

Determination of Physico-Chemical Parameters of Ground Water Used for Irrigation in Villages of Akola District of Maharashtra, India

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ABSTRACT: Determination of physico-chemical parameters of ground water used for irrigation in Gram-Babhulgaon and Chandur of Akola district of Maharashtra, India was worked out to evaluate the factors that regulate ground water quality. In the month of February-2016, ten ground water samples from open wells were assessed for parameters i.e. temperature, colour, pH, EC, alkalinity, chloride, sulphate, calcium, magnesium, sodium, potassium, TDS, COD, DO and BOD. Using SSP and SAR criteria, sodium hazard associated with the irrigation water was evaluated. Results were compared with Bureau of Indian Standards (BIS) limits. Based on the irrigation quality parameters, most of the samples were found to be suitable for irrigation.

Keywords: Determination; physico-chemical parameters; ground water; irrigation and Akola.

INTRODUCTION: In India ground water is the major source of irrigation. For long term soil productivity, irrigation water quality is an important factor and it depends on percentage of constituents that dissolved in water, water table depth, climate, soil composition, topography etc. In irrigated areas, water quality is an important factor for appraisal of salinity. Good quality water has potential to give maximum yield whereas poor quality water may cause accumulation of salts in root zone, decreases soil permeability because of excess sodium or calcium leaching and affects irrigated crop by containing pathogens or contaminants that are directly toxic to plants or to those consuming them. Contaminants present in irrigation water may accumulate in soil and after some years make the soil unfit for agriculture use. Hence to maintain full crop productivity it is essential to have special management practices.

Irrigation water quality depends on temperature, colour, hydrogen ion concentration (pH), electrical conductivity (EC), alkalinity (HCO_3^{2-} , CO_3^{2-} , OH^-), chloride (Cl^-), sulphate (SO_4^{2-}), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+) present in water. It is judged by some determining factors such as soluble sodium percentage (SSP) and sodium absorption ratio (SAR).¹⁻⁵ Quality of water also get affected by the presence of total dissolved solids (TDS), chemical oxygen demand (COD), dissolved oxygen

(DO) and biological oxygen demand (BOD).⁶⁻⁹ Assessment of physico-chemical parameters of water of dams, rivers, canals, wells used for irrigation in different regions of India was studied earlier by many co-workers.¹⁰⁻¹⁵ In this study, determination of physico-chemical parameters of ground water used for irrigation in villages of Akola district of Maharashtra, India was worked out.

MATERIALS AND METHODS: Present work of determination of physico-chemical parameters of ground water used for irrigation in villages of Akola district of Maharashtra, India was carried out in the month of February-2016. Temperature and colour of ground water were checked at the site itself. pH was measured by pH-meter (Systronics-MKVI) having glass and saturated calomel electrode. EC was checked using conductivity meter (Systronics-304). Dissolved salts i.e. SO_4^{2-} was estimated using spectrophotometer (Systronics-166) while Na^+ and K^+ were detected by flame photometer (Systronics-130). Other parameters i.e. HCO_3^{2-} , CO_3^{2-} , OH^- , Cl^- , Ca^{2+} , Mg^{2+} , COD, DO and BOD were determined by standard titrimetric methods.¹⁶ TDS present in irrigation water was also checked. SSP and SAR are the most common criteria for evaluation of sodium hazard associated with irrigation water.^{4,5} All weighings were done on electronic balance, Precisa-310-M (± 0.001 g). Chemi-

cals and solvents of A.R. grade were used. All solvents were purified and made anhydrous.

Study area: Ground water used for irrigation in Gram-Babhulgaon and Chandur, District-Akola, Region-Vidarbha, State-Maharashtra, Country-India.

Method of sampling: Glass bottles having leak proof cap were used for collection of samples of irrigation water. Glass bottles were thoroughly washed and rinsed twice with water before sampling. Samples of irrigation water from wells were collected directly from pump discharge after pumps were run for half an hour. Bottles were properly labeled and brought to the laboratory.

RESULTS AND DISCUSSION: During present work, total ten samples of ground water were drawn from open wells and assessed for physico-chemical parameters. Results were compared with Bureau of Indian Standards (BIS) limits.¹⁷

Temperature: Temperature of samples of irrigation water W-01 to W-10 was observed to be 29.1, 28.2, 25.9, 25.0, 25.1, 28.1, 27.2, 29.9, 29.0 and 28.2°C respectively. BIS limit (1998) is maximum 40°C. Temperature of all samples was found in desirable limit. All samples were collected from nearby areas during same period and mostly in same hours of February-2016 and hence there was no much change in temperature. Growth and death of microorganisms, kinetics of biochemical oxygen demand are regulated to some extent by water temperature. Characteristics of water like dissolution of gases, pH and conductivity get affected by temperature.

Colour: Colour of samples of irrigation water W-01 to W-10 was found to be colourless and mostly transparent at the time of samples collection.

Hydrogen Ion Concentration (pH): pH of samples of irrigation water W-01 to W-10 was observed to be 6.53, 6.79, 6.77, 6.54, 6.47, 6.64, 7.08, 6.58, 6.70 and 6.66 at 28°C respectively. BIS limit (1998) is 6.5 to 8.5. pH of all samples was found in desirable limit except one. Most of the water samples were acidic in nature. Acidic nature of water samples might be because of low temperature which increases solubility of CO₂.

Electrical Conductivity (EC): Electrical conductivity of samples of irrigation water W-01 to W-10 was found to be 1190, 1150, 1130, 1020, 1220, 870, 840, 910, 970 and 930 μS/cm respectively. BIS limit (1998) is 3000 μS/cm. EC of all samples was found in desirable limit. As per the water classes of US Salinity

Laboratory for determining suitability of water for irrigation purpose, 100% water samples were found in Class-C3 (Table 1). In some samples high electric conductivity might be due to large percentage of dissolved inorganic salts.

Table 1: Classes of water on the basis of EC (US Salinity Laboratory).

EC (μS/cm)	Quality of water	Suitability	Class
< 250	Low salinity	Suitable for most soil	C1
250 to 750	Medium salinity	Suitable for moderate drainage soil	C2
750 to 2250	High salinity	Unsuitable for restricted drainage soil	C3
> 2250	Very high salinity	Unsuitable for irrigation under average conditions	C4

Alkalinity (HCO₃²⁻, CO₃²⁻, OH⁻): Total alkalinity of samples of irrigation water W-01 to W-10 in terms of CaCO₃ was observed to be 9.348, 9.479, 10.824, 9.741, 9.676, 12.464, 12.595, 4.690, 14.432 and 14.104 meq/lit respectively. BIS limit (1998) is 40 meq/lit. Total alkalinity of all samples was found in permissible limit. Investigation showed that in eight water samples CO₃²⁻ and OH⁻ ions were absent and hence whatever alkalinity of water samples was found, that was because of presence of HCO₃²⁻ i.e. bicarbonates only. In water sample W-03 and W-07 the alkalinity was because of presence of CO₃²⁻ and HCO₃²⁻ i.e. carbonates and bicarbonates both.

Chloride (Cl⁻): Chloride present in samples of irrigation water W-01 to W-10 was found to be 4.180, 4.560, 3.648, 3.952, 5.472, 1.824, 1.596, 1.824, 1.900 and 1.672 meq/lit respectively. BIS limit (1998) is 6 meq/lit. Chloride content of all samples was found in permissible limit. According the chloride present in irrigation water samples, 50% water samples were found in Class-C1 and 50% in Class-C2 (Table 2). It was observed that, with increase in electrical conductivity of water generally concentration of chloride gets increased.

Table 2: Classes of water on the basis of concentration of chloride.

Chloride (meq/lit)	Quality of water	Class
< 2	Excellent	C1
2 to 6	Good to injurious	C2
> 6	Injurious to unsuitable	C3

Sulphate (SO₄²⁻): Sulphate present in samples of irrigation water W-01 to W-10 was observed to be 0.116, 0.077, 0.102, 0.066, 0.058, 0.016, 0.033, 0.024, 0.033 and 0.020 meq/lit respectively. BIS limit (1998) is 3.5 meq/lit. Sulphate content of all samples was found in desirable limit. According the sulphate present in irrigation water samples, 100% water samples were found in Class-C1 (Table 3).

Table 3: Classes of water on the basis of concentration of sulphate.

Sulphate (meq/lit)	Quality of water	Class
< 4	Excellent	C1
4 to 12	Good to injurious	C2
> 12	Injurious to unsuitable	C3

Calcium (Ca²⁺): Calcium present in samples of irrigation water W-01 to W-10 was found to be 4.345, 3.562, 2.259, 3.562, 3.910, 1.216, 1.390, 1.824, 1.303 and 1.651 meq/lit respectively. BIS limit (1998) is 5 meq/lit. Calcium content of all samples was found in permissible limit.

Magnesium (Mg²⁺): Magnesium present in samples of irrigation water W-01 to W-10 was observed to be 1.824, 2.085, 2.607, 1.564, 1.998, 2.085, 1.365, 1.738, 1.452 and 1.738 meq/lit respectively. BIS limit (1998) is 4 meq/lit. Magnesium content of all samples was found in permissible limit.

Sodium (Na⁺): Sodium present in samples of irrigation water W-01 to W-10 was found to be 1.957, 2.435, 4.306, 2.566, 2.870, 4.828, 5.089, 4.958, 5.654 and 5.350 meq/lit respectively. BIS limit (1998) is 8.5 meq/lit. Sodium content of all samples was found to in permissible limit.

Soluble Sodium Percentage (SSP): SSP value of samples of irrigation water W-01 to W-10 was observed to be 24.080, 30.128, 46.983, 33.359, 32.695, 59.390, 64.870, 58.190, 67.960 and 61.210 meq/lit respectively. As per the water classes of Wilcox based on SSP, 40% water samples were found in Class-S2, 30% in Class-S3 and 30% in Class-S4 (Table 4). Most of the water samples were found suitable for all type of soils. SSP was calculated by using following equation.

$$SSP = \frac{[Na^+]}{[Ca^{2+}+Mg^{2+}+Na^++K^+]} \times 100$$

Sodium Adsorption Ratio (SAR): SAR value of samples of irrigation water W-01 to W-10 was found to be 1.114, 1.449, 2.762, 1.603, 1.782, 3.758, 4.336, 3.715,

4.740 and 4.110 meq/lit respectively. As per the water classes of US Salinity Laboratory based on SAR, 100% water samples were found in Class-S1 (Table 5). All water samples were found to be suitable for all type of soils. SAR was calculated by using following equation.

$$SAR = \frac{[Na^+]}{\sqrt{[Ca^{2+}+Mg^{2+}] / 2}}$$

Table 4: Classes of water on the basis of SSP (US Salinity Laboratory).

SSP	Quality of water	Class
< 20	Excellent	S1
20 to 40	Good	S2
40 to 60	Permissible	S3
60 to 80	Doubtful	S4
> 80	Unsuitable	S5

Table 5: Classes of water on the basis of SAR (US Salinity Laboratory).

SAR	Quality of water	Suitability	Class
< 10	Low sodium	Suitable for most soil	S1
10 to 18	Medium sodium	Suitable for coarse soil	S2
18 to 26	High sodium	Unsuitable for coarse soil	S3
> 26	Very high sodium	Unsuitable for most soil	S4

Potassium (K⁺): Potassium present in samples of irrigation water W-01 to W-10 was observed to be nil. BIS limit (1998) is 2.5 meq/lit.

Total Dissolved Solids (TDS): Total dissolved solids present in samples of irrigation water W-01 to W-10 was found to be 1100, 1300, 1600, 600, 1500, 600, 1200, 1100, 1400 and 1400 mg/lit respectively. BIS limit (1998) is 600 mg/lit. TDS value of only two samples was not found in permissible limit.

Chemical Oxygen Demand (COD): Chemical oxygen demand of samples of irrigation water W-01 to W-10 was observed to be 0, 40, 0, 80, 160, 80, 0, 40, 40 and 40 mg/lit respectively. BIS limit (1998) is 250 mg/lit. COD value of all samples was found in permissible limit.

Dissolved Oxygen (DO): Dissolved oxygen present in samples of irrigation water W-01 to W-10 was found to be 0.52, 0.20, 4.04, 0.28, 0.80, 0.52, 1.88,

1.80, 0.12 and 1.12 mg/lit respectively. BIS limit (1998) is 10 mg/lit. DO value of all samples was found in permissible limit.

Biological Oxygen Demand (BOD): Biological oxygen demand of samples of irrigation water W-01 to W-10 was observed to be 0.28, 0.12, 1.12, 0.16, 0.52, 0.32, 0.72, 0.56, 0.08 and 0.28 mg/lit respectively. BIS limit (1998) is 30 mg/lit. BOD value of all samples was found in permissible limit. BOD value of all water samples was much less.

CONCLUSION: It was found that physico-chemical parameters like temperature, colour, pH, EC, alkalinity, chloride, sulphate, calcium, magnesium, sodium, potassium, COD, DO and BOD of almost all water samples were found in desirable and permissible limit. pH of almost all samples was acidic. TDS of maximum samples was not in desirable limit. On the basis of all these irrigation quality parameters, SSP and SAR criteria, almost all water samples were found to be of good quality and suitable for irrigation in most of the soils.

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