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# Effect of reusing treated wastewater on the some soil properties by drip irrigation system

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**ABSTRACT**

The objective of this study was to evaluate the impact of using treated wastewater on soil physical and chemical properties using drip irrigation system in the demonstration farm of Faculty of Agriculture, University of Khartoum, Sudan. The experimental work involved using magnetic technology and a comparison was made to comparing the effect of four types of water vis treated wastewater (WW), normal water (NW), magnetized wastewater (MWW) and magnetized normal water (MNW). The results indicated that irrigation with magnetized water decreases soil salinity. Using treated wastewater and magnetized treated wastewater improve soil porosity. Moreover, the soil physical and chemical properties were improved after being irrigated with treated wastewater and magnetized treated wastewater. There were increases of 38%, 21%, 89 %, and 39%, in N%, $Ca^{+}$ Mg and K, respectively. There was an increase in the soil pH and a reduction in the sodium adsorption ratio (SAR).

***Keywords:*** *magnetized wastewater, drip irrigation system, sodium adsorption ratio, physical and chemical properties.*



## INTRODUCTION

The increasing need for water in the arid and semiarid areas of the world has resulted in the emergence of wastewater application for agriculture. Rapid industrial developmental activities and increasing population growth had declined the resources day to day throughout the world. The population increase has not only increased the fresh water demand but also increased the volume of wastewater generated. Therefore, there is an urgent need to conserve and protect fresh water and to use the water of lower quality for irrigation. Treated or recycled wastewater appears to be the only water resource that is increasing as other sources are dwindling (Hossein, 2010).

Urban wastewater contains many nutriments (macro-nutriment N, P, K, Ca, Mg and micro-nutriments Fe, Zn, Cu, Mn …) under forms more or less complex; in trace elements and phosphorus. The wastewater nutriments supply each irrigation represents a sort of fertigation. This technique is economically useful because it allows reducing fertilization costs. However, the continuous application of nutrients by wastewater irrigation could lead to a nutritional imbalance in certain plants that are sensitive to the excess of fertilizing elements (Ayer and Wescort, 1989).

Magnetic fields are produced by the motion of charged particles, for example, electrons flowing in a wire will produce a magnetic field surrounding the wire. The magnetic fields generated by moving electrons are used in many household appliances, automobile, and industrial machines. One basic example is the electromagnet, which is constructed from many coils of wire wrapped around a central iron core. The magnetic field is present only when electric current is passed through the wire coils (Mike, 1998). In many cases researchers report findings with no significant magnetic treatment effects. In other cases, however reasonable evidence for an effect is provided. Liburkin et al. (1986) found that magnetizing treatment affected the structure of gypsum. Gypsum particles formed in magnetically treated water were found to be larger and more regularly oriented than those found in ordinary water. Similarly Kronenberg (1985) reported that magnetic treatment changed the mode of calcium carbonate precipitation such that circular disc-shaped particles are formed rather than the dendrite (branching or tree-like) particles observed in non-treated water. This study was conducted to achieve the following objectives:

1. Evaluation of the impact of using treated wastewater by drip irrigation on some soil properties.
2. To study the effect magnetizing treated wastewater and normal water on the studied soil properties.

## MATERIALS AND METHODS

The experiment was conducted during the 2006 and 2007 in the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, Shambat at the interaction of latitude 15º36′N longitude 32º32′E and altitude 380 m above mean sea level. The climate is tropical semi-arid, hot dry summer and mild dry in the winter with a great seasonal variation in temperature. Mean annual rainfall is 160 mm falling mainly during July, September period.

An area of 3500 $m^2$ was used for the experiment. The treatments included four types of irrigation water: Wastewater (WW), Magnetized wastewater (MWW), Normal water (NW) and Magnetized Normal water (MNW).

The same amount of irrigation water was applied from wastewater and normal water. Magnetizing devices (modifiers) were installed randomly with the lateral lines. Adistance of 0.2 m was kept as a buffer zone between treatments. At the end of each of the two seasons the soil was analyzed for pH, electrical conductivity (ECe), potassium concentration (K%), sodium adsorption ratio (SAR), nitrogen (N%), Organic carbon (O.C%), organic matter (O.M%) and porosity recorded (sp).

## RESULTS AND DISCUSSION

Soil pH was affected by type of irrigation water and soil. Fig (1) shows soil pH values with different irrigation water types. In general, there are significant differences in soil pH values between treatments. The water type effect on the soil pH is in the order: (WW) > (M.WW) > (M.NW) > (NW). High pH value was recorded in the soil irrigated with WW and M.WW. This may be due to the fact that a soil pH is associated with the high bicarbonate content in the wastewater as concluded by Ayer and Wescort (1989). Magnetization treatment of water registered variable effects on soil pH, as for the first season MNW recorded a pH value of 7.27 while in the second season the value was decreased to 7.22. On the other hand MWW recorded a pH value of 7.26 in the first season, and in the second season recorded a pH value of 7.3. This is attributed to the high bicarbonate content and presence of Na and Mg. This agrees with the findings of El Shiekh (2007) and (McGrath,1994). Nguyen, (2008) reported that applying wastewater for irrigation significantly increased soil pH.

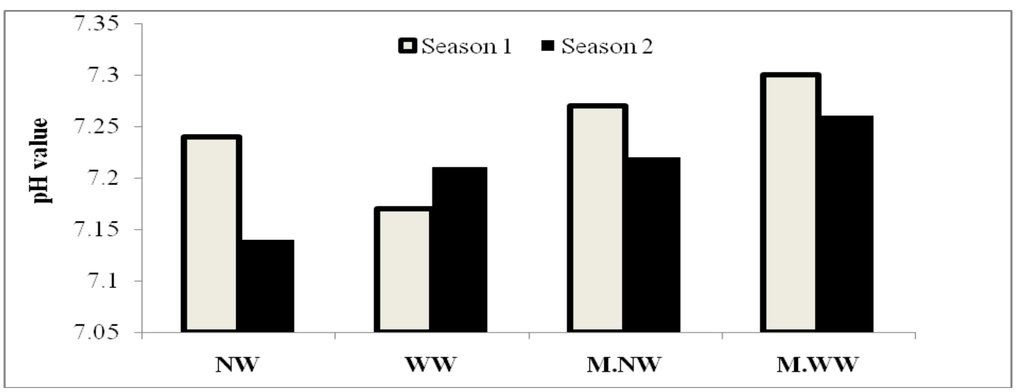


Figure 1. Soil pH values as affected by water type
NW =Normal water, WW=Wastewater, MNW=-Magnetized normal water and MWW=Magnetized wastewater

Electrical conductivity is most important parameter in determining the suitability of irrigation water. Fig.2 shows that the soil electrical conductivity (ECe) was significantly affected by magnetizing water. The ECe value according to the irrigation water type, follow the sequence: MNW > NW > MWW > WW in the first season. In the second season, the ECe values in the order: NW > MNW > MWW > WW. This result is attributed to the fact that irrigation with treated wastewater increases the accumulation of minerals as suggested by McGrath et al, (1994) particularly due the increase of Na concentration as stated by Moore, (1972). Nguyen, et al, (2008) found that the effect was observed for electrical conductivity, which was higher in the wastewater treatments than in the control.

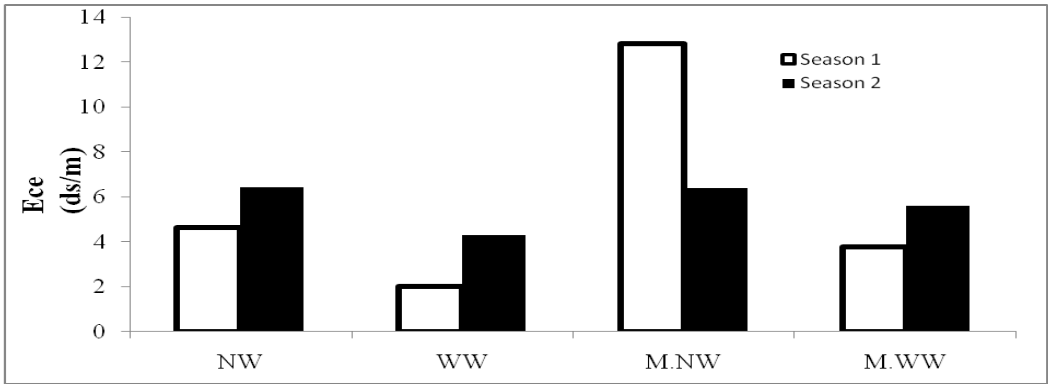


Figure 2. Soil ECe as affected by water type
NW =Normal water, WW=Wastewater,MNW=-Magnetized normal water and MWW=Magnetized wastewater

There was a significant increase in soil K concentration, which was irrigated with (WW) followed by irrigated with (M.WW) (Fig.3). So, the increase in K concentration of soil irrigated with treated wastewater as compared with irrigated with normal water may be due to the fact that the treated wastewater is rich in many ingredients such as N, P, and K, this agrees with the findings of Singh et al. (2004).

Potassium concentration increased by irrigation with wastewater rather well water. It explains the importance of wastewater to supply these elements in the soil results from other studies had increase in potassium in the soil as a result of wastewater application (Monnett, 1996).

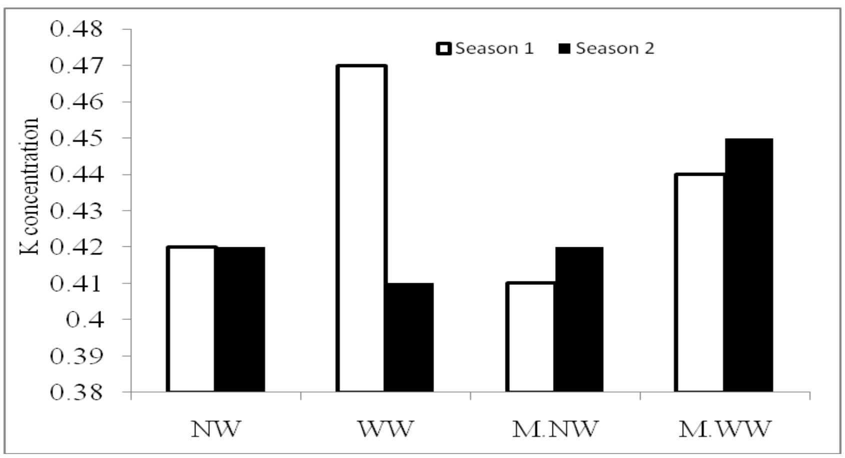


Figure 3. Soil K concentration as affected by water type
NW =Normal water, WW=Wastewater, MNW=-Magnetized normal water and MWW=Magnetized wastewater

Permeability and aeration problems can occur when the irrigation water has a sodium adsorption ratio (SAR) and high salinity to cause a large increase in the sodium status of the soil. Fig. 4 presents the effect on soil sodium adsorption ratio (SAR) as a result of the different irrigation waters applied. There are differences in soil SAR between the treatments. SAR recorded high value of 10.9, 7.35, 6.7 and 3.5 were recorded for soil irrigated with NW, MNW, MWW and WW respectively during both seasons. These results may be attributed to the increase of Na in the soil as compared with Ca and Mg. These results agree with the findings of Ramirz et al, (2002). In general, wastewater had negative impact on soil when it was used for long-terms (Ayers and Westcott, 1989). Mohammad, (2010) found that sodium absorption ratio increased in soil solution by wastewater irrigation as maximum value was observed.

Moreover, soil salinity level increased in all wastewater treatments in compare with control. The maximum soil salinity was obtained by wastewater.

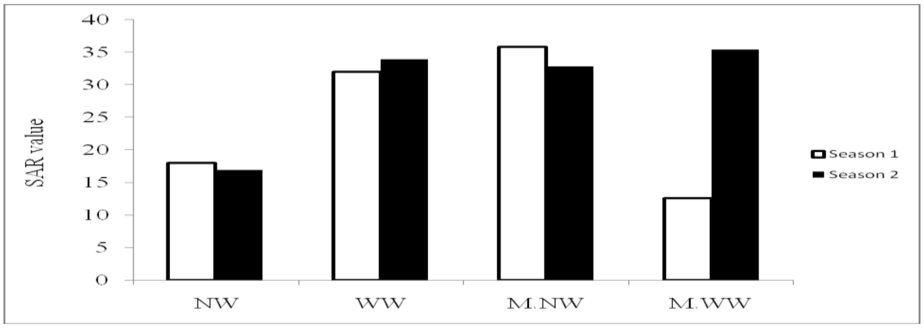


Figure 4. The effect of water type on Soil sodium adsorption ratio
NW =Normal water, WW=Wastewater, MNW=-Magnetized normal water and MWW=Magnetized wastewater

Figures 5, 6 and 7 show that the soil N, O.C, and O.M concentrations as a result of the application different irrigation water type. The soil N % concentration is in the order: (WW) > (M.WW) > (NW), (M.NW). This sequence of concentrations may be due to the fact that the treated wastewater is rich in several useful ingredients such as N, P, and K as confirmed by the result of Singh et al. (2004). Nguyen, et al (2008) reported that irrigation by wastewater caused an increase in total nitrogen. Soil nitrogen increased by wastewater treatments because of plentiful urea and nitrogen in urban wastewater (Bernala, 2006; Fonseca, 2005). Mohammad. (2010) found that the highest and lowest value of total nitrogen was obtained by irrigation with wastewater and control treatments respectively. Rusan et al. (2007) found that application provides N up to 10 times more than forage plants need. Fuentes et al. (2002) reported that total soil nitrogen increased under the influence of urban wastewater or wastewater sludge irrigation. Nguyen, et al. (2008) reported that the reuse of wastewater for irrigation caused an increase in total organic carbon content. Mohammad, et al. (2010) reported that irrigation with wastewater increased soil organic carbon (O.C %).

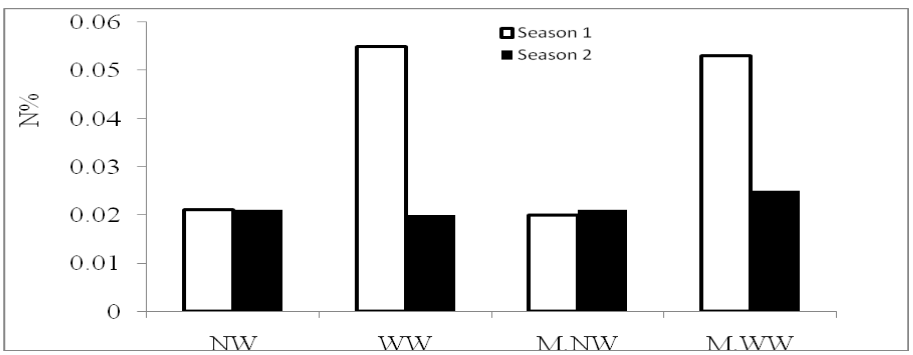


Figure 5. The effect of water type on N%
NW =Normal water, WW=Wastewater, MNW=-Magnetized normal water and MWW=Magnetized wastewater

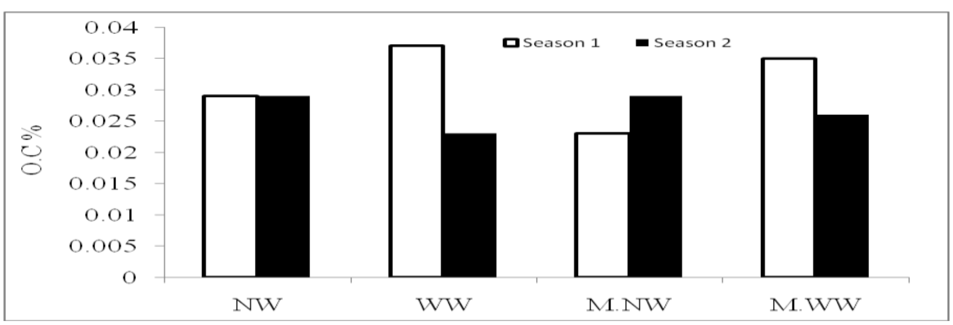


Figure 6. The effect of water type on O.C %
NW =Normal water, WW=Wastewater, MNW=-Magnetized normal water and MWW=Magnetized wastewater

The effect of water type on soil O.C% concentration is shown by Fig 6 where WW and M.WW resulted in high concentrations as compared with NW and M.NW. The increase of O.C concentration improves soil properties as pointed out by Pagliai (1981). On the other hand fig (7) shows that the increases of soil O.M concentration between different irrigation waters are in the order of (WW) > (M.WW) > (M.NW) > (NW). This result can be attributed to the fact that the high content of O.M in treated wastewater improves the soil physical properties and hence agricultural productivity. This agrees with the findings of Pagliai, (1981). Zhang, et al. (2008) have reported the significant increase in percentage of organic matter and improvement in soil structure as a result of irrigation with wastewater.

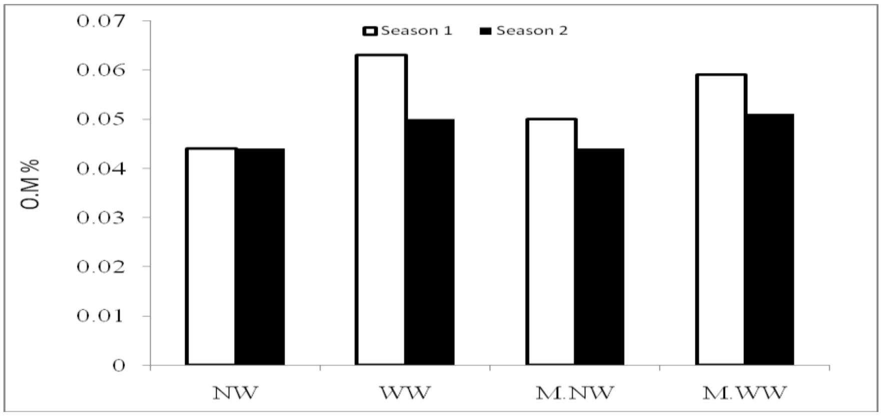


Figure 7. The effect of water type on O.M %
NW =Normal water, WW=Wastewater, MNW=-Magnetized normal water and MWW=Magnetized wastewater

Values of soil porosity of 64.2, 66.3, 62.1 and 60.8 were recorded with WW, MWW, MNW and NW, respectively. The high organic matter content can increase soil porosity because of improved soil aggregation. This agrees with the findings of Pagliai (1981).

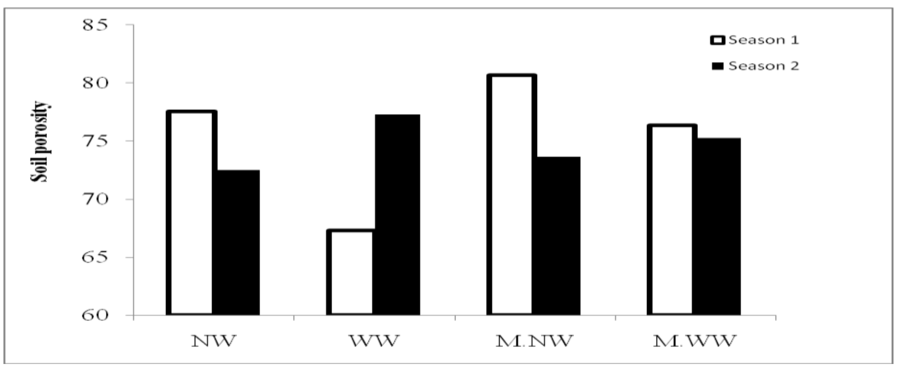


Figure 8. The effect of water type on soil porosity
NW =Normal water, WW=Wastewater, MNW=-Magnetized normal water and MWW=Magnetized wastewater

## CONCLUSIONS

Irrigation by treated wastewater increases the soil pH, electric conductivity, Na and SAR.
Irrigation with magnetized water decreases soil salinity.
Using treated wastewater and magnetized treated wastewater improved soil porosity.

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