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EVALUATION OF IRRIGATION WATER FOR HEAVY METALS OF AKBARPURA AREA

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ABSTRACT

A study was conducted on heavy metal contents of irrigation water in Akbarpura area of District Nowshera, NWFP, Pakistan. Water samples were collected from two irrigation sources (canal and Bara River) with three replications each from Akbarpura, Kurvi and Banda Sheikh Ismail villages. Water samples were collected in clean bottles at 10cm depth. The samples collected were analyzed for their heavy metal contents including copper, lead, zinc, iron, manganese, cadmium, nickel and chromium by Atomic Absorption Spectrophotometer. Heavy metal contents were found much lesser in irrigation canal water as compared to Bara River water. Copper, lead, iron, cadmium, nickel and chromium were found in normal concentrations in both irrigation canal and Bara River, while zinc and manganese were found in deficient concentrations

Keywords: Irrigation water, Heavy metals, toxic elements.

INTRODUCTION

A mixture of municipal and industrial wastewater is used for crop production in some parts of Pakistan. Many other countries including even some developed one also reuse wastewater in agriculture. The mixture of industrial and domestic wastewater contains nitrogen, phosphorus, potassium, total dissolved solids, viruses, trace organic and trace metals specially heavy metals. Living organisms require trace amounts of some heavy metals including cobalt, copper, iron, manganese, molybdenum, vanadium, strontium, and zinc. Excessive levels of essential metals however, can be detrimental to the organism. Non-essential heavy metals of particular concern to surface water systems are cadmium, chromium, mercury, lead, arsenic, and antimony (Kennish, 1992). Heavy metals come from local sources mostly industry (mainly non-ferrous industries, but also power plants and iron, steel and chemical industries), agriculture (irrigation with polluted water use of mineral fertilizers especially phosphates, contaminated manure, sewage sludge and pesticides containing heavy metals) from waste incineration, burning of fossil fuels and road traffic. Water pollution by heavy metals is mainly caused by point source emissions from mining activities and a wide variety of industries.

Chemicals usually present in wastewater are also an important concern for reuse application especially for irrigation of food crops. The mechanisms of food crop contamination by irrigation of reclaimed water may be either physical contamination, where evaporation and repeated irrigation may cause build up of contaminants on crops or uptake of the chemical constituents through roots from irrigation water or soil. Waste water from factories often contains toxin if it is not disposed, toxicity may make aquatics death or mutation especially in the downstream. Toxins include strong acid, strong base, cyanide, chrome, copper, mercury, and radiation materials. The fate and effects of pollutants discharged into a particular water body will depend not only on the amount of polluting substances emitted but also on the hydrological, physical, chemical and biological conditions characterizing the water body concerned.

MATERIALS AND METHODS

Water Sampling and Analysis

Eighteen water samples were collected; nine form canal water and nine from Bara River water at three different locations (Akbarpura, Kurvi and Banda Sheikh Ismail) with three replications. Water samples were taken in plastic bottles labeled and transported to the laboratory of Soil and Environmental Sciences and were analyzed for heavy metals (Cu, Pb, Zn, Fe, Mn, Cd, Ni, Cr), pH and EC. (Walsh 1971, Richards 1954,).

RESULTS AND DISCUSSION

The water samples were analyzed for various parameters. The results are presented in Tables 1-4.

Irrigation Water Analysis

Two different sources of irrigation water were selected, canal irrigation water and Bara River. These sources were analyzed for pH, EC and heavy metal contents (Cu, Pb, Zn, Fe, Mn, Cd, Ni and Cr).

pH Measurement

The pH and EC of irrigation canal and Bara River are given in Table-1 and 2. The average pH of irrigation canal water ranged from 8.1 to 8.3. The average pH value of Bara River ranged from 8.4 to 8.9.

Electrical Conductivity (EC)

The average electrical conductivity of irrigation canal water ranged from 0.86 to 1.02 dSm^{-1}. The average electrical conductivity of Bara River ranged from 1.05 to 1.38 dSm^{-1}. All the water samples were found non-saline

and will not contribute any harmful effect to agricultural land and crop. Hameed *et al.* (1966) stated that waters having electrical conductivity of 1.5 dSm^{-1} were safe for irrigation, those having 1.5 to 3.0 dSm^{-1} were marginal and waters having EC values more than 3.0 dSm^{-1} were unsafe.

Table-1. Average pH of irrigation Canal water and Bara River water.

Water Source (Irrigation Canal)			Water Source (Bara River)		
S. #	**Sample Location**	**pH**	**S. #**	**Sample Location**	**pH**
1.	Akbarpura	**8.3**	1.	Akbarpura	**8.4**
2.	Kurvi	**8.2**	2.	Kurvi	**8.6**
3.	Banda	**8.1**	3.	Banda	**8.9**

Table-2. Average EC of irrigation Canal water and Bara River water.

Water Source (Irrigation Canal)			Water Source (Bara River)		
S. #	**Sample Location**	**EC dSm^{-1}**	**S. #**	**Sample Location**	**EC dSm^{-1}**
1.	Akbarpura	**1.02**	1.	Akbarpura	**1.05**
2.	Kurvi	**0.94**	2.	Kurvi	**1.24**
3.	Banda	**0.86**	3.	Banda	**1.38**

Table -3. Average heavy metal contents of canal water from Akbarpura, Kurvi and Banda village ($\mu g\ mL^{-1}$)

Sample Locations	Cu	Pb	Zn	Fe	Mn	Cd	Ni	Cr
Akbarpura	0.73	0.43	0.04	1.02	0.71	0.14	0.39	0.17
Kurvi	0.69	0.38	0.04	0.93	0.67	0.11	0.34	0.15
Banda	0.59	0.34	0.05	0.90	0.61	0.09	0.33	0.13

Table-4. Average heavy metal contents of Bara River from Akbarpura, Kurvi and Banda village ($\mu g\ mL^{-1}$)

Sample Locations	Cu	Pb	Zn	Fe	Mn	Cd	Ni	Cr
Akbarpura	0.90	0.43	0.02	1.29	0.77	0.15	0.53	0.16
Kurvi	1.03	0.52	0.03	1.55	0.82	0.17	0.64	0.21
Banda	1.20	0.62	0.06	1.75	0.85	0.20	0.72	0.29

Heavy metal contents of irrigation water

The Average heavy metal contents of canal water and Bara River from Akbarpura, Kurvi and Banda village are given in Tables-2 and 3.

Cu:

The average value of Cu content of Akbarpura, Kurvi and Banda village was 0.73, 0.69 and 0.59 $\mu g\ mL^{-1}$ respectively in canal water. The average value of Cu content of Akbarpura, Kurvi and Banda village was 0.90, 1.03 and 1.20 $\mu g\ mL^{-1}$ respectively in Bara River water. These results shows that Cu content of canal were found in safe range while in case of Bara River it approaches to toxic level in Banda village. Sadiq and Zaidi (1994) reported a higher concentration of Cu content in Tarut Bay by the influence of agricultural drainage from the Qateef Oasis and discharges of municipal wastewater. Ahumada et al. (1999) concluded that untreated wastewater increase Cu content in these soils. Shivkumar and Biksham (1995) analyzed the industrial effluents, surface water and subsurface ground water for Cu content. The concentration of Cu content was 5 to 10 times above the permissible limits.

Pb:

The average value of Pb content of Akbarpura, Kurvi and Banda village was 0.43, 0.38 and 0.34 $\mu g\ mL^{-1}$ respectively in canal water. The average value of Pb content of Akbarpura, Kurvi and Banda village was 0.43, 0.52 and 0.62 $\mu g\ mL^{-1}$ respectively in Bara River water. The standard for irrigation water approved by NEQS (National Environmental Quality Standards) for Pb is 0.5 $\mu g\ mL^{-1}$. These results shows that Pb content of canal and Bara River were found in safe range and can be used for irrigation without any hazards. Athar (1973) found similar results. Komosa (1999) reported that river sediment contamination with Lead content did not exceed the permissible concentration limit in sewage sludge introduced to soils.

Zn:

The average value of Zn content of Akbarpura, Kurvi and Banda village was 0.04, 0.04 and 0.06 μg mL^{-1} respectively in canal water. The average value of Zn content of Akbarpura, Kurvi and Banda village was 0.02, 0.03 and 0.06 μg mL^{-1}respectively in Bara River water. The standard for irrigation water approved by NEQS (National Environmental Quality Standards) for Zn is 5.0 μg mL^{-1}. These results show that Zn content of canal and Bara River were found in deficient concentrations. Komosa (1999) reported that contamination of river sediment with Zn content did not exceed the permissible concentration limit in sewage sludge introduced to soils.

Fe:

The average value of Fe content of Akbarpura, Kurvi and Banda village was 1.02, 0.93 and 0.90 μg mL^{-1} respectively in canal water. The average value of Fe content of Akbarpura, Kurvi and Banda village was 1.29, 1.56 and 1.75 μg mL^{-1} respectively in Bara River water. The standard for irrigation water approved by NEQS (National Environmental Quality Standards) for Fe is 2.0 μg mL^{-1}. These result shows that Fe content of canal and Bara River were found in safe range. Awadallah *et al.* (1996) concluded that river sediment contain a smaller concentration of Fe content than the beach soils. Reemtsma *et al.* (2000) reported a high concentration of Fe content in urban runoff provided by municipal wastewater.

Mn:

The average value of Mn content of Akbarpura, Kurvi and Banda village was 0.71, 0.67 and 0.61 μg mL^{-1} respectively in canal water. The average value of Mn content of Akbarpura, Kurvi and Banda village was 0.77, 0.82 and 0.85 μg mL^{-1} respectively in Bara River water. The standard for irrigation water approved by NEQS (National Environmental Quality Standards) for Mn is 1.5 μg mL^{-1}. These results show that Mn content of canal water found in safe range while in Bara River it is slightly above the maximum permissible level. Gonzalez *et al.* (2000) reported that in the river where sediments are most abundant the heavy metal concentration was the greatest. Komosa (1999) founds that river sediment contaminated with Mn did not exceed the permissible concentration limit in sewage sludge introduced to soils.

Cd:

The average value of Cd content of Akbarpura, Kurvi and Banda village was 0.14, 0.11 and 0.09 μg mL^{-1} respectively in canal water. The average value of Cd content of Akbarpura, Kurvi and Banda village was 0.15, 0.17 and 0.20 μg mL^{-1} respectively in Bara River water. The standard for irrigation water approved by NEQS (National Environmental Quality Standards) for Cd is 0.10 μg mL^{-1}. These results show that Cd content of canal and Bara River were found in slightly toxic range. Ahumada *et al.* (1999) finds that high concentrations of Cd content in untreated wastewater increase their concentrations in the applied soils. Boruvka *et al.* (1996) reported that a high concentration of Cd content in floodwater increase its concentrations in the contaminated soils. Setia *et al.* (1998) concluded that sewage water contain 4 to 10 times more Cd content than tube well water.

Ni:

The average value of Ni content of Akbarpura, Kurvi and Banda village was 0.39, 0.34 and 0.33 μg mL^{-1} respectively in canal water. The average value of Ni content of Akbarpura, Kurvi and Banda village was 0.53, 0.64 and 0.72 μg mL^{-1}respectively in Bara River water. The standard for irrigation water approved by NEQS (National Environmental Quality Standards) for Ni is 1.0 μg mL^{-1} for neutral to alkaline soils. These results show that Ni content of irrigation canal and Bara River were found in safe range. Similar results were found by Athar (1973).

Cr:

The average value of Cr content of Akbarpura, Kurvi and Banda village was 0.17, 0.15 and 0.13 μg mL^{-1} respectively in irrigation canal water. The average value of Cr content of Akbarpura, Kurvi and Banda village was 0.16, 0.21 and 0.29 μg mL^{-1} respectively in Bara River water. The standard for irrigation water approved by NEQS (National Environmental Quality Standards) for Cr is 1.0 μg mL^{-1}. For neutral to alkaline soil. These results show that Cr content of irrigation canal and Bara River were found in safe range. Similar results were obtained by Athar (1973), while Ansari et al. (1999) and Gonzalez *et al.* (2000) reported a high concentration of Cr content in irrigation water and river sediments.

Most of the heavy metal contents of canal water decreases as it approach towards its end. It might be due to sedimentation. Stephens *et al.* (2001) reported that canal sediment could act as sink for a wide range of contaminants including heavy metals from various sources (e.g. Agricultural and wastewater discharge). No external addition of heavy metal occurs in case of irrigation canal. While in Bara River the addition of sewage sludge and municipal wastewater results an increase in the total heavy metal contents as we go down the stream. Reemtsma *et al.* (2000) reported that Fe, Pb and Zn originate from urban runoff, while Cr and most alkaline earth metals are provided by municipal wastewater.

CONCLUSION

The following conclusion can be drawn from the present research:

- Both the irrigation water sources (Canal and Bara River) were found in normal concentration of heavy metals. Therefore, these sources can be used for irrigation purposes without any hazardous effect on soil and plants.

- Heavy metal contents of Bara River were slightly high as compared to heavy metal contents of canal water.

RECOMMENDATIONS

The following recommendations were formulated from the present research:

- Both the sources of irrigation water are well suited for irrigation and can be used for irrigation without any hazardous effect to plants and soils.
- If the municipal compost and sewage sludge is regularly added in Bara River, it will raise the concentration of certain heavy metals like Cu, Fe, Pb and Cr to toxic level. Therefore, it is recommended that some safe ways should be used for the disposal of these wastes.
- Zinc was found in deficient concentration in both irrigation sources therefore, Zn fertilizer should be added to the soils irrigated with theses sources.

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