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ASSESSMENT OF GROUNDWATER QUALITY FOR IRRIGATION IN BARWALA BLOCK OF HISAR DISTRICT OF HARYANA

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ABSTRACT

An investigation to determine the quality of underground irrigation waters of Barwala Block of Hisar District in Haryana was undertaken. On the basis of EC, SAR and RSC values of the waters 54.2, 11.7, 13.3, 10.1, 5.3, 2.4 and 1.2% in saline, high SAR saline, marginally saline, good, high alkali, alkali and marginally alkali classes, respectively. The data also revealed that 66.9% waters had EC values above 4 dS/m and 22.1% had EC values above 10 dS/m.The waters are sodium-magnesium-calcium type dominated by chloride. Another interesting feature of these waters is the predominance of magnesium over calcium. Carbonate is either absent or is very little and the concentration of bicarbonates ions did not vary much in all the ranges.

INTRODUCTION

Rapid depletion of available irrigation water supplies has been reported in many areas of the world. In developing countries of South-Asian region including India, scarce water availability is a genuine concern, keeping in mind the increased demand of irrigation water, domestic and industrial needs due to higher demographic pressure. Presently, agriculture is the major user (89%) of the India's water resources but the estimates show that the growing demands from municipalities, industry and energy generation will claim about 22% (24.3 m ha-m/year) of the total water resources (105 m ha-m/year) by the year 2025 AD (Minhas and Tyagi, 1998). A major portion (59%) of the total irrigated acreage (40% of the cultivated land) in the country is receiving water from minor schemes involving ground water development (Ministry of Water Re-sources, 1987).

In Haryana state, out of the total cultivated area of 3.4 million ha, canal irrigated area is only 66 %, whereas, the rest of the area is dependent either on rainfall or upon wells/tubewells, the latter are mostly of doubtful quality. In the past attempts have been made to establish water quality zones of Haryana state (Manchanda, 1976), but due to less exploitation of underground water for irrigation and consequently rise in water table @ 9.28 cm/year (Manchanda, 1998) in western part of the state (Hisar, Fatehabad and Sirsa) led to change in water quality. Therefore, a reappraisal on nature, properties and extent of underground water quality is essential for sound irrigation planning. Hence, a location specific investigation was carried out to study the under-ground water quality and ionic composition of Barwala block of Hisar district.

MATERIAL AND METHODS

The survey and characterization of underground irrigation water of Barwala block of Hisar district was undertaken during 2000-2001. The district constitutes the western most extremity of Haryana and lies between 28^0 59′ South to 30^0 North latitude and 74^0 32′ West to 76^0 18′ East longi-tude. Geologically, it is a part of Indo-gangetic alluvial plain, mostly laid down by Indus system tributaries and other non-existent rivers of pluvial age. The soils of Barwala block are mostly sandy loam/fine sandy loam in the surface, but loam down below. They are calcareous throughout the profile with enrichment of calcium carbonates at lower depths and are well drained. At some places, there are thick deposits of aeolian sand also. According to 7th approximation, most of the soils are coarse loamy, calcareous, Typic Camborthids / Calciorthids and Typic

Torripsamments. A variety of crops like cotton, pearlmillet, sorghum and vegetables are grown in *kharif*. The major rabi crops are wheat, mustard, berseem, sugarcane, vegetables etc. These crops are irrigated with canal and tubewell water.

The study is based on 661 water samples collected from Barwala block. The samples were analyzed for pH, EC, CO_3^{-2}, HCO_3^-, Cl^-, Ca^{+2}, Mg^{+2} and Na^+ according to methods as described by Richards (1954). Residual sodium carbonate (RSC) and sodium adsorption ratio (SAR) were calculated using the formulae given by Eaton (1950) and Richards (1954), respectively. Water samples were categorized on the basis of EC, SAR and RSC values as suggested by Gupta *et al.* (1994).

RESULTS AND DISCUSSION

The range of different water quality parameters of Barwala block is presented in Table 1. EC values ranged from 0.3 to 28.5 dS/m in Barwala block. The highest EC (28.5 dS/m) of water was recorded in Rajli village of the block. The RSC values ranged from 0.3-39.1 meq/l. Manchanda (1976) also reported water samples dominated by RSC in Hisar district. The SAR ranged from 0.15 to 20.0 $(mmol/l)^{1/2}$ in Barwala block and the highest SAR $\{(20.0\ (mmol/l)^{1/2}\}$ was observed in Kumbhakhera village of the block.

Similar results in respect of SAR (0.36- 26.31) were reported by Singh and Bhumbla (1968) in the 73 well water samples from Hisar district. In cations, Na^{+1}, Ca^{+2} and Mg^{+2} were present in appreciable amounts whereas, the Cl^{-1} (0.3-268 meq/l) and HCO_3^{-1} (1.6-26.5 meq/l) were the dominant anions in the groundwater samples and CO_3^{-2} (nil-4.2) was recorded in traces except few samples. The results indicated that underground irrigation waters of this region are saline dominated by chlorides. Earlier studies made by Manchanda (1976) also reported chloride dominated waters in this region.

The per cent samples in various quality classes according to AICRP classification (Gupta *et al.*, 1994) based on parameters EC, SAR and RSC is presented in Table 2. It is revealed that a lion's shares of samples in Barwala block are classified in saline (54.2%) category. The per cent samples in other classes are 11.7, 13.3, 10.1, 5.3, 2.4 and 1.2% in high SAR saline, marginally saline, good, high alkali, alkali and marginally alkali classes, respectively. However, 1.8% samples did not fall in any of the categories. Minhas *et al.* (1998) reported on the basis of the surveys conducted under the project AICRP on use of saline water that 32-84% of running wells in India are rated to be of poor quality. However, Manchanda (1976) reported 60-64% samples of this region lying in saline and saline sodic quality classes.

The average chemical composition and related quality parameters in different EC classes for Barwala block are given in Table 3. The data revealed that 66.9% of the samples recorded EC values above 4 dS/m and 22.1% had EC values above 10 dS/m. The average SAR ranged from 3.33 to 8.35 $(m\ mol/l)^{1/2}$. The average RSC values varied in the range of 0-5.11 meq/l. The concentration of Na^+, Ca^{+2}, Mg^{+2} and Cl^- ions generally increased with increase in EC of the water samples whereas CO^{3-2}, HCO_3^-, RSC and SAR did not have any relationship with the EC of the water (Table 3). The highest Na^+ concentration 46.2 me/l was observed in EC class >10 dS/m. Concentration of Ca^{+2} ions remained lower than those of Na^+ (except 7-8 and 8-9 EC values) and Mg^{+2} ions. Chloride was the dominant anion over HCO_3^- and CO_3^{-2}. The average concentration of HCO_3^- ranged from 5.14 to 11.39 meq/l in different EC classes. Carbonates were negligible/in traces over different range of EC. The concentration of chloride increased with the increase in EC of

Table 1. Salient features of groundwater samples of Barwala block

S.No.	Parameters	Range
1	EC (dS/m)	0.3-28.5
2	SAR $(mmol/l)^{1/2}$	0.15-20.0
3	RSC (meq/l)	0.3-39.1
4	Na (meq/l)	0- 128.0
5	Ca (meq/l)	0.2 - 80.2
6	Mg (meq/l)	0.4-141
7	CO_3 (meq/l)	0-4.2
8	HCO_3 (meq/l)	1.6-26.5
9.	Cl (meq/l)	0.3-268.0

Table 2. Frequency distribution of water samples of Barwala block in various categories

Quality parameters			Quality	Category	Per cent
EC	RSC	SAR			
<2	<2.5	<10	Good	A	10.1
2-4	<2.5	<10	Marginally saline	B_1	13.3
>4	<2.5	<10	Saline	B_2	54.2
>4	<2.5	>10	High SAR saline	B_3	11.7
<2	2.5-4.0	< 10	Marginally alkali	C_1	1.2
<2	>4.0	< 10	Alkali	C_2	2.4
Variable	>4.0	> 10	High alkali	C_3	5.3
			Unclassified		1.8

Table 3. Average chemical composition of groundwater samples of Barwala block in different EC classes

EC classes (dS/m)	No. of samples	Na	Ca	Mg	CO_3 (meq/l)	HCO_3	Cl	RSC	SAR $(mmol/l)^{1/2}$
0-1	34	4.06	1.97	2.12	0.08	5.14	1.43	3.91	3.33
1-2	68	7.86	3.45	8.04	0.8	7.98	10.93	2.58	5.12
2-3	57	12.22	3.97	5.18	0.36	11.39	7.18	5.11	8.03
3-4	60	13.76	8.59	10.38	0.14	11.26	13.94	4.68	8.35
4-5	75	16.75	10.42	15.68	0.04	9.84	22.94	1.17	6.47
5-6	76	17.77	14.20	20.10	0.09	8.95	31.45	0.62	5.48
6-7	52	25.04	10.99	20.99	0.2	9.97	31.62	0.57	7.41
7-8	41	15.47	19.60	36.58	0.2	7.73	53.09	-	3.16
8-9	36	17.53	22.99	36.67	0.11	6.05	59.11	0.42	3.39
9-10	16	28.75	25.30	41.03	-	7.3	73.23	-	5.36
>10	146	46.20	34.53	75.00	-	6.65	151.62	-	6.8

the water samples (Table 3). Regarding individual ionic composition, highly saline waters are dominated by sodium and chloride ions. Another important feature of these waters is the predominance of magnesium over calcium. In these waters carbonate is either absent or is very little and the concentration of bicarbonates ions varied in a narrow range. Paliwal (1972) also reported similar results in Rajasthan well waters.

It is concluded from this study that the underground irrigation water of Barwala block is Na-Mg-Ca type dominated by chloride. The brackish waters are saline in nature. Good quality and marginally saline waters can be successfully used for crop production without any hazardous effect on soil and plant. The waters rated as saline and high SAR saline are unfit for irrigation. Their indiscriminate use will cause secondary salinization and

sodification of soil resulting in serious effect on crop growth. But in emergency these waters can be used with special management practices depending upon the rainfall, crop to be grown and soil type. The continuous use of poor quality irrigation water may not only cause calcium deficiency but also create poor soil physical condition, as both sodium and magnesium damage the soil structure by their highly dispersive action. The degree of adverse effect of magnesium and the possibility of its precipitation (as magnesium carbonate due to presence of bicarbonate) would depend on the actual proportion of Na : Mg : Ca in the soil solution near the root zone and the climatic condition.

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