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Determining importance of irrigation with wastewater at agronomy in Iran

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Abstract

In order to investigate the effects of wastewater on soil properties an experiment was conducted in Islamic Azad University, Shahr-e-Qods Branch, Iran by measuring essential features related to soil characteristics. For this end, we used of 9 lysimeters that lysimeters of 1, 2 and 3 were irrigated by domestic wastewater and first drainage water accumulated from these lysimeters. Lysimeters of 4, 5 and 6 were irrigated by this water and secondary drainage water accumulated from upon lysimeters. To compare soil properties lysimeters of 7, 8 and 9 were irrigated by normal water and finally, soil and water properties analyzed in each stage. The results indicated that soil could filtering the wastewater and reduced BOD_5 and COD of wastewater sorely. Also, irrigation with wastewater increased nutritive elements in soil that can be source of nutrition for plants. Our findings may give applicable advice to commercial farmers and agricultural researchers for management and proper use of water.

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Introduction

Sewage, often untreated, is used to irrigate 10 percent of the world's crops, according to the first ever global survey of wastewater irrigation. This is a largely hidden practice and is outlawed in many countries. However, many farmers, especially those in urban areas, use sewage because it is free and abundant, even during droughts, and, being full of nitrates and phosphates, acts as an effective fertilizer (Arceivala, 1981; Banu *et al.*, 2007). The use of wastewater by farmers will not go away. It can't be ignored or dealt with by imposing bans on its use. Municipal policy-makers and planners need to confront reality and face the challenge in innovative ways (Scott *et al.*, 2004). Irrigation is an excellent use for sewage effluent because it is mostly water with nutrients. For small flows, the effluent can be used on special, well-supervised "sewage farms," where forage, fiber, or seed crops are grown that can be irrigated with standard primary or secondary effluent. However, agronomic aspects related to crops and soils must also be taken into account (Bouwer and Idelovitch, 1987). Irrigation may be defined as the application of water to soil for the purpose of supplying the moisture essential for plant growth. Irrigation plays a vital role in increasing crop yields and stabilizing production. In arid and semi-arid regions, irrigation is essential for economically viable agriculture, while in semi-humid and humid areas, it is often required on a supplementary basis (Oron *et al.*, 1986). In a field experiment was carried out on a sandy soil in Agadir region, two types of water were used: the rainfall supplemented with treated wastewater irrigation of which five treatments were tested. Leaf, root content of nitrogen, phosphorus, potassium, calcium and magnesium was increased proportionally to the irrigation doses. The electrical conductivity of the soil increased from the start to the end of the experiment. The evaluation of soil nutrients for the three soil layers indicated their accumulation with increasing irrigation dose (Mosab, 2000). The objective of Mancino and Pepper (1992) was to determine the influence of secondarily treated municipal wastewater irrigation on the chemical quality of bermudagrass (*Cynodon dactylon* L.) turf soil (Sonoita gravelly sandy loam: coarse-loamy, mixed, thermic Typic Haplargid) when compared to similarly irrigated potable water plots. Research plots were irrigated using a 20% leaching fraction. After 3.2 yr of use, effluent water increased soil electrical conductivity by 0.2 ds m^{-1}, Na by 155 mg kg^{-1}, P by 26 mg kg^{-1}, and K by 50 mg kg^{-1} in comparison to potable irrigated plots. Soil pH was not significantly affected by effluent irrigation. The concentrations of Fe, Mn, Cu, and Zn were found to be within the range considered normal for agricultural soil. Effluent irrigation increased soil total organic carbon and nitrogen during the first 1.3 yr of irrigation only. Total aerobic bacteria populations were similar in all irrigated plots indicating these microbes were not promoted or inhibited by the use of this wastewater (Balakrishnan and Eckenfelder, 1970; Bataineh *et al.*, 2007). The main objective of this study was to investigate the effects of wastewater on soil properties.

Material and methods

This study was conducted on experimental lysimeters of Islamic Azad University, Shahr-e-Qods Branch at Iran with loam soil and the soil consisted of 32% clay, 30% silt and 38% sand (Table 1). The volume of 12 lysimeters was 440 lit (80 × 65 × 85 cm) that were filled by loam soil (height = 50 cm). In order to preventing of water influx from field to lysimeters, those placed on wooden legs (height = 40 cm). In the end of the lysimeters was a pore draining (diameter = 50 cm) that wastewater accumulated in the graduated tubs. In this experiment, we had 9 lysimeter that 1, 2 and 3 lysimeters irrigated by domestic wastewater (150 lit in the each lysimeter). Then, first drainage water accumulated from these lysimeters and 4, 5 and 6 lysimeters were irrigated by this water and secondary drainage water accumulated from upon lysimeters. In order to comparison soil properties 7, 8 and 9 lysimeters were irrigated by normal water and lysimeters irrigated each 15 days regularly for 3 months. Finally, data were subjected to repeated measure analysis.

Results and discussion

In this study, we analyzed lysimeters soil (Table 1) and domestic wastewater (Table 2) then lysimeters 1, 2 and 3 were irrigated by domestic wastewater.

In the next stage, we accumulated first water from 1, 2 and 3 lysimeters and analyzed soil (Table 3) and water (Table 4) in these lysimeters.

Table 1. The analysis of lysimeters soil.

Soil texture	Sand (%)	Silt (%)	Clay (%)	K (mg/lit)	P (mg/ lit)	pH	Ca (mg/ lit)	Mg (mg/ lit)	EC (ds/m)
Loam	38	30	32	180.36	4.75	7.4	11.92	16.14	5.91

Table 2. The analysis of domestic wastewater.

Ca (mg/ lit)	Mg (mg/ lit)	TSS (mg/ lit)	SAR	pH	EC (ds/m)	BOD5 (ppm)	COD (ppm)
13.81	14.75	198.2	5.42	7.1	4.2	150	232

Table 3. The analysis of lysimeters soil after first irrigation.

K (mg/lit)	P (mg/ lit)	pH	SAR	Ca (mg/ lit)	Mg (mg/ lit)	EC (Ds/m)
210.32	13.17	7.34	9.12	13.04	15.42	8.03

The results showed that soil was a bio-filter that could reduce a great part of waste pollutions, for example BOD5 and COD decreased sorely, but this filtering increased EC, SAR, Na, Ca and Mg of soil. The 4, 5 and 6 lysimeters irrigated by first drainage water. Secondary drainage water was accumulated from 4, 5 and 6 lysimeters and analyzed soil (Table 5) and water (Table 6) in upon lysimeters.

Table 4. The analysis of first drainage water.

Ca (mg/ lit)	Mg (mg/ lit)	TSS (mg/ lit)	SAR	pH	EC (Ds/m)	BOD5 (ppm)	COD (ppm)
12.11	12.23	184.58	4.32	6.52	3.45	14	27

Table 5. The analysis of lysimeters soil after second irrigation.

K (mg/lit)	P (mg/ lit)	pH	SAR	Ca (mg/ lit)	Mg (mg/ lit)	EC (Ds/m)
202.13	11.38	7.4	9.03	12.65	13.18	7.82

Table 6. The analysis of secondary drainage water.

Ca (mg/ lit)	Mg (mg/ lit)	TSS (mg/ lit)	SAR	pH	EC (Ds/m)	BOD5 (ppm)	COD (ppm)
10.98	11.07	180.12	4.01	6.94	3.42	4	6

Our data indicated that waste pollutions reduced again, but EC, SAR, Na, Ca and Mg of soil increased under this condition.

In the Tables 7 and 8 we compared in each stage soil and water of lysimeters with soil before irrigation and normal water.

Table 7. Comparison of soil before irrigation with after irrigation.

Treatment	K (mg/lit)	P (mg/ lit)	pH	SAR	Ca (mg/ lit)	Mg (mg/ lit)	EC (Ds/m)
Before irrigation	180.36	4.75	7.4	11.92	11.92	16.14	5.91
First stage	210.32	13.17	7.34	9.12	13.04	15.42	8.03
Second stage	202.13	11.38	7.4	9.03	12.65	13.18	7.82

Table 8. Comparison of domestic wastewater with first and secondary drainage water.

Treatment	Ca (mg/ lit)	Mg (mg/ lit)	TSS (mg/ lit)	SAR	pH	EC (Ds/m)	BOD5(ppm)	COD (ppm)
Domestic wastewater	13.81	14.75	198.2	5.42	7.1	4.2	150	232
First drainage water	12.11	12.23	184.58	4.32	6.52	3.45	14	27
Secondary drainage water	10.98	11.07	180.12	4.01	6.94	3.42	4	6

Both opportunities and problems exist in using wastewater for landscape irrigation. Recycled wastewater irrigation in urban landscapes is a powerful means of water conservation and nutrient recycling, thereby reducing the demands of freshwater and mitigating pollution of surface and ground water. However, potential problems associated with recycled wastewater irrigation do exist (Arceivala, 1981; Banu *et al*., 2007). These problems include salinity build up and relatively high Na and B accumulation in the soil. Especially, the significantly higher soil SAR in wastewater irrigated sites compared with surface water irrigated sites provided reason for concern about possible long term reductions in soil hydraulic conductivity and infiltration rate in soil with high clay content, although these levels were not high enough to result in short term soil deterioration. Salt leaching would become less effective when soil hydraulic conductivity and infiltration rate were reduced. These chemical changes may in part contribute to the stress symptoms and die off observed in some ornamental trees (Balakrishnan and Eckenfelder, 1970). As more landscape facilities and development areas plan to switch to recycled wastewater for irrigation, landscape managers must be prepared to face new challenges associated with the use of recycled wastewater. Persistent management practices, such as applications of soil amendments that provide Ca to replace Na; periodic leaching to reduce salt accumulation; frequent verifications to maintain infiltration, percolation, and drainage; regular soil and plant monitoring, and selection and use salt tolerant turf grass and landscape plants will be helpful in mitigating the negative impact and ensuring continued success in using wastewater for landscape irrigation. Many wastewater irrigators are not landowning farmers, but landless people that rent small plots to produce income-generating crops such as vegetables that thrive when watered with nutrient-rich sewage. Across Asia, Africa and Latin America these wastewater micro-economies support countless poor people. Stopping or over-regulating these practices could remove the only income many landless people have (Arceivala, 1981; Scott *et al.*, 2004; Bataineh *et al*., 2007).

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