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Germination and Emergence Response of Some Onion Cultivars of Southern Iran to Salinity Stress

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ABSTRACT

The onion plant is sensitive to salinity, but the reaction of various onion cultivars to salinity is different. The effect of different salinity levels (0.01, 1, 2, 3, 5, 7 and 9 ds/m) on the germination and emergence stages of six onion cultivars ('Bardsiri', 'Hendijani', 'Texas Early Grano', 'Ramhormozi', 'Sarkareh', and 'Behbahani') were evaluated. The effect of cultivar and salinity on all investigated attributes was significant ($P<0.01$). Also, the cultivar × salinity interaction on germination percentage (GP), germination rate (GR), and root length (LR) were significant, although it did not have any significant effect on shoot length (SL). With increasing salinity, GP, GR, RL, and SL decreased. 'Ramhormozi', 'Bardsiri', and 'Behbahani' were most tolerant (in this order) to salinity stress than other cultivars; 'Sarkareh', 'Texas Early Grano' and 'Hendijani' were most sensitive. Noteworthy is that the GP of 'Ramhormozi' did not change despite the increase in salinity levels.

Keywords: *Allium cepa*, germination rate, root length, shoot length, tolerance

INTRODUCTION

Different stresses such as salinity stress cause plant establishment to decrease (Goldani and Latifi 1997; Enferad *et al.* 2003).This phenomenon causes decreased crop production due to the accumulation of salts or other stresses. The first stage of an onion plant begins with germination, whose percentage and rate determine the density and yield of an onion crop. Therefore, the plant germination stage is sensitive and has an important role in the production process and in the suitable establishment of plants (Voss *et al.* 1999). Salinity tolerance in vegetables is so important because of the economic value of a crop. Onion is an important and popular vegetable in the world, but little genetic variation for salt-tolerant cultivars has been detected even though many cultivars have been tested (Shannon 1999). Iran and its neighboring countries are known as the origin of onion (*Allium cepa*) in the world (Hanelt 1990). This means that maximum genetic variation may be found in this region (Alemzadeh Ansari 2007). Salinity tolerance of plants differs among various varieties (Jafarzadeh and Aliasgharzad 2007). Salinity-tolerance depends on genetic and biochemical characteristics of species, and sufficient genetic variation related to salinity exists in agricultural crops (Misra and Dwivedi 2004). Much data indicates that many plants are sensitive to salinity at the germination stage (Ghavami *et al*. 2004; Misra and Dwivedi 2004) and that there are differences among varieties of *A. cepa* cultivars in salinity tolerance (France *et al*. 2005; Othman *et al.* 2006; Sivirtepe and Sivirtepe 2007). Ozcoban and Demir (2006) manifested that with increasing salt concentration, germination percentage (GP) decreased and the suitable period for tomato germination increased. Sivritepe and Sivirtepe (2006) reported that onion var. 'Texas Early Grano-5O2' was more tolerant than 'Valencia' to salinity. Jamil *et al.* (2005) indicated that increasing salinity level caused germination percentage to decrease in three species (cauliflower, cabbage and canola), but the decrease in cauliflower was higher than in cabbage and canola. Schmidhalter and Oertli (1990) indicated that decreasing osmotic potential was less than 0.2 MP in carrot, decreasing GP and delaying germination rate (GR). France *et al.* (2005) showed that the presence of salt in concentrations more than 50 mol/m^3 NaCl affected germination, seedling growth and protein synthesis of cotyledons in three varieties of cowpea studied: root length decreased but hypocotyl length increased. Mauromicale and Licandro (2002) showed that GP and GR in artichoke, which is moderately resistant to salinity stress, decrease by decreasing the osmotic potential of the environment. Othman *et al.* (2006) indicated that at high salinity levels, there is a difference between various barley genotypes resistant to salinity. By increasing salinity levels, germination percentage of all wheat cultivars decreased. Ghavami *et al.* (2004) manifested that among Iranian wheat cultivars, 'Mahut' was superior with regard to GP, GR, root length (RL), and shoot length (SL), than other factors, and by increasing the salinity level, GP, GR, RL, and SL in all cultivars decreased. Misra and Dwivedi (2004) indicated that when increasing the salinity level in seed germination of green gram vars. T-44 and SML-32, RL and SL decreased, but T-44 showed more resistance to salinity. In both varieties root dry weight decreased while shoot dry weight increased. The aim of the present article is to introduce the capacity of some southern Iranian onion cultivars to salinity stress in the germination and emergence stages.

MATERIALS AND METHODS

To study the response of southern Iranian onion cultivars to different salinity levels in germination and emergence stages, this experiment was carried out in 2006 in the Physiology lab of the Horticulture Department of Shahid Chamran University of Ahwaz. Five cultivars ('Bardsiri' from Kerman province, 'Sarkareh' from Booshehr province, 'Hendijani', 'Ramhormozi', and 'Behbahani' from Khuzestan province) and 'Texas Early Grano' were considered. Salinity treatments included seven salinity levels (0.01, 1, 2, 3, 5, 7, and 9 ds/m). Water for providing salinity media was from research-oriented agronomy. Primary salinity solution was 10.72 ds/m. Seeds were disinfected with 5% NaOCl for 5 min and washed for 5 min with distilled water (Ghavami *et al.* 2004). 50

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Short Communication

seeds from every cultivar were sown on a paper towel inside 10 cm-wide Petri dishes to maintain relative humidity. Seven ml of saline solution (0.01, 1, 2, 3, 5, 7, and 9 ds/m) were added to each Petri dish, which were placed at 25°C in the laboratory for 9 days. The percentage of germinated seeds was assessed daily at 10 a.m. Only those seeds whose RL was at least 2 mm were considered to be germinated. GP and GR were determined daily. RL and SL were measured on the 9th day. Total biomass was dried in an oven at 75°C for 48 h in order to determine the plant dry weight in each treatment (Ehteshami and Chaeichi 1998; Enferad *et al.* 2003).

GR was calculated by the following formula (Jalilie 2003):

$$GR = \sum n / \sum Dn$$

where D is the number of days from the start of germination and *n* is the number of germinated seed in D days.

The experiment was a completely randomized design (with three replications and every replication including two Petri dishes). Factorial-based statistical analysis was performed using Mstatc v. 1.2 and the means were separated by Duncan's multiple range test at $P = 0.05$.

RESULTS

Effects of the onion cultivars and salinity levels were significant for all measured characters at $P = 0.01$. Also the interaction effects of salinity and cultivars were significant for all attributes except for SL and BDW.

Seed germination (GP)

The result of this experiment showed that cultivars have different GPs. The maximum and minimum GPs were observed in 'Ramhormozi' and 'Bardsiri', respectively (**Table 1**). Also GP was reduced by increasing salinity level in all cultivars (**Table 2**). 'Sarkareh' dropped from a GP = 96% in distilled water to 67% in EC = 9; 'Texas Early Grano' dropped from 93 to 65% indicating hat it was the most sensitive to salinity stress. 'Ramhormozi' dropped from 85 to 80% and 'Bardsiri' decreased from 75 to 60%, making these two cultivars the most tolerant to salinity stress (**Table 3**). In 'Ramhormozi' germination increased slightly, although statistically insignificant, at 1 ds/m compared to the control. Huang *et al.* (2003) found that germination of *H. ammodendron* seeds was not influenced by low concentrations of NaCl (0.05–0.2 mol/l) while Ehteshami *et al.* (1998) showed that GP at a high concentration improved the germination of *Hordeum vulgare* cv. 'Torkaman' more than other cultivars. With regard to the effect of salinity stress levels, by applying the first salinity level, significant difference happened in seeds GP compared with distilled water (**Table 3**).

Table 1 Comparison of average considering attribute in various onion cultivars and cultivars.

Cultivars	GP	GR	RL(mm)	SL(mm)
Bardsiri	69.85 e*	17.20 b	28.67 bc	68.80 ab
Hendijani	80.38 c	15.07 c	30.84 ab	63.62 c
Texas Early Grano	83.19 b	12.69 d	27.69 c	56.96 d
Ramhormozi	83.52 a	16.79 b	32.32 a	70.79 a
Sarkareh	80.47 c	11.86 d	22.33 d	59.28 d
Behbahani	70.19 d	20.4 a	30.25 abc	66.59 bc

*Means followed by the same letter did not differ significantly at P=0.05.

Table 2 Comparison of average considering attribute in solutions with different electrical conductivity (concentration factor effect).

EC*	GP	GR	RL(mm)	SL(mm)
0.01	85.83 a**	18.88 a	29.93 b	69.53 ab
1	84.44 b	18.91 a	34.68 a	72.01 a
2	81.22 c	17.95 a	30.01 b	73.37 a
3	76.88 d	15.72 b	28.58 bc	69.29 ab
5	75.61 e	15.37 bc	30.72 b	66.70 b
7	73.22 f	14.64 c	25.85 c	54.41 c
9	68.33 g	12.41 d	21.01 d	45.04 d

*EC - Electrical conductivity (meq/l), **Means followed by the same letter did not differ significantly at P=0.05.

Germination rate (GR)

The result of this experiment showed that cultivars have different GRs. The maximum and the minimum GRs were related to 'Behbahani' and 'Sarkareh', respectively and significant difference between 'Sarkareh' and 'Texas Early Grano' were not observed (**Table 1**). Significant difference in seeds GR were not observed until the salinity stress level reached 2 ds/m, with a highly significant decrease above 3 ds/m, with as much as a 33% decrease in 9 ds/m compared with distilled water (**Table 3**). GR decreased with increasing salinity level in all cultivars (**Table 2**). The maximum and the minimum decrease in GR were in 'Texas Early Grano' and 'Ramhormozi', respectively (**Table 3**).

Root length (RL) on the ninth day

Results indicated that the maximum and minimum RL was achieved by 'Ramhormozi' and 'Sarkareh', respectively (**Table 1**). RL decreased with increasing salinity level in all cultivars, except for 1 ds/m (**Table 2**). RL at 9 ds/m decreased up to 39.41% in comparison with 1 ds/m (**Table 2**). The maximum decreasing of RL by increasing the salinity level was observed for 'Texas Early Grano' (33 to 16 cm), but no difference between distilled water and salinity water treatments in RL was observed in 'Ramhormozi' (**Table 3**).

Shoot length (SL) on the ninth day

The maximum and the minimum SLs, respectively, were related to 'Ramhormozi' and 'Texas Early Grano', respectively (**Table 1**). SL decreased with an increase in the salinity level (**Table 2**). SL decreased up to 38% at 9 ds/m compared with 1 and 2 ds/m (**Table 2**). The interaction between cultivar and salinity was not significant for SL, even though RL and SL were similarly affected by salinity.

DISCUSSION

Increasing salinity in the environment in which plants grow causes a decrease in seed germination and delays seedling emergence. Genetic variation of a species is a valuable tool for preserving species survival in various environments, especially saline ones. Onion plants are very broadly sensitive to salinity, but this depends on the cultivar different (Palaniappan *et al.* 1999). Our results indicated that 'Ramhormozi' is more tolerance to salinity than others. Sivritepe and Sivritepe (2007) indicated that 'Texas Early Grano', followed by 'Valencia', were tolerant to salinity, although in our results, the former cultivar was very sensitive to salinity when GP, GR and LR were compared to 'Ramhormozi' at 9 ds/m.

This variation in salinity tolerance might arise from genetic variation among genotypes (Othman *et al.* 2006). Plants with salinity resistance under saline conditions have less Na^+ and more K^+ in comparison with sensitive plants (Misra and Dwivedi 2004). In resistance genotypes, K^+ and organic solutes such as proline accumulate in the cytoplasm and organelles to balance the low osmotic potential in the vacuole. Organic solutes such as proline also preserve protein structure and activity and reduce enzyme denaturizing by inactivating hydroxyl radicals and other reactive chemical species (Naidoo and Kift 2006). Such type of osmotic adjustment lowers the toxic concentration of ions in the cytoplasm by restriction the influx of Na^+ or its sequestration into the vacuole and/or its extrusion (Misra and Dwivedi 2004).

In the life cycle of a plant, seedlings have the highest susceptible to extreme environmental stresses; but seeds are most resistance. As a result, successful establishment of a plant population is dependent on the adaptive aspects of seed germination and of early seedling growth (Qu *et al.*

Table 3 Interaction effect of some onion cultivars of Iran southern and salinity on GP, GR, LR.

Cultivars	**Electrical conductivity (meq/l)**						
	0.01	**1**	**2**	**3**	**5**	**7**	**9**
GP							
Sarkareh	96.00 a*	92.00 abc	88.00 bcde	76.00 ijkl	73.33 klm	70.00 lmn	67.33 mno
Texas Early Grano	93.67 ab	91.33 abcd	88.00 bcdef	82.00 efghi	81.00 efghi	81.00 efghi	65.33 no
Hendijani	90.33 klmn	86.67 cdefg	81.67 cdefg	77.00 hijkl	77.33 hijk	77.00 hijkl	72.67 klm
Ramhormozi	85.00 defg	86.67 cdefg	83.00 efgh	84.67 defg	83.33efgh	81.33F gfhij	80.67 ghij
Behbahani	74.67 jkl	74.67 jkl	73.33 klm	71.33 klmn	67.33 mno	66.67 mno	63.33 o
Bardsiri	75.33 ijkl	75.33 ijkl	72.67 klm	70.33 klmn	71.33 klmn	63.33 o	60.67 o
GR							
Bardsiri	20.59 bcd	19.40 cde	18.13 defgh	17.18 efghij	16.32 fghijk	14.98 jklm	13.81 klmn
Hendijani	17.03 efghij	16.47 fghijk	16.62 fghijk	14.61 jklm	15.05 jklm	15.29 ijklm	10.48 pqr
Texas Early Grano	15.62 hijkl	15.12 jklm	14.08 klmn	12.52 mnop	11.54 nopq	11.58 nopq	8.41 r
Ramhormozi	18.47 cdefg	18.68 cdef	18.01 defghi	16.21 fghijkl	16.18 fghijkl	15.69 ghijkl	14.35 jklm
Sarkareh	13.85 klmn	14.54 jklm	13.44 lmno	11.52 nopq	10.95 opqr	9.37 qr	9.36 qr
Behbahani	27.78a	29.30 a	27.45 a	22.30 b	22.21 b	20.93 bc	18.07 defghi
LR (mm)							
Bardsiri	27.38 cdefghijk	33.16 abcde	28.00 cdefghijk	29.55 cdefghi	31.99 abcdef	30.16 cdefgh	20.50 jklm
Hendijani	25.39 defghijkl	40.00 a	31.66 bcdef	33.05 abcde	34.72 abc	28.05 cdefghij	23.05 ghijklm
Texas Early Grano	33.61 abcd	32.50 abcde	31.11 bcdefg	27.22 cdefghik	30.94 bcdefg	22.50 hijklm	16.00 m
Ramhormozi	31.00 bcdefg	38.89 ab	35.00 abc	30.27 cdefgh	31.66 bcdefd	28.33 cdefghij	31.11bcdefg
Sarkareh	30.83 bcdefgh	24.66 efghijkl	21.83 ijklm	18.94 lm	23.66 fghijklm	20.66 jklm	15.72 m
Behbahani	31.39 bcdefg	38.88 ab	32.50 abcde	32.50 abcde	31.39 bcdefg	25.44 defghijkl	19.72 klm

*Means followed by the same letter did not differ significantly at P=0.05.

2008). In this experiment all cultivars indicated showed > 50% germination even at EC = 9ds/m. Generally, all varieties of common onion in the southern part of Iran considered in this research have high salinity tolerance, in particular 'Ramhormozi', which showed higher tolerance to salinity stress, higher germination and also greater RL and SL in comparison with other cultivars.

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