J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 5 (8): 1105 - 1124 , 2014

EFFECT OF MAGNETIZED WATER ON SOME PHYSICAL AND CHEMICAL PROPERTIES OF THE CALCAREOUS SOIL AND GROWTH OF TOMATO PLANTS.

Hassanein, A.H.A.
Soils, Water and Environment Research Institute, Agricultural ResearchCenter, Giza, Egypt.

ABSTRACT

This study aimed to Quantify the performance of magnetically treated Nile water, and saline water on plant growth, and nutrient content of Tomato, anddetermine the changes in soil properties due to irrigation with magnetically treated water.This study aimed mainly at investigating the effect of different irrigation water qualities on redistribution of soluble salts in soils due to intermittent leaching. It aimed also at studying effect of using these waters after being treated with recent magnetic technologies on seed germination, seedling emergence and redistribution of soluble salts in soils, to provide better soil water plant relation. To fulfill the objectives of this investigation three different soils were selected for conducting this study i.e. clay, calcareous and sandy soils under five types of irrigation water quite different in qualities i.e. tap water, three types of moderately saline water and one type of highly saline water. Tow laboratory experiments were conducted, the first and the second experiments were laboratory ones by using soil columns subjected to intermittent leaching with different water qualities applied at volume equal to 1.50 times the soil water saturation capacity. In the first experiment, effect of sequence of different water qualities on the redistribution of soluble salts and exchangeable ions in soil was examined. In the second experiment, effect of the previously mentioned water qualities after being magnetized, on redistribution of salts within the different depths of soil columns was also under taken. A greenhouse experiment was conducted to study the effect of magnetizing irrigation water on some chemical properties and plant dry weight yield. A germination experiment was conducted to clarify the effect of magnetizing the used waters on both germination percentage and rate. The obtained results reveal that, increasing salinity level of irrigation water gradually and significantly increased soil EC, $Cl^-$and $SO4^{2-}$ concentration. The concentrations of soluble Ca^{2+}, Mg^{2+}, K^+ and Na^+ were sharply increased as salinity levels of irrigation water increased. Usage of magnetized waters resulted in percentages and rates of germination to increase at a high level of significance compared with the corresponding ones of the nonmagnetized (untreated) waters. Moreover magnetized water was shown to have two main effects, the first, increasing the leachability of soluble salts and the second, lowering soil sodicity.

Keywords: Salts redistribution - magnetized water- calcareous soil - soluble salts - intermittent leaching – tomato plants.

INTRODUCTION

Agricultural production is one of the most basic elements contribute to the economic income and food security, despite the problems that accompanied such as lack of water, desertification, salinity and low yield. These problems can be remedied relatively using a technique of magnetic treatment of water. This technique has become the focus of researchers compared the physical ways and other chemicals, as provided by the purity of the environmental and health safety and easy to use.

On the other side, climate change has made the situation worse by reducing the amount of rainfall and increase irrigation-water requirements as higher temperatures will cause more evapotranspiration. Under the population pressure in Egypt country, the need to provide additional land for farming to increase food production to support the acceleration of population growth compels the country to use all sources of low quality water. The use of low quality water for agricultural production in water scarcity regions requires innovative and sustainable research, and an appropriate transfer of technologies. There is a pressing need for a system as magnetic field that can help in using low quality water. That ongoing study in this area was to understand this phenomenon and take advantage of the applied fields, the fact that physical ways are effective, cheap, and increase the yield without causing any damage to the environment.

Many claim magnetized water gives increased performance in regards to scale reduction *(Alim et al 2006)*, increased crop yields *(Lin &Yotvat, 1990)*, health benefits *(Yueet al.1983)*, change in pH *(Busch, & Busch 1997)*, water tension reduction *(Cho & Lee, 2005)* and increased cement compressive and tensile strength (Nan *et al.* 2000).*El Said (1990)* concluded that increasing salinity level in irrigation water from 1 mM to 150 mM delayed and reduced germination percentage for all tomato varieties.

In previous studies, the germination and growth of tomato seeds magnetically treated have been evaluated; the authors have found that magnetic treatment produces a biostimulation on initial growth stages and an early sprouting of several seeds *(Amaya et al., 1996 and E. Martínez et al.2009). Selim (2008)* indicated that magnetized water induced changes in mobility of nutrient elements in root zone differed greatly from element to another according to element magnetic susceptibility. Also, *Souza et al. (2005)* reported that, in the nursery stage, the treatments of the Magnetized led to a significant increase in root length, fresh and dry root weight, stem length, fresh and dry stem weight, leaf area and dry weight. Specifically, at the fruit maturity stage, the magnetically treated seeds produced plants with significantly more fruits (17.9-21.3%), with a significantly greater mean fruit weight (22.3-25.5%), and with a greater fruit yield per plant (47.3-51.7%) and per area (48.6-50.8%) than did the control plants. According to *Ahmed Ibrahim (2013)* the results showed that the using of magnetic with saline water had the valuable effect on soil and plant. The electrical conductivity of the soil was decreased with using magnetic saline water in irrigation sandy soil. The improvement in plant growth parameters which reflected in yield per plant was increased until the treatment of 6000 ppm magnetic water, and there were statistically significant increases in plant growth and some chemical contents of Tomato plant. The results of the current study demonstrated that magnetic treatments improved fresh and dry weights of Tomato plant compared to control. On the other hand *Dunand et al, (1989)* showed that irrigation with magnetized compared with ordinary water increased growth of tomato, onion, maize, peppers and beans by 19.5, 67.6, 24.7, 8.5 and 19 % respectively. *Fernandez et al, (1996)* found that magnetized irrigation water increased bulb of onion weight (from 64.12 to 82.85 g) and diameter (from 51.96 to 57.92 mm) compared with untreated water but also encouraged weed growth.

Amaya etal, (1996) found that, when tomato, lentil [Lens Culinaris] and thistle seeds were subjected to magnetic treatment, germination percentage, length and weight of stem and entire seedlings, measured 4-15 days after sowing, were all significantly increased*. Hilal and Hilal (2000)* reported that full wheat germination of 100 % was obtained after 6 days for magnetic treatment compared to a rate of 83 % after 9 days for normal practice.*Guo Liang et al., (1994),* reported that magnetizing seeds is very efficient to increase the number of germinating seeds and to hasten the germination process. However, very recently, magnetic technologies has still fact in different approaches of our live, available review on the application of magnetize seeds and water in agriculture is very limited.

In general, the effect of salinity on plant may vary depending on the stage of its development. For instance, sensitivity may by quite different during germination than at later growth stage and fruiting. Some crops may be more or less affected in vegetative growth also some varieties may fail to give good germination even at EC of 4 dSm^{-1} of water whereas, others may do well up to 20 dSm^{-1}. It is not necessary that varieties, which are tolerant at germination stage, should do equally in final yield *(AbdElaal, 1989).*

It has been mentioned by *ElSharawyet*al*, (1997)* that the uptake of N, P and K significantly decreased with increased salinity level of irrigation water due to reduction in dry weight of wheat plants**.** *Aichetal, (1998)* on the other hand, found that upon application of three grades of brackish water (EC 0.7, 2.5 and 5.0 dSm^{-1}) N and P increased but K decreased in rice grown on pots as salinity increased. Generally, plants showed higher concentration of N and P at higher salinity, which may be associated with stunted growth of the plants caused by excessive Na.

Regarding the N uptake**,** *El-Ghanam (1993)*found that nitrogen uptake by corn plants was decreased from 125.0 to 14.0 mg/pot in case of light-textured soil and from 111.0 to 47.0 mg/pot in case of heavy textured one with increasing soil salinity from EC 4 to 16 dSm-1. Also, he found that N-uptake by corn plants was reduced from 130.0 to 26.0 mg/pot and from 155.0 to 78.0 mg/pot for light and heavy textured soils with increasing soil sodicity from ESP 10 to 25.*Mostafaetal, (1992)*found, in a greenhouse experiment conducted by using clay, calcareous and loamy soils that the use of saline irrigation water showed a depressive effect on soil available P as compared with the control treatment, while decreasing salinity level from 1500 to 750 mgL^{-1} somewhat increased available P in the studied soils. In this respect, irrigation with different water qualities showed no significant effect on total nitrogen content in the investigated soils.*Mass and Poss (1989)***,** *Al-Sager (1991) and Chauhanetal, (1991)*indicated that potassium content of wheat plants sharply decreased as the salinity of irrigation water increased up to 28 dSm^{-1}. K- content of corn plants was decreased from 2.56 to 1.52% in case of sandy soil and from 3.48 to 2.34 % in case of clay soil as the soil salinity increased from EC 4 to 16 dSm^{-1} in both soils.The adverse effect due to soil salinity on K-uptake was reported by*Janardhanetal*, *(1979), Rabieet al,* *(1985) and Dravid and Goswami (1986)*claimed that K-uptake by wheat plants significantly decreased with increasing soil salinity up to 14.9 mmohs/cm. Almost similar observations were recorded by*Nouretal, (1989)*who found that potassium uptake by wheat seedlings grown on a clay loam soil was decreased with increasing the soil salinity from 0.2 to 0.4%.

On the other side, *Mostafa et al, (1992)* found a high and significant increase in concentrations of Na^+ and K^+ in soil as the salinity of irrigation water increased. They also, reported that increasing salinity level of irrigation water up to 4000 mgL^{-1} slightly and negatively affected HCO_3^- concentration in calcareous and loamy soils. *Somaya et al, (1993)* reported that, the concentration of most cations and anions increase with increasing salt concentration in irrigation water. The cation concentrations are in the following order in all locations $Na^+ > Ca^{2+} > Mg^{2+}$, but the anions concentrations are in the descending order $SO_4^{2-} > Cl^- > HCO_3^-$ in the same areas. Also,*Alimi et al. (2006)* magnetized irrigation water has also induced changes in solubility of some soil components such as $CaCO_3$ and gypsum. Magnetized irrigation water was also effect on seed germination, full seed germination of 100 % for wheat, barley, tomato and pepper after 6 days from sowing compared to a rate of 83, 86, 78 and 74 % after 9 days from sowing for untreated one, respectively.

According to *Bogatin et al (1999)* an increase in the amount of CO_2 and H^+ in alkaline soils is similar to the addition of fertilizers. In wet soil, CO_2 forms H_2CO_3, which converts insoluble carbonates into soluble bicarbonates. Bicarbonates exchange with Na of the cation exchange complex. As a result of the exchange reaction, Na is removed from cation exchange complex into the soil, which improves properties of alkaline soils and accelerates their leaching.

Zhu et al, (1982) found that the desalinization was 29.5% greater due to the first leaching and 32.7% greater due to the second leaching with magnetized water compared with untreated water.

Tkatchenko (1997) has introduced a set of dipole magnetic units for magnetizing irrigation water. Efficiency of using such units for the magnetic treatment of water depends upon water chemical composition. Maximum magnetic effect is obtained for hydro carbonate (HCO_3^-) water. Such effect weakens for Cl^- water and hits its low for water of the sulphate class. *Bogatin (1999)* concludes from their findings that MWT induces an increased yield by 10-15%, a more intensive root formation, the transfer of phosphorus fertilizers into more soluble form and a decrease in the risk of secondary salinization of soil. The magnetic treatment improves conditions of root layers due to (a) leaching of superfluous salts (b) better permeability of irrigated water and (c) better dissociation of mineral fertilizers.

The experiment of *Oleshko et al., (1981)* and *katchenko, (1997)*, Highlight the using cheap magnetic energy to improve the properties of soil and water quality. Also, *Tackashinko, (1997)* stated that the possibility of using magnetized water to desalinate the soil is accounted for the enhanced dissolving capacity of the magnetized water, which has been registered repeatedly. He added that magnetized water removed 50 % to 80 % of soil Cl^-, compared to a removal of 30 % by normal irrigation water. *Zhu et al.,* *(1986)* has also reported that laboratory tests have showed that desalination of a saline soil was 29 % greater in the first leaching and 33 % greater in the second leaching with magnetized water compared to untreated water. *Hilal and Hilal (2000)* found that magnetizing saline water led to better salt salability. They reported that irrigation of a sandy loam soil with highly water led this soil to retain salts in higher amounts compared with those retained upon irrigation with magnetized saline water.

Tai et al (2008) showed that their water sample's pH decreased from pH 9.2 to 8.5 after magnetic treatment. *(Busche et al, 1997)* showed an initial decrease in pH of 0.5 pH units from 7.0 to 6.5, followed by a gradual increase throughout the time of the experiment to pH 7.5 – 8.0. *Parsons et al (1996)* also recorded a decrease of 0.5 pH units after passing water through a MTD.

Under Egyptian condition, application of magnetic technologies is new concept. Therefore, the present study aims to evaluate the applicability of using of magnetized low quality water in irrigation of Tomato plant. Also, some of the soil chemical changes were evaluated.

MATERIALS AND METHODS

A field experiment was carried out during the season of 2011 on a calcareous soil at AbouMasooud village (48 Km south-west from Alexandria) Alexandria Governorate, Egypt. Some physical and chemical properties of the studied soil are presented in Table (1) analyzed according klute (1986) and Page *et al.* (1982).

Table (1): Some physical and chemical properties of the soil under investigation.

Practical size distribution	**EC (dS/m) 11.00**
Clay (%) 30.10	Cationsmeq/L :
Silt (%) 23.50	Ca^{2+}34.12
Fine sand (%) 35.30	Mg^{2+}28.00
Coarse sand (%) 11.10	Na^{+}61.95
Textural class : Sandy clay loam	K^{+}3.30
$CaCO_3$(%) 28.50	Anions meq /L :
K (cm/hour) 1.00	CO_3^{2-}Nil
SP (%) 47.00	HCO_3^{-}4.61
WP (%) 10.81	Cl^{-}74.40
Total porosity (%) 48.80	SO_4^{2-}48.36
FC (%) 21.75	O.M(%) 1.60
Bulk density (gcm^{-3}) 1.33	pH 7.65
	CEC me/100g soil 18.15
Available macronutrients	ESP 11.18
Available N mg/kg soil64.00	Exchangeable cations (me/100g soil):
Available P mg/kg soil10.70	Ca^{2+}9.11
Available K mg/kg soil315	Mg^{2+}4.31
	Na^{+}2.03
	K^{+}2.00

EC and soluble ions were determined in soil past extract.

Two water types were selected for the study: Nile water, and saline water. Irrigation waters used for this study were obtained from three sources of quite different qualities as indicated below:
Nile water (*W_0*),EC value 0.35 dSm^{-1}was used as a control treatment,*well water* (*W_1*) EC 2.82 dSm^{-1}, and*drainage water* (*W_2*) EC 3.70 dSm^{-1}.Data in Table (2) presents the chemical analysis of different irrigation water sources.

Table (2): Chemical analysis of the investigated water qualities.

Chemical properties	W_0	W_1	W_2
EC (dSm^{-1})	0.35	2.82	3.70
pH	7.65	8.35	8.50
TSS (mgL^{-1})	266.60	1917.86	2383.02
Soluble cations meL^{-1}:			
Ca^{2+}	1.44	7.20	6.33
Mg^{2+}	0.96	3.80	5.49
Na^{+}	1.00	16.75	25.27
K^{+}	0.15	0.47	0.69
Soluble anions meL^{-1} :			
CO_3^{2-}	---	---	---
HCO_3^{-}	2.55	4.49	5.53
Cl^{-}	0.49	7.06	17.44
SO_4^{2-}	0.51	16.67	14.80
RSC	0.15	none	none
SAR	0.91	7.14	10.40
Adjusted SAR	1.55	16.78	25.48

The study involved experiment and laboratory analysis of soil and plant properties. The experiment was conducted to examine the effects of magnetic treatment of different types of irrigation water on plant yield, soil properties, and nutrients composition of Tomato.

Tomato cultivar (Lycopersionesculentum,L) variety flora was transplantedin plots with 10.5 m^2 on April 7th,2011 and harvested on 23rd of August ,2011. The soil of the plot was divided into four wide furrows, each one (75 cm) width. Each furrow had two trickle irrigation lateral lines, with 4L/hr discharge and 50 cm spacing of each emitter.All the other agronomic practices including pest control and applied the recommended doses from the mineral fertilizers in the form of ammonium nitrate, superphosphate and potassium sulphate carried out according to the MALR recommendations.
A magnetron of a four-inch diameter kindly supplied for magnetizing the different water types studied.

The plots were divided into two groups in a split plot design with three replicates; the first group of plots was irrigated with the different irrigation water qualities, while the second group was irrigated with the same types of water after being magnetized.All soil plots were subjected to intermittent leaching with different water qualities applied at a volume equal to 1.50 times the filed capacity.

The tomato crop was picked once a week from each plot to measure the total yield (kg) and weight of fruits per plant were calculated from the whole yield. The plant samples were analyzed for nitrogen according to Cottenie *et al.* (1982), phosphorus according to Olsen *et al.* (1965) and potassium according to Page *et al.* (1982). Soil samples were collected from all experimental plots after harvesting from depths 0-15, 15-30 and 30-50cm Organic matter content was determined by the Walkey and Black method (Black, 1965). Available N, P and K in soil were determined according toPage *et al.* (1982).

All obtained data were statistically analyzed and compared by using least significant differences (L.S.D) according to the procedure described by Gomez and Gomez (1984).

The aim of the current study is to evaluate the applicability of using the magnetized saline water for irrigation Tomato plant and study its effect on soil and plant properties.

RESULTS AND DISCUSSION

Effect of magnetized irrigation waters on dry weight (g/ plant) of tomato plants and concentration of N, P and K.

Data presented in Table (3) illustrate effect of the different used irrigation water qualities before and after being magnetized on dry weight and N, P and K percentage of tomato plants.

Table (3):Effect of magnetized irrigation water on N, P and K concentrations (%) and dry weigh in tomato plants.

Irrigation water	N %	P%	K%	Dry weight
	Magnetized water			
W0	0.87	0.18	1.48	2.86
W1	0.87	0.18	1.41	2.56
W2	0.88	0.19	1.37	2.21
	Non-magnetized water			
W0	0.80	0.18	1.40	2.34
W1	0.68	0.18	1.38	2.13
W2	0.93	0.20	1.30	1.94

The dry matter yield was generally, highest upon irrigation with the best quality of the used water (W_0), lowest upon irrigation with the worst water (W_2). These results agree with those of El-Sharawy et al, (1997) who reported a depressive effect of increasing salinity of irrigation on dry matter yield of tomato. The dry matter yield attained due to magnetization of the used irrigation water was markedly higher the corresponding one attained due to irrigation with the non-magnetized water. This is likely to be due to enhancement of protein and photosynthesis upon irrigation with magnetized water *(Tkatchenko, 1997)*.Also, Values of N, P and K percentage varied from irrigation water to another and also due to quality of the used irrigation water whether it was magnetized or not Table (3).Regarding concentration of N in the tomato plants that were irrigated with either of the investigated waters, it could be noticed that it was generally lower when the used water was magnetized. The superiority of N concentration with the non-magnetized water over the magnetized.

Values of P concentration seemed lowest in the plants grown on the studied soil (calcareous). This occurred whether the used waters were magnetized or not.The low values of P concentration in the plants grown on the sandy clay loam soil are attributed mainly to the low uptake values of P in this soil due to its calcareous nature.

K concentration values in tomato plants grown on the studied soils seemed higher when these plants were irrigated with the magnetized waters than the corresponding K concentration values attained when the plants were grown with the non-magnetized waters, such a finding is due to the higher uptake values of K by the plants irrigated with the magnetized water.It is of importance to indicate that K concentration was also dependent on type of the water used for irrigation, therefore it was in the order: W0 > W1 > W2.Such a finding could be attributed to many factors; the most important one among them is the salinity of the used water which affects adversely the uptake of water, due to the high osmotic pressure of the soil solution, and consequently uptake of K.

It could be concluded from the aforementioned discussion that magnetic the water used for leaching soil or irrigating the different plants can provide better soil-water–plant relationships and is thus worth further consideration.

Effect on N, P and K uptake

Values of N, P and K uptake by tomato plants grown on thestudied soil and irrigated with the investigated water qualities before or after being magnetized are presented in Table (4).

Table (4): Effect of magnetized irrigation water on N, P and K uptake (mg/plant) by tomato plants grown on the studied soil.

Irrigation water	N	P	K
	Magnetized water		
W0	24.88	5.15	42.33
W1	22.27	4.61	36.10
W2	19.44	4.20	30.28
	Non-magnetized water		
W0	18.72	4.21	32.76
W1	14.48	3.83	29.39
W2	18.04	3.88	25.22

It is obvious from this table that N and K uptake values of the plants irrigated withgood water quality were generally higher than the corresponding ones of the plants irrigated with lowwater quality whereas the corresponding values of the plants grown and irrigated with (W_2) were the least. The uptake values of both N and K reflect the natural fertility status of the investigated soil. The calcareous nature of the sandy clay loam accounts for such a finding because phosphate may be absorbed on surface of $CaCo_3$ particles present in this soil besides soluble phosphate undergoes precipitation reactions with the soluble Ca^{2+} of soil solution and hence is converted to forms unavailable for plant uptake. Such findings could be observed when the plants were irrigated with the used water qualities whether before being magnetized or after magnetization.

Values of N, P and K uptake recorded due to usage of the different water qualities were in the descending order: W_0> W_1> W_2 regardless of magnetization process of these waters. However, it is of importance to indicate that the values attained due to irrigation with quality of water after being magnetized were generally higher the corresponding ones achieved due to irrigation with the same water before being non-magnetized.

Chemical analysis of the studied soils after harvest of tomato plants:

Data presented in Table (5) reveal the changes that might take place in some chemical properties of the investigated soil due to cultivation of this soil and irrigating then with the studied water qualities.

Table (5): Analysis of soil irrigated with magnetized water or non-magnetized water after tomato harvest.

Irrigation water	SP	pH	EC dSm^{-1}	Anions meL^{-1}				Cations meL^{-1}			
				CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	K^+
	Non-magnetized water										
W_0	43	7.60	2.60	---	4.44	5.88	17.04	7.73	4.28	14.25	1.13
W_1	45	7.65	7.60	---	3.64	39.90	40.60	24.30	12.38	45.25	2.21
W_2	42	7.60	8.00	---	4.16	41.80	43.89	24.84	13.64	49.14	2.23
	magnetized water										
W_0	43	7.60	1.90	---	3.64	3.92	12.41	5.15	3.37	10.41	1.04
W_1	45	7.55	6.70	---	3.12	35.65	35.28	20.52	11.56	39.89	2.08
W_2	43	7.65	7.10	---	3.12	38.00	40.12	21.60	12.10	45.43	2.11

EC, pH and soluble ions were determined in soil past extract.

Cultivation of the soil using the different water qualities for irrigation resulted in marked decreases in the original *EC* value of this soil which was already high ($11dSm^{-1}$). This finding means that the used waters were able to leach a part of the soluble salts out of the sandy loam soil i.e. the salt balance was towards removal of salts out of the soil.

Regarding effect of the magnetized water as compared with that of the non-magnetized ones, on *EC* values of the investigated soils, data showed relatively lower values of *EC* upon irrigation with the former than upon usage of the later especially when the soluble salt content of water was highest (W_2).

On the other hand, Values of soluble HCO_3^- of the cultivated soil, which were irrigated with the different water qualities, tended to be almost around their original contents in the studied soil. However, the magnetized waters seemed to cause relatively lower HCO_3^- values as compared with the non-magnetized ones.These results agree with those of Alimi *et al.* (2006).

Cultivation and irrigation of the studied soil resulted in decrease in its content of solubleCl^-. The decrease was more pronounced upon irrigation with the magnetized waters than the non-magnetized ones.

In the cultivated sandy clay loam soil, cultivation resulted in contradictory effects on soluble SO_4^{2-}content dependent on the used water content of soluble SO_4^{2-}. Thus soluble$SO_4^{-2}$was reduced upon irrigation with eitherW_0 , W_1 or W_2water.In all cases of the used waters, magnetization of these waters seemed to be of a reducing effect on soil content of solubleSO_4^{2-}as compared with the non-magnetized waters.

In regards to soluble cations, cultivation as well as irrigation with all water qualities except for the control waterW_0, resulted in accumulation of solubleCa^{2+}in soil. The increases in solubleCa^{2+}content seemed corresponding to the used water contents of solubleCa^{2+}. However, caused soluble Ca^{2+}content of this soil to decrease generally. Such a finding might be due to precipitation of Ca^{2+}in the form of $CaCO_3$, or even Ca_3 $(PO_4)_2$due to the calcareous nature of such a soil. In all cases magnetization of the used waters caused solubleCa^{2+}content of the investigated soils to be lower as compared with the corresponding ones achieved due to usage of the non-magnetized waters.

Soils contents of solubleMg^{2+}as influenced by irrigation with cultivation and irrigation with the studied water qualities whether as they are or after being magnetized as shown in Table (5). It is obvious that the solubleMg^{2+}content of soil increased regardless of the magnetization process which caused effect of the used waters an accumulation solubleMg^{2+}obviously lower than that the non-magnetized waters. SolubleMg^{2+}content of the sandy clay loam tended to decrease as compared with the originalMg^{2+}content of this soil. Once again the magnitudes of increase in values of solubleMg^{2+}were reduced when the magnetized waters substituted the non-magnetized one for irrigation.

Values of soluble Na^+ tended to increase obviously inthe soil due to cultivating with the tomato plants and irrigation with all the used water qualities except for the Nile water where soluble Na^+ tended to decrease when it was used for irrigation.Yet the magnitude of decrease was marked when this water was magnetized. On the other hand, Soluble K^+ content, as it was expected, increased in soil``o due to their cultivation and irrigation with all qualities of the irrigation water except for the control or the Nile water (W_0). However, cultivation of the soil resulted in decrease in its soluble K^+content. Magnetization of water, however, was of a slight effect on reducing accumulation of soluble K^+ due to irrigation with most of the used waters.

Soluble salts redistribution in soils under intermittent leaching using normal and magnetized waters:

Data presented in Table (6) reveal values of EC in (dSm^{-1}) in the different depths of the studies soils due to leaching them with saline and magnetized saline waters. It could be seen from the table that using well water (W_1) resulted in decreases in EC values of all the investigated soils, however the rate of change (RC) was highest in the soil. Magnetizing this type of water (W_1) caused rate of change to be more obvious in all the investigated soil where it increased from 70.00 to 79.24 %. Using drain water (W_2) for intermittent leaching of the soil was of positive effect on removal of soluble salts from the soil. However rate of change in EC value was higher in the soil treated with magnetic water thanno treated. Similar results were attained by Alawi etal, (1980), Abd-Allah (1988) and Mostafaetal, (1992).Magnetizing drain water caused its removal effect on soluble salts of the soil to increase where rate of change in EC values of these soils increased from 62.52 % to 74.70 %. Moreover, the magnetization of (W_2) water and its usage in intermittent leaching resulted in reduction in EC value of the soil i.e. it resulted in removal of soluble salts instead of increasing it upon utilization of the same type of water (W_2) but without being magnetized. Such a finding reveals that application of magnetic technology in treating saline water may improve its effect on leaching soluble salts of the salt affected soils.

Table (6): Soluble salts (EC dSm^{-1}) in saturation paste extract ofsoil asaffected magnetization of irrigation water.

Depth (cm)	**Irrigation water**			**L.S.D at 0.05 level**
	W_0	**W_1**	**W_2**	
	Magnetized irrigation water			Treat. : 0.11
0-20		2.65	3.15	Depth : 0.14
20-40		2.10	2.45	Water : 0.18
40-60		2.10	2.75	Treat. × Depth : 0.20
Average		2.28	2.78	Treat. × water : 0.25
∆ EC		-8.72	-8.22	Depth × water : 0.31
RC %		79.24	74.70	Treat.× Depth× water: 0.44
	Non-magnetized irrigation water			
0-20	2.00	4.70	5.70	
20-40	1.50	2.50	3.25	
40-60	1.70	2.70	3.42	
Average	1.73	3.30	4.12	
∆ EC	-9.27	-7.70	-6.88	
RC %	84.24	70.00	62.52	

It seems from data presented in Table (7) that using well water (W_1) for intermittent leaching of the soil generally reduced their contents of soluble HCO_3^-, however, rate of change seemed higher in the soil. Magnetization of well water improved its effect on leaching soluble HCO_3^- out of the soil, where the rates of change in this soil increased from 13.51 % to 25.57 %,. This means that the magnetized water was of more noticeable effect on leaching HCO_3^- out of the clayey loam soil.

Tkatchenko (1997) and *Hilal and Hilal (2000)* reported similar results where they concluded that magnetized water was of pronounced higher ability on removing HCO_3^- than normal water.

Usage of drain water (W_2) for intermittent leaching of the studied soil resulted in general decrease in HCO_3^- content with a rate of change about 6.22%. The reducing effect of the magnetized water on soluble HCO_3^- content of the sandy clay loam soil increased from an average of 6.22 to

23.83 %. In studied soil, HCO_3^- was highest in the surface layer followed by the deepest one. This occurred generally, regardless of quality of the used water. Magnetization of the water used for leaching seemed to be of no effect on changing pattern of HCO_3^- distribution within the different depths of the soil.

Table (7): Soluble bicarbonate (me L^{-1}) in saturation paste extract ofsoil asaffected magnetization of irrigation water.

Depth (cm)	Irrigation water			L.S.D at 0.05 level
	W_0	**W_1**	**W_2**	
	Magnetized irrigation water			Treat. : 0.10
0-20		3.68	3.61	Depth : 0.12
20-40		3.12	3.33	Water : 0.16
40-60		3.51	3.61	Treat. × Depth : N.S
Average		3.44	3.52	Treat. × water : 0.22
Δ EC		-0.55	-0.52	Depth × water : 0.27
RC %		25.57	23.83	Treat.× Depth× water: 0.39
	Non-magnetized irrigation water			
0-20		4.44	4.68	
20-40		3.38	3.89	
40-60		4.16	4.42	
Average		3.99	4.33	
Δ EC		-0.29	-0.13	
RC %		13.51	6.22	

On the other hand, Usage of well water (W_1) or drain water (W_2) for intermittent leaching of the studied soil whether without magnetization or after being magnetized generally reduced soils content of Cl^- ions. Tkatchenko (1997)found that magnetized water removed 50% to 80% of soil Cl^- compared to a removal of only 30% by normal water.

The data in Table (8) declared the effect of magnetization of water on increasing its efficiency of the used waters (W_1 and W_2) on removal of soluble Cl^- out of all studied soil.

Concentration was highest in the surface layers (0-20 cm) of all the investigated soils, lowest in the subsurface layer (20-40 cm) and came in between in the deepest one (40-60 cm). No certain effect for magnetizing the water or the type of the used water could be observed on redistribution of the soluble Cl^- within the different soil depths.

Table (8): Soluble chloride (me L^{-1}) in saturation paste extract ofsoil asaffected magnetization of irrigation water.

Depth (cm)	Irrigation water			L.S.D at 0.05 level
	W_0	W_1	W_2	
	Magnetized irrigation water			Treat. : 0.90
0-20		4.07	8.15	Depth : 1.10
20-40		3.29	5.95	Water : 1.42
40-60		3.76	8.20	Treat. × Depth : 1.56
Average		3.71	7.43	Treat. × water : 2.01
∆ EC		-33.23	-31.48	Depth × water : 2.47
RC %		95.02	90.01	Treat.× Depth× water: 3.49
	Non-magnetized irrigation water			
0-20		13.43	21.64	
20-40		4.57	6.14	
40-60		6.71	9.50	
Average		8.24	12.43	
∆ EC		-31.10	-29.13	
RC %		88.93	83.30	

Data in Table (9) showed that intermittent leaching of the soils with the non-magnetized as well as the magnetized saline water (W_1 and W_2) resulted in partial removal of soil contents of soluble SO_4^{2-}. The magnitudes of removal and consequently the rate of reduction in soluble SO_4^{2-} content were higher in case of the magnetized waters than in the case of the non-magnetized ones. *Hilal and Hilal (2000)* went almost to similar results and indicated that magnetized water has doubled the leaching of SO_4^{2-}.

Table (9): Soluble sulphate (me L^{-1}) in saturation paste extract ofsoil asaffected magnetization of irrigation water.

Depth (cm)	Irrigation water			L.S.D at 0.05 level
	W_0	W_1	W_2	
	Magnetized irrigation water			Treat. : 1.51
0-20		19.13	22.06	Depth : 1.85
20-40		14.97	16.31	Water : 2.38
40-60		14.66	17.28	Treat. × Depth : 2.61
Average		16.25	18.55	Treat. × water : 3.37
∆ EC		-15.09	-14.01	Depth × water : 4.13
RC %		66.39	61.64	Treat.× Depth× water: 5.84
	Non-magnetized irrigation water			
0-20		33.57	41.45	
20-40		17.28	24.70	
40-60		17.84	21.93	
Average		22.90	29.36	
∆ EC		-11.97	-8.93	
RC %		52.66	39.29	

Regarding the soil, its leaching with well water (W_1) whether before magnetization or after being magnetized resulted in reduction in its soluble SO_4^{2-} content yet rate of reduction increased upon utilization of the magnetized water from 52.66 to 66.39 %. Leaching of this soil with the non-magnetized water of drainage water (W_2) caused its content of soluble SO_4^{2-} to increase by 39.92 %. However, magnetization of such water caused its original soluble SO_4^{-} content to increase to 61.64%.

In regards to soluble cations, Data presented in Table (10) showed that soluble calcium Ca^{2+} content of all the studied soil decreased due to intermittent leaching of these soils using the saline water of well water (W_1) or drainage water (W_2) whether before magnetization of these waters or after these waters have been magnetized. Magnetization of well water (W_1) caused reduction in soluble Ca^{2+} content of the studied soil to increase from 75.32 % to 83.06 %. Magnetized water of (W_2) reduced the original soluble contents of the soil by 64.32% upon usage of this water after being magnetized for intermittent leaching of the studied soil.

Table (10): Soluble calcium (me L^{-1}) in saturation paste extract ofsoil asaffected magnetization of irrigation water.

Depth (cm)	Irrigation water			L.S.D At 0.05 level
	W_0	**W_1**	**W_2**	
	Magnetized irrigation water			Treat. : 0.59
0-20		6.29	7.21	Depth: 0.72
20-40		5.95	6.70	Water : 0.93
40-60		5.10	5.84	Treat.× Depth : 1.02
Average		5.78	6.58	Treat. × water : 1.32 Depth × water : 1.62
∆ EC		-13.32	-12.95	Treat.× Depth× water: 2.28
RC %		83.06	80.71	
	Non-magnetized irrigation water			
0-20		11.34	18.50	
20-40		7.07	10.30	
40-60		6.86	7.73	
Average		8.42	12.18	
∆ EC		-12.08	-10.32	
RC %		75.32	64.32	

Depthwise distribution pattern of Ca^{2+}cations seemed to be identical with that of SO_4^{2-} anions i.e. these ions where found in highest concentration in the surface layers and tended to decrease depthwise. Magnitudes of Ca^{2+} concentrations though were reduced in the different soil depths due magnetization of water, yet pattern of depthwise distribution of Ca^{2+}remained unaffected by this process.

Table (11) showed that usage of either of well water (W_1), drainage water (W_2) resulted in reduction in original soil content of the soluble Mg^{2+}. This was true for all plots soil whether upon usage of the non-magnetized waters or the magnetized ones. However, percentage of reduction seemed dependent not only on type of the leached soil and type of the water used for leaching but also on the magnetization process of the used waters where such a process could succeed in enormousing effect of the used water for leaching soluble Mg^{2+} out of the studied soil.

Table (11): Soluble magnesium (me L^{-1}) in saturation paste extract ofsoil asaffected magnetization of irrigation water.

Depth (cm)	Irrigation water			L.S.D at 0.05 level
	W_0	W_1	W_2	
	Magnetized irrigation water			Treat. : 0.09
0-20		5.66	5.76	Depth : 0.12
20-40		3.33	4.61	Water : 0.20
40-60		3.91	5.50	Treat. × Depth : 0.24
Average		4.30	5.29	Treat. × water : 0.39
Δ EC		-11.14	-10.67	Depth × water : 0.59
RC %		84.64	81.11	Treat.× Depth× water: 1.18
	Non-magnetized irrigation water			
0-20		7.67	10.82	
20-40		3.80	5.28	
40-60		4.45	5.50	
Average		5.31	7.20	
Δ EC		-10.67	-9.78	
RC %		81.05	74.29	

Depthwise distribution pattern of aMg^{2+} ion coincided with that of Ca^{2+} ones i.e. Mg^{2+} concentration tended to decrease downwards.

Data presented in Table (12) revealed that the original soluble Na+ content of all the investigated soils was reduced due to intermittent leaching of these soils using well water (W1) whether in its non-magnetized form or the magnetized one. However, values of reduction rate seemed to be higher upon usage of the magnetized water. The intermittent leaching with drainage water (W2) was of an effect on reduction of soluble Na+ similar to that achieved due to utilization of well water (W1). Such an effect was observed on the soil whether the used water was magnetized or not. however, the accumulation percentage of soluble Na+ was reduced when the magnetized water was used in leaching instead of the non-magnetized one. The depthwithe distribution pattern of Na+ in the investigated soil revealed that

Na+ was accumulated in highest concentration in the surface layer of the investigated soil and tended to decrease with depth. The upward movement of the saline solution in drying periods among the successive applications of the leaching water might account for such a phenomenon

Table (12): Soluble sodium (me L^{-1}) in saturation paste extract ofsoil asaffected magnetization of irrigation water.

Depth (cm)	Irrigation water			L.S.D at 0.05 level
	W$_0$	**W$_1$**	**W$_2$**	
	Magnetized irrigation water			Treat. : 1.15 Depth : 1.40 Water : 1.81 Treat. × Depth : 1.99 Treat. × water : 2.57 Depth × water : 3.14 Treat.× Depth× water: 4.44
0-20		13.65	18.90	
20-40		10.88	12.82	
40-60		11.84	16.27	
Average		12.12	16.00	
∆ EC		-23.42	-21.60	
RC %		80.43	74.18	
	Non-magnetized irrigation water			
0-20		30.86	35.14	
20-40		13.34	17.00	
40-60		15.86	20.82	
Average		20.02	24.32	
∆ EC		-19.71	-17.69	
RC %		67.69	60.75	

Data presented in Table (13) showed redistribution of soluble K^+ within the different depths of the investigated soils due to their leaching intermittently using the different types of waters in their magnetized form as well as their non-magnetized one. All the used waters whether before magnetization or after being magnetized caused the original content of soluble K^+ in the soil to increase, yet rate of change in soil content was more less when the magnetized waters were used.

Table (13): Soluble potassium (me L^{-1}) in saturation paste extract ofsoil asaffected magnetization of irrigation water.

Depth (cm)	Irrigation water			L.S.D at 0.05 level
	W$_0$	**W$_1$**	**W$_2$**	
	Magnetized irrigation water			Treat. : 0.09 Depth : 0.11 Water : 0.14 Treat. × Depth : 0.15 Treat. × water : 0.20 Depth × water : 0.24 Treat.× Depth× water: 0.34
0-20		1.28	1.58	
20-40		1.22	1.27	
40-60		1.08	1.11	
Average		1.19	1.32	
∆ EC		-0.99	-0.93	
RC %		63.82	59.97	
	Non-magnetized irrigation water			
0-20		1.57	2.31	
20-40		1.53	1.64	
40-60		1.54	1.80	
Average		1.55	1.92	
∆ EC		-0.82	-0.65	
RC %		53.10	41.88	

CONCLUSION

It can be concluded that magnetic technologies can provide better soil water plantrelation and is thus worth further consideration.Using the magnetized saline water for irrigation tomato plant and study its effect on soil and plant properties. This study found that the effects of magnetic treatment varied with the type of irrigation water used, and there were statistically significant increases in plant growth.On the other hand, as to soil properties after plant harvest, the use of magnetically treated irrigation water reduced soil pH alsodecreased soil EC and available P. Overall, the results indicate some beneficial effect of magnetically treated irrigation water, particularly for saline water.

REFERENCES

Abd-Allah, A.E.A. (1988). Effect of water quality on some physical chemical and pedological characteristics of soil. Ph.D. Thesis Fac. Agric. Ain Shams, Univ. Egypt.

Abd-Elaal, A. I. (1989). Cotton growth as a function of variation in water table depth under saline irrigation practice. M.Sc. Thesis, Institute Agronomique Mediterranean de-Bari- Italy

Ahmed Ibrahim Mohamed(2013). Effects of Magnetized Low Quality Water on Some Soil Properties and Plant Growth .*Int. J. Res. Chem. Environ. Vol.3 Issue 2 April 2013(140-147).*

Alawi. B.J.; Stroehlein, I. L; Hanlon, A.E. and Turner, F. (1980).Quality of irrigation water and effects of sulphuric acid and gypsum o soil properties and sudan grass yields. Soil Sci., 129: 315 – 319.

Al– Sager, F.T. (1991). Effect of quality and quantity of irrigation water on some soilchemical properties. M.Sc. Thesis, Fac. of Agric., Moshtohor, Zagazig Univ., A.R.E.

Alimi F., Tlili M. M., Gabrielli C., Georges M. and Ben Amor.(2006). Effect of a magnetic water treatment on homogeneous and heterogeneous precipitation of calcium carbonate, Water Res. 40, 1941–1950

Amaya J.M., Carbonell M.V., Martínez E., and Raya A., (1996).Effect of stationary magnetic field on growth and germination of seeds (in Spanish). Agricultural, 773, 1049-1064.

Aich-AC; Mandal-R; Ahmed-AHM(1998). Impact of soil amendments and brackish water on macronutrients (Na, K,Ca, Mg, N, P and S) contents of wheat grain grown in coastal saline soil. J. of-Phytological-Res. 11:1, 1-6.

Bogatin, J, Bondarenko, N, Gak, E, Rokhinson, E, Ananyev, I, 1999, Magnetic Treatment of Irrigation Water: Experimental Results and Application Conditions, *Environ. Sci. Technol.*, 33 (8), 1280-1285.

Busch, K.W., Busch, M.A., (1997). Laborator studies on magnetic water treatment andtheir relationship to a possible mechanism for scale reduction. *Desalination 109 (2),131–148.*

Black, C. A. (1965). Methods of soil anaylsis, Amer. Soc. Of Agronomy .Inc Madison, Wisconsin. USA.

Chauhan, R.P.S.; Pathak, D.C. and Chauham, C.P.S. (1991).Nitrogen and phosphorus requirements and irrigation schedule of wheat irrigation of saline water. Fertilizer-News. 36:11-18.

Cottenie, A.; Verso, M.; Kiekens, L.; Veighe, G. and R. Camerlynck (1982). Chemical Analysis of Plants and Soils.Lap.Anal.and Agrochem. StateUniv., Gent.Belgium, Chapter 2, 3, PP.14-54.

De Souza, A. ,D. García, L. Sueiro, L. Licea and E. Porras (2005).*Pre-sowing magnetic treatment of tomato seeds: effects on the growth and yield of plants cultivated late in the season.* Spanish Journal of Agricultural Research, 3(1), 113-122

Dravid,M.S. and Goswami, N.N. (1986).Soil salinity- fertility- moisture interaction in relation to yield and nutrient uptake by wheat (Triticumarstivum L.) and maize (Zea mays L.). Ann. Agric. Res., 7:89-102. (c.f. Field Crop Abst., 40: 7516, 1987).

El–Ghanam, M.M.M. (1993).Same chemical transformations in salt affected soils and their relation to soil productivity. M. Sc. Thesis, Fac .Agric .Moshtohor, ZagazigUnv., A.R.E.

El-Said, A.H. (1990).Effect of drainage water quality on soil and plant. M. Sc. Thesis, Fac. Agric., Ain Shams Univ.

EL-Sharawy, M.O., Mostafa, M. A. and El-boraei, F. M. (1997).Use of sea water irrigation: 1- effect on plant Growth and nutrient uptake. Int. Symp. On Salt Affected Soils, cairo, Egypt, 22-26 Sept. 1997.

Fernandez-L; Teran-Z; Leon-M. (1996).The effect of magnetically treated irrigation water on quality of onion seedling grown in zeoponics. Cultivos-Tropicales. 17: 2, 55-59.

Guo,Liang,Zhao-Oingkai and Han-Yali (1994):Germination test of seeds treated by magnetized water and rare earth fertilizer solution. Particular Science II (1),32 .Cable Abs. 1993-1994

Gomez, K. A., Gomez, A. (1984): Statistical Procedures for Agricultural Research 2nd ed. John Wiley & Sons, New York.

Hilal M.H. and Hillal M.M., (2000).Application of magnetic technologies in desert agriculture 1- Seed germination and seedling emergence of some crop in a saline calcareous soil. Egypt J. Soil Sci. 40(3), 413-421.

Janardhan, k.V.; Panchaksharaiah, S.; Balakrishna.Raw, K. and Patil, B. N. (1979). Effect of varying K : Na ratios in saline irrigation water on grain yield and ionic composition of wheat. Current Science. 48 (16): 739-741. (c.f. Soils and Fert. 44 (10) 1981).

Klute, A. (1986). Methods of Soil Analysis.part 1.2nd ed. ASA and SSSA. Madison.

lin, i. yotvat, j, (1990). exposure of irrigation and drinkingwater to a magnetic field with controlled power and direction**,** *journal of magnetism and magnetic materials 83 (1990) 525-526 525north-holland*.

Martínez,E.M.V. Carbonell, M. Flórez, J.M. Amaya, and R. Maqueda (2009).*Germination of tomato seeds (Lycopersiconesculentum L.) under magnetic field.* Int. Agrophysics, 23, 45-49

Mass, E. V. and Poss, J. A. (1989).Salt sensitivity of wheat at various growth stages.Irrg. Sci., 10: 29-40.

Mostafa, M .A.;Khaled, E.M.; El-Smeedy, A.M. and Abd El-NourA.Sh. (1992).The effect of irrigation water quality on some Chemical properties of certain soils of Egypt.Egypt .J. Soil .Sci .32, No.3, pp 391-406.

Nan, S , Yeong-Hwa, W, Chung- Yo, M, 2000, Effect of magnetic water on the engineering properties of concrete containing granulated blast-furnace slag, *Cement and Concrete Research, v 30, n 4, p 599-605, April*.

Oleshko, k,P.,vadyunina,A.F., zhilyayeva,V.A. and Trukhin,V.I. (1981). Effect of a magnetic field on the properties of soil and plants .Pochvovedeniye, No.7, 91-98.

Page, A. L., R.H.Miller and D.R.Keeny (1982).Methods of Soil Anaiysis. Part 2. Chemical and Microbiological Properties.Agron.9, SSSA Madison,WI, USA.

Parsons, S. Wang, B, Judd, J.Stephenson, T., (1997). MAGNETIC TREATMENT OF CALCIUM CARBONATE SCALE-EFFECT OF pH ,Water Research 31 (2), 339–342.

Selim, M. M.(2008). *Application of Magnetic Technologies in Correcting Under Ground Brackish Water for Irrigation in the Arid and Semi-Arid Ecosystem.*The 3rd International Conference on Water Resources and Arid Environments (2008) and the 1st Arab Water Forum.

Takatshinko, Y. (1997): Hydromagnetic systems and their role in creating micro climate .International symposium on Sustainable Management of SaltAffected Soils, Cairo, Egupt,22-28.sept.

Tai, C, Chang, M, Shieh, R , Chen, T, (2008), Magnetic effects on crystal growth rate of calcite in a constant-composition environment, Journal of Crystal Growth 310 (2008) 3690– 3697.

Yue, Y, Huaxiang, W, Wenhui, X, Xiehe, Z, Dingxiang, M, Tingjie, M, SU, L,(1983), STUDIES ON THE EFFECT OF MAGNETIZED WATER IN THE TREATMENT OF URINARY STONE AND SALIVARY CALCULUS. Proceedings of the Seventh International Workshop on Rare Earth-Cobalt Permanent Magnets and Their Applications.

Zhu,TY.; Sheng,DG.; Han,C.J.; Liu, HW.; Tang, YB.; Chen, YY. andLu,GL. (1982). Studies on the effectiveness of magnetized water in improving saline soils using 131I. J. Soil Sci. Turang-Tongbao. No. 3:16-19.
(c.f. CAB Abstract, 1984-1986).

" تـاثير مـاء الـرى المعالـج مغناطسـياّعلى بعض الصـفات الطبيعيـة والكيميائيـة فـى الارض الجيرية ونمو نباتات الطماطم.

أحمد حسنين أحمد حسنين
معهد بحوث الاراضى و المياه و البيئه ، مركز البحوث الزراعيه- الجيزه

يعـد الانتـاج الزراعـي مـن اهـم العناصـر الاساسـية المسـاهمة فـي الـدخل الاقتصـادي والامنالغذائي ، على الرغم من المشاكل التي ترافقه كنقص المياه والتصحر والملوحة وانخفاض الغلة ، والتي يمكن تداركها نسبياً باستخدام تقنية المعالجة المغناطيسية للماء. اصبحت هذه التقنية محط انظار الباحثين مقارنة بالطرق الفيزياوية والكيمياوية الاخرى ، لما توفره من نقاوة بيئية وسلامة صحية وسهولة في الاستخدام.

اقيمت تجربة حقلية تحت ظروف بيئية طبيعية خلال موسم 2011 بقرية ابو مسعود بمصر لدراسة تقييم تأثير المعاملات المغناطيسية على الطماطم المزروعة تحت ظروف الري المالحة (مياه النيل، 1000، 3000، 6000، 9000 و 12000 جزء في المليون) فى ثلاث مكررات باستخدام الماء الممغنط والغير ممغنط. كما هدفت هذه الدراسة ايضاً دراسة تأثير مختلف صفات مياه الري على إعادة توزيع الأملاح الذائبة في التربة الجيرية باستخدام الرى المتقطع.

أظهرت النتائج أن :

- استخدام تقنيةالمغناطيسية مع المياه المالحة كان له أثر قيما على التربة والنبات. وقد انخفض التوصيل الكهربائي للتربة مع استخدام المياه المالحة في التربة الجيرية المروية بماء مغناطيسي.
- وقد زاد التحسن في نمو النبات التي انعكس على الإنتاجية حتى استخدام الماء المغناطيسي 6000 جزء في المليون. وأثبت تحليل البيانات التي تم جمعها خلال الدراسة أن هناك زيادة ذات دلالة إحصائية في نمو النبات وبعض المحتويات الكيميائية لنبات الطماطم.
- أظهرت نتائج الدراسة ايضاً ان التقنيةالمغناطيسية تحسن الأوزان الرطبة والجافة لنبات الطماطم بالمقارنة بالكنترول.
- عظمت عمليه مغنطة المياه من مقدرة عملية غسيل وتحريك الأملاح القابلة للذوبان الي اسفل ، وأيضا خفض ملوحة التربة.

ومع ذلك فان استخدام التقنية الحديثة لمغنطه المياه يمكن أن توفر علاقات افضل بينالتربة والمياه ، لذلك فهي تستحق مزيد من الاهتمام.