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# The Effect of Various Levels of Salinity and Superabsorbent on Agronomic Characteristics of Basil in Greenhouse Condition

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**ABSTRACT: To investigate the effect of different levels of salinity and super absorbent material on seedling vigor and growth characteristics of basil in greenhouse cultivation, a factorial experiment carried out in a randomized complete block design with 12 treatments and 3 replications in green house agriculture research station Traditional. Treatments consisted off our salinity levels (zero, 100, 150 and 200Mm salt) and super absorbent material in three levels (zero, 5 and 10g) per pot. The effect of salinity on four levels (zero, 100, 150 and 200mM salt) in a completely randomized design with three replications was studied in vitro cultivation. Analysis of variance showed that the effects of salinity on Shoot length at five percent and the root length, wet Biomass of root and Shoot, dry Biomass of root and shoot, number of leaves and number of lateral branches in pot cultivation was significant at the probability of one percent. The results of variance analysis showed that the effects of superabsorbent on root length and root dry Biomass at Probability level of five percent, and the Shoot length, shoot wet Biomass, shoot dry Biomass, number of leaves and number of lateral branches in pot cultivation was significant at the probability of one percent. The interaction between salinity and super absorbent material on all traits were not significant. Duncan mean comparison test with five percent for pot cultivation in green houses for salinity, the maximum shoot and root length, wet Biomass shoot and root, dry Biomass of shoot and root, number of leaves and number of lateral branches of control treatment and the lowest rate, for the treatment of 200mMol salt. The super absorbent material effect on all traits except dry Biomass of root and branch number was significant. With increasing amounts of super absorbent materials all studied traits increased.**

**Keywords:** Agronomic Characteristics, Basil, Salt Stress, Seedling vigor, Super absorbent materials

## INTRODUCTION

In most areas of the world, salinity tension is the most important environmental factor that constrains the performance of agricultural products by decreasing osmotic potential and disruption in absorption of some food elements (Demir Kaya *et al*, 2006; Netondo *et al*, 2004). Salinity affects all metabolisms and changes the anatomy and morphology of the plant. Some of these changes are in fact the compatibilities that help the herb tolerate the salinity-induced stress; however, most observed changes indicate the damage due to salinity (Azar Neivand and Gorbani, 2007).

Increased salt absorption and ionic toxicity leads to disruption of cellular function and damage to physiologic processes including photosynthesis and respiration (Munns, 2002). Change in chromosome and chromatin structure, DNA mutilation, polyploidy and multiplication or deletion of DNA strings are the main effects of salinity (Walbt and Cullis, 1985). Increased salinity can also lead to hyperosmotic and hypertonic tensions and the death of the plant (Mahajan and Tuteja, 2005).

Superabsorbent in soil absorbs water with its dissolved fertilizers and sends it to the root according to its demand. Thus, this method, if used alone or beside to other new irrigation methods and based on the studied data, can save Iran from drought and environmental disasters, extreme food demands, release the employment crisis and make a revolution in agriculture and economy (Ganji Khoram Del, 2001). Although superabsorbent can keep water event under the pressure, as soon as the root needs water, it carries water to root easily. Superabsorbent increases absorption output of dispersed raining water through rapid absorption of water and its keeping and in case of soil irrigation, the irrigation distances also increases. This increase depends on physical condition of soil, climate of region and consumption of superabsorbent in soil. The use of superabsorbent in planting seed and sapling eliminates the moisture tensions and helps the compatibility of the planted herbs with the environment (Dareh Shouri, 2015).

Salinity is an unavoidable issue and the plants have limited ability for fighting with this tension. In basil, there is no resistant variety to this tension; however, concerning the fact that basil is a high-consumption vegetable for salad or as food appetizer and in some cases, it has pharmacological effect in some cases. This test has been carried out to study the effect of various levels of salt concentration and superabsorbent on basil and the morphologic responses of plant to salinity.

## MATERIAL AND METHODS

*A. Planting basil seeds*

First the selected seeds are disinfected with hypochlorite sodium 0.1% and then washed with distilled water. The infected seeds were placed in distilled water for one hour. For planting in pot, the pots with diameter of 20 cm were used filled with perlite, sand, clay and organic fertilizer. Superabsorbent polymer was added in three levels (zero, 0.1 and 0.2 Biomass percentages that are respectively 0, 5 and 10 gr in 5 kg soil of each pot). Then the soaked seeds were transferred to the pots. For each treatment, 3 pots were considered as 3 reiterations. In each pot, 15 seeds were planted; the pots were transferred to a greenhouse in Gachsaran after planting. The moisture of greenhouse was 75% and its temperature was 25 degree centigrade. The pots were irrigated everyday such that the moisture of soil was at the farm capacity. The planted basils grew in the mentioned condition for one week after germination and after 10 days of germination, the plants were prepared for treatment with various salinity levels. The plants were treated by salinity treatment through irrigation with distilled water five times on alternate days (Dareh Shouri, 2015).

*B. The studied morphologic traits*

In the present study, the morphologic studies were performed in growth stage. In the growth stage of the plant, the length of shoots of plant, the root length, wet Biomass of shoots, dry Biomass of shoots, the number of leaves, nodes and branches were measured and recorded.

*C. The measuring of wet Biomass of shoots*

After separating the root from the shoots, the Biomass was measured in respect to gram through BPSIID Sartorious scale with precision of $10^{-4}$. For each treatment group, three iterations were calculated and the mean was reported in respect to gram unit.

*D. Measuring wet and dry Biomass of shoots and root*

To measure these parameters, each pot was considered one iteration, and 10 plants were considered from each pot. To determine the wet Biomass, BPSIID Sartotious scale with accuracy of 10-4 was used, then placed in aluminum foil and kept in oven of 70 degree centigrade for 48 hours. After drying the samples completely, their dry Biomass was measured.

*E. Measuring the length of shoots and plant root*

The length and root lengths were calculated through millimeter ruler. For each treatment group, three iterations were calculated and the mean was reported in respect to centimeter unit.

*F. Statistical operation*

In this test, for each treatment three iterations were considered. In each iteration, 5 plants were evaluated. To determine the effect of superabsorbent materials and salinity on morphologic parameters, statistical analysis was performed. The superabsorbent materials were used in three levels of 0 gr (H1), 5 gr (H2) and 10 gr (H3). The obtained data were statistically analyzed in greenhouse with factorial test in form of random block plan using SPSS software and the figures were drawn by Excel 2010 (Dareh Shouri, 2015).

## RESULTS AND DISCUSSION

The results of variance analysis showed that the effect of various levels of salinity factor becomes meaningful on the shoot length in the probability level of 5% and on root length, wet Biomass of root and shoot, dry Biomass of root and shoot, the number of leaves and the number of lateral branches (Table 1).

**Table 1: The variance analysis of mean square of different levels of salinity and superabsorbent on Basil.**

| Alteration sources | Degree of freedom | Mean square | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Root Height | Shoot Height | Wet Biomass of Roots | Wet Biomass of Shoots. | Dry Biomass of Shoots. | Dry Biomass of Roots. | Number of Leaves | Number of Lateral Branches |
| **Replication** | 2 | $11^{*}$ | $37.23^{**}$ | $0.22^{ns}$ | $15.46^{ns}$ | $0.01^{ns}$ | $0.01^{ns}$ | $62.52^{**}$ | $0.083^{ns}$ |
| **superabsorbent** | 2 | $11.54^{*}$ | $76.39^{**}$ | $1.704^{*}$ | $227.4^{**}$ | $0.72^{*}$ | $0.72^{*}$ | $119.3^{**}$ | $0.583^{**}$ |
| **salinity** | 3 | $26.14^{**}$ | $52.19^{*}$ | $6.35^{**}$ | $156.4^{**}$ | $1.84^{**}$ | $1.84^{**}$ | $68.96^{**}$ | $0.694^{**}$ |
| **superabsorbent × salinity** | 6 | $2.263^{ns}$ | $0.768^{ns}$ | $0.151^{ns}$ | $23.03^{ns}$ | $0.076^{ns}$ | $0.076^{ns}$ | $2.10^{ns}$ | $0.139^{ns}$ |
| **Eror** | 22 | 2.236 | 4.804 | 0.488 | 10.52 | 0.20 | 0.20 | 5.194 | 0.114 |

*: Significant at %1 **: Significant at the 5% level. Ns: no significant

The results of variance analysis showed that the effect of various levels of superabsorbent on the root length and wet and dry Biomass of root becomes meaningful in probability level of 5% and in probability level of 1% on shoot height, wet biomass of shoot, dry biomass of shoot, the number of leaves and the number of branches. The interaction effect of salinity and superabsorbent materials doesn't become meaningful in any trait (Table 1) (Dareh Shouri, 2015).

*A. Wet Biomass of shoots*

**Various levels of superabsorbent materials.** The comparison of the mean effect of various levels of superabsorbent materials on wet Biomass of shoot showed that the wet biomass of shoot increased with the use of superabsorbent hydrogels. The mean wet biomass of control treatment was 16.67 gr that reached 24.53 gr by adding 10 gr superabsorbent materials. The treatments were placed in two different groups (Table 2). The superabsorbent materials cause better growth of shoots and increased biomass of the plant through water absorption and delivery to plant when needed. Allahdadi (2005) studied the effect of water superabsorbent values of type A200 on the growth and function of soya and reported that the highest function and soya function elements will be obtained by sufficient irrigation (6-day irrigation period) and the application of highest superabsorbent polymer value will be obtained as 225 kilogram in hectare.

**The effects of various levels of salinity.** The comparison of mean effect of various levels of salinity through Dunken test in probability level of 5% on wet Biomass of shoots showed that the treatments were located in two different groups. It is such that the highest wet Biomass of shoot was related to control treatment (0 mmol) with mean of 24.88 gr and minimum wet Biomass was related to treatment 200 mmol with mean of 15.01 gr (Table 3). Increased salinity leads to decreased wet Biomass. Increased salt causes lower growth of roots and smaller size leaves, shorter height and thus reduced biomass or wet Biomass.

**Table 2: Means comparison of Basil affected by superabsorbent.**

| Treatments | Mean square | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Root Height (Cm) | Shoot Height (Cm) | Wet Biomass of Roots (gr) | Wet Biomass of Shoots (gr) | Dry Biomass of Roots (gr) | Dry Biomass of Shoots (gr) | Number of Leaves | Number of Lateral Branches |
| **Superabsorbent** 0 | 7.43[b] | 22.5[b] | 2.58[a] | 16.67[b] | 1.20[a] | 2.79[b] | 14.17[b] | 3.75[a] |
| **Superabsorbent** 5gr | 7.75[b] | 24.02[b] | 2.75[a] | 17.37[b] | 1.37[a] | 2.99[b] | 14.42[b] | 3.83[a] |
| **Superabsorbent** 10 gr | 9.27[a] | 27.43[a] | 3.45[a] | 24.53[a] | 1.68[a] | 4.3[a] | 19.75[a] | 4.16[a] |

Means scores of each column with at least one shared letter, are not significantly different

**Table 3: Means comparison of Basil affected by salinity.**

| Treatments | Mean square | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Root Height (Cm) | Shoot Height (Cm) | Wet Biomass of Roots (gr) | Wet Biomass of Shoots (gr) | Dry Biomass of Roots (gr) | Dry Biomass of Shoots (gr) | Number of Leaves | Number of Lateral Branches |
| **Salinity** 0 | 10.27[a] | 27.91[a] | 4.12[a] | 24.88[a] | 1.97[a] | 4.6[a] | 19.56[a] | 4.22[a] |
| **Salinity** 100 mmol | 8.69[ab] | 24.86[ab] | 3.11[ab] | 20.28[ab] | 1.51[ab] | 3.43[ab] | 16.78[ab] | 4[ab] |
| **Salinity** 150 mmol | 7.27[b] | 23.47[b] | 2.72[b] | 17.92[b] | 1.30[ab] | 2.98[ab] | 15.11[b] | 3.88[ab] |
| **Salinity** 200 mmol | 6.37[b] | 22.35[b] | 2.12[b] | 15.01[b] | 0.88[b] | 2.43[b] | 13[b] | 3.55[b] |

Means scores of each column with at least one shared letter, are not significantly different

**Interaction effect of various salinity levels and superabsorbent materials.** The comparison of mean effect of interaction of various salinity levels and superabsorbent materials through Dunken test on wet Biomass of shoots showed that the least wet Biomass of shoot (13.43 gr) was related to H1S4 treatment (0 kg superabsorbent materials and 200 mmol salt) and the highest wet Biomass of shoot (33.70 gr) was related to H3S1 treatment (10 gr superabsorbent and 0 mmol salt). Increased rate of superabsorbent materials and decreased salt led to increased wet Biomass of shoots (Tables 4). Superabsorbent materials reduce the dryness tension due to salinity by saving water and lead to increase of the shoots length, grow of leaves and increase of plant biomass.

*B. Wet Biomass of Roots*

**Various levels of superabsorbent materials.** The comparison of the mean effect of various levels of superabsorbent materials on wet Biomass of Roots showed that the wet Biomass of Roots increased with the use of superabsorbent. The mean wet Biomass of control treatment was 2.56 gr that reached 3.45 gr by adding 10 gr superabsorbent. All treatments were placed in one groups (Table 2). Not observed significant effect in all treatments.

**The effects of various levels of salinity.** The comparison of mean effect of various levels of salinity through Duncan test in probability level of 5% on wet Biomass of Roots showed that the treatments were located in two different groups. It is such that the highest wet Biomass of Root was related to control treatment (0 mmol) with mean of 4.12 gr and minimum wet Biomass was related to treatment 200 mmol with mean of 2.12 gr (Table 3). Increased salinity leads to decreased wet Biomass. Increased salt causes lower growth of roots and smaller size leaves, shorter height and thus reduced biomass or wet Biomass. Qorbanly *et al* (2010) reported various levels of salinity led to significant effect on Dry and Wet Biomass of Shoot and Root and total biomass of Fennel flower

**Interaction effect of various salinity levels and superabsorbent materials.** The comparison of mean effect of interaction of various salinity levels and superabsorbent showed that the least wet Biomass of Root (1.83 gr) was observed in H1S4 treatment (0 kg superabsorbent materials and 200 mmol salt) and the highest wet Biomass of Roots (4.83 gr) was observed in H3S1 treatment (10 gr superabsorbent and 0 mmol salt). Increased rate of superabsorbent materials and decreased salt led to increased wet Biomass of Roots (Table 4). Superabsorbent materials reduce the dryness tension due to salinity by saving water and lead to increase of the roots length, grow of leaves and increase of plant biomass.

**Table 4: Means comparison of Basil affected by interaction of superabsorbent and salinity.**

| Treatments | | Mean square | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Root Height (Cm) | Shoot Height (Cm) | Wet Biomass of Roots (gr) | Wet Biomass of Shoots (gr) | Dry Biomass of Roots (gr) | Dry Biomass of Shoots (gr) | Number of Leaves | Number of Lateral Branches |
| **superabsorbent** 0 | **salinity**0 | 8.74$^{bcd}$ | 26.12$^{bcd}$ | 3.8$^{ab}$ | 21.73$^{bc}$ | 1.9$^{ab}$ | 3.73$^{bc}$ | 16.67$^{bc}$ | 4$^{b}$ |
| | **Salinity**100 mmol | 8.08$^{bcd}$ | 22.46$^{cdef}$ | 2.96$^{bcde}$ | 17.3$^{cd}$ | 1.43$^{bcd}$ | 3$^{bcd}$ | 14.33$^{cde}$ | 4$^{b}$ |
| | **Salinity**150 mmol | 6.87$^{d}$ | 21.16$^{ef}$ | 2.46$^{bcde}$ | 14.7$^{d}$ | 1.2b$^{cd}$ | 2.43$^{bc}$ | 13.67$^{cde}$ | 4$^{b}$ |
| | **Salinity**200 mmol | 6.04$^{d}$ | 20.25$^{f}$ | 1.83$^{e}$ | 13.43$^{d}$ | 0.96$^{cd}$ | 2.36$^{cd}$ | 12$^{de}$ | 3.2$^{c}$ |
| **superabsorbent** 5gr | **salinity**0 | 9.83$^{abc}$ | 26.58$^{bc}$ | 3.73$^{abc}$ | 19.13$^{cd}$ | 1.6$^{abcd}$ | 3.66$^{bc}$ | 18$^{bc}$ | 4$^{b}$ |
| | **Salinity**100 mmol | 7.47$^{cd}$ | 24.79$^{bcde}$ | 3$^{bcde}$ | 18.43$^{cd}$ | 1.36$^{bcd}$ | 3.13$^{bcd}$ | 15.33$^{cd}$ | 4$^{b}$ |
| | **Salinity**150 mmol | 7.18$^{cd}$ | 22.71$^{cdef}$ | 2.43$^{cde}$ | 17.20$^{cd}$ | 1.06$^{bcd}$ | 2.8$^{bcd}$ | 13.67$^{cde}$ | 3.6$^{bc}$ |
| | **Salinity**200 mmol | 6.54$^{d}$ | 22$^{def}$ | 2.2$^{de}$ | 14.20$^{d}$ | 0.76$^{d}$ | 2$^{d}$ | 10.67$^{e}$ | 3.3$^{c}$ |
| **superabsorbent** 10gr | **salinity**0 | 12.23$^{a}$ | 31.04$^{a}$ | 4.83$^{a}$ | 33.70$^{a}$ | 2.43$^{a}$ | 6.4$^{a}$ | 24$^{a}$ | 4.6$^{a}$ |
| | **Salinity**100 mmol | 10.54$^{ab}$ | 27.32$^{b}$ | 3.36$^{bcd}$ | 25.1$^{b}$ | 1.73$^{abc}$ | 4.16$^{b}$ | 20.67$^{ab}$ | 4$^{b}$ |
| | **Salinity**150 mmol | 7.73$^{bcd}$ | 26.55$^{bc}$ | 3.26$^{bcd}$ | 22.37$^{bc}$ | 1.63$^{abcd}$ | 3.73$^{bc}$ | 18$^{bc}$ | 4$^{b}$ |
| | **Salinity**200 mmol | 6.54$^{d}$ | 24.79$^{bcd}$ | 2.33$^{de}$ | 16.90$^{cd}$ | 0.93$^{cd}$ | 2.93$^{bcd}$ | 16.32$^{c}$ | 4$^{b}$ |

Means scores of each column with at least one shared letter, are not significantly different

*C. Dry Biomass of shoots*

**The effect of various levels of superabsorbent materials.** The comparison of the mean effects of various levels of superabsorbent materials on dry Biomass of shoots showed that the use of superabsorbent hydrogels leads to increase of the dry Biomass of shoots. The mean Dry Biomass of shoot in control treatment was 2.79 gr that by adding 10 gr superabsorbent materials, it reached 4.30 gr. The treatments were placed in two various groups (Table 2). The superabsorbent materials lead to better growth of shoots and increased biomass and dry Biomass in the plant by absorbing water and its delivery to the plant when needed. In a test by Szmidt and Grahom (2002) on the tomato, cucumber and lettuce in library using hydrogel and very salty water, the results indicated increased production in function elements and dry Biomass.

**The effect of various salinity levels.** The comparison of the effect of various salinity levels through Dunken test in probability level of 5% on dry Biomass of shoot showed that treatments were placed in two different groups such that the highest dry Biomass of shoot is related to control treatment (0 mmol) with mean of 4.60 gr and the lowest dry Biomass of shoot is related to 200 mmol treatment with mean of 2.43 gr (Table 3). The increased salinity led to decreased dry Biomass of shoot. With the increase of salt rate, the roots grew less, the size of leaves decreased, the height of plant shortened and thus the dry Biomass of plant decreased.

**The Interaction effect of various levels of salinity and superabsorbent materials.** The results of average data comparing with Duncan's test showed had significant effect between interaction of various levels of salinity and superabsorbent and dry Biomass of shoot highest Biomass of dry shoot (6.40 gr) belonged to treatment H3S1 treatment (10 gr superabsorbent and 0 mmol salts) and lowest dry Biomass of shoot (2 gr) belonged to treatment H1S4 treatment (0 kg superabsorbent materials and 200 mmol salts) (table 2). The increase of the rate of superabsorbent materials and decrease of salt rate led to increased dry Biomass of shoot (table 4). Superabsorbent materials decrease the tension due to salinity by storage of water and lead to increased shoot, growing of leaves and increased plant biomass.

*D. Dry Biomass of Roots*

**The effect of various levels of superabsorbent materials.** The comparison of the mean effects of various levels of superabsorbent materials on dry Biomass of Roots showed that the use of superabsorbent hydrogels leads to increase of the dry Biomass of Roots. The mean Dry Biomass of Roots in control treatment was 1.2 gr that by adding 10 gr superabsorbent materials, it reached 1.68 gr. All treatments were placed in one group (Table 2). Not observed significant effect in all treatments.

**The effect of various salinity levels.** The results of average data comparing with Duncan's test showed had significant effect between various salinity levels and dry Biomass of root on 5%. Treatments were placed in two different groups. Highest Biomass of dry root (1.97 gr) belonged to treatment control treatment (0 mmol) and lowest dry Biomass of root (0.88 gr) belonged to treatment 200 mmol (Table 3). The increased salinity led to decreased dry Biomass of Root. With the increase of salt rate, the roots grew less, the size of leaves decreased, the height of plant shortened and thus the dry Biomass of plant decreased.

**The Interaction effect of various levels of salinity and superabsorbent materials**. Interaction of various levels of salinity and superabsorbent had showed highest Biomass of dry Root (2.43 gr) belonged to treatment H3S1 treatment (10 gr superabsorbent and 0 mmol salts) and lowest dry Biomass of Root (0.76 gr) belonged to treatment H1S4 treatment (0 kg superabsorbent materials and 200 mmol salts) (Table 4). The increase of the rate of superabsorbent materials and decrease of salt rate led to increased dry Biomass of Root (Table 4). Superabsorbent materials decrease the tension due to salinity by storage of water and lead to increased shoot, growing of leaves and increased plant biomass.

*E. Root Height*

**The effect of various levels of superabsorbent materials.** The results of average data comparing with Duncan's test showed the use of superabsorbent hydrogels leads to increase of the Root height (Table2).

The effect of various salinity levels. The results of average data comparing with Duncan's test showed had significant effect between various salinity levels and root height on 5%. Treatments were placed in two different groups. Maximum root height (10.27 Cm) belonged to treatment control treatment (0 mmol) and minimum root height (6.37Cm) belonged to treatment 200 mmol (Table 3). The increased salinity led to decreased root height. With the increase of salt rate, the roots grew less, the size of leaves decreased, the height of plant shortened.

**The Interaction effect of various levels of salinity and superabsorbent materials.** Interaction of various levels of salinity and superabsorbent showed maximum root height (12.23 Cm) belonged to treatment H3S1 treatment (10 gr superabsorbent and 0 mmol salts) and minimum root height (6.04 cm) belonged to treatment H1S4 treatment (0 kg superabsorbent materials and 200 mmol salts) (Table 2). The increase of the rate of superabsorbent materials and decrease of salt rate led to increased root height (Table 4).

*F. Shoot Height*

*The effect of various levels of superabsorbent materials.* The comparison of the mean effects of various levels of superabsorbent materials on Shoot height showed that the use of superabsorbent hydrogels leads to increase of the Shoot height. The mean Shoot height in control treatment was 22.5 Cm that by adding 10 gr superabsorbent materials, it reached 27.43 cm. The treatments were placed in two various groups (Table 2). The superabsorbent materials lead to better growth of shoots and increased Shoot height in the plant by absorbing water and its delivery to the plant when needed.

**The effect of various salinity levels.** The results of average data comparing with Duncan's test showed had significant effect between various salinity levels and Shoot height on 5%. Treatments were placed in two different groups. Maximum Shoot height (27.91 Cm) belonged to treatment control treatment (0 mmol) and minimum Shoot height (22.5 Cm) belonged to treatment 200 mmol (Table 3). The increased salinity led to decreased Shoot height. With the increase of salt rate, the Shoots grew less, the size of leaves decreased, the height of plant shortened. Study of (Safar Nejad and Hamidi, 2005) showed that various levels of salinity led to decreased Shoot height and root height of plants.

**The Interaction effect of various levels of salinity and superabsorbent materials.** Interaction of various levels of salinity and superabsorbent showed maximum Shoot height (31.04 cm) belonged to treatment H3S1 treatment (10 gr superabsorbent and 0 mmol salts) and minimum Shoot height (20.25 cm) belonged to treatment H1S4 treatment (0 kg superabsorbent materials and 200 mmol salts) (Table 4). The increase of the rate of superabsorbent materials and decrease of salt rate led to increased Shoot height (Table 4).

*G. Lateral branches*

**The effect of various levels of superabsorbent materials.** The comparison of the mean effects of various levels of superabsorbent materials on lateral branches showed that the use of superabsorbent hydrogels leads to increase of the lateral branches. The mean lateral branches in control treatment was 3.83 that by adding 10 gr superabsorbent materials, it reached 4.16. All treatments were placed in one groups (Table 2). The superabsorbent materials lead to better growth of shoots and increased lateral branches in the plant by absorbing water and its delivery to the plant when needed.

**The effect of various salinity levels.** The results of average data comparing with Duncan's test showed had significant effect between various salinity levels and lateral branches on 5%. Treatments were placed in two different groups. Maximum lateral branches (4.22) belonged to treatment control treatment (0 mmol) and minimum lateral branches (3.55) belonged to treatment 200 mmol (Table 3). The increased salinity led to decreased lateral branches.

**The Interaction effect of various levels of salinity and superabsorbent materials.** Interaction of various levels of salinity and superabsorbent showed maximum lateral branches (4.6) belonged to treatment H3S1 treatment (10 gr superabsorbent and 0 mmol salts) and minimum lateral branches (3.2 cm) belonged to treatment H1S4 treatment (0 kg superabsorbent materials and 200 mmol salts) (Table 4). The increase of the rate of superabsorbent materials and decrease of salt rate led to increased lateral branches (Table 4).

*H. The number of leaves*

**The effect of various levels of superabsorbent materials.** The comparison of the mean effects of various levels of superabsorbent materials on number of leaves showed that the use of superabsorbent hydrogels leads to increase of the number of leaves. The mean number of leaves in control treatment was 14.17 that by adding 10 gr superabsorbent materials, it reached 19.75 (Table 2). Treatments were placed in two different groups.

**The effect of various levels of salinity.** The results of average data comparing with Duncan's test showed had significant effect between various salinity levels and the number of leaves on 5%. Treatments were placed in two different groups. Maximum number of leaves (19.56) belonged to treatment control treatment (0 mmol) and minimum number of leaves (13) belonged to treatment 200 mmol (Table 3). The increased salinity led to decreased number of leaves.

**The interaction effect of various levels of salinity and superabsorbent materials.** Interaction of various levels of salinity and superabsorbent showed maximum number of leaves (24) belonged to treatment H3S1 treatment (10 gr superabsorbent and 0 mmol salts) and minimum number of leaves (12) belonged to treatment H1S4 treatment (0 kg superabsorbent materials and 200 mmol salts) (Table 4). The increase of the rate of superabsorbent materials and decrease of salt rate led to increased number of leaves (Table 4). Superabsorbent materials decrease the tension due to salinity by storage of water and lead to increased shoot, growing of leaves and increased number of leaves. Increase of superabsorbent materials led to ascending trend in the height of plant, the number and surface of leaves, the number of branches, relative rate of water in leave and the height of corymb; however, decreased aggregation of proline and dissolved sugars. The results showed that superabsorbent polymer is able to control the water relation between soil and plant and decrease the dry tension.

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