

Groundwater quality and its suitability for irrigation in Matar Tehsil of Kheda district, Gujarat

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ABSTRACT

Ninety one ground water samples were collected from open and tube-wells located in different villages of Matar Tehsil of Kheda district, Gujarat. The samples were analyzed for salinity/sodicity parameters as per the standard procedures. The open wells varied in depth from 40 to 250 feet whereas the tube-wells pumped out water from 50 to 150 feet depth. The quality of groundwater samples collected indicated that pH, EC, sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) ranged from 6.67 to 8.79, 0.26 to 12.63 dS/m, 1.79 to 37.06 and nil to 13.8 me/l respectively. On the basis of category classification of quality of water, maximum 38.46 per cent samples were classified as high SAR (B3) saline water whereas 18.68 per cent samples were under high alkali (C3) water. The pH of irrigation water showed significant positive correlation with RSC ($r = 0.405$) and positive correlation with SAR ($r = 0.106$) of water. A highly significant correlation coefficient between EC and SAR ($r = 0.673$) was recorded. The SAR of irrigation water exhibited significant and positive correlation with RSC ($r = 0.225$).

Keywords: Groundwater quality; pH; EC; RSC; SAR; samples

INTRODUCTION

Water is an indispensable source of life for all the systems and is critical component for sustainable agriculture. However over exploitation of groundwater leads to lowering of groundwater strata to an extent that it becomes very difficult to get good quality water for drinking as well as irrigation purposes. Quality of irrigation water plays a pivotal role in agriculture production. Large areas in Rajasthan, Haryana, Uttar Pradesh, Karnataka, Punjab

and Gujarat are underlain with saline and high residual sodium carbonate (RSC) groundwater (Manchanda et al 1989, Manchanda 1976) and due to prolonged use of poor quality water these areas developed sodicity and salinity problems which induced changes in physicochemical properties leading to reduced crop yield (Manchanda et al 1982, Bajwa and Josan 1989, Bajwa et al 1992, Minhas and Bajwa 2001, Choudhary et al 2002). Development of salinity, sodicity and toxicity problems of salts in soils not only

reduces crop productivity and quality but also limit the scope of choice of the crops. The deterioration of groundwater quality is one factor responsible for various problems of Matar block of the Kheda district. Therefore it is very essential to categorize the underground water use for irrigation.

MATERIAL and METHODS

Kheda district is situated in the middle part of Gujarat. The soils of the district are under the broad group of alluvial soils. The major crops like paddy, cotton etc are grown in Kharif. During Rabi (winter) crops grown are tobacco, wheat, tomato etc. Main sources of irrigation are canals, open wells, bores and tanks. In the present study groundwater samples (ninety one) from Matar block of Kheda district were collected for analysis.

The open wells varied in depth from 40 to 150 feet whereas the tube-wells pumped out water from 40 to 250 feet depth. The samples were analyzed for salinity/sodicity parameters viz pH, electrical conductivity (EC), cationic concentration (Na^+ , Ca^{2+} , Mg^{2+}) and anionic concentration (CO_3^{2-} , HCO_3^- and Cl^-) as per the standard procedures (Richards 1954).

Sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) were calculated by the formula as given below:

Sodium adsorption ratio (SAR)=

$$\frac{\text{Na}^+}{\sqrt{\frac{\text{Ca}^{2+} + \text{Mg}^{2+}}{2}}}$$

Residual sodium carbonate (RSC)= ($\text{CO}_3^{2-} + \text{HCO}_3^-$) – ($\text{Ca}^{2+} + \text{Mg}^{2+}$) (all values of cations and anions in me/l)

The underground waters were grouped in different frequency classes (Table 1) on the basis of EC, SAR and RSC problems by adopting the criterion given by Minhas and Gupta (1992). Correlation coefficients for different physico-chemical parameters of ground waters were also worked out.

RESULTS and DISCUSSION

Water quality

The suitability of groundwater for irrigation depends on its chemical composition. Irrigation water quality is determined in several ways including the degree of acidity or alkalinity (pH), EC, SAR and RSC. Excessive amount of salt in general and sodium in particular affect the soil permeability, soil structure and create toxic conditions for plants. The ranges of values of analyzed parameters are given in Table 2.

Table 1. Criterion for characterization of ground waters based on EC, SAR and RSC

Water quality		EC (dS/m)	SAR (mmo/l) ^{1/2}	RSC (me/l)
A	Good	<2	<10	<2.5
B	Saline water			
B1	Marginally saline	2-4	<10	<2.5
B2	Saline	>4	<10	<2.5
B3	High SAR saline	>4	>10	<2.5
C	Alkali waters			
C1	Marginally alkali	<4	<10	2.5-4.0
C2	Alkali	<4	<10	>4.0
C3	Highly alkali	Variable	>10	>4.0

(Minhas and Gupta 1992)

Table 2. Salient features of ground water samples of Matar Tehsil of Kheda district

Parameter	Minimum	Maximum	Average
pH	6.67	8.79	7.46
EC (dS/m)	0.26	12.63	4.25
SAR (mmo/l) ^{1/2}	1.79	37.06	12.19
RSC (me/l)	Nil	13.8	Nil

pH: A perusal of the data in Table 2 reveals that the pH of irrigation waters varied from 6.67 to 8.79 with mean value of 7.46.

The pH of irrigation water showed highly significant positive correlation with RSC ($r = 0.405$) and positive correlation with SAR ($r = 0.106$) (Table 3). These results are in agreement with the finding of Singh and Dubey (2012) and Katiyar et al (2014).

Electrical conductivity (EC): The electrical conductivity of the irrigation waters of studied area varied between 0.26 to

12.63 dS/m with a mean value of 4.25 dS/m (Table 2).

EC of irrigation water showed significant positive correlation with SAR ($r = 0.673$) and negative correlation with pH ($r = -0.220$) and RSC ($r = -0.450$) (Table 3). These results are supported by the findings of Singh and Dubey (2012) and Katiyar et al (2014).

Sodium adsorption ratio (SAR): The data presented in Table 2 show that the SAR values of the studied area ranged between 1.79 to 37.06 with mean value 12.19.

The SAR of irrigation water exhibited significant and positive correlation with RSC ($r = 0.225$) (Table 3). These results are supported by the findings of Singh and Dubey (2012).

Residual sodium carbonate (RSC): The RSC indicated the excess of carbonates and bicarbonates over calcium and magnesium in irrigation water. The data presented in Table 2 reveal that RSC values of irrigation waters varied from nil to 13.8 me/l.

Categorization of Irrigation water

The distribution of ground water samples into different categories of water quality is represented in Table 4. A large number of samples fell in high SAR saline water category (B3-38.46%) followed by highly alkali water category (C3-18.68%) and marginally saline water (B1-14.29%). The waters which were rated as good (A), saline (B1), marginally alkaline

Table 3. Correlation coefficient 'r' values for different physico-chemical parameters of ground water in Matar Tehsil of Kheda district

Parameter	EC	pH	SAR	RSC
EC	1.000	-0.220*	0.673**	-0.450**
pH	-	1.000	0.106	0.405**
SAR	-	-	1.000	0.225*

Table 4. Frequency distribution of water samples into different categories of water quality in Matar Tehsil of Kheda district

Category	Water quality	Samples	
		#	%
A	Good	9	9.89
B	Saline water		
B1	Marginally saline	13	14.29
B2	Saline	5	5.49
B3	High SAR saline	35	38.46
C	Alkali waters		
C1	Marginally alkali	5	5.49
C2	Alkali	7	7.69
C3	Highly alkali	17	18.68

(C1) and alkaline (C2) were 9.89, 5.49, 5.49 and 7.69 per cent.

CONCLUSION

It can be concluded that about 38.46 per cent of water of the Matar Teshil of Kheda district had high SAR saline groundwater and its indiscriminate and prolonged use might cause secondary salinization and sodification of soils resulting in serious effect on crop growth. But in the contingency this poor quality groundwater can be used with special management practices depending upon the rainfall, crops to be grown and soil type.

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