Asian Journal of Plant Sciences 5 (3): 438-440, 2006
ISSN 1682-3974


# Irrigation with Sewage Water: Assessment of Water Quality, Nutrients and Heavy Metal Distribution

[1]R.G. Kakar, [2]M.Yasinzai, [3]A.U. Salarzai, [4]F.C. Oad and [5]M.H. Siddiqui
[1]Department of Botany, Government Girls Degree College, Quetta, Pakistan
[2]Institute of Biochemistry, University of Balochistan, Quetta, Pakistan
[3,4]Sindh Agriculture University Tandojam, Pakistan
[5]University College of Agriculture Rawalakot, Azad Kashmir, Pakistan

**Abstract:** Study was conducted to examine quality, distribution of nutrients and heavy metals in sewage water used for irrigation in and around of Quetta city, Pakistan. Water samples were collected from three main sewage drains (Habib nala, Ispini and Sabzal Road). Collected water samples were analyzed for EC, SAR, RSC, $Cl^{-}$, $SO_4^{++}$, $Ca^{++} + Mg^{++}$, $Na^{+}$, $K^{+}$, P, $Fe^{++}$, Mn, Zn, Cu, Pb and Ni. Results revealed that the EC was 9.96 ds $m^{-1}$ for Ispini road drain. and overall range of SAR were 33.50 Habib nala, 19.16 Subzal road and 18.21 for Ispini road. The pH of sewage water varied from 7.24 to 9.21. The concentration of essential nutrients (macro+ micro) and toxic metals varied greatly in samples between locations. The concentration of P and $K^{+}$ was high (1.18 ppm and 0.81 me $L^{-1}$) in Habib nala than Ispini and Subzal road sewage drain. The concentration of micro nutrients ($Fe^{++}$, Mn, Zn, Cu) were with permissible limits. With respect to toxic metals, Pb was generally greater (0.12ppm) in Ispini road drain compared with (0.05-0.08 ppm) in other sewage drains. The minimum and maximum Ni (0.09 and 0.18 ppm) was found in Ispini and Subzal road drain.

**Key words:** Sewage water, nutrients, heavy metals, analysis, assessment, distribution, Irrigation

## INTRODUCTION

The attention of whole world is focused today on the problem of pollution which is an undesirable change in physical, chemical and biological characteristics of air, water and soil which affects human life and other useful living things like animals and plants (Misra and Dinesh, 1991).

Soil, water and plant pollution is much related with an increase in urbanization and industrialization, which has generated and increased in municipal waste water. This waste water in Pakistan like many other developing countries is being used for irrigation to raise the vegetables, forages and crops in the immediate surrounding of the cities and the towns. However, a better taste is observed in vegetables grown with canal water than sewage irrigated vegetables (Hussain *et al*., 1991). The sewage effluent is considered to be a source of organic matter and plant nutrients and among these much emphasis has been placed on the values of its nitrogen and phosphorus contents, yet on the other hand it also contains considerable amounts of soluble salts and varying amounts of harmful substances including heavy metals like iron, manganese, copper, zinc, lead, nickel and pathogens which are undesirable (Shah and Riazullah, 2003). Heavy metals are elements having atomic weight between 63.546 and 200.59 (Kennish, 1992) and a specific gravity greater than 4.0 (Connell and Miller, 1984). Living organisms require trace amounts of some heavy metals, including Cobalt (Co) Copper (Cu) iron ($Fe^{++}$), Manganese (Mn), Molybdenum (Mo), Vanadium (V), Strontium (Sr) and Zinc (Zn). Excess levels of essential metals, however, can be detrimental to the organism. On essential heavy metals of particular interest are Candum (Cd). Chromium (Cr) Mercury (Hg) Lead (Pb) Arsenic (As) and Atimony (sb) (Kennish, 1992).

Excess metal levels in surface water and agriculture products may pose a health risk to humans and to the environment. Ingestion of metals such as Pb, Cd, Hg, As, Ba and Cr may pose greater risk to human health. The organic waste can be a good and cheap source of nutrients for plant growth as it contains essential plant food nutrients (Shah and Khan, 2003). But at the same time, it may contain some toxic metals. Repeated applications of such waste to soil might build up the concentration of heavy metals to levels toxic to crops or to man and animals that consume the crops. The elements of most concern are As, Cd, Cr, Hg, Mu, Ni, Pb, Se and Zn

**Corresponding Author:** Dr. F.C. Oad, Sindh Agriculture University Tandojam, Pakistan

(Stevenson and Cole, 1999). Cadimum and Hg are Specially toxic to man and animals and their entry in the food chain and the environment must be kept within acceptable limits.

The state of pollution in Quetta city presents gloomy picture and of course points to more unsafe and unhygienic environment in the years to come. Some elementary studies have shown that Quetta is one of the cities badly affected by various forms of pollution (EPA, 2002; Kakar *et al*., 2004). The present study is a continuation of such attempts. Therefore, present investigations were under taken to study the quality, mobility and accumulation of these trace and heavy metals in the sewage water, where such water is being used and the vegetables are commonly grown over there.

## MATERIALS AND METHODS

An experiment was conducted to evaluate sewage water for quality, nutrients and heavy metals distribution during 2004 in Quetta city. Three main sewage drains i.e., Habib nala, Ispini road and Subzal road were selected. Water samples were collected at various points of the drains and at the point from where it was being supplied to the field as well water samples were collected four times during research period in plastic bottles and separately labeled. Collected sample were analyzed for quality and distribution of nutrients and heavy metal concentration.

**Analytical methods:** The determinations were carried out on water samples according to the method as outlined in Handbook 60 by U.S Salinity Laboratory staff (1954). The pH and EC were determined by digital meters, $Cl^-$ by titration with $AgNO_3$, $Ca^{++}$ and $Mg^{++}$ by titration with EDTA and $Na^+$ by flame emission. $SO_4^{++}$ by subtracting $CO_3 + HCO_3 + Cl^-$ from total soluble Salts. Calculations of Sodium Adsorption Ratio (SAR) and Residual Carbonates (RSC) were based on the methods suggested by Rowell (1996). The guidelines suggested by WAPDA (1982) were used to classify the quality of water samples for irrigation purpose.

## RESULTS AND DISCUSSION

Chemical analysis of sewage water is presented in Table 1. The analysis was repeated four times by taking samples after 15 days interval. The analysis did not show any sharp difference, therefore, the average of these four repeats were taken.

**Electrical conductivity ($dsm^{-1}$):** The data indicated that the EC of different drains ranged from 5.11 to 9.96 ds $m^{-1}$. The minimum 5.11 ds $m^{-1}$ and maximum 9.96 ds $m^{-1}$ were observed in the water of Ispini road and Habib nala respectively. The EC of the most of the sewage drains is highly problematic (Table 1).

**pH:** It is clear from the data of Table 1 the pH was 9.21 for Habib nala, 7.24 for Subzal road and 8.05 for Ispini road drain. Considering pH, most of the waters are within the permissible limits except Habib nala. James (1971) in his experiment concluded that pH 7-9 is considered fit for irrigation.

**Soluble anions and cations:** It is evident from the data presented in the Table 1 that all the drain sewage water samples had higher concentration of $Cl^-$ and $SO_4^{++}$ anions. The amount of $Na^+$ ions was higher than $Ca^{2+}$ and $Mg^{2+}$ in all drain water samples. The minimum (18.21) and the maximum (33.50) SAR was observed in the effluents of Habib nala and Subzal road drain. The higher values of SAR were associated with higher concentration of $Ca^{2+}$ and $Mg^{2+}$ resulted in higher values of RSC in all water samples. These results are inconsonance with those reported by Sial *et al.* 2003. The higher SAR (>18) and RSC values (>5) place almost all he water samples into hazardous ($C_3R_3S_3$) class (Qureshi and Barret-Lennard, 1998).

**Concentration of macro nutrients in sewage water:** The data regarding nutrients and heavy metals analysis of sewage water at Quetta locality is given in Table 2. the results revealed that the concentration of macro nutrients (P and $K^+$) in the sewage water is enough for growing vegetables and other crops. Lone *et al.* (1997) reported that the sewage effluent contains more macro nutrients. The concentration of P and $K^+$ is high (1.18 ppm and 0.81 $meL^{-1}$) in than Habib nala and Subzal road drains.

**Concentration of micronutrients:** The minimum and maximum iron (0.55 and 1.00 ppm) was found in sewage water of Ispini and Habib nala drains. The iron of these drains is within the permissible limits. The manganese of all the sewage drains are also within permissible limits. Subzal and Ispini road drains show maximum (0.23 ppm) and minimum (0.14 ppm), respectively. Zinc concentration of all the sewage drains was within permissible limits. The maximum concentration was zinc (0.21 ppm) was found in Habib nala drain and the minimum (0.08 ppm) was recorded in Ispini road sewage drain. The cupper concentration varied from (0.03 to 0.07 ppm) in Subzal and Habib nala drain respectively and was also within permissible limits.

Table 1: Chemical analysis of sewage water of different outlets at Quetta city

| Source of the water | EC (dS $m^{-1}$) | pH | SAR (mmol $l^{-1}$)½ | RSC (meq $L^{-1}$) | $Cl^-$ (meq $L^{-1}$) | $SO_4^{++}$ (meq $L^{-1}$) | $Ca^{++}+Mg^{++}$ (meq $L^{-1}$) | $Na^+$ (meq $L^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| Habib nala | 9.96 | 9.21 | 33.50 | 21.42 | 76.90 | 24.32 | 9.34 | 68.16 |
| Subzal road | 8.70 | 7.24 | 19.16 | 16.10 | 48.11 | 18.21 | 7.80 | 50.92 |
| Ispini road | 5.11 | 8.05 | 18.21 | 18.0 | 30.82 | 14.44 | 6.52 | 36.40 |
| SD | 7.92±2.157 | 8.16±0.99 | 23.62±8.56 | 19.17±1.94 | 51.94±2327 | 18.99±4.89 | 7.88±1.41 | 51.84±15.87 |

Table 2: Nutrients and heavy metals analysis of sewage water at various irrigation points

| Source of the water | $K^+$ ($meqL^{-1}$) | P (ppm) | $Fe^{++}$ (ppm) | Mn (ppm) | Zn (ppm) | Cu (ppm) | Pb (ppm) | Ni (ppm) |
|---|---|---|---|---|---|---|---|---|
| Habib nala | 0.81 | 1.18 | 1.00 | 0.19 | 0.21 | 0.07 | 0.08 | 0.10 |
| Subzal road | 0.62 | 0.14 | 0.68 | 0.23 | 0.08 | 0.03 | 0.05 | 0.18 |
| Ispini road | 0.48 | 0.12 | 0.55 | 0.14 | 0.11 | 0.06 | 0.12 | 0.09 |
| SD | 0.63±0.16 | 0.48±0.60 | 0.74±0.23 | 0.18±0.04 | 0.13±0.06 | 0.05±0.02 | 0.08±0.03 | 0.12±0.04 |

**Concentration of toxic metals:** With respect to toxic metals Pb was generally greater (0.12 ppm) in Ispini road drain as compared with (0.05-0.08 ppm) in other drain. The maximum and the minimum Ni (0.18 and 0.09 ppm) were found in Subzal and Ispini road sewage drains. Huma and Khan (2003) reported that sewage effluent is a good source of nutrients $Fe^{++}$, Mn, Zn and Cu).

## CONCLUSIONS

It is matter of great concern that repeated applications of such sewage water to soil might build up the concentration of heavy metals to level toxic to crops or to man and animals that consume crops. The elements of most concern are As, Cd, Cr, Hg, Mo, Ni, Pb, Se and Zn. Cadmium and Hg are especially toxic to man and animals and their entry into the food chain and the environment must be kept within acceptable limits. Generally, all the drains have bad quality irrigation water and values were much higher than those fit for irrigation.

## REFERENCES


Connell, D.W. and G.J. Miller, 1984. Chemistry of Ecotoxicology Pollution. John Wiley and Sons, NY.

Environmental Protection Agency (EPA), 2002. Pollution affecting Quetta City. Report to the honorable chief justice of high court Balochistan, Quetta.

Hussain, M., M. Iqbal, M. Yaqub and A. Ali, 1991. Human Environmental Control: Effect of Canal and Sewage Water on Vegetables. M.Sc Thesis, Uni. Agric. Faisalabad, pp: 63-65.

Huma, R. and M.A. Khan, 2003. Effect of land application of sewage sludge on heavy metal contents in soil and plant, soil fertility and wheat yield. Pak. J. Soil Sci., 22: 51-57.

James, G.V., 1971. Water Treatment. Tech. Press Scotland. 4th Edn., pp: 175-181.

Kakar, R.G., S. Ahmed, K.M. Kakar and M. Yasinzai, 2004. Monitoring the air pollution at Meezan chowk, Quetta. Symposium on plant nutritional management for horticultural crops under water stress condition. Abstracts. Soil Sci. Soc. Pak. 5-6th October Quetta Pakistan, pp:18-19.

Kennish, M.J., 1992. Ecology of Estuaries: Anthropogenic effects. CRC, Inc, Boca Raton, FL.

Lone, M.I. and Rizwan, 1997. Evaluation of industrial effluents for irrigation and their effect on soil chemical properties. Proc. NSM TCC.97. Environ. Pollution. Feb 24-26 Islamabad Pakistan. pp: 269- 280.

Misra, S.G. and M. Dinesh, 1991. Soil pollution. Ashish Publishing House 8/81 Punjabi Bagh New Delhi-10026, pp: 7.

Qureshi, R.H. and E.G. Barret Lennard, 1998. Saline Agriculture for irrigated land in Pakistan. A hand book ACIAR, Canberra, Australia.

Rowell, D.L., 1996. Soil Science Methods and Applications. Longman, UK., pp: 284-286.

Shah, Z. and Riazullah, 2003. Evaluation of farm wastes for heavy metals. Pak.J. Soil Sci., 22: 42-50.

Shah, Z. and A.A. Khan, 2003. Evoluation of crop residues for mineralizable nitrogen in soils. Sarhad J. Agric., 19: 81-92.

Stevenson, F.J. and M.A Cole, 1999. Cycles of Soil Carbon, nitrogen, Phosphorus, Sulphur and micronutrients. 2nd Edn. John Willey and Son, Inc. NY.

Sial, N.B., I. Rajper, H.R. Mangio and J.K. Suther, 2003. Assessing irrigation quality of well water in Thar Dessert. Pak. J. Agric., Agril. Eng., Vet. SC., 19: 8-10.

US Salinity Lab. Staff, 1954. Diagnosis and Importantance of Saline and Alkali Soils. US Department Agri., Hand book No.60 Washington DC.

WAPDA, 1982. Water quality classification based on measurement of electrical conductivity, sodium adsorption ratio and residual sodium carbonate.