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 ‘Bebbahani’) was 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 ‘Bebbahani’ 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 Aliasgharzadi 2007). Salinity tolerance of plants differs among various varieties (Jafarzadeh and Aliasgharzadi 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 (França et al. 2005; Othman et al. 2006; Sviritepe and Sviritepe 2007). Ozcozan and Demir (2006) manifested that with increasing salt concentration, germination percentage (GP) decreased and the suitable period for tomato germination increased. Sviritepe and Sviritepe (2006) reported that onion var. ‘Texas Early Grano-SO2’ 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 Oerthi (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/m3 NaCl affected germination, seedling growth and protein synthesis of cotyledons in three varieties of cowpea studied: root length decreased but hypocotyl length increased. Mauronicale and Licandro (2002) showed that GP and GR in artichoke, which is moderately resistant to salinity stress, decreased 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 ‘Bebbahani’ 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...
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).

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

\[
GP = \sum n_i / \sum Dn
\]

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

RESULTS

Effects of the onion cultivars and salinity levels were significant for all measured characters at \( P = 0.05 \). 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 ‘Ramhormoz’ 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 that it was the most sensitive to salinity stress. ‘Ramhormoz’ 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 ‘Ramhormoz’ 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).

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 ‘Ramhormoz’, respectively (Table 3).

Root length (RL) on the ninth day

Results indicated that the maximum and minimum RL was achieved by ‘Ramhormoz’ 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 ‘Ramhormoz’ (Table 3).

Shoot length (SL) on the ninth day

The maximum and the minimum SLs, respectively, were related to ‘Ramhormoz’ 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 ‘Ramhormoz’ 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 ‘Ramhormoz’ at 9 ds/m.

This variation in salinity tolerance might arise from genetic variation among genotypes (Ohman 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 (Naïdou and Kid 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. 2008).
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.

ACKNOWLEDGEMENTS

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REFERENCES


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

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>0.01</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<td>Sarekheh</td>
<td>96.00 a*</td>
<td>92.00 abc</td>
<td>88.00 bcde</td>
<td>76.00 ikl</td>
<td>73.33 klm</td>
<td>70.00 lmn</td>
<td>67.33 mno</td>
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<td>88.00 bcdef</td>
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<td>81.00 efgi</td>
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<td>81.67 cdefg</td>
<td>77.00 hijk</td>
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<td>77.00 hijk</td>
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<td>86.67 cdefg</td>
<td>83.00 efgi</td>
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<td>83.33 cdefg</td>
<td>81.33 fghi</td>
<td>80.67 ghij</td>
</tr>
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<td>74.67 jkl</td>
<td>73.33 klm</td>
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<td>72.67 klm</td>
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<td>18.07 defg</td>
</tr>
</tbody>
</table>

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

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