Ann. Pl. Soil Res 14(1): 5-9 (2012)

SEASONAL VARIATION IN SALINITY, PH AND CONTENTS OF NITRATE, FLUORIDE AND HEAVY METALS IN IRRIGATED SOILS OF ALIPUR BLOCK OF DELHI STATE

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Received: November, 2011

ABSTRACT

A study was carried out to assess the seasonal variation in salinity, pH, nitrate, fluoride and heavy metals concentration in irrigated soils of Alipur block of Delhi State during the year 2007-08. The soil samples were collected from the tube well irrigated fields of 20 selected villages in Alipur block during pre and post-monsoon seasons (May and October, 2007). Results indicated that salinity of soil samples in terms of total soluble salts ($EC_{1:2)}$ was in the range of 0.14 -1.38 and 0.12 -1.05 dS m^{-1} in pre and post monsoon seasons, respectively. Nitrate-nitrogen in soil samples during pre and post-monsoon season ranged from 9.60 to 22.10 mg kg^{-1} and 5.4 to 12.7 mg kg^{-1} with mean value of 14.9 and 9.2 mg kg^{-1} and fluoride concentration ranged from 0.75 to 1.82 mg kg^{-1} and 0.72 to 1.78 mg kg^{-1} with mean values of 1.31 and 1.29 mg kg^{-1}, respectively. The DTPA extractable heavy metals, (Cu, Zn, Cd, Pb) in soil samples ranged from 0.65 to 2.45, 1.22 to 2.89, 0.02 to 0.09 and 0.79 to 1.92 mg kg^{-1}, respectively with mean values of 1.61, 2.11, 0.06 and 1.41 mg kg^{-1} in pre monsoon and 1.39, 1.97, 0.04 and 1.37 mg kg^{-1} in post monsoon season. The lower values of salinity, nitrate, fluoride and heavy metals in irrigated soils during post-monsoon season indicated the effect of rainfall.

Key words: Soil, nitrate, fluoride, heavy metal, Delhi.

INTRODUCTION

Delhi is the largest metropolis after Mumbai in India and located in northern India on the banks of the river Yamuna, Delhi has the political status of a federally-administered union territory known as National Capital Territory (NCT). Delhi's metropolitan area, informally known as the National Capital Region (NCR) comprises of the NCT and the neighbouring satellite towns of Faridabad and Gurgaon in Haryana, Alwar in Rajasthan, Noida and Ghaziabad in Uttar Pradesh, making it the sixth most populous agglomeration in the world. So it is obvious that daily huge amounts of solid, liquid and gaseous wastes are generated from houses, industries, agriculture fields, automobiles etc. Various constituents of these wastes comprises household chemicals e.g. detergents, insecticides residues, human waste and animal waste along with organic chemicals, urban pesticides, inorganic chemicals and heavy metals from industries, pesticides and plant nutrients from agricultural run-off from upstream areas have entered into environment *i.e*. air, soil and water (CPCB 2000). Surface runoff with these organic and inorganic pollutants through numerous drains ultimately ends up in Yamuna river and deteriorated the river water quality. Moreover, due to the over exploitation of the groundwater in adjoining areas of the Yamuna river basin pollutants also enter into the groundwater aquifers along with the river water. So the Yamuna river may be acts source of groundwater pollution. Further, Yamuna water is also directly used for irrigation in some areas, so these pollutants added through irrigation water may pollute the field soil. The farmers of peri-urban areas are also using unbalanced fertilizers and pesticides to promote the intensive agriculture. The indiscriminate use of agro-chemicals like fertilizers and pesticides and irrigation with contaminated water can also pollute the soils of that irrigated areas. It has necessitated undertaking the present study.

MATERIALS AND METHODS

Delhi State is a narrow strip forming a part of Indo-Gangetic plain, situated between $28^0$24`17``N and $28^0$53`00``N latitude and $76^0$50`24``E and $77^0$20`37``E longitude. The National Capital Territory of Delhi covered total geographical area of 1483 km^2. Out of that, 558.32 km^2 comes under rural or peri-urban area and rest 924.68 km^2 is urban area. Administratively, Delhi State is divided into 9

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districts, 27 tehsils and 6 community development blocks namely Najafgarh, Mehrauli, Alipur, Nangloi, Shahdara and main City block. The Alipur block of Delhi State was selected as study area. The area is located in the path of Indian southwest monsoon trough, receives about 80% of the annual rainfall during July to September. The average annual rainfall of the study area is approximately 714 mm and climate is of semi arid type. The monthly mean temperature ranges from 21^0C to 41^0C, while the annual mean temperature recorded is 31.5^0C. The soils of Delhi state are grouped under orders Inceptisols (81.3 %) and Entisols (18.7 %) (Mahapatra *et al.* 2000). These soils are alluvial in origin and influenced by annual rainfall and flooding of Yamuna river due to rains during June to September. National Bureau of Soil survey and Land Use Planning identified 15 soil series named as: Razapur, Kakra, Hamidpur, Holambi, Daryapur, Nabha, Hissar, Ghoga, Khampur, Hiranki, Palla, Wazirabad, Mehrauli, Garhi and Palam (NBSS&LUP 1979) in Delhi state. The cropping pattern in Alipur block was sorghum, bajra and vegetables in *kharif* and wheat, mustard and vegetables in *rabi* seasons. Soil samples from 0-15 cm soil depth were collected at pre and post monsoon period (May and October, 2007) from same irrigated fields. The soil samples were air dried and passed through 2 mm sieve. The sieved samples were used for analysis. The electrical conductivity (EC) of the soil samples was measured in 1:2 soil: water extract by conductivity bridge meter. The pH was also measured in 1:2 (soil: water) suspension by pH meter using glass electrode assembly (Jackson 1973). The nitrate-nitrogen (NO_3^- -N) and fluoride (F^-) concentration in the soil samples were estimated by UV-VIS Spectrophotometer (APHA 1992). The Diethylene triamine penta acetic acid (DTPA) extractable heavy metals such as Cu, Zn, Cd and Pb in the soil samples were estimated by atomic absorption spectrophotometer (Lindsay and Norvell 1978).

RESULTS AND DISCUSSION

The minimum, maximum and mean values of salinity ($EC_{1:2}$) and $pH_{1:2}$, nitrate-nitrogen (NO_3^--N), fluoride (F^-) and heavy metals (Cu, Zn, Cd and Pb) of soil samples at pre and post-monsoon seasons are given in Tables 1 and 2. The physico-chemical characteristics of groundwater in the villages of Alipur block are given in Table 3.

Table 1: The pH, electrical conductivity, nitrate-nitrogen and fluoride concentrations in irrigated soils of selected villages in Alipur block of Delhi State during pre and post monsoon season (May and October, 2007)

S.N.	Name of village	Pre- monsoon (May, 2007)				Post- monsoon (October, 2007)			
		pH (1:2)	$EC_{1:2}$ (dS m^{-1})	NO_3^--N (mg kg^{-1})	F^- (mg kg^{-1})	pH (1:2)	$EC_{1:2}$ (dS m^{-1})	NO_3^--N (mg kg^{-1})	F^- (mg kg^{-1})
1.	Holambi kalan	7.65	0.32	18.4	0.91	7.56	0.26	12.2	0.88
2.	Kheda khurd	7.55	0.46	19.7	1.77	7.45	0.38	11.4	1.75
3.	Barwala	8.96	0.38	19.8	0.75	8.24	0.29	11.4	0.72
4.	Burari	7.96	0.14	16.2	0.88	7.84	0.12	9.7	0.85
5.	Hiranki	8.24	1.05	15.9	0.76	8.01	0.84	9.8	0.75
6.	Bankoli	7.55	0.36	11.8	1.08	7.42	0.28	8.8	1.06
7.	Bakatawarpur	7.76	1.14	9.8	0.88	7.66	1.02	5.4	0.85
8.	Alipur	8.08	1.38	22.1	1.68	8.00	1.05	12.7	1.65
9.	Palla	8.25	0.46	9.6	0.96	8.12	0.34	5.5	0.97
10.	Akbarpur majra	7.58	0.84	11.6	0.98	7.48	0.74	6.4	0.95
11.	Kosak	8.22	1.06	13.8	1.48	8.11	0.89	7.8	1.45
12.	Mohd. Ramjanpur	8.15	1.18	12.6	1.44	8.06	0.98	7.9	1.42
13.	Tajpur	7.96	0.65	12.1	1.41	7.78	0.54	8.4	1.40
14.	Jagatpur	7.65	0.45	11.8	1.82	7.46	0.33	8.7	1.78
15.	Jaroda	8.24	0.31	13.5	1.51	8.22	0.22	7.6	1.51
16.	Shamapur	7.68	0.46	11.6	1.72	7.56	0.35	7.8	1.68
17.	Akshardham	7.55	0.78	12.1	1.52	7.52	0.54	8.5	1.51
18	Wazirabad	8.14	0.52	19.6	1.65	8.11	0.42	11.9	1.61
19.	Bijapur	7.88	0.86	17.8	1.48	7.68	0.71	10.7	1.47
20.	Nanglapoon	8.29	0.78	16.1	1.55	8.15	0.65	10.8	1.52
	Minimum	**7.55**	**0.14**	**9.6**	**0.75**	**7.42**	**0.12**	**5.4**	**0.72**
	Maximum	**8.96**	**1.38**	**22.1**	**1.82**	**8.24**	**1.05**	**12.7**	**1.78**
	Mean	**7.99**	**0.69**	**14.9**	**1.31**	**7.82**	**0.55**	**9.2**	**1.29**

pH and salinity (EC1:2): The pH of soil samples varied from 7.55 to 8.96 at Kheda khurd and Barwala village, respectively with a mean value of 7.99 in pre-monsoon and 7.82 in post-monsoon season. The pH was slightly decreased during post-monsoon season possibly due to influx of rainwater of lower alkalinity. As far as soil salinity ($EC_{1:2}$) is concerned, it was observed that soils of Alipur block were quite variable from village to village and $EC_{1:2}$ ranged from 0.14 dS m^{-1} to 1.38 dS m^{-1} at Burari and Alipur village, respectively with a mean value of 0.69 dS m^{-1} in pre-monsoon and 0.55 dS m^{-1} in post-monsoon season. The higher salinity in the soil samples may primarily be attributed to the application of poor quality water for irrigation. The decreased salinity (EC) in all the soil samples collected during post monsoon season may be due to leaching/flushing of salts either below the soil surface (0-15 cm) or out of field by runoff during rains. Paliwal and Yadav (1976) also reported considerable improvement in groundwater quality of Delhi state during post monsoon period.

Nitrate Content: NO_3^--N concentration in soil samples ranged from 9.60 to 22.10 mg kg^{-1} in Palla and Alipur villages, respectively with a mean value of 14.90 mg kg^{-1} in pre-monsoon and 9.20 mg kg^{-1} in post-monsoon season. The higher NO_3^--N concentration in soil samples may be due to irrigation with nitrate rich water. The decreased concentration of NO_3^--N in soil during post monsoon season may be attributed to leaching of nitrate below the soil surface (0-15 cm) by rain water. The spatial variation in nitrate-nitrogen content in groundwater and soils may be due to different degrees of evaporation/recharge, amount of fertilizer applied, anthropogenic activities and adsorption/desorption processes in the soil system (Datta *et al*. 1996, 1997). The seasonal variation in nitrate content may be due to the combined effect of recharge processes, nature of vegetation cover, microbial reactions and activities of man (Datta *et al*. 1996). The higher level of NO_3^--N in soils may also be due to application of N fertilizers in excess to crop requirements by the farmers and may be due to presence of high amount of nitrate in groundwater used for irrigation (Singh *et al*. 1987). Due to high rate of N fertilizer application in Punjab, an increase in NO_3-N was reported from 0.04 to 6.15 mg L^{-1} in 1975 and 0.31 to 13.3 mg L^{-1} in 1988 in shallow well waters by Singh *et al*. (1995). Based on groundwater NO_3-N analysis of 236 samples of Punjab State, Bajwa *et al*. (1993) observed that 17 % of samples containing >5 mg L^{-1} NO_3-N were from tubewells located in vegetables growing areas as compared to only 3 % of samples from region where rice-wheat rotation was practiced. The nitrate levels in Delhi groundwater ranged from <1 to 135 mg L^{-1} and large part of the area to the south-west, having very little recharge from rainfall is severely affected by nitrate pollution of groundwater (Datta *et al*. 1997).

Table 2: Heavy metals concentration (mg kg^{-1}) in irrigated soils of selected villages in Alipur block of Delhi State during pre and post-monsoon season (May and October, 2007)

Name of village	Pre monsoon (May, 2007)				Post monsoon (October, 2007)			
	Cu	Zn	Cd	Pb	Cu	Zn	Cd	Pb
Holambi kalan	1.18	1.92	0.04	1.24	1.12	1.78	0.02	1.22
Kheda khurd	0.96	1.22	0.07	1.53	0.78	1.14	0.04	1.48
Barwala	2.24	1.68	0.09	1.75	2.12	1.56	0.06	1.72
Burari	2.21	2.68	0.02	1.64	2.11	2.54	0.02	1.61
Hiranki	1.68	2.06	0.08	1.36	1.54	1.98	0.05	1.32
Bankoli	1.42	2.15	0.06	1.28	1.36	2.05	0.04	1.22
Bakatawarpur	2.37	1.98	0.08	0.85	2.26	1.65	0.06	0.81
Alipur	2.45	2.89	0.04	0.79	2.35	2.72	0.03	0.75
Palla	2.41	2.78	0.07	1.92	2.28	2.65	0.05	1.84
Akbarpur majra	0.65	1.65	0.08	1.36	0.45	1.46	0.06	1.32
Kosak	0.87	1.57	0.09	1.37	0.77	1.48	0.05	1.35
Mohd. Ramjanpur	1.15	1.98	0.04	1.28	0.88	1.82	0.04	1.21
Tajpur	0.88	1.86	0.06	1.64	0.64	1.75	0.05	1.65
Jagatpur	2.44	2.88	0.02	1.46	2.37	2.65	0.02	1.42
Jaroda	1.58	1.65	0.05	1.54	0.46	1.51	0.04	1.49
Shamapur	1.18	1.86	0.07	1.17	1.12	1.74	0.06	1.11
Akshardham temple	0.98	1.95	0.04	1.64	0.88	1.82	0.04	1.58
Wazirabad	2.34	2.87	0.08	1.86	2.28	2.76	0.05	1.82
Bijapur	1.72	2.46	0.03	1.35	1.67	2.31	0.03	1.32
Nanglapoon	1.56	2.24	0.05	1.33	1.45	2.15	0.04	1.29
Minimum	**0.65**	**1.22**	**0.02**	**0.79**	**0.64**	**1.14**	**0.02**	**0.75**
Maximum	**2.45**	**2.89**	**0.09**	**1.92**	**2.37**	**2.76**	**0.06**	**1.84**
Mean	**1.61**	**2.11**	**0.06**	**1.41**	**1.39**	**1.97**	**0.04**	**1.37**

Fluoride Content: Fluoride concentration in soil samples was also quite variable from village to village. It was maximum (1.82 mg kg^{-1}) in Jagatpur and minimum (0.75 mg kg^{-1}) in Barwala village with a mean value of 1.31 mg kg^{-1} in pre monsoon and 1.29 mg kg^{-1} in post-monsoon season.Wide variation in fluoride concentration in the soils suggests possible contribution from both point as well as non point sources. Although there is no firm evidence yet, brick kilns appear to be a major point source for very high level of fluoride in groundwater as well as irrigated soils. The higher values of fluoride in irrigated soils may be due natural presence of fluoride in the soils or irrigation with nitrate rich groundwater. Singh and Dass (1993) have reported very high fluoride contents (1.5-13.0 mg L^{-1}) in the groundwaters of areas surrounding Delhi. Datta *et al*. (1996a) also reported that very high fluoride (3-16 mg L^{-1}) groundwater occurred mostly in the northern, western and southwestern parts of the area in Najafgarh block, Nangloi block and Alipur block. Thus, it is evident that a quite significant part of groundwater in rural Delhi is affected by fluoride contamination that too beyond the permissible limit. The post monsoon soil sample had lower values of fluoride because of leaching of fluoride to lower layers by rain water.

Table 3: Physico-chemical characteristics of groundwater of the study area

Parameter	Minimum	Maximum	Mean
pH	7.58	8.12	7.78
Electrical conductivity (dS/m)	0.46	5.89	2.89
Calcium (as Ca^{2+}), me L^{-1}	0.36	13.01	4.35
Magnesium (as Mg^{2+}), me L^{-1}	1.09	15.32	7.17
Sodium (as Na^{+}), me L^{-1}	0.27	44.19	15.44
Potassium (as K^{+}), me L^{-1}	0.04	0.58	0.23
Bicarbonates (as HCO_3^{-}), me L^{-1}	3.58	12.1	7.40
Carbonates (CO_3^{2-}), me L^{-1}	ND	ND	ND
Chlorides (as Cl^{-}), me L^{-1}	0.57	33.37	10.64
Sulfates (as SO_4^{2-}), me L^{-1}	0.05	10.43	3.50
Nitrates (as NO_3^{-}-N), mg L^{-1}	0.90	11.80	3.81
Fluoride (as F^{-}), mg L^{-1}	0.14	4.19	1.52
Copper (Cu), mg L^{-1}	0.00	0.21	0.11
Zinc (Zn), mg L^{-1}	0.54	1.18	0.91
Cadmium (Cd), mg L^{-1}	ND	ND	ND
Lead (Pb), mg L^{-1}	ND	ND	ND

Heavy Metals Content: The DTPA extractable heavy metals, Cu, Zn, Cd, Pb ranged from 0.65 to 2.45, 1.22 to 2.89, 0.02 to 0.09 and 0.79 to 1.92 mg kg^{-1}, respectively with mean values of 1.61, 2.11, 0.06 and 1.41 mg kg^{-1} in pre monsoon and 1.39, 1.67, 0.04 and 1.37 mg kg^{-1} in post monsoon season. The maximum concentration of Cu, Zn, Cd and Pb was found in the soil samples of Alipur, Burari and Palla villages, respectively. All the irrigated soil samples were well supplied with Cu and Zn as their levels were generally higher than their critical deficiency levels of 0.2-0.5 and 0.6 mg kg^{-1} (Rattan *et al*., 2005), respectively. The higher concentration of heavy metals in irrigated soils may be due to practice of intensive farming or long term use of heavy metals contaminated water for irrigation. The intensive farming on peri-urban lands leads to contaminate the soils and crops with pollutants including heavy metals such as copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), lead (Pb), cadmium (Cd), nickel (Ni) and mercury (Hg) by different sources (Smit 1996). This loading of heavy metals often leads to degradation of soil health and contamination of food chain mainly through the vegetables grown on such soils (Rattan *et al*. 2002). The long-term use of heavy metals contaminated water on agricultural lands often results in the build- up of the elevated levels of these metals in soils (Rattan et al., 2002). Extent of build-up of metals in contaminated water- irrigated soils depends on the period of its application (Bansal *et al*. 1992). The crops raised on the metals contaminated soils accumulate metals in quantities excessive enough to cause clinical problems both to animals and human beings consuming these metals rich plants (Tiller, 1986). Metals such as Pb, Cd, Cr, As and Ni are often cited as primary contaminants of concern, but Zn and Cu may also be problematic at some sites. These latter two metals, which are also micronutrients, can be toxic to plants if the concentration of available metal in the growth media is very high.

Conclusions

The seasonal variation in terms of salinity, pH and content of nitrate, fluoride and heavy metals was found in the soils of almost all the villages of Alipur block. The salinity and pH of the soils were found almost safe for crop production. The irrigated soils of the block were not much contaminated with nitrate, fluoride and heavy metals.

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