EFFECT OF MAGNETIZING TECHNOLOGY ON THE DRIP IRRIGATION SYSTEM HYDRAULIC PERFORMANCE AND EMITTER CLOGGING

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ABSTRACT

The experiment was conducted in 2006 and 2007 in the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, Sudan to evaluate the effect of magnetizing technology on the hydraulic performance of drip irrigation system and emitters clogging using four types of water, normal water (NW), wastewater (WW), magnetized wastewater (MWW) and magnetized normal water (MNW).

The emitter's average discharges during two years were 3.46, 2.65, 3.75 and 3.33 with NW, WW, MNW and MWW, treatments respectively. The emission uniformity for two years 89% 71%, 96.5% and 87% with NW, WW, MNW and MWW treatments respectively. The irrigation efficiencies were high with MNW, NW, MWW and WW treatments respectively, in the two seasons.

Keywords: *drip irrigation system, treated wastewater, magnetized wastewater, emission uniformity, irrigation efficiency.*

INTRODUCTION

Irrigated agriculture is the largest consumer of water in the world. (Hamdy, 2001). Where it is more difficult to meet the agricultural water demand with conventional water resources, wastewater reuse represents a viable option (Capra and Scicolone, 2004). Reuse of wastewater for irrigation is increasingly gaining popularity worldwide as one of the non-conventional water resources targeted to overcome the envisaged international water crises. The treatment and reuse of the wastewater can improve a potential cause of environment, ground and surface water pollution and at the same time can help in solving the expected water scarcity (Eltoum *et al.*, 1998). Wastewater from industries and municipalities, organic sludge and animal manures should be considered as resources rather than wastes that need to be put out of sight (Omer, 2003).

Drip irrigation slowly and regularly applies water and fertilizers directly to the root zone of plants through a network of economically designed plastic pipes and low discharge emitters. The advantage of using a drip-irrigation system is that it can significantly reduce soil evaporation and increase water use efficiency by creating a low wet area in the root zone (Haijun and Guanhua, 2009). The use of wastewater for irrigation purposes is being established as a future alternative in those areas where there is heavy competition for water. In this perspective, the irrigation system that has more advantages in terms of the environment and public health is drip irrigation. Despite these advantages, drip irrigation has a serious limitation in that the emitters tend to clog which affects the water application uniformity. Filtration is a key aspect in drip irrigation with wastewater but this does not prevent emitters to clog (Puig-Bargues *et al.* 2005). To prevent emitter clogging, some methods have been used on both experimental and on field scales. Filtering and flushing drip lines are simple and useful methods to prevent emitter clogging, particularly for physical clogging (Nakayama and Bucks, 1991). Chemical clogging can be controlled with acid injection, which can lower the pH value of irrigation water and thus prevent chemical precipitation. Biological clogging is quite difficult to control. Chlorination is one of the most common and efficient ways used to prevent and treat emitter clogging caused by algae and bacteria (Dehghanisanij *et al.*, 2005).

Sahin *et al.* (2005) found that antagonistic bacterial strains have the potential to be used as anti-clogging agents for the treatment of emitters in drip-irrigation systems. Zhang *et al.* (2007) studied the hydraulic performance of emitters with labyrinth channels and suggested several structural optimization schemes for the design of emitters with high anti-clogging capability. Emitter clogging varies based on effluent quality, emitter type, filtering methods and environmental conditions. The objectives of this work were to study the effect of magnetizing technology on solving the problem of emitter clogging and drip irrigation system performance.

Materials and Methods

The experiment was conducted in year 2006 and 2007 in the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, Shambat, Sudan (latitude 15°36′N longitude 32°32′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.

Two drip irrigation systems were used, one with treated wastewater and the other with normal water. The two systems were designed and installed on an area of 3500 m^2. Each system consisted of a storage tank, vacuum breaker (to remove the air from the system), screen filter, pressure gauge, fertilizing system, a main and a sub-main PVC pipelines and a13 mm PE pipe laterals. From the storage tanks entire mainlines were buried 50 cm below the soil surface to prevent mechanical damage due to the movement of farm implements and human beings.

The standard procedure recommended by Choudhary and Kadam (2006) was followed to test the drip irrigation system. After reaching the steady-state flow condition, discharges of randomly selected emitters were measured volumetrically. The emission uniformities were computed using the following equation:

1. Emission uniformity

$$Eu = \frac{Qmin}{Qavg} \times 100 \quad \text{.............................} (1)$$

Where EU is field emission uniformity (%).Qmin is the minimum emitter discharge (lh) and Qavg is the average emitter discharge (lh).

2. Irrigation efficiency

The overall application efficiency of drip irrigation (Ea) is defined by Vermeiren and Gobling (1990) equation:

Ea =Ks× Eu .... (2)

Where Ks is ratio between water stored and that diverted from the field, it expresses the water storage efficiency of the soil. It takes into account unavoidable deep percolation as well as other losses (0.95). Eu is emission uniformity of drip irrigation system.

Results and discussion

Irrigation water type and emitters discharge

From Table (1) it is clear that in the first year the discharges recorded were 3.5, 2.7, 3.75 and 3.4 for normal water (NW), wastewater (WW), magnetized normal water (MNW) and magnetized wastewater (MWW) Treatments respectively. In the second year the emitters discharge recorded 3.42, 2.6, 3.75 and 3.25 for the above treatment respectively. WW and M.WW registered highly significant effect as compared with MNW and NW. This result may be due to the fact that there is a decrease in emitter flow rate with WW due to the concentrations of physical (inorganic particles suspended), chemical (dissolved solids) and organic (organic matter) contaminants, which may often cause clogging to emitters. This finding is consistent with those of Ayers and Westcott, (1989) and Nakayama and Bucks (1981).

In general, emitter clogging is a major problem incurred in the operation of drip irrigation system utilizing wastewater effluent as stored in surface reservoirs. Narrow passages and small openings are inherent to all emitters of drip irrigation system. Therefore, all emitters in common are vulnerable to clogging due to physical, chemical and biological contaminations Nakayama and Bucks (1981).

Table 1. The average emitters discharges

Water type	Year I		Year 2	
	Discharge (l/h)	Pressure (bar)	Discharge (l/h)	Pressure (bar)
NW	3.50[b]	1.8	3.42[b]	1.8
WW	2.7[c]	1.8	2.6[c]	1.8
MNW	3.75[a]	1.8	3.75[a]	1.8
MWW	3.4[a]	1.8	3.25[a]	1.8

NW=Normal water, WW=Wastewater, MNW=Magnetized normal water and MWW=Magnetized wastewater

Irrigation water emission uniformity (Eu)

Fig. 2 shows that emission uniformity (Eu) differs with different types of irrigation water. In the first year the emission uniformity recorded 89% 72%, 96% and 89% with NW, WW, MNW and MWW treatments respectively. In the second season it recorded 89%, 70%, 97% and 85% with NW, WW, MNW and MWW, treatments respectively. The emission uniformity was excellent with MNW, was good with NW and MWW and was acceptable with WW in the two seasons according to Choudhary and Kadam (2006). This clearly indicates that magnetization of irrigation water improves the performance of drip emitters, reducing the effect of clogging by salt accumulation. This results agrees with the findings of Basher (2006).

Irrigation efficiency (Ea)

The irrigation efficiency was high with MNW, NW, MWW and WW respectively, in the two year (Fig 3). These results indicated that treatments magnetization of irrigation water improves the performance of drip irrigation system. This agrees with the findings of Basher (2006).

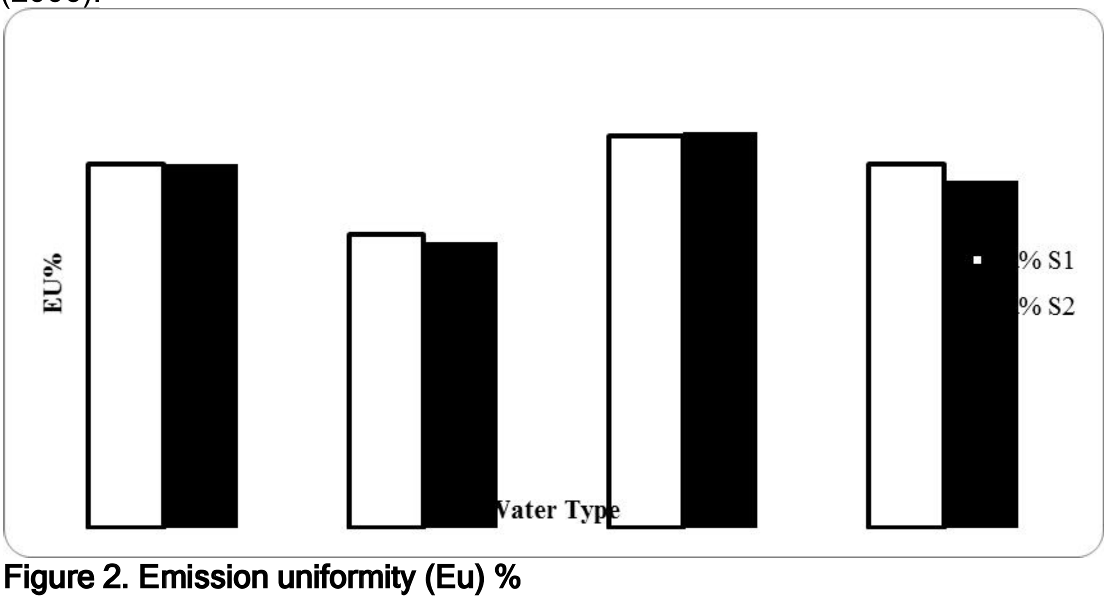

Figure 2. Emission uniformity (Eu) %

S1= year1, S2=year 2, NW=Normal water, WW=Wastewater, MNW=Magnetized normal water and MWW=Magnetized wastewater

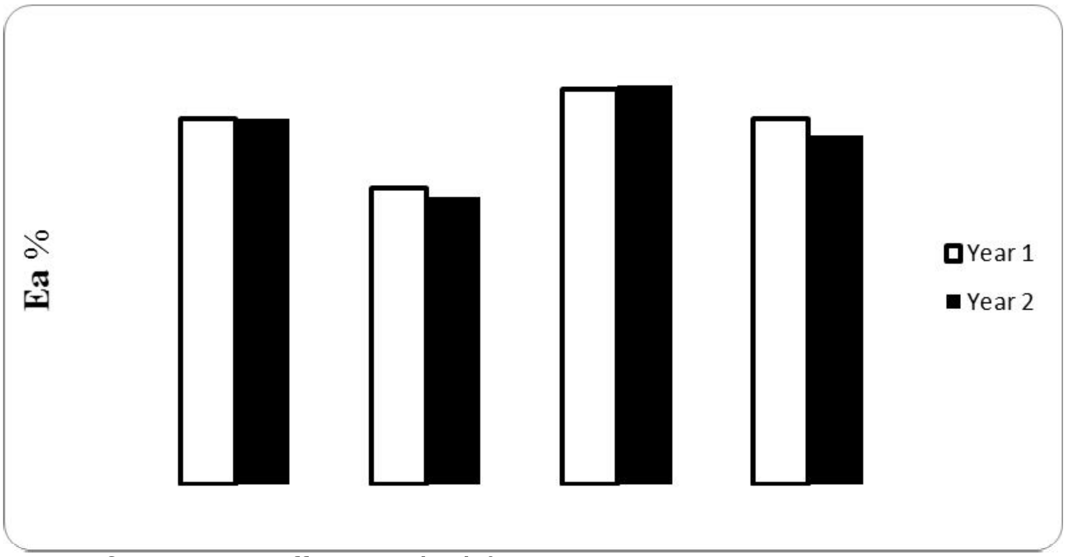

Figure 3. Irrigation efficiency (Ea) %
S1= year1, S2=year 2, NW=Normal water, WW=Wastewater, MNW=Magnetized normal water and MWW=Magnetized wastewater

Conclusion

Magnetization of irrigation water improves the performance drip irrigation systems.

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الملخص العربي

أثر استخدام تقنية المغنطة على الاداء الهيدروليكى لنظام الرى بالتنقيط وانسداد المنقطات

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أجريت التجربة خلال عامي 2006 و 2007 في المزرعة التجريبية لكلية الزراعة، جامعة الخرطوم، السودان لتقييم تأثير تكنولوجيا المغنطة على الأداء الهيدروليكية لنظام الري بالتنقيط و انسداد المنقطات تحت أربعة أنواع من المياه: العادمة المعالجة (WW)، والمياه الطبيعية (NW)، المياه العادمة الممغنطة (MWW) و المياه الطبيعية الممغنطة (MNW). كانت متوسط تصريف المنقطات خلال العامين 2.65،3.46، 3.75 و3.33 مع، NW، MNW، WW وMWW على التوالي. انتظامية تصريف المنقطات لفترة العامين كانت 89٪ ،71٪ ، 96.5٪ و 87٪ مع NW، MNW، WW وMWW على التوالي. كفاءة الري كانت عالية مع، MNW MWW، NW وWW على التوالي، في السنة الأولى والثانية.