

Role of Magnetic Water in Agriculture

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SUMMARY

MWT has opened new research avenues in agriculture. Safety, compatibility and simplicity, environmentally friendliness, low operating cost and not proven harmful effects are the main advantages of this technique. Improvements of irrigation water quality and quantity, crop yields and quality, soil improvement, scale prevention/elimination in water-using systems, and water saving are some of the reported benefits of MWT in agriculture. In addition, MF treatments have shown beneficial effects on the germination of seeds, plant growth and development, the ripening and yield of field crops. The main challenge in applications of MW in agriculture is efficient integrating of irrigation components, designing suitable pumps compatible with technical and field requirements of magnetic MWT systems. To shed light on the exact mechanism of actions of MWT in exerting physical and electrochemical effects conducting further controlled laboratory and field studies are necessary. In this regard, few studies have been conducted on the effects of magnetic treatment of irrigation water on plant growth and crop and water productivity. In addition, further field and laboratory experiments are needed to overcome the field challenges and to gain knowledge about the mechanism of action of the MWT.

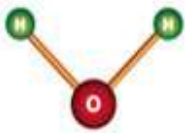
INTRODUCTION

Electromagnetic fields (EMFs) have shown great potentials in medical, industrial and environmental applications.¹⁻⁷ Because of the electrical origin of the live and existence of all cells and living creatures, EMFs can interact with all living cells so that can modulate their functions. These modulations in appropriate conditions can have useful outcomes such as treatment or inducing the desire characteristics in different compounds. Water is a crucial source for life on the earth. Any living creature needs water to hydrate every cell. Long term and frequent droughts and competing water demands in most parts of the world have caused severe pressure on water resources. In addition, high costs of irrigation in the most countries are the main problem of agriculture development. Annually large quantities of water are used in agriculture. Therefore, emerging of new strategies to reduce consumption of water is of significant importance. One of the new strategies is magnetic water technology. Various studies have revealed that magnetic treatment of irrigation water can improve the productivity of water.⁸⁻¹⁰ MWT has shown promising potential in saving water resources that will be of significant importance in near future. MWT has shown various potentials in environmental and agricultural applications.^{6,3} Some of these applications are therapeutic effects of MW, preventing scale deposition, improving irrigation water quality and crop yield, scale elimination, soil improvement, corrosion control and wastewater treatment.¹¹⁻¹³

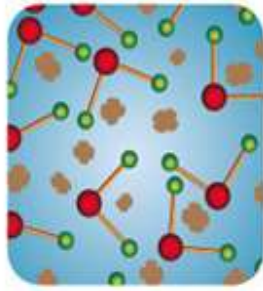
What does magnetic water mean:

Water is Paramagnetic meaning that it holds a magnetic charge. Paramagnetism occurs primarily in substances in which some or all of the individual atoms, ions, or molecules possess a permanent magnetic dipole moment. Water has a dipole moment and is, therefore, subject to paramagnetism. However, water won't destroy magnets but it can significantly reduce the strength of their magnetic fields because water is a good conductor of electricity and it can easily disrupt the flow of electrons within a magnet. In addition, water can corrode the materials that make up a magnet, weakening its structure.

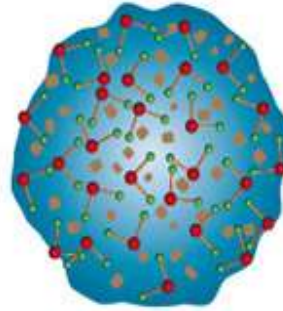
A water molecule consists of one oxygen and two hydrogens. Thus: H₂O. Simply put, the oxygen act as a negative, while each hydrogen acts as a positive. Water molecules do not travel alone. They form clusters with other water molecules by the attraction of a positive hydrogen of one molecule to the negative oxygen of another. Water molecule clusters come in many sizes, depending on the number of water molecules involved.



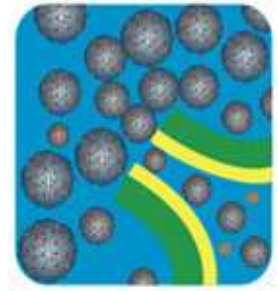
Water molecules



bond together



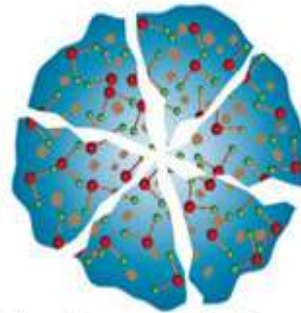
to form water molecule clusters.



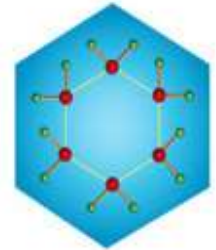
Many are too large to enter the cell.



Omni's Magnetic science



breaks apart clusters



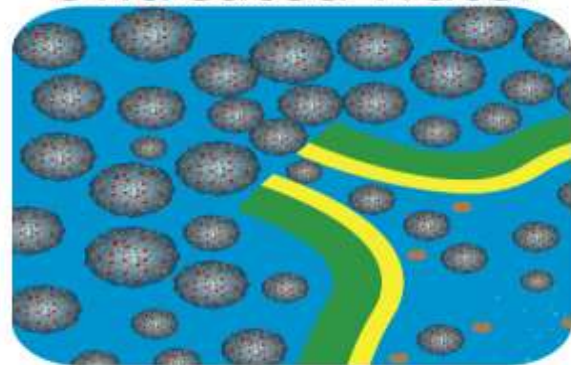
into smaller hexagonal clusters.

Treated Water



Full Hydration

Untreated Water



Partial Hydration

In the case of water that has not been magnetically structured, the water molecule clusters are generally comprised of many water molecules that are loosely attracted. This loose and chaotic form of attraction allows for toxins and pollutants to travel inside the water molecule cluster. As these water molecule clusters pass by the cell membrane, many of them are sloughed off because they are too large or because of the toxins contained, which the plant is programmed to reject. The smaller of these chaotic clusters will enter the cell, some carrying toxins with them. It requires a great deal of unstructured water to hydrate a plant. Magnetic field, when applied to normal water, *restructures* the water molecules into very small water molecule clusters, each made up of six symmetrically organized molecules. This minuscule cluster is recognized by the cell as "bio-friendly" due to its hexagonal structure and because the toxins cannot travel within the cluster, and easily enters the passageways in plant and animal cell membranes. The result provides maximum, healthy hydration with less water.

Magnetic Water Treatment in Agriculture

In normal or non-MW, the water molecule clusters comprising of many water molecules are loosely attracted. This loose and chaotic form of attraction predisposes the water to toxins and pollutants to travel inside the water molecule cluster. The large structure of these water molecule clusters or presence of toxins blocks large portions

of these clusters when they pass through the cell membrane. The smaller size of these chaotic clusters, some of them carrying toxins, can enter the cell with consequent harmful effects.¹¹⁻¹³ Therefore, to hydrate a plant a great deal of normal water is required. Magnetic treatment of water restructures the water molecules into very small clusters, each made up of six symmetrically organized molecules. This tiny and uniform cluster has hexagonal structure thus it can easily enter the passageways in plant and animal cell membranes. In addition, toxic agents cannot enter the MW structure. These features make MW a bio-friendly compound for plant and animal cells. MW can be used to increase crop yield, induce seed germination and benefit the health of livestock. Studies have demonstrated that MW for irrigation can improve water productivity; thus, conserving water supplies for the expected future global water scarcity.¹⁴ In addition, MW is reportedly effective at preventing and removing scale deposits in pipes and water containing structures.

Magnetic Treatment of Irrigation Water

Previous studies have shown several beneficial effects of MF treatment on the growth of plants. It was demonstrated that an optimal external EMF can increase the rate of the plant growth, especially the percentage of seed germination.^{11,12} Podleony et al. (2004) reported that exposing the broad bean seeds to variable magnetic strengths during before sowing imposes significant effects on seed germination and seed yield.¹² In addition, they showed that applying MF to broad bean during the growing season can increase the number of pods per plant and reduce the plant losses per unit area. Several studies have demonstrated the effectiveness of MFs on the root growth of various plants.¹⁴⁻¹⁸ Similarly, Muraji et al. (1992) observed that MF treatment increases the root growth of maize.¹⁸ Turker et al (2007) reported that static MF has an inhibitory effect on the root dry weight of maize plants, but had a beneficial effect on root dry weight of sunflower plants.¹⁹ Different studies have shown the inhibitory effect of weak MF on the growth rate of primary roots during early growth.^{16,19} It was demonstrated that MF can decrease the proliferative activity and cell reproduction in meristem cells in plant roots.¹⁶

Effects on Quality of Water

Several studies demonstrated that MWT influences molecular and physicochemical properties of water that alter the quality of water.²⁰ The origin of physical and chemical modulations of water molecules under magnetic treatment is the alteration of water nucleus.²⁰⁻²³ The effects of magnetic treatment on irrigation water include increasing the number of crystallization centers and the altering the free gas content.²⁴ Both effects improve the quality of irrigation water. The important components for effective magnetic treatment are flow rate through the apparatus and certain chemical parameters of water, namely, carbonate water hardness of more than 50 mg/L and concentration of hydrogenous ions in water at pH>7.2. Irrigation with magnetically treated water is the most effective for soils with high soda content.²⁴

Effects on Crop Yield

In the field of crop yield, researchers have focused on using of physical growth stimulation approach because of no known adverse effect on the environment. MW technology is a promising physical growth stimulation approach. The characteristics of water treated by the magnetic field can be altered to cause changes in plant properties, growth and production. MW can be used for saving irrigation water. MWT can increase the seed germination. Irrigation with MW modulates several parameters that are associated with the crop yield: growth characteristics, potassium, GA3, kinetin, nucleic acids (RNA and DNA), photosynthetic pigments (chlorophyll a & b and carotenoids), photosynthetic activity and translocation efficiency of photo-assimilates. Several studies have shown the enhancement of water productivity in both crop and livestock production, number of flowers and total yield of fruits for different crops including strawberry and tomatoes.

Benefits to plants

Several studies have revealed beneficial effects of MF treatment in fruit yield and plant growth. imilarly, several studies have shown that MF treatments enhance the flowers and total fruit yield of strawberry and tomatoes. Duarte Diaz et al (1997) observed that magnetic treatment increases the nutrients absorption in tomato.¹⁰ Some of the main effects of magnetic treatment of seeds or irrigation with MW in plants include plant growth rate, transplant dry weight,

Transplant leaf area and seed germination.**Effects on plant growth**

Using MW for irrigation of squash increases the weight of squash. Bio-magnetic water is more solvent and has a lower surface tension; therefore, nutrients are absorbed greater in the water. MW is the water which are treated with magnetic field or pass through a magnetic device. When water is magnetized, some properties changed which can alter the characteristics of plant, growth and production. In addition, magnetic treatment before sowing increases the number of pods per plant and decreased plant losses per unit area.¹² The root growth of various plant species can be enhanced using MWT technique.¹⁵⁻¹⁹ Muraji et al reported that the roots of maize plants have the highest growth rate under an MF of 5 mT at 10 Hz.¹⁷ Moreover, MFs have an important influence on root dry weight of sunflower plants.^{16,19}

Effects on Seed Germination

An optimal external EMF can influence the speed and percentage of germination.^{11,12} The strength of MF and exposure time are among the most significant factors influencing the seed germination, emergence rate and seed yield. Magnetic treatment can accelerate the plant emergence to 2–3 days, compared with the control plants. Furthermore, exposure time to MF plays a significant role on the germination rate where different exposure periods result in different minimum time required for germination. However, Florez et al (2007) showed that the time needed for germination in each magnetic treatment of various strengths and periods are lower than values recorded by control.¹³

Technical Considerations

A typical MWT system is a simple flange installed on the main pipeline and contains powerful, specific magnetic inductions that restructure the water and minerals passing through them. Most of the devices are in-line invasive and non-invasive as opposed to side-stream. The invasive devices require a section of pipe to be removed and replaced with the device. Most of the invasive devices are larger in diameter than the section of pipe they replace. The increased diameter is partially a function of the magnetic or electromagnetic elements, and also a function of the cross sectional flow area. The flow area through the devices is generally equivalent to the flow area of the section of pipe removed.

The non-invasive in-line devices are designed to be wrapped around the pipe. Therefore, downtime, or line out-of-service time, is minimized or eliminated. In MWT, when irrigation water passes under an MF, it gains a magnetic moment that persists for 24 to 48 hrs. Magnetic treatment of irrigation water depends on MF intensity, composition of dissolved salts and velocity of crossing a magnetron of 0.5 inch diameter.

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