Study on the effect of wastewater irrigation on nutrient uptake by safflower seeds: (A case Study in Zahedan)

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Abstract: Given that Iran is facing a shortage of water resources, and recent drought has intensified this shortage, new water resources (wastewater) are taken into consideration so that wastewater consumption has increased day by day. Therefore, the concern about transferring of some of the elements to the plants is taken into consideration. For this purpose, study on the effect of wastewater on plant nutrients absorption was carried out in a completely randomized block design and in the form of split plot in a research farm located in Zahedan during 2013-2014. In this experiment, two types of irrigations including irrigation with regular water (W1), and irrigation with Zahedan refinery treated wastewater (W2) was carried out during whole plant growing season. The results showed no significant difference in seeds heavy metal content. According to our results, wastewater can be used for irrigation, in the absence of proper water resources.
[Ali asghari, Saeed Shojaei, Ahmad Mehraban. **Study on the effect of wastewater irrigation on nutrient uptake by safflower seeds: (A case Study in Zahedan).** *Stem Cell* 2016;7(2):69-71]. ISSN: 1945-4570 (print); ISSN: 1945-4732 (online). http://www.sciencepub.net/stem. 12. doi:10.7537/marsscj07021612.

Key words: greywater, wastewater, heavy metal, plant.

1. Introduction

Although the wastewater is one of the main concerns of the world's great cities, but it should be considered as one of the important sources of water as well as nutrients. On the other hand, municipal and household wastewater and their improper disposal play a major role in the contamination of the environment as well as surface and groundwater resources (Emamgholi, 2012). Due to water shortages in arid and semi arid regions like Iran, in order to develop and exploit new water sources, especially in the agricultural, wastewater can be considered as one of the water sources. Application of wastewater generally leads to increased concentrations of heavy metals in the soil as well as plants (Baygi Harchegani & Banitalebi, 2013). Sometimes, application of wastewater leads to decreased concentration of an element in the soil as well as plants (Faizi, 2001). The studies also have shown that adding organic materials to the soil, depending on their divergent characteristics, can impose different effects on the physical, chemical as well as biological properties of the soil, so that in most of the cases optimizing essential conditions can facilitate the production of crops with high quality as well as quantity (Hosseini, 2013). Nowadays the use of wastewater or greywater is rising day by day and has given special attention in all the environmental agenda. Therefore, this study was to aimed to assess the effect of lead (Pb), chromium (Cr), iron (Fe) and manganese (Mn) concentration in plants irrigated with treated wastewater.

2. Materials and methods

This study was conducted at a research farm in Zahedan during 2013-2014. The research area is located at geographical coordinates of 28° 14′/ 61° 31′E, and with a height of 1333 meters above sea level. The climate is hot and arid according to Koppen climate classification system. The average annual rainfall is 150 mm per year, the average maximum temperature is 27.4 ° C, and the average minimum temperature is 12.3 ° C. To determine the physical and chemical properties of the soil, before any land preparation sampling from zero to 30 cm depth of different parts of the land was carried out. Samples were transferred to the laboratory for physical and chemical analysis. The results are presented in Tables 1and 2. Furthermore, one liter of irrigation water was sent to the laboratory for water analysis. The results are presented in Table 3.

Table 1. The physical properties of the test soil

Soil texture	Silt %	Sand %	Clay %	Sample characteristics	Soil depth (cm)
Loam	26	49	24	Test sample	0-30

Table 2. The chemical properties of the test soil

Mn (ppm)	Pb (ppm)	Fe (ppm)	Cr (ppm)	Electrical conductivity (ds/m)	Soil depth (cm)
0/0621	0/021	0/019	0/0084	89/2	0-30

Table 3. The physical and chemical properties of the test water

SSP (%)	SAR	CO3	pH	EC (ds/m)
31/4	3/1	0	7/34	2387

In order to assess safflower seeds heavy metal content, first one gram of plant powder sample was incinerated in the electrical oven at 550 ° Celsius, and after dissolving sample ashes in the hydrochloric acid (Westerman, 1990), lead and chromium concentrations in the filtered solution was measured using GBC923plus atomic absorption spectrophotometer. Statistical analysis was carried out in SAS software. Means comparison was performed using Duncan's multiple range test. P value of < 0.05 was considered as significant.

3. Discussion

Table 4. Variance analysis of the effects of irrigation and fertilizer treatment on seed mineral element content

Mn	Fe	pb	Cr	Degree of freedom	S.O.V
Mean Square					
0.006^{ns}	0.02^{ns}	0.007^{ns}	0.011^{ns}	2	repeat
0.005^{ns}	0.003^{ns}	0.0004^{ns}	0.0004^{ns}	1	Irrigation type
0.00003	0.002	0.001	0.037	2	Irrigation error
0.002	0.0370	0.007	0.024	12	Total error
17.41	19.89	26.75	23.21	-	CV (%)

**: significant at 1% level
*: significant at 5% level
n.s: nonsignificant

Our results on variance analysis showed no significant effect of municipal treated wastewater on chromium, lead, iron, and manganese concentration (Table 4). Since the treated wastewater used in this experiment is urban wastewater, and is not mixed with factories and industrial estates wastewater, such results are completely expected. Of course there are other factors that can have more effect on the uptake of these elements by plants which include soil pH, soil moisture, and the type of cultivated crops that can be effective in the integration of these elements into the plants (Esmailiyan, 2008). Basically, pH determines plants access to soil micronutrients. There is an inverse relation between soil access to heavy metals and soil pH (Esmailiyan et al., 2009). Erfani et al., (2002) showed that lead, cobalt, and molybdenum concentrations in the organs of the wastewater treated lettuce were insignificant. Esmailiyan (2008) measured the accumulation of heavy metals in the corn seeds crops of the lands that were irrigated with Zabol treated municipal wastewater. Their results showed low heavy metal content in the wastewater treated corn seeds. The effect of manure and chemical fertilizers on the concentration of the mentioned elements was not statistically significant. The interaction of the fertilizer and the use of municipal wastewater had no significant effect on the mentioned characteristics (Table 4). The mean effect for lettuce, spinach, and watercress was measured. As compared to other treatments, more effect was observed in wastewater treatments due to its high organic materials and nutrients content. Therefore, It is expected that heavy metals adsorption is higher in these treatments than other ones (Houji, 2001). Increasing seed potassium content due to animal manure treatment could be because of the increased availability of this element in the soil which is actually the result of improved physical and chemical soil properties and increased soil microbial activity (Pandey et al., 1999). There was no significant difference in the soil heavy metals (chromium, lead, iron and manganese) content following soil wastewater and fertilizer treatments. Mean comparison of sunflower elements content demonstrated that chicken manure treatment as well as combination of cow manure and chemical fertilizer treatment showed the most effect on increasing seeds nitrogen content as compared to other treatments. The highest sun flower seed potassium content was observed following animal manure treatment (Esmailiyan et al., 2014). In a study on the effect of wastewater irrigation on the accumulation of some

elements in plants, Faiyzi et al., (2001) showed that corn seeds iron and magnesium content is higher in the fields which were irrigated with wastewater. Furthermore, manganese and zinc was more in wastewater treated wheat seeds. There was a significant difference in seeds element content in wastewater treated fields as compared to regular water treated ones. Zinc, copper, lead, cadmium, and chromium was higher in wastewater treated wheat and corn seeds as compared to well water treated seeds. Except for zinc and copper, this value was above the global standards (Baygi Harchegani & Banitalebi, 2013). According to Allen et al., (1995) factors such as soil pH, organic carbon content, soil phosphate content, plant physiology, and duration of plant exposure to heavy metals can affect copper, lead and zinc transition index.

4. Conclusion

Irrigation with semi-treated wastewater has no effect on the contamination of plant seeds with heavy metals (lead, and chromium) or other elements (iron, and manganese). The results showed that wastewater irrigation is recommended to the farmers, in case achievement of high yield safflower oil is aimed. Wastewater can be used as a water resource in the absence of a proper one.

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6/9/2016