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Economical Value of Irrigation with Wastewater Instead of Agronomical Water at Iran

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Abstract: To investigate the beneficial impacts of wastewater on agricultural economics by analysis of soil properties, we conducted an experiment in the lysimeter by measuring certain features essentially related to soil characteristics. Our objectives in this study were (i) the wastewater infiltration by soil and (ii) the effect of wastewater on soil properties. In this experiment, we had 9 lysimeter that 1, 2 and 3 lysimeters irrigated by domestic wastewater. Then, primary drainage water accumulated from these lysimeters and 4, 5 and 6 lysimeters irrigated by primary drainage water. In order to comparison soil properties, 7, 8 and 9 lysimeters irrigated by agronomical water and finally, soil and water properties analyzed in each stage. The results showed that soil could treating 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.

Key words: Agricultural economics, domestic wastewater and irrigation

INTRODUCTION

The rapid population growth in many municipalities in the arid and semiarid of the world continues to place increasing demands on limited fresh water supplies. Many cities and districts are struggling to balance water use among municipal, industrial, agricultural, and recreational users. The population growth hasn't only increased the fresh water demand but also increased the volume of wastewater produced. Treated or recycled wastewater appears to be the only water resource that is increasing as other sources are dwindling. Use of RWW (Raw Waste Water) for irrigating landscapes is often viewed as one of the approaches to maximize the existing water resources and stretch current urban water supplies (USEPA, 1992). 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 of charge and abundant, even during droughts, and, being full of nitrates and phosphates, acts as an effective fertilizer. The use of wastewater by farmers will not go away and 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 carried out on a sandy soil in Agadir region, treated wastewater was applied as supplemental irrigation. Leaf, root content of nitrogen, phosphorus, potassium, calcium and magnesium was increased proportionally by treated wastewater. 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 (Mosab, 2000). The objective of study done by Mancino and Pepper (1992) was to determine the influence of secondarily treated municipal wastewater 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 year 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

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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 year 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. In summary, the irrigation of this turf soil for 3.3 year with the secondarily treated wastewater used in this study had no serious detrimental effects on soil quality. Therefore, the objective of this experiment was to determine the role of soil in treating of wastewater and effect of primary drainage water on agricultural economics by analysis of soil properties.

MATERIALS AND METHODS

This study was conducted on experimental lysimeters of Islamic Azad University, Shahr-e-Qods Branch, Iran. The volume of each lysimeter was 150 lit (Height = 100 cm and Radius = 30 cm) filled by loam soil consisted of 30% clay, 28% silt and 42% sand (Table 1). The depth of soil in lysimeters was 80 cm. In order to prevent water influx from field to lysimeters, those placed on metal legs (height = 40 cm). In the bottom of the lysimeters was a pore (diameter = 5 cm) that primary drainage water to accumulate in the barrel graduate. In this experiment, we had 9 lysimeter that 1, 2 and 3 lysimeters irrigated by domestic wastewater (150 lit in each lysimeter). Then, primary drainage water accumulated from these lysimeters and 4, 5 and 6 lysimeters irrigated by primary drainage water. In order to comparison soil properties, 7, 8 and 9 lysimeters irrigated by agronomical water and all lysimeters were irrigated every 15 days regularly for 3 months. At the each stage, soil and water properties analyzed and were compared with normal soil and water properties.

RESULTS AND DISCUSSION

The following table is showing economic value of water purification and reuse of wastewater for irrigation of agricultural products. We need water for irrigation crops and despite limited water resources; reuse of domestic wastewater is the best of selection in terms of economic value

Different options	**Estimated cost**
Reuse of wastewater for irrigation	X – 10 X
Reduce irrigation water to produce crops (Low irrigation)	6 X -12 X
Sweetening of salty and brackish waters	9 X – 15 X
Sweetening of seas and rivers waters	20 X – 30 X

X = Variable that is constant for all options

Table 1: The analysis of lysimeters soil before irrigation by domestic wastewater

K (mg/lit)	P (mg/ lit)	Na (mg/ lit)	pH	SAR	Ca (mg/ lit)	Mg (mg/ lit)	EC (Ds/m)
201.41	5.12	30.21	7.2	8.72	12.01	14.12	5.68

Table 2: The analysis of lysimeters soil after irrigation by domestic wastewater

K (mg/lit)	P (mg/ lit)	Na (mg/ lit)	pH	SAR	Ca (mg/ lit)	Mg (mg/ lit)	EC (Ds/m)
208.40	12.14	38.14	7.41	9.92	14.02	16.17	8.71

Table 3: The analysis of lysimeters soil after irrigation by primary drainage water

K (mg/lit)	P (mg/ lit)	Na (mg/ lit)	pH	SAR	Ca (mg/ lit)	Mg (mg/ lit)	EC (Ds/m)
219.12	18.38	45.17	7.48	11.17	18.52	19.22	8.82

Table 4: The analysis of lysimeters soil after irrigation by agronomical water

K (mg/lit)	P (mg/ lit)	Na (mg/ lit)	pH	SAR	Ca (mg/ lit)	Mg (mg/ lit)	EC (Ds/m)
202.53	5.5	30.29	7.1	8.69	12.09	13.98	5.53

In the beginning of this study, we analyzed lysimeters soil before irrigation by domestic wastewater (Table 1) and then 1, 2 and 3 lysimeters irrigated by domestic wastewater (Table 2). In the next stage, we accumulated primary drainage water from 1, 2 and 3 lysimeters and the 4, 5 and 6 lysimeters irrigated by primary drainage water and analyzed soil in these lysimeters after irrigation by primary drainage water (Table 3). In order to comparison soil properties, 7, 8 and 9 lysimeters irrigated by agronomical water (Table 4, 5).

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. 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. 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

Table 5: Comparison of agronomical water with domestic wastewater and primary drainage water

	K (mg/lit)	P (mg/ lit)	Na (mg/ lit)	pH	SAR	Ca (mg/ lit)	Mg (mg/ lit)	EC (Ds/m)
domestic wastewater	208.40	12.14	38.14	7.41	9.92	14.02	16.17	8.71
agronomical water	202.53	5.5	30.29	7.1	8.69	12.09	13.98	5.53
primary drainage water	219.12	18.38	45.17	7.48	11.17	18.52	19.22	8.82
agronomical water	202.53	5.5	30.29	7.1	8.69	12.09	13.98	5.53

applications of soil amendments that provide Ca to replace Na; periodic leaching to reduce salt accumulation; frequent verificationsto 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.

CONCLUSION

We need water for irrigation crops and despite limited water resources; reuse of domestic wastewater is the best of selection in terms of economic value. 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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