Evaluation of Effective Use from Urban and Industrial Wastewater in Agriculture

M. Mostashari

Agricultural and Natural Resources Research Center of Qazvin, Qazvin, Iran, Email: mm_mohasses@yahoo.com

ABSTRACT

In order to effective use of urban and industrial wastewater in agriculture, a plan of lands in Alborz industrial city on 3 products (wheat, barley and maize) was carried out. First, were prepared Composite sample of soil from every 10 hectares, 0-15 and 15-30 cm of depth with 2 reps. after cultivation. Desired products were irrigated with wastewater sources. Analysis of soil showed that in lands were irrigated with waste water in Alborz industrial city, the amount of heavy metals, especially cadmium, zinc, Pb, Cu and also P increased compared to control lands (without irrigation with waste water). During much use of the waste water, the amount of these elements will be higher than world standard. After sampling the plant was found that in the analysis of seed plants studied, the amount of heavy metal reported negligible and this shows that movement elements of root to shoot and finally seed plant is slow. On the other hand, the use of waste water leads to increasing the amount of soil salinity. Therefore in order to correct use of waste water and environmental protection and development of water resources for irrigation agriculture and the use of urban and industrial wastewater, filtration and removal of salts and elements harmful substances seem necessary.

Keywords: Agriculture, Industrial Wastewater, Urban Wastewater, Reuse

INTRODUCTION

Unusual water volume including urban and industrial wastewater in Iran (statistics 1996) is 3/36 billion cubic meters per year (2/5 billion cubic meters of Urban sewage wastewater). The amount of wastewater in 2001 has reached 4/5 billion cubic meters per year and it is expected that wastewater volume in 2011 reach to 7 billion cubic meters per year. Therefore it is necessary that status this wastewater in the form of long-term researches in the world including Iran seriously be considered. Alborz industrial city area is 900 hectares and it has 400 great Industrial units and the amount of waste water that they produce, is 40-35 million cubic meters per day. The area of agricultural lands irrigated with waste water the industrial city is about 200 hectares and according to reporting charge company Alborz industrial wastewater, the amount of waste water indicators after filtration as follows: Acidity or pH is equal 6- 7/8, TDS is equal 2000-2400 mg/Lit, TSS is equal 450-850. Other factors are the amount of oxygen required for biochemical reactions (BOD) is equal to 450 to 700 and the oxygen required for chemical reactions (COD) is equal to 800-1800 that after filtration, the amount of BOD will decrease to 100; the amount of COD will decrease to 200. On the other hand, increase the growth of World and the need to greater production and also limitations of water resources and indiscriminate use of them, especially in arid and semi-arid and also huge volumes of wastewater produced in cities and the need for their appropriate excretion has increased importance of the use of waste water in agriculture and artificial recharge of groundwater aquifers [1,2]. For

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decades, waste water and sewage sludge in agricultural land are used as a supplemental source of irrigation water, fertilizers and soil modifiers.

Using them in the short term may not cause toxicity in the plant [3], but long-term use of this wastewater or in other words uncontrolled entry of heavy metals in soils may increase these elements in the soil and plants cultivated in these soils absorbs these elements and easily enters to food chain. Bitterly about the release of wastewater to agricultural land says that although sewage disposal in land has lowest price but its adverse effects can be accumulation of metals such as chromium, nickel and cadmium that first this elements will pollute soil [4]. According to the report [5], concentration of heavy metals in soils is accordance with table 1.

Table 1. The concentration of some from heavy metals in soil and soil solution.

Element	Concentration in the soil solution (toxic soils) (mg/L)	Average rate (μg/g)	The concentration in toxic soils (Total) (μg/g)	The amount of balance from total elements in the soil (μg/g)
Cr	0/001	100	75-100	5-1000
Mn	0/1-10	600	1500-3000	200-2000
Co	0/01	8	25-50	1-70
Ni	0/05	40	100	10-1000
Cu	0/03-0/3	30	60-125	2-100
Zn	<0/005	50	70-400	10-300
Cd	0/001	0/06	3-8	0/01-7
Sn	Nd	10	50	<5
Hg	0/001	0/03	0/3-5	0/02-0/2
Pb	0/001	10	100-400	2-200

Studies like Sidle [6] showed that cadmium added to the soil due to the use of waste water often does not exist in the soil profile. Also, have seen Pb accumulation in surface layers of soil in most studies. The main cause of accumulation of elements (Zn, Pb and Cd) in the soil surface layer is absorption high capacity these third element by soils [7]. This feature is the result of the reaction of these elements with the components of the soil solid phase including silicate clay, oxides and hydroxides of metals particularly iron and aluminum, amorphous minerals of lime and organic matter and the formation of strong links with these components.

Aphioni et al. [8] reported that addition of sewage sludge to soil significantly increases the concentrations of extractable Cu, Zn and Pb by EDTA in the soil and absorption of these metals in plant. Khaiambashi [9] in a study showed that application of sewage sludge leads to an increase in the total amount and absorbable Zn, Cu, Mn, Pb and Ni in the soil. In evaluation the effects Urban sewage wastewater water feeding in forage maize cultivation was founded that in surface layer of agricultural land, % organic matter, absorption P, absorption K and heavy metal including Cu and Zn increased. The use of urban wastewater in olericulture land in Hamedan city showed that concentrations of heavy metals in vegetables (except Cu and Zn) were less than the permissible limit. Research results [10] showed that in all wastewater irrigated soil sample, % organic matter, absorption P, absorbable concentration in all heavy metals tested was beyond from values of these parameters in soils irrigated by wells water [11]. In many reports showed that wastewater have the ability to increase the concentration of heavy metals in the soil and in some cases reach to harmful border.

Jafarzadeh Haghighi [12] during effect evaluation of using from wastewater Shiraz city in irrigation of crops on increasing the concentration of heavy metal in soil and some products believes that discharge wastewater into seasonal river Shiraz lead to increase the concentration of heavy metals above the exposure limits for use in irrigation of crops and the average Pb, iron, Cu and Cd in studied products is more than recommended amounts and it is understood that direct application of sewage discharged into the seasonal river Shiraz due to various metal elements in the long term can lead to increasing contamination of soils adjacent to the river and the transfer the some pollutants elements in agriculture.

MATERIALS AND METHODS

First, location and land surface and the type of products which are irrigated with the waste water, were identified. Then, three plants that are major crops and its land irrigate with the wastewater, were prepared at the level of 100 to 200 hectares based on uniformity fields and maximum from every ten hectares were prepared two soil samples from the bottom of 0-15 and 15-30 cm to two replications as mixture. It should be noted that in Qazvin, adjacent lands of Alborz Industrial city are about 200 hectares and they are irrigated with the wastewater of this industrial city and major crops are corn, wheat, barley, and as scatter of sugar beet which was selected for the above research project.

Then, in order to evaluate the effect of the use of waste water on crops from ten hectares of land area that are planted to similar plants and irrigate by non-waste water sources, were taken samples as control plots. Of each segment of ten hectares irrigated with the waste water and also control plots, according to the type of product, uniformity and safety of the plant before crop harvest were collected a sample the plant seed is composed in two repeat.

Thus from every ten hectares plot of original treatments were obtained four soil samples and two plant samples. Analysis of desired for soils include EC, pH, phosphorus, organic matter, calcium carbonate, soil texture and heavy metals (Cu, Pb, Ni, Zn and Cd) and for plant samples include phosphorus and heavy elements. Measurement method the absorption amounts of heavy metals in soil were carried out using DTPA and determining its amount in plant to method of wet ash in mixed three acids. Finally, the results of analysis of samples of soil and plants in each region were examined and were analyzed.

RESULTS AND DISCUSSION

The concentration of heavy metals Pb, Cu, Cd and Zn and phosphorus in soils irrigated with wastewater is several times the amount of these elements in soils of control fields. Also, the amount of soil salinity in fields irrigated with wastewater is about 2 times of the salinity soil in control fields. The following levels of heavy metals and phosphorus in of soils irrigated with wastewater are interpreted compared to control at depth of 0-15 cm of contaminated soils, Pb is 5/6 times, Cu is 5/8 times, Cd is 23 times, Ni is 1/1 times, Zn is 25 times and P is 8/5 times and at depth of 15-30 cm of contaminated soils, Pb is 4/5 times, Cu is 5 times, Cd is 18/2 times, Ni is 1/1 times, Zn is 19/7 times and P is 8 times control soils that according to the results in amount of nickel contaminated soils, not seen a significant change compared to the control. In wheat fields have been irrigated with wastewater compared to the control farms, the amount of heavy elements are as follows: at the depth 0-15 cm of soils contaminated farms, Pb is 1/3 times, Cu is 1/9 times, Cd is 1/3 times, Ni 0s 3/3 times and P is 3/5 times and at the depth 15-30 cm, Pb is 1/2 times, Cu is 3 times, Cd and Ni haven't changed very much, Zn is 2/8 times, P is 1/6 time compared to control farms. Amount of heavy metals including Cd, Pb and Ni in seed corn, barley and wheat have been reported negligible. Based on the results laboratory and the amount of P, Zn and Cu is normal. Therefore, it follows that the above elements have not gathered in studied seed plant and them move in the plant. Toward seed is very slow and in comparison the pollution treatment and control is not observed a significant change.

The concentration of heavy metals Pb, Cu, Cd and Zn and P in soils irrigated with wastewater is Several times the amount of these elements in the soil the control fields that these results are match with research that Rahmani [10] carried out on examination of the quality urban and industrial wastewater. The amount of soil salinity in fields irrigated with wastewater is about 2 times the salinity soil of the control fields that this match with research results of Rahmani [10]. Given that one of the main sources of heavy metals are chemical fertilizers, therefore, the use of these fertilizers should be done by studying and exact amount of: (1) Wastewater the industrial cities due to having large amounts of salts and unnecessary and heavy metals should be used with sufficient accuracy And in this regard should be conducted controlled trials; (2) Not use for agricultural products from untreated sewage and dangerous industrial effluents; (3) Industrial and urban waste water be treated in terms of chemical and biological materials, and (4) In order to protect the environment and nutrition and development of water resources for irrigation farms is necessary that consumption urban and industrial wastewater be done after filtration and removal of salt and nutrients and harmful substances from that.

Table 2. Average the soil chemical properties of corn field.

Name of treatment	Depth (cm)	pH	EXC 103	OC (%)	Pb $mgkg^{-1}$	Cu $mgkg^{-1}$	Cd $mgkg^{-1}$	Ni $mgkg^{-1}$	Zn $mgkg^{-1}$	P $mgkg^{-1}$
Control	0-15	7/75	0/8	1/12	7/5	1/6	0/13	0/33	1/09	19/5
	15-30	7/75	0/8	1/15	7/5	1/45	0/13	0/31	1/29	18/5
Contamination	0-15	7/2	1/76	1/62	42/1	9/3	2/99	0/35	27/1	165/2
With the wastewater	15-30	7/4	1/85	1/33	33/9	7/36	2/36	0/33	25/4	150/3

Table 3. Average the soil chemical properties of barely field.

Name of treatment	Depth (cm)	pH	EXC 103	OC (%)	Pb $mgkg^{-1}$	Cu $mgkg^{-1}$	Cd $mgkg^{-1}$	Ni $mgkg^{-1}$	Zn $mgkg^{-1}$	Pb $mgkg^{-1}$
Control	0-15	7/65	0/8	0/75	7/5	1/15	0/11	0/31	0/66	58
	15-30	7/5	0/7	0/7	7/75	1/15	0/11	0/48	0/58	34
Contamination	0-15	7	3/17	1/67	22/4	10/9	0/34	3/72	38/4	275/5
With the wastewater	15-30	7/12	2/95	1/35	45/3	10/8	0/34	4/35	28/1	272/2

Table 4. Average the soil chemical properties of wheat field.

Name of treatment	Depth (cm)	pH	EXC 103	OC (%)	Pb $mgkg^{-1}$	Cu $mgkg^{-1}$	Cd $mgkg^{-1}$	Ni $mgkg^{-1}$	Zn $mgkg^{-1}$	Pb $mgkg^{-1}$
Control	0-15	8/1	1/13	0/51	2/55	1/88	0/17	0/22	1/08	8/46
	15-30	8/1	1/75	0/58	2/6	1/18	0/22	0/42	0/72	14/14
Contamination	0-15	8	1/7	0/64	3/15	3/58	0/22	0/73	2/44	29/3
With the wastewater	15-30	8	1/26	0/5	2/95	3/58	0/19	0/48	2/05	22/48

REFERENCES

[1] Asano T, Cotruvo JA. Water Res. 2004, 38:1941-1951.
[2] Haruvy N. Agri, Eco and Environ. 1997, 66:113-119.

[3] Page AL. Second International Symposium on Land Application of Sewage Sludge. Tokoyo, Japan, 1995, 154-181.
[4] Torabian, E, Baghori A. J Ecol. 1996, 2(18):33-45.
[5] Rose SM. Toxic metals in soil-plant system. John Wiley and Sons Ltd., 1996.
[6] Sidle RC. J. Water Pollutes. Controfed. 1977, 49:311-318.
[7] Carey JE. Soil Sci. 1987, 143:124-131.
[8] Aphioni M, Rezaei Nehad E. Agri Sci Natural Res. 1998, 19:1-30.
[9] Khaiambashi B. Master Thesis, Faculty of Agriculture, Isfahan University, 1997.
[10] Rahmani HR. Ninth Congress of Soil Science, 2005.
[11] Elliot LF, Stevenson FJ. Soil. Sci. Am. Inc., Madison, Wisconsin, USA, 1986, 650.
[12] Jafarzadeh Haghighi N. Collections of Congress soil and water issues in the country, 2005.