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ASSESSMENT OF THE CONCENTRATIONS OF SOME PLANT NUTRIENTS AND HEAVY METALS IN SHRUBS (OLEANDER AND JASMINE PLANTS) IRRIGATED WITH TREATED MUNICIPAL WASTE WATER EFFLUENTS OF YASOUJ TOWNSHIP

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ABSTRACT: In a pot experiment, some green space plants among them Oleander (*Nerium Oleander*) and Jasmine (*Syringa Amurensis*) shrubs were irrigated with treated municipal wastewater effluent (TMWE) of Yasouj township and fresh water. A calcareous loamy soil was used. Irrigation with tape water(fresh water) was used as control treatment. During the12 months of the experiment, irrigation of plants was done according to plant water requirements. The results for Oleander plant showed that the application of TMWE increased leaves concentrations of Phosphorus, Potassium, Manganese, Zinc, Iron, and Copper by 20.68, 4.46, 64.59, 62.85, 25.26, and 4.94 % respectively. However the concentration of N and Co was decrease by 4.61 and 26.67% respectively. For Jasmine plant, the concentrations of N, P, K and Mn were increased by 12.50, 44.58, 72.73, and 6.57% respectively. But the concentrations of Co, Zn, Cu and Fe were decreased by 27.65, 25.83, 14.45 and 4.10% respectively. Moreover the leaves content of Pb, Ni and Cd were below the detection limits.

***Keywords*:** Heavy metals, irrigation, Soil, Treated Municipal Wastewater, Phosphorus, Potassium

INTRODUCTION

Spreading out of pollution, development of agricultural activities accompanied by industrial activities and successive drought periods are some of the reasons for water shortage in most arid and semi- arid countries such as Iran (Izadiar and Yargholi, 2010)

Water scarcity is a serious crisis in recent years in Iran. Due to constantly increasing population, large amounts of waste water is being produce in cities in Iran. Indiscriminate disposal of such water can be the cause of environmental pollution such as soil, ground water, rivers and air. As there is high pressure on fresh water resources, the recycle or waste water could be substantial sources of irrigation water for crops, trees and also green space plants and also provides most of nutrients for plants that may lead to higher agricultural productions. Waste water is a potentially source of supplement of organically nutrients such as nitrogen, Phosphorus and Potassium and inorganically micro nutrients to promote plant growth(Weber etal,1996).In spite of beneficial aspects of the application of waste water to landscapes (supplying of irrigation water and plant nutrients), it may have some detrimental effects on plant, soil and environment. Moreover, discharge of waste water in streams, rivers and

watersheds causes environmental pollution and possibly transfer to human body through food chain. Green spaces are a non- separable part of human life.

A safe way of waste water disposal is using it as irrigation water for landscapes. Also proper application of waste water to green spaces will help to save fresh water for more preferable proposes such as drinking, cooking, making medicals, washing hand, bathing etc….

Application of waste water for irrigation has obtained importance attention throughout the world due to restricted water sources and costly waste water treatment for discharge (Kiran. 2012). Impact of Domestic Wastewater irrigation on Soil Properties and Crop Yield. International Journal of Scientific and Research Publications, Volume 2, Issue 10, pp. 1-7). Heavy metals, inorganic and organic compounds, oils and tars, toxic and explosive gases, flammable substances, harmful wastes and explosives are among the most important contaminants(WHO,2006 and Iranian Ministry of Energy,2010). Contamination levels of easily available metals; Cu, Zn and Fe had been shown in surface soils around industrial areas. The plants also were contaminated with these metals in that area (Kebir Tahar and Bouhadjera Keltoum,2011). Heavy metals finally enter the human body via soil, water, plant and food (Shad Ali Khan. 2008).

Landscape plants can uptake significant amounts of heavy metals and preventing them entering to the environment and damage to living beings. Oleander (*Nerium Oleander*) and Jasmine (*Syringa Amurensis*) shrubs are among the main green space plants around the country. Oleander widely grows in parks, beaches, seashores, riversides and roadsides around the country. The plant is fast-growing and high foliage evergreen shrub. Evidence showed that it may by Pb and Cd tolerant plant (Kadukova. 2006). Jasmine plant also is a commonly plant in green space area around major cities and satellite towns.

The absorption and accumulation of heavy metals pollutants vary from plant to plant, and also from species to species within a genus. More over hyper accumulation limits of each metal versus plant dry weight varies (Baker and Brooks, 1989). Fast growing trees could be a proper candidate for remediation of heavy metal-polluted soils and production of notable economic non-food biomass usable for energy production (Jayakumar and Cheruth Abdul Jaleel, 2009).

MATERIALS AND METHODS

The aim of this work was to examine the N, P, K, Mn, Zn, Fe, Cu and Co content of leaves in two green space plants (*Nerium Oleander* and *Syringa Amurensis*) irrigated with treated municipal waste water effluent (TMWE). Therefore a pot experiment carried out in a calcareous loamy soil, pH; 7.53(in saturated paste), electrical conductivity of saturated paste; 0.71 ds/m and 5.60% organic matter. Seedlings of non-productive green space plants: *Nerium Oleander* and *Syringa Amurensis* were planted. After establishment of plants, they divided in two groups: one group was irrigated with potable water (as control) and the second group was irrigated with treated municipal waste water effluent for whole experimental period. A complete randomized design with three replications was used. The wastewater samples collected in polyethylene bottles from the last sewage treated disposal pond of municipal waste water site. Potable water collected from tap water system nearby the experimental site. Some properties of treated municipal waste water Effluent (TMWE), potable water and also soil under the experiment were measured and reported previously [Panahikordlaghari 2013a and Panahikordlaghari 2013 b]. In general the chemical characteristics of TMWE were reasonable. On an average basis the $EC*10^6$, TDS and Na+ were significantly higher in TMWE with compare to potable water. After twelve months of experiment, leaves samples of plants were collected and prepared. The sample preparation process involves; washing, drying, grinding and storage. Heavy metal content of leaves measured using method of Emami (1996).

Using sewage in a controlled irrigation,may achieve to safe disposal of sewage and higher crop yield. The sewage water provides nutrients for plants which help in their vegetative growth. However, waste water irrigation should be in optimum level; otherwise the high metal content will cause health problems and soil sickness.

RESULTS AND DISCUSSION

1. Concentration of nitrogen in plant:

Measurement of N content of leaves showed that the concentration was 1.52 and 1.45% in average for plants irrigated with fresh water (control) and with treated municipal waste water respectively. Therefore irrigation with treated municipal waste water decreased the nitrogen content of leaves in Oleander plant by 4.61%. In contrast the nitrogen content of leaves for Jasmine (*Syringa Amurensis*) increased by application of treated municipal waste water with compare to tape water. Measurements showed that nitrogen content of leaves raised by 12.5% (from 1.12% for

control treatment to 1.26% for wastewater treatment). Several studies showed that irrigation with waste water increased nitrogen contents of plants(Galavi 2010, Khaskhoussy 2013, Gadallah.1994, Moazzam 2009 ,Rusan 2007,Nogueira etal,2013 and Adnan Çıçek,M. 2013). Waste water is usually rich of organic matter and plant nutrients such as nitrogen and causes better plant growth(Ghanbari et al, 2007 and Ayadi, 2004).

2. Phosphorus concentration of leaf:

Application of waste water increased the P content of leaves in Oleander plant by 4.46%; from 0.15% (control treatment) to 0.18 %(waste water treatment) in average. For Jasmine plant the phosphorus content of leaves increased by waste water significantly (72.73%). The phosphorus content of leaves was increase from 0.11% (control) to 0.19% in waste water treatment. Studies (Adnan Çıçek, M. 2013) showed of the significant increase of Phosphorus content of wheat plant as a result of full irrigation with municipal waste water.

3. Potassium concentration of leaves:

The results showed that the K content of leaves in Oleander plant increased by 4.46% due to application of waste water. The K content of leaves in waste water treatment was 1.17% with compare to 1.12% for tape water treatment. For Jasmine plant the potassium content of leaves was increased from 0.83% in control treatment to 1.2% in average for waste water treatment. Application of municipal waste water increased K content of wheat plant (Adnan Çıçek, M. 2013)

4. Concentration of Iron in leaves:

The iron content in leaves of Oleander plant was 163.6 and 204.93 mg/kg in average for W and Wf treatments respectively. Application of treated municipal waste water (wf) increased iron content of leaves by 25.26 % with compare to water treatment (control). The concentration of Fe in both treatments was in range of 116-378 mg/kg dry matter reported by Monu Aroraa (2008) in vegetables irrigated with waste water. The results are in agreement with Galavi, , (2010). They found that irrigation of sorghum plant with wastewater increased iron content of plant with compare to control treatment.

However the application of TMWE in irrigation of Jasmine plant, reduced of the concentration of Fe by 4.1 % in average. The average of iron concentration for treated municipal waste water treatment (Wf) was 77.8 mg/kg in average. But it was 81.13 mg/kg for control treatment. Evidence showed that the concentration of iron in plants with compare the other elements is higher (Shad Ali khan 2008). The concentrations of Fe in Jasmine plant in both treatments (W and Wf) were considerably lower than the concentrations in different vegetables irrigated with waste water and the other sources of water reported by Monu Aroraa (2008).

Studies showed a high concentration of iron as: 206.69, 201.38, 180.91, 87.14, 85.27,81.39, 33.21 mg/kg of dry weight in plants: Withania somnifera , Stevia rebaudiana, Calium aparine,Cyamopsis tetragonoloba, Asparagus adscendens, Artemisia vulgaris and Mucuna pruriens respectively(Shad Ali Khan, , 2008)

5. Manganese content of leaves:

The results showed that the average of Mn in leaves of Oleander plant was increased by application of TMWE with compare to control treatment significantly. In average a 64.59% increase was found in Mn content of leaves for F treatment with compare to control (W). The average of Mn in leaves was 35.44 and 58.33 mg/kg dry weight for W and F treatments respectively. Studies showed that Mn concentration is high in all plants and it's concentration in some medicinal plants collected from natural habitat was 52.94, 43.16,32.87, 23.77,14.70, 9.70 and 1.39 mg/kg dry weight for *Artemisia vulgaris* ., Galium aparine, Stevia rebaudiana L., Withania somnifera , Mucuna pruriens , *Asparagus adscendens* ,and *Cyamopsis tetragonoloba* respectively(Shahid Ali Khan,2008).

The application of treated municipal waste water effluent (Wf treatment) was increased the Mn content of leaves by 6.57% in average for Jasmine plant. The Mn contents of leaves were 52.8 and 56.27 mg/kg dry weight for F and W treatments respectively.

The Mn concentration of leaves of Oleander and Jasmine plants was in the range of 12-69 mg/kg in vegetables irrigated with wastewater(Monu Aroraa 2008).

With compare to the critical concentration of Mn in plants (300-500 mg/kg), the concentration of Mn in both plants (Oleander and Jasmine) was considerably lower (Kabata-Pendias, 1992)

6. Zn content of leaves:

In Oleander plant the average of Zn concentration of leave were 22.80 and 37.13 mg/kg for Wf and W treatments (treated and untreated plants) respectively. It means the irrigation with TMWE led to a significant increase (62.85%)

of Zn contents of leave in Oleander plant. Whereas in Jasmine plant, the Zn concentration of leave was decreased by 25.83% (from 60.13 mg/kg for W to 44.6 mg/kg for wf treatments) in average. The results showed that the concentration of Zn is considerably lower than the hyperaccumulation limit (10,000 mg/kg plant dry weight) reported by Baker and Brooks (1989). These results are in agreement with the results of Kaskhoussy, (2013) in corn, Arora (2008) in vegetables and Galavi (2010) in sorghum. Ait Ali (2002) in corn, Palit (1994) in vegetables and Pharagmites and Chandra (2009) in wheat and Indian mustard.

However the results showed that the application of TMWE decreased the Zn content of leaves by 25.83% in average (from 60.13 to 44.60 mg/kg for F and W treatments)in Jasmine plant.

The results are in agreement with finding of Monu Aroraa, (2008). They found that irrigation of vegetables with waste water increased Zn concentration by 22-46 mg/kg.

7. Cu content of leaves:

In Oleander plant, using of TMWE (Wf treatment) increased copper concentration of leaves by 4.94% in average with compare to control treatment (w). The averages of Cu in leaves were 5.40 and 5.67 mg/kg for W and F treatments respectively. The measured values are in reported range of 5.2-16.8 mg/kg in vegetables irrigated with wastewater (Monu Aroraa, 2008). In comparison to the permissible level of Cu (10 mg/kg DW) reported by Anon.,(1996), the concentration of Cu in the plant for both irrigation treatments (W and WF) was significantly lower. According to Yoon etal(2006), the concentrations of Cu in the 17 plant species of the contaminated sites varied from 6-460 mg/kg.

In contrast the irrigation of Jasmine plant with treated municipal waste water (TMWE) caused reduction of Cu contents of leaves by 14.45% in average. The Cu contents of leaves for F and W treatments were 9.47 and 11.07 mg/kg in average, which are below the phytotoxicity level of 20-100 mg/kg(Shad Ali khan, 2008). According to Borkert et al (1998) accumulation of more than 20 mg/kg Cu in leaves or shoots can be toxic for plants. The concentrations of Cu in this experiment were in the range of 5.2-16.8 mg/kg reported by Monu Aroraa, (2008).
However irrigation with wastewater (WF treatment) in Jasmine plant increased the Cu content of leaves to higher than the permissible level of 10 mg/kg DW stated by Anonymous.,(1996).

8.Comparison of plant nutrients and heavy metals concentration in Oleander and Jasmine plants:

The order of metal concentrations in Oleander plant for control treatment (fresh water: W) and treated municipal waste water effluent treatment (F) were in the order of : Fe>Mn>Zn>Cu. It means in all treatments. It means in all cases, the concentration of Iron was more than of Mn and Mn more than Zn and Zn more than Cu. The was no change in the order of metal concentration in plants by irrigation with TMWWE.

For Jansmine plant, the order of metals concentration of leaves for fresh water treatment(W) followed the same order for Oleander plant including of Fe>Mn>Zn>Cu. Although for waste water treatment (F) the metals content of leaves were in order of : Fe>Zn>Mn>Cu. It means waste water application (F treatment) caused more uptake of zinc rather than Mn.

The response of two plants (Oleander and Jasmine) to application of treated municipal waste water effluent was different. N, P, K, Fe contents of leaves for control treatment (W) was 35.7, 36.36, 34.94 and 101.65 % higher in Oleander than Jasmine plant respectively. Whereas the concentrations of Mn, Zn and Cu were in average 33, 62 and 51% lower than that of Jasmine plant in control treatment respectively.

Irrigation with treated municipal waste water caused 15% increase of N, 163.4% of iron, 4% of Mn contents of leaves for Oleander plants with compare to Jasmine plants respectively.

Irrigation with treated municipal waste water had little effects on K contents of leaves in both the plants. Whereas TMWE treatment caused 5% reduction in P concentration of Oleander plant leaves with compare to Jasmine plant.

As a result of treated waste water effluent(TMWE) treatment, Jasmine plant accumulated more Zn (17%) and Cu(40%) rather than Oleander plant.

CONCLUSION

The results obtained here showed that irrigation of Oleander plant with urban treated waste water effluent increased of phosphorus, potassium, Manganese, Zinc, iron and copper in the plant. However decreased the concentration of nitrogen and cobalt. In case of Jasmine plant the concentration of N,P, K and Mn increased, but the concentrations of Co, Zn, Cu and Fe were decreased. The green space shrubs are non edibale for human and animals and also the safe proposal of waste water in the area is highly important. Therefore a contoled systm of irrigation of green space plants may be a safe way (if not the best) of waste water and also a way of saving fersh water, improving of the plant growth.

REFERENCES

Ait Ali N, Bernal MP, Ater M. 2002.Tolerance and bioaccumulation of copper in Phragmites australis and Zea mays. Plant and Soil, 239: 103-111

Anonymous. 1996. Guidelines for drinking water quality. Health criteria and other supporting information /9960 Mstercom/Wiener Velag-800, Australia.

Baker AJM and Brooks RR. 1989. Terrestrial higher plants which hyperaccumulate metallic elements- a review of their distribution , ecology and phytochemistry. Biorecovery 1: 81-126.

Borkert CM, Cox FR and Tucker MR. 1998. Heavy metal accumulation and tolerance in British populations of the metallophyte Thlaspi caerulescens. J. C. presl (Brassica ceae). New phytologist, 127:61-68.

Chandra R, Bahargava RN, Yadav S and Mohan D. 2009. Accumulation and distribution of toxic metals in Wheat (Triticum aestivum L.) and Indian mustard (Brassica Campestris L.) irrigated with distillery and tannery effluent. J. Hazard. Mater.162: 1514-1521.

Chichek A, Rushtu Karaman M, Turan M, Gunesh A and Alim CH. 2013. Yield and nutrient status of wheat plant (T. aestivum) influenced by municipal Waste water irrigation. Journal of Food,Agriculture & Environment, 11(1): 733-737.

Emami A. 1996. Description of plant analysis method (in Persian), 1: No.982. Soil and Water Institute, Theran, Iran. http://seminarprojects.com/Thread-sewage-water-as-the-source-of-irrigation-and-plant-nutrients-full-report#ixzz2t8UehdXg

Galavi MA, Jalali A, Ramroodi M, Mosavi SR and Galavi H. 2010. Effect of treated municipal waste water on soil chemical properties and heavy metal uptake by Sorghum (Sorghum biocolor L.). J.Agric. Sci. 2: 235-241.

Galavi M, Jalali A and Ramroodi M. 2010. Effects of Treated Municipal Wastewater on Soil Chemical Properties and Heavy Metal Uptake by Sorghum (Sorghum Bicolor L.) Journal of Agricultural Science Vol. 2, No. 3; September 2010

Iranian Ministry of Energy. 2010. Environmental Criteria of Treated Waste Water and Return Flow Reuse(in Persian). No.535.

Izadyar M H and Yargholi B. 2010. Study of cadmium absorption and accumulation in different parts of four forage, American-Eurasian Journal of Agriculture & Environment Science., 9(3):231-238.

Jayakumar K and Cheruth AJ. 2009. Uptake and Accumulation of Cobalt in Plants: a Study Based on Exogenous Cobalt in Soybean, Botany Research International 2 (4): 310-314, 2009

Kabata-Pendias A and Pendias H.1992. Trace elements in soils and plants,1st ed. Boca Raton, F1: CRC press, p.365

Kadukova J, Manousaki E and Kalogerakis N. 2006. Lead and Cadmium accumulation from contaminated soils by Nerium Oleander. Acta Metallurgica Slovaca. 12:181-187.

Kebir Tahar and Bouhadjera Keltoum. 2011. Effects of Heavy Metasl Pollution in Soil and Plant in the Industrial Area, West ALGERIA. Journal of the Korean Chemical Society. 55,no.6 : 1018-1023.

Khan SA, Khan L, Hossain I, Marwat KB and Akhtar N. 2008. Profile of Heavy metals in Selected Medicinal Plants. Pakistan Journal Weed Science Research 14(1-2):101-110.

Khan SA, khan L, Hussain I, Shah H and Akhtar N. 2008. Comparative Assessment of heavy metals in Euphorbia helioscopia L. Pak. J. Weed Sci.Res. 14(1-2): 91-100)

Khaskhoussy K, Hachicha M, Kahlaoui B., Messoudi-Nefzi B, Rejeb A, Jouzdan O and Arselan A. 2013. Effect of treated wastewater on Soil and Corn Crop in the Tunisian Area. Journal of Applied Sciences Research, 9(1): 132-140.

Khodabakhsh Panahi Kordlaghari, Abdolhossin Salehi and Maryam Panahi. 2013. Metals concentration of soil irrigated with treated municipal wastewater effluent (TMWE) of Yasouj. Annals of Biological Research,4 (12):115-122

Khodabakhsh.Panahikordlaghari2013.Annals of Biological Research, 4 (3):105-108.

Kiran D Ladwani, Krishna D Ladwani, Vivek S Manik and Ramteke DS. 2012. Impact of Domestic Wastewater irrigation on Soil Properties and Crop Yield. International Journal of Scientific and Research Publications, Volume 2, Issue 10, pp. 1-7

Moazzam A, Khan S, Shahid S and Ataf K. 2009. Growth, Yield and nutrient content of Sunflower (Heliantus Annuus L.) using treated wastewater from waste estabilization ponds. Pak. J. Bot.,41(3): 1391-1399.

Mohammad MJ and Ayadi M. 2004. Forage yield and nutrient uptake as influenced by secondary treated waste water. J.Pl. Nutr., 27(2): 351-365.

Monu A, Bala K, Shweta R, Anchal R, Barinder K and Neeraj M. 2008. Heavy metal accumulation in vegetables irrigated with water from different sources, Food Chemistry, 111:4, pp.811-815.

Nogueira SF, Pereira BFF, Gomes TM, de Paula AM, dos Santos JA and Montes CR. 2013. Treated sewage effluent: Agronomical and economical aspects on Bermuda grass production. Agricultural Water Management. 116:151-159.

Nogueiraa SF, Pereirab BFF, Gomesc TM, de Paulad AM, dos Santose JA and Montes CR.2013. Treated sewage effluent: Agronomical and economical aspects on Bermuda grass production. Agricultural Water Management, 116, 151–159

Palit S, Sharma A and Talukder G. 1994. Effects of cobalt on plants. The Botanical Review, 60(2): 149-181.

Rusan MMJ, Hinnawi S and Rousan L. 2007.Long term effect of waste water irrigation of forage crops on soil and plant quality parameters. Desalinization , 215: 143-152.

Weber B, Y.Avnimelech and Juanico M.1996. Salt enrichment of municipal sewage new prevention approaches in Israel, Environmental Management,20(4): 487-495.

Yoonki Yoon, Xinde Cao,Qixing Zhou and Lena Q Ma. 2006. Accumulation of Pb, Cu, and Zn in native plants growing on a contaminated Florida Site. Science of the Total Environment 368:456-464.