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Characterization of Irrigation Quality of Ground Water in Union Council Gakhra Kalan, District Gujrat (Pakistan)

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ABSTRACT

This study was carried out to provide guidelines to farmers and researchers for better crop production by adopting water management practices. A total of 52 water samples from tube wells (depth 60±5 feet) of 13 villages were collected, analysed and classified for electrical conductivity (EC), sodium adsorption ratio (SAR), residual sodium carbonate (RSC) during the years September, 2002 to August, 2003. Out of 52 water samples of villages of union council Gakhra Kalan, only 4 (7%) were fit, 17(33%) marginally fit and the rest 31(60%) unfit. Water samples of villages, Chak Wassan 0,25,75, Dewan Kot 0,0,100, Gakhra Kalan 25,0,75, Gakhra Khurd 0,25,75,Jamobola 25,0,75, Kang Chanan 0,100,0, Kang Sehari 25,75,0, Keeranwala 0,50,50, Khanwali 0,0,100, Kot Kana 25,75,0, Nawan Lok 0,0,100, Nawan Lok Noshera 0,50,50 and Ruppoki 0, 25, 75% were fit, marginally fit and unfit, respectively. Further, most of the unfit water samples are unfit due to higher EC followed by RSC and EC+RSC. Almost all the area has highly saline water, which is affecting yield of various crops.

Key Words: EC; SAR; RSC; Ground water; Gujrat; Pakistan

INTRODUCTION

Agriculture is the backbone of Pakistan, employing 54% of the labour force, accounting for 26% of GDP (Anonymous, 2002) and contributing to the export earning considerably. Pakistan has the largest irrigation system in the world. The largest continuous gravity flow canal system for irrigation carrying 82 MAF canal water (Anonymous, 2002) is falling short for crops due to increase cropping intensity and non-agriculture demands over the years (Mohtadullah *et al*., 1993). Most of the irrigated area (Indus plain) of Pakistan receives average rainfall of 200 mm, which is not enough to grow a single crop (Anonymous, 2001-02). To meet this shortage, ground water is being exploited of which 70-75% is brackish (Ghafoor *et al*., 1991). Continuous use of such ground water without appropriate management or any amendment could make the soil saline/sodic. By now about 3.0 MAF soils have developed surface salinity/sodicity due to the use of poor quality irrigation waters (Rafique, 1990). However, low quality waters can be used for irrigation and ameliorating salt-affected soils if proper management practices are followed (Suarez & Lebron, 1993; Ghafoor *et al*., 2000; Qadir *et al*., 2001).

In Gujrat district, underground water is being used for irrigation regularly alone or along with canal water. The 40% water of Gujrat district are fit, 23% marginally fit and the rest 37% are unfit for irrigation (Pervaiz *et al*., 2003). During field visit or contact of farmers themselves belong to union council Gakhra Kalan (situated in irrigated area in the South West corner of district Gujrat), it was known that rice crop fails at penical stage, soil salinity/sodicity is developing day by day and the cause reported was brackish water and shortage of canal water. Thus, it was very important to ascertain the quality of underground water used for irrigation. Voluminous work has been done for Punjab but very little information is available at district/ tehsil/ union council level. More over informations available regarding the quality of tube well water are general (fit, marginally fit and unfit) and no comprehensive study has been made. The objective of this study was to monitor the quality of water of tubewells of every village and to find out the extent of various parameters contributing individually or collectively to the quality of tube well water.

MATERIALS AND METHODS

The study area was Union Council Gakhra Kalan, tehsil and district Gujrat during the years September 2002 to August 2003. Groundwater samples from running tubewells were collected from 13 villages of union council covering four sides (East, West, North and South) each of the village with in radius of 1 kilometer of the village. A total of 52 samples of tube wells of depth of 60±5 were collected in plastic bottles after ½ hour of tubewell operations. The collected water samples were analysed within three days for EC, CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-}, Na^+, and $Ca^{2+}+Mg^{2+}$. Then the sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) were computed (Anonymous, 1954). Based on the value of EC, SAR and RSC, the water samples were categorized using the International Standards (Anonymous, 1954). Simple statistical analyses (Mean, standard deviation, coefficient of variation percent and percentage) were done (Steel & Torrie, 1980).

Table I. Data profile of villages of union council Gakhra Kalan, district Gujrat during the year September 2002 to August 2003

Sr. No	Name of villages	Tubewell (Depth 60 ± 5 feet)											
		EC (dSm^{-1})				SAR				RSC (me L^{-1})			
		Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.
1	Chak wassan	2.13	2.87	2.44	0.31	6.27	10.59	7.90	1.88	0.10	0.20	0.15	0.06
2	Dewan Kot	2.86	3.29	3.06	0.19	7.03	8.18	7.58	0.53	0	0	0	0
3	Gakhra Kalan	1.29	2.89	2.14	0.66	3.8	10.08	7.84	2.78	0	4.02	1.71	1.93
4	Gakhra Khurd	1.27	2.85	2.18	0.68	2.66	11.96	5.71	4.25	0	4.6	1.9	2.29
5	Jamobola	0.92	2.73	2.25	0.89	5.57	12.40	9.86	3.04	0.20	3.9	1.50	1.72
6	Kang Chanan	1.09	1.66	1.30	0.27	1.56	4.28	2.74	1.19	1.50	2.0	1.78	0.26
7	Kang Sehari	1.12	1.65	1.39	0.24	1.90	3.75	2.71	0.88	0	1.40	0.65	0.66
8	Keeranwala	1.50	2.21	1.90	0.30	4.83	9.58	7.01	2.45	1.9	4.9	3.08	1.42
9	Khanwali	2.46	4.12	3.10	0.76	6.28	8.44	7.57	0.92	0	0	0	0
10	Kot Kana	1.44	1.83	1.64	0.17	4.04	5.06	4.39	0.46	0	1.8	0.6	0.83
11	Nawan Lok	2.91	3.40	3.24	0.23	7.34	9.17	8.5	0.80	0	0	0	0
12	Nawan Lok Noshera	1.34	2.11	1.62	0.35	4.24	7.55	6.29	1.45	2.10	5.0	3.53	1.59
13	Ruppoki	1.68	2.61	2.27	0.51	4.17	7.04	6.0	1.59	0	1.5	0.67	0.76

S.D = Standard deviation

RESULTS AND DISCUSSION

Data with respect to different quality parameters of every village of union council Gakhra Kalan for irrigation purposes are presented in Table I.

Under ground water quality characteristics (EC, SAR and RSC) and their fitness are given in Table II and III. Range of EC, SAR and RSC for fit water samples was 0.92 to 1.41 dSm^{-1}, 1.90 to 5.57, and 0 to 0.24 meL^{-1}, respectively (Table IV). Range of EC and SAR for marginally fit water samples was 1.58 to 2.13 dSm^{-1}, 1.40 to 2.10 meL^{-1}, respectively (Table V). Range of EC and SAR for unfit water samples was 2.54 to 3.24 dSm^{-1}, 2.56 to 4.9 meL^{-1}, respectively (Table VI).

Water samples of these villages are highly saline and sodic which are not suitable for irrigation under ordinary condition, but may be used occasionally under very special circumstances. The soil must be permeable, drainage must be adequate, and irrigation water must be applied in excess to provide considerable leaching, alternate supply of canal water and very salt tolerant crops should be selected. The area where canal water is insufficient, underground water is brackish and soil are salt affected; the farmers should promote biosaline agriculture along with addition of farmyard manure/green manure. Goat, sheep and fish farming can also raise the farmer's income.

The unfit waters due to high electrical conductivity will cause salinization (Ghafoor *et al*., 1990, 1993). It is imperative to find good quality of irrigation water by increasing the depth or site of bore if has to use for all type of crops.

The sodium adsorption ratio (SAR) indicates the relative proportion of sodium to calcium+magnesium, whereas residual sodium carbonate is an index, which indicates the sodium hazards (sodication of soil). The unfit water samples (containing excess of carbonate and bicarbonate) for irrigation will precipitate soil solution calcium and increase solution sodium, resulting in soil dispersion (Emerson & Bakker, 1973) as well as impaired nutrient uptake by plants (Kanwar & Chaudhry, 1968.). It is, therefore, recommended that unfit water samples may need special management practices if to be used for irrigation but preferably should be avoided because all these factors will combine to lower down the farm production. However, the extent of deteriorating effect of these factors will vary with soil type and management practices.

Table II. Under ground water quality characteristics of union council Gakhra Kalan, district Gujrat

Parameters	Values				
	Minimum	Maximum	Mean	Standard Deviation	Coefficient of variation (%)
EC (dSm^{-1})	0.92	4.12	2.19	0.76	35
SAR	1.56	12.40	6.48	2.75	42
RSC (me L^{-1})	0	5.0	1.21	1.55	128

Table III. Underground water quality of union council Gakhra Kalan district Gujrat

Sr. No	Name of village	No. of sample	Quality of water		
			Fit	Marginally Fit	Unfit
1	Chak wassan	4	-	1(25)	3(75)
2	Dewan Kot	4	-	-	4(100)
3	Gakhra Kalan	4	1(25)	-	3(75)
4	Gakhra Khurd	4	-	1(25)	3(75)
5	Jamobola	4	1(25)	-	3(75)
6	Kang Chanan	4	-	4(100)	-
7	Kang Sehari	4	1(25)	3(75)	-
8	Keeranwala	4	-	2(50)	2(50)
9	Khanwali	4	-	-	4(100)
10	Kot Kana	4	1(25)	3(75)	-
11	Nawan Lok	4	-	-	4(100)
12	Nawan Lok Noshera	4	-	2(50)	2(50)
13	Ruppoki	4	-	1(25)	3(75)
	Total	52	4(7)	17(33)	31 (60)

Figures in parenthesis are percentage of their respective village samples analysed.

Table IV. Distribution of useable underground water in respect of EC, SAR and RSC of union council Gakhra Kalan, district Gujrat

Sr. No.	Name of villages	No of useable samples	Values		
			EC(dSm^{-1})	SAR	RSC (me L^{-1})
1	Gakhra Kalan	1	1.29	3.80	0.24
2	Jamobola	1	0.92	5.57	0.20
3	Kang Sehari	1	1.12	1.90	1
4	Kot Kana	1	1.41	4.13	0
	Total	4			

Table V. Distribution of marginally fit underground water in respect of EC, RSC and EC+RSC of union council Gakhra Kalan, district Gujrat

Estimation	Statistical character St	Name of villages							
		Chak Wassan	Gakhra Khurd	Kang Chanan	Kang Sehari	Keera-nwala	Kot Kana	Nawan Lok Noshera	Ruppoki
EC(dSm^{-1})	N	1	1	-	2	-	2	-	-
	Mean	2.13	2.06	-	1.58	-	1.70	-	-
	%	100	100	-	67	-	67	-	-
RSC (meL^{-1})	N	-	-	3	1	1	-	1	-
	Mean	-	-	1.87	1.40	1.90	-	2.10	-
	%	-	-	75	33	50	-	50	-
EC+RSC	N	-	-	1	-	1	1	1	1
	EC Mean	-	-	1.66	-	1.88	1.71	2.11	1.68
	RSC Mean	-	-	1.50	-	2.0	1.80	2.2	1.50
	%	-	-	25	-	50	33	50	100
Total		1	1	4	3	2	3	2	1

Table VI. Distribution of unfit underground water in respect of EC, RSC and EC+RSC of union council Gakhra Kalan, district Gujrat

Estimations		Name of villages									
	Statistical Character	Chak Wassan	Dewan Kot	Gakhra Kalan	Gakhra Khurd	Jamobola	Keeranwala	Khanwali	Nawan Lok	Nawan Lok Noshera	Ruppoki
EC (dSm^{-1})	n	3	4	1	1	2	-	4	4	-	3
	Mean	2.54	3.06	2.89	2.85	2.69	-	3.09	3.24	-	2.50
	%	100	100	33	33	67	-	100	100	-	100
RSC (meL^{-1})	n	-	-	1	1	-	2	-	-	2	-
	Mean	-	-	2.56	3.0	-	4.2	-	-	4.9	-
	%	-	-	33	33	-	100	-	-	100	-
EC+RSC	n	-	-	1	1	1	-	-	-	-	-
	EC Mean	-	-	2.30	2.53	2.70	-	-	-	-	-
	RSC Mean	-	-	4.02	4.60	3.90	-	-	-	-	-
	%	-	-	33	33	33	-	-	-	-	-
Total		3	4	3	3	3	2	4	4	2	3

CONCLUSIONS

1. Most of the unfit waters are unfit due to higher EC followed by RSC and EC+RSC.
2. SAR is not the great problem of the area.
3 Almost all the area of union council Gakhra Kalan has highly saline water, which is affecting yield of crops alongwith increasing salinity/sodicity hazardous in the soil.

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