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Characterization of Irrigation Quality of Ground Water in Mandi Baha-ud-Din District

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Abstract: Detail study was carried out for the provision of guidelines to farmers and researcher for better crop production by adopting water management practices. A total of 121 water samples were collected/received, analyzed and classified for EC, SAR and RSC during the year July 1986 to June 1996. Out of 121 water samples, 25% were found fit, 17% marginally fit and 58% unfit according to the suitability criteria given by the Soil Fertility Punjab, Organization. Whereas 29% fit, 24% marginally fit and 47% unfit according to the international standards.

Key words: Fit, marginally fit, unfit, EC, SAR and RSC

Introduction

In arid and semi arid region where rains are erratic and scarce, one has to rely upon irrigation through canals and tube wells. Forced by the canal water shortage and increasing cropping intensity to feed the ever-growing population, farmers have been tapping ground water resource on a very large scale (Kijne and Velde, 1990; Javaid *et al*., 1998). On the other hand, it is reported that about 70% tube well discharge is used in agriculture sector (Anonymous, 1995) and about 75% of discharge of existing wells is saltish (Malik *et al*., 1984). The use of groundwater of marginal and poor quality without proper mixing may degrade soils, especially at tail end of the system (Mohtadullah, 1997). This practice may also give rise to some apparent and hidden soil problems, directly or indirectly associated with the tube well irrigations (Javaid *et al*., 1997).

It is a general opinion of farmers that irrigation with tube well water makes the soil hard and decreases water percolation. Since most of the farmers install tube wells at their own and bothers little to get the water samples analyzed during installation. The consequences appear two-three years later in the form of soil deterioration as well as decreased farm production. Quality of water is of immense importance because poor quality of both surface and groundwater is not only a limiting factor in crop production but also its constant and indiscriminate use cause secondary salinization. The extent and nature of salt accumulation and the degree of soil alkalinity depends on the quality of irrigation water. To avoid indiscriminate use of ground water, proper management practices are deemed necessary keeping in view the crops to be grown and the soil to be used. The water quality research is also needed to develop management practices. In Mandi Baha-Ud-Din district (whole district, which was the tehsil namely Phalia of district Gujrat before July 1993) underground water is being used for irrigation regularly alone or along with canal water. Thus it is 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 level. More over the information available regarding the quality of tube well water is general (fit, marginally fit and unfit) and no comprehensive study at district level has been made. The objective of this study was to categorize the irrigation quality of tube well water in Mandi Baha-Ud-Din district 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 district Mandi Baha-Ud-Din during the years July 1986 to June 1996. Groundwater samples from running tube wells were collected from 121 locations. These water samples were collected/received in polythene bottles after ½ hour of tube well operations. The collected water samples were analyzed within three days for EC, CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}, Na^+ and $Ca^{++}+Mg^{++}$. 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 standards given by the Soil Fertility ,Punjab, Organization (Malik *et al*, 1984) and international standards (Anonymous, 1954). Simple statistical analyses (means, standard deviation and percent) were done (Steel and Torrie, 1980).

Results and Discussion

Survey of 121 water samples of running tube well of Mandi Baha-Ud-Din district revealed that, 25% water samples were fit, 17% marginally fit and the rest of 58% unfit for irrigation purposes according to the standards

Table 1: Quality of tube well water in Mandi Baha-Ud- Din district according to the international standards and standards given by soil fertility, Punjab organization

Particulars		
Quality of water	No of samples according to Soil Fertility, Punjab Organization (%)	No of samples according to International standards (%)
Fit	30 (25)	35 (29)
Marginally fit	21 (17)	29 (24)
Unfit	70 (58)	57 (47)
Total	121	121

Figure in parentheses are percentage of total samples analysed.

Table 2: Values of fit water samples in respect of EC, SAR and RSC according to international standards and standards given by soil fertility organization

Particular			
Parameters	EC (uS m^{-1})	SAR	RSC (meq L^{-1})
According to soil fertility, Panjab organization standards			
No of samples	30	30	22*
Average	729±175	1.42±1.18	0.46±0.29
According to international standards			
No of samples	35	35	23**
Average	783±213	1.33±1.17	0.46±0.29

SAR= sodium adsorption ratio RSC= Residual sodium carbonate
* = Out of 30 fit samples only 22 samples had RSC value.
** = Out of 35 fit samples only 23 samples had RSC value.

Table 3: Distribution of marginally fit water samples in respect of EC, SAR and RSC according to international standards and standards given by Soil Fertility, Punjab organization

Particulars			
		Name of standards	
Name of estimations	Statistics	Soil Fertility, Punjab	International
EC (uS m^{-1})	n	4	9
	Average	1037	1825
	%	19	32
SAR	n	-	-
	Average	-	-
	%	-	-
RSC (meq L^{-1})	n	9	20
	Average	1.80	1.85
	%	43	68
EC+SAR	n	-	-
	EC.Average	-	-
	SAR.Average	-	-
	%	-	-
EC+RSC	n	6	-
	EC. Average	1144	-
	RSC. Average	1.92	-
	%	28	-
SAR+RSC	n	1	-
	SAR.Average	6.50	-
	RSC. Average	1.76	-
	%	5	-
EC+SAR+RSC	n	1	-
	SAR.Average	1090	-
	RSC. Average	8.90	-
	%	1.70	-
Total		21	29

EC=Electrical conductivity . SAR= Sodium adsorption ratio
RSC= Residual sodium carbonate

given by the soil fertility, Punjab organization, (Malik *et al*., 1984) where as 29% fit, 24% marginally fit and the rest of 47% were unfit (Table 1) according to the international standards (Anonymous, 1954). Maximum numbers of samples were unfit followed by fit and marginally fit.

Table 4: Distribution of un-fit water samples in respect of EC, SAR and RSC according to international standards and standards given by Soil Fertility, Punjab, organization

Particulars			
		Name of standards	
Name of estimations	Statistics	Soil Fertility, Punjab	International
EC (uS m^{-1})	n	18	9
	Average	2445	4516
	%	26	16
SAR	n	-	-
	Average	-	-
	%	-	-
RSC (meq L^{-1})	n	16	27
	Average	4.38	5.13
	%	23	47
EC+SAR	n	3	-
	EC.Average	5638	-
	SAR.Average	10.99	-
	%	4	-
EC+RSC	n	25	17
	EC. Average	1645	1901
	RSC. Average	6.00	6.00
	%	36	30
SAR+RSC	n	-	-
	SAR.Average	-	-
	RSC. Average	-	-
	%	-	-
EC+SAR+ RSC	n	8	4
	EC. Average	3316	4605
	SAR.Average	17.23	23.09
	RSC.Average	8.19	10.55
	%	11	7
Total		70	57

Data was indicated that 30 fit (According to Soil fertility, Punjab Organization) water samples had average value of EC as 729±175 uS m^{-1}, SAR 1.42±1.18 and RSC 0.46±0.29 meq L^{-1}. Out of these 30 samples, 8 samples had zero RSC value. According to international standards, 35 fit water samples had average value of EC 783±213 uS m^{-1}, SAR 1.33±1.17 and RSC 0.46±0.29 meq L^{-1}. Out of these 35 samples 12 samples had no RSC value (Table 2). This water could be used safely for crop production.

Data was revealed that out of 21 marginally fit (According to Soil Fertility, Punjab Organization) water samples, 4 were marginally fit due to higher EC with average value of 1037 uS m^{-1}, 9 due to RSC with average value of 1.8 meq L^{-1}, 6 due to EC+RSC with average value of EC and RSC 1144 uS m^{-1} and 1.92 meq L^{-1} respectively, one due to SAR+RSC with average value of SAR and RSC 6.50 and 1.76 meq L^{-1} respectively and again one samples was marginally fit due to the combined effect of EC+SAR+RSC

with average value of EC, SAR and RSC 1090 uS m^{-1}, 8.90 and 1.70 meq L^{-1} respectively. According to international standards, out of 29 marginally fit water samples, 9 were marginally fit due to higher EC with average value of 1825uS m^{-1} and the rest of 20 samples were marginally fit due to higher RSC with average value of 1.85 meq L^{-1} (Table 3).

Results revealed that out of 70 unfit (According to Soil Fertility, Punjab Organization) water samples, 18 were unfit due to higher EC with average value of 2445 uS m^{-1}, 16 unfit due to RSC with average value of 4.38 meq L^{-1}, 3 unfit due to EC+SAR with average value of ECand SAR 5638 uS m^{-1} and 10.99 respectively, 25 due to EC+RSC with average value of EC and RSC 1645 uS m^{-1} and 6 meq L^{-1} respectively and the rest of 8 were unfit due to the combined effect of EC+SAR+RSC with average value of EC, SAR and RSC 3316 uS m^{-1}, 17.23 and 8.19 meq L^{-1} respectively. According to international standards, out of 57 unfit water samples, 9 were unfit due to higher EC with average value of 4516 uS m^{-1}, 27 due to RSC with average value of 5.13 meq L^{-1}, 17 due to EC+RSC with average value of EC and RSC 1901 uS m^{-1} and 6 meq L^{-1} and the rest of only 4 water samples were unfit due to the combined effect of EC+SAR+RSC with average value of EC, SAR and RSC 4605 uS m^{-1}, 23.09 and 10.55 meq L^{-1} respectively (Table 4).

In all the parameters marginally fit waters could be manageable with some special management practices, like use of gypsum, flushing with good quality of water, alternate supply of canal water etc. However, unfit water due to high electrical conductivity will cause salinization (Ghafoor *et al*., 1990, 1993). To avoid salinization, it was proposed to increase/decrease the depth of bore or change the place of bore to find good quality of water due to variation in water status at different depth (Ahmed and Chaudhry, 1968, Youns, 1977). 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 and Bakker, 1973) as well as impaired nutrient uptake by plants (Kanwar and 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.

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