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Investigate and feasibility of the *Paspalum notatum* lawngrass irrigation by sea water in coastline region

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Abstract

Water shortages and excessive exploitation of underground resources led to reduction of irrigation water and use of unconventional waters will increase. In order to investigate and feasibility of the *Paspalum notatum* lawngrass, irrigation by sea water in coastline region, an experiment based on a randomized complete block design with 3 replications was conducted in Bushehr, Iran. Treatments consisted of 6 levels of saline and fresh water at 0, 20, 40, 60, 80 and 100% concentrations, respectively. The overall evaluation of experimental traits revelead that *Paspalum notatum* lawngrass, irrigation by different percentages of seawater gradually causes, there were no differences between the growth of plant to compare to control trait. This result was observed at 80% seawater irrigation. Growth of *Paspalum notatum* lawngrass with 100% seawater irrigation had decreased. Maximum leaf chlorophyll index of lawngrass with 40% seawater irrigation was obtained. Also, the amount of chlorophyll grass in the same plots that irrigated with 60% seawater had not significant differences and there were in same statistical group. With the increase of seawater from 80 to 100 % the amount of chlorophyll content was decreased. The chlorophyll concentrations in control and 20% seawater treatments had not significant differences compere to other treatments. In general, it can conclude that gradual irrigation with 80% seawater was proper treatment for maintenance of *Paspalum notatum* lawngrass.

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Introduction

One the significant goal of developing green space is providing beautiful and pleasant green spaces and mental peace. The most fundamental factor of natural life maintenance in modern civilization is green space and lawngrass is considered as one of the basic elements in providing green space (Etemadi and Kolahriz, 2000). Lawngrasses are various according to their function, visual forms, water requirements, and maintenance condition. In addition, each lawngrass needs its own specific climate. A main part of Iran is considered as arid and semi-arid area in the world. Precipitations are low or scattered and evaporation is high in this area so that salts can be accumulated at the soil surface. These saline soils are approximately estimated as 15 to 18 million hectare in Iran (Mirmohammadi Meibodi and Gharehyazi, 2002). For most lawngrasses, soil that is somewhat fertile, a bit acidic, or neutral, adequate ventilation and drain are ideal (Morris, 2002). But we cannot find lands which have all these conditions altogether. Besides the restricted parts of the country, the remaining parts are taken into account as arid and semi-arid areas. Because of low precipitation, specific weather and other factors, formation and spread of saline soils in arid and semi-arid areas of Iran are favorably possible (Afiooni *et al.,* 1996). In many cases, providing green spaces with various lawngrass species is impossible. Making green cover with different species of grass, especially salt-tolerant grasses, is considered as the most important strategies in this respect (Etemadi and Kolahriz, 2000). The main part of green space of Iran southern regions covered with lawn that is mostly Bermudagrass, the African lawn. *Paspalum notatum* lawngrass as a tropical lawngrass with salinity tolerance and it can be improved in south part of Iran. On the one hand, lack of water resources in south parts of Iran is obvious more than this and it is concerned as one of the main challenges in improving plants with lawn cover. In case that there are salt-tolerant species, development of *Paspalum lawngrass* by using salt water resources (seawater and other resources) is possible and expanding cultivation by using these resources is clear more than this. At present, lawngrass salinity tolerance towards seawater is not specified and because of its importance it is considered as research priorities in growth improvement (lawns) in green spaces of south of Iran (Bakhshandeh and Pakizeh, 2005). As the valuable water resources become salty and fresh water amount is decreasing, especially in south parts of Iran, the purposes of this experiment are investigating the irrigation of bermudagrass tolerant species, grown in tropical areas such as salt -tolerant *Paspalum venijatum* in coastline region and spreading that species as a substituting lawngrass in those areas. Achieving this goal reduces stress on fresh water resources in those areas. This experiment aimed at introducing plant species for lawngrass covers in green spaces by irrigation with saltwater and seawater resources. Another goal of this study is to determine *Paspalum* salinity tolerance in south of Iran and feasible improvement of salt-tolerant species in the green spaces of south of Iran.

Material and methods

Experimental situations

This experiment was carried out during the last days of June 2014 in Lian Park, 20 km out of Bushehr, Iran, at the beach for a period of six months. Bushehr Province is hot and dry and it is located in a hot and humid coastline region. Its absolute maximum temperature is 52.5 degree centigrade, minimum temperature is -1 and annual medium temperature is 25.7 degree centigrade. Precipitation is 220 millimeter. In Bushehr weather is hot for 7 months, it is cold-temperate for 2 months and hot-temperate for 3 months.

Experimental design

This experiment based on randomized complete block design with 3 replications was conducted. Treatments consisted of 6 levels of saline and fresh water at 0, 20, 40, 60, 80 and 100% concentrations respectively. A 28 * 20 square meters land was used in this project and the soil was made of flowstones. To prepare and plot by Picor digging was taken into action and 2*2 plots with 40 centimeters depth were made. Plots were filled with sand with EC=1.5. Before doing the research, soil and water trial was done (table 1). On June 22, 2014 *Paspalum lawngrass.*

Table 1. (a) Results of fresh water experiment before starting experiment.

clay (%)	slime (%)	sand (%)	potassium (%)	Total phosph-orous (%)	Total nitrogen azote (%)	organic matter	crayon percen-tage	Lime percen-tage	satura-tion percen-tage	Acidity (pH)	Electrical conductance (dS/m) (EC*10⁶)
1.6	0.8	97.6	60	2.4	–	–	–	54.2	29.0	7.6	1.3

belonging to Bushehr Province species were cultivated. In each plot lawngrass seedlings were planted with 16 cm distance. In this way 64 seedlings were planted in each plot so that all seedlings were totally 1152. After 72 days and planting all seedlings, saline stress was exerted. For this purpose, two 10000-liter tankers and four 5000-liter tankers were used.

Table 1. (b) Table of soil properties of the under experiment place before conducting experiment.

sodium intake ratio	Sodium (meq/li)	magnesium+ calcium (meq/li)	Sulfate (meq/li)	Chlorine (meq/li)	bicarbonate (meq/li)	Carbonate (meq/li)	Acidity (pH)	electrical conductance (Us/m) (EC*106)
1.6	4.0	12.0	7.0	2.5	4.0	0	7.0	1552

Saline stress exertion was done as the followings: On September 04, 2014, B, C, D, E, F plots with 5 % saline stress concentration were irrigated (plot A was control trait). After 10 days, saline stress concentration reached 10%. This process was carried out for all plots except plot A (control trait). Then plot B with 20% saline stress concentration, plot C with 40% saline stress concentration, plot D with 60% saline stress concentration, plot E with 80% saline stress concentration, and plot F with 100% saline stress concentration were irrigated. Eventually, after ten days traits were evaluated in this experiment during two stages. Ruler measured lengths of bud, stolon, and flower, scale with 0.0001 accuracy measured dry weight of leaf and Fig paper measured leaf area. Chlorophyll index trait was evaluated by SPAD (MINOLTA SPAD) at the end of experiment. SAS 9.1 was applied for conducting variance analysis and Duncan multiple range test at the level of 5 % was administered for compare mean. Also, Excel was applied to draw Figs.

Results and discussion

The results of traits at the first stage of measurement

According to the variance analysis results, the effect of different seawater concentrations on bud length lawngrass was significant at the level of 5% (table 2). Based on the results of compare mean the maximum length of bud was related to control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D). Also, there was no significant difference between the irrigation of plot E by seawater with 80% concentration and the above mentioned plots and they were in the same statistical group. Irrigation of plot F by seawater with 100% concentration caused a dramatic decrease in bud length (Fig. 1).

Table 2. Variance analysis of experimental traits examined at the first stage.

leaf area	dry weight of leaf	flower length	stolon length	bud length	df	Sources of variation
975.89^{ns}	0.0044^{ns}	0.98^{ns}	3.46^{ns}	0.0097^{ns}	2	Replicastion
5054.57**	1.97**	26.74**	21.77**	0.227*	5	Salinity
295.38	0.0045	3.79	2.94	0.062	10	Error
20.12	16.63	23.62	20.83	11.84	-	Coefficient of variation (%)

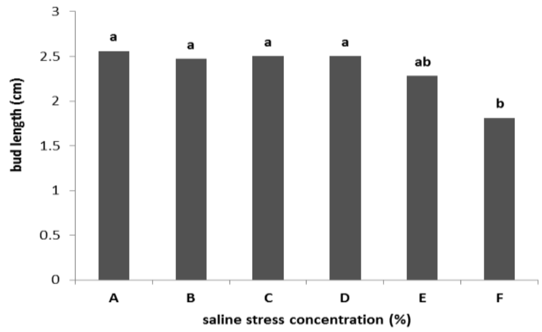

Fig. 1. The effect of saline stress concentration on bud length of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

Varaince analysis results indicated that the effect of different seawater concentrations on stolon length lawngrass was significant at the level of 1% (table 2). According to the results of compare mean, stolon length had no difference in control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D) and 80% seawater (plot E) and they were in the same statistical group. Irrigation of plot F by seawater with 100% concentration resulted in significant decrease in stolon length and it had the minimum amount (4 cm) (Fig. 2).

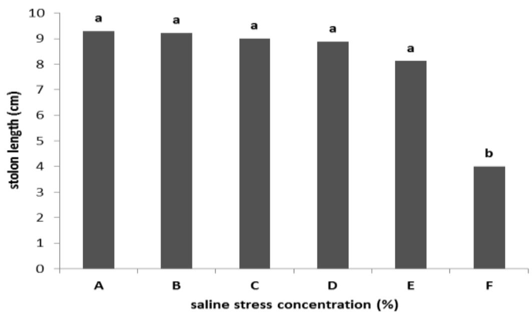

Fig. 2. The effect of saline stress concentration on stolon length of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

In mechanism plants, it is identified as salt secretion in saline condition (Živković *et al.,* 2007). This mechanism decreased salt concentration in plant organs. Plants lose more than 30 to 70 times consuming water for cell expansion by transpiration. This amount mainly depends on climate condition. This is to say that, the concentration of non-secreted substances by roots is over 30 to 70 times more than insoluble substances in soil (Machado-Domenech, *et al.,* 2003). This concentration can be avoided by soil excretion. Under this condition, plant loses water through transpiration over 50 times more than conserved water and it only allow to enter 2 percent of soil salt solute (98% of salt are not allowed to be absorbed). Then salt concentration in stems will not exceed soil and plant can grow in saline soil without specific changes (Machado-Domenech, *et al.,* 2003). Thus, it seemed likely the reason that lengths of stolon and bud were not affected by seawater salinity up to 80 %. But the irrigation of plot F by 100% concentration resulted in stolon and bud lengths being affected. According to visual observations, plots irrigated by 80% seawater had no significant growth regarding control treatment. Quality and lawngrass density of plot F irrigated by 100% seawater decreased dramatically and its growth was affected. According to the results of variance analysis, the impact of different seawater concentrations on lawngrass flower length was significant at the level of 1% (table 2). Based on the results of compare mean the flower length in control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D), 80% seawater (plot E) had no significant differences and they were in the same statistical group. Irrigation of plot F by seawater with 100% concentration caused a dramatic decrease in flower length and it had the minimum amount (0.6 cm) (Fig. 3).

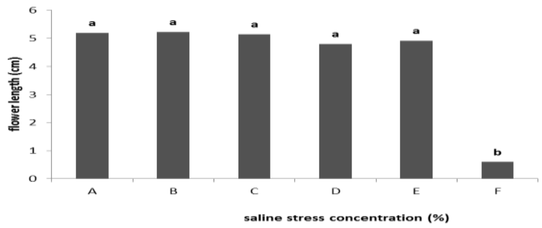

Fig. 3. The effect of saline stress concentration on flower length of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

Salinity tolerance is not only a function of organ activity or a plant trait but also it is considered as a resultant of most important traits of plant. Thus, lawngrasses show superiority in most traits associated with salinity tolerance can be useful in stress condition. The results of variance analysis revealed that the effect of different seawater concentrations on dry weight of lawngrass leaf was significant at the level of 1% (table 2). According to the results of compare mean the dry weight of leaf in control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D), 80% seawater (plot E) had no significant differences and they were in the same statistical group. Irrigation of plot F by 100% seawater brought in a significant decrease in dry weight of leaf and it had the minimum amount (0.001 g) (Fig. 4).

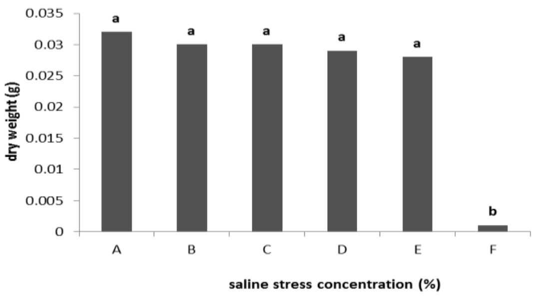

Fig. 4. The effect of saline stress concentration on dryweight of leaf of *Paspalum* lawngras A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

In this experiment, dry weight of leaves of lawngrasses in B to E plots (salinity from 20 to 80 in seawater) had no difference with control trait and enhancing seawater use to 100% induced a dramatic decrease in dry weight of leaves. Mostly leaves were affected by saline stress. Dissolved salts through transpiration process, will be accumulated in leaves after water evaporation and salt gradually will be accumulated over time (Ashraf *et al.,* 2003). Therefore, at any moment, salt concentration in older leaves in comparison with younger leaves is too much. In older leaves, salt concentration gradually kills the cells. Keeping salt away mechanism from leaves involve the followings (Lee *et al.,* 2004): 1) targeted absorption by root. It is not clear yet what kind of cells controls ions targeted selection out of soil solution. The primary intake of Na^+ and Cl^- can occur in epiderm or endoderm if soil solution flows around root cortex flexibly.2) loading in vessel tissue. There is some evidence that indicates the superiority of loading K^+ regarding Na^+ in vessel cells due to genetic factors.3) removing salt from vessel tissue in upper part of roots, stems, leaflet or leaves sheathes (Lee *et al.,* 2004). In most species Na^+ is maintained in upper part of root and lower part of stem so it indicates that K^+ is exchanged with Na^+ by cells placed in excretion flow pathway (Carpici *et al.,* 2009). Paspalum lawngrass studied in this research tolerated 80% seawater salinity thoroughly. But 100% seawater irrigation inhibited aerial parts growth and increased lawngrass weight.

According to the results of variance analysis, the impact of different seawater concentrations on leaf area of lawngrass was significant at the level of 1% (table 2). Regarding the results of compare mean the leaf area in control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D), 80% seawater (plot E) had no significant differences and they were in the same statistical group. Irrigation of plot F by 100% seawater caused a significant decrease in leaf area and it had the minimum amount (Fig. 5).

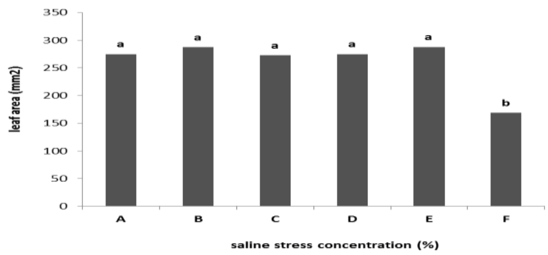

Fig. 5. The effect of saline stress concentration on leaf area of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

In this study, lawngrass leaf area tolatered 80% of seawater and they had no difference with control trait. Scintists believe that it occurs because of the following reasons (Egan and Unger, 1998; Carpici *et al.,* 2009). Some factors manage low ratio of salt accumulation in leaves. High ratios of stem decrease root and high inner growth, speed of salt entry (through excreting flows) and accumulation in stem. Expanding a flexible path in roots affects salt movement around root in xylem vessel (Egan and Unger, 1998; Carpici *et al.,* 2009).

Transporting salt from leaves to xylem vessel is another method which constributes the management of salt low concentration. However, salt translocation (demineralization) from leaves is low toward entry of salt into leaves (Reggiani *et al.,* 1995).

This issue can be observed as a result of salt existence in leaves constantly and sometime after demineralize around roots. Measuring ions in xylem vessel sap has determined that high salt-tolerant species can keep excess Na^+ and Cl^- away in xylem vessel while low salt-tolerant species will not confront these limitations (Marcum and Pessarakli, 2006). Keeping salt away from xylem vessel assures us that salt will not enter growing tissues of stem again. Other mechanism of secreting salt from leaves is salt through salt glands excretion or excreting resources. These mechanisms can help to manage salt balance conservation in leaves over long periods. These kind of specialized cells are specially adapted for halophytes (Carpici *et al.,* 2009).

The results of traits at the second stage of measurement

The results of variance analysis indicated that the effect of different seawater concentrations on bud length of lawngrass leaf was significant at the level of 1% (table 3). According to the results of compare means, the maximum bud length was related to lawngrasses of control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D). Moreover, the irrigation of plot E by 80% seawater concentration had no significant different with the mentioned treatments and they were in the same statistical group. Irrigation of plot F by 100% seawater brought in a significant decrease in bud length (Fig. 6).

Table 3. Variance analysis of experimental traits examined at the second stage.

chloro phyll index	leaf area	dry weight of leaf	flower length	stolon length	bud length	df	Sources of variation
33.84 ns	125.11 ns	0.001 ns	0.02 ns	1.02 ns	0.001ns	2	Replicastion
73.20*	3052.10**	4.36**	25.04**	18.41**	2.58**	5	Salinity
15.08	412.38	0.0001	2.10	1.65	0.005	10	Error
22.05	20.12	4.09	10.52	11.88	8.03	-	Coefficient of variation (%)

significant at the level of %1 ** significant at the level of %5 * non-significant ns

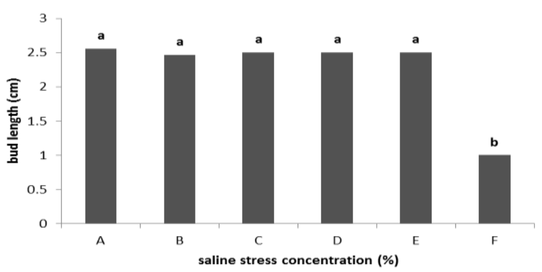

Fig. 6. The effect of saline stress concentration on bud length of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

Plants growth will lessen in salinity stress condition because of water potassium decrease in root environment and the special impact of ions on metabolic processes (Gholam *et al.,* 2002). The rate of various plants growth in salinity condition is different according to their salinity tolerance. Factors affect plant growth in salinity condition include water potassium decrease due to salts existence in root, the effect of ions toxicity, especially sodium and chlorine ions, and ion non-equilibrium among sodium, chlorine, potassium, nitrate and phosphate (Naidoo and Rughunanen, 1990). It seems apparent in this study that lawngrasses subjected to salinity stress adapted to condition after a while and they had no significant growth decrease. Mechanisms can interfere with plants salinity tolerance include non-intake or little intake of salt in plant, tissue tolerance, salt accumulation in vacuoles without sequestering physiologic processes, separating ions such as K^+, Cl^-, Na^+, SO_4^{-2} and at the time of root intake and transporting to aerial parts, and different biochemical processes like producing some enzymes, hormones and antioxidants (Leopoid and willing, 1984).

According to the results of variance analysis, the effect of different seawater concentrations on lawngrass stolon length was significant at the level of 1% (table 3). Regarding the results of compare mean the stolon length in control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D), 80% seawater (plot E) had no significant differences and they were in the same statistical group. Irrigation of plot F by 100% seawater caused a significant decrease in leaf area and it had the minimum amount (Fig. 7).

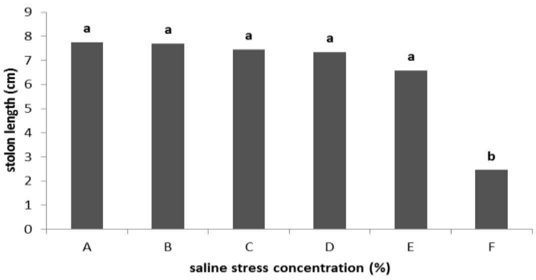

Fig. 7. The effect of saline stress concentration on stolon length of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

The results of variance analysis showed that the effect of different seawater concentrations on lawngrass flower length was significant at the level of 1% (table 3). Based on the results of compare mean the flower length in control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D), 80% seawater (plot E) had no significant differences and they were in the same statistical group. Irrigation of plot F by 100% seawater caused a significant decrease in flower length and it had the minimum amount (Fig. 8).

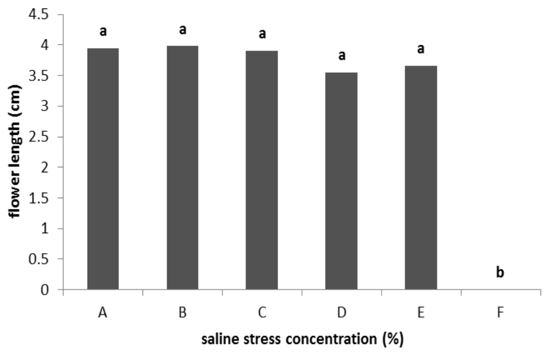

Fig. 8. The effect of saline stress concentration on flower length of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

Salinity stress causes changes in amount and type of metabolic substances which regulate plant growth so that it affects plant growth (Arshi *et al.,* 2002). Because of salinity, the amount and activity of growth hormones such as auxin, gibberellin, cytokinines, and other growth-stimulating substances like putrescine are decreased while growth regulators like abscisic acid are boosted. In general, these variations lead to decrease growth in plants (Taize and Zeiger, 1998; Arshi, *et al.,* 2002). The results of variance analysis demonstrated that the effect of different seawater concentrations on dry weight of lawngrass leaf was significant at the level of 1% (table 3). Based on the results of compare mean dry weight of leaf in control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D), 80% seawater (plot E) had no significant differences and they were in the same statistical group. Irrigation of plot F by 100% seawater induced a significant decrease in dry weight of leaf and it had the minimum amount (Fig. 9).

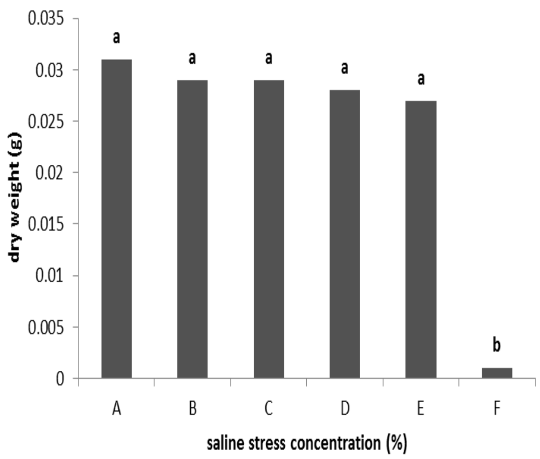

Fig. 9. The effect of saline stress concentration on dry weight of leaf of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

According to the results of variance analysis, the effect of different seawater concentrations on leaf area of lawngrass was significant at the level of 1% (table 3). Based on the results of compare mean leaf area in control trait (plot A), 20% seawater (plot B), 40% seawater (plot C), 60% seawater (plot D), 80% seawater (plot E) had no significant differences and they were in the same statistical group. Irrigation of plot F by 100% seawater caused a significant decrease in leaf area and it had the minimum amount (Fig. 10).

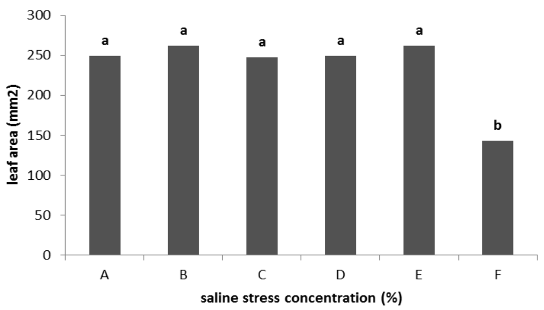

Fig. 10. The effect of saline stress concentration on leaf area of *Paspalum* lawngrass A: control treatmnet, B 20% seawater, C 40% seawater, D 60% seawater, E 80% seawater, F 100% seawater.

Ionic toxity and intake decrease of substance and essential nutrients because of salinity stress enhancement and intake level decrease restricted plant growth. This finding adjusteded to reports of Ejazrasll and Rao (1997) and Reggiani *et al.* (1995) on sugarcane and barely. Producing smaller leaves can decrease leaf area. In this regard, leaf cells cannot reach their maximum growth under salinity condition. Salt slows the speed of cell expansion and it will stop it in high concentrations. One of the plants adjustments to salinity is that they can maintain salt out of their cells so that water will move out of leaf cell and reduce its area. Leaf area decrease leads to lessen light absorption, new dry substance production, and plant growth (Volkmar *et al.,* 1998).

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