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ORIGINAL ARTICLE

Effect of Magnetized and Saline Water on the Biomass yield of Stevia (*Stevia rebaudiana* Bertoni.)

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ABSTRACT
This experiment was lay out in order to evaluate the effect of magnetic saline water on growth of Stevia (stevia rebaudiana Bertoni.) in a factorial design based of RCBD with 8 replications in pots. Treatments included four saline levels (0, 2, 4 and 6 ds.m-2) and three magnetic densities (0, 3000 and 6000 Gauss) and the treatments were applied after the establishment of plantlets in the pots. Plant height, number of main and sub branches, main and sub branches diameter, chlorophyll content, leaf area index, length and width of leaves, fresh and dry weight of leaves and plant performance parameters measured in this experiment. Based on the results, the effect of salinity on all morphological characters accept the number of main and sub branches were significant at 1% probability. The effect of magnetic saline water was significant on the fresh and dry weight of leaves. Plant height, fresh and dry weight of the plants was significantly influenced by the interaction effect of salinity and magnetic density. The lowest plant height was recorded in the pots in which treated with magnetized water of 6000 Gauss. The findings obtained in this important field, LAI in control plant was more than stress treated plants in terms that effect of changes in intensity of magnetic saline water was not significant on it. The findings of present study not obtained that magnetic increase ability of plant or consume of saline water. The findings showed that Stevia is sensitive to saline water and pre-treatment of it with magnetic saline water was not useful for increasing of yield.
***Key words**: Salinity, Magnetic water, stevia, Morphological characters*

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INTRODUCTION

Plants that are the basis of life on earth are influenced by environmental stresses. A wide range of world affected by salinity and each year added to this amount [28]. After drought stress, salt is the main environmental stresses that affect plants and greatly reduces the growth and development of salt-sensitive plants [21 and 28]. Furthermore, notion that solve of grow plants problems by irrigation management is impossible, but by using of magnetic water can be not only reduced the effect of salinity, but also has positive effects on morphological characters [21]. By note to crucial role of leaves on growth of plant, this important organ from different aspects such as area, weight, chlorophyll and nitrogen were studied. Salinity stress reduced leaf area due to reducing of plant growth [46 and 47]. Leaf size depends on the number of cells (cell division) and size of the leaf cells. The early stages of the shoot formation and the leaves is under control of cell division and is relatively insensitive to drought and salinity, but develop of leaf area is sensitive to drought and salinity [29 and 30]. In salinity condition inflammation in the leaf cells decreased thus may affect the development of leaf and shoot growth [44]. Plants needs to absorb of nutrients from soil for achieve to ideal growing in photosynthetic process. But plants not use much food in the soil. Normal water solves low amounts of nutrients for irrigation, resulting reduced availability of nutrients for plants. When the plant irrigated with hard non-magnetic water, white and hard layer of calcium bicarbonate and carbonates formed on the surface of and just some of the calcium bicarbonates washing by and penetrate in the soil, and then meeting on root plants. As a result, the plant is need produce more roots and spent of extra energy. Because of the increased of water molecules per unit due to be magnetic, increased it solubility and result to increase of water ability to absorb captions and anions has cell division accelerate [3]. The change in charged water molecules (cations and anions) result to of form smaller molecules of water, increasing of number of water molecules per volume unit, reducing the surface tension of water, increase of water solubility and reduce the degree of water hardness [16]. Also, the pass of water through a magnetic field, thereby reducing the surface tension and viscosity [36 and 39] and increasing of heat water evaporates as well as result of the rapid evaporation of water [19]. [31] reported that the use of magnetic water can lead to an increase in water productivity in plants. The increase in number of fruits of strawberries and tomatoes under magnetic water were reported by [13].

Stevia (*Stevia rebaudiana* Bertoni) plant known as honey leaf plant is perennial, medicinal plant from *Asteracea* family [22; 25 and 42]. Extracted sugar of is 300-200 times sweeter than sucrose. Stevia leaves are empty of saccharin and aspartame and calories [9 and 35]. Studies show that Stevia is salt-sensitive plants. Therefore, this study was laid out in order to determine the strength of Stevia tolerance to magnetic field and salinity on increasing of WUE saline water in Stevia.

MATERIAL AND METHODS

This experiment was laid out in order to evaluate the effect of saline and magnetic water on yield and morphological traits of Stevia (*Stevia rebaudiana* Bertoni). The experiment was laid out a factorial based on randomized complete block design with eight replicates in horticulture faculty of Gorgan Agricultural and Natural Resources University, Iran, at 2014. Treatments were different saline levels (0, 2, 4, and 6 $ds.m^{-1}$) and three magnetic water such as (0, 3000, and 6000 Gauss) that treated after establishment of plants in plots. In order to provide of experimental plants, cuttings in late spring separate from native plants that grown in farm production and after post-rooted of them it and in disinfected with fungicides in mist system, after that transferred to pots. Any time irrigation, about 200 ml of water with determined salt and magnetic transferred to all pots. After 70 days of rooted cuttings transfer, traits such as plant height, number of main and sub stem, main and sub stem diameter, chlorophyll content, leaf length and width, leaf area index, wet and dry yield were measurement.

RESULTS AND DISCUSSION

The results showed that the effect of saline treatment on all traits was significant at 1% excepting number and diameter of main stem (table 1). Also, water magnetic had significant effect on productive yield. Analysis of variance showed that although interaction effect of salt and magnetic water was not significant on number and size of main and sub branches and chlorophyll concentration but, but the changes in productive was yield significant. Table 1. Analysis of variance of Stevia traits under salinity stress and magnetic water The salinity water reduced plant height (Fig1), number of branches per plant (Fig 2), chlorophyll content (Fig4), leaf area (Fig5), length and wide of leaf (Fig6). In saline water treatment maximum of all trait was founded at control treatment. Minimum of traits was recorded at 6 ds.m-2 salinity treatment. Increasing of treatment levels laid to decrease of morphological traits. Also all salinity treatments were not significant on number and diameter of main branches. Saline treated plants to a concentration of 6 ds.m-2 lost their ability to produce of branches. In some characteristics such as diameter, branch, chlorophyll, leaf length and width between the control and treatment of saline water significant difference was observed. It is obvious that with increasing salinity of irrigated water, reduced crop yield. Application of magnetic water had a significant effect on fresh weight of plants so that maximum fresh and dry weight recorded at 3000 Guess and minimum of that was founded at control treatment (Fig7). Also magnetic water treatment had not significant effect on other traits. Based on observations, irrigation with magnetic water improved plant yield due to simplest insert of water molecules to plant tissues. However, irrigation with magnetic water had positive effect on fresh and dry weight. Kaya et al, [26] reported that, increasing of saline stress decreased seedling length and weight of sunflower. Also Jamil *et al* [24] reported that increasing of salinity stress result to decrease of seedling length and dry weight in sugar beet and cabbage. Severe saline stress result to significant decrease of number of leaf, leaf area, Dry and fresh weight of leaves [6]. Also in a research on rice Gholizadeh *et al* [20] founded that increasing of salinity laid to decreasing of shoot length shoot weight and chlorophyll content. Increasing of salinity laid to decrease of plant height, leaf area, stem diameter and shoot dry weight [11].

Table 1. Analysis of variance of Stevia traits under salinity stress and magnetic water

S.O.V	df	Plant height	Number of main branches	Number of sub branches	Stem diameter	Sub stem diameter	Leaf length	Leaf wide	Fresh weight	chlorophyll	LAI
Salinity(s)	3	2799.79**	0.36^{ns}	2175.35**	4.42^{ns}	4.58**	341.40**	36.58**	323.21**	9066.51**	527.23**
Magnetic water(m)	2	34.04^{ns}	0.04^{ns}	31.95^{ns}	13.08^{ns}	0.01^{ns}	2.56^{ns}	0.18^{ns}	5.11**	18.46^{ns}	6.63^{ns}
S*m	6	122.82**	0.11^{ns}	33.80^{ns}	12.61^{ns}	0.04^{ns}	4.58*	0.43^{ns}	4.77**	22.31^{ns}	9.70*
Error	24	41.2	0.35	28.2	13.24	0.17	2.1	0.28	0	27.08	3.91
CV(%)		11.82	2.21	15.9	13.17	1.6	5	2.02	0	11.85	6.6

**,* significant at 1% and 5% levels

In a research on *Aeluropus logopoides* and *Aeluropus litttoralis,* severe salinity levels decreased leaf area and leaf weight of them [1]. Increasing of salinity on Ronass leaf laid to increasing of chlorophyll content as SPAD because of increasing of leaf thickness in high saline levels. Other researchers reported increasing of chlorophyll content with increasing of leaf thickness in high saline levels [34]. Decrease of chlorophyll content in highest saline levels related to chlorophyll injury and blocked of them. Researches on other plants had to same result [34 and 12]. Chlorophyll content of leaves had positive correlation with plant metabolism, Rubisco activity, and amount of leaves nitrogen [43; 4; 15, 28 and 46]. The high concentration of minerals, due to effect of ions on the protein that they weakened the connection between chlorophyll and chloroplast proteins and chlorophyll to be destroyed. With increasing of saline levels number of branches per plant was decreased in Ronass [1]. Many researchers reported that number of branches per plant was decreased in saline stress treatment. Maas *et al* [32] in wheat reported that decreasing of branches per plant under salinity stress laid to decreasing of plant yield. Some reports revealed that salinity laid to decreasing of all morphological traits such as leaf area, and plant dry weight in *Foeniculim vulgare* (41), rice [38], *Trachyspermum ammi* [5] and Cumin [45]. In other research Khorsandi *et al* [27] reported that saline stress had significant effect on traits of *Agastache foeniculum.* They reported that increasing of salinity levels, laid to plant height, number and length of branches, node distances, number and area of leaves, dry and fresh leaf weights. Besant and Maheswari [33] reported that positive effect of magnetic water is related to biochemical changes and their effect on plant calls.

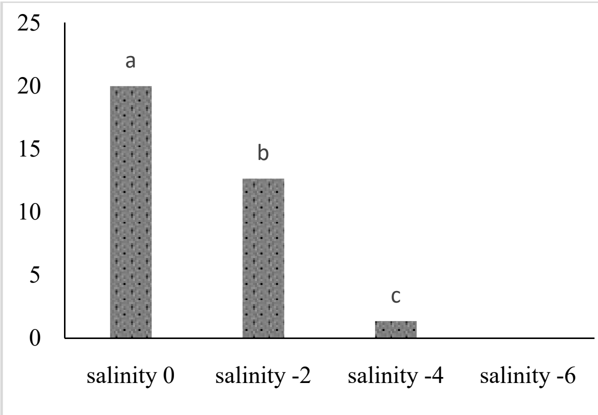

Figure1. Effect of salinity on plant height

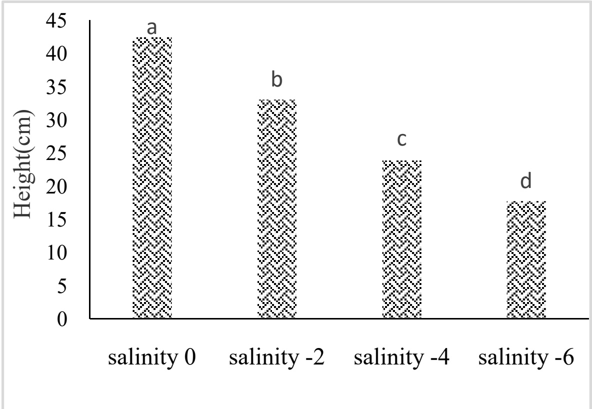

Figure2. Effect of salinity on number of branches per plant

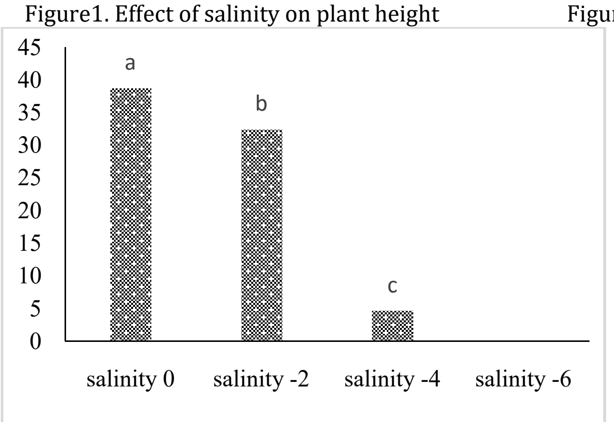

Figure3. Effect of salinity on stem diameter

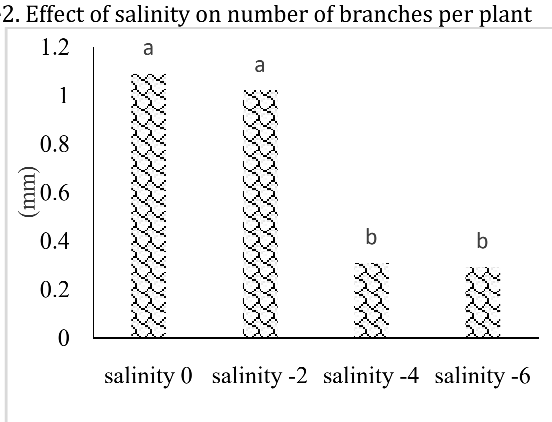

Figure4. Effect of salinity on chlorophyll content

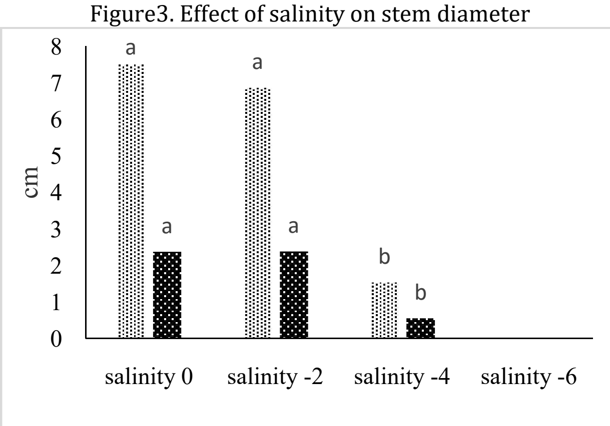

Figure5. Effect of salinity on stem diameter leaf area index

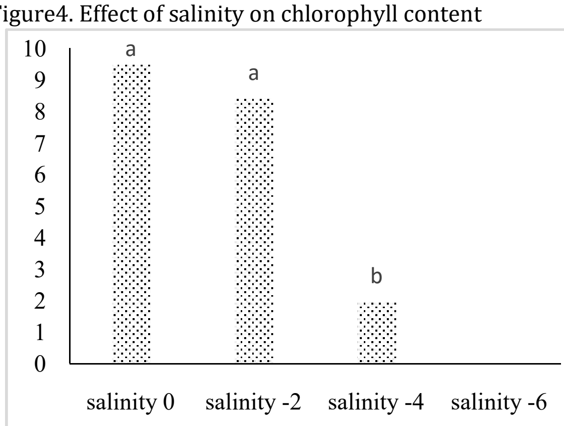

Figure6. Effect of salinity on leaf length(white) and wide(black)

Interaction effect of salinity and magnetic water on yield components was significant (fig11). Maximum yield was recorded at magnetic water treatment in low salinity treatment. Maximum fresh and dry yield related to non-application of saline in 3000 Gauss magnetic water treatment. It seems that in some traits magnetic water decreased destructive effects of salinity until 2 ds.m-1.

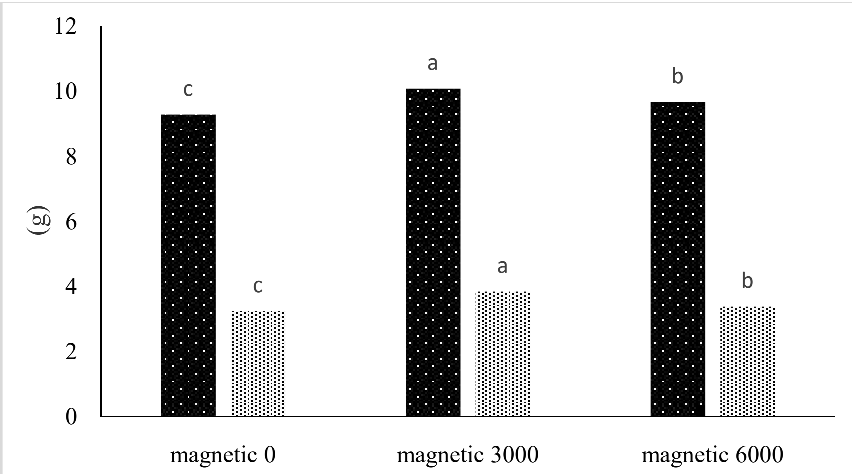

Figure7. Effect of magnetic water on fresh (black) and dry (white) biomass

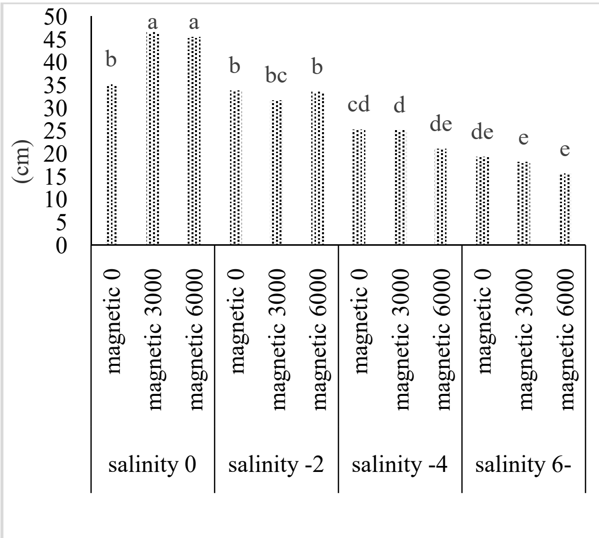

Figure8. Interaction effect of salinity and magnetic water on plant height

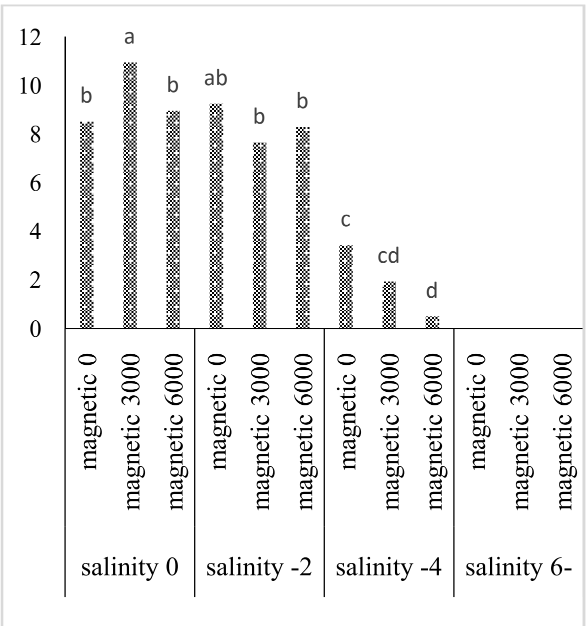

Figure9. Interaction effect of salinity and magnetic water on leaf area index

Interaction effect of treatment had not significant deference on some traits in 2 ds.m-1. Because it would be likely to offset the burden of nutrient cations by the magnetic water and remain in the soil solution, resulting in faster absorption by the plant. Due to the above factors, we can conclude that magnetic water has been able to partially reduce the effects of saline stress in the Stevia plant. The study of saline water with a salinity of 3000 mg per liter under magnetic field 5.3-136mTesla increased celery crop production and productivity in the 12 to 23 percent and water efficiency 12 to 24 percent [33]. Fluz *et al* [17] and Racuciu *et al* [37] founded that total fresh stem weight in maize increased under irrigation with magnetic water. Racuciu *et al* [37] reported that weak magnetic field had a stimulating effect on increasing of fresh weight, photosynthetic pigments, nucleic acid and seedling length. Higher amounts (100-200 mTesla) had inhibitory effect on all traits. It was reported that the magnetic water had significant effect on the metabolism of cells, particularly meristematic cells of some plants such as peas, lentils and flax [8]. Sadeghi *et al* [40] reported that, due to magnetism of distilled water, groundwater and seawater with magnetic intensities 400, 500 and 600 gauss, the maximum fresh weight in wheat was recorded at 400 Gauss magnets were treatment. In most cases the water treatment with 3000 Gauss field was effective in most cases. Reduction of leaf area due to saline stress was reported in many studies [1, 46, 47]. In saline condition in leaves ABA was increased and laid to closed of stomata and reduced water loss and leaf growth Galand *et al* [19] reported that Davis, a leaf rust and control the spread of abscisic acid (ABA) and has reported that the increased concentration of acid in normal conditions and laboratory reduce the leaf length. The main reason of growth decreasing under salinity condition is decrease of leaf area [46 and 47]. Saline medium have a lot of harmful ions that disrupt the metabolism of other nutrients. For example competition of Na+ with K+ and CL with NO-3 laid to interfere with the absorption of nutrients. The parameters involved in tolerance to salinity, maintaining and regulating intracellular osmotic swelling due to the absorption of salt (salt ions) and the organic material. Plants spend a lot of energy to produce organic matter that for osmotic adjustment, the growth of plant tissues reduced.

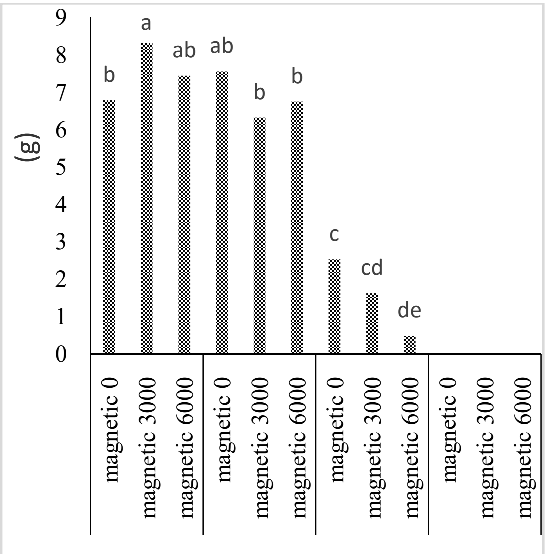

Figure10. Interaction effect of salinity and magnetic water on leaf length

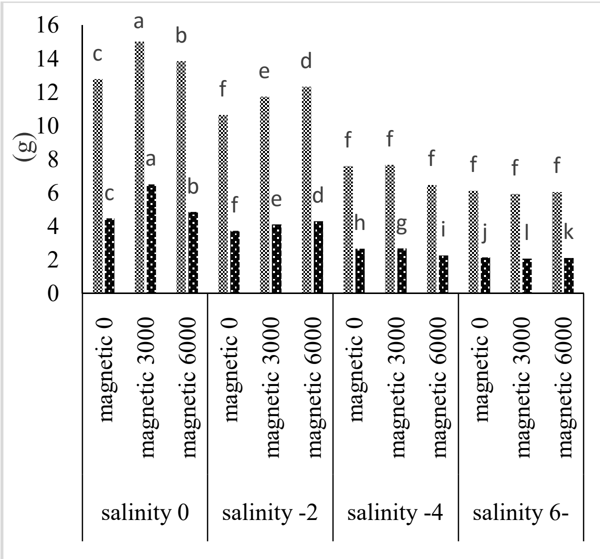

Figure10. Interaction effect of salinity and magnetic water on fresh (white) and dry (black) biomass

CONCLUSION

In Stevia saline water had deleterious effect on growth and final yield. So we conclude that magnetic water reduced saline effects on this plant. Applying a magnetic water reduced effect of harmful minerals in the water that As a result of that is becoming crystal ionic to molecular crystals. These molecules joined together to create the snow phenomenon that are floating in the water so that not do other deposits only but also removes coarse grains is possible with relatively simple filters. This will reduce the surface tension, resulting in the release of water and increased water solubility. In result irrigation with saline water reduced yield and growth of Stevia but magnetic water reduced effect of salinity. Results showed that Stevia is sensitive to salinity so that salinity mare that 2 ds.m-1 laid to inhibit of growth and magnetic water not useful in this treatment.

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