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Evaluation of the effects of reclaimed urban wastewater on soil calcium carbonate concentration case study: Yazd waste water refinery

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ABSTRACT

Water crisis is an important issue in arid and semi-arid regions like Iran. This situation has been exacerbated in recent years because of successive droughts. So the use of unconventional water is increasing in where there is no water with good quality. One of these resources is urban wastewater that can provide nutrient for plant in addition to supplying water. If municipal wastewater does not led to negative impact on physical and chemical properties of soil and water; it can be used for irrigation in de desertification projects. So in this research the effect of reclaimed urban wastewater on soil Calcium Carbonate concentration was assessed in Yazd wastewater refinery. For this purpose, soil samples were collected from depths of 0-30 cm and 30-60 cm in three different regions

consist of control area, planting area that was irrigated with reclaimed urban wastewater and region that had no plant but was influenced by treated wastewater. Samples were dried and then transported to the laboratory and Calcium Carbonate concentration was evaluated in all of them and then the results were analyzed using SPSS software. Results showed that the amount of Calcium Carbonate has decreased in planting area that was irrigated with treated wastewater and it has increased in region with no plant that was affected by treated wastewater.

Keywords: Unconventional water, Irrigation, Water crisis, Reclaimed wastewater, Calcium Carbonate.

1. INTRODUCTION

The population growth rate is estimated to average about 7.1 percent [12]. According to estimates, every year 100 million people, or in other words per second more than three people added to the world population. According to the forecast, in 2025 the world's population of 8.5 billion will go beyond border. Meet the needs of a growing population; the food can be considered a major problem for many nations [2]. In developing countries the increasing need for fresh water in agriculture production is not limited to, but needs per person and also supplies the needed water resources industry needs and priorities of the urban communities in these areas [10]. Existence large population centers and industrial centers in the vicinity of fresh water resources according to the prioritization of municipal and industrial water supply, the share of agriculture in reduced access to these resources [1]. These factors have led to the idea of planning to provide new sources of water. This idea that purification of domestic and industrial wastewater should led to production of recycled water with high quality that can be reused for different projects, has been strong in late twentieth century. This idea has created the motivation of the use of treated wastewater in many parts of the world [4]. Using wastewater for irrigation can be a proper alternative for water with good quality and also can reduce plant requirement to fertilizer [3]. In fact the reuse of wastewater for irrigation is increasingly being considered as a technical solution to minimize soil degradation and to restore nutrient contents of soils [9]. Also the reuse of treated domestic wastewater in agriculture purposes has been increasingly considered to be beneficial for crop production [12, 14].The impact of wastewater on physical and chemical properties of soil is so important because of its impact on plant establishment and soil erosion and if it doesn't led to negative effect onphysical and chemical properties of soil and water; it can be used for irrigation. Many researches have been done about irrigation with wastewater around the world.

Rana Hassan Ali has evaluated the effect of treated wastewater on soil chemical properties and crop productivity in Gaza strip and showed that irrigation with wastewater led to significant increase in OM, CEC, K, Ca, Mg, Na and Cl in soil and also the increase of Zn, Fe, Mn and Pb in soil and sorghum plant compared to fresh water [7]. Emam Qoli study showed that irrigation of Haloxylonpersicum and Nitrariaschoberi with urban wastewater in Segzi plain of Isfahan has caused the increase of canopy cover and decrease of richness, also because of irrigation with wastewater the amount of EC, Na, total Ca and Mg and K has been decreased and the amount of N and Phosphor has been increased compared to control area [6]. Qishlaqi et al assessed the impact of untreated wastewater irrigation on soil and crops Shiraz suburban area; they believe that increase of pH, OM and Ca happened because of irrigation with untreated wastewater [16]. Salehi et al evaluated the effect of irrigation with urban wastewater on soil and pine trees in Tehran and showed that concentration of nutrients such as N, K, Ca, Mg and Ph has been increased in soil irrigated with wastewater [18]. Hoda A.A. Galal showed that long-term application of mixed wastewater for irrigation induced significant increase of soil pH and Ec, particularly in surface layer. She also indicated that mixed wastewater resulted in accumulation of K, Fe, Mn, Cu, Zn, Ni and Na in soil [8]. Elena et al evaluated the effects of wastewater irrigation on soil properties and indicated that there were no negative effects with respect to changes in soil pH but a significant increase in electrical conductivity and sodium content was observed in wastewater-irrigated soil [5].

As a regard, the majority of freshwater resources, is assigned to drinking, health and industry and a large amount of wastewater is produced, the reuse of reclaimed urban wastewater for different goals is an effective solution for compensation of lack of water resources. The main purpose of this study was evaluation of the effect of reclaimed urban wastewater on soil Calcium Carbonate concentration.

2. MATERIALS AND METHODS

2.1. Study area

Yazd is one of the provinces with the lowest precipitation in Iran, since the average of annual precipitation is only 61.02 mm [15]. Temperature diurnal and seasonal fluctuations are very high. The maximum temperature of Yazd province has been recorded in July about 45 °C and the minimum temperature has been recorded in January about -20 °C [15]. Low amount of precipitation, high temperature, high evaporation rate, successive drought and deep ground water level are the most important issues of Yazd province

[17]. Wastewater refinery of Yazd is located in 31°54′ north latitude and 54°24′ east longitude in north of Yazd city and its height is 1145 meters above sea level.

2.2. Methodology

Soil sampling:

Soil samples were taken from depths of 0-30 cm and 30-60 cm [19] in three different regions including control area, planting area that was irrigated with reclaimed urban wastewater and region that had no plant but was influenced by treated wastewater. Samples were dried and then transported to the laboratory for analyzing. Samples were collected by auger.

Laboratory section:

Lime index indicates the absence or presence of carbonates in soil. About 1% to 3% of it is tolerable for most of plants and more than this amount may damage plants. A large number of minerals, including K, Fe, Zn, Co and Phosphor are absorbed so slowly in calcareous soil. In Iran, absorption of trace element in soil is so difficult because of calcium ion presence. The amount of Organic Matter is low in this kind of soil; in fact, one of this soil disadvantages is lack of OM and humus. By adding Organic Matter to this soil, we can prevent Calcium Carbonate harmful effect.

In this research, Calcium Carbonate concentration was assessed using calcimeter method. This method is an accurate method that is used in different researches and is based on following equation:

$$CaCo_3 + 2HCL \longrightarrow CaCo_3 + Co_2 + H_2O$$

$$\% CaCo_3 = (0.15/ 36) \times (\text{Volume of emitted Co2/ Soil sample weight})$$

In fact, in this method the volume of emitted Co_2 is measured and then $CaCo_3$ concentration is counted.

Statistical analysis:

Statistical analysis of data was done using SPSS software, after determining the amount of Calcium Carbonate in samples. First, data normalization test (Kolmogorov-Smirnov) was done then data were analyzed using Duncan test in format of factorial design.

3. RESULTS AND DISCUSSION

Results:

The results showed that the amount of Calcium Carbonate has decreased in planting region that was irrigated with treated wastewater and it has increased in region with no plant that was affected by treated wastewater (table.1). Also the result indicated that land use and depth factors had a significant effect on Calcium Carbonate concentration in soil but the interaction between them had no significant effect (table.2, figure.1).

Table 1

Mean and Standard Deviation of Calcium Carbonate in study area

Region	depth	Mean	Std. Deviation	N
Planted region (wastewater irrigation region)	Surface layer	21/49	1/044	12
	deep layer	22/39	1/206	12
	total	21/94	1/196	24
No-planted region, influenced by wastewater	Surface layer	24/07	0/210	4
	deep layer	24/06	0/398	4
	total	24/06	0/294	8
Control region	Surface layer	22/81	0/524	4

deep layer	24/27	0/205	4
total	23/54	0/865	8

Table 2 Effect of irrigation with reclaimed urban wastewater on soil Calcium Carbonate

Resource	df	F	Sig
Land use	2	19/731	0/000
Depth	1	5/515	0/025
Land use*depth	2	1/279	0/291

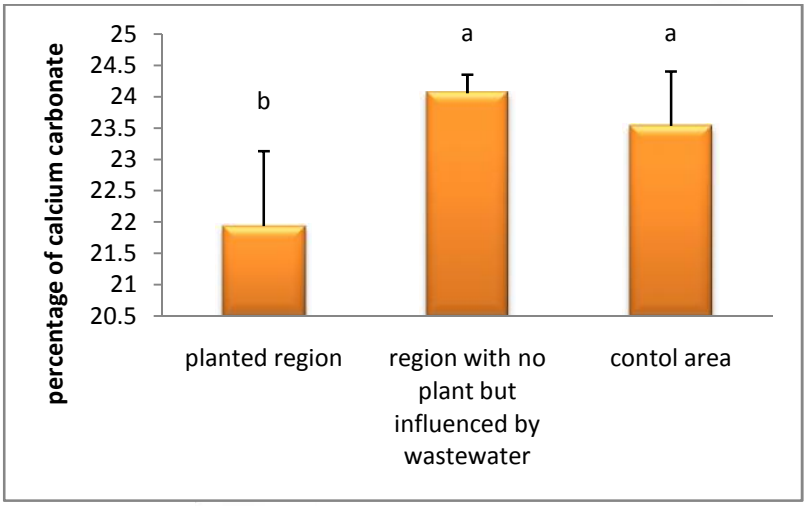

Figure 1
Changes of Calcium Carbonate in regions influenced by reclaimed urban wastewater compared to control area

Discussion:

Most soils of central plateau of Iran are alkaline soil and their pH is more than 7 because of Calcium Carbonate, Calcium Sulfate and salinity in soil. These soils are so poor in Organic Matter and one of their disadvantages is lack of humus and Organic Matter. Lime causes proper structure in soil but if the amount of it exceed, it can cause problems for plants by creating hard pan, high pH and salinity in root zoon [11].

In this study the amount of Calcium Carbonate has been decreased in planting region that was irrigated with treated wastewater and it has been increased in region with no plant that was affected by treated wastewater.

In general, using wastewater for irrigation or other activities should be done with careful planning and management and long-term conservation of resources should be considered in addition to protection of public health. On the other hand, under certain condition, use of this type of water if not well managed, can have negative impacts on cultivated crops and soils, so that the effluent for reuse must comply with reuse standard to minimize environmental and health risks [20].

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