population had the higher resistance through the drought stress compared to Karaj population (Abin and Eslami, 2009) reported the drought stress at -0.1 MPa and higher significantly lead to lower germination percentage of *Sonchus arvensis* in Birjand compared to Ahvaz population.

The Effect of Salinity Stress on Germination Behavior of Centaurea depressa

By increasing salinity rate, the percentage of germination, radicle and shoot length and seedling dry weight of *Centaurea depressa* in both populations of Karaj and Ahvaz decreased. The germination rate of

Karaj and Ahvaz population in sterilized water treatment reported 85.25 and 90.5% respectively. By increasing the intensity of salinity stress to 500 mille molar, the percentage germination rate of Ahvaz and Karaj population get to 8 and 0 % respectively.

Table 1: Effect of drought on seed germination radicle and shoot length and seedling dry weight of two *Centaurea depressa* populations

Osmotic potential (Mpa)	Population	Germination (%)	Radicle length (mm)	Shoot length (mm)	Seedling dry weight (g)
0	Karaj	87 a	15.25 b	9.87 a	0.318 ab
	Ahvaz	91.5 a	16.5a	10.02 a	0.324 a
-0.2	Karaj	77 b	14.37 c	7.25 c	0.287 b
	Ahvaz	81 b	15.23b	8.68 b	0.296 b
-0.4	Karaj	55.25	8.68 e	5.32 d	0.231 d
	Ahvaz	67 c	12.65 d	7.24 c	0.254 c
-0.6	Karaj	28 e	6.5 f	2.85 e	0.155 e
	Ahvaz	51.5 d	8.85 e	5.62 d	0.21 d
-0.8	Karaj	12.5 f	2.32 h	1.27 f	0.047 f
	Ahvaz	27 e	5.85 g	2.38 e	0.167 e
-1	Karaj	0 g	0 j	0 h	0 g
	Ahvaz	13.5 f	1.87 i	0.87 g	0.054 f

Means within a column followed by the same letters are not significantly different at the %1 level according to Duncan's multiple range tests.

Table 2: Effect of drought on seed germination radicle and shoot length and seedling dry weight of two *Centaurea depressa* populations

NaCl Concentration (Mm)	Population	Germination (%)	Radicle length (mm)	Shoot length (mm)	Seedling dry weight (g)
0	Karaj	85.25 a	16.86 a	10.32 ab	0.324 a
	Ahvaz	90.5 a	17.68 a	11.21 a	0.331 a
100	Karaj	63 b	11.25 b	8.24 c	0.237 c
	Ahvaz	71 b	12.54 b	9.78 b	0.285 b
200	Karaj	51.25 c	8.65 d	6.31 cd	0.196 d
	Ahvaz	57.5 c	9.31 c	7.05 c	0.214 c
300	Karaj	21.5 e	4.32 f	3.21 e	0.101 e
	Ahvaz	32.25 d	6.86 e	6.12 d	0.184 d
400	Karaj	19.75 e	1.67 g	0.98 g	0.074 f
	Ahvaz	29.5 d	4.87 f	3.14 e	0.107 e
500	Karaj	0 g	0 h	0 h	0 g
	Ahvaz	8 f	2.32 g	1.34 f	0.078 f

Means within a column followed by the same letters are not significantly different at the %1 level according to Duncan's multiple range tests.

The length of radicle and seedling and also the dry weight of seedling showed the same process by increasing the intensity of salinity stress. The higher rate of these factors correlated to evidence treatment (sterilized water). So that; by adding the intensity of salinity from 0 to 500 mille molar, the rate of aforementioned factors reduced. So, in Karaj population the less radicle length (1.67 mm) shoot length (0.98 mm) and the dry seedling weight (0.07 g) at Nacl 400 mille molar observed.

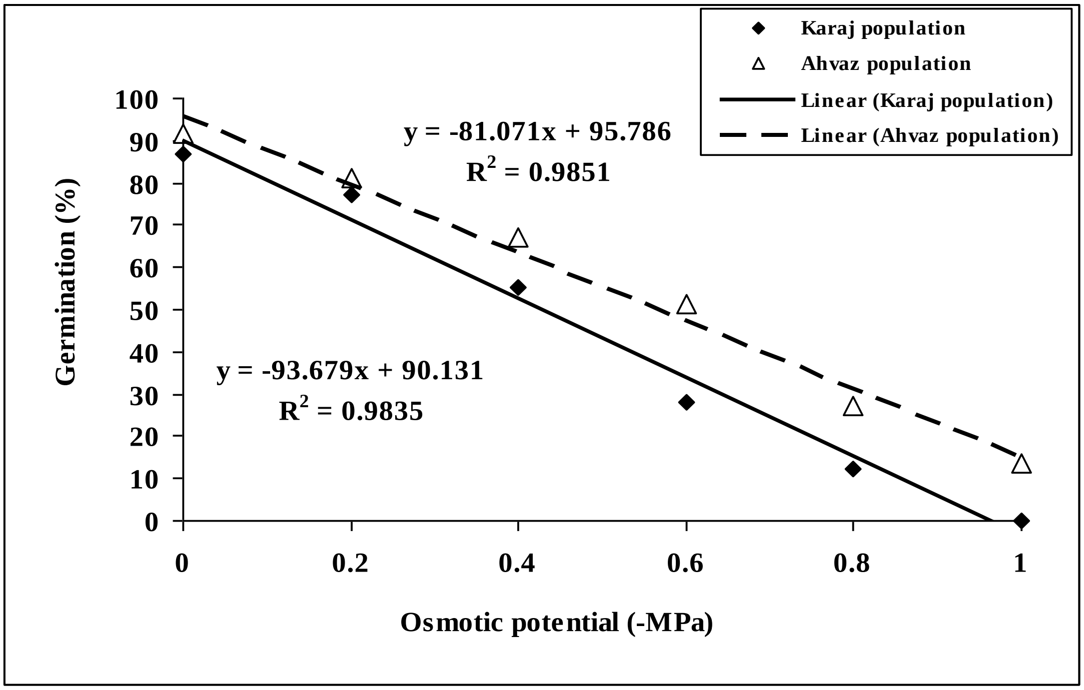

Figure 1: The effect of osmotic potential on germination percentage of *Centaurea depressa* seed populations in Karaj (◆) and Ahvaz (△)

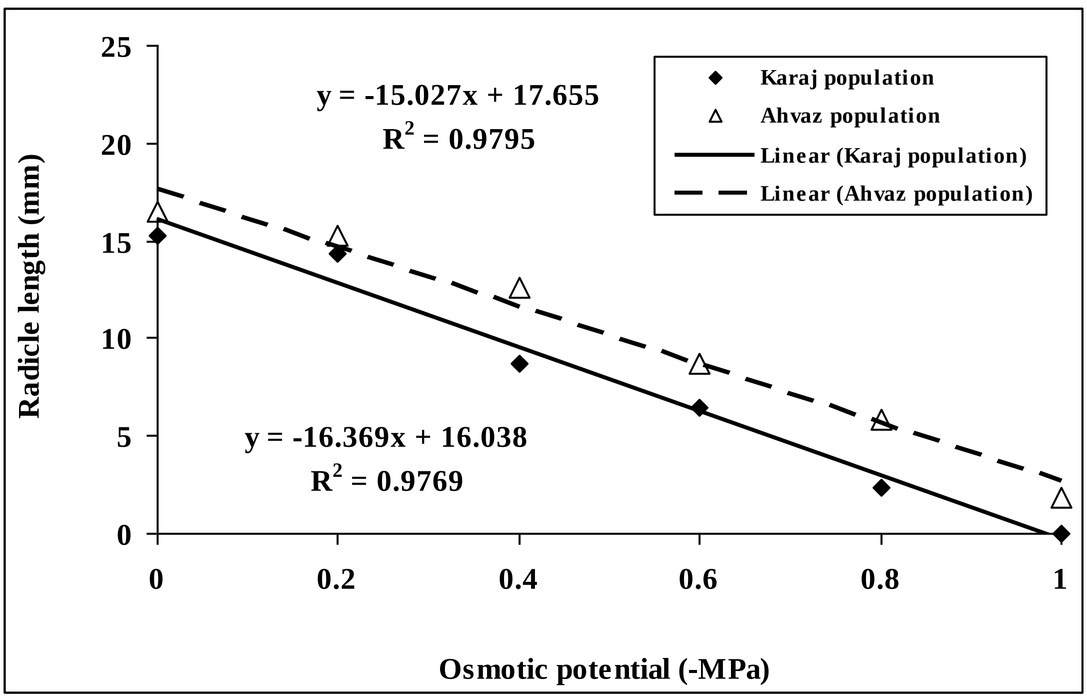

Figure 2: The effect of osmotic potential on radicle length of *Centaurea depressa* seed populations in Karaj (◆) and Ahvaz (△)

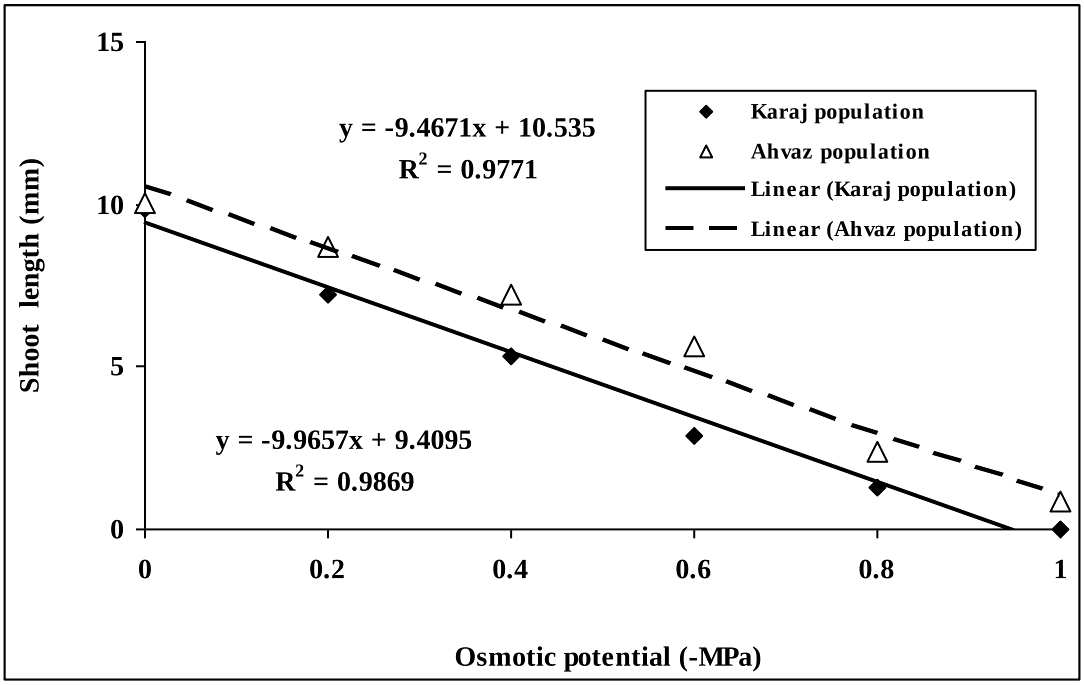

Figure 3: The effect of osmotic potential on shoot length of *Centaurea depressa* seed populations in Karaj (◆) and Ahvaz (△)

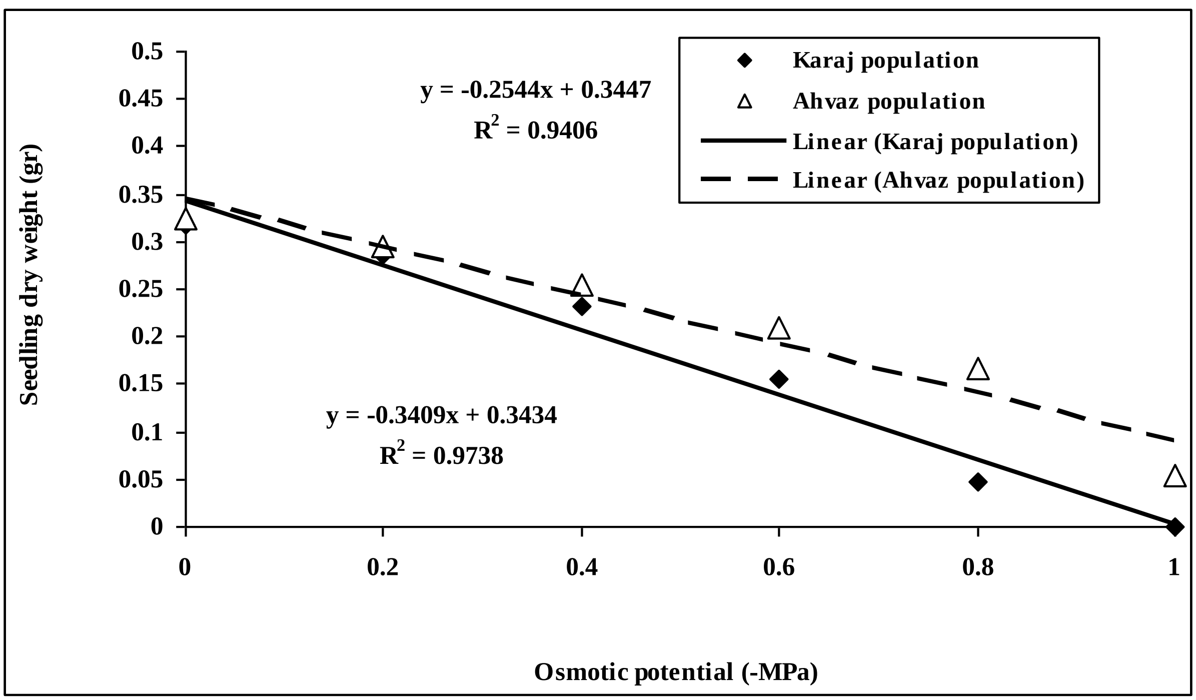

Figure 4: The effect of osmotic potential on seedling dry weight of *Centaurea depressa* seed populations in Karaj (◆) and Ahvaz (△)

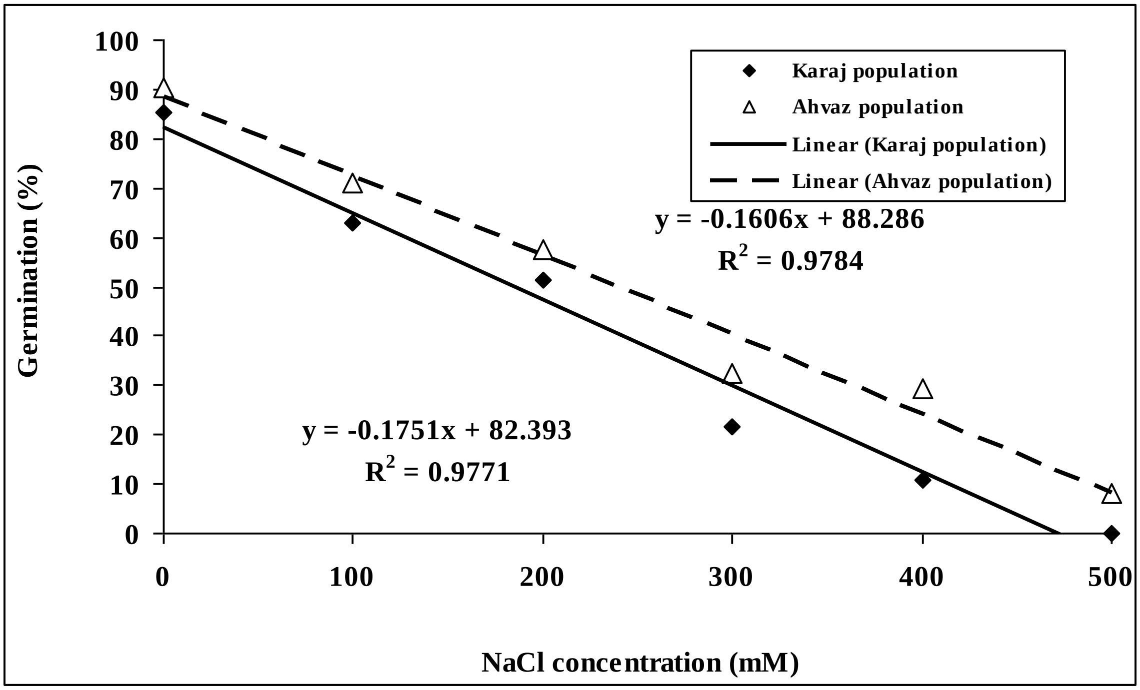

Figure 5: The effect of NaCl concentration on germination percentage of *Centaurea depressa* seed populations in Karaj (◆) and Ahvaz (△).

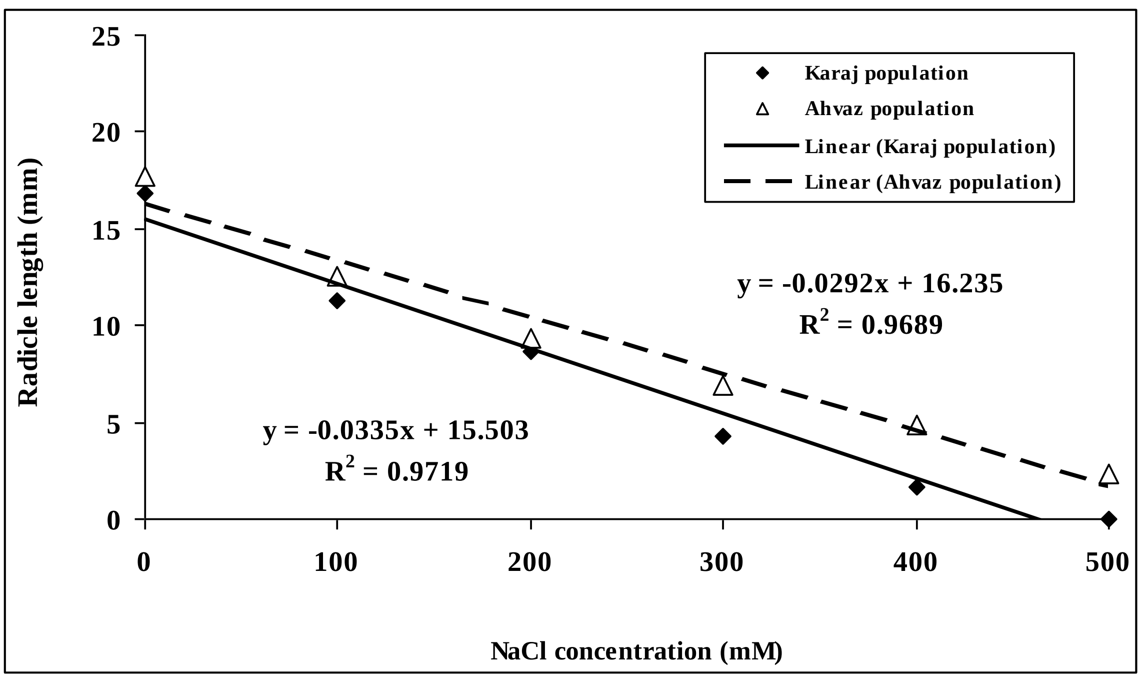

Figure 6: The effect of NaCl concentration on radicle length of *Centaurea depressa* seed populations in Karaj (◆) and Ahvaz (△).

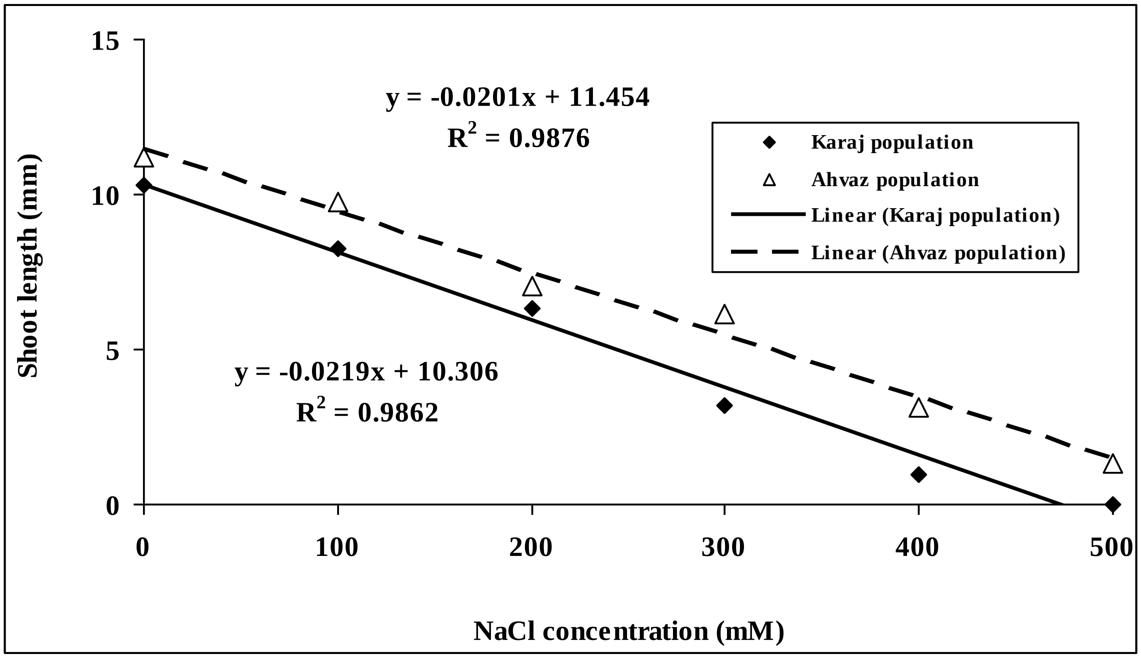

Figure 7: The effect of NaCl concentration on shoot length of *Centaurea depressa* seed populations in Karaj (◆) and Ahvaz (△)

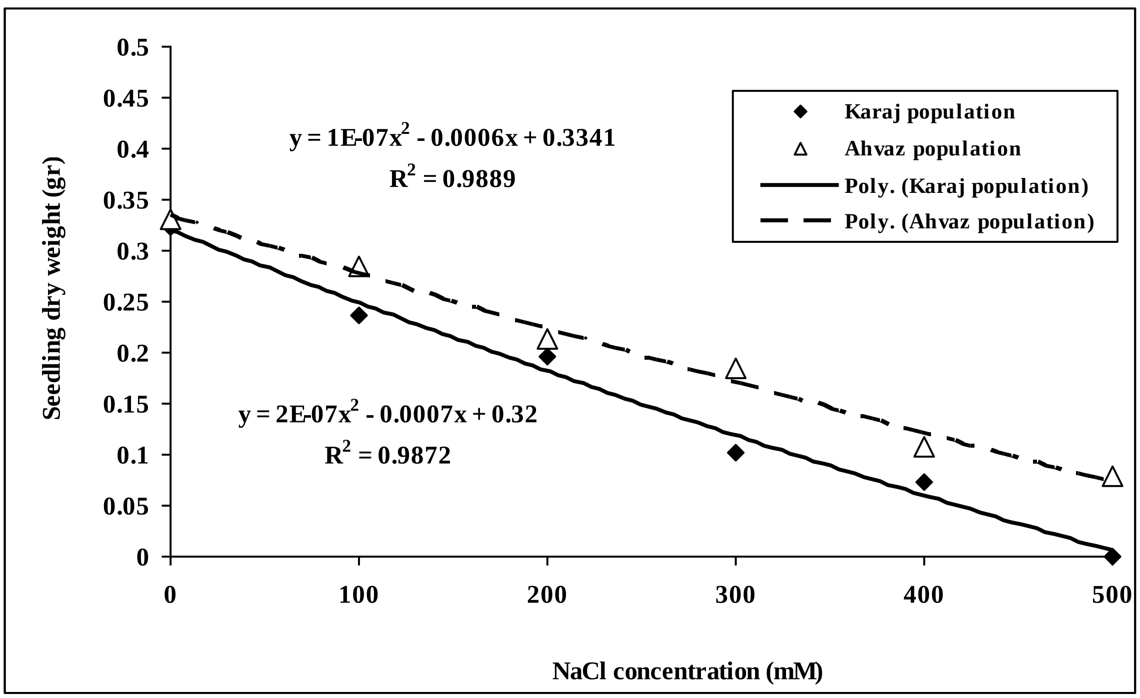

Figure 8: The effect of NaCl concentration on seedling dry weight of *Centaurea depressa* seed populations in Karaj (◆) and Ahvaz (△)

And also in salinity stress rate of 500 mille molar these factors get to 0 point. In Ahvaz population the less radicle length (2.32 mm) shoot length (1.34 mm) and the dry seedling weight (0.078 g) reported at salinity stress of500 mille molar. Cordazzo (2007) reported by increasing salinity, the emergence of *Blutaparon portulacoides* (*Amaranthaceae*) will decreased. In this study the seedlings of *Blutaparon portulacoides* showed the gradual decrease in its vitality and dry weight by increasing the period of salinity stress with sea water. As it showed, the lowest rate of germination rate in both populations (Karaj & Ahvaz) attributed to concentration of 500 mille molar. Karaj seeds germination rate in this concentration get to 0 point. Whereas, in the same situation in Ahvaz population, this rate reported at 8 percent (Figure 5-8). Result represented that Ahvaz population had the higher germination resistance rate in salinity stress. Therefore Ahvaz population has the more germination ability in salty reigon compared to Karaj ones. Golzardi *et al*., (2012) in the same study in order to investigate of the maternal environment effect on drought and salinity resistance in germination period of *Cynanchum acutum* L. showed Kerman population had the higher resistance through the drought stress compared to Karaj population (Abin and Eslami, 2009) reported the drought stress at 0.1 Mpa and higher significantly lead to lower germination percentage of *Sonchus arvensis* in Birjand compared to Ahvaz population.

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