Eco. Env. & Cons. 27 (November Suppl. Issue) : 2021; pp. (S86-S93)
Copyright@ EM International
ISSN 0971–765X

Magnetized water as a resource of irrigation for the Barley and Legumes Cultivation an Experimental Study

Ali Ghazi[1], Samah Hussein Kadhim[2] and Asaad H. Sayer[3]

[1,2,3] Department of Chemistry, College of Science , University of Thi -Qar, Iraq

(Received 15 April, 2021; Accepted 27 May, 2021)

ABSTRACT

Water shortages and salinity are chronic problems in many areas globally. In the present study, the magnetization of water of the river of General Down Stream) AL-Massab AL-Aam(in Iraq was investigated. The effect of the magnetic field was observed by measuring some physical properties of treated and untreated water. Furthermore, the suitability of magnetized water for the irrigation of legumes and barley plants was studied. The results showed that there is a noticeable change in some properties of the treated water such as pH, dissolved Oxygen and turbidity. On the other hand, there was no significant change in density. Moreover, it was found that the magnetic treatment of salty water improved its suitability for the cultivation of legumes and barley plants. The germination of the two plants was enhanced by 15 and 10% for barley and legumes respectively. Additionally, there was a noticeable improvement in the growth of the two plants when they were irrigated with the magnetized water.

***Key words** : Magnetic water, Total dissolved salts, Turbidity*

Introduction

Water is the most liquid required for our life and for all other living things such as animals and plants. Therefore, there is no probable life on our planet without wate (Pang *et al.*, 2008). Civilizations flourish wherever water is abundantly available, and it is the resource that has become more significant than other natural resources. Its shortage, decrease or even a change in the quality have serious economic, social and environmental effects (Gaafar *et al.*, 2015). Simply, Water molecule consists of two hydrogen atoms and one oxygen atom covalently linked. Water molecules are linked with each other by hydrogen bonds which are responsible of many unique properties for water. These include surface tension, relatively high boiling point compared to other liquids. Additionally, water molecule is stable and octet rule can be applied on it, there are no unpaired electrons in the water molecule (Gaafar *et al.*, 2015). Naturally, water cannot be pure, it mostly contains many different organic and inorganic compounds, elements and impurities (Kredy, 2006).

Salinity of the water

Soil salinity could be one of the most serious problems in the agricultural sector worldwide. The main reason for this salinity might be the accumulation of salts in the root capillaries of the soil. This soil salinity will lead to a sharp decrease in the crop production or even to the death of plants.

During the past decades, many researchers studied the effects of magnetic fields on irrigation water and soil; interestingly new applications have been developed and tested in many areas including the United States of America (USA), Europe, the Middle East, Africa and Australia. The magnetic field water treatment process has been known for many years and has been reported to be effective in many cases (Ayers *et al.*, 1985). The indiscriminate and ill-considered use of irrigation water, especially saline water, will lead to negative returns on the yield and the soil. Consequently, it is necessary to find or develop means and mechanisms to treat saline water and remove or reduce its negative impacts on agricultural production (Gallon, 2004).

On the other hand, the moisture depletion leads to a shortage of water available for the plants which affects the natural growth of the plants (Lowe, 1996). Plants are adversely affected by the increase in elements and salts of the irrigation water. This increase will cause a rise in the osmotic pressure of the soil solution, which makes the plants' absorption of water difficult. Occasionally, the presence of some salts could have a toxic impact on the plants (Reminick, 2001).

The problem of salinity is one of the main problems that hardly influenced the soil of Iraq, particularly in central and southern Iraq. This problem has received great attention and many attempts have been made to investigate and find ways to treat or tackle this problem. A significant change has been observed in the physical and chemical properties and consequently quality in the water of the two main rivers in Iraq Tigress and Euphrates. Salinity increased due to the continuous wash of the soil, the impact of evaporation, the lack of water levels and the lack of rain (Sarhan *et al.,* 2011; Vasilevski, 2003).

To introduce practical solutions to the problem of salinity and decrease the pollution in Tigress and Euphrates the General Downstream Project (Al-Musab Al-Aam) was established. The aim of the establishment was to discharge wastewater of neighboring agricultural lands and water from civil and industrial activities away to the sea. The river has a length of about 665 km, and it extends from the north of Baghdad City in the city of Ishaqi until Khor Al-Zubair.

The importance of the downstream project is that it could be the key to the success in the agricultural field in the country of Iraq. It helps in treating salinity in areas of up to six million hectar and also assists open river navigation in central and southern Iraq. Moreover, the quality of the water of the Tigris and Euphrates rivers could be noticeably improved and this is due to decrease in salt concentrations (Al-Ani, 2008).

The effect of magnetic field on water

As a result of the scientific and technical development and the need to find sound scientific means in treating irrigation water and rationalizing its consumption, scientific techniques have recently appeared in water treatment, including the magnetic technique (water magnetization), which have been used in various applications including agricultural, industrial, medical and civil fields. The question is what happens to the water when it enters the magnetic field? Many explanations were introduced, one of them is that water is a dipolar liquid. Consequently, its magnetic or electric field can be changed by the rotation of the molecule in one direction to

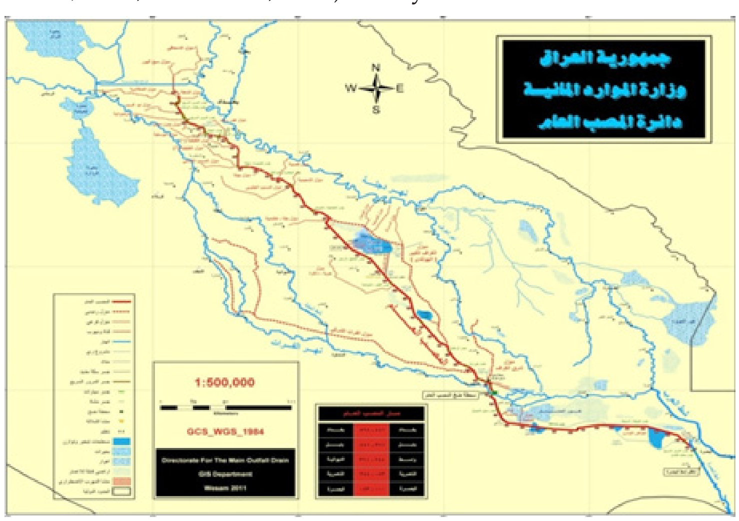

Fig. 1. The extension of General Downfall Project (Al-Musab Al-Aam)

take a high voltage, either negative or positive, depending on the magnetic field used on a positive or negative north pole (Hong *et al.*, 1997). This might mean that magnetic water treatment leads to restructuring and arranging water molecules into hexagonal groups. Therefore, it easy for water to penetrat plant and animal cell membranes (Harichand *et al.*, 2002)

On the other hand, some studies have shown that the magnetic treatment of water leads to a reduction in the bonding angle of hydrogen and oxygen inside the water molecule from 104.45 to 103 degrees (Gang *et al.*, 1995) . Additionally, the magnetic treatment also adapts the properties of water and makes it more soluble and has a high ability to wash out the salts in the soil, as well as increases the readiness of the nutrients in the soil. It found that irrigation with magnetized water increases plant growth and yield by 45% (Takatshinko, 1997). In this study, it was claimed that the effect of magnetization on the water's properties was directly reflected on the plant in light of increased production as well as improved quality (Altamimi *et al.*, 2014).

Recently, the concept of using magnetized water technologies in agriculture (magnetic technology) has emerged, or the so-called biomagnetic stimulation to raise crop yields by creating desirable stimuli such as accelerating plant metabolism and changes in the properties of living membranes (Alaa *et al.*, 2012). Reported significant differences in dry weight, plant height, and root weight of peas and barley for fresh and salty irrigation water, magnetized and non-magnetized. The highest plant heights were achieved in the case of irrigation with magnetized fresh water. The plant height in the first season was 125.8 and 123.3 cm. The first and the third, and the second season to 128.5 and 110.0 cm respectively, the reason for the increase in the plant height and dry weight is that the roots of the yellow corn plant when irrigated with magnetized water leads to an increase in the readiness of nutrients and ready water for the plant in light of the increased ability of the soil to retain water Al-Ani, 2002. Investigated the effect of treating yellow corn seeds with magnetized water with different intensities for periods ranging from a few minutes to 21 hours. They found that there was an increase in the percentage of seed germination, root length, number of root hair, plant leaf area, and the ratio of shoots to roots. The optimum conditions were observed when seeds were treated with magnetic field with an intensity of 1150 - 1200 T for a period of 15-20 minutes (Ela, 2007; Schroeder, 1985) .

Another study investigated the effect of different magnetic technologies on the growth characteristics of two types of wheat, it was found that there were physiological differences in seedlings vitality, bud growth, leaf length, and root length between treated and untreated seeds. Furthermore, it was found that the response of the two wheat classes to the magnetic technologies differed according to the different types of magnetic technologies used (Schroeder, 1985). Takatshinko observed that the magnetized water could reduce the resistance of cell walls to elongation during the growth process. This action will led to an increase in the leaf area and vegetation, which increased carbohydrate photosynthesis products and thus increased dry matter accumulation(Takatshinko, 1997).

Location and experimental part

Study Site

The General Downstream Project passes through the city of Nasiriya, to the north of the Euphrates River, and it passes through many agricultural areas. An area near the Dutch bridge, located in the coordinates (31 ° 05'47.0 "N 46 ° 14'45.7" E), was chosen for sampling (Figure 2). The site is located within the borders of the city of Nasiriyah. Environmental information for the research was obtained, and a number of physical and chemical variables were studied according to the standard methods were used

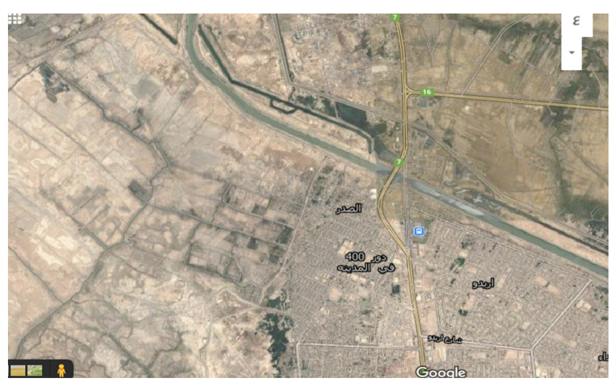

Fig. 2. The site of sampling area of the general downstream project

Experimental part

To performe the experimental work of the present study, water samples were taken from the river

(AL-Massab AL-Aam) and treated with a magnetic field. To do this job, a magnetized tube with a magnetic force of 12,000 kauss was used; it had a length of 85 cm and made by Delta Water Company. The used pipe had a diameter of 5 cm. Some physical properties of the treated and untreated samples were measured to examine the effect of the used magnetic field on these properties. The treated and untreated water was used for the irrigation of the plants which were cultivated in the present study.

To obseve the effect of magnetized water on plants, two types of plants were considered and planted in the area of the study (Department of Chemistry, College of Science, University of Thi-Qar). The two plants were Legumes and barley, an area of 0.5 m^2 was prepared for each plant. The area of each plant was divided into two equal halfs (0.25 m^2 each). One of them was watered with the treated water while the second one was watered with the untreated water. Figure 3 shows the area used for the plants cultivation. The area of the cultivation was prepared and divided by using a wooden slats and consequently four equal parts were made, two parts were used for Legumes and the others were used for barley. Peat moss fertlizer was mixed with local soil and used in all cultivated area to make sure for better germination. Irrigation was performed with the same amount of water and same considered areas were calculated and the growth of the plants were monitored.

Results and Discussion

To investigate the effect of magnetization on the water of the AL-Massab AL- Aam, all tests mentioned in Table 1 were analysed. This could be helpeful for the comparison between the two types of water (mangnetized and non-magnetized). The results confirmed the existence of a mixed and convergent effect in some cases on the chemical and physical properties when treating water with a magnetic field of 12000. A length of 85 cm, and a constant flow rate of 5 l/m were considered. The water was also treated with the same system more than once, and the extent of the magnetic field's effect on the water was observed. All measurements are listed in Table 2.

In general,The acidic function is the measurement that determines whether a liquid is acidic, basic, or neutral. As commonly known that the pH scale ranges from 0 to 14, and therefore if the pH value of water is 7, it is considered neutral, and it is equal to the pH of pure water at a temperature of 25 degrees Celsius. As can be observed from Table 2 that pH values increase when water is treated. This increase becomes bigger when time of expossure increaed by repeating the megnetization process and this was performed by circulating water in the magnetized tube (AL-Mosuly, 2013).

Total Dissolved salts (TDS) have an importantance since they indicate the amount of dissolved salts that cannot be removed by traditional filtration methods. TDS are used to classify water, whether it is fresh, salty or semi-salty. Water with soluble substances less than 1500 mg/L is classified as fresh, while whenwater has soluble substances range between (1500-5000) mg/L is semi-salty water. Finally, water withtotal soluble substances exceed 5000 mg/L is considered as salty water. It can be noted from Table 2 that there is a

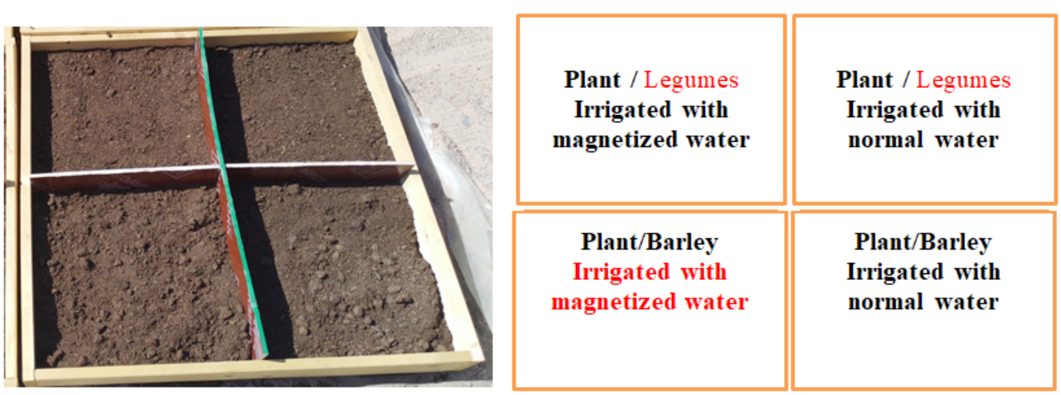

Fig. 3. Area of the plant cultivation, it is located in the department of Chemistry, College of Sciences, University of Thi-Qar, Nasiriya City, south of Iraq

Table 1. The effect of magnetization on the water of the AL-Massab AL- Aam

No.	Type of analysis	Method of analysis
1	pH	HANNA PH211 Microprocessor PH Meter
2	Total Dissolved Solid Salts (TDS)	Hanna Instruments™ HI-2550/TDS
3	The electrical conductivity of EC water	EC 214 Conductivity meter HANNA
4	Surface tension	Practical experience
5	Viscosity	Brookfield Viscometer
6	Dissolved oxygen	Multi Direct From a company Lovibond
7	Boiling point	Practical experience
8	Turbidity	Multi-Direct From a company Lovibond
9	Density	Pycnometer

reduction in TDS in general, and there is a noticeable change from 3430 to 3310 (mg/l) when the period of exposur increases by repeating the manetization process. Studies have also shown the possibility of using salty water by treating it magnetically, and this leads to the dismantling of dissolved salt compounds and converting them into ions, which causes their decrease and consequently a decrease in TDS and elimination tothe harmful effects of TDS (Wassef, 1996).

Density of the collected samples were measured by utilizing a density pycnometer with a volume of 25 cm^3. The pycnometer was washed well with distilled water and acetone, and then its was weighted when it was empty (M_1). Then it was filled with the required liquid, closed tightly and dried from the outside, and its weight (M_2) was measured. The mass of the liquid was determined by applying Equation 1.

$$M = M_2 - M_1 \quad .. \quad (1)$$

The absolute liquid density is calculated from the following relationship:

$$\rho = \frac{m}{v} \quad .. \quad (2)$$

The measured density was the water density of the General Downstream Project and itwas 1.0298 g/ml on average. It is higher than the density of of pure water, which is 0.997 g/ml at a temperature of 25 degrees Celsius. This might be as a result of dissolved salts increase the mass of water without causing a significant change in its volume. Water density was measured before and after magnetization. The results showed that there are slight differences in the average values of water density (Table 2). This can be explained by the fact that water molecules are linked with each other by hydrogen bonds. These bonds may be double or multiple, up to tens of bonds. The level of union of water molecules with each other reduces the number of water groups connected to each other, and thus the density of magnetized water will decrease compared to the normal or non-magnetized water (Al-Hassan, 2011).

Daniel indicated that the boiling point of water decreases with the increase in its purity and the absence of salts (Daniel, 1990). The increase in the salinity of water as a result of the increase in the concentration of ions in the water leads to a decrease in the movement of these ions. This means a decrease in their energy. Consequently, the salty water needs more energy compared to the pure water. In other words, it needs a higher boiling point to disengage the ions first, then boil and evaporate secondly. Interestingly, it was observed that the value of the boiling point of magnetized

Table 2. Water property measurements

Times of treatment	Untreated water	one treatment	Two treatments	Three treatments
pH	7.85	8.36	8.43	8.50
TDS	3430	3400	3380	3310
Density	1.0298	1.0262	1.0241	1.0223
Boiling point	104	103	103	102
Surface tension	45.5032	44.3805	44.2754	44.2134
Dissolved oxygen	59	76	84	86
Turbidity In NTU	17	16	13	10

water is slightly less than that of non-magnetized water (Table 2). The reason behind this behavior could be that the magnetization of water contributed to reducing the salt effect as it gave higher energy to water ions and thus helped to disentangle the ions from some of them. Moreover, a decrease in the number of hydrogen bonds, and thus the escape of water molecules from the surface and evaporation will be faster and in a shorter period of time compared to saltyuntreated water.

The phenomenon of surface tension of water occurs as if it is covered by an elastic membrane, which leads to a shrinkage of the surface. The surface tension of water depends on the strength of the relationship between the water molecules itself as well as the pressure applied to it and the degree of salinity. When the bonding forces between water molecules and solute are greater than the cohesion forces between the water molecules themselves, the surface tension increases. Based on that the tension in salts solutions is greater and vice versa if the cohesive attraction between the liquid molecules is greater than the attraction with the solute molecules on the melt, the solute moves away and is concentrated more towards the surface (Daniel, 1990). The results of the present study (Table 2) showed that there is a decrease in the values of average surface tension of magnetized water compared to the normal water. This could be explained by that magnetization gives more energy to the water. Thus, the solute particles can be easily escape to the surface, which leads to a decrease in the surface tension of the water (AL-Mosuly, 2013).

As shown in Table 2, the results demonstrate that the values of dissolved oxygen in the magnetized water reached a value of 86 mg/l. This means that there is a significant increase in dissolved oxygen when water is magnetized. This is in accordance with the findings of Al-Mawsili, 2013 who found that when water is exposed to a magnetic field, the oxygen concentration increased by 10% and this percentage will positively affect the respiration and growth of the root system of plants (Brown *et al.*, 2009).

The final measured property is the water turbidity, it can be defined as the amount of light absorbed or scattered in a sample of water, and it is measured by a unit calledNTU (Units Turbidity Nephelometric), suspended matter, clay, organics, and microelements can contribute to increased turbidity (Al-Hassan, 2011). Turbidity measurement is an important indicator of the type of liquid. The presence of a cloud or fog inside any fluid is caused by small particles (suspended objects in the water) and often cannotbe seen with the naked eye, which is similar to smoke in the air. The high turbidity may mean the presence of high concentrations of harmful bacteria or algae (pesticides) or minerals. Therefore, a sudden change in the turbidity may be an indication of the presence of a new source of pollution (biological, organic or inorganic) in natural waters (Wassef, 1996). Brown and Foos, 2009 stated that measuring turbidity is a fundamental process in testing water quality (Brown, 2009). The results obtained in the present study (Table 2) showed that the magnetic field clearly and strongly affects values of turbidity. There is a significant reduce in the turbidity of magnetized water since it decreases from 17 t0 10 NTU.

In parallel with the measurements of the properties of magnetized and normal water. This water was used in the irrigation of two plants Legumes and barley. This process was performed to examine the effect of magnetization on the plantation and growth of the two plants. It is believed that field study can introduce useful results which can be used to improve agriculture. Lin and Yotvat, 1988 studied the effects of magnetizing irrigation water

Table 3. Germination

AL-Massab AL-Aam	Plant type	Planting date	The number of seeds sown	The percentage of germination	Growth (height in cm)			
					15 day	30 day	60 day	90 day
Legumes	Regular irrigation water	20/10/2020	50	19%	6cm	13cm	38 cm	49cm
	Magnetized irrigation water	21/10/2020	50	29%	8cm	19cm	46 cm	59 cm
Barley	Regular irrigation water	19/10/2020	100	82 %	12 cm	27cm	60 cm	71cm
	Magnetized irrigation water	20/10/2020	100	97 %	16 cm	30 cm	68 cm	82cm

and its agricultural applications. It was conducted that the magnetization treatment affected the quality of irrigation water (AL-Mosuly, 2013). As previously mentioned, the field experimentswere carried out at the Department of Chemistry, College of Science, University of Thi-Qar (Figure 3). The results of cultivation are listed in Table 3.

The results of monitoring germination speed, percentage of germination, as well as the average rate of rise of the barley plant indicate that there are significant differences between the magnetized and normal water (Table 3). It is apparent that the germination percentage is 97% for the magnetized water while it is 82 for the normal water. An increase with 15% was achieved when water was magnetized, and this means an increase in the productivity when the crops are harvested. The results listed in Table 3 also showed a clear variation in the growth of the plant, as well as in the height of the plant and the weight of the dry and fresh crop, as well as the average weight of the barley grain.

Likewise, for Legumes plant, the germination rate was 19% when irrigated with regular water, while it was 29% when watered with magnetized water (Table 3). It is clear from Table 3 that the growth of plants watered with magnetized water is significantly quicker than plants watered with untreated water. The germination and growth of the two selected plants are shown in Figures 4 and 5 for the barley plant and Figure 6 for the legumes plant.

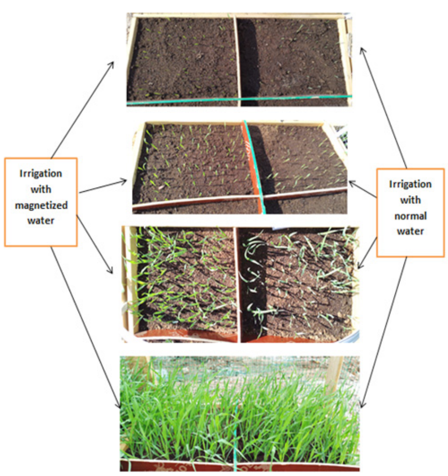

Fig. 4. The germination and plant growth of barely plant, the growth is after 10, 20, 30, 60, and 90 days.

Significant differences were also observed in the number of leaves, leaf area and main stem diameter.

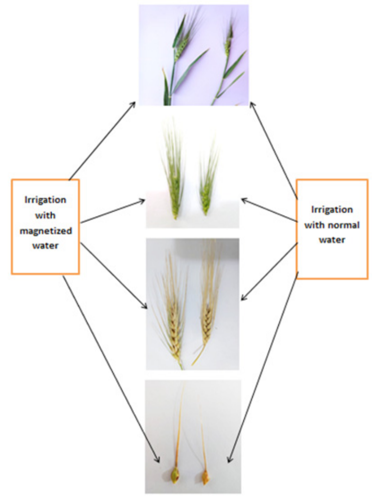

Fig. 5. The leaves and crops of barely plant.

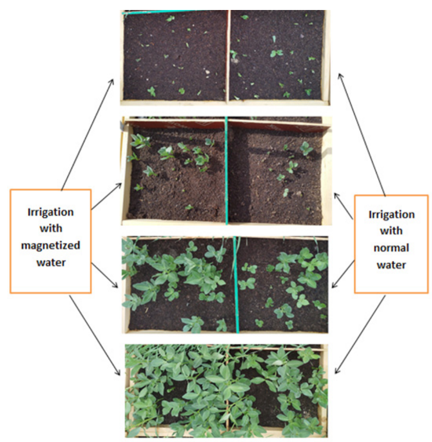

Fig. 6. The germination and plant growth of legumes plant, the growth is after 15, 30, 60, and 90 days.

This increase might came as a result of the low level of salinity, which is necessary for the growth and expansion processes of the plant cells, as well as in the absorption of water and ions and the building of plant hormones necessary for the growth, and thus led to an increase in the occasional expansion of cells. This matches with what was found by Mousavi; Chartzoulakis, who found that the decrease in stem diameter is a result of high salt levels that negatively affect the various other activities of plants (Alaa *et al.*, 2012; Ela, (2007).

Magnetic field might break the large crystals into small crystals, to pass easily through the capillaries of the roots of plants and the pores of the soil. Therefore,there is no significant decrease in the

(صورة ٥)

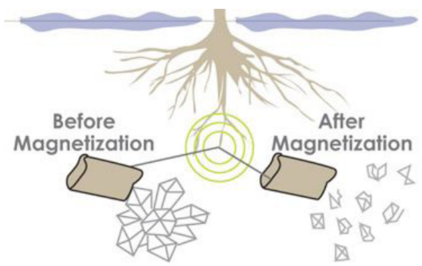

Fig. 7. The effect of magnetizing water on the fragmentation of salts (Reference)

amount of salts dissolved in water; however, salts harmful effect will be reduced noticeably. This is because the plant will take all its need only to grow. The rest of the salt crystals and other useless components will be easier to pass through the soil pores, to reach the ground water drains in the lower layers of the soil. The previous explanation is shown in Figure 7.

Conclusion

Magnetic water treatment technology is a simple and cost-effective method to be used in the agricultural sector to enhance the suitability of salty water for farming applications. In this paper, water of the river of AL-Massab AL-Aamin Iraq was investigated and magnetically treated. Some physical properties of the water were measured before and after the treatment. It was found that there was a change in The pH and TDS and dissolved oxygen. While there was no significant change in the density. It was also found that the magnetization of water enhanced the germination and growth of legumes and barely plants.

References

Al-Ani, S.N. 2008. *Effect of magnetization of irrigation water on some physical properties of calcareous and gypsum soils and growth of maize zea mays.* Master Thesis, Dep Soil Water Sci Coll Agric - Univ *Baghdad.*

Alaa, A. A., Ali, A. and Jalal, H. H. 2012. Magnetic water treatment technology and its effect in the agricultural field. *Sci Bull Fac Agric Univ Baghdad* 25.

Al-Hassan, S. 2011. *Environmental pollution in Basra City*, Iraq. PhD thesis Coll Arts, Univ Basra.

AL-Mosuly, M.A. 2013. Magnetic Water. Published online.

Altamimi, Deia, A.M. and Bed, A. 2014. The effect of the source of irrigation water, magnetization and spraying with some materials that are resistant to environmental stress on the growth and yield of cucumbers in the protected environment. *Diyala J Agric Sci.* 179-186.

Ayers, R.S. and Westcot, D.W. 1985. Water for Agr Water Uality for Agriculture. 1 : 1985.

Brown, M.T. and Foos, B. 2009. Assessing children's exposures and risks to drinking water contaminants: a manganese case study. *Hum Ecol Risk Assess.* 15(5): 923-947.

Daniel, H. 1990. *Fundamentals of soil physics.* Book. This Infor: 16-18.

Ela, W.P. 2007. *Introduction to Environmental Engineering and Science.* 3rd ed.

Gallon, P.A. 2004. The magnetizer and water, internet. Life streams international Mfg. Co 24.

Gang, X., Yunjing, Y. and Song, X. 1995. Research on the Effect of Difference Upon Germination and Growth of Wheat with Different Resistance in the Treatment of Magnetic Fields [J]. Agric Reseach Arid Areas2.

Harichand, K.S., Narula, V. and Raj, D. 2002. Harichand, K. S., V. Narula, D. Raj and G. Singh. 2002. Effect of magnetic fields on germination, vigour and seed yield of wheat. *Seed Res.* 30 (2) : 289-293. Published online 2002.

Hong, C., Guolin, Z. and Gaoqing, L. 1997. Preliminary Studyof BiologIcal Effectionof Maize Soakedin the Magnetized Water. *Acta Bot Boreali-occidentalia Sin.* 17(6) : 91-94.

Kredy, H.M. 2006. Study of the environmental determinants of the water of the Euphrates River in Dhi Qar Governorate. *Univesity Thi-Qar Journal* 2(2) : 1-5.

Lowe, S. 1996. The Mechanism of the Vortex Water Energy System. Help Agric Environ through 21st Century, Fluid Energy Aust.

Reminick, H. 2001. Effects of Naturally Magnetized Water On Increasing Organic Bioenergy and Function. Fluid Energy Aust. 10(4).

Sarhan, A.H. and Al-Sheikhly, A.H. 2011. Influence of Irrigation Intervals and the Distance Between Emittersupon the Moistureand Salt Distribution insalty soll. *Journal of Techniques.* 24(5) : 141-154.

Schroeder, G.T. 1985. Water quality Characteristics-Modeling-Modification.

Takatshinko, Y. 1997. Hydromagnetic systems and their role in creating micro climate. In: International Symposium on Sustainable Management of Salt Affected Soils, Cairo, Egypt 22 (28).

Vasilevski, G. 2003. Perspectives of the application of biophysical methods in sustainable agriculture. *Bulg J Plant Physiol.* 29(3) : 179-186.

Wassef, D.R.K. 1996. New magic formula. Magnetized water treats diseases, accelerates plant growth, and solves industry problems. Magnetic technique. Al Khaleej.