Asian Journal of Chemistry Vol. 15, Nos. 3 & 4 (2003), 1284–1290

Impact of Sewage Water on Physico-chemical Characteristics of Soil of Bikaner City

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The quality of waste-water at Vallabh Garden and Madhosingh Bari in Bikaner is quite poor for irrigation and is deteriorating the growth of crops and altering the physical and chemical properties of soil. To study the impact of the polluted water on the soil, it was necessary to examine the physico-chemical characteristics of soil. In order to examine the quality 11 soil samples were collected to determine the concentration of some parameters as pH, conductivity, total dissolved solids, total hardness, alkalinity, chloride, potassium, sodium, zinc and iron. The study of the parameters revealed that the variation of these parameters is significant. Variation in values of parameters with distance in soil samples was also studied. If irrigation with this polluted water continues there is very possibility of human beings developing intestinal diseases and the land become barren. The quality of soil of Vallabh Garden is much poorer than Madhosingh Bari. Values of parameters are very high in Vallabh Garden soil and heavy metals, *i.e.*, iron and zinc are also present in toxic range in this soil Therefore it should be used after treatment.

Key Words: Impact, Sewage water, Soil, Bikaner city.

INTRODUCTION

Soil, the most precious natural resource, has been built slowly over thousands of years. Soil is the receptor of large quantities of waste products, domestic, human, animal, industrial and agricultural. Indiscriminate dumping of industrial wastes and municipal wastes leads to the leaching and/or seepage of toxic substances into the soil.

Application of sewage sludges to land has become the main cause for metallic contamination. The distribution of metals in the soil profile following sewage sludge additions is complicated by the fact that an excess of organic matter is added to the soil along with the metals. The presence of excess of organic matter not only affects the distribution of applied metal, but also the distribution of metals already present in the soil. Soil pH also affects the distribution and mobility of metals, applied with sewage sludge.

Due to mixing of domestic wastes the soil loses its natural properties which favour the growth of characteristic plants[1]. Wheat yield is adversely affected by high pH and Na^+ and Cl^- rich effluents[2]. River discharges and atmospheric transport were suggested as the major contributors of metals to the ground[3]. Cable factories cause heavy metal pollution in grass and soil[4]. Thermal power plants

also cause high soil metal level[5] (mg/kg). Near zinc smelters also, the soil has high concentration of heavy metals (μg/L)[6]. Effluents of a chemical and fertilizer factory near Varanasi are 40 times richer in sodium than well water and it reduces the water holding capacity of the soil irrigated by the effluent water[7].

The purpose of this study is firstly to study the physio-chemical characteristics of soil; secondly to study the impact of sewage water on physio-chemical characteristics of soil and thirdly to study the variation of parameters with distance in soil samples.

EXPERIMENTAL

11 Soil samples were collected to study the influence on physico-chemical characteristics of soil. Standard procedures were employed for physical and chemical analysis[8, 9]. Physical parameters include conductivity while chemical parameters include pH, TDS, alkalinity, anions (carbonates, bicarbonates, chlorides) and cations (calcium, magnesium, sodium and potassium).

Impact of Sewage Water on Physico-chemical Characteristics of Soil (Hydrogen ion concentration)

Availability and uptake of nutrients by plants is dependent upon the pH of soil. The pH range of 6.5 to 8.00 has been recommended for proper growth of plants to obtain optimum yield.

pH value near Sursagar was found 7.60. Near Vallabh Garden and Madhosingh Bari the values of pH range from 7.40 to 7.90 and 7.30 to 8.01 respectively (Table-1). These values show the alkaline nature of soil and are in permissible limit.

Electrical conductivity: EC of samples under investigation, collected from Sursagar, Vallabh Garden and Madhosingh Bari ranges from 20.1 mS, 2.68 to 14.8 mS and 3.30 to 12.50 mS respectively. (Table-1), which is very high.

TABLE-1
PHYSICO-CHEMICAL CHARACTERISTICS AND ANALYSIS OF Zn AND Fe IN SOIL SAMPLES

S.No.	Conductivity	pH	TDS	$Ca^{2+} + Mg^{2+}$	CO_3^{2-}	HCO_3^-	Na	K	Chlorides	Fe	Zn	SAR
S-1	20.10	7.60	12864	98.50	–	Nil	133.00	40.00	30.00	5.00	4.54	18.97
S-2	14.80	7.90	9472	85.00	–	7.50	99.00	8.40	13.50	36.40	6.96	15.20
S-3	13.80	7.75	8832	76.00	–	7.00	88.00	8.20	09.50	23.00	5.60	13.27
S-4	3.34	7.70	2137	22.00	–	6.00	12.25	4.40	09.00	10.28	5.44	3.78
S-5	3.30	7.46	2112	21.00	1.00	4.50	11.25	2.20	06.00	8.20	3.98	3.39
S-6	2.68	7.40	1715	16.00	1.00	3.00	10.00	1.80	02.50	5.52	3.42	3.53
S-7	12.50	8.01	8000	59.50	1.00	7.00	92.00	2.00	18.50	9.14	3.96	16.88
S-8	3.65	7.80	2336	20.00	–	4.50	17.25	1.50	15.00	8.42	3.94	5.93
S-9	3.44	7.43	2201	18.50	1.00	3.50	17.25	1.50	12.00	7.02	4.54	1.89
S-10	3.33	7.36	2131	17.00	1.00	3.50	13.00	1.00	08.00	4.26	1.40	4.11
S-11	3.30	7.30	2112	16.00	0.80	3.50	12.00	1.00	07.00	4.20	1.30	4.24

Salt affected soils are of three types on the basis of values of sodium absorption ratio (SAR) and electrical conductivity (EC). Types are presented in Table-2.

TABLE-2
SODIUM ABSORPTION RATIO (SAR) AND ELECTRICAL CONDUCTIVITY (EC) VALUES OF SOILS

SAR	EC	Soil type
< 15	< 4	Non-saline; non-alkaline
< 15	> 4	Saline soil
> 15	< 4	Alkaline soil
> 15	> 4	Saline-alkaline soil

It appears that soil near Sursagar has high value of SAR, *i.e.*, 18.97. Hence soil is of saline-alkaline type and not suitable for cultivation. In soil samples of Vallabh Garden only S-2 sample has slightly higher SAR value, *i.e.*, 15.20 and unsuitable for plant growth; in soil samples of Madhosingh Bari, S-7 has higher SAR value, *i.e.*, 16.88 (Table-1).

Total dissolved solids: Total dissolved solids value of soil samples collected from Sursagar was found very high, *i.e.*, 12864 ppm. Samples of Vallabh Garden and Madhosingh Bari show the range of TDS from 1715.2 to 9472 and from 2112.0 to 8000 ppm respectively. These values are very high (Table-1).

Total Hardness: Concentration of Ca^{2+} and mg^{2+} in soil is found to be very high, *i.e.*, 98.5 meq/L near Sursagar, 16.00 to 85.00 meq/L near Vallabh Garden and 16.00 to 59.5 meq/L near Madhosingh Bari, which is unsuitable for optimum growth of plants (Table-1).

Total Alkalinity: Sursagar soil samples show absence of carbonate and bicarbonate ions. Concentration of bicarbonate ions in samples collected from Vallabh Garden and Madhosingh Bari is in the range of 3.0 to 7.50 meq/L and 3.50 to 7.00 meq/L respectively (Table-1).

Sodium: Sodium concentration in soil samples is found to be very high, *i.e.*, 133 meq/L near Sursagar, 10 to 99 meq/L near Vallabh Garden and 12.00 to 92.00 meq/L near Madhosingh Bari (Table-1).

Potassium: Potassium concentration in soil samples is found to be insufficient for optimum growth, *i.e.*, 40 meq/L (40 mg/L) near Sursagar, 1.80 to 8.40 meq/L (1.80–8.40 mg/L) near Vallabh Garden and 1.0 to 2.0 meq/L (1.0–2.0 mg/L) near Madhosingh Bari (Table-1) (for optimal growth potassium concentration is 110–200 ppm).

Chloride: Chloride concentration in soil samples was also found very high, *i.e.*, 30 meq/L, near Sursagar, 2.5 to 13.5 meq/L near Vallabh Garden and 7.0 to 18.5 meq/L near Madhosingh Bari (Table-1). These findings indicate the predominance of sodium and chloride ions in soil samples under investigation.

Iron: Concentration of iron in soil was found to be 5.00 ppm near Sursagar, 5.52 to 36.40 ppm near Vallabh Garden and 4.26 to 9.14 ppm near Madhosingh

Bari (Table-1). Iron concentration is found to be high in Vallabh Garden soil and unsuitable for optimum growth of plant.

Zinc: Concentration of Zn is found to be 3.42 ppm near Sursagar, 3.42 to 6.96 ppm near Vallabh Garden and 1.40 to 3.96 ppm near Madhosingh Bari (Table-1). Zinc concentration is found to be high in the soil of these areas and unsuitable for optimum growth of plants.

Heavy metals are particularly toxic for public health even at extremely low concentration. Accumulation of these heavy metals should not be tolerated.

Characterization of Salinity Hazard

The degree of salinity has been summarized in Table-3 as follows:

TABLE-3

Average EC value (m-mhos/cm)	Degree of salinity
< 3.0	Low
3.00 to 5.00	Medium
5.00 to 10.00	High
> 10.00	Very high

Based on the above categories the relative degree of salinity of soils under investigation can be summarized in Table-4.

TABLE-4

Area	Average EC (m-mhos/cm)	Degree of salinity
Sursagar	20.10	Very High
Vallabh Garden	7.58	High
Madhosingh Bari	5.22	High

It can, therefore, be inferred that these salt-affected soils can be put under the categories of very high and high saline soils. The normal growth of crops under such condition of salt is not possible. The reduction in growth of wheat, gram and fodder maize by high salt contents in soil was observed by various workers in the past. Presence of sodium in soil may also exert a secondary effect on plant growth through adverse physical properties of soil.

Variation in Values of Parameters with Distance

To find out the variation in values of parameters with distance in soil samples we studied two areas:

(i) Vallabh Garden (S-2 to S-6 Samples)

(ii) Madhosingh Bari (S-7 to S-11 Samples)

We collected soil samples at 10 metre distance. The values of iron and zinc in

soil samples decreases with distance. These values are shown in Table-1 and Figs. 1 and 2.

It envisages that the value of soil parameters studied as per Table-5 decreases as distance from Nallah increases. About 10 metre away from Nallah there is steep decrease in the soil parameters.

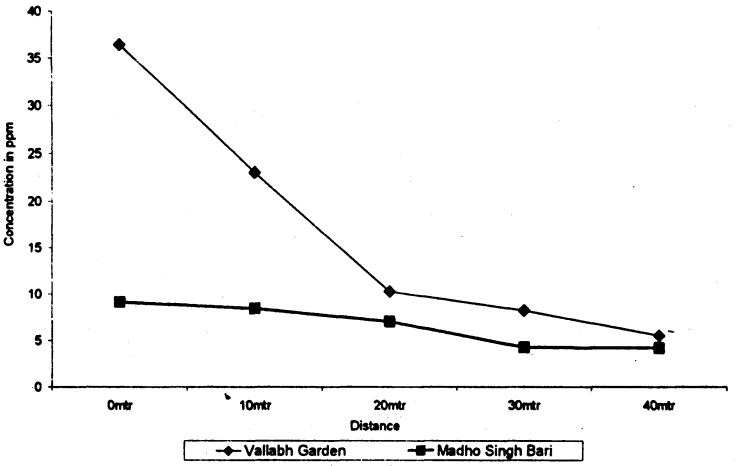

Fig. 1. Variation of Iron Concentration with distance

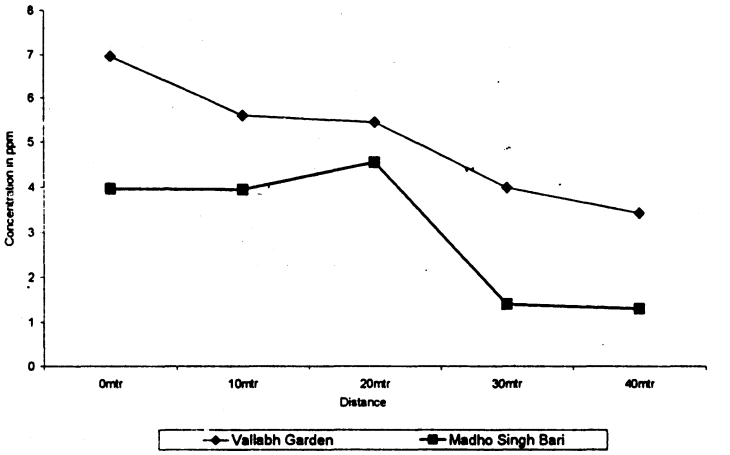

Fig. 2. Variation of Zinc Concentration with distance

As shown in Table-6 the concentration values decrease from Sursagar to Vallabh Garden and further to Madhosingh Bari. However, concentration of heavy metals was found more at Vallabh Garden and Madhosingh Bari than at Sursagar. It appears that it is due to discharge of industrial waste merges into nallah after Sursagar and it further decreases from Vallabh Garden to Madhosingh Bari.

TABLE-5
VARIATION OF SOIL PARAMETERS WITH DISTANCE IN VALLABH GARDEN AND MADHOSINGH BARI

S. No.	Various parameters (Unit)	Concentration with distance from nallah at	
		Vallabh Garden	Madhosingh Bari
1.	pH	decreasing	decreasing
2.	Conductivity (mS)	decreasing (14.8 to 2.68)	decreasing (12.50 to 3.30)
3.	SAR	decreasing (3.53 to 15.20)	decreasing (4.24–16.88)
4.	TDS (ppm)	decreasing (9472 to 1715.20)	decreasing (8000 to 2112)
5.	Sodium (meq/L)	decreasing (99 to 10.00)	decreasing (92.00 to 12.00)
6.	Potassium (meq/L)	decreasing (8.40 to 1.80)	decreasing (2.00 to 1.00)
7.	Ca^{2+} and Mg^{2+} (meq/L)	decreasing (85.00 to 16.00)	decreasing (59.5 to 16.0)
8.	Cl^- (meq/L)	decreasing (13.50 to 2.50)	decreasing (18.50 to 7.00)
9.	CO_3^{2-} (meq/L)	almost constant	almost constant
10.	HCO_3^- (meq/L)	decreasing (7.50 to 3.00)	decreasing (7.00 to 3.50)
11.	Zn (ppm)	decreasing (6.96 to 3.42)	decreasing (3.96 to 1.40)
12.	Fe (ppm)	decreasing (36.40 to 5.52)	decreasing (9.14 to 4.26)

TABLE-6
COMPARISON OF SOIL PARAMETERS OF SURSAGAR, VALLABH GARDEN AND MADHOSINGH BARI

S. No.	Name of parameter (Unit)	Concentration in soil near by nallah as we are moving away from city		
		Sursagar	Vallabh Garden	Madhosingh Bari
1.	pH	7.60	7.901	8.01
2.	Conductivity (mS)	20.10	14.80	12.50
3.	SAR	18.97	3.52–15.20	4.24–16.00
4.	TDS (ppm)	12864	9472	8000
5.	Sodium (meq/L)	133	99	92
6.	Potassium (meq/L)	40	8.40	2.00
7.	Ca^{2+} and Mg^{2+} (meq/L)	98.50	85.00	59.50
8.	Cl^- (meq/L)	30.00	13.50	18.50
9.	CO_3^{2-} (meq/L)	–	1.00	1.00
10.	HCO_3^- (meq/L)	–	7.50	7.00
11.	Zn ppm	4.54	6.96	3.96
12.	Fe ppm	5.0	36.40	9.14

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(*Received*: 20 September 2002; *Accepted*: 26 March 2003) AJC-3020