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RESEARCH ARTICLE

Magnetized water improved germination, growth and tolerance to salinity of cereal crops

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Abstract

Water scarcity is a major limitation for increased agricultural production and food security for world population. Under these conditions using low quality water for irrigation is mandatory in the present and near future. This necessitates looking for an approach to overcome this problem. Among approaches used to develop methods for cultivation in low quality water and adverse conditions is magnetic field stimulation. This approach is proven to be harmless, healthy and eco-friendly. Therefore, magnetic treatment of marginal quality irrigation water was used in this study to examine its impact on improving germination and early seedling growth in absence and presence of salinized water. Two cereal crops were used: *Triticum aestivum* L. (cv. Suds 1) and *Hordeum vulgare* L. (cv. Gustoe). The caryopses of both crops were germinated in Petri dishes containing non-magnetized (non-saline and saline) and magnetized water (non-saline and saline) for 12 d. After 12 day of germination, the length of radical and plumule was measured. Each treatment was replicated 4 times, and each replication consists of 24 caryopses. NaCl stress reduced the germination and early seedling growth (length of radical and plumule) of both crops. Magnetized water mitigated the injurious effect of NaCl and enhanced the length of the plumule and radical in presence and absence of salt stress. It can be concluded that irrigating cereal crops with magnetized water can improve germination and early seedling growth under saline conditions.

Introduction

Increasing world population is facing a critical problem of depleted water resources, which is combined with increasing food demands to cover the human needs all over the world. Therefore, water scarcity is increasingly accepted as a major limitation for increased agricultural production and food security for world population in this century. As good quality water is scare, water of marginal quality has to be considered for use in agriculture. Based on the previous background, it is a must to look for cheap, healthy and ecologically save approaches to improve the properties of soil and water quality, which in turn enhances plant growth and productivity. One of these approaches that improve higher productivity and quality assurance is using static electromagnetic fields. The use of magnetically treated water for irrigation in agriculture takes an important place in the list of environmentally clean methods (Bugatin et al. 1999, Sala 1999).The water treated by the magnetic field or pass through a magnetic device called magnetized water. The influence of magnetic field on various growth processes of plants such as seed germination, seedling growth, plant growth, yield and the properties of crop quality have been the object of several researches (Gholami and Sharafi 2010, Rochalska et al. 2011, Grewal and Maheshwari 2011, Koizumi and Kano 2014).

Salinity is defined as the presence of excessive concentration of soluble salts in the soil or in the irrigation water that suppresses plant growth and eventually yield. Salt stress has been identified as one of the most serious environmental factors limiting the productivity of crop plants. The deleterious effects of salinity on plant growth are associated with 1) low osmotic potential, 2) nutritional imbalance, 3) specific ion effect, or 4) a combination of these factors (Munns and Tester 2008, Mansour 2013). In addition, there is evidence that salt stress can induce oxidative stress due to generation of reactive oxygen species (Gill and Tuteja 2010).The study was therefore undertaken to evaluate the use of magnetically treated water in improving caryopsis germination and early seedling growth (i.e., radical and plumule growth) of two cereal crops in presence and absence of salt stress. The work was carried out at germination stage because germination is known as a key process that allows seed embryo to grow and evolve into photosynthetic organism (Sanchez-Linares et al. 2012), and it is also a critical stage for plant response to salinity.

Material and methods

Magnetic treatment device, supplied by Magnetic Technologies L.L.C., model A 100, Russia, with 6 m^3/ h water flow, was used for magnetic treatment of tap water. Magnetized water was prepared by passing the tape water through a magnetic field using the magnetic device. Saline irrigation water was prepared by adding sodium chloride to tap water (100 mM).The saline magnetic water was prepared by passing saline water into the magnetic device using two funnels. Two cereal crops were used to study the effect of magnetism and salinity of irrigation water. Caryopses of *Triticum aestivum* L. (cv. Suds 1) and *Hordeum vulgare* L. (cv. Gustoe) of uniform size and shape without defects and malformation were selected. The caryopses were soaked in tap water or magnetically treated water for 24 h; water of both treatments was renewed every 4 h. The caryopses soaked in tape water were further divided into two groups: one group was irrigated with tap water alone and the other group was watered with tap water containing 100 mM NaCl. The caryopses soaked in magnetic water were also divided into two groups: one group was germinated in magnetic water alone and the other group was germinated in saline magnetic water. The caryopses of the different treatments were germinated on filter paper in Petri dishes (12 caryopses per dish) in the presence of 10 mL of the respective treatment. The filter paper of each dish was changed and new 10 mL of the respective treatment was added daily. A caryopsis was considered germinated when the radical emerged 2 mm from the caryopsis coat. The experiment was carried out in darkness with maximum and minimum temperatures of 31±2^{o}C and 24±2^{o}C, respectively. All treatments were replicated 4 times and each replication contained 24 caryopses. The physiological method to define caryopsis productivity was through measuring the length of the radical and plumule after 12 d of salt treatment.

Statistics. The results were analyzed by ANOVA using the commercial program STATISTICA.

Results and discussion

Table1 presents the detailed statistical analysis of the experimental treatments. The data clearly indicates a significant impact of magnetism, salinity and the interaction

Table 1: Statistical analysis of the experimental treatments

Effect	F	P
Intercept	590.0595	0.000000**
Water treatment (Tap & Magnetized)	49.4611	0.000000**
Salinity treatment (non-saline & saline)	294.6746	0.000000**
plant type (wheat & barley)	22.4098	0.000004**
Water treatment (Tap & Magnetized)*Salinity treatment (non-saline & saline)	4.1080	0.029821*
Water treatment (Tap & Magnetized)*plant type (wheat & barley)	4.6241	0.020514*
Salinity treatment (non-saline & saline)*plant type (wheat & barley)	33.2782	0.000000**
Water treatment (Tap & Magnetized)*Salinity treatment (non-saline & saline)*plant type (wheat & barley)	2.1351	0.141074

(i.e. between magnetism and salinity, between magnetism and plant type and between plant type and salinity) on the development of seed germination. Only triple interaction (magnetism, salinity and plant type) showed insignificant effect.Figures 1-10 illustrated effective hypothesis decomposition (i.e. vertical bars denote 0.95 confidence intervals). Only significant treatments and interactions are presented.

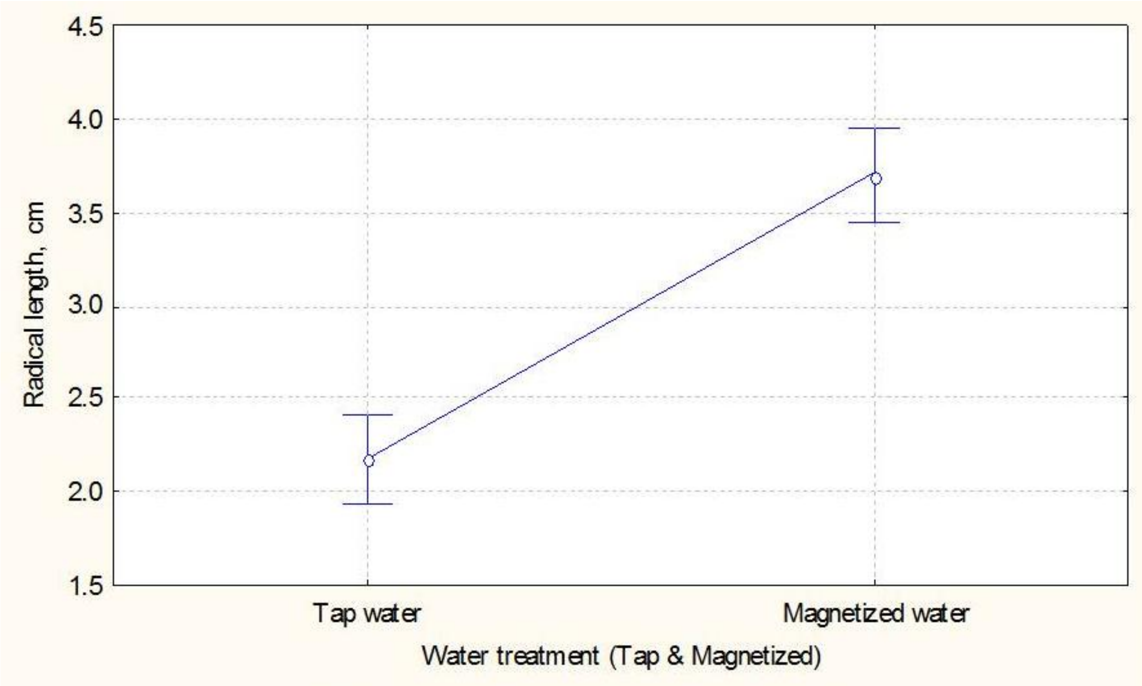

Fig. 1: Effect of Water treatment (Tap &Magnetized) on radical length

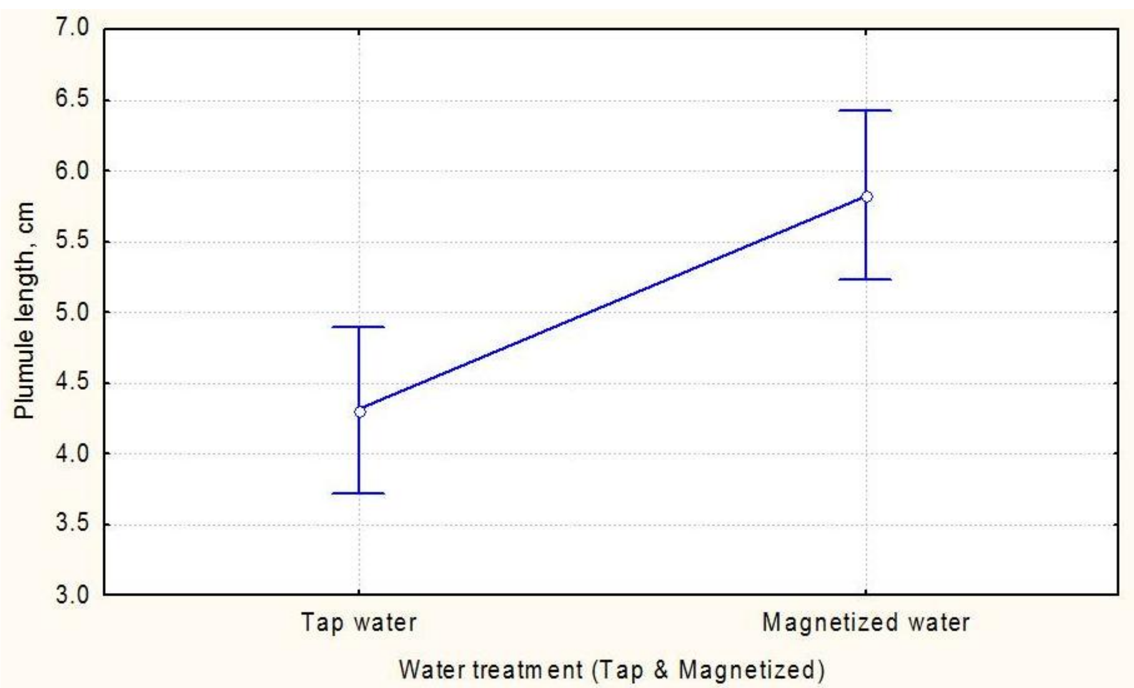

Fig. 2: Effect of Water treatment (Tap & Magnetized) on pulmule length

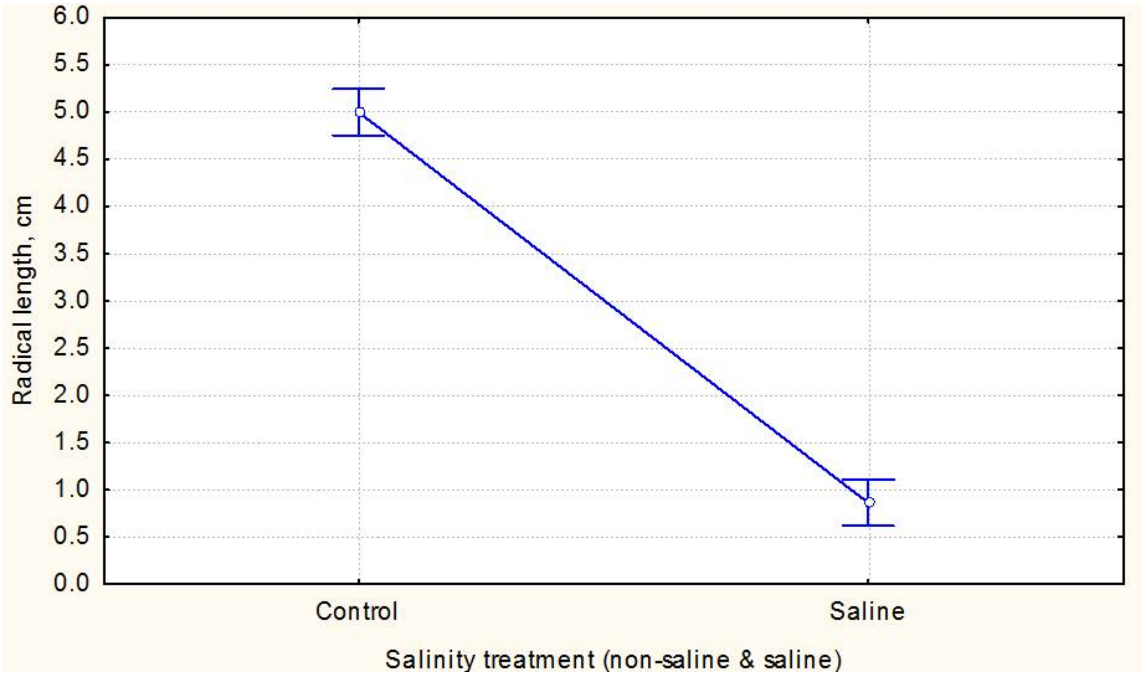

Fig. 3: Effect of salinity treatment (non-saline&saline) on radical length

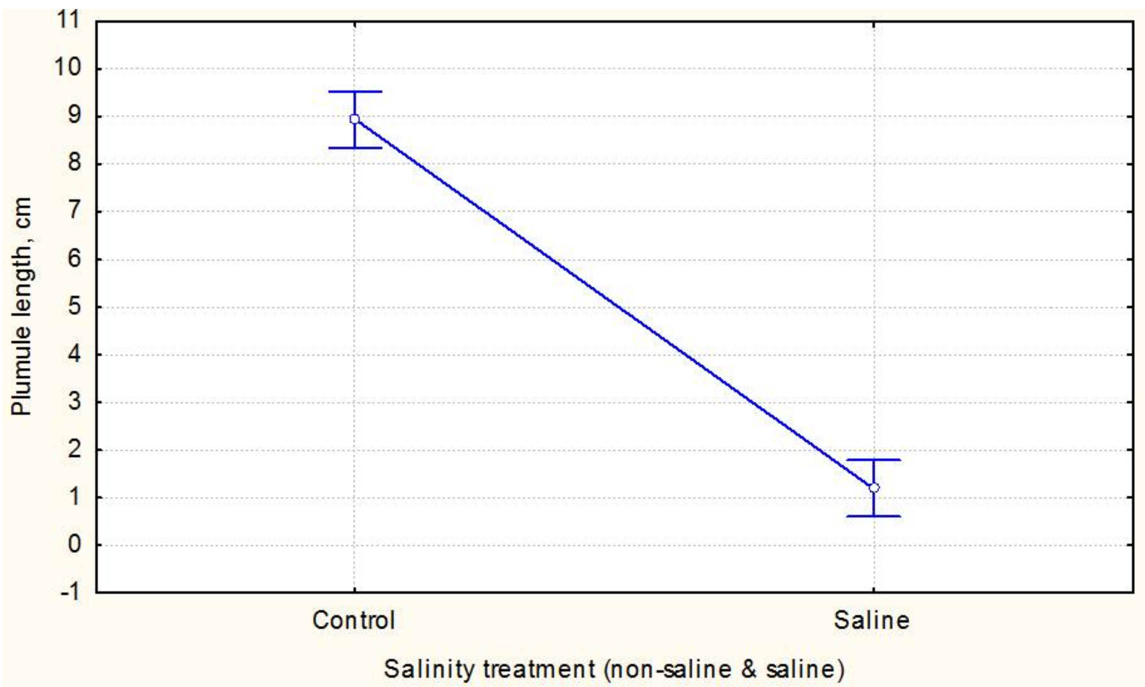

Fig. 4: Effect of salinity treatment (non-saline&saline) on plumule length

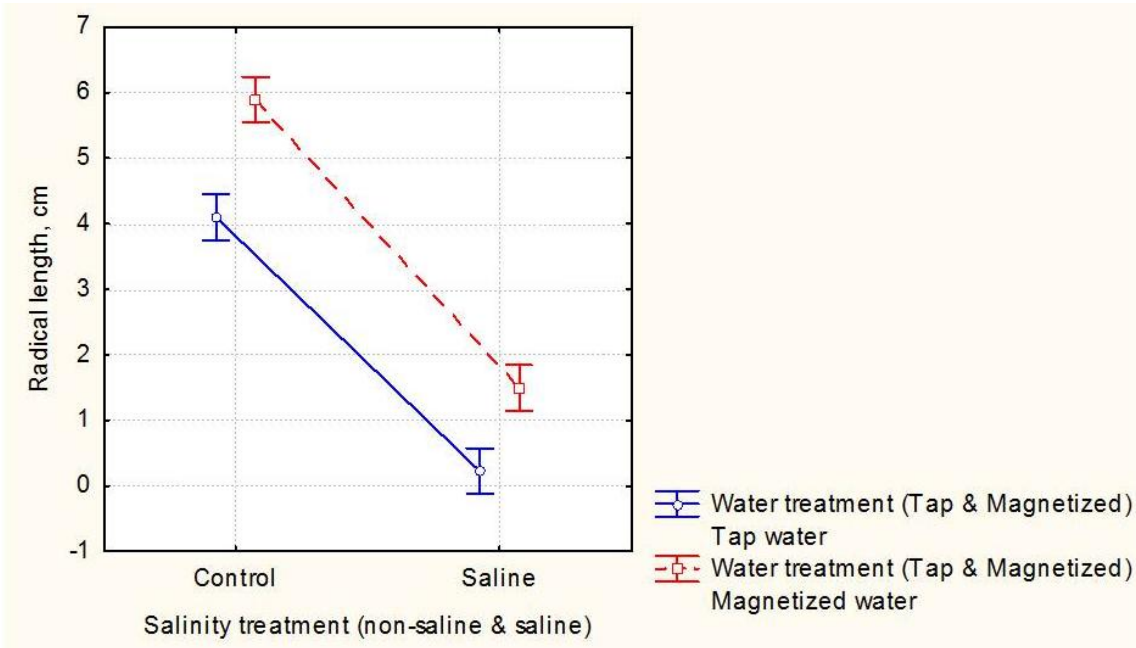

Fig. 5: Effect of interaction between water and salinity treatments on radical length

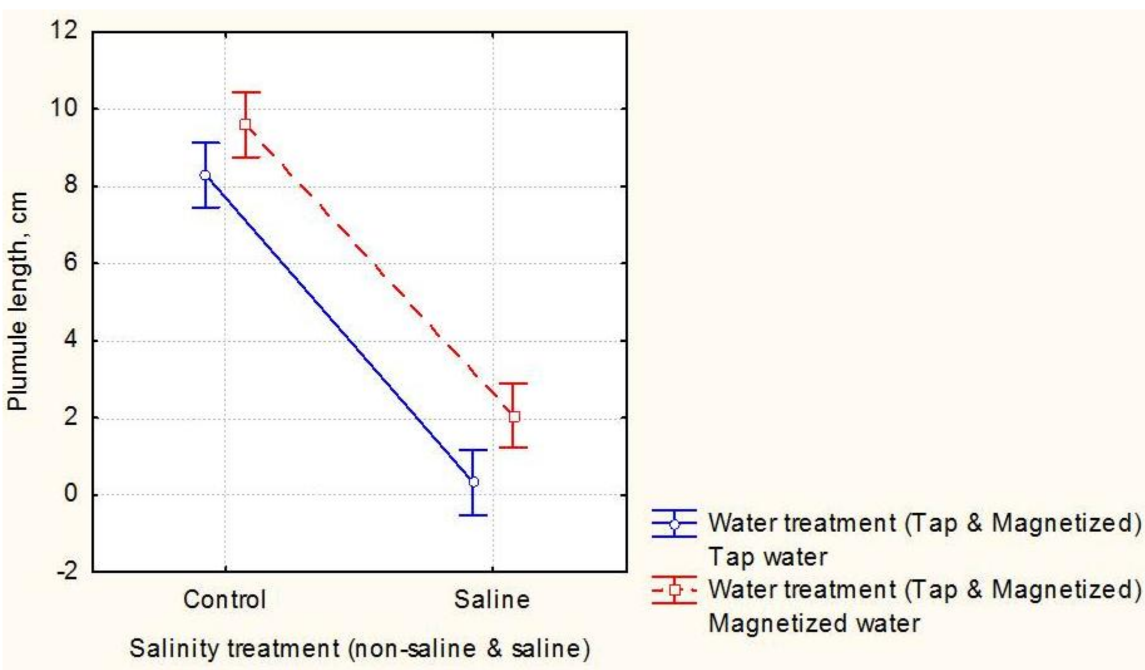

Fig. 6: Effect of interaction between water and salinity treatments on plumule length

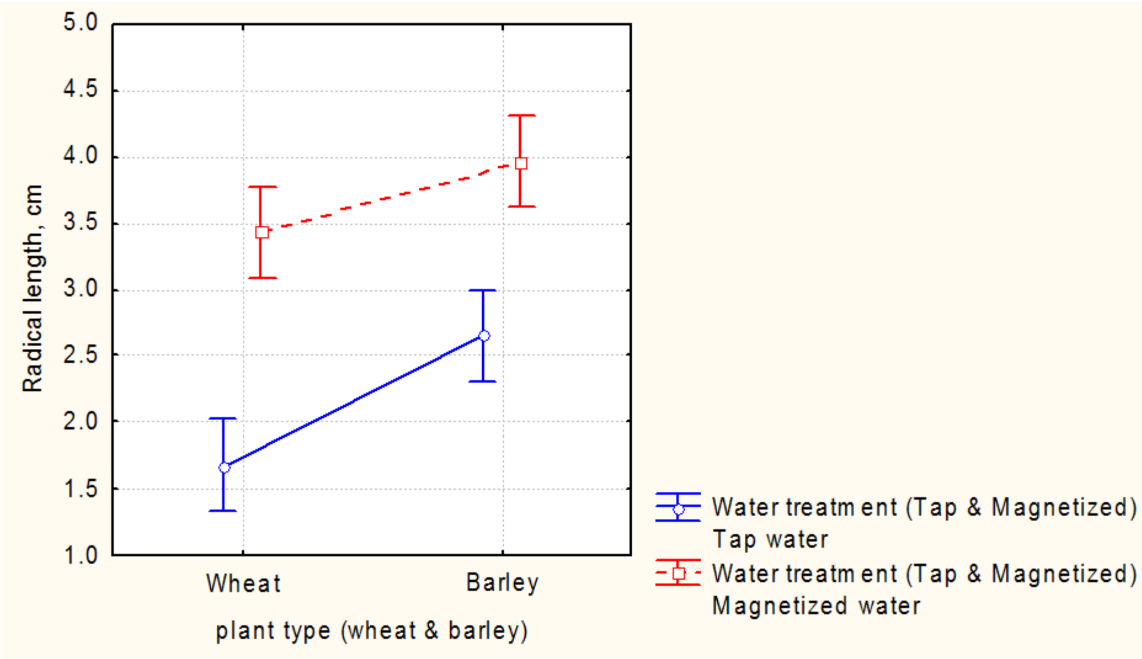

Fig. 7: Effect of interaction between water and plant type treatments on radical length

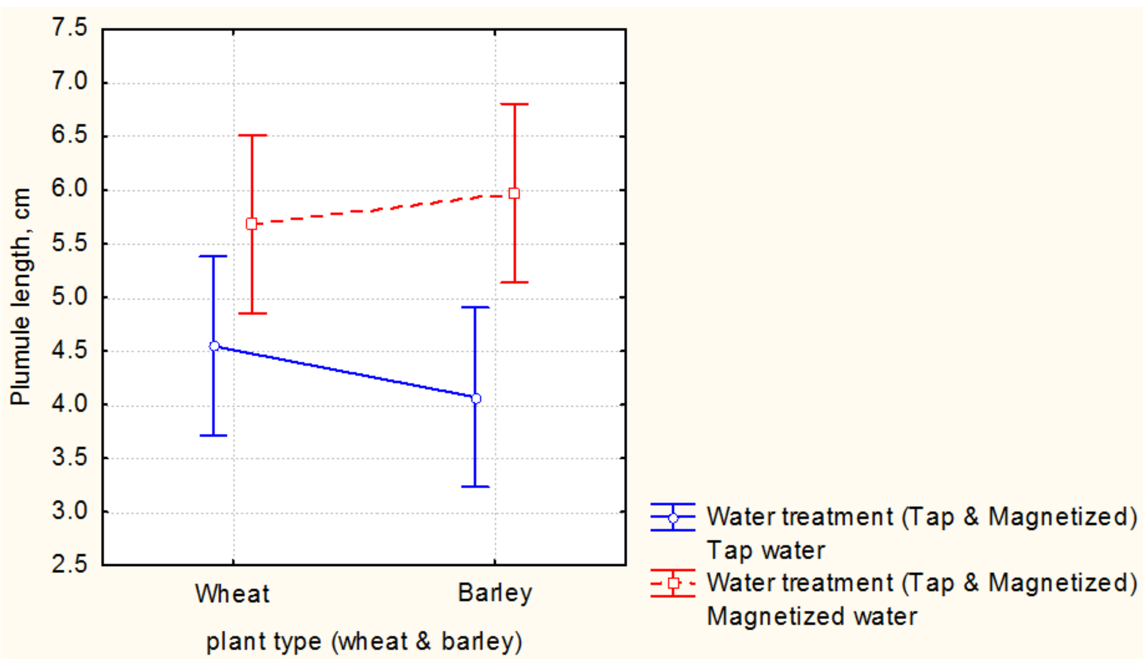

Fig. 8: Effect of interaction between water and plant type treatments on plumule length

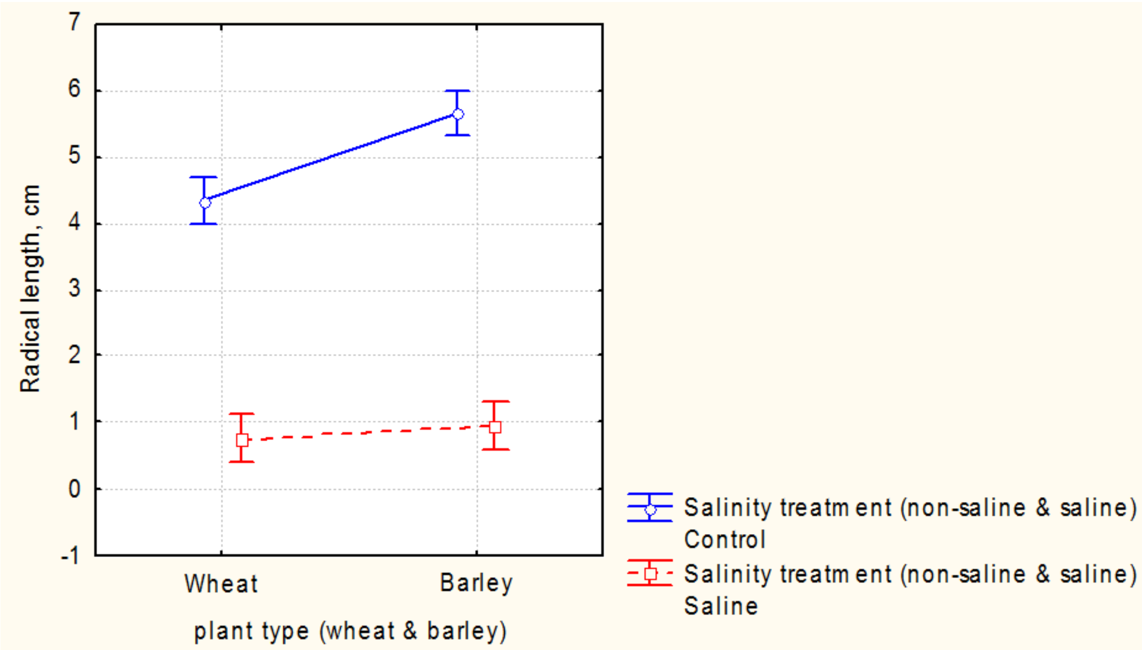

Fig. 9: Effect of interaction between salinityand plant type treatments on radical length

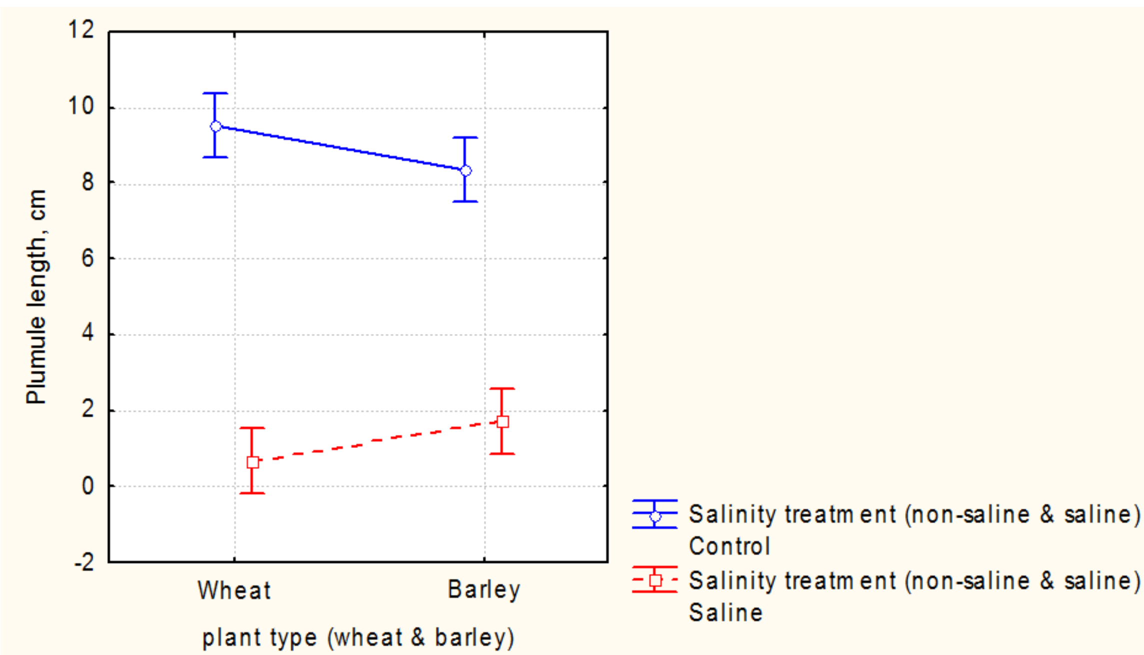

Fig. 10: Effect of interaction between salinityand plant type treatments on plumule length

The previously presented figures (e.g. single effect as fig. 1 through 4 or interaction as fig. 5 through 10) clearly indicate that the growth of both radical and plumule was improved under magnetized water with and without saline water. Improved growth was observed in barley and wheat, the effect was more pronounced in barley. The results also showed that there were enhancing significant effect of interaction between magnetism and salinity. The positive effect of magnetized water was greater in barley than in wheat. Our results are in agreement with the findings of Alexander and Doijode (1995), Carbonell et al. (2000), and Moon and Chung (2000) who reported that magnetic fields had positive effects on the germination of seeds. Other investigations demonstrated that magnetic treatment of seeds improves plant tolerance to salt stress (Lihua and Jixun 2001). The mechanism by which magnetized water improves germination and growth in absence and presence of salt stress is not fully understood. It could be proposed that magnetized water increased the water absorption and hence increased Ca^{2+} and K^{+} uptake (Reina et al. 2001), resulting in improved germination and growth. The ameliorative effect of magnetized water on germination and early seedling growth under NaCl reported here in consistent with the results of Atak et al. (2003), Lihua and Jixun (2001), and Sanchez-Linares et al (2012). The authors interpreted this effect to be due to increased nutrient uptake resulted from magnetic field induced changes in cell membrane characteristics, gene expression, protein biosynthesis and enzyme activities.

Conclusion

Magnetized water is harmless, healthy and eco-friendly technology. Magnetized irrigation water enhanced radical and plumule growth of cereal crops (barley and wheat) under non-saline and saline conditions. The study recommended using magnetized water in irrigating cereal crops when either high or low quality water is used.

References

Alexander MP, Doijode SD 1995. Electromagnetic field, a novel tool to increase germination and seedling vigour of conserved onion (*Allium cepa* L.) and rice (*Oryza sativa* L.) seeds with low viability. Plant Gen. Resou. Newslett. 104: 1-5.

Atak C, Emiroglu O, Aklimanoglu S, and Rzakoulieva A 2003. Stimulation of regeneration by magnetic field in soybean (*Glycine max* L. Merrill) tissue cultures. J. Cell Mol. Biol. 2:113–119.

Bugatin J, Bondarenko N, Gak EZ, Rokhinson E, and Aranger IP 1999. Magnetic treatment of irrigation water: Experimental results and application conditions. Environ. Sci. Technol., 33(8), 1280-1285.

Carbonell MV, Martinez E, Amaya JM 2000. Stimulation of germination in rice (*Oryza sativa* L.) by a static magnetic field. Electro-Magnetobiol. 19: 121–128.

Gholami A and Sharafi S 2010. Effect of magnetic field on seed germination of two wheat cultivars. World Acad. Sci. Eng. Technol., 62: 279-282.

Gill SS and Tuteja N 2010. Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. Plant Physiol. Biochem. 48: 909-930.

Grewal HS and Maheshwari BL 2011. Magnetic treatment of irrigation water and snow pea and chickpea seeds enhances early growth and nutrient contents of seedlings. Bioelectromagnetics 32: 58-65.

Koizumi M and Hiromi K 2014. Water channel for dry broad bean seeds at germination observed by micro-magnetic resonance imaging. Am. J. Biol. Life Sci. 2(2): 37-40.

Lihua X, Jixun G 2001. Effect of magnetic seed treatment on growth and saline-alkali tolerance of *Leymus chine-nsis*. Acta Prataculturae Sinica. 10: 58-63.

Sanchez-Linares L., Gavilanes-Ruız M, Dıaz-Pontones D, Guzman-Chavez F, Calzada-Alejo V, Zurita-Villegas V, Luna-Loaiza V, Moreno-Sanchez R, Bernal-Lugo I, Sanchez-Nieto S 2012. Early carbon mobilization and radicle protrusion in maize germination. J. Exp. Bot. 63: 4513–4526.

Mansour MMF 2013. Plasma membrane permeability as an indicator of salt tolerance in plants. Biol. Plant. 57: 1-10.

Moon J., Chung H 2000. Acceleration of germination of tomato seeds by applying AC electric and magnetic fields. J. Electrostatics 48: 103-114.

Munns R, Tester M 2008. Mechanisms of salinity tolerance. Annu. Rev. Plant Biol. 59: 651-681.

Reina FG, Pascual LA, Fondora IA 2001. Influence of stationary magnetic field on water relations in Lettuce seeds. Part II. Experimental results. Bioelectromagnetics. 22: 596-602.

Rochalska M, Grabowska-Topczewska K, Mackiewicz A 2011. Influence of alternating low frequency magnetic field on improvement of seed quality. Int. Agrophys. 25: 265-269.

Sala F1999. Magnetic fluids effect upon growth processes in plants. J. Magn. Mater., 201: 440-442.