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Effect Of Different Concentrations Of Magnetic Saline Water (Urmia Lake Water) On Germination And Seedling Growth Of *Lathyrus* Sp.

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Abstract

To evaluate the effect of salinity of Urmia Lake water on *Lathyrus* sp, as an adaptive crop to undesirable environment factors, a factorial experiment was carried out based on randomized complete block design with four replications. Treatments included application time of salinity (pre- and post germination) and salinity (0, 2, 4, 6 & 8 ds/m) of no magnetic and magnetic Urmia Lake water. Means comparison indicated that the longest root (1.75 cm), longest shoot (2.2 cm), greatest root dry weight (0.19 g) belonged to seedlings that treated with no magnetic Urmia Lake water before germination stage. The greatest shoot dry weight (0.15 g) belonged to seedlings that treated with 4 ds/m of no magnetic Urmia Lake water added after germination to *Petri* dishes. The highest shoot/root dry weight ratio (1.91) belonged to seedlings that treated with 4 ds/m of Urmia Lake water (no magnetic) added before germination to *Petri* dishes. However, the longest root (2.29 cm) and longest shoot (2.37 cm) belonged to seedlings that treated with Urmia Lake water before germination stage. The greatest shoot dry weight (0.079 g) belonged to seedlings that treated with 6 ds/m of magnetic Urmia Lake water added before germination to *Petri* dishes. The maximum shoot/root dry weight ratio (2.27) was occurred at 8 ds/m of Urmia Lake water (magnetic) added after germination to *Petri* dishes.

Key words: *Lathyrus sativus*, Magnetic water, Root, Salinity, Seeding weight, Shoot length.

INTRODUCTION

Lathyrus sativus (grasspea or chickling vetch, guaya in Ethiopia, khesari in India), belonging to the family Fabaceae is a common food legume widely grown and eaten throughout many parts of the world (1). Grass pea is an important pulse crop grown as a rich source of protein for stock feed and human consumption in drought-prone areas of Africa and Asia (2). Grass pea is valued as a nutritious staple food and fodder crop primarily due to its relatively high protein content of 18-34% dry weight in grain, 17% in mature leaves and its high lysine content (3). The annual grass pea is a dual purpose crop cultivated as a winter pulse, and grown both as stock feed (4, 5, 6). Grass pea is a very hardy plant with a penetrative root system that enables it to grow on a wide range of soil types, including very poor soil and heavy clays. Its tolerance to drought, flood and moderate salinity, combined with its ability to fix atmospheric nitrogen to assist in maintaining soil fertility, are added benefits of including grass pea in a cropping system. *Lathyrus sativus* has been reported to be resistant to ascochyta blight, caused primarily by *Mycosphaerella pinodes* (7). Grass pea (*Lathyrus sativus* L.) is an annual winter pulse crop in India occupying an area of about 1.6 million ha (8).

Salinity is one of the most important challenges for human life in recent decades. Soils can become saline due to geohistorical processes or man-made activities. Salinity affects at least 20% of world's arable land and more than 40% of irrigated land to various degrees (9). Many arid and semi-arid regions in the world contain soils and water resources that are too saline for most of the common economic crops (10). Salt causes oxidative stress and can generate reactive oxygen species that damage membranes and the macromolecules (11). Iran is a classical country with saline soils and Kavirs. Saline and alkaline soils are expanding in arid and semi arid areas of Iran and cover 12.5 % of the total area of the country. Although, NaCl is the major salt in Iran's soil, Cl^- increases with salinity increasing (12). Lin and Yotvat (13) reported an increase in water productivity in both crop and livestock production with magnetically treated water. Some studies have shown that there is an increase in number of flowers, earliness and total fruit yield of strawberry and tomatoes by the application of magnetic fields (14). Turker et al. (15) reported an inhibitory effect of static magnetic field on root dry weight of maize plants, but there was a beneficial effect of magnetic field on root dry weight of sunflower plants.

Reduction in osmotic potential in salt stressed plants can be result of inorganic ion (Na, Cl and K) and compatible organic solute (soluble carbohydrates, amino acids, proline, betaines, etc) accumulations (16). The main objective of this study is the effect of different concentrations of magnetic and not magnetic Urmia Lake water on germination and seedling growth of lentil as an important crop for highly protein production. Urmia Lake water represent salinity of rivers provides its water and uses for irrigation of agricultural farms in Urmia.

MATERIALS AND METHODS

To evaluate seed germination and seedling growth of *Lathyrus sativus*, a factorial experiment was conducted based on randomized complete block design with four replicates. Treatments were growth stage that salinity was occurred (before and after germination) and concentration of magnetic water and no magnetic water of Urmia lake (0, 2, 4, 6 and 8 ds/m). Seeds of *L. sativus* of Urmia landrace were collected from Urmia (1320m above sea level, 37°32' N, 45°5'E), Iran. They were sterilized with sodium hypo chloride (10%) and washed by distilled water. For each treatment, one hundred seeds were randomly placed in four *Petri* dishes with 25 cm diameter, lined with two Whatman discs with filter paper No. 1 at the bottom. Three ml of deionized water were added to each dish at the beginning of the experiment, by using a pipette.

Germination assays were conducted in an incubator at constant temperature of 25°C in darkness for 10 days. Germinated seeds from individual *Petri* dishes were counted and removed every day at an interval of 24 hours. A seed was considered as germinated when radicle protrusion was more than 2 mm length. The final germination percentage, average germination rate (relative number per day) and germination index were measured for each Petri dish as follows (17, 18):

Germination Rate = $\Sigma Xn / Yn$

In which, Xn was percentage of germinated seeds at Yn days.

Fifteen germinated seedlings of *L. sativus* from each *Petri* dish were grown in light during day and darkness during night under treatment conditions (different concentrations of salts) until cotyledonal leaves fully opened and then root length, shoot length, seedling dry weight were measured. At the end, root/shoot ratio of length and root/shoot ratio of dry weight were calculated.

Analysis of variance (ANOVA) on data was performed using the general linear model (GLM) procedure in the SAS software. The Student-Neuman Keul's test (SNK) was applied to compare treatment means using the MSTATC software package.

RESULTS

No magnetic water

Result of Analysis of Variance showed the significant effect ($P \leq 0.01$) of Urmia Lake exposure growth stage on root length, shoot length, root/shoot fresh weight ratio and root dry weight. There was significant effect of salinity concentrations ($P \leq 0.01$) on root length, shoot length and root dry weight. Interaction effect between growth stage and salinity on root fresh weight, shoot fresh weight, shoot dry weight and root/shoot dry weight ($P \leq 0.01$) was significant, too (Table 1).

Means comparison indicated that the longest root (1.75 cm), longest shoot (2.2 cm), greatest root dry weight (0.19 g) and the highest shoot/root fresh weight ratio (1.31) belonged to seedlings that treated with Urmia Lake water before germination stage. And the lowest amounts of root length (1.52 cm), shoot length (1.8 cm), root dry weight (0.11 g) and the shoot/root fresh weight ratio (0.91) belonged to seedlings that treated with Urmia Lake water after germination stage (Figures 1-A, 1-B, 1-C, 1-D).

Means comparison of root length and root fresh weight indicated that the longest root (2.07 cm) and shoot (2.41 cm) was obtained from 8 ds/m salinity of Urmia Lake water. This roots and shoot was the longest than seedlings obtained from control treatment. The greatest root fresh weight (0.13 g) belonged to seedlings treated by 4 ds/m, that greatest than 0, 6 and 8 ds/m salinity (Figures 2-A, 2-B, 2-C).

Means comparisons indicated that the greatest root fresh weight (1.79 g), shoot fresh weight (1.7 g) and shoot dry weight (0.15 g) belonged to seedlings that treated with 4 ds/m of Urmia Lake water added after germination to *Petri* dishes, and the highest shoot/root dry weight ratio (1.91) belonged to seedlings that treated with 4 ds/m of Urmia Lake water added before germination to *Petri* dishes. The most little fresh weight of root (0.37 g) belonged to seedlings treated by 8 ds/m of Urmia Lake water before germination. The minimum fresh (0.33 g) and dry (0.51 g) weight of shoot belonged to seedlings treated by 8 ds/m of Urmia Lake water before germination, as same as 6 ds/m of Urmia Lake water before germination. The lowest amounts of root/shoot dry weight ratio (0.9) belonged to seedlings treated by 4 ds/m of Urmia Lake water after germination (Figures 3-A, 3-B, 3-C, 3-D). In this growth stage (Treated before germination) the higher salinity caused the sharp reduction of root and shoot weight, so that seedlings treated by 6 and 8 ds/m of salt had the higher amounts of reduction shoot and root weight before germination (Figures 3-A, 3-B, 3-C, 3-D).

Table 1. Analysis of variance the effect of no magnetic Urmia Lake water on seedling growth treated at two germination stages (before and after germination) of *Lathyrus sativus*

Source of Variation	df	Root length	Shoot length	Root fresh weight	Shoot fresh weight	Root/shoot fresh weight	Root dry weight	Shoot dry weight	Root/shoot dry weight
Replication	1	0.38	0.57	3.68	6.7	1.63	0.001	0.032	4.05
Growth stage (A)	1	0.88**	1.16**	0.82**	0.60**	0.03**	0.002**	0.002**	0.07**
Salinity (B)	4	0.005**	0.0002**	0.24**	0.24**	0.03	0.0002**	0.001**	0.14*
A×B	4	0.43	0.89	0.06**	0.03**	0.035	0.0001	0.0001**	0.07**
Error	27	0.006	0.0002	0.036	0.023	0.016	0.00009	0.00006	0.027
Coefficient of Variance (%)		5.05	0.85	20.21	17.62	11.66	9.14	8.93	12.68

* and ** Significant at $P \leq 0.05$, $P \leq 0.01$, respectively; df, degree of freedom

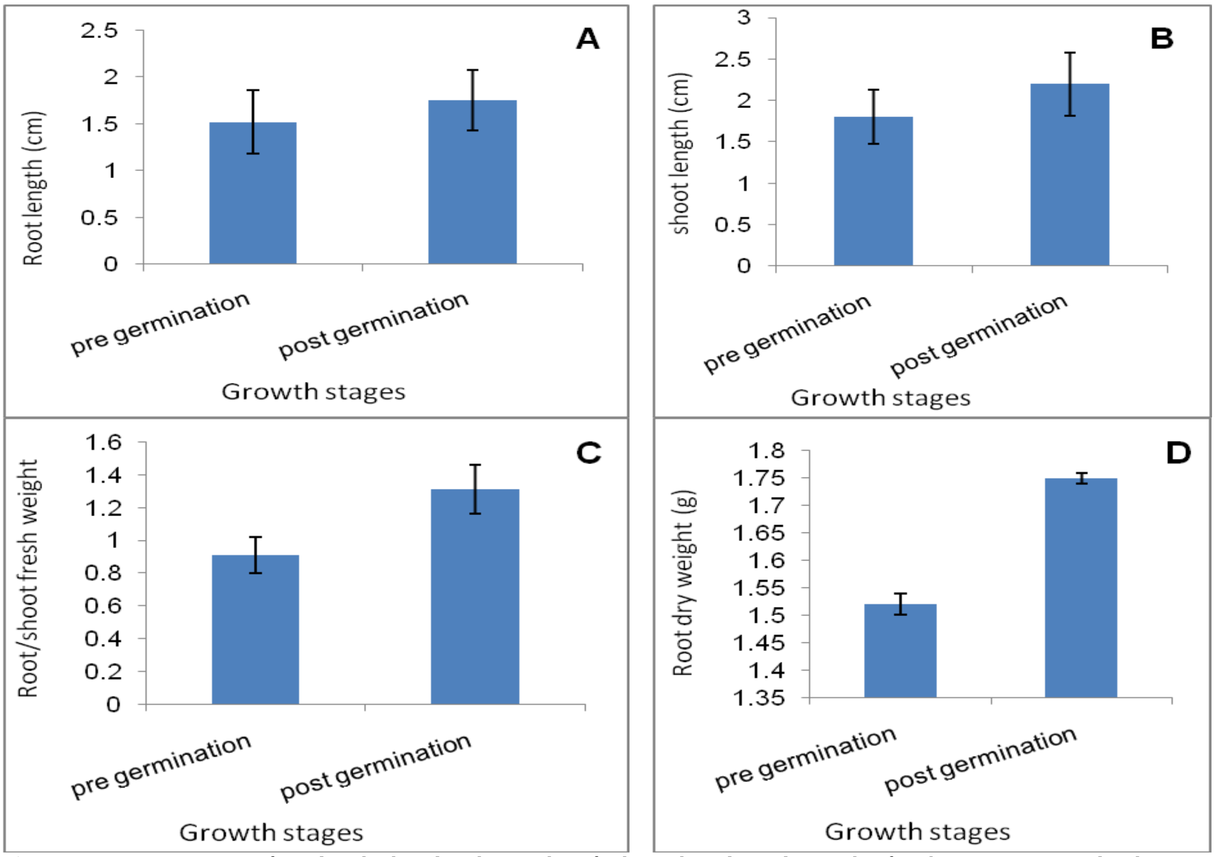

Figure 1. Means comparison of root length, shoot length, root/shoot fresh weight and root dry weight of *Lathyrus sativus* treated with Urmia Lake water at two growth stages.

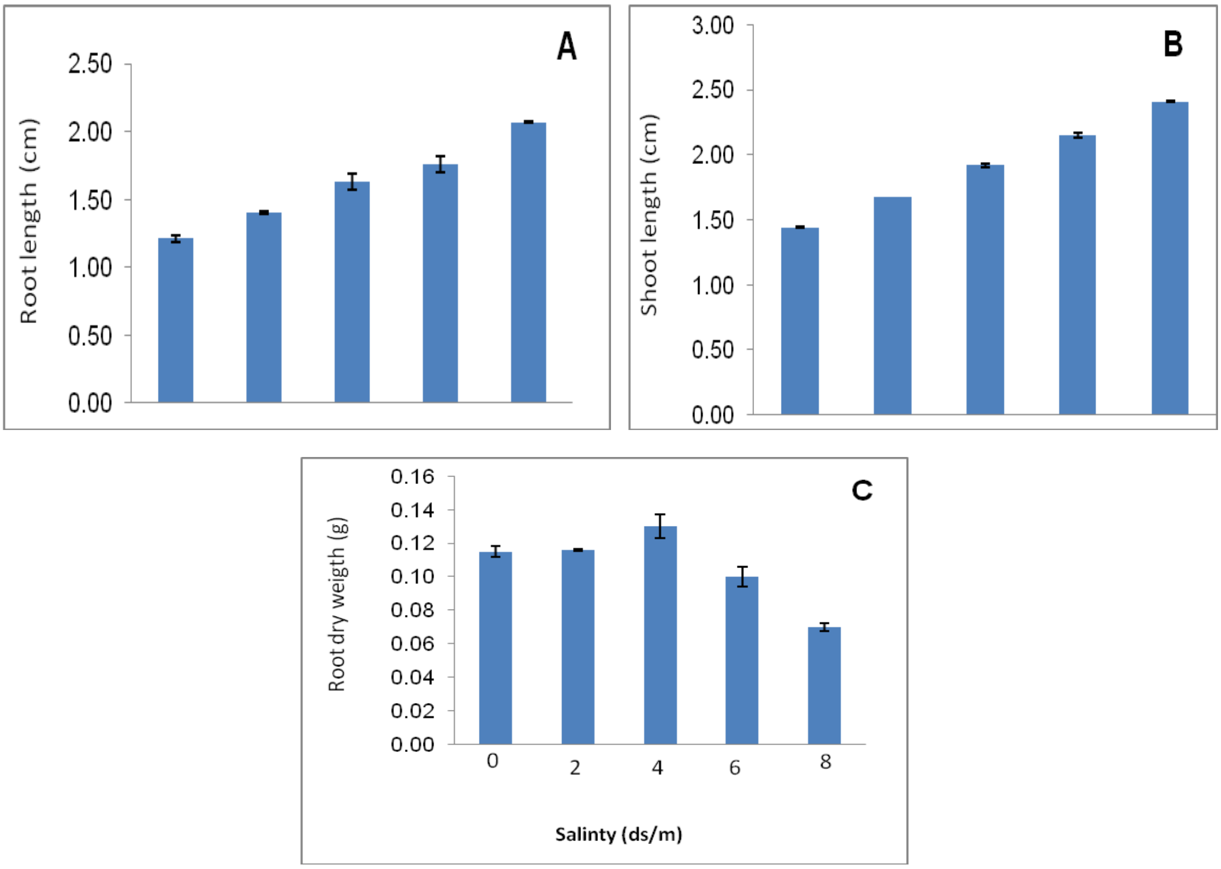

Figure 2. Means comparison root length (A), shoot length (B) and root fresh weight (C) in *Lathyrus sativus* under different levels of salinity.

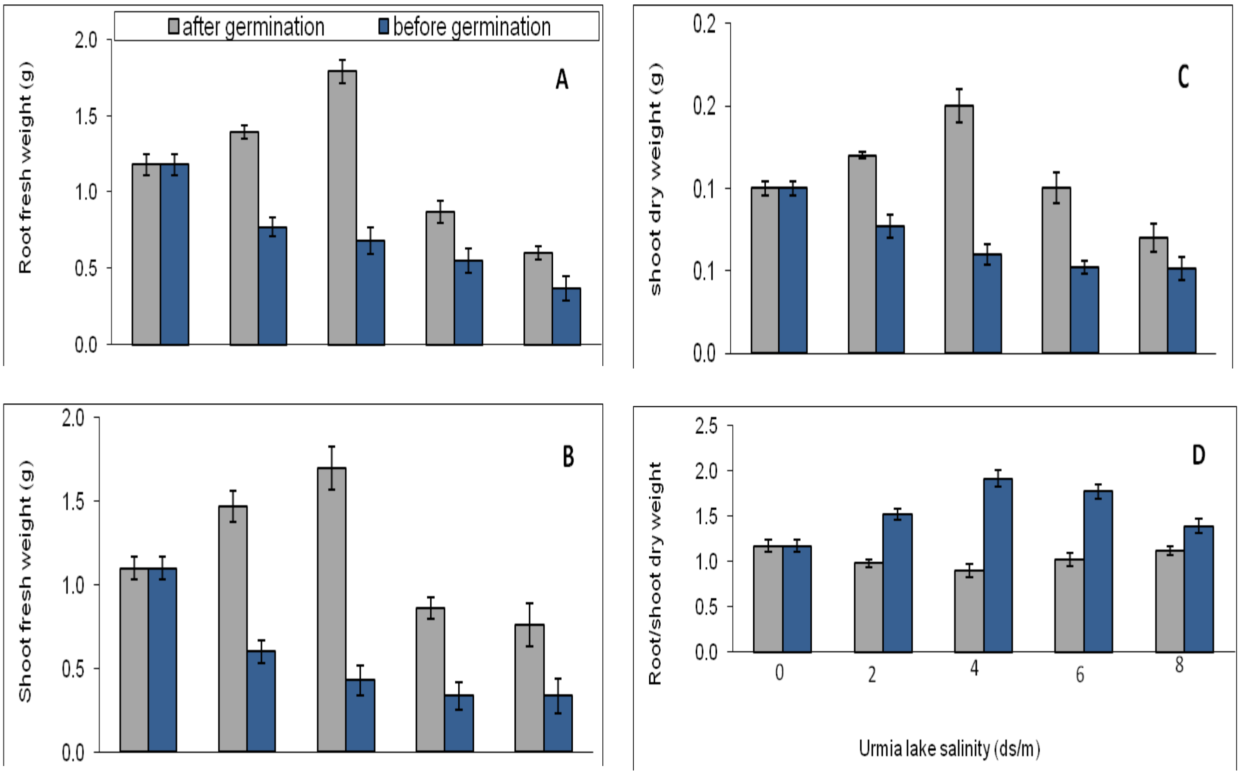

Figure 3. Means comparisons of root fresh weight (A), shoot fresh weight (B), shoot dry weight (c) and root/shoot dry weight ratio (D) under different concentrations of Urmia Lake water after and before application on *Lathyrus sativus.*

Magnetic water

Result of Analysis of Variance showed the significant effect ($P\leq0.01$) of magnet Urmia Lake exposure growth stage on root length, shoot length and root dry weight. There was significant effect of salinity concentrations ($P\leq0.01$) on root length, shoot length and root dry weight. Interaction effect between growth stage and salinity on root fresh weight, shoot fresh weight, root/shoot fresh weight, shoot dry weight and root/shoot dry weight ($P\leq0.01$) was significant, too (Table 2).

Means comparisons indicated that the longest root (2.29 cm) and longest shoot (2.37 cm) belonged to seedlings that treated with Urmia Lake water before germination stage, and the maximum root dry weight (0.095 g) was obtained after germination (Figures 4-A, 4-B, 4-C).

Means comparison of root length and root fresh weight indicated that the longest root (2.18 cm) and shoot (2.6 cm) was obtained at 8 ds/m salinity of Urmia Lake water. These roots and shoots were the longest than control seedlings. The greatest root dry weight (0.098 g) belonged to seedlings treated by 2 ds/m. The lowest root length (2.18 cm) and shoot length (2.6 cm) was obtained from 0 ds/m salinity of magnet Urmia Lake water (control treatment), the lowest root dry weight (0.07 g) belonged to seedlings treated by 4 ds/m of magnet Urmia Lake water (Figures 5-A, 5-B, 5-C).

The greatest root fresh weight (0.67 g), shoot fresh weight (0.71 g) and shoot dry weight (0.079) belonged to seedlings that treated with 6 ds/m of Urmia Lake water added before germination to *Petri* dishes, with the same value of control treatment and 2 ds/m of Urmia Lake water added after germination. The lowest amounts of root fresh weight (0.27 g), shoot fresh weight (0.25 g) and shoot dry weight (0.045 g) belonged to seedlings treated by 6 ds/m of Urmia Lake water after germination (Figures 6-A, 6-B, 6-D).

The maximum shoot/root fresh weight ratio (1.77) and shoot/root dry weight ratio (2.27) were occurred at 8 ds/m of Urmia Lake water added after germination to *Petri* dishes. The minimum shoot/root fresh weight ratio (0.82) and shoot/root dry weight ratio (1.20) belonged to seedlings treated by 0 ds/m of Urmia Lake water (control treatment) (Figures 6-C, 6-E).

Table 2. Analysis of variance the effect of magnetic Urmia Lake water concentration on seedling growth treated at two germination stages (before and after germination) of *Lathyrus sativus*.

Source of Variation	df	Root length	Shoot length	Root fresh weight	Shoot fresh weight	Root/shoot fresh weight	Root dry weight	Shoot dry weight	Root/shoot dry weight
Replication	1	0.38	0.55	0.10	0.005	0.93	0.002	0.00000	0.83
Growth stage (A)	1	0.71**	1.20**	0.048**	0.14	0.31**	0.0008**	0.0005	0.47**
Salinity (B)	4	0.005**	0.014**	0.058**	0.11**	0.313**	0.0005*	0.0007**	0.40**
A×B	4	0.50	0.44	0.017**	0.019**	0.33**	0.0001	0.00005**	0.049**
Error	27	0.004	0.018	0.006	0.011	0.024	0.0002	0.00005	0.05
Coefficient of Variance (%)		3.05	6.11	16.71	21.10	14.58	17.82	11.01	16.17

* and ** Significant at $P\leq0.05$, $P\leq0.01$, respectively; df, degree of freedom

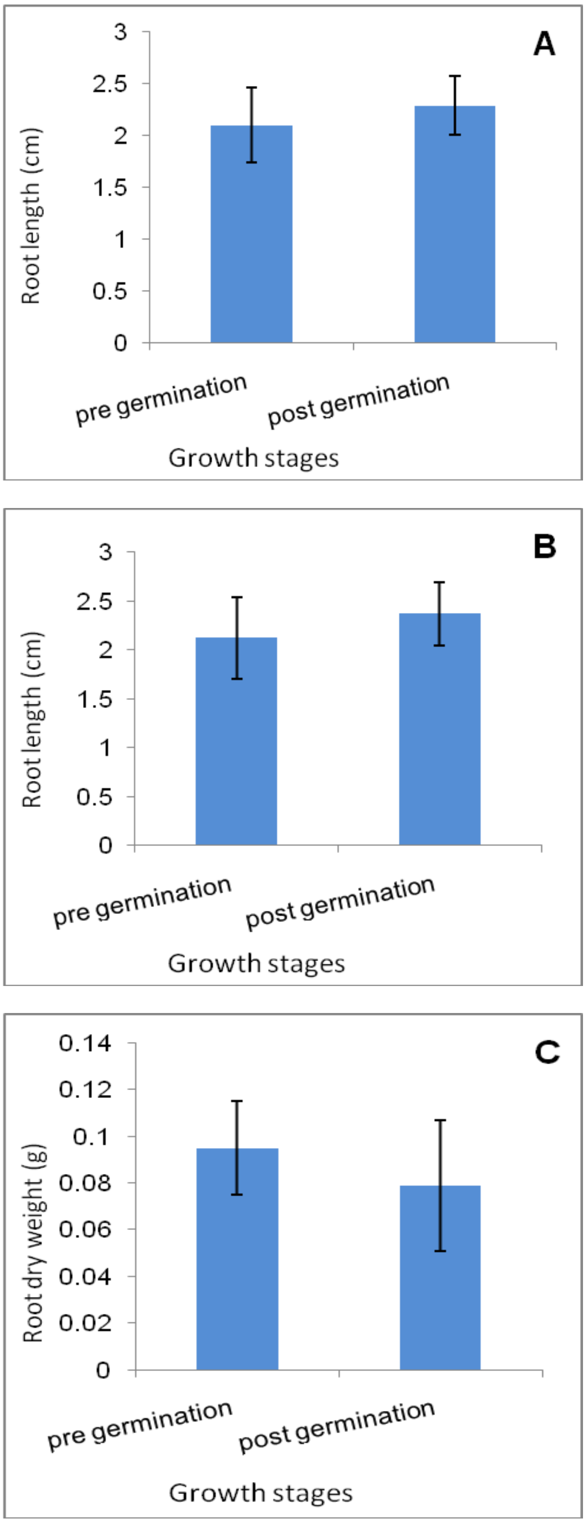

Figure 4. Means comparison of root length (A), shoot length (B), and root dry weight (C) of *Lathyrus sativus* treated with magnetic Urmia Lake water at two growth stages.

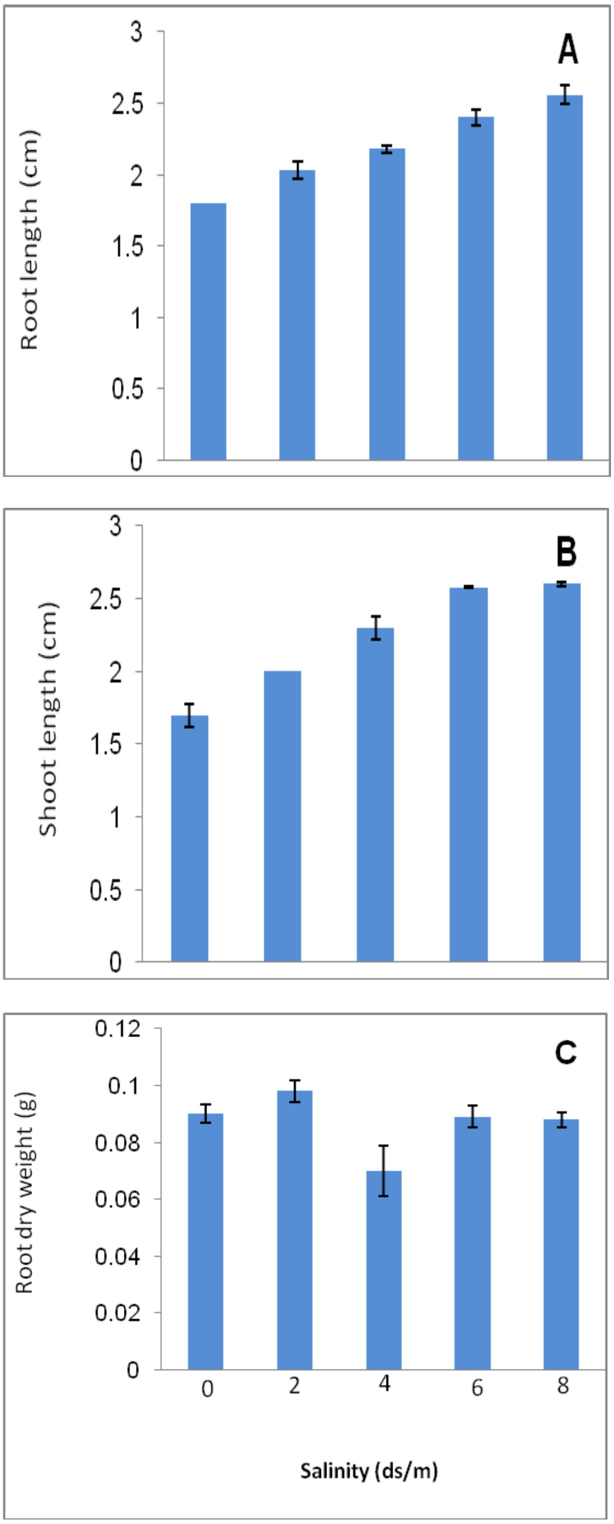

Figure 5. Means comparison of root length (A), shoot length (B) and root dry weight (C) in *Lathyrus sativus* affected by salinity.

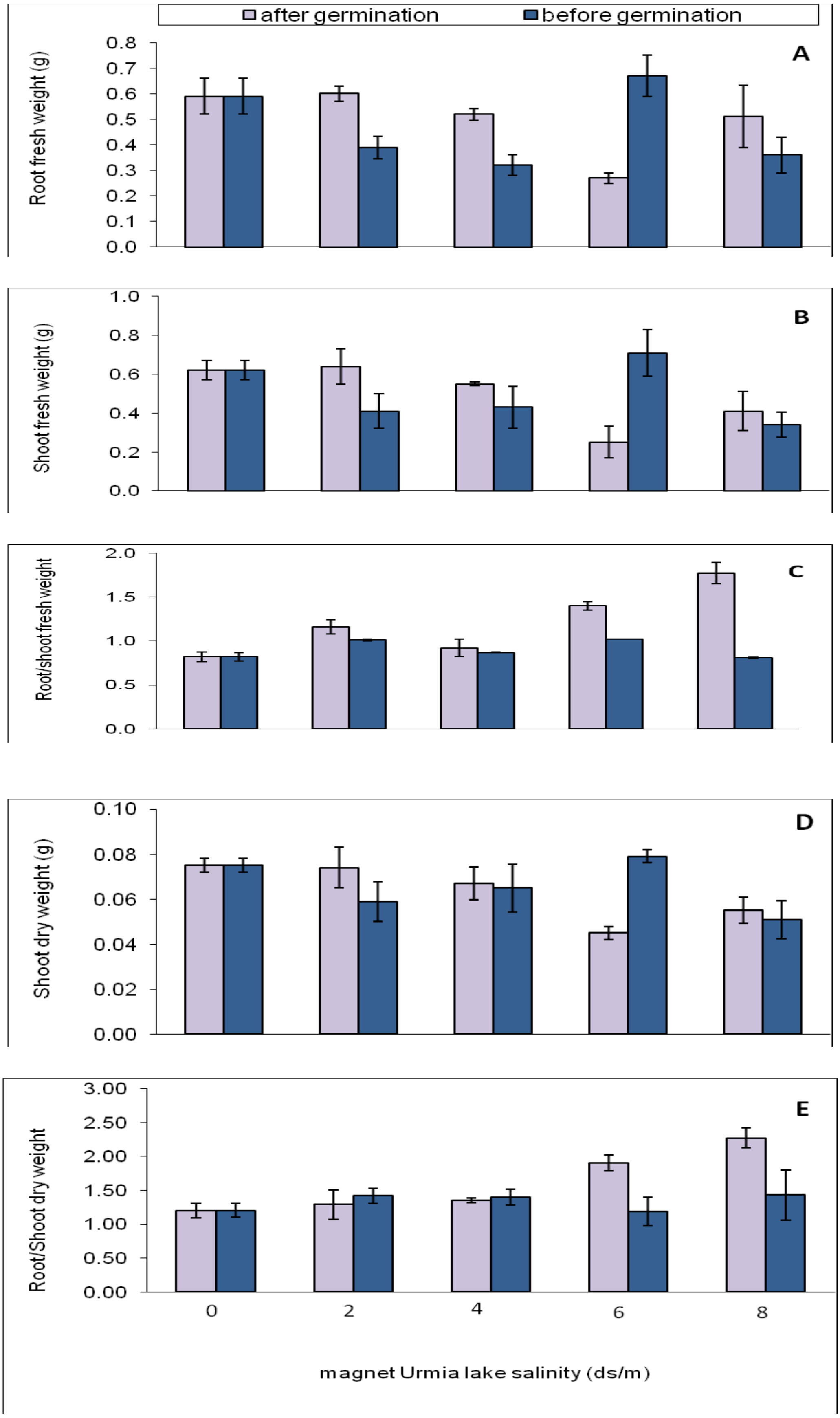

Figure 6. Means comparisons of root fresh weight (A), shoot fresh weight (B), root/shoot fresh weight ratio(C), shoot dry weight (D) and root/shoot dry weight ratio (E) under different concentrations of salinity applied at two stages (after and before germination) of magnetic Urmia Lake water.

DISCUCTION

Reduction in seedling fresh weight is due to decreasing water uptake by seedlings. This result is similar to the previous report of Sharma et al. (19), which showed decreasing seedling fresh weight under salinity. Salinity also reduced shoot and root fresh weight (20). Radicle and hypocotyle dry weight of wheat and triticale were reducing by salinity (21). Salt decrease the osmotic water potential, creating a water stress in seedling. The loss of water from the cells may affect turgor and bring about changes in size and membrane properties. It is hypothesized that increased medium salinity could restrict the synthesis of plant growth promoters such as cytokinins and increase the production of inhibitors such as abscisic acid (22, 23). At high salinities, growth reduction might either be caused by a reduced ability to adjust osmotically as a result of saturation of the solute uptake system, or because of excessive demand on the energy requirements of such systems (24). This study shows that decreasing of Ca^{2+}, Mg^{2+} and K^{+} and increasing of Na^{+} when salinity increases is an active mechanism of salt tolerance in Glasswort, that has been reported by Khan et al. (25) and Tikhomirova et al. (26). It seems that there are mechanisms for Na^{+} transfer against other ions but uptake of Cl^{-} depends on soil salt. Although, NaCl is the major salt in Iran's soil, Cl^{-} increases with salinity increasing. In contrast, Cl^{-} decreases in *S. herbacea* at Na_2SO_4 salt. It may be suggested that uptake of Cl^{-} depends on its abundance and existence of other anions in soil.

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