T.J.A.N.R.S

The Journal of Agriculture and Natural Resources Sciences

Journal homepage: http://www.journals.wsrpublishing.com/index.php/tjanrs

Online ISSN: 2383-238X Print ISSN: 2423-4397

**Original Article**

# Effect of Water Salinity on Seedlings Growth of Brown Turkey and Royal Fig Cultivars

Hutheyfa Ali Alswalmeh[1], Rashed Sultan Al-Obeed[1] and Alaa El-Din Khalil Omar[1, 2,*]

[1] Plant Production Dept., College of Food and Agric. Sci., King Saud Univ., P.O. Box 2460, Riyadh 11451, Saudi Arabia
[2] Horticulture Dept. (Pomology), Fac. of Agric., Kafrelsheikh Univ., Kafr El-Sheikh 33516, Egypt

**ARTICLE INFO**

**Corresponding Author:**
Alaa El-Din Khalil Omar
alaa.omr@agr.kfs.edu.eg

**How to Cite this Article:**
Alswalmeh, H.A., Al-Obeed, R.S., and Khalil Omar, A. El-D. (2015). Effect of Water Salinity on Seedlings Growth of Brown Turkey and Royal Fig Cultivars. *The Journal of Agriculture and Natural Resources Sciences*, 2(3), 510-516.

**Article History:**
Received: 17 March 2015
Revised: 17 April 2015
Accepted: 21 April 2015

**ABSTRACT**

Saline water was previously considered unusable for irrigation but some researchers have shown that these waters can be used successfully to grow crops under certain conditions Bravdo 2000, Dordipour *et al.*, 2004. It is well known that salt can impair the performance of production and growth of many horticultural plants especially fruit trees. (Glenn *et al.*, 1999, Abd El-Hady *et al.*, 2003). This study was aimed to evaluate the effect of water salinity on the vegetative growth of fig (*Ficus carica,* var Brown Turkey and Royal). The study was carried out during April, May and June 2009/2010, under the conditions of Riyadh, Saudi Arabia). Four irrigation treatments were applied using four levels of sodium chloride (NaCl): 0.8, (control), 2.5, 4.6 and 5.2 dS $m^{-1}$, plus a fifth treatment that combined all concentrations starting gradually from low concentration to high concentration of NaCl. Irrigation was 1.5 L $seedling^{-1}$, 2 times per week for three months in each season. In both varieties there were significant differences among treatments in leaf chlorophyll (a) and chlorophyll (b), but no differences in total chlorophyll. Proline free concentrations of Brown Turkey were higher than those in the Royal as salinity increased. Generally, Brown Turkey was less affected by salinity than Royal. Water irrigation containing salinity levels up to5.2 $dSm^{-1}$ is recommended for Brown Turkey in contrast with the Royal variety in order to overcome the shortage of water resources.

**Keywords**: Water salinity, fig, proline free, vegetative growth.



## INTRODUCTION

Fig plant, *Ficus carica* L., cv. Brown Turkey grows mostly as individual trees, rarely in specialized orchards in Hofuf, Saudi Arabia (Condit and Horne, 1933). Several studies have been carried out on fig seedlings resistance to certain levels of salinity, and its effect on plant growth and productivity. In arid and semi-arid areas, salinity is one of the most severe problems of water availability for irrigation. In these regions there is an urgent need to use water with high levels of salinity in irrigation because of the shortage of water resources. The successful use of saline water for economic crop production can be achieved using good management practices to reduce the negative effects of salinity on crop productivity; so the introduction of salinity-tolerant crops and varieties is highly required.

Saline water was previously considered unusable for irrigation; however, this water can be used successfully to grow crops under certain conditions (Zeid, 2011). Shalhevet (1994) and Minhas (1993) indicated that applying non-saline water in sensitive growth stage and saline water in relatively tolerant stage could minimize the reduction in yield by salinity. Golombek and Ludders (1993) studied the influence of short-term salinity on Bardajik and Faro fig varieties (*Ficus* carica L.), where root mass varied in relation to leaf area. The net photosynthetic rate of plants with big root mass was stimulated by NaCl on certain days of the first week of treatment, whereas the net assimilation rate of plants with small root mass remained the same or decreased by NaCl. Only the assimilation of the salt-treated plants of one cultivar for some days during the first week of treatment seemed to be influenced by stomata conductance. There is little information about the combined action of light intensity and salinity on photosynthesis. Gale (1975) and Downtown *et al.,* (1985) reported a reduction in net photosynthesis with the increase in salinity and light intensity, based on plant species. Salinity generally affects the growth of plant by either ion excess or by water deficit in the expanded leaves (Greenway and Munns 1980). Plant tolerance to water salinity can be developed by selection and breeding programs (Norlyn and Epstein 1982, Dordipour *et al.,* 2004). This work was performed to evaluate the effect of water salinity on the vegetative growth of fig *Ficus carica*, L cvs. Brown Turkey and Royal.

## MATERIALS AND METHODS

The experiment was carried out during two successive seasons (2009/2010) on seedlings of two fig varieties (Brown Turkey and Royal), age 6 months produced from tissue culture. Potted fig seedlings were grown in a wooden house at the Education Farm, College of Food Sciences and Agriculture, King Saud University, Riyadh, KSA. Seedlings were grown in plastic pots (40 cm diameter and 30 cm depth) filled with 20kg clay and sand (1:1). All seedlings were grown for three months (April, May and June) and received the same agricultural practices before the experiment. Seedlings were divided into five groups (5 replicate/treatment), each one representing a different irrigation treatment with a different salinity level; 0.8 (normal water as control); 2.5; 4.6 and 5.2 $dSm^{-1}$ of NaCl, beside a fifth treatment that combined all concentrations starting gradually from a low concentration to a high concentration of NaCl. The irrigation rate was 1.5 liter/ seedling, 2 times/week for three months in each season.

### Measurements

***Seedling Growth***

The following growth parameters were measured; stem length (cm), stem diameter (cm), root length (cm), number of leaves, leaf area, and fresh and dry weight of roots (g) were determined at the end of the experiment.

***Chlorophyll Content (mg/g)***

Fifteen leaves were frozen using liquid nitrogen to extract chlorophyll using 80 % acetone. Chlorophyll (total, A and B) was determined using a spectrophotometer, according to Porra *et al*., (1989).

***Proline Free Content (μ mole/g F.w)***

Total proline was extracted according to Bates *et al.,* (1973). Leaf samples (0.1 g) were homogenized in 10 ml of 3% aqueous sulfosalicylic acid and the homogenate was filtered through Whatman # 2 filter paper. Two milliliters of the filtered extract were mixed with 2 ml ninhydrin acid and 2 ml glacial acetic acid in a test tube and incubated for 1 hour at 100°C, and then tubes were placed in ice to stop the reaction. The solution was mixed with 4 ml toluene and shaken for extraction. The chromophore containing toluene was aspirated from the aqueous phase, and warmed to room temperature. The chlorophyll content was measured using a spectrophotometer at 520 nm wave length, using toluene as a blank.

***Soil Analysis***

Soil samples were taken from the area of the major roots before the cultivation of the seedling sand at the end of the growing season. Each sample was prepared to form soil texture using the hydrometer method according to Bouyoucos (1936). Soil chemical analysis was conducted following the procedures described by Jackson (1973) (Table1-2).

***Experimental Design and Statistical Analysis***

The experiment was designed in a complete randomized (split plot) model with five replicates per treatment. One way ANOVA was run using SAS program (2000). Means were compared using least significant differences (LSD) at $P \leq 0.05$ (1970).

**Table 1: Average of soil chemical analysis before experiment in 2009/2010 seasons**

| pH | EC (Ds/m) | Soluble Cations (meq/L) | | | | Soluble Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $Ca^{2+}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ | $CO_3^{2-}$ | $HCO_3$ | $Cl^{-}$ | $SO_4^{2-}$ |
| 6.40 | 8.10 | 81.25 | 10.5 | 7.71 | 0.68 | - | 5.30 | 9 | 8.3 |

**Table 2: Effect of saline water on soil chemical analysis after the experiment in 2009/2010 seasons**

| | No | pH | EC (Ds/m) | Soluble Cations (meq/L) | | | | Soluble Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ | $CO3^{--}$ | $HCO3^{-}$ | $Cl^{-}$ | $SO4^{--}$ |
| Royal | $T_1$ | 8.22 | 9.15 | 42.50 | 29.12 | 20.00 | 1.23 | 0.00 | 4.00 | 45.00 | 39.30 |
| | $T_2$ | 8.16 | 15.12 | 47.00 | 47.84 | 27.83 | 2.64 | 0.00 | 3.50 | 100 | 44.50 |
| | $T_3$ | 8.27 | 18.79 | 50.00 | 62.92 | 33.90 | 2.77 | 0.00 | 3.47 | 127.5 | 50.20 |
| | $T_4$ | 8.34 | 21.91 | 48.75 | 71.50 | 36.50 | 3.05 | 0.00 | 4.25 | 153.70 | 55.70 |
| | $T_5$ | 8.23 | 13.01 | 46.25 | 44.20 | 27.80 | 1.87 | 0.00 | 3.75 | 80.00 | 47.70 |
| Brown Turkey | $T_1$ | 8.21 | 11.34 | 45.00 | 38.22 | 27.00 | 1.56 | 0.00 | 4.50 | 75.00 | 43.00 |
| | $T_2$ | 8.14 | 14.16 | 47.50 | 45.50 | 29.60 | 1.92 | 0.00 | 4.45 | 92.75 | 48.40 |
| | $T_3$ | 8.24 | 18.24 | 48. 48 | 57.20 | 34.80 | 2.49 | 0.00 | 3.75 | 137.50 | 49.70 |
| | $T_4$ | 8.34 | 29.25 | 57.50 | 91.00 | 47.80 | 4.58 | 0.00 | 4.25 | 230.00 | 62.70 |
| | $T_5$ | 8.32 | 12.48 | 47.00 | 41.60 | 27.00 | 1.92 | 0.00 | 3.80 | 77.50 | 45.50 |

$T_1$=0.8 $dSm^{-1}$ (Control); $T_2$=2.5 $dSm^{-1}$; $T_3$=4.6 $dSm^{-1}$; T4=35.2 $dSm^{-1}$; $T_5$=Gradual Irrigation from 0.8 to 5.2 $dSm^{-1}$

**Table 3: Effect of saline water on some characters of vegetative growth for fig seedling var Royal and Brown Turkey during 2009/2010 seasons**

| Variety | No | High seedling (cm) | Seedling diameter (cm) | leaves/ seedling | Leaf area ($cm^2$) | Root length (cm) | Root fresh weight (g) | Root dry weight (g) |
|---|---|---|---|---|---|---|---|---|
| Royal | $T_1$ | 24.25d | 4.96c | 10.50a | 49.00f | 28.75b | 18.40c | 11.29bcd |
| | $T_2$ | 24.00d | 5.09bc | 10.25a | 45.65g | 22.25c | 17.57c | 10.01bcd |
| | $T_3$ | 23.75d | 5.09bc | 10.25a | 43.00h | 14.75d | 15.17cd | 8.38cd |
| | $T_4$ | 22.75d | 4.94c | 9.75a | 26.50j | 14.06d | 14.12d | 4.41e |
| | $T_5$ | 23.25d | 4.8c | 9.75a | 38.16i | 15.41d | 18.00c | 7.49d |
| Brown Turkey | $T_1$ | 33.00a | 6.2a | 13.25a | 93.00a | 32.00a | 32.12a | 18.43a |
| | $T_2$ | 31.25ab | 5.91ab | 12.75a | 84.67b | 27.25b | 24.82b | 17.71a |
| | $T_3$ | 30.00bc | 5.91ab | 12.25a | 72.52d | 21.00c | 19.00c | 12.05bc |
| | $T_4$ | 28.00c | 5.88ab | 12.17a | 66.12e | 20.5c | 13.87d | 10.61bcd |
| | $T_5$ | 30.75ab | 5.06bc | 12.25a | 75.6c | 22.5c | 17.90c | 12.67b |

$T_1$=0.8 $dSm^{-1}$ (Control); $T_2$=2.5 $dSm^{-1}$; $T_3$=4.6 $dSm^{-1}$; T4=35.2 $dSm^{-1}$; $T_5$=Gradual Irrigation from 0.8 to 5.2 $dSm^{-1}$

**Table 4: Effect of saline water on prolin free (μ mole/g F.w), total chlorophyll, chlorophyll a and chlorophyll b (mg/g) during 2009/2010 seasons**

| Variety | No | free Prolin | Total chlorophyll | Chlorophyll (A) | Chlorophyll (B) |
|---|---|---|---|---|---|
| Royal | $T_1$ | 1.84a | 2.36a | 1.5a | 0.83bc |
| | $T_2$ | 1.97a | 2.3a | 1.3ab | 0.79bc |
| | $T_3$ | 1.97a | 1.9ab | 1.03bc | 0.65bcd |
| | $T_4$ | 2.07a | 0.89de | 0.51c | 0.36d |
| | $T_5$ | 1.921a | 1.67bc | 0.98bc | 0.59bcd |
| Brown Turkey | $T_1$ | 1.84a | 1.77bc | 1.01bc | 2.12a |
| | $T_2$ | 1.91a | 1.2cde | 0.84bc | 0.96b |
| | $T_3$ | 2.02a | 1.06de | 0.62c | 0.41d |
| | $T_4$ | 2.14a | 0.75e | 0.56c | 0.37d |
| | $T_5$ | 1.92a | 1.44bcd | 0.73c | 0.49cd |

$T_1$=0.8 $dSm^{-1}$ (Control); $T_2$=2.5 $dSm^{-1}$; $T_3$=4.6 $dSm^{-1}$; T4=35.2 $dSm^{-1}$; $T_5$=Gradual Irrigation from 0.8 to 5.2 $dSm^{-1}$

## RESULTS AND DISCUSSION

### Effect of Irrigation with Saline Water on the Growth of Fig Seedlings

***Stem height (cm)***

Data in Table 3 showed that there were a significant between all saline treatments in Brown Turkey and the others in Royal seedling. Control ($T_1$), $T_2$ and $T_5$ recorded (33.00, 31.25 and 30.75 $dSm^{-1}$, respectively) the highest significant of high seedling as compared to other treatments in Brown turkey seedling. All Royal seedling were treated by different saline water treatments recorded (24.25, 24.00, 23.75, 22.75 and 23.25 $dSm^{-1}$, respectively) the lowest significant values as compared with other treatments.

***Stem Diameter (cm)***

All treatments of irrigation with saline water had non-significant variations in both varieties. Treatments 5and 4 were recorded the lowest seedling diameter in Royall variety than other treatments. On the other hand treatment 1 (control) record the highest (6.2cm) diameter in Brown Turkey, but the differences not significant in both case.

***Number of Leaves / Seedling***

Compared to the control, both varieties did not show any difference in leaves number in response to different levels of water salinity. In general, Brown Turkey showed higher number of leaves than Royal with all treatments during both seasons. Control showed the highest number of leaves per seedlings in both varieties (Table 1).

***Leaf Area ($cm^2$)***

Was changed significantly with all treatments compared to control ($T_1$) in Brown Turkey fig seedlings. Control showed the biggest leaf area (93.00 $cm^2$), and $T_4$ showed the smallest leaf area (26.50 $cm^2$), (Table 3).

Through the above results, increasing salinity of water decreased the vegetative growth and chlorophyll pigments of Brown Turkey and Royal cultivars. This reduction in the vegetative growth with the increase in salinity levels might be due to the increase in osmotic pressure that affects the ability of the plant to absorb water for its growth, or it might be due to the toxicity of specific ions to various plant physiological processes. It might be also due to the secondary specific-ions effects, such as sodium. The excess of exchangeable sodium can lead to soil swelling and/or dispersion causing water infiltration, aeration and root penetration problems (Ayers, 1952 and Ashraf, 2002).

***Root Length (cm)***

Irrigation with saline water significantly affected root length in both varieties. Treatments 3,4 and 5 in Royal variety exhibited the shortest (14.75, 14.06 and 15.41cm) significant root length in comparison to other treatments for both varieties, while the tallest (32.00cm) significant root length was in Treatment 1 (control) in Brown Turkey variety (Table 3).

***Roots Fresh Weight (g)***

Control ($T_1$) flowed $T_2$ increased significantly root fresh weight (32.12 and 27.25g, respectively) in Brown Turkey compared to other treatments in both varieties (Table13).

***Roots Dry Weight (g)***

Like fresh weight, dry weight was the highest with $T_1$ and $T_2$ in Brown Turkey variety compared to other treatments in both varieties. Treatment ($T_4$) in Royal variety significantly decreased (4.41g) root dry weight in compared to other treatments in both varieties (Table 1).

In general, the root weight showed a greater decline than the shoot mass in both varieties; however, the smallest reduction was seen in pots irrigated with highest saline water (5.2milmos/cm). Decreases in root and shoot mass have been reported by (Elsheikh and Wood, 1990, Hawkins and Lewis, 1993 and Singh *et al.*, 2001). A decline in root dry mass may be a disadvantage in terms of the plant's ability to seek nutrients in the soil and transport them to growing shoots. Vegetative growth is a complex process and several factors other than reduced root growth are involved. According to Cheeseman (1988), salinity stress imposes additional energy requirements on plant cells and diverts metabolic carbon to storage pools so that less carbon is available for growth.

***Prolin Free (μ mole/g F.w)***

The higher proline content (2.14 μ mole/g F.w) was recorded by $T_4$ (35.2 $dSm^{-1}$) in Brown Turkey variety seedlings as compared other treatments, as shown in Table (4); however no treatment had significant effect on prolin content compared to the control in both varieties.

Our results agree with Stewart *et al*., 1977 and Salim, 1989, who found that, gradually increased as salt concentrations increased. Accumulation of free proline in plant tissues might be due to other soluble compounds, because of the reduction in oxidation enzymes content/activity. Tissue accumulations of proline under stress may result mainly from de-novo biosynthesis since proline content was increased in tissues compared to the control (Dobrá et al., 2011).So Proline accumulation is an important mechanism for osmotic regulation under salt stress (Munns and Tester 2008).

***Total Chlorophyll (mg/g)***

Treatment 1 (0.8 $dSm^{-1}$) in Royall variety showed the highest (2.36 mg/g) total chlorophyll content, while the lowest (0.75 mg/g) content was in Brown Turkey seedlings treated by $T_4$ (35.2 $dSm^{-1}$ ). But the differences were not significant compared to other treatments (Table 4).

***Chlorophyll A (mg/g)***

As shown in Table (4), non-significant variations were noticed among levels of salinity in chlorophyll A content in both varieties. $T_1$ and $T_2$ (0.8 and 2.5$dSm^{-1}$), recorded the highest content (1.5 and 1.30 mg/g) of chlorophyll (A) as compared with other treatments. While lowest content was 0.51 mg/g by $T_4$ (4.6 $dSm^{-1}$) in Royall seedlings variety.

***Chlorophyll B (mg/g)***

$T_1$ (0.8 dSm-1) increased significantly Chlorophyll b (2.12 mg/g) in Brown Turkey compared to other treatments in both varieties. While the lowest content was 0.35 was recorded by $T_4$ (35.2 dSm-1) in Royall variety, but this decrease was not significant among all treatments (Table 4).

Through the above results in chlorophyll pigments, salinity stress led to leaves yellowing due to a significant damage of chlorophyll pigments. Similar results have been reported for legumes (Soussi *et al.*, 1998, Al-Khanjari *et al.*, 2002). The inhibitory effects of salt on chlorophyll could be due to suppression of specific enzymes responsible for the synthesis of green pigments (Strogonove *et al.,* 1970); an effect that depended on the biological processes and the development stages of the plant and also on the type and concentration of the salts. The decrease in chlorophyll may be attributed to increased chlorophyllase activity (Sudhakar *et al.,* 1997). The less reduction of chlorophyll pigments in the tolerant genotypes might have been responsible for the higher dry matter accumulation in them (Mudgal *et al.,* 2009).

***Effect of Irrigation with Saline Water on Soil Quality***

Soil chemical analyses were carried out on soil samples before and after the experiment (Table 2). These results show that the concentration of magnesium, sodium and potassium of the soil irrigated with saline water increased by all treatments. $T_4$ (5.2 $dSm^{-1}$) was the highest in Mg, Na, and K concentration at the end of experiment in both varieties. While, control treatment ($T_1$) showed the lowest Mg, Na, and K concentrations in both varieties. Irrigation with saline water increased EC of soil saturated extract. $T_4$ recorded the highest EC (21.90 and 29.25 Ds/m) after of experiment in Royal and Brown Turkey pots, respectively, while it was 8.10 Ds/m before the experiment. All treatments increased pH after experiment, and the highest value of pH was 8.34 with $T_4$ treatment in both varieties compared with 6.40 before the experiment. On the other hand, calcium concentration after the experiment was lower than that before experiment in both Royal and Brown Turkey pots. Soluble Anions, such as Cl and $So_4$ were increased with all treatments by the end of the experiment than that before the experiment. Treatment ($T_4$) recorded the highest concentrations of Cl (153.70; 230.00 meq/L) and $SO_4$ (55.70 and 62.70 meq/L) after experiment in Royal and Brown Turkey pots, respectively. The concentration of $HCO_3$ was decreased with all treatments in Royal and Brown Turkey pots after the experiment. Control ($T_1$) showed the highest $HCO_3$ concentration (4.00 and 4.50 meq/L), while treatment ($T_3$) showed the lowest $HCO_3$ concentration (3.47 and 3.75 meq/L) in Royal and Brown Turkey pots, respectively. These results agree with Shalhevet (1994) reported that it is still controversial whether the reduction in water uptake with increasing salinity is the cause or result of the reduction in growth. Also, Van-Ieperen (1996) and Wan *et al.* (2007) reported that salt accumulation in the field was an important factor in reducing the yield.

## CONCLUSION

It is necessary to look for alternative water resources or new varieties of fig compatible with high levels of soil salinity. The present study indicated that Brown Turkey variety was little affected by saline water than Royal variety. It may be recommended to irrigate Brown Turkey variety with water contains salinity levels up to 5.2dSm$^{-1}$ in order to overcome the shortage of water resources needed for irrigation as compared with Royal variety.

## ACKNOWLEDGEMENTS

The authors would like to thank the Deanship of Scientific Research and Research Center, College of Food and Agricultural Sciences, King Saud University, KSA for the financial support of this research.

## REFRENCES

Abd El-Hady, A.M., Aly, M.A., and El-Mogy, M.M. (2003). Effect of some soil conditioners on counteracting the adverse effects of salinity on counteracting the adverse effects of salinity on growth and fruiting of Flame Seedless vines. Minia J. growth and fruiting of Flame Seedless vines. *Minia J. of Agric. Res. and Development*, 23(4), 699-726.

Al-Khanjari, S., A. Al-Kathiri, and Esechie, H. A. (2002). Variation in chlorophyll meter readings, nodulation and dry matter yields of alfalfa (*Medicago sativa* L.) cultivars differing in salt tolerance. *Crop Res*. 24:350-356.

Ashraf, M. (2002). Salt tolerance of cotton: Some new advances. *Critical Reviews in Plant Sciences* 21: 1-30.

Ayers, A. D. (1952). Seed germination as affected by soil moisture and salinity. *Agron. J*. 44, 82-84.

Bates, L. S., Waldren, R. P., and Tear, I. D.(1973). Rapid determination of free prolin for water stress studies, *Plant and Soil*, 39, 205-208.

Bouyoucos, G. L. (1936). Direction for making mechanical analysis of soils by the hydrometer methods. *Soil Sci*., 42, 225-228.

Bravdo, B.A. (2000). Effect of mineral nutrition and salinity on grape production and wine quality. *Acta Horticulture*. 512: 23-30.

Cheesman, J.M. (1988). Mechanisms of salinity tolerance in plants. *J. Plant Physiol*. 87,547-550.

Condit, I.J. and Horne, W. T. (1933). A mosaic of the fig in California. Phytopathology, 23, 887-897.

Dobrá J, Vanková, R., Havlová, M., and Burman, L. (2011). Tobacco leaves and roots differ in the expression of proline metabolism-related genes in the course of drought stress and subsequent recovery. *Journal of Plant Physiology*. 168: 1588–1597.

Dordipour, I, Ghadiri, H., Bydordia, M., Siadat, H., Malakouti, M. J., and Hussein, J. (2004). The use of saline water from Caspian Sea for irrigation and Barley production in Northern Iran. *ISCO 2004 - 13th International Soil Conservation Organisation Conference – Brisbane, July 2004*, Paper No. 986, p:1-4.

Downton, W.J.S, Grant W. J. R., and Robinson, S.P. (1985). Photosynthesis and stomatal responses of spinach leaves to salt strees. *Plant phsiol*., 77, 85-88.

Elsheikh, E. A. E., and Wood, M. (1990). Effect of salinity on growth, nodulation and nitrogen yield of chickpea (*Cicer arietinum* L.). J. Exp. Bot., 41, 1263-1269.

Gale, J. (1975). The combined effect of environmental factors and salinity on plant growth. *In plant in saline Environments* (eds. A. Poljakoff- Mayber & J. Gale), pp.186-192. Springer- Berlin.

Glenn, E.P., Brown, I. I., and Blumwald, E. (1999). Salt tolerance and crop potential of halophytes. Salt tolerance and crop potential of halophytes. *Crit. Rev. Plant Sci*., 18, 55-227.

Golombek, S.D., and Ludders, P. (1993). Effects of short-term salinity on leaf gas exchange of the fig (*Ficus carica* L.), *Plant and Soil*. 148( 1).

Greenway, H., and Munns, R. (1980). Mechanisms of salt tolerance in no halophytes. *Annual Reviews in Plant Physiology*, 31, 149-190.

Hawkins, H. J., and Lewis, O. A. M. (1993). Combination effect of NaCl salinity, nitrogen form and calcium concentration on the growth, ionic content and gaseous exchange properties of Triticum aestivum L.cv. Gamtoos. *New Phytol*., 124,161-170.

Jackson, M.L. (1973). Soil Analysis. *Constable Co. Ltd., London*, pp: 1-15.

Minhas, P.S. (1993). Modelling crop response to water and salinity stresses. *In. Sustainable Irrigation in Saline Environment* (eds. Tyagi et al.), Central Soil Salinity Research Institute, Karnal, pp. 96-109.

Mudgal, V., Madaan, N., Mudgal, A., Mishra, S., Singh, A., and Singh, P. (2009). Changes in growth and metabolic profile of chichpea under salt strees. *J. Appl. Biosci*., 1436-1446.

Munns R., and Tester, M. (2008) Mechanisms of salinity tolerance. *Annual Review of Plant Biology*, 59, 651–681. doi: 10.1146/annurev.arplant.59.032607.092911.

Norlyn, J. D., and Epstein, E. (1982). Barley production: Irrigation with sea water on coastal soil. *Environmental Science Research*. 23, 525-529.

Porra, R. J., Thompson, A., and Friedelman, P.E. (1989). Determination of accurate extraction and simultaneously equation for assaying chlorophyll a and b extracted with different solvents: verification of the concentrationn of chlorophyll standards by atomic absorption spectroscopy," *Biochim. Biophys. Acta*, 975, 384-394.

Salim, M., (1989). Effect of NaCl and KCl salinity on growth and ionic relations of red kidney beans (*Phaseolus vulgaris* L.). *J. Agron. and Crop Sci*., 163, 338-344.

SAS Institute. (2000). SAS/ STAT User`s guide: Statistics. Version 6.03, Cary, NC. USA.

Schanderi, SH. 1970. Methods in Food Analysis. *Academic Press, New York*. P.709.

Shalhevet, A. (1994). Using water of marginal quality for crop production: *major issues. Agric. Water Manage*. 25, 233–269.

Shalhevet, J. (1994). Using water of marginal quality for crop production: major issues. *Agric Water Manage*, 25: 233-269.

Singh, A. K., Singh, R. A., and Sharma, S. G. (2001). Salt stress induced changes in certain organic metabolites during seedling growth of chickpea. *Legume Res*. 24:11-15.

Soussi, M., Ocana, A., and Lluch, C. (1998). Effect of salt stress on growth, photosynthesis and nitrogen fixation in chickpea (*Cicer arietinum* L.). *J. Exp. Bot*., 49, 1329-37.

Stewart, G. R., Beggess, S. F., Aspinall, D. and Paleg, L. G. (1977). Inhibition of proline oxidation by water stress. *Plant Physiol*., 59, 930-932.

Strogonove, B. P., Kabanov, V. V., Shevajakova, N. I., Lapine, L. P., Kamizerko, E. I., Popov, B. A., Dostonova, R. K., and Prykhodko, L.S. (1970). Structure and Function of Plant Cells in Saline Habitats. *John Wiley and Sons, New York*.

Sudhakar, C., Ramanjulu, S., Reddy, P.S., and Veeranjaneyulu, K. (1997). Response of some calvin cycle enzymes subjected to salinity shock in vitro. Indian J. Exp. Bot., 35, 665-67.

Van-Ieperen, W. (1996). Effects of different day and night salinity levels on vegetative growth, yield and quality of tomato. *J Hort Sci*., 71, 99-111.

Wan, S., Y. D. Kang, SH. Wang, Liu and Feng, L. (2007). Effect of drip irrigation with saline water on tomato (*Lycopersicon esculentum*) yield and water use in semi-humid area. *Agric Water Manage*, 90, 63-74.

Zeid, M. (2011). Alleviation of seawater stress during germination and early growth of barley. *International Journal of Agriculture: Research and Review*, 1 (2), 59-67.