

Bio-Chemical Characterization of Ground Water of IARI Farm

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ABSTRACT

Groundwater samples of IARI New Delhi campus collected from tube wells, hand-pumps and drains during Feb - March, 2001 were analysed for different water quality indices including BOD. Based on total salt content in terms of electrical conductivity (dSm^{-1}), more than 80% samples were rated as good or safe for irrigation purpose and only 14% samples fell in slightly poor category. Characterization of samples into sodicity hazard (RSC) indicated that more than 30% samples fell into unsafe category ($\text{RSC} > 2.5 \text{ meL}^{-1}$). However, there was slight sodicity hazard in water samples in terms of sodium adsorption ratio (SAR). Nitrate content was more than 10.0 mg L^{-1} particularly in low lying drainage basin (rice area) of the watershed. A water quality map of Institute campus was also prepared. Bio-degradable organic pollutant was more in Yamuna canal than that in sewage of the Institutional area. Monitoring of ground water quality for chemical parameters during last decade revealed little variation in different water quality indices.

Key words: Water Quality, Electrical conductivity, Residual sodium carbonate, Nitrate, BOD

Introduction

Quality of water resource plays an important role for their judicious and appropriate utilization. Presence of soluble salts and the relative dominance of cations and anions in irrigation water affect the growth and yield of crops and physico-chemical characteristics of the irrigated soil. However, magnitude of the adverse effect also depends upon the alkalinity and contents of some specific toxic constituents in the water. Detailed chemical analysis of the water samples is, therefore, essential for the precise appraisal of the constraints and to evolve the remedial strategy accordingly. Generally, quality of underground water resources is often poor and impregnated with varying levels of salinity and alkalinity as compared to surface or river/canal water. Keeping this in view, an appraisal of water resources (tube wells/ sewage drain/canal) of IARI Farm for chemical constituents was carried out during the months of Feb.- March 2001.

Materials and Methods

Indian Agricultural Research Institute is situated between $28^{\circ}37' - 28^{\circ}37' \text{ N}$ latitude and $77^{\circ}9' - 77^{\circ}11' \text{ E}$ longitude covering an area of about 475 hectares. On east side Arawali range indicates the highest point while on western side natural drain forms the last western boundary of the farm. Soil of the

research farm is alluvial in origin and sandy loam in texture (Typic mixed hypothermic ustocrept). Watertable in the farm area is about 5-7 meters.

Twenty two water samples in duplicate were collected from tubewells in clean pre-rinsed 100 ml plastic bottles. Tubewells were allowed to run for one hour before collecting the samples. Sample of sewage drain and Yamuna Canal was also collected. 2-3 drops of toluene were added in each bottle to prevent microbial growth. Samples were analyzed for total salt (EC dSm^{-1}), cations (Ca , Mg , Na , K) and anions ($\text{CO}_3 + \text{HCO}_3^-$) and NO_3^- (Richards, 1954). BOD of the samples was determined (Yadav and Khera, 1993). Water quality indices of Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) were also worked out (Ayers and Westcot, 1985).

Results and Discussion

Bio-chemical analysis of tubewells including drain and canal samples for total salt (EC dSm^{-1}), cations, anions and BOD is given in Table 1 and overall quality rating based on EC dSm^{-1} and RSC is given in Table 2. It is evident that the values of electrical conductivity (EC dSm^{-1}) ranged from 0.88 (agronomy division) to 2.61 (microbiology division) indicating safe to moderate quality and suitability rating for irrigation purposes. Tubewells located

Table 1. Chemical Analysis of IARI Tubewells, Yamuna canal, and Sewage drain samples during Feb.-March, 2001

Sr.No	Location	E.C dSm ⁻¹	Na ⁺ meL ⁻¹	K ⁺ meL ⁻¹	Mg ²⁺ meL ⁻¹	Ca ²⁺ meL ⁻¹	CO ₃ ²⁻ + HCO ₃ ⁻ meL ⁻¹	NO ₃ ⁻ meL ⁻¹	BOD meL ⁻¹
1	T.W. Scientists apartment	1.38	11.0	0.04	3.5	1.5	7.5	35	1.2
2	Todapur (grapes garden) T.W.-16	1.61	13.0	0.09	2.5	2.5	7.6	5.0	1.5
3i.	Loha Mandi T.W.	1.08	10.0	0.06	4.0	1.0	11.5	68.5	1.6
4ii.	-do-	1.12	11.0	0.27	0.5	2.0	-	25.8	1.5
5iii.	-do-	1.28	11.0	0.14	1.0	1.5	-	54.1	1.4
6	T.W.MB-17	1.48	7.0	0.54	7.0	2.5	5.5	57.8	1.5
7	T.W. No.7	1.38	6.0	0.69	7.0	2.0	7.5	32.1	1.6
8	T.W. Indo-Israel	0.94	8.0	5.51	8.5	2.5	7.5	5.6	1.4
9	Floriculture T.W.	1.20	5.0	0.59	7.6	1.5	6.5	29.4	1.3
10	T.W. No.6	0.98	8.0	3.14	3.5	1.5	7.5	9.6	1.4
11	Botany Block T.W.	1.30	8.0	1.30	1.5	3.0	5.5	32.2	1.3
12	T.W. No.8	1.34	7.8	0.07	4.0	2.0	5.5	33.8	1.3
13	MB-2 T.W.	2.60	17.5	1.54	9.0	3.5	8.5	30.1	1.5
14	T.W. SPU	1.47	12.0	0.20	3.0	1.5	8.5	6.6	1.4
15	T.W. WTC	1.45	9.0	0.04	5.5	2.0	4.5	21.3	1.3
16	T.W. No.1 SP Unit	1.47	11.5	0.14	2.0	2.0	9.5	35.3	1.5
17	Agronomy pump	0.88	7.5	0.04	2.5	1.0	8.5	23.00	1.6
18	T.W. 2 Old Kisan Mela	2.42	16.5	3.77	8.5	3.0	7.5	14.4	1.3
19	T.W. Microbiology MB I	2.61	17.0	1.62	7.5	5.5	6.5	11.5	1.4
20	T.W. rice field MB 14	1.00	5.0	0.29	4.0	2.0	8.5	26.1	1.5
21	Y.E. MB 8	1.45	7.5	0.06	6.0	2.0	7.5	26.4	1.6
22	T.W. Pusa School	1.59	10.0	0.03	3.5	4.0	5.5	11.9	1.2
23	Sewage Drain	1.20	9.0	0.03	4.	2.5	5.8	4.5	66.4
24.	Yamuna canal	1.28	10.2	0.08	5.8	2.3	6.4	3.6	83.7

near the *Kisan Mela* ground and microbiology division have the salinity in terms of EC more than 2.0. Salinity status of the tubewells as EC dSm⁻¹ located in the area adjoining seed production unit, residential parts (B, D and E type residences) and genetics division varied from 1.0 to 2.0 dSm⁻¹. Good quality groundwater with EC < 1.0 dSm⁻¹ was

found near the agronomy division and the rice block. Concentration of sodium, calcium, magnesium and potassium also varied in different tubewells of the IARI campus. Average sodium concentration in low, low to moderate and moderate saline water was 6.5, 10.5 and 16.5 me/l, respectively. Similarly, average concentration of calcium + magnesium in

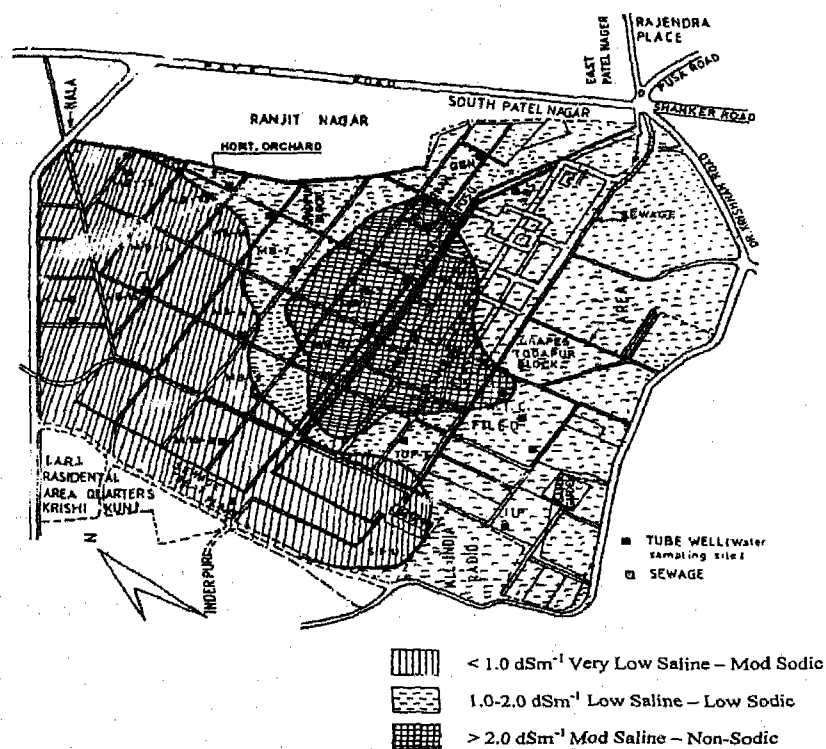
Table 2. Quality Rating of IARI Groundwater

S.No.	EC (dSm^{-1})	RSC (me L^{-1})	Rating Class
1	< 1.0	> 4.38	V. Low Saline and Moderate Sodic
2	1.0 - 2.0	3.8	Low Saline and Low Sodic
3	> 2.0	< 1.5	Moderate Saline and Non Sodic

low, low to moderate and moderate saline waters were 1.5, 8.5 and 12.5 me/l , respectively. However, potassium content did not follow the sodium and calcium trends as well as that of electrical conductivity of the samples. High K content of 5.5 me/l was found in the tubewell water of Indo-Israel project and lowest content of 0.3 me/l was found in tubewell samples of residential areas located near Pusa Sr. Secondary School and Scientists apartments. Concentration of carbonate and

bicarbonates exhibited reverse trend. Low salinity waters ($\text{EC} < 1.0 \text{dSm}^{-1}$) contained about 8.7 me L^{-1} of $\text{CO}_3 + \text{HCO}_3$ while those of moderate salinity ($\text{EC} > 2.0 \text{dSm}^{-1}$) had it to the tune of 6.5 to 7.0 me L^{-1} . Therefore, sodicity hazard in terms of RSC was of moderate intensity with its value of 4.38 me L^{-1} (Table 2) in very low saline waters and there was no sodicity hazard in tubewell waters having moderate level of salinity ($\text{EC} > 2.0 \text{dSm}^{-1}$). Similar trend of sodicity variation with respect to total salt concentration has also been reported by Paliwal and Yadav (1976). Alkali hazard of the waters in terms of sodium adsorption ratio (SAR) was also evaluated and most the samples had the value of $\text{SAR} < 10.0$ except one or two and so there was negligible alkalinity hazard in groundwater of Institute Farm.

Nitrate content varied in the different samples of the farm. It ranged from 5.0 mg L^{-1} in T.W - 16 (grape garden-Sindhu Guest House) to 68.5 mg L^{-1} in tubewells of *Loha mandi* area. In other words nitrate content exhibited higher values in lowest part of the farm. It may possibly be due to leaching of NO_3^- from experimental fields of middle block and

**Fig. 1. Water quality map of IARI farm**

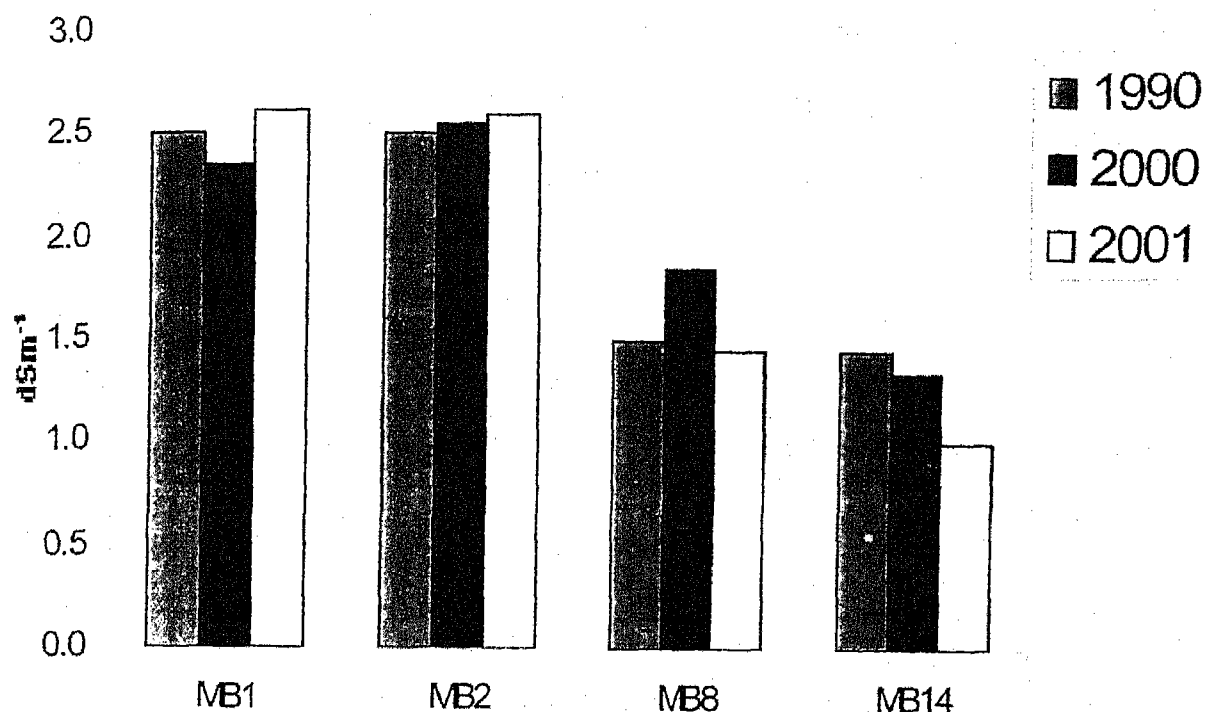


Fig. 2. Changes in salt concentration (EC dSm⁻¹) in Groundwater of IARI Farm

finally its gradual movement towards the lower portion of the *Loha mandi* area. Higher NO₃⁻ content in IARI groundwater has also been reported by Dutta (2003). Bio-chemical Oxygen Demand (BOD) of groundwater, Yamuna canal and sewage drain was 1.6, 83.7 and 66.4 mgL⁻¹. It clearly indicate higher load of organic pollutant in Yamuna canal as compared to sewage of the neighbouring colonies of the Institute.

Based on the salinity and sodicity hazard of the ground water, the farm area of the Institute has been categorized into three water quality zones (Fig. 1). These are as very low saline - low to moderate sodic; low saline - low sodic and moderate saline - non sodic. Organic pollutants in terms of BOD were more in Yamuna canal water as compared to that in the sewage. It also indicates that pretreatment including its oxidation and sedimentation in ponds is essential before using for irrigation.

Variation in total salt content in terms of electrical conductivity of four tubewells samples located in blocks of MB-1, MB-2, MB-8 and MB-14 of IARI Farm during 1990, 2000 and 2001 has

been depicted in Fig. 2. It is clear that the salt content in terms of electrical conductivity (EC_{iw} dSm⁻¹) in groundwater of rice block (MB-14) exhibited gradual decrease from 1.5 dSm⁻¹ (1990) to 1.00 dSm⁻¹ (2001) during the last twelve years. However, there was no appreciable change in salt content of the tubewells studied during the last twelve years.

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