Evaluation in Wastewater Application in the soil properties

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Abstract: Water scarcity and the need for water for food production and environmental protection in the world have forced human beings to seek new water sources. Nowadays, application of unconventional water resources (wastewater) has been proposed in the countries facing shortage of water resources. However, limited studies have assessed this issue. The present study evaluated changes in elements of the soil irrigated with wastewater. For this purpose, an experiment was conducted as a randomized complete block design with three replications. Soil samples were collected from the studied regions at two depths of 0-30 cm and 30-60 cm. Studied parameters included acidity (Ph) and electrical conductivity (EC) of the soil. Three studied regions (no irrigation, irrigation with treated wastewater, irrigation with river waters) were considered. The results showed an increase in pH of the effluent from Zahedan Wastewater Treatment Plant compared to control. However, electrical conductivity decreased in the soil irrigated with wastewater.

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1. Introduction

Iran has arid and semi-arid ecosystems. The highest percentage of water consumption is accounted for agricultural sector compared to other purposes. Critical state of water scarcity in many parts of Iran has made water resource planners and managers to consider conventional and unconventional water resources (low quality water resources) in development planning. Urban treated wastewater is one low quality water resource whose application in agriculture necessitates careful management. Population growth in recent decades, development of human needs and increased public health have led to excessive exploitation of surface and underground water resources, which might result in a massive crisis. This problem is exacerbated in drought periods. This crisis is more highlighted and requires special attention in such countries as Iran, which lies in the arid belt. Unconventional freshwater resources (wastewater) should be used in agriculture in order to solve this problem, so that water resources would be available for other purposes (Hussein Oghli, 2002). Application of unconventional water resources (such as wastewater from water treatment plants) is increasingly important since less pressure is imposed on freshwater resources (Moazed and Hanife Lu, 2006). In fact, wastewater is rich innutrients and is the most accessible source of water for irrigation in most countries facing water scarcity (Fatta and Kythreotou, 2005). Wastewater as a rich source of nutrients can be used as a fertilizer. Abedi Koupai et al. (2001) evaluated the effect of wastewater of Shahin Shahr Water Treatment Plant on irrigation of sugar beet, maize and sunflower. They showed that irrigation with wastewater reduces saturated electrical conductivity and increases bulk density and ph of the soil. Shojaei (2014) evaluated the effect of urban sewage on soil chemical properties. They showed that irrigation with wastewater reduces electrical conductivity, dissolved sodium content, total soluble calcium and magnesium, potassium, and increases nitrogen and phosphorus of the soil compared to control. The present study aimed to assess the effect of application of wastewater of Zahedan Water Treatment Plant on accumulation of ph and EC at different depths of the soil, so that more adequate water resource can be identified for agricultural purposes.

2. Materials and Methods

This research lasted for 3 years in which the effects of wastewater application on levels of sodium, total calcium and magnesium, pH and electrical conductivity of soil were determined. Zahedan Water Treatment Plant was selected as a case study. Three sites were selected where following treatments were applied to: no irrigation, irrigation with treated wastewater, irrigation with river water (Lar River). The area without irrigation (control) was the pasture around the Water Treatment Plant the experiment was conducted as a randomized complete block design with three replications by drilling soil profiles. Two samples were collected from each profile at two shallow depths (0-30cm) and deeper depths (30-

60cm). Soil samples were dried in the open air before being transferred to the laboratory. The samples were screened using a 2mm sieve and transferred to the laboratory. Following steps were taken to determine soil acidity: soil samples were saturated with distilled water. After 24 hours, acidity of the soil saturated extract was measured using a pH meter (Sparks et al., 1996). After preparing saturated mud and saturated extract of the soil, electrical conductivity of the samples was recorded using an electrical conductivity meter device in terms of 25cdsm-1 (Sparks et al., 1996). SPSS version 11.5 was used for data analysis.

3. Results

ANOVA results at various depths for the first year showed a significant difference between level and electrical conductivity of the soil at 5% significance level. ANOVA and Duncan's test results also showed no significant difference between acidity of the soil at 1% significance level (Table 1). Table 1 shows results of analysis of variance relevant to the effect of applied treatments at different depths in the second year. The results showed that all parameters (acidity and electrical conductivity) were significant at 5% significance level.

Table 1. Results of analysis of variance relevant to the effect of applied treatments at different depths

	Parameter	Sum of squares	Mean of squares	Statistical F	Sig.
	Acidity	0.842	0.210	22.286ns	0.1
the first year	Electrical conductivity	68.342	17.085	66.616^	0.00
the second year	Acidity	0.875	0.219	393.14*	0.00
	Electrical conductivity	67.187	16.797	1379.29*	0.00
the third year	Acidity	1.471	0.368	115.114ns	0.02
	Electrical conductivity	72.129	18.032	405.279*	0.00

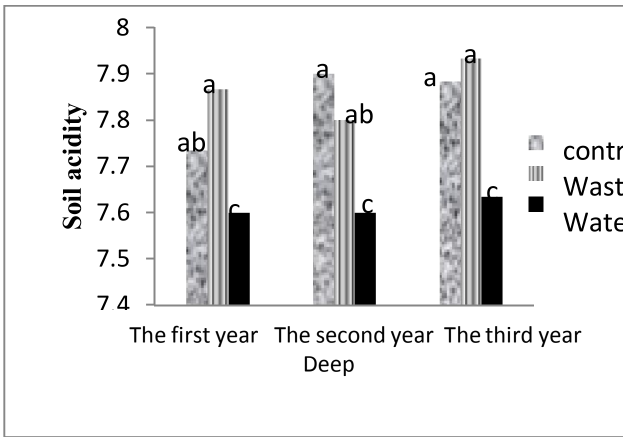

Fig. 2 Soil acidity at 30-60cm depth.

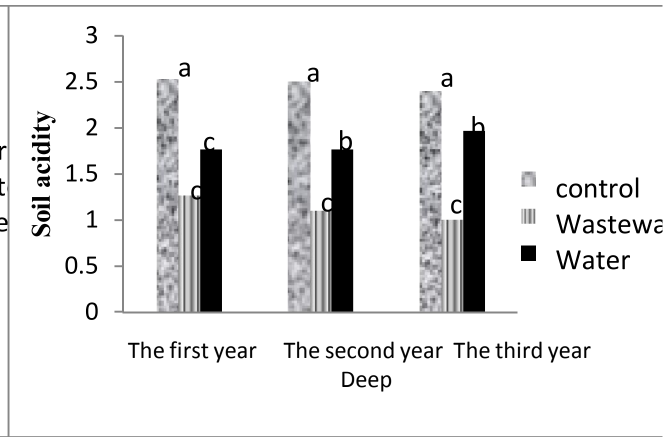

Fig. 1 Soil acidity at 0 -30cm depth.

Fig 1 shows mean comparison of soil acidity at 0-30cm depth. The results showed that irrigation with wastewater has increased soil acidity compared to control. This difference was significant. However, irrigation with freshwater did not increase acidity. There was no difference between irrigation with freshwater and control. According to the graph, soil acidity has increased in later years (the second and the third years) due to irrigation with wastewater. There was no difference between the first and second years in irrigation with wastewater in terms of soil acidity. Irrigation with freshwater did not significantly increase soil acidity (Fig 1). Fig 2 shows mean comparison of soil acidity at 30-60cm depth. Irrigation with wastewater increased soil acidity compared to other treatments in the first year at 30-60cm depth. However, no significant difference was observed between irrigation with wastewater and control. No significant difference was also observed between irrigation with freshwater and irrigation with wastewater in terms of soil acidity in the second and the third years. The least soil acidity was obtained in the soils irrigated with freshwater at all studied periods. However, no significant difference was observed between all studied periods in terms of soil acidity. Comparison of soil acidity at 0-30cm and 30-60cm depths showed that application of wastewater for irrigation has increased acidity in the surface layer (0-30cm). Increased soil acidity at 0-30cm and 30-60cm depths at all studied periods was due to high acidity of wastewater compared to freshwater.

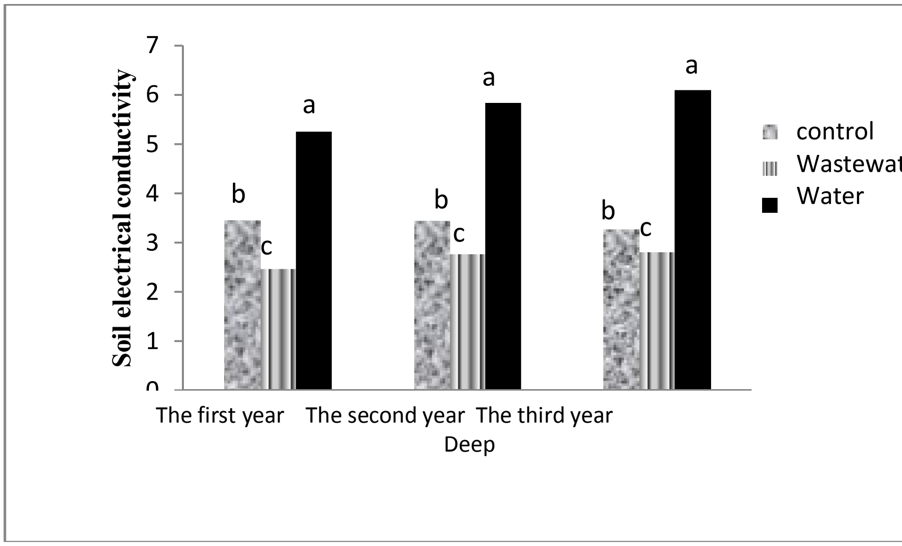

Fig. 4 soil electrical conductivity at 30-60 cm depth.

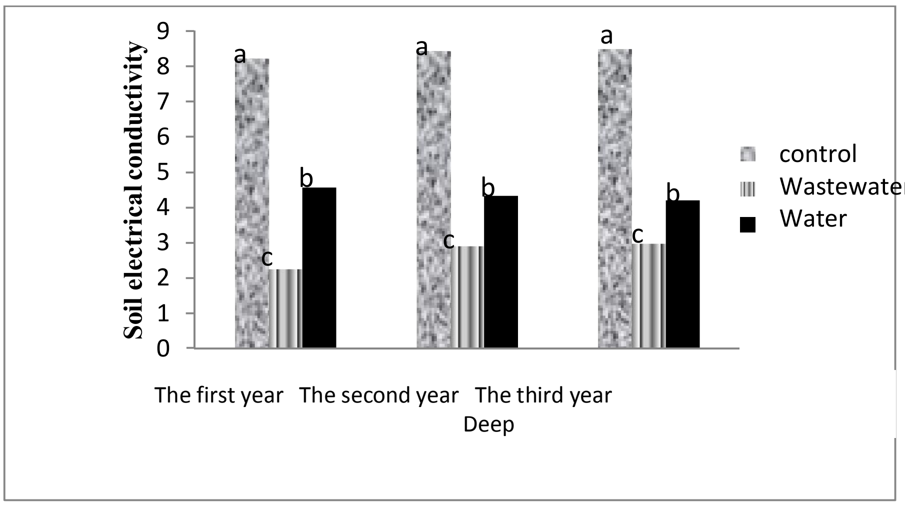

Fig. 3 soil electrical conductivity at 0-30cm depth.

Fig 3 shows mean comparison of soil electrical conductivity at 0-30 cm depth. The results showed that soil electrical conductivity has significantly reduced in the first year of irrigation with wastewater and freshwater compared to control. In addition, a significant difference was found between irrigation with wastewater and freshwater in terms of electrical conductivity. The results also showed that electrical conductivity has reduced in the land irrigated with freshwater at surface layer after the second year. However, no significant difference was observed between all studied periods in this treatment in terms of electrical conductivity. Mean comparison results in terms of electrical conductivity at 30-60cm depth showed that the highest electrical conductivity belonged to irrigation with freshwater, which increased electrical conductivity in deeper layers compared to surface layers. This was due to increased leaching and transport of salts to deeper layers of the soil (Fig 4). However, so significant changes were observed in electrical conductivity of the soil in irrigation with wastewater at all studied periods at the two depths. According to Fig 5 and 6, lack of leaching and transport of soil elements in the control area caused no significant changes in the soil electrical conductivity.

4. Discussion

Studied wastewater contained significant amounts of nutrients needed by plants. Thereby, wastewater is not only an adequate water supply for irrigation of crops, but also improves soil fertility. PH is the most prominent soil chemical property. Many chemical properties of the soil and consequently plant growth, activity of soil organisms and availability of nutrients to plants depend on soil pH (Guidi et al., 1983, Ghollarata and Raiesi, 2007). The results of ANOVA at studied depths showed no significant difference in terms of soil acidity. This can be due to presence of organic acids and non-acidic compounds in sewage sludge (Bahremandet al., 2002). Zamani et al. (2010) studied the effect of sewage sludge of a Polydactyl factory on soil properties. They reduced soil acidity by 1.8 unit using 45 tons per hectare sewage sludge of the factory compared to the control but there was no significant difference between the treatment and control. The results of examining electrical conductivity of soil samples in three years showed the significant effect of irrigation with wastewater in the region at 5% significance level, so that soil electrical conductivity was significantly increased in the areas irrigated with wastewater compared to control. These results are consistent with those results obtained by Zamani et al. (2010) who showed that saturated hydraulic conductivity was reduced by adding sewage sludge to the soil. In another experiment, the effect of irrigation with wastewater on soil properties was studied in the northern Isfahan, which was irrigated with wastewater for 9 years. The results of the former experiment showed that wastewater reduced electrical conductivity compared to well water (Shahraki and Mahdavi, 2005).

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