



كلية الهندسة - جامعة بغداد

Association of Arab Universities Journal of Engineering Sciences

مجلة اتحاد الجامعات العربية للدراسات والبحوث الهندسية



اتحاد الجامعات العربية

Treatment of Salt Water for Irrigation by Magnetization Integrated with Forced Vortex

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Published online: 31 March 2023

Abstract— Recent studies have indicated that it is possible to obtain many positive effects on the properties of irrigation water when exposed to a magnetic field at specific intensities and time. In this research, the impact of applying the magnetic treatment with an intensity of 3000 Gauss merged with vortex on irrigation water was studied. The study was conducted at the laboratories of the Iraqi Ministry of Science and Technology to evaluate the effects of the vortex magnetic system on salt water on the germination of barley crop. The seeds were planted in pots with clay loam soil. Salt water was used after treated with the magnetic and vortex techniques separately and by using both techniques together. Three discharges were used, these are 0.25, 1.0, and 4.0 l/min. Three replications were conducted for each treatment and discharge. The results of field experiments of barley crop for the three treatments were compared with the experiments with untreated water, control. The results showed that the effect of vortex and magnetic system provide positive effects on germination rate. The highest percentage of increase was 60% at the lowest discharge compared to untreated water. Moreover, the treatment with both vortex and the magnetic positively impacted the stem height and root length. The highest percentage of increase was 69.23% in stem height and 75% in the root length as compared to the control.

Keywords— Water treatment, vortex, germination, magnetic field.

1. Introduction

Agricultural production is essential for any national to ensure food security. It is necessary to work to improve this production and the water quality used for irrigation by following modern scientific techniques.

The use of low-quality water for irrigation has become important with the shortages of available water and the increasing demand. The benefits of applications magnetic techniques in many fields encouraged researchers in the fields of irrigation to study its effects to improve some characteristics of salt water. Using a magnetic field is one of the treatments to overcome this challenge.

Treating water within a magnetic field change and dissociates hydrogen bonds between molecules, which leads to change many properties of water such as the electrical conductivity, the percentage of dissolved oxygen, the ability to dissolve salts and acids, the surface tension, and changing the rate of chemical reactions. Electrophoresis, increasing the permeability, which makes the water active for energy and flow more than it was, Fahad et al. [2].

There are many studies related the magnetic treatment of irrigation water to the increase of the growth of crops. Such studies are the experiment of Abedinpour and Rohani [9], they studied the effect of magnetic field technology on improving the germination of maize seeds by passing irrigation water through a magnetic field with different

salinity levels having electrical conductivities of 0.5, 2, 4 and 6 dS/m. The use of magnetically treated irrigation water improved the germination parameters, decreased the soil pH, and increased the electrical conductivity of the soil from 7.6 to 10.2, from 9.1 to 11.1, from 10.3 to 13.3, and from 11.8 to 13.3 dS/m. When magnetic treatment uses different salinity levels, the rate of nitrogen is increasing. In general, the maize growth coefficients were improved by using magnetic technology with saline water, while its effect was negative to increase salinity without magnetic treatment.

Elhindi et al. [6], investigated the effect of magnetization of water on the growth and productivity of *Calendula officinalis* L. plants. Three types of water were used, tap water as a control, well water, and magnetized well water, applied on two types of soil. The results showed that irrigation of *Calendula officinalis* L. plants with magnetized water improved the vegetative and flowering growth parameters, while irrigation with saline well water negatively affected growth and flowering compared to tap water. This indicates the role of magnetization in decreasing the harmful effects of salinity in irrigation water.

Laboratory experiment to evaluate the depth of infiltration on two types of clay and sandy soils conducted by Alzubaidy et al. [14] showed that the magnetization of the water increases the accumulated infiltration depth and the hydraulic conductivity for both soils. The highest results for the infiltration rate when using magnetized water for clay and sandy soils were 98.2% and 34.2%, respectively, when compared with untreated water.

The field experiments study conducted by Massah et al. [5] that was conducted to study the effect of magnetic field on two types of water, that is ground water and distilled water on the germination of Wheat seeds showed that the germination rate of wheat seeds when magnetizing distilled water and groundwater was higher by 53.3% and 20% than the germination rate of seeds irrigated with distilled water and groundwater without magnetization, respectively.

Samarah et al. [12], conducted three experiments to evaluate seed germination and seedling growth of Tomato crop using saline water after exposing it to a magnetic field. The experiments were carried out by passing four salt water concentrations of NaCl, of 0,5,10 and 15 dS/m, through a magnetic field of with a range of 3.5 to 136mT and exposing the Tomato seeds to the same magnetic field for 20 minutes before sowing. In the greenhouse experiment, plants were irrigated with magnetically treated saline water and untreated saline water for comparison purposes. Magnetic treatment of salt water and seeds improved seed germination percentage, germination fast, seedling length and dry weight of Tomato crop under saline conditions. The higher of salinity level, the performance of germination and plant growth decreased significantly compared to the untreated water.

Mohammed [1], studied the effect of magnetic treatment on Tomato growth, five concentrations of saline were used water passing through magnetic with three replicates of pot experiment using magnetic and non-magnetic treatment. It was noticed that an increase in Tomato growth and productivity was occurred when using magnetized water for irrigation.

Abd [3], carried out a study on the effect of magnetized saline irrigation water on seed germination and seedling growth of bread Wheat in Iraq. Three levels of salt concentrations of water were treated with magnetic field were used and compared with raw water without magnetization as a control. The results indicated that the magnetic field significantly stimulated the vegetative growth of seedlings and increased the percentage of germination and faster of germination compared to the control.

Marie et al. [11], proved that magnetic treatment of irrigation water and seeds had a positive effect on the germination rate of three types of field crops, hard Wheat, bread Wheat, and white barley in a sandy-loam soil texture, they achieved higher productivity when using magnetic treatment of irrigation water.

Abd et al. [10], conducted field experiment on wheat and barley crops that indicated there is increase in the vegetative growth rate and productivity of the crops when exposing irrigation water to the magnetic field.

Abdulraheem and Jameel [8], noticed that it is possible to use a magnetic field to treat saline water that can improve plant growth. They used different levels of salinity for irrigation water on the growth of sunflower plants. The results showed that exposing the used irrigation water to a magnetic field has valuable effects on the growth of sunflower plant.

Abdul-Raheem and Azzubaidi [7], applied a laboratory experiment to get remove of salts in three types of clay, silty and sandy soils. Soil samples were tested for EC, positive and negative ions. The results showed that the efficiency of magnetized water in removing salts from the soil is higher than untreated water. With the increase of magnetic intensity and exposure time, the infiltration of salts from the soil increased. When comparing experiments conducted with magnetized water with in the untreated water, the highest increase in EC value was 58.6%, and in pH values was 2.4%.

The Fractal Water Company [4], the manufacturer of vortex device, carried out some field experiments on plant growth. The vortex effects were experimentally studied on a seed germination growth by connecting the vortex and magnetic to a water reservoir as an irrigation source. The water of reservoir pumped into the vortex, and back into the reservoir on a continuous or timed loop setup. The water recycled multiple times, making it more effective after each pass. They found a 68% increase in germination growth compared to untreated water. They conducted an experiment on sunflower seeds grown in two containers,

the first was irrigated with tap water and the other was irrigated with water passed through the vortex and magnetic. The difference was significant in more growth on the container that was irrigated with vortex and magnetic in addition to the difference in green growth is clearer. Vortex and magnetic produces effective regulated energy water that improves seed germination and nutrient absorption and increases germination by up to 50% more than tap water. The company conducted an experiment on greenhouse hydroponics to note the differences that water quality can make in plant performance. The difference was evident in crop health and growth when using high quality water under real growing conditions. Treated water by vortex and magnetic improves greenhouse, it was accelerated seed germination, and reduced time by 5 days. Moreover, the Fractal Water Company noted that treated water by vortex and magnetic provides a higher level of water and general health for crops, animals and people.

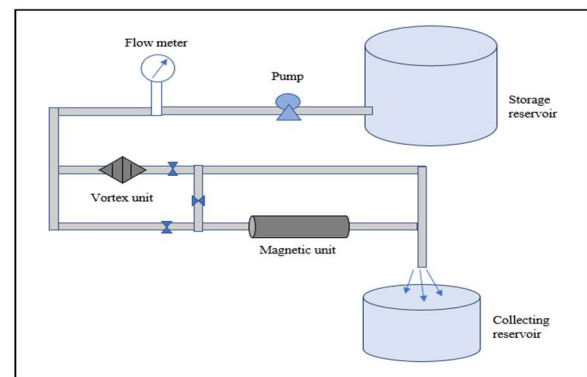
In this research, the effects of the vortex system combined with magnetic treatments on improving salt water for germination of the barley crop and the possibility of using salt water for agricultural purposes were studied. Barley crop is one of the crops that is characterized by many benefits, it is one of the crops that humans and animals feed on, barley is characterized by its ability to grow in any conditions and any soil and can be irrigated with salt water. The germination rate, stem height and root zone length of the barley crop will be measured. The results of the properties of germination for barley crop using water treated with vortex magnetic system will be compared with the untreated water.

2. Materials and Methods

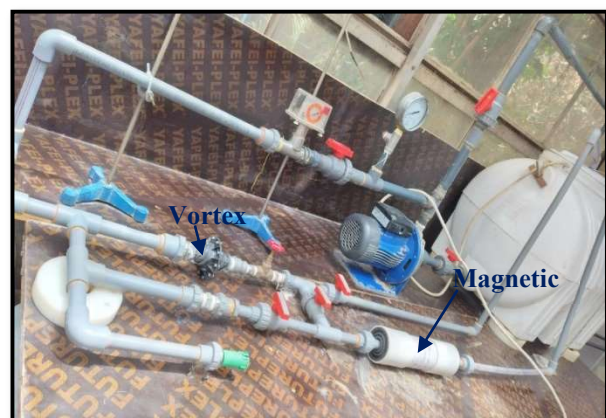
A clay loam soil having a weight of 200 g placed in pot with a diameter of 7 cm. Thirty pots were prepared. Ten seeds of barley crop were planted in each pot. The pots were irrigated from the salt water. Three treatments were used for the salt water. The first, second, and third treatments are by using vortex, magnetization, and vortex and magnetization together, respectively. Three different discharges were applied in each treatment that is 0.25, 1.0, and 4.0 l/min. The process of magnetization of irrigation water was carried out by passing it through a magnetic field with an intensity of 3000 Gauss. Three replicates of each pot under a same condition of the irrigation water were made to ensure the validity of the results. So, that the number of pots included in the experiments are 30 pots. The germination of the seeds was measured. The seedlings continued to grow for twenty days, after which measurements were taken on the developing seedlings included measuring the length of stem and root parts. The results of germination of barley crop using treated water were compared with the results using untreated water. All of the required tests were conducted at the laboratory of Water Research Center of Environment and Water Directorate of the Ministry of Higher Education and Scientific Research, and Science and Technology.



Figure 1 shows the vortex magnetic treatment system installed in the laboratory. It consists of a water reservoir, pump, vortex unit and magnetic unit. The water flows through a plastic pipe with a diameter of 0.5 inch. Six valves were used to control of water flow, the first one is installed at the outlet of reservoir, the second is placed after the pump and the third was installed to control of the water returning to the collection reservoir. The fourth valve was installed to control the water passing through the vortex, the fifth valve was used to control the water out of the magnet, and the sixth valve was installed to connect the vortex with the magnetic unit.



a- Schematic showing system.



b- System installed in laboratory.

Figure 1: Vortex magnetic treatment system.

The details of a vortex unit are shown in **Figure 2**. It is a perfect symmetry in its function, uses amazing principle to spin. The principals of spinning water into a vortex for the

purpose of structuring water are to use directional nozzle to create a water vortex in perfect symmetry. Water flows into the first chamber, then it flows through 5 channels, which are shaped as a spline on a cone. All 5 channels meet together on the output and spiral together. The vortex is created with silky smoothness of the highest quality. Water reacts to touch because of the nature of the vortex energy created. This silky smoothness ensures that water is properly structured when passes through magnetic system designed with high flux intensity magnets. This vortex unit was purchased from Fractal Water Company, USA.

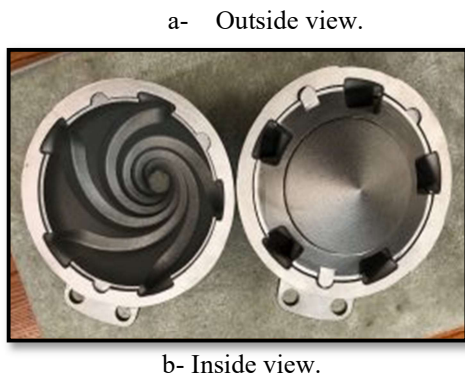


Figure 2: The vortex unit.

The Magnetic unit, shown by Figure 3, was used for treatment saline water with magnetic intensity at 3000Gauss. This magnetic was produced by the Directorate of Environment and Water of the Ministry of Science and Technology.



Figure 3. The magnetic Unit.

Table 1 shows the salt water properties tested before treatment for saline water sample for control and after vortex treatment (V), magnetic treatment (M), and vortex and magnetic treatments (VM). According to the presented values of EC and TDS by the Food and Agriculture Organization guidelines for irrigation and livestock drinking, Ayers and Westcot [13], a slight to moderate degree of restriction must be taken into consideration on use this quality of untreated water for irrigation.

Table 1: Some tested properties of the used irrigation water samples.

Parameter	Control	Type of treatment		
		V	M	VM
pH	7.3	7.8	7.6	7.1
EC $\mu\text{s/cm}$	3100	3430	3420	3430
TDS ppm	1182	1513	1507	1513
SO ₄ ppm	370	392	330	395
Ca ppm	220	250	241	252
Mg ppm	85	79	82	78
Na ppm	250	300	320	330
Cl ppm	350	400	420	400
T.H ppm	900	950	940	950
ORP mv	-15.9	-34.9	-31.5	-4.7

To investigate the effects of the vortex magnetic treatments system on the barley crop, three different discharges of water were applied, these are 0.25, 1.0, and 4.0l/min. Water flow is controlled by the valve at the outlets of the pump. For comparison purposes, the system was operated by using untreated water and magnetically treatment water without vortex treatment. The coding used in the experiments is that V, M, and VM. The letter V refers to the vortex treatment. The letter M refers to the magnetic treatment and VM refers to the use of both vortex and magnetic treatment.

3. Results and Analysis

Table 2 shows the mean germination rate of the barley seeds irrigated with saline water when using the three treatments, V, M, and VM with the three applied discharges. The germination rate without treatment (control) was five. When using treatment with V and discharge of 4.0 l/min, the highest percentage of germination increased over the control by 20%. The highest germination percentage obtained when using M treatment was 40% at a discharge of 1.0 l/min. But when using the treatment with VM, the highest percentage of increase in germination was 60% when using discharge of 0.25 l/min. Appendix A, shows the growth snap shot of the barley crop after germination.

Table 2: The mean of germination rate of barley crop after two weeks.

Type of treatment	Number of seedlings		
	Discharge, l/min		
	0.25	1.0	4.0
V	4 (-20%*)	5 (0%)	6 (20%)
M	6 (20%)	7 (40%)	6 (20%)
VM	8 (60%)	7 (40%)	3(-40%)

* Represents the percentage of difference as increase or decrease compared to the seedlings without treatment.

Table 3 shows the measured stem height of barley crop. Stem height without treatment was 6.5 cm. When using the V treatment, the highest percentage of increase was obtained when using a discharge of 0.25 l/min was 38.5% compared to the control. When magnetization was used, the highest percentage of increase from the control at discharge 0.25 l/min was 53.85%. But for the VM treatments, the highest percentage of increase as compared to the control was 69.23% when using the discharge of 1.0 l/min.

Table 3: The mean of the measured stem height of Barley crop after two weeks.

Type of treatment	Mean stem height, cm		
	Discharge, l/min		
	0.25	1.0	4.0
V	9 (38.5%*)	8 (23.08%)	6.5 (0%)
M	10 (53.85%)	9 (38.5%)	8 (23.08%)
VM	9 (38.5%)	11 (69.23%)	8 (23.08%)

* Represent the percentage of difference as increase or decrease compared to the seedlings without treatment.

The results of measured root depth of barley crop after two weeks from seedling shown in **Table 4**. The average root depth without treatment (control) was 4 cm. For using vortex, the highest percentage of increase was recorded when using the discharge 1.0 l/min was 50% compared to the control. At magnetization was used, the highest percentage of increase from the control at discharge 0.25 l/min was 50%. But when using the vortex and the magnetic together, the highest percentage of increase was 75% from the control when using the discharge 4.0 l/min.

Table 4: The mean of the measured root depth of barley crop after two weeks.

Type of treatment	Mean root depth measured, cm		
	Discharge, l/min		
	0.25	1.0	4.0
V	5 (25%*)	6 (50%)	5 (25%)
M	6 (50%)	6 (50%)	5 (25%)
VM	5 (25%)	5.5 (37.5%)	7 (75%)

* Represent the percentage of difference as increase or decrease compared to the seedlings without treatment.

4. Conclusions

In this study, the effects of the vortex magnetic system on treating and improving the saline water was investigated to be used to irrigate barley crop. Germination, stem height, and root length of the barley crop were evaluated and compared to the results of the untreated water. The following conclusions were achieved:

- 1- The vortex and magnetic system positively affected the germination rate. The highest percentage of increase as 60% in germination was recorded at the lowest discharge of 0.25 l/min as compared to the control.
- 2- The use of vortex and magnetic treatment a positive effect on the rate of stem height. The highest percentage of the increase was 69.23% compared to the control.
- 3- The effect of the vortex and the magnetic treatment was clearly on the average root length of barley crop, as compared to the control; the highest percentage of increase was 75%.

5. Recommendations

It is recommended to continue experimental investigations on the use of vortex treatment of water integrated with the use of magnetic with other different intensities to understand its effects on other water quality parameters and on plant growth.

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Appendix A

Below a snap shot showing the germination of the barley crop after two weeks:



Figure A-4: Barley crop without treatment, the control.

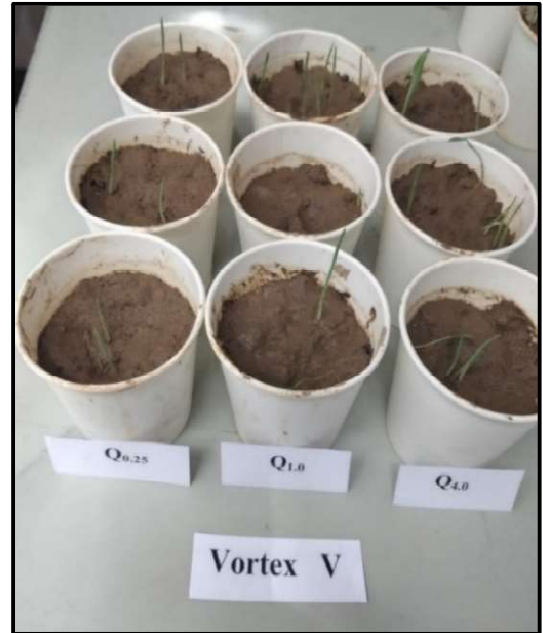


Figure A-5: Barley crop with V treatment.

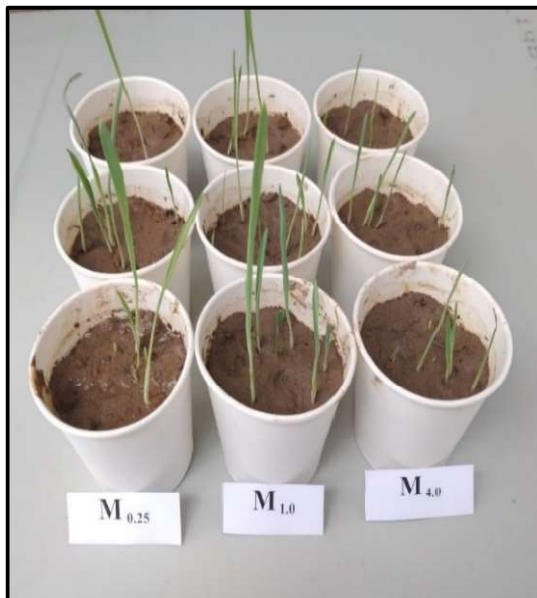


Figure A-6: Barley crop with M treatment.



Figure A-7: Barley crop with VM treatment.

معالجة المياه المالحة للري بالمغنطة المتكاملة مع الدوامة القسرية

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نشر في: 31 اذار 2023

الخلاصة – أشارت الدراسات الحديثة إلى أنه من الممكن الحصول على العديد من التأثيرات الإيجابية على خصائص مياه الري عند تعريضها لمجال مغناطيسي بشدة وزمن معينين. في هذا البحث تمت دراسة تأثير تطبيق تقنية المعالجة المغناطيسية بشدة 3000 كوس معززة بتقنية الدوامة على مياه الري. أجريت الدراسة في مختبرات وزارة العلوم والتكنولوجيا العراقية لتقييم تأثير منظومة الدوامة المغناطيسية على المياه المالحة على إنبات محصول الشعير. زرعت البذور في أصص ذات تربة مزيجية طينية. تم استخدام المياه المالحة بعد معالجتها بتقنيتي المغناطيسية والدوامة كلاً على أفراد وباستخدام كليهما معاً. تم استخدام ثلاث تصاريح وهي 0.25 و 1.0 و 4.0 لتر/ دقيقة. أجريت ثلاث مكررات لكل معالجة وتصريف. تمت مقارنة نتائج التجارب الحقلية لمحصول الشعير للمعالجات الثلاثة مع التجارب باستخدام المياه غير المعالجة، السيطرة. أظهرت النتائج أن منظومة الدوامة المغناطيسية لها تأثيرات إيجابية على معدل الإنبات. أعلى نسبة زيادة كانت 60% عند أقل تصريف مقارنة بالمياه غير المعالجة. علاوة على ذلك، أثرت المعالجة بالدوامة والمغناطيسية بشكل إيجابي على ارتفاع الساق وطول الجذر. أعلى نسبة زيادة كانت 69.23% في ارتفاع الساق و 75% في طول الجذر مقارنة مع السيطرة.

الكلمات الرئيسية – معالجة المياه ، الدوامة ، الانبات ، المجال المغناطيسي.