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# Assessment of Ground Water Quality of Agricultural Land for Irrigation Purpose in Some Villages of Akola District of Maharashtra, India

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**ABSTRACT: Assessment of ground water quality of agricultural land for irrigation purpose in Gram-Kolvihir, Kumbhari and Shivapur of Akola district of Maharashtra, India was carried out to evaluate the factors regulating ground water quality. Total fifteen samples of the ground water were drawn from the open wells in the month of September-2017 and analyzed for various physico-chemical parameters such as temperature, colour, pH, EC, alkalinity, chloride, sulphate, calcium, magnesium, sodium, potassium, TDS, COD, DO and BOD. Sodium hazard associated with the irrigation water was judged using SSP and SAR criteria. Results obtained were compared with the Bureau of Indian Standards (BIS) limits. Almost all the samples were found to be suitable for the irrigation purposes based on the irrigation quality parameters.**

**Keywords:** Assessment; ground water quality; agricultural land; irrigation and Akola.

**INTRODUCTION:** Ground water is the major source for irrigation in India. Quality of irrigation water is a crucial factor for long term soil productivity and it depends on the concentration of dissolved constituents present in water, depth of water table, topography, climate, composition of soil etc. Quality of water is an important consideration for appraisal of salinity in an irrigated area. Good quality water has the potential to cause maximum yield whereas poor quality water can develop various soil and cropping problems. Hence special management practices may then be required to maintain full crop productivity. The poor quality water may affect irrigated crops by causing accumulation of salts in the root zone, by causing loss of permeability of the soil due to excess sodium or calcium leaching or by containing pathogens or contaminants which are directly toxic to plants or to those consuming them. Contaminants in irrigation water may accumulate in the soil and after a period of years render the soil unfit for agriculture.

Quality of irrigation water is mostly judged by some determining factors such as soluble sodium percentage (SSP) and sodium absorption ratio (SAR).[1-5] It also depends upon 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. Total dissolved solids (TDS), chemical oxygen demand (COD), dissolved oxygen (DO) and biological oxygen demand (BOD) also affects the quality of water.[6-9]

The study of physico-chemical characteristics of water of various dams, canals, rivers, wells used for irrigation of agricultural land in various regions of India was carried out earlier by many co-workers. Literature is enriched with the determination of various parameters of irrigation water.[10-15] In present work, assessment of ground water quality of agricultural land for irrigation purpose in some villages of Akola district of Maharashtra, India was carried out.

**MATERIAL AND METHODS:** The present study of assessment of ground water quality of agricultural land of some villages in Akola district of Maharashtra, India for irrigation purpose was carried out in the month of September-2017. The physico-chemical parameters like temperature and colour of ground water utilized for purpose of irrigation were measured at the site itself. The pH was measured using digital pH-meter (Systronics-MKVI) with glass as an indicator electrode and saturated calomel as a reference electrode. The EC was checked by digital conductivity meter (Systronics-304) using conductivity cell (K=1). Dissolved salts i.e. $SO_4^{2-}$ was analyzed by using spectrophotometer (Systronics-166)

whereas $Na^+$ and $K^+$ were detected by the use of flame photometer (Systronics-130). Other physico-chemical parameters viz. $HCO_3^{2-}$, $CO_3^{2-}$, $OH^-$, $Cl^-$, $Ca^{2+}$, $Mg^{2+}$, COD, DO and BOD were estimated by standard titrimetric methods.[16] Amount of TDS present in irrigation water was also found out. SSP and SAR are the most common and reliable criteria for evaluating sodium hazard associated with the irrigation water.[4,5] These were calculated by using the following equations.

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

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

All weighing were made on Precisa-310-M (±0.001 g) balance. The chemicals and solvents used were of A.R. grade. Solvents were purified and made anhydrous by standard methods. Care was taken to protect the titrant from atmospheric moisture and carbon dioxide.

**Study area:** The ground water utilized for purpose of irrigation of agricultural land of Gram-Kolvihir, Kumbhari and Shivapur, District-Akola, Region-Vidarbha, State-Maharashtra, Country-India.

**Method of sampling:** The clean glass bottles with a leak proof cap were used for collection of an irrigation water samples. Bottles were thoroughly cleaned before sampling and rinsed several times with water before the water was finally drawn. Water samples from wells were collected directly from the pump discharge after the pumps have been run for 20 to 30 minute. Bottles were properly marked, labeled and brought to the laboratory.

**RESULTS AND DISCUSSION:** During present work, total fifteen ground water samples were drawn from the open wells and analyzed for various physico-chemical parameters. Results obtained were compared with the Bureau of Indian Standards (BIS) limits[17].

**Temperature:** The temperature of irrigation water samples W-01 to W-15 was found to be in the range of 25.6 to 29.2ºC. The limit of temperature for irrigation water as specified by BIS limits (1998) is maximum $40^0$C. The temperature of all the samples was found to be in desirable limit (Table 6). As all samples were collected from nearby areas to each other during the same period and almost same hours of the month September-2017, the environmental conditions were specifically the same and hence there was no great variation in temperature. The growth and death of microorganisms, kinetics of biochemical oxygen demand are regulated to some extent by water temperature. Temperature also affects characteristics of water like dissolution of gases, pH and conductivity.

**Colour:** The colour of irrigation water samples W-01 to W-15 was found to be the colourless and mostly transparent at the time of collection of samples.

**Hydrogen Ion Concentration (pH):** The pH of irrigation water samples W-01 to W-15 was observed to be in the span of 4.40 to 4.87 at 28ºC. The limit of pH value for irrigation water as specified by BIS limits (1998) is 6.5 to 8.5. The pH of all the samples was not found to be in desirable limit (Table 6). All the water samples were acidic in nature. The acidic nature of water samples might be due to low temperature that increases the solubility of $CO_2$.

**Electrical Conductivity (EC):** The electrical conductivity of irrigation water samples W-01 to W-15 was observed between 510 to 2190 µS/cm. The limit of electrical conductivity value for irrigation water as specified by BIS limits (1998) is 3000 µS/cm. The electrical conductivity of almost all the samples was found to be in desirable limit and some samples in permissible limit (Table 6). According to the water classes proposed by US Salinity Laboratory for judging the suitability of water for irrigation purpose, 40% water samples were found to be in the Class-C2 and 60% water samples in the Class-C3 (Table 1). Large amount of dissolved inorganic salts must have been the cause for high electric conductivity in some samples.

**Table 1: Water classes based on EC (US Salinity Laboratory).**

| Class | Water Quality | EC (µS/cm) | Suitability |
|---|---|---|---|
| C1 | Low salinity | < 250 | Suitable for most soil |
| C2 | Medium salinity | 250 to 750 | Suitable for moderate drainage soil |
| C3 | High salinity | 750 to 2250 | Unsuitable for restricted drain-age soil |
| C4 | Very high salinity | > 2250 | Unsuitable for irrigation under average condi-tions |

**Alkalinity ($HCO_3^{2-}$, $CO_3^{2-}$, $OH^-$):** The total alkalinity of irrigation water samples W-01 to W-15 in terms of $CaCO_3$ was found to be varied from 1.140 to 20.660

m.eq./lit. The limit of total alkalinity value for irrigation water as specified by BIS limits (1998) is 40 m.eq./lit. The total alkalinity of all the samples was found to be in permissible limit (Table 7). During investigation it was found that in all water samples $CO_3^{2-}$ and $OH^-$ ions were not present and hence whatever the alkalinity of water samples was observed, that was because of presence of $HCO_3^{2-}$ i.e. bicarbonates only.

**Chloride ($Cl^-$):** The chloride present in irrigation water samples W-01 to W-15 was found to be in the range of 0.894 to 6.733 m.eq./lit. The limit of chloride value for irrigation water as specified by BIS limits (1998) is 6 m.eq./lit. The chloride content of all the samples was found to be in permissible limit except one (Table 7). On the basis of chloride present in irrigation water samples, 47% water samples were found to be in the Class-C1, 47% water samples in the Class-C2 and 6% water samples in the Class-C3 (Table 2). It was observed that, generally the concentration of chloride get increased with increase in electrical conductivity of water.

**Table 2: Water classes based on concentration of chloride.**

| Class | Water Quality | Chloride (meq/lit) |
|---|---|---|
| C1 | Excellent | < 2 |
| C2 | Good to injurious | 2 to 6 |
| C3 | Injurious to un-suitable | > 6 |

**Sulphate ($SO_4^{2-}$):** The sulphate present in irrigation water samples W-01 to W-15 was observed to be in the span of 0.012 to 0.179 m.eq./lit. The limit of sulphate value for irrigation water as specified by BIS limits (1998) is 3.5 m.eq./lit. The sulphate content of all the samples was found to be in desirable limit (Table 7). On the basis of sulphate present in irrigation water samples, 100% water samples were found to be in the Class-C1 (Table 3).

**Table 3: Water classes based on concentration of sulphate.**

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

**Calcium ($Ca^{2+}$):** The calcium present in irrigation water samples W-01 to W-15 was observed between 0.995 to 4.988 m.eq./lit. The limit of calcium value for irrigation water as specified by BIS limits (1998) is 5 m.eq./lit. The calcium content of all the samples was found to be in permissible limit (Table 7).

**Magnesium ($Mg^{2+}$):** The magnesium present in irrigation water samples W-01 to W-15 was found to be varied from 1.295 to 4.587 m.eq./lit. The limit of magnesium value for irrigation water as specified by BIS limits (1998) is 4 m.eq./lit. The magnesium content of all the samples was found to be in permissible limit except one (Table 7).

**Sodium ($Na^+$):** The sodium present in irrigation water samples W-01 to W-15 was found to be in the range of 1.221 to 5.397 m.eq./lit. The limit of sodium value for irrigation water as specified by BIS limits (1998) is 8.5 m.eq./lit. The sodium content of maximum samples was found to be in desirable limit and some samples in permissible limit (Table 7).

**Soluble Sodium Percentage (SSP):** The SSP value of irrigation water samples W-01 to W-15 was observed between 16.86 to 55.30 m.eq./lit. (Table 7). According to water classes proposed by Wilcox on the basis of SSP, for judging the suitability of water for irrigation purpose, 7% water samples were found to be in the Class-S1, 60% water samples in the Class-S2 and 33% water samples in the Class-S3 (Table 4). All water samples were found to be suitable for all type of soils.

**Table 4: Water classes based on SSP (US Salinity Laboratory).**

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

**Sodium Adsorption Ratio (SAR):** The SAR value of irrigation water samples W-01 to W-15 was observed between 0.721 to 2.902 m.eq./lit. (Table 7). According to water classes proposed by US Salinity Laboratory on the basis of SAR, for judging the suitability of water for irrigation purpose, 100% water samples were found to be in the Class-S1 (Table 5). All water samples were found to be suitable for all type of soils.

**Table 5: Water classes based on SAR (US Salinity Laboratory).**

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

**Potassium ($K^+$):** The potassium present in irrigation water samples W-01 to W-15 was observed to be in

the span of 0.097 to 3.532 m.eq./lit. The limit of potassium value for irrigation water as specified by BIS limits (1998) is 2.5 m.eq./lit. The potassium content of all the samples was found to be in permissible limit except one (Table 7).

**Total Dissolved Solids (TDS):** The total dissolved solids present in irrigation water samples W-01 to W-15 was observed between 310 to 1280 mg/lit. The limit of TDS value for irrigation water as specified by BIS limits (1998) is 600 mg/lit. The TDS value of overall nine samples was not found to be in permissible limit (Table 6).

**Table 6: Physico-chemical analysis of irrigation water samples W-01 to W-15.**

| Sample | Temp. | pH | EC | TDS | COD | DO | BOD |
|---|---|---|---|---|---|---|---|
| --- | (ºC) | --- | (µS/cm) | (mg/lit.) | | | |
| **W-01** | 26.5 | 4.78 | 615 | 350 | 170 | 1.42 | 0.65 |
| **W-02** | 25.6 | 4.84 | 645 | 590 | 135 | 5.82 | 1.19 |
| **W-02** | 27.1 | 4.81 | 710 | 800 | 45 | 6.81 | 1.10 |
| **W-04** | 28.2 | 4.81 | 755 | 920 | 60 | 1.29 | 0.38 |
| **W-05** | 26.4 | 4.87 | 560 | 690 | 90 | 1.26 | 0.68 |
| **W-06** | 28.2 | 4.84 | 910 | 950 | 230 | 6.90 | 0.09 |
| **W-07** | 27.5 | 4.82 | 930 | 710 | 85 | 4.09 | 0.09 |
| **W-08** | 25.6 | 4.80 | 790 | 1090 | 115 | 7.62 | 1.30 |
| **W-09** | 27.8 | 4.74 | 1810 | 1280 | 85 | 7.84 | 1.10 |
| **W-10** | 28.8 | 4.79 | 2190 | 810 | 85 | 2.81 | 0.06 |
| **W-11** | 28.5 | 4.47 | 1120 | 310 | 285 | 7.34 | 3.18 |
| **W-12** | 28.7 | 4.48 | 730 | 550 | 230 | 4.55 | 0.25 |
| **W-13** | 27.7 | 4.52 | 745 | 830 | 240 | 7.41 | 4.15 |
| **W-14** | 29.2 | 4.41 | 1450 | 600 | 55 | 7.78 | 2.81 |
| **W-15** | 28.0 | 4.40 | 1235 | 580 | 190 | 8.05 | 2.64 |
| **BIS Limits** | 40 | 6.5-8.5 | 3000 | 600 | 250 | 10 | 30 |

**Table 7: Physico-chemical analysis of irrigation water samples W-01 to W-15.**

| Sample | $HCO_3^{2-}$ | $Cl^-$ | $SO_4^{2-}$ | $Ca^{2+}$ | $Mg^{2+}$ | $Na^+$ | $K^+$ | SSP | SAR |
|---|---|---|---|---|---|---|---|---|---|
| --- | (m.eq./lit.) | | | | | | | | |
| **W-01** | 16.849 | 1.254 | 0.026 | 1.299 | 1.692 | 3.215 | 0.149 | 50.59 | 2.630 |
| **W-02** | 20.660 | 1.071 | 0.023 | 1.394 | 1.892 | 3.308 | 0.177 | 48.85 | 2.580 |
| **W-02** | 18.485 | 1.792 | 0.025 | 1.491 | 1.898 | 3.008 | 0.131 | 46.07 | 2.310 |
| **W-04** | 17.475 | 2.152 | 0.026 | 1.590 | 2.290 | 2.699 | 0.108 | 40.36 | 1.937 |
| **W-05** | 15.960 | 1.164 | 0.012 | 0.995 | 1.394 | 3.172 | 0.174 | 55.30 | 2.902 |
| **W-06** | 16.885 | 0.894 | 0.023 | 2.591 | 1.494 | 1.389 | 0.125 | 23.15 | 0.972 |
| **W-07** | 16.510 | 2.331 | 0.056 | 3.390 | 1.791 | 2.004 | 0.336 | 26.64 | 1.245 |
| **W-08** | 18.338 | 1.165 | 0.032 | 3.091 | 1.295 | 1.301 | 0.106 | 22.45 | 0.879 |
| **W-09** | 17.588 | 4.662 | 0.109 | 3.689 | 2.891 | 4.389 | 3.532 | 30.26 | 2.419 |
| **W-10** | 18.290 | 6.733 | 0.160 | 4.988 | 4.587 | 5.397 | 2.481 | 30.92 | 2.466 |
| **W-11** | 1.140 | 3.830 | 0.062 | 3.789 | 2.290 | 1.258 | 0.123 | 16.86 | 0.721 |
| **W-12** | 1.172 | 1.601 | 0.037 | 2.098 | 1.793 | 1.691 | 0.104 | 29.73 | 1.212 |
| **W-13** | 1.305 | 2.101 | 0.025 | 1.493 | 1.695 | 1.221 | 0.129 | 26.90 | 0.967 |
| **W-14** | 1.823 | 4.890 | 0.179 | 1.590 | 2.598 | 2.689 | 0.097 | 38.55 | 1.858 |
| **W-15** | 1.709 | 2.741 | 0.120 | 1.892 | 2.496 | 2.613 | 0.148 | 36.55 | 1.764 |
| **BIS Limits** | 40 | 6 | 3.5 | 5 | 4 | 8.5 | 2.5 | --- | --- |

**Chemical Oxygen Demand (COD):** The chemical oxygen demand of irrigation water samples W-01 to W-15 was found to be varied from 45 to 285 mg/lit. The limit of COD value for irrigation water as specified by BIS limits (1998) is 250 mg/lit. The COD value of all the samples was found to be in permissible limit except one (Table 6).

**Dissolved Oxygen (DO):** The dissolved oxygen present in irrigation water samples W-01 to W-15 was found to be in the range of 1.26 to 8.05 mg/lit. The limit of DO value for irrigation water as specified by BIS limits (1998) is 10 mg/lit. The DO value of all the samples was found to be in permissible limit (Table 6).

**Biological Oxygen Demand (BOD):** The biological oxygen demand of irrigation water samples W-01 to W-15 was observed to be in the span of 0.06 to 4.15 mg/lit. The limit of BOD value for irrigation water as specified by BIS limits (1998) is 30 mg/lit. The BOD value of all the samples was found to be in permissible limit (Table 6). The BOD value of all water samples was much less.

**CONCLUSION:** During the study, it was found that the physico-chemical parameters like temperature, colour, EC, alkalinity, chloride, sulphate, calcium, magnesium, sodium, potassium, COD, DO and BOD of almost all water samples were found to be in desirable and permissible limit. The pH of all samples was not in desirable limit and they were found to be acidic in nature. The TDS of maximum samples was not found to be 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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