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EFFECT OF MAGNETIC TREATED IRRIGATION WATER ON SALT REMOVAL FROM A SANDY SOIL AND ON THE AVAILABILITY OF CERTAIN NUTRIENTS

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Abstract:

Ferro magnetism is a property of certain metals and alloys, while Para magnetism is a property of all materials and water is not an exception. When passing a magnetic field, irrigation water gain a magnetic moment and retain it for 24 to 48 hrs. Magnetic treatment of irrigation water depends on magnetic field intensity, composition of dissolved salts and velocity of crossing a magnetron of 0.5 inch diameter. In this work magnetic activation of 3 different sources of irrigation water, namely: Ismailia canal; El-Salam canal; Abou-Sewer well, caused a little effect on water analyses. However magnetic treated water undergoes several changes in its physical properties. It also exerts several effects on the soil waterplant system. A column experiment was carried out to evaluate the effect of magnetic treated irrigation water on the movement and availability of certain nutrients and on the leaching of ions and salts from a sandy soil (Suez Canal Uni. Farm). Total salt removal from the soil after six leachates was significantly increased with magnetized water as compared with the normal water. Total salt removal from the soil after the course of leaching of soil irrigated with magnetized Ismailia Canal, El-Salam Canal or Abou-Sewer well water were about 39, 32 and 25%, respectively over the non -magnetized water.

The rate of both of salt removal and magnetization effect keep dropping by successive leaching. Assessment of Soil salinity after leaching indicated that Abou-Sewer well water increased soil salinity by 10 folds over that of Ismailia canal water. The highest Extractable soil K After leaching, with normal and magnetized water, was detected at soil depth of 15-30 cm while the lowest K value was present at soil surface of (0-5 cm). That indicated that K moved down ward to the third depth (15-30 cm). K concentration in soil water extract increased significantly after leaching with magnetized water compared with normal water at all soil depths. Percentages of phosphate in the first leachate, with magnetized water, were about 39, 45 and 46%, over the non-magnetized irrigation water, of Ismailia Canal, El-Salam Canal and Abou-Sewer well water, respectively. Leaching the soil with magnetized water significantly increased available soil P content compared with the leaching with normal water at all soil depths. Behavior of nutrients in a magnetic field is a function their magnetic susceptibility.

Keywords: Magnetron unit; Magnetic susceptibility; Irrigation water quality; Soil columns.

Introduction:

Magnetized water was shown to have 3 main effects: 1) increasing the leaching of excess soluble salts, 2) lowering soil alkalinity and 3) dissolving slightly soluble salts such carbonates, phosphates and sulfates. However, the degree of effectiveness of magnetized water on soil salinity and ionic balance in soil solution depended greatly on the traveling distance of magnetized water along the drip irrigation lines (Hilal and Hilal, 2000a and b).

Tai et al. (2008) observed that on subjecting water to magnetic field, it leads to modification of its properties, as it becomes more energetic and more able to flow which can be considered as a birth of new science called Magneto biology. They also pointed out that, magnetized water prevents harmful metals such as, lead and nickel, from uptake by roots and reaching fruits and roots. However, it increases the percentage of nutrient elements like phosphorus, potassium and zinc.

The objective of the current study is to evaluate the effect of magnetized irrigation water quality (i.e. Ismailia canal, El-Salam canal and Abou-Sewer well water) on the availability of certain nutritional elements and the movement and leach-ability of salinity from a sandy soil.

Materials and methods

Column experiment was carried out to investigate the role of magnetized irrigation water on the availability of certain nutritional elements, the efficiency of salt removal and leach-ability from a sandy soil (Table 1). The PVC columns with 35 cm in length and 8.6 cm in diameter were used. The PVC columns were covered at the bottom with plastic screen, with 2.0 mm hole at the center. The bottom of PVC column was covered with filter paper. The Sandy soil sample which was collected from the experimental farm of the Faculty of Agriculture, Suez Canal University, was air dried, sieved by 2.0 mm sieve and thoroughly mixed. The PVC column was thoroughly packed with soil at rate of 3.0 kg with 32 cm height.

The experimental design was divided into two main plots, i.e. normal and magnetized irrigation water. The subplots were divided into three sets, i.e. Ismailia canal, El-Salam canal and Abou-Sewer well waters.
The chemical analysis of the different water sources are presented in Table (2). Irrigation water sources were magnetized by passing a magnetic field and will acquire a magnetic moment for 24-48 hours after crossing the magnetic field. However, such time is good enough for magnetized irrigation water to impose magnetic effect on the soil plant– water system. The water passed throws 1000 gauss magnetron unit of 0.5 inch diameter which produced by magnetic technologies (Takatchenko, 1997).

Saturated soil columns were kept 4 days periods from the first leaching; followed by 6 leachates at 15-day intervals. Water of different treatments was added at 1.5 times of the water holding capacity. Water leachates of the different treatments were collected and prepared for analyses electrical conductivity (EC, dSm-1), soluble K and P. The pH of the soil samples is determined by bench type Beckman glass electrode pH meter in 1: 2.5 soil water suspensions according to Page et al, (1982). Also, total salt removal (mg/column) from each soil was calculated. Split-split plot design with three replicates was used and Plabstat version 2D computer program was used for statistical analysis.

Soil water holding capacity and mechanical analysis were determined according to Richards, (1954). Electrical conductivity was measured in the saturated soil and 1:5 soil: distilled water extracts and expressed as (dSm-1) using conductivity meter model 710 according to Richards (1954). Soil extracts were used for the determinations of soluble K and P according to Richards (1954).

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Table 1. Some chemical and physical characteristics of used soil.

pH	7.60
EC_e, dSm^{-1}	2.10
Ca^{2+}, $meql^{-1}$	5.70
Mg^{2+}, $meql^{-1}$	5.30
Na^{+}, $meql^{-1}$	8.10
K^{+}, $meql^{-1}$	1.20
HCO_3^{-}, $meql^{-1}$	4.80
Cl^{-}, $meql^{-1}$	7.50
SO_4^{-2}, $meql^{-1}$	8.30
Available N, (ppm)	8.00
Available P, (ppm)	5.00
Available K, (ppm)	10.5
$CaCO_3$, %	0.69
Organic matter, %	0.43
Water holding capacity, %	16.0
Mechanical analysis: Sand, %	88.20
Silt, %	9.40
Clay, %	2.40
Texture class:	Sand

Table 2. Some chemical properties of the used water sources before and after magnetizing

Parameters	Non-magnetized water			Magnetized water		
	Ismailia Canal	El-Salam Canal	Abou Swear Well	Ismailia Canal	El-Salam Canal	Abou Swear Well
pH	7. 30	7.66	8.20	7.20	7.49	8.10
EC, dSm^{-1}	0.32	1.36	3.70	0.33	1.37	3.81
Ca^{2+}, $meql^{-1}$	0.84	3.00	13.00	0,99	3,05	14.1
Mg^{2+}, $meql^{-1}$	0.73	1.00	4.40	0,79	1,02	4.47
Na^{+}, $meql^{-1}$	1.02	9.29	18.65	0,92	9.29	18.6
K^{+}, $meql^{-1}$	0.61	0.40	0.95	0,63	0.40	0.96
HCO_3^{-}, $meql^{-1}$	1.30	3.70	5.40	1,28	3.70	5.30
Cl^{-}, $meql^{-1}$	1.21	7.50	25.2	1,20	7.50	25.2
SO_4^{-2}, $meql^{-1}$	0.83	2.50	6.30	0,82	2.56	7.67
Soluble P, ppm	3.21	3.86	4.12	3.39	3.98	4.23

Available K in soil was determined in ammonium acetate extract by using flame photometer and Available phosphorus was determined calorimetrically in 0.5 M NaHCO3 extract according to Jackson (1958). Electrical conductivity and soluble –K+, -Ca+2, -Mg+2, Na+ and Cl- in sewage sludge compost extract (1:1) and pH in sewage sludge compost suspension (1:2.5) were determined as described by APHA, (1985). Sewage sludge compost sample was digested for the determinations of total-N, and P according the method described in APHA (1985).

Electrical conductivity and pH in both irrigation water sources and leachates were measured using conductivity meter model 710 and pH meter, respectively, according to APHA, (1985). Anions of CO3-2, HCO3-, Cl-, and SO4-2, cations of Ca2+, Mg2+, Na+ and K+ and P were determined according to APHA, (1985).

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Results and Discussion

A column experiment was carried out to evaluate the effect of different magnetized irrigation water on the availability of certain nutritional elements and their movement and distribution in sandy soil. Salt removal from the soil columns was also evaluated.

3.1 Electrical conductivity in water leachates

Table (3) showed that electrical conductivity values (EC, dSm-1) in water leachates of columns magnetized water were higher compared with non-magnetized water. It seems that magnetizing the irrigation water plays an important role in removing the soluble salts from the soil. Total soluble salts concentration in the first leachate of all columns was higher compared with subsequent leachates while it was lower in the last leachate. The efficiency of magnetizing water on removing soluble salts from the soil which received high saline irrigation water was more less than those received low saline irrigation water.

3.2 Salt removal from soil

Salt removal from the soil was significantly higher in soil columns with both non- and magnetized irrigation water. Using magnetized irrigation water resulted in much salt removal from the soil compared with the normal irrigation water after each leaching process. It was found that salt removal decreased with subsequent leaching frequency (Table 4). Magnetic treatment of water has been reported to change some of the physical and chemical properties of water, mainly hydrogen bonding, polarity, surface tension, conductivity, pH and solubility of salts (Smikhina, 1981; Amiri and Dadkhah, 2006; Chang and Weng, 2008).

Total salt removal from the soil after the six leachates was greater in soil irrigated with magnetized water compared with the normal water. Since, total salt removal percentages for soil irrigated with magnetized Ismailia Canal, El-Salam Canal and Abou-Sewer well water were about 39, 24 and 25%, respectively, over the non-magnetized water

Table (3). Total soluble salts (EC, dSm-1) changes in water leachates as affected by using of normal and magnetized irrigation water

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Normal Water			Magnetic Water		
Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water	Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water
Leachate 1					
1.07	1.90	2.86	1.26	2.17	3.14
Leachate 2					
0.72	1.26	1.89	0.88	1.37	2.02
Leachate 3					
0.68	1.20	1.84	0.86	1.35	1.98
Leachate 4					
0.66	1.15	1.70	0.85	1.34	1.84
Leachate 5					
0.53	1.01	1.52	0.63	1.12	1.62
Leachate 6					
0.43	0.72	1.11	0.48	0.76	1.18

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Factors	$LSD_{0.05}$					
	Leachate 1	Leachate 2	Leachate 3	Leachate 4	Leachate 5	Leachate 6
Magnetism (M)	0.05	0.03	0.02	0.03	0.01	0.02
Water Type (W)	0.05	0.06	0.05	0.04	0.01	0.02
M x W	0.04	0.02	0.03	0.03	0.03	0.02

Table (4). Salt removal (mg/column) from soil columns after each leachate affected by using of normal and magnetized water and different soil treatments.

Normal Water			Magnetic Water		
Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water	Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water
Leachate 1					
115	209	315	164	268	431
Leachate 2					
47.8	81.6	117	67.1	95.3	138
Leachate 3					
41.0	77.8	115	56.0	93.0	135
Leachate 4					
35.5	73.8	115	50.5	92.1	134
Leachate 5					
27.8	56.6	96.3	37.1	70.3	114
Leachate 6					
22.1	39.9	69.7	26.8	46.9	84.1

Factors	$LSD_{0.05}$					
	Leachate 1	Leachate 2	Leachate 3	Leachate 4	Leachate 5	Leachate 6
Magnetism (M)	33.86	4.61	2.32	2.22	1.81	2.99
Water Type (W)	21.88	6.36	4.55	4.68	1.63	2.79
M x W	36.01	7.92	4.71	3.17	1.31	1.45

Hilal et al, (2002) reported that magnetized water was shown to have 3 main effects: 1) increasing the leaching of excess soluble salts, 2) lowering soil alkalinity and 3) dissolving slightly soluble salts such carbonates, phosphates and sulfates. However, the degree of effectiveness of magnetized water on soil salinity and ionic balance in soil solution depended greatly on the traveling distance of magnetized water along the drip irrigation lines.

3.3 Soluble K in water leachates

Data obtained on soluble K concentration in soil water leachates as affected by using of normal and magnetized irrigation water qualities are presented in Table (5). These results indicated that using of magnetized irrigation water resulted in significant increase in soluble K concentration as compared with normal water.

Concentration of soluble K in water leachates gradually decreased with leaching process frequency and the lowest soluble K concentration was found after the last leaching process.

Table (5). Soluble potassium (me l-1) in leachates after each leachate affected by using of normal and magnetized water of different soil treatments.

Normal Water			Magnetic Water		
Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water	Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water
Leachate 1					
0.80	0.77	0.94	0.93	0.90	1.12
Leachate 2					
0.53	0.47	0.65	0.87	0.78	0.97
Leachate 3					
0.48	0.40	0.59	0.80	0.71	0.90
Leachate 4					
0.45	0.32	0.50	0.78	0.67	0.87
Leachate 5					
0.30	0.25	0.42	0.38	0.33	0.47
Leachate 6					
0.18	0.19	0.35	0.28	0.26	0.44

Factors	$LSD_{0.05}$					
	Leachate 1	Leachate 2	Leachate 3	Leachate 4	Leachate 5	Leachate 6
Magnetism (M)	.05	0.01	0.02	0.02	0.09	0.03
Water Type (W)	.02	0.04	0.04	0.02	0.12	0.02
M x W	.07	0.08	0.02	0.02	0.16	0.02

3.4 Soluble phosphates in water leachates

Data obtained on soluble phosphate concentration in water leachates influenced by magnetized irrigation water and soil treatments are presented Table (6). These results indicated that the concentration of soluble phosphates in water leachates was increased by using magnetized irrigation water compared with non-magnetized water.

This clearly shows that magnetized irrigation water helps in increasing the solubility of phosphate salts in soil. Concentrations of soluble phosphates in water leachates gradually decreased with leaching frequency and the lowest soluble phosphate concentrations was found after the sixth leaching process. It can be concluded that irrigation with magnetized water helps an important role in increasing P solubility and availability.

Percentages of soluble phosphate in water leachate after the first leaching process were about 39, 45 and 46%, over the non-magnetized irrigation water, for magnetized Ismailia Canal, El-Salam Canal and Abou-Sewer well water, respectively.

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Table (6). Soluble phosphates (me l-1) changes in leachates after each leachate affected by using of normal and magnetized water qualities and different soil treatments.

Normal Water			Magnetic Water		
Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water	Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water
Leachate 1					
3.71	4.38	5.70	5.16	6.35	8.34
Leachate 2					
3.10	3.67	4.33	4.65	5.26	5.68
Leachate 3					
2.68	3.35	3.74	4.29	4.60	5.61
Leachate 4					
2.31	3.20	3.60	3.83	4.35	5.13
Leachate 5					
1.49	1.89	2.76	2.23	2.39	4.17
Leachate 6					
0.95	0.99	1.43	1.42	1.26	2.79

3.5 Soil salinity after leaching

Data show that soil salinity (EC, dSm-1) in soil water extract 1:5 was significantly increased with soil depth after leaching process Table (7). It was noticed that the highest soil salinity was obtained at 15-30 cm soil depth while the lowest soil salinity was obtained at 0-5 cm soil depth. This clearly indicated that the soluble soil salts moved and concentrated at the 15-30 cm. Soil salinity was significantly decreased after the leaching with different magnetized irrigation water compared with the different normal water at all soil depths.

Table (7).Influence of leaching with different normal and magnetized irrigation water and soil treatments application on soil salinity* (EC*, dSm-1).

Normal Water			Magnetic Water		
Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water	Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water
0 – 5 cm					
0.55	2.14	5.48	0.51	2.00	5.23
5 – 15 cm					
0.62	2.31	5.60	0.56	2.12	5.48
15 – 30 cm					
0.68	2.36	5.70	0.60	2.26	5.59

EC in soil was measured in soil water extract 1:5

Factors	$LSD_{0.05}$		
	0 – 5 cm	5 – 15 cm	15 – 30 cm
Magnetism (M)	0.08	0.03	0.04
Water Type (W)	0.06	0.06	0.02
M x W	0.09	0.05	0.18

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This may be due to the increase of removed of soluble salts by leaching with the magnetized water compared with the normal water. The fact that the removal of soluble soil salts by leaching with magnetized water play an important role in projects of improvement and reclamation of salt-affected soils.

3.6 Soluble soil K after leaching

Data concerning the effect of leaching with the different normal and magnetized water on the soluble soil K concentration in soil water extract (1:5) is presented in Table (8). The concentration of K in soil water extract was significantly increased with soil depth under the leaching process conditions of different normal and magnetized water. The highest K concentration was found at soil depth 15-30 cm while the lowest K concentration was found at soil surface (0-5 cm). It was indicated that K was moved downward and concentrated at the third depth (15-30 cm).The K concentration in soil water extract was significantly increased after leaching with different magnetized water compared with different normal water at all soil depths.

3.7 Available soil P after leaching

Data obtained on the effect of leaching with different normal and magnetized water on the available soil P content are shown in Table (9). These data indicated that, leaching the soil with magnetized water significantly increased available soil P content compared with the leaching with normal water at all soil depths. This indicated that magnetized water plays an important role in increasing the availability of soil P.

Table (8).Influence of leaching with different normal and magnetized irrigation water and soil treatments application on the concentration of soil soluble **potassium*** (me l^{-1}).

Normal Water			Magnetic Water		
Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water	Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water
0 – 5 cm					
0.54	0.54	1.48	0.61	0.63	1.56
5 – 15 cm					
0.70	0.59	1.82	0.75	0.70	2.01
15 – 30 cm					
0.80	0.67	1.88	0.84	0.74	2.09

*Soluble potassium in soil was measured in soil water extract 1:5

Factors	$LSD_{0.05}$		
	0 – 5 cm	5 – 15 cm	15 – 30 cm
Magnetism (M)	0.24	0.08	0.15
Water Type (W)	0.09	0.14	0.08
M x W	0.11	0.14	0.33

Table (9).Influence of leaching with different normal and magnetized irrigation water and soil treatments application on the content of available soil **phosphorus*** (ppm).

Normal Water			Magnetic Water		
Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water	Ismailia Canal Water	El-Salam Canal Water	Abou Swear Well Water
0 – 5 cm					

0.50	0.94	1.34	0.78	1.41	1.93
5 – 15 cm					
0.41	0.71	1.05	0.65	1.14	1.40
15 – 30 cm					
0.19	0.21	0.38	0.27	0.35	0.57

* Available soil phosphorus was measured in sodium bicarbonate (0.5 M) extract 1:20

Factors	$LSD_{0.05}$		
	0 – 5 cm	5 – 15 cm	15 – 30 cm
Magnetism (M)	0.98	0.23	0.42
Water Type (W)	0.22	0.15	0.15
M x W	0.90	0.69	0.76

It was found that available soil P was decreased with soil depth, and it reached highest values in the surface soil layer (0-5 cm) compared with the second (5-15 cm) and the third (15-30 cm) soil depths under the conditions of leaching with both the normal and magnetized irrigation water. This result indicated that the P element un-moved through the soil. The use of magnetically treated irrigation water increased available soil P in celery and snow pea. (Maheshwari and Grewal, 2009). The wash-out produce by magnetized water the soil was obsereved to have an increase in phosphate mobile forms (Tackashinko, 1997).

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