Effects of Irrigation Water Quality on the Yield and Yield Components of Cotton

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Abstract: To study the effect of irrigation on yield and yield components of cotton, an experiment was conducted in the form of randomized complete block design with 3 replications in the Delgosha research field of Ferdows. During this experiment, the effects of four water treatments - including brine water with the salinity of EC=6.8 ds/m, tap water EC=0.7ds /m, magnetic salt water and saline water in a land where Potassium-based super-absorbent was added – on the yield and yield components of cotton was evaluated. Finally, the results were analyzed with the SAS software according to Duncan's multiple range tests.During this experiment, it was determined that these four irrigation water quality had a significant effect on the yield and yield components of cotton, cotton fiber production, fiber weight and the weight of a thousand cottonseeds, biological yield per hectare, the shading surface, boll number per plant and boll number per hectare. However, it had a negative effect on the cotton fiber harvest per hectare index and the grain harvest per hectare. Also, correlation coefficients analysis indicated a negative correlation between the last two factors and other measured factors. Stem diameter and the number offside branches also showed significant differences between treatments. Furthermore, despite observing the 12-day watering circuit, the total volume of water in the super absorbent treatment and magnetic water treatment were half and three fourth the other two treatments, respectively. Overall, it can concluded that using modifications such as magnetizing the water or using super absorbent polymers, we can decrease adverse effects caused by saline and low quality water on cotton and achieve the possibility of using saline water in dry areas while maintaining the desired performance besides increasing the cultivation area.

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1. Introduction

The cotton crop is called the white gold due to its economic and commercial value all over the world (Shahbazipour, Shahbazi, 1996). In fact, it can be claimed that all people in the world use it in everyday routines (Vaghefi. Marashi. 1974). what places cotton alongside other invaluable plants are the various functions of its different components in different industries which sometimes make its application even inevitable. In Iran too, based on available evidence this plant has been cultivated since the era of the Achaemenids is one of the main crops of Iran (Hashemi Toroghi, 2010).

Unfortunately in recent years due to numerous problems, cotton cultivation declined sharply which has led to irreparable damages to the body of the Iranian economy. One of these major problems was reduction in precipitation and frequent droughts followed by a severe shortage of water resources needed for cultivation. Currently, freshwater, as an economic good, plays a major role in agricultural and industrial production as well as in drinking and health needs globally. Substantial investments have been made in the agricultural sector of Iran as the focus of development in the country such that all the potential of recoverable resources enters the production cycle. In this context, the effective management of water use supply and demand to increase productivity and available resources will be pivotal (Ebrahimi, 2008).

The other point is the continuous need of plants to growth factors such as water. In time of tension, even if it does not lead to plant death it will certainly reduce product performance. Cotton is a plant that always requires adequate moisture and is therefore sensitive to irrigation quality and quantity. Thus the distribution of water and the duration of irrigation vary in regards to soil type, growth stage and heat intensity of (Rastgar, 2005). On the other hand, with the proper management of irrigation water we can increase the cultivation area and help the country become self-sufficient in this regard. Magnetic water technology is a subject that has attracted the attention of experts in the water and agricultural sector in recent years.

One of the important advantages of the use of magnetic water in agriculture is the modification of soil with minimum use of chemicals and acids. Therefore, it seems that the use of magnetic water in arid regions, saline and alkaline soils and areas that are temporary faced with drought and water scarcity crisis, can be effective due to increased irrigation and leaching efficiency followed by lower expenditure

Also, using materials and methods for water storage in the root zone is certainly useful and worthy of consideration. If moisture tension occurs at the boll formation stage, the yield considerably reduces.

Agricultural super absorbents with easy application and affordable price act as a food source besides collecting and storing water in the consumption area by absorbing nutrient elements. Further, their application leads to positive changes in the soil texture and does not leave negative effects on the environment on the other hand. Limitation in cultivation due to the current water crisis, especially the drought in recent year, makes the use of super absorbents inevitable (Bordbar. 2010). Haynes & Naidu in 1998 declared that Hydrogel can help keep macro and micro elements and nutrients (fertilizer) in the soil besides increasing water storage capacity.

Ngobeni conducted an experiment in 2007 in Africa to evaluate the effect of super absorbent polymers on cotton cultivation. Ngobeni concluded that the use of these polymers increases the absorption of nutrients and thereby increase the cotton yield. Maheshwari et al (2009) in their study concluded that the yield of peas and celeries increases in salinity conditions using magnetic water while the soil PH is also corrected. However, it increased soil EC and phosphorus in the long term. Hozayni et al (2007) showed that magnetic water causes changes in some chemical structures of the plant including different types of chlorophyll and arytenoids, pigments, indoles, phenols and vegetable protein. Further, it also increases the seeds, straw and biological yield.

Materials and Methods:

The current experiment was conducted in South Khorasan province, the town of Ferdows and in the Delgosha research field. The geographical coordinates are utm: X=608306.Y=3768366. The experiment was conducted in the form of a randomized complete block designwith3replications. The water treatments consisted of four treatments as follows: Saline water with EC = 6800, magneticwaterusingamagnetizer installed on the water pipe, tap water with EC = 700-1000), and the salty and super absorbent water of Aquasorb 200A.

Plot sizes were 10square meters (2×5) spaced 60 cm apart with a replication distance of 2 meters from each other. There was a total of 12 plotsinthe experiment. In the winter2011, earthembankmentwas carried out with homogeneous embankment and the farm was completely flooded such that the soil subsides adequately. Then, a winter plowing was conducted and the field was abandoned until May2012. Then, in the third week of May, the field was plowed in two stages using a tiller. Finally, the field was leveled and classified into plots. Then, 400 grams of Biosol Forte fertilizer was added to every ten meter plot. Also 300grams of super absorbent was spray unevenly to the plots included in the super absorbent treatment. Again, the plots were plowed using a tiller, leveled using a rake. Seeding was carried out on June 2, 2012. The first irrigation was conducted on the same date.

The cultivated variety of cotton was the local variety of Ferdows. Cultivation was performed in five rows of cm in each plot with a distance of 40 cm from the border of plot. The seeds were mixed with sand and sown into the plots more than needed. After twigging, the plants were thinned to achieve the desired density (row spacing of 40 cm, 60 plants per plot). To facilitate irrigation, a piping system was installed with three 63 mm taps were for each replication, the first with freshwater, the second with salty water and the third with magnetic water.

The rate of each valve was adjusted on 1 liter per second so we can calculate the volume of water used for each treatment during the study period. The phonological stages of cotton were recorded by daily visits to the farm and the harvesting was carried out at the beginning of the harvest season from different plots separately (in two stages due to the gradual opening of bolls). In the study period, at the8-leaf stage, 100grams of topdressing fertilizer was added to each plot. Also before the flowering of treatments, foliar fertilizing was conducted using the special Trio fertilizer 15-5-35 with a concentration of 0.003 with a motorized backpack sprayer of 100 liters.

In order to measure the yield components, we used a 50 cm metal ruler and a 0.1 g or 0.01 g digital scale. The cotton fiber collected from cotton bolls of each plant was weighted separately for each boll, then for each plant based on the plot number. Then, the fibers were separated from the seeds by hand. Again, the fibers and the seeds were weighted by a 0.01 g digital scale and the weights were recorded. (To delete the marginal effect, plants in two rows on either side of the margin were not picked and only the three middle rows were picked).

Regarding the congestion of the plan – that is, 60 plants per 10 square meters – we calculated the number of plants per hectare and generalized the resulting yield to units of one hectare. By recording the details and cotton growth stages completely at the end of the period, cotton yield components including plant length, plant dry and wet weights, cotton fiber weight, the number of seeds, etc. were evaluated at different intervention conditions and with different irrigation qualities to analyze the effects of irrigation water quality.

Results and Discussion

The results of data variance analysis showed that irrigation water quality has a significant impact on many morphological and yield traits of cotton.

1 –The number of branches per plant: the type of water has a high impact on the number of branches per plant such that brine water had the lowest and magnetic water had the highest number per plant. Since young plants are exposed to greater losses, because their roots are in the upper layers of the soil that contain higher concentrations of salt, severe salt tension has led to stunted growth and shorter internodes. In the reconditions, crown growth stops and the leaves become smaller, cells are destroyed and signs of necrosis appear on the roots, buds, leaf margins and tips of stems (Kamkar, 2008). The high number of lateral branches in the magnetic water treatment could be due to the greater availability of nutrients as a result of better solubility in the soil that leads to a higher growth possibility for plants.

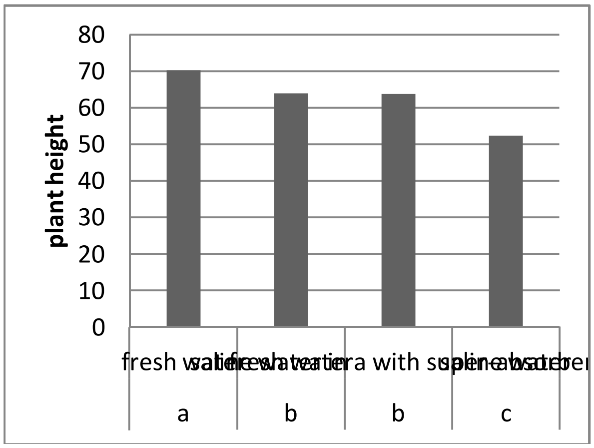

Figure 1.1-The effect of water on the number of lateral branches per plant

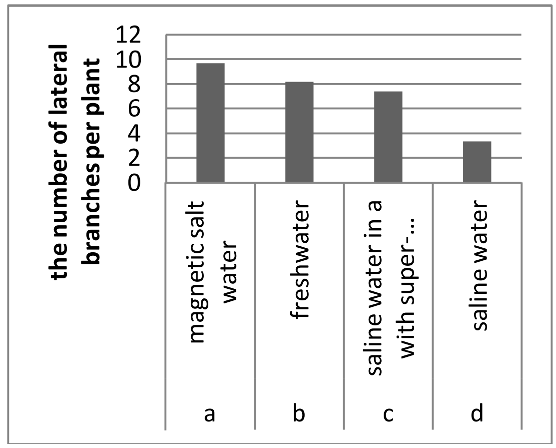

Figure1-2-The effect of water on plant height

2 - Plant height: Both freshwater and super absorbent water had the same effect on plant height. Magnetic water accounted for the longest plants whereas magnetic water and brine treatment accounted for the shortest. Since the height is influenced by inter node distance and since the latter factor is also affected by the moisture regime, height changes were also less affected by intervention in the super absorbent treatment where moisture tensions were the least. Ghorbanli et al (2010) also reported that salinity tension causes a statistically significant difference – that is, decrease - in the shoot height, wet and dry weights of the shoot, wet and dry weights of the root, the total biomass and the number of nodes in Nigella Sativa. Usually with the increase of plant height, the number of nodes also increases. But the correlation is not 100 percent. Internodes distance is affected by the irrigation system. This difference of height in the magnetic water treatment can result from the dissolution of more nutrients in the soil, easier access to them by the roots and consequently faster and better growth of the plants. The root is the first organ that is directly confronted with tension because it uptakes. According, to experiments conducted on soybean, salinity reduces hoot height due to the ionic toxicity of harmful elements and disruption in all the biological activities of the plant and plant metabolism, which will lead to shoot and root weight reduction due to the loss of ionic and osmotic balance. (Dadraset al., 2012)

3 –dry weight of the each cotton plant: the salinity of the water has a significantly negative impact on the dry weight of a single cotton plant such that it has the lowest weight in the brine treatment, the highest weight in the super absorbent treatment and a middle weight between the freshwater and super absorbent treatments in the magnetic water treatment. This may be due to a greater root volume in the super absorbent treatment followed by high nutrient uptake factors in this treatment.

Also, because Potassium is involved in the production of plant dry matter as a very important element and since reduced potassium concentrations in plant tissues is one of the first reactions of plants to salinity tension (Khatun and Flowers, 1995), the use of potassium-based super absorbents can reduce the effects of salinity and better abortion of this element. The results of a study by Kafi et al. (2012) and also of another study by Marschner (1995) affirmed plant dry weight reduction in salinity conditions caused by reduction in vegetative growth and reduced photosynthetic surface. Shoot dry weight decreases by both reduction in the amount of vegetative growth and reduced photosynthetic surface (Dadraset al, 2012).Reduction in vegetative growth and dry weight due to the swelling of the cells under salinity conditions is caused by osmotic processes (Etesami and Galeshi, 2008).

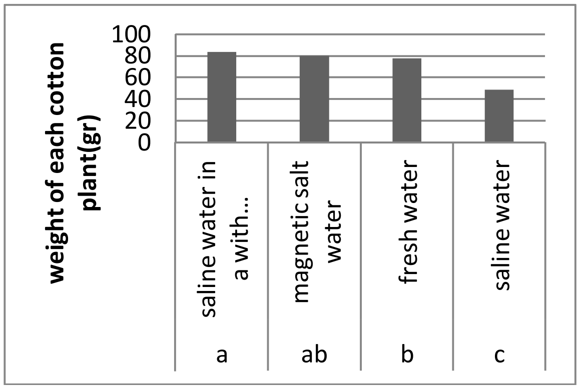

Figure1.3-The effect of water on the dry weight of each boll

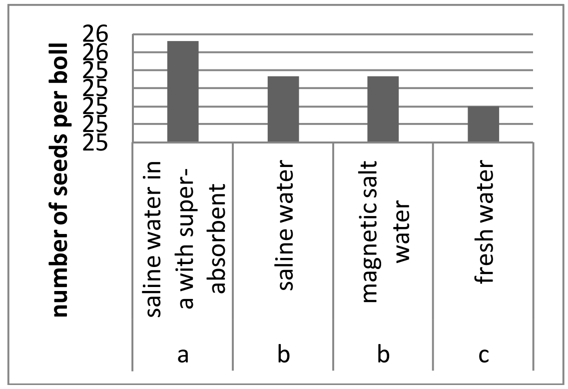

Figure 1-4-The effect of water type on seed number per cotton plant

4- Number of seeds per boll: The number of seeds per boll under super absorbent irrigation was considerably significantly higher than the other treatments. Among the most significant factors in plant responses to environmental tension is the reduction of photosynthesis caused by impaired activity in photo system II (Andrews et al., 1995). Under such conditions, due to a reduction in the production and storage of electron transport products – that is, ATP and NADPH -in light-dependent photosynthetic reactions, the quantum yield of photo system II (ΦPSII) drops. On the other side, the descent of provoked electron energy increases from the non-photochemical path and thereby impairs the function of photo system II. Followed by these changes, the number of produced seeds reduces dramatically (Blum, 1988).

5 - Cotton fiber yield per hectare: All fertile branches are originated from vegetative leaf axes and the extent of fertile branch formation depends on vegetative growth. Regarding the correlation between the number of fertile branches and the yield, the treatments that include a large number of fertile branches feature a high yield too. Also in other experiments, cotton fiber yield using irrigation water with the salinity of 6.3 and 10.2dS/m during the cultivation season had a decrease of 33% and 66%, respectively, compared with irrigation water with the salinity of 2.9 dS/m. One of the effects of salinity is reduced photosynthetic activity in the plant which reduces the amount of chlorophyll as well as reduced co2 absorption and photosynthetic capacity (Rezaee, 2004). Taherian et al (2006) achieved similar results concerning reduced cotton yield under the salinity tension treatment. In the super absorbent treatment, the flowers have better growth conditions because they have opened earlier, hence increased fiber weight.

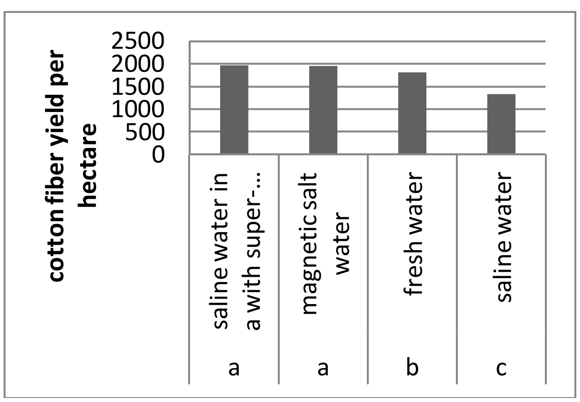

Figure1-5-The effect of water on cotton fiber yield per hectare

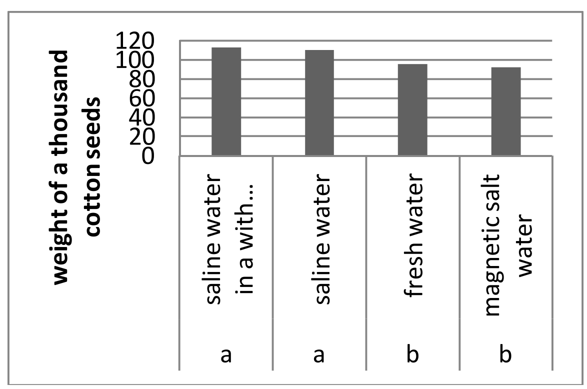

Figure1-6 -The effect of water on the weight of a thousand cotton seeds

6 –The weight of a thousand cottonseeds: the weight of a thousand cottonseeds is shown to be identical in the brine and super absorbent treatments as well as in the other two treatments. In other words, the treatments had no effect on the weight of a thousand cottonseeds two by two, which can be

caused by stronger roots in the super absorbent treatment for better nutrient uptake and its allocation for producing carbon hydrates and ultimately contributing to weight gain in the seed. In the brine treatment, it appears that under tension the plant spends its maximal power to produce more seeds to ensure regeneration since the seeds are the main factor for survival. In other words, the lower number of water resources in the brine treatment leads to greater use of resources and consequently heavier seed production.

7 - Biological yield: The effect of water on the biological yield suggests that the highest performance belongs to the superabsorbent treatment and the lowest performance belongs to the brine treatment. The cotton plant requires large amounts of potassium for growing and developing cotton fiber. Sensitivity to the availability of potassium is relatively higher in cotton than in other plants (William & Pettigrew, 2008). If the plant is exposed to salt for a long period, it also experiences ionic tension which leads to the premature aging of mature leaves. So, it reduces the photosynthetic surface that supports growth. Many important physiological and morphological processes such as leaf growth, photosynthesis, and development of stomata are directly affected by the swelling pressure of leaves (Jones & Turner, 1978). There are numerous reports associated with a relative decrease in leaf water content caused by salinity tension (Jones and Turner, 1978; Munns and Tester, 2008). Further, as a result of salinity tension, secondary tensions such as oxidative stress can also occur. In such condition, the production and accumulation of active radicals leads to the oxidation of proteins and lipids resulting in cell death (Molassiotis et al, 2006,).A buildup of hydrogen peroxide and lipid peroxidation caused by salinity reduce membrane stability in plants (Farooq and Azam, 2006). Calcium and potassium are important macronutrients in controlling different types of environmental tension particularly salinity due to their special functions. Calcium plays a pivotal role in plants from small amounts in the regulation of cell metabolism to high amounts in the creation of cell wall. Many roles are (Akinci and Simsek, 2004). However, in terms of environmental tension particularly salinity, in addition to conflicts between calcium and other minerals (such as sodium), the function of this element in the vital activities of plants finds a special role in tension tolerance. In addition to reduced photosynthesis, reduced growth as a result of salinity in plants that cannot grow in saline conditions may be because of the speeding of respiration and light absorption which in turn leads to a faster consumption of photosynthetic elements otherwise used for growth (Gersani et al., 1993). Plants under tension use less radiant energy for photosynthesis. Some part of the additional energy is drained by chlorophyll fluorescence such that to minimize damage to the photosynthetic system, especially photosystem II (PSII) and electron carrier compositions (Maslenkova, et al., 1993).

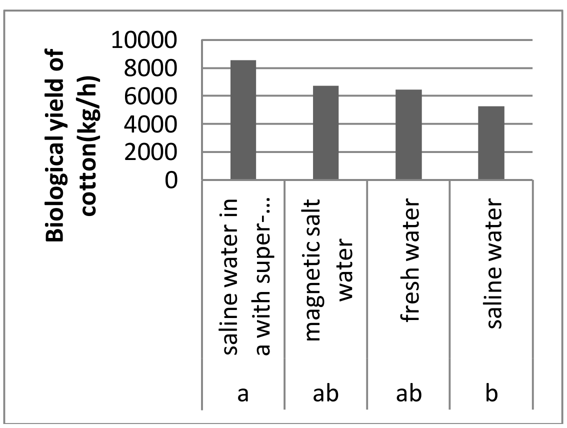

Figure1-7-The effect of water on the Biological yield of cotton

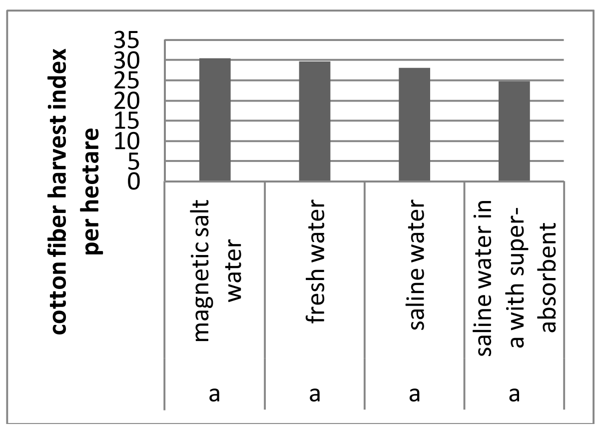

Figure1-8-The effect of water on cotton fiber harvest index per hectare

8 - Cotton fiber harvest index per hectare: the cotton fiber harvest index per hectare does not change significantly under different irrigation water treatments although minor differences can be observed. The cotton fiber harvest index is obtained by dividing the cotton fiber yield per hectare by the biological yield. Therefore, any factor that increases the numerator or decreases the denominator can reduce this index. Any increase in the factors associated with vegetative growth such as leaf number, leaf surface, the number of lateral branches and the extent of root expansion can increase the

biological yield. In the freshwater, super absorbent and magnetic water treatments, vegetative factors increase these factors and consequently lead to the increase of the biological yield and the decrease of the cotton fiber harvest index per hectare. The increase of other factors such as seed weight, fiber weight and cotton fiber weight in the boll will also reduce this index. As already mentioned, despite the reduction of vegetative factors in the brine treatment, more photosynthetic elements are allocated to reproductive factors, particularly the seeds. Despite the decrease of the denominator, cotton fiber harvest index per hectare increased in this treatment because the numerator remained constant or changed little. The same condition applies tothe seed harvest index per hectare

Conclusion:

Overall, based on the survey results, we can conclude that:

1 - Regarding the severe constraints of suitable water resources for cultivation in Iran and the necessity of cultivating crops, the proper management of saline water resources can lead to a significant performance besides saving water. As it can be seen in the results, the super absorbent and magnetic water treatments can easily compete with the freshwater treatment. In other words, drawing on one of these two methods, we can achieve a performance close to that of freshwater irrigation.

2- Using magnetic or super absorbent water can prevent soil degradation in farms where saline water is used for irrigation. Test results on the soil before and after the experiment confirm this point.

3- Using magnetic or super absorbent water can save a considerable amount of water. This is particularly visible in the super absorbent treatment.

4 - Using magnetic water not only prevents the formation of a salt layer on the soil surface and the resulting soil degradation, it also can dissolve more salts and carbonates in the soil and facilitate their uptake by the plant. As a result, it reduces fertilizer use, increases the performance elements such as calcium, and helps the plant grow better. This is particularly visible in the magnetic water treatment where the diameter of cotton increased considerably.

References:

1. ebrahimi.Nasseryan the street. In 1382. Comparison of tissue culture and whole plant response to salinity stress in soybean. Proceedings of the Third National Conference on Biotechnology. Ferdowsi University. Mashhad Vol. Pp. 60-58
2. Etesami, M.. Slippers, SA. The. In 1387. Evaluation of ten barley genotypes in response to salinity at germination and seedling growth. Journal of Agricultural Sciences and Natural Resources. Gorgan. Volume 15. Issue 5
3. tolerant. R.. Village. M.. C. Moafpuryan. Conv. R.. Effect of irrigation levels on yield and yield components of sunflower polymer, super absorbent 200. Master's Thesis. Faculty of Agriculture. University arsanjan..
4. Akinci. I.E., Simsek M, 2004, Ameliorative effects of potassium and calcium on the salinity stress in embryo culture of cucumber (*Cucumis sativus* L.). J. Biol. Sci. 4, 361-365.
5. A magistrate. Evangelical h. Q Ketabchi. In 1391. Effects caused by sodium chloride salinity on growth and biological nitrogen fixation in soybean cultivars. Journal of Soil Science (soil and water). Volume 26. No. 2. Pp. 174-165.
6. rastegar. M.. AS. In 1384. Agriculture, industrial plants. Printing. Brhmnd publications. Tehran
7. Rezaei. M.. AS., 1385. Effect of soil salinity on peroxidase activity in two varieties of natural cotton. Journal of Sciences, Islamic Azad University. Science and Research Branch. Tehran. No. 62 /
8. - M. Shahbazi. Researcher friend 0.1375 g. Effects of sodium chloride on growth and accumulation of organic and inorganic compounds in wheat. Journal of Agricultural Science. Volume 27. No. 4. Pp. 78-70.
9. Ghorbanli CE. F. Adib Hashemi. The linkage of 0.1389. Effect of salinity and ascorbic acid on some physiological responses in plant seeds. Journal - Medicinal and Aromatic Plants Research of Iran. Volume 26. No. 3. Pp. 388-370.
10. kafi.. nabati. Mehrjardi the farmer. The pot. Q Khani race. Of Kashmir. AS Noroozian. In 1391. Improve ROE Effects of calcium and potassium on the physiological characteristics Coscia (Kochia scoparia) under salt stress. Journal of environmental stresses in agricultural sciences. Volume V, Issue II, part II ¬ 91. Pp. 192-181.
11. Hashemi toragi. AS. Mobini khorsand. AS. The. Afkhami Lotfabadi. SA. In 1389. Farming cotton. Khorasan Agricultural Extension Coordination Team. Mashhad.
12. Farooq S, Azam F, 2006, The use of cell membrane stability (CMS) technique to screen for salt tolerant wheat varieties. J. Plant Physiol. 163, 629-637.
13. Gersani M, Graham E.A, Nobel P.S, 1993, Growth responses of individual roots of *Opuntia ficus-indica* to salinity. Plant Cell Environ. 16, 827–834.

14. Hozayn M, Amany A, Monem A, Abdol Qados A, 2011, Irrigation with magnetized water, a novel tool for improving crop production in egypt, fifteen international Water Technology Conference, IWTC- 15 2011, Alexandria Egypt.
15. Kafi M, Asadi H, Ganjeali A, 2010, Possible utilization of high salinity waters and application of low amounts of water for production of the halophyte *Kochia scoparia* as alternative fodder in saline agroecosystems. Agric. Water Manage. 97, 139-147.
16. Khatun S, Flowers T.J, 1995, Effects of salinity on seed set in rice. Plant Cell Environ. 18: 61–67.
17. Maslenkova L.T, Zanev Y, Popova L.P, 1993,Adaptation to salinity as monitored by PSII oxygen evolving reactions in barley thylakoids. J. Plant Physiol. 142, 629–634.
18. Molassiotis A, Sotiropoulos T, Tanou G, Diamantidis G, Therios I, 2006, Boron-induced oxidative damage and antioxidant and nucleolytic responses in shoot tips culture of the apple rootstock EM9 (*Malus domestica* Borkh). Environ. Exp. Bot. 56, 54–62.
19. Munns R, Tester M, 2008, Mechanisms of salinity tolerance. Annu. Rev. Plant Biol. 59, 651-681.
20. Munns R, 2002, Comparative physiology of salt and water stress. Plant, Cell and Environment, 25: 239-250.

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