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A STUDY ON COMPARATIVE ASSESSMENT OF QUALITY OF UNDERGROUND WATERS BY USDA AND AYERS METHODS

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One hundred and forty two water samples from different wells were collected and analysed to assess for its quality both by USDA and Ayers methods. The majority of waters studied were $C_3 S_1$ (36.62%), $C_3 S_1$ (21.83%) and $C_4 S_2$ (14.79%) and of Na Cl type. Permeability of the soil may be affected due to high Na content but not due to low Salt concentration of the waters studied.

In Karnataka, the area irrigated by open wells amount to nearly 23 per cent of the total irrigated area and the quality of such waters is of particular importance in arid zone. Bijapur with less than 500 mm annual rainfall is one of the dry districts of Karnataka State, where irrigation is mainly through ground water. Considering that a sizable area of this district is under wells irrigation and also taking into stock the paucity of information on the quality of irrigation water, the present study was taken up.

MATERIALS AND METHODS

Irrigation water samples from 142 open wells located at different places of Mudhol taluka, Bijapur district of Karnataka State were collected for the present study. The waters were analysed for pH, EC, water soluble cations viz., sodium, potassium, calcium and magnesium and anions namely chlorides, carbonates and Bicarbonates by standard methods as per Richards (1954). Adjusted SAR and RSC were computed as per methods suggested by Ayers (1977) and Eaton (1950).

$$\text{Adj SAR} = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}} \quad 1 + (8.4 - pHc)$$

where,

$$pHc = (PK'_2 - PKC') + P' (Ca + Mg) + P (ALK),$$

$(PK'_2 - PKC')$ is obtained from the table by using the sum of Ca + Mg + Na in me/l.

P' (Ca + Mg) is obtained from the table by using the sum of Ca + Mg in me /1.

P (ALK) is obtained from the table by using the sum of $CO_3 + HCO_3$ in me/l.

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Table 1. Chemical composition (ranges) of underground water samples

a) pH	:	7.6–9.1
b) EC (μ mhos/cm)	:	200–5700
c) Cations (me/litre)		
i) Na	:	0.44 –30.45
ii) Ca	:	0.40 – 8 00
iii) Mg	:	0 50 –19.20
iv) K	:	0.026– 7 23
d) Anions (me/litre)		
i) CO_3	:	1 94 – 5 82
ii) HCO_3	:	0.97 –13.50
iii) Cl	:	1.10 –31.90

RESULTS AND DISCUSSION

Table 1 shows that the pH of irrigation waters varied from 7 6 to 9.1 and EC ranged between 200 and 5,700 μ mhos/cm This indicates that the water samples have medium to very high amounts of salts, Table 2 (20.41 to 51 41 %). Among cations, a large variation was noticed with respect to sodium content (0.44 to 30.45 me/1), followed by magnesium (0.50 to 19.20 me/1). This indicates that nearly 88.03 per cent of the samples studied were low in hazard while 11.97 per cent fall under medium category as per USDA Classification (Table 2).

Among the anions studied the variation in concentration of chlorides was large (1.10 to 31.90 me/1) (Table 1). But on the basis of RSC, 21.83 per cent of samples are not suitable for irrigation purposes while 19.72 per cent marginal and 58.45 per cent were in the safe limit (Table 2). As per USDA Classifications, the majority of water samples can be grouped under C_3S_1 (36.62%), C_2S_1 (21.83%) and C_4S_1 (14 79%).

A general evaluation of water samples were also made by interpreting in terms of problem related constituents viz., salinity, permeability, toxicity and miscellaneous as described by Ayers (1977). Nearly 60.56 per cent samples were in the 'increasing problem' group, 27.46 percent under 'no problem' group while 11.97 per cent under 'severe problem 'group with respect to salinity (Table 3). Results show that the permeability of the soils may be affected in this region severely due to high sodium content (Adj SAR 56.34%), but not due to low salt concentration. Nearly 94.37 per cent of the sample fall under 'no problem, group of permeability and not even a single well water come under 'severe problem' category with respect to salt concentration. Sodium was the specific ion causing the toxicity to an extent of 56.34 per cent (Table 3) compared to chloride (23.94%).

Results also reveal that 80 28 per cent of the samples fall under 'increasing toxicity problem group' (foliar) due to sodium. Foliar absorption of such

Table 2. Classification of underground waters as per USDA.

Water quality guidelines	EC (μmhos/cm)	SAR	RSC	Irrigation Classes
Low	Nil (100—250)	88.03 (<10)	58.45 (<1.25)	C_1S_1 = 2.11 C_2S_1 = 21.83
Medium	28.17* (250—750)	11.97 (10—18)	19.72 (1.25—2.5)	C_1S_2 = 3.52 C_2S_2 = 0.70
High	51.41 (750—2250)	Nil (18—26)	21.83 (>2.5)	C_2S_1 = 36.62 C_3S_2 = 2.11
Very high	20.42 (>2250)	Nil (>26)	— —	C_2S_4 = 2.82 C_4S_1 = 2.82 C_4S_2 = 14.79 C_4S_3 = 4.22

NOTE: Figures in parentheses indicate ranges * Percentage values

Table 3. Interpretation of waters of Mudhol taluk as per the guidelines given by Ayers (1977).

water quality guidelines	Salinity	permeability	Specific ion toxicity: Root absorption			Miscellaneous: Foliar	
	Ecw (μmhos/cm)	Ecw (μmhos/cm)	Adj SAR	Sodium (me/l)	Chloride (me/l)	Sodium (me/1)	Bicarbonate (me/l)
No Problem	27.46* (750)	94.37 (>500)	28.87 (<6)	11.97 (<3)	35.91 (<4)	19.72 (<3)	4.22 (<1.5)
Increasing problem	60.56 (751—3000)	5.63 (<500)	14.78 (6—9)	31.69 (3—9)	40.14 (4—10)	80.28 (>3)	85.91 (1.5—8.5)
Severe Problem	11.97 (>3001)	Nil (<200)	56.34 (>9)	56.34 (>9)	23.94 (>10)	—	9.86 (>8.5)

NOTE: Figures in the parentheses indicate ranges * Percentage values.

waters may lead to the leaf burn under low humidity coupled with high evaporation conditions. Majority of waters were in the 'increasing problem' group (85.91%) with respect to bicarbonate.

The study thus indicates that the underground waters used for the quality assessment are of mostly sodium chloride type, since the specific ion toxicity of sodium and chloride being high (56.34% and 23.94 %) and majority of waters (58.45%) are low in residual sodium carbonate (RSC) value. The findings are in conformity with the results published by Channal *et. al.*, 1984.

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