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Overview of Role of Magnetizing Treated Water in Agricultural Sector Development

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Abstract

The increase of soil and water salinity is considered the major stress in agricultural sector worldwide; this is mainly emerging in developing countries like Middle East region, the chronic water shortage in the Middle East North Africa (MENA) region is a perplexing issue, certainly because of various operational sectors. The use of magnetic water treatment is an important factor in enhancing the agricultural production; there are beneficial effects of magnetically treated irrigation water, particularly for low quality water and recycled water, on the yield and water productivity of various plants. This work focuses on the use of magnetizing treated water (MTW) in agricultural sector to alter plant growth and food productivity, irrigation with MTW can improve the growth and development of plants both quantitatively and qualitatively, also, it can improve seeds germination, early vegetative development of seedlings and mineral content of seeds or fruits, moreover use of magnetic water treatment enhancement plant production, increase water use efficiency, reduced soil pH, and increased available P in different plants. Furthermore, MTW induced positive significant effect on mobility and uptake of micronutrient concentration and improved growth criteria, and thus all these parameters reflected in increasing biomass and total yield. MTW could use as an abiotic stress agent, or as a growth-inducing, preferably use permanent magnets with sustained magnetism, since magnetize treated water can lose its magnetism over time and distance. Therefore, magnetic treatment for irrigation water could be one of encouraged way in the future to enhance agricultural production in an environmentally friendly way. This review aims to explain the role of MTW in agricultural sector development, evaluate the effect of magnetic water on different growth parameters and total yield.

Keywords: Water salinity; Magnetizing treated water, plant growth, seed germination, and yield

Abbreviations: MENA: Middle East North Africa; MTW: Magnetizing Treated Water; MFs: Magnetic fields; MTA: magnetic treatment advice.

Introduction

Magnetic fields (MFs) can enhance plant growth and development agricultural sector, magnetizing treated water (MTW) considered one technique of magnetic field

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application. Irrigation with MTW can enhancing the agricultural production, development of plants growth both quantitatively and qualitatively, also, enhancing seed germination, accelerating vegetative growth of seedlings, it is also improving the mineral content of seeds and fruits. Therefore, MTW could be one of the most promising ways of applying a magnetic field in the future to enhance agricultural production in an environmentally friendly way. The effect of MTW depends on the quality and ion-content of the water and on the type of magnetization, it could use as a growth inducing substances in arid and semiarid regions. This type of physical treatment helps to avoid the use of synthetic substances like polyphosphates or corrosive ingredients that are expensive and can be injurious to human or disorderly the environment [1]. Agriculture in arid and semi-arid regions is currently affected by the shortage of fresh water and a notable increase in salt saline soil and underground water, in the same time increment of water use is becoming more of an important issue all over the world, and there is global demand for more food from lesser water resources. MTW technology is one of hopeful technique to enhancement water quality and crop productivity.

The magnetic field applications have been known for centuries [2], the first commercial magnetic device for water treatment was patented in Belgium by Vemeiren [3]. Although, magnetic field applications were rapidly getting attention from researchers and industrialists worldwide [4]. Magnetic energy could enhance the physical and or chemical properties of soil and water quality; also, dissolving capacity of the soil can be increased by using MTW. Different experiments were carried out all over the world, aimed to examine beneficial effects of magnetic treatment on correcting low-quality water for irrigation. In the same concern there is laboratory research indicated that desalination of a saline soil was 29% greater in the first leaching and 33% greater in the second leaching with MTW compared to non-treated water [5], also, there are various researches on the effect of magnetic fields on biological systems reported by many researchers [6,7].

Water scarcity

Water shortage and low water quality are becoming an international issue, especially in the arid and semi-arid region due to several reasons; water resources are being always under pressure and require a scientific approach to sustain the productivity of agricultural crops. Besides, the use of low- quality irrigation water is achievement importance in the agricultural sector in many countries all over the world because of the water quality problems and due to the scarcity of good quality water.

Magnetic field treatments

Magnetic field treatments have been extensively studied during the last 80 to 90 years and summarized their physiological and biochemical influences and possible physiological mechanisms. Practical application and use of magnetic field treatments in agricultural sector has wide application in varied fields, including seed germination, seedling development and yields of different species, like, fodder and industrial crops [8], herbs and medicinal plants [9], different vegetables and tree species [10], grasses, ornamentals [11], and poultry production, which has an important role in addressing the shortage of nutrition in developing countries [12].

Irrigation with magnetizing treated water is another special aspect of using magnetic fields for improving crop growth and development, although need more experiment in different areas around the world.

What is magnetic water treatment?

Magnet water treatment does not change the chemical properties of the water; it adjusts the structure of liquid water, so, there is no effect on super-molecules in normal water, however, in a magnetic treatment device, as the water passes through the magnetic field, all super-molecules vibrate, this will intensify the internal vibration of these super-molecules to the breaking point, and these super-molecules fracture and release their encaged particles. Magnetically water treatment reduces the bond angle of the hydrogen-oxygen within the water molecule, so, these formatting smaller clusters of water molecule than in ordinary water (Figure 1), and then it is leads to enhanced absorption of water into the cell [13].

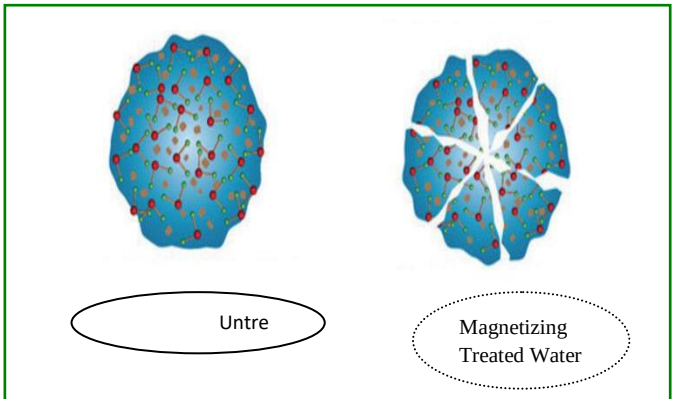

Figure 1: Modification of water clusters due to MF. untreaed water; Right MTWLeft: (Based on information by Toledo *et al*. (2008).

Physically, exposure of the water to a magnetic field changes the water's properties including raising the pH, dissolved oxygen, and minerals, moreover increasing the total hardness and magnetized water becomes more

alkaline [14]. Recently, the interest in water technologies has increased in the agricultural sector, magnetizing treated water considered one of these technologies, which depend on the interaction between a magnetic field and a moving electric charge. MTW can exist in nature by greater naturally occurring magnetic energy, this water emerges saturated with oxygen that can support the immune system, the use of magnets to improve water quality is of notable interest because of its low cost compared with other methods. The magnetic scale technology can be used as a replacement for chemical softening, ion exchange, and reverse osmosis for improving water quality. The mineral content of water may be altered with exposure to strong magnetic fields, and the water quality can be better by increasing the magnetic field [15]. Magnetize treated water can exist in nature by greater naturally occurring magnetic energy. This water emerges saturated with oxygen that can support the immune system. The use of magnets to improve water quality is notable interest because of its low cost compared with other methods. The magnetic scale technology can be used as a replacement for chemical softening, ion exchange, and reverse osmosis for improving water quality. The mineral content of water may be altered with exposure to strong magnetic fields, and the water quality can be better by increasing the magnetic field [16].

Changes in the properties of water after magnetization

Applied magnetic field causes changes in the properties of the molecules resulting in reduced surface tension, reduced viscosity, increased dissolvability, increased permeability and improved oxygen content hence making mineral elements more readily available to plants, therefore MTW bears different chemical and physical properties than untreated water[17]. Also, MTW has various important features, including a saturation effect, a memory effect, also, hardening and boiling point and dielectric constant, the formation of clustering structures from linear and ring hydrogen-bound chains of molecules, the magnetic interaction between these clustering structures and increasing polarization effects of water molecules [18], there are various changes of molecule clustering considered a direct result of the magnetic treatment such as atomic polarization and change in the transition dipole-moment of electrons inside molecules. MTW devices use magnetic fields to change the molecular form of various water constituents such as calcium [19].

The saturation effect of Magnetize treated water

The saturation effect depending on both exposure time and field strength, there is a maximum after which the properties of magnetizing treated water cannot be changed further, either by increasing the exposure time or by increasing the field strength.

a. Memory effect

Applied magnetic field changes memory effect which not disappears directly after removing magnetic field, and is the main feature of its application; the memory time of MTW depends on the magnetic field strength and time of exposure [20].

b. Surface tension force:

Surface tension plays a vital role in the effective irrigation of plants, surface tension force of MTW reduced comparing with untreated water, also, its hydrophobicity, due to the clustering structure and improved polarizing effect of treated water, (Figure2) therefore, the movement of water is fast in plant system, so plant absorbs more water results in faster growth.

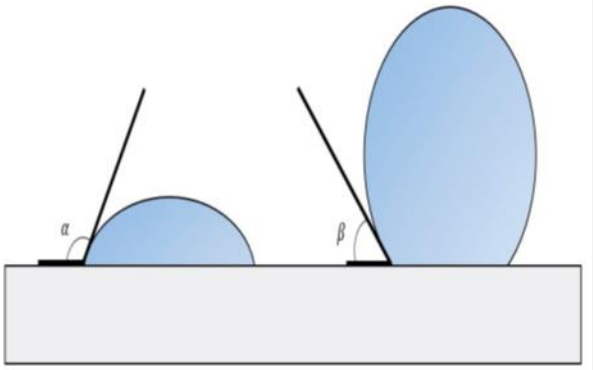

Figure 2: Changes on the surface tension according the contact angle. α: MTW, β: tap water(Adapted from [21]).

c. Effects of Magnetically treated water

The effects of MTW varied with plant type and the type of irrigation water used, and their interaction, irrigation by magnetizing treated water for different plants achieved increment in growth parameters, photosynthetic activity and translocation efficiency for photo assimilates [22].

The advantages of using magnetize treated water

Irrigation by MTW helps in soil leaching through cracking disintegrating molecules salts, the magnetic technique makes it is possible to use traditionally unsuitable salty water (salt content of 2,000 ppm and up to 5,000 ppm), efficiently for irrigating crops. Magnetizing treated water enhancing plant water nutrients absorption, even under saline soil conditions and enhancing different growth

criteria which reflected in increasing biomass as compared to untreated plants (Abobatta 2015[b]).

a. In particular, irrigation by magnetizing underground water revealed notably increased germination percentage as compared to non- treated water.

b. Moreover, MTW revealed notable response with the ratio chlorophyll a to chlorophyll b, indicate the role of magnetizing treated water on light harvest from plant chloroplasts [23].

c. In addition, use MTW as irrigation water increase the yield and water productivity of crops [24], Also, MTW promotion the maturity of crops, and increase the ability of plants to resist diseases, furthermore, reduce water quantity which used in irrigation, and decreases the use of synthetic fertilizers.

Application of magnetized water to plant growth and development research

Reduce soil salinity magnetized water technology

Soil salinity is one of the most critical problems in the agricultural sector all over the world; the main reason of this process is the accumulation of salts in soil capillaries leading to a severe decrease in crop production. Salt concentration left in plant capillaries, with lacking amount of nutritious elements leads to plants dying.

During last decade's different scientists study the effects of magnetic fields on irrigation water and soil, from this research exciting new applications, have been developed and tested in USA, Europe, Middle East, Africa, and Australia. The phenomenon of MWA has been known for many years and has been reported as being effective in numerous instances [25]. Also, MWA induced changes in solubility of some soil components such as CaCO3 and gypsum; this is turn favorably influenced soil pH and resulted in higher nutrient uptakes, therefore, increases their concentrations in the plant tissues [26]. Obviously, there is a change of the physiochemical characteristics of water after magnetic treatment leading to improved filtration and dissolvability [27].

Effect of magnetic treatments on seed germination

Seed germination may be fail to emerging under various abiotic stress conditions, saline soil or saline water or both are the most important factors affecting seed germination. Therefore, a number of seedling seeds may express some tolerance. Magnetize treated water can enhance the acceleration of seeds metabolism and improved germination ratio compared to non-treated water. The stimulatory effect of magnetic field application on the water with respect to enhancing in seed germination ratio due to greatly influence on hydrogen bond in liquid water by electrical and magnetic fields, therefore magnetize treated water bears different chemical and physical properties than untreated water [17]. The experiments and researches are clarified that the magnetic treatment effect on the plant growth and improving the seeds production depends on the time of exposure and strength of the magnetic field. Nowadays the use of the magnetic technique as a pre-sowing treatment is becoming more regular among researchers, as it is nearer to the agricultural practices. Recently, the research on plants growths was improved with seeds treatment using a magnetic field. Therefore, magnetized water treatment is affecting the plant production, [28], also, the measurement of elements contents in plants irrigated with magnetized water has greatly affective effects on seeds product compared to normal water irrigation [29]. Moreover, magnetic treatment has been found to stimulate germination and improve early growth characteristics of various crops like cotton seedlings [30].

Effect of magnetic treatments on micronutrients concentration

Among the different water treatments, magnetize treated water increased micronutrients absorption, due to the effect of magnetic field in increasing ions mobility in the root zone and ions absorption by the plants which are varied seriously from one element to another according to the element magnetic field, [31]. Magnetize treated water increased dissolving and deeper penetration of fertilizers in soil irrigated compare with untreated water; it's considered as most effective methods in arid regions where water alkalinity is high and there is a tendency for soda salinization of soil [32]. The effect might be due to the stimulation effect on the biosynthesis of molecular structure and their interactions in the different processes in the plant. Whereas the magnetic field has positive effects on decreasing the surface tension and increasing of viscosity, water is more stabilized with magnetic treatment with minimal molecular energy while greater in activation energy [33]. Concentrations of different elements such as K, N, P, Na, Ca and Mg varied in soils irrigated with magnetically treated water when compared those with untreated water, this effect due to reduce minerals movement in water after magnetic treatment, or as a consequence to the effect of acceleration of the crystallization and precipitation processes of the solute minerals [34]. Also, soils irrigated with magnetizing treated water had higher concentrations of mobile forms of nitrogen, phosphorus, and potassium.

Effect of magnetic treatments on plant growth criteria

Stimulatory effect of magnetizing treated water on the growth criteria may be due to its effect on biochemical changes or altered enzyme activities, such as tilling and heading stages for some cereal crops are affected by use magnetize treated water compared to irrigation with untreated water, Magnetize treated water increased the plant growth rate and this is reflected in biomass increase [17&35]. The electromagnetic fields increase the plant growth regulator induced Phenylalanine Ammonia-Lyrase during cell differentiation in the suspended cultured plant cell, plants irrigated with magnetizing treated water easily take up mineral from the soil and no residue is shaped on the soil surface [23], also, enhancement vegetation growth and the crops ripe days earlier than normal, also, irrigation with magnetize treated water reduces plant disease rates dramatically comparing with untreated plants, and the taste of agricultural products improves. Hence the plants were supplied with adequate nutrients for proper growth stage and metabolic processes, this, in turn, redirected in better rates of all growth parameters and better plant growth. The stimulatory effect of irrigation by magnetize treated water on growth criteria probably due to induction of mitosis and cell metabolism, all catalytic processes involving oxidation or reduction speed up in this plants, and cause an increase and accelerate the activity of growth and development of the plant, which is related to increase GA_3, RNA, DNA and enzyme activities, these effects caused enhancement the plant criteria [36].

Effect of magnetic treatments on yield and yield component characters

Magnetic water application increased yield and yield parameters of some cereal crops [37], this increment due to increase ions mobility or improve ions uptake under MF treatment which leads to biochemical changes or altered enzyme activities, which might have resulted in better development of photosynthesis stimulation [38], similar results were reported by [35&39]. Also, application of magnetic fields increase different yield criteria like total yield, fruit number and improved fruit quality of Valencia orange [23], also, increased number of flowers and total fruit yield of strawberry [40].

Effect of magnetized water on poultry productive

Magnetic treatment of water has a wide application in varied fields, including poultry production, which has an important role in addressing the shortage of nutrition in developing countries [12]. However, eggshell quality is one of the most significant issues in the egg industry. It has an important role in the protection of egg contents [41]. The magnetization of water improves the water properties, which consequently improve the growth performance of broiler chicks [42]. Magnetized water helps to precipitate calcium in the bones when the shell calcification process is occurring intensively [43]. Magnetic field treatment of water increases the solubility of calcium salts [13]. This would prevent the mobilization of bone calcium and phosphorus reserves, ensuring the high demands of Ca and P export during the laying cycle of hens and affecting eggshell quality [44]. The increment of salts solubility in water can enhance the biological activity of solutions and improve animal performance [45]. The source and quality of water have been shown to influence animal performance, limit animal production, and increase health hazards [46]. Also, magnetic treatment improved the quality of the well water and affected the reproductive traits, broiler chickens that drinking magnetizing treated water had better hatchability and viability [47&48].

Conclusion

The use of magnetic water technology is an essential aspect in improving crop production, there are useful effects of magnetically treated irrigation water in arid and semiarid regions like MENA region, magnetizing treated water can improve the growth and development of plants both quantitatively and qualitatively, also, it can improve seeds germination, increase seedlings surviving and raise mineral content of seeds or fruits, moreover use of magnetic water devices increase water use efficiency, reduced soil pH, also, magnetizing treated water could use as an abiotic stress agent, or as a growth-inducing, furthermore, magnetizing treated water induced positive significant effect on mobility and uptake of micronutrient concentration. Therefore, magnetic treatment for irrigation water could be one of encouraged way in the future to enhance agricultural production in an environmentally friendly way. In addition, many efforts are needs to increase farmer's awareness that magnetic water technique can assist in saving irrigation water and reducing salt accumulation. Therefore, we highly encourage future research efforts focusing on the application of this technology for enhanced agricultural practices in water-scarce regions.

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