Quality of Irrigation Water: Need and Criteria

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ABSTRACT

Water is an important input in crop production. Before using, the water's suitability for usage needs to be determined by testing its quality. Whether it is pumped from tube wells or diverted from streams, irrigation water contains a sizable amount of dangerous compounds in solution that could lower crop output and can reduce the fertility of the soil. The primary attributes used to evaluate the quality of irrigation water are sodium absorption ratio (SAR), total dissolved solids (TDS), and Residual Sodium Carbonate (RSC) and Electrical Conductivity (EC). The water's quality is being declined as a result of the untreated industrial effluent and agricultural saline being disposed of effluents straight into canal water and groundwater. Therefore, determination of the quality of irrigation water is important before applying it to irrigation.

INTRODUCTION

The importance of water quality is a key factor when evaluating salinity or alkali conditions in a irrigated region. Around 127340 square kilometers of land in the nation is categorized as arid and semi-arid areas, where there is a scarcity of surface water resources. Water in dry areas for irrigation typically contains dissolved salts such as Ca^{+2}, Mg^{+2}, Na^{+} cations, and anions like Cl^{-}, SO_4^{-}, HCO_3^{-}, and CO_3. Occasionally, borate (BO_3^{-}) and nitrate (NO_2^{-}) can also be present. The water quality is determined by the quantity and type of salts dissolved in it.

In India there is urgent need to give a fresh look to introduce new concepts of water quality due to following reasons:

- The population is growing rapidly. Taking out too much high-quality water can result in the lowering of the water table and decline in water quality. In the future, an increasing amount of saline waters will need to be utilized for agricultural purposes.
- The impact of irrigation water on soil characteristics is altered, opening up possibilities for using extremely salty waters. Various innovative irrigation methods like sprinkler, drip, and pitcher techniques have been developed, utilizing less water and enabling the use of more saline water.
- Utilizing both canal and ground waters together, along with implementing new irrigation techniques and growing crops that can tolerate salinity, will result in more efficient use of highly saline/sodic waters.
- Crops have demonstrated the ability to tolerate salt at various growth stages, indicating that it is possible to use even very salty water.

CRITERIA OF SUITABILITY OF WATER FOR IRRIGATION

The characteristics of irrigation water that appear to be important in determining its quality are:

Total Concentration of Soluble Salts in Water.

Electrical conductivity (EC) is used to measure the concentration of total soluble salts (TSS). An increase in salt content directly correlates with an increase in EC. Therefore, consistent use of irrigation water with moderate to high salt levels can lead to saline conditions. The irrigation water is categorized into four classes based on electrical conductivity (EC) readings which are shown in table no. 1.

Table no. 01

Conductivity (dS/m)	Class	Inference
0.00-0.25	Low salinity (C1)	Suitable for most of the crops.
0.25-0.75	Medium salinity (C2)	Moderate leaching is required. Moderate salt tolerant crops should be grown.
0.75-2.25	High salinity (C3)	Should not be used where drainage is restricted.
2.25-5.00	Very high salinity (C4)	Not suitable for irrigation.

Sodium Adsorption Ratio (SAR)

The categorization of irrigation waters based on Sodium adsorption ratio (SAR) focuses mainly on the impact of exchangeable sodium on soil physical conditions. High levels of sodium lead to increased risk of alkali hazard. The waters are categorized into four groups based on the Na risks as listed in table no. 02.

Sodium Adsorption ratio is estimated by

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

Where Ca^{+2}, Na^{+}, and Mg^{+2} represent the concentration in millimoles per litre (m mole/l) of the respective ions.

Table no. 02

SAR value	Class	Inference
0-10	Low Na water (S_1)	Suitable for all soils with little danger for Na sensitive crops.
10-18	Medium Na water (S_2)	Suitable for soils having high permeability while hazardous in fine

		textured one.
18-26	High Na water (S_3)	Needed management practices like leaching and application of organic matter and gypsum.
>26	Very high Na water (S_4)	Not Suitable for irrigation unless special management as above applied

Residual Sodium Carbonate

High levels of bicarbonate ions in water cause calcium and magnesium to form carbonate precipitates. This can be demonstrated as RSC = (CO_3^{2-} + HCO_3^-) - (Ca^{2+}+Mg^{2+}). Where, CO_3^{2-} , HCO_3^- Ca^{2+}, Mg^{2+} represents the concentration in millimoles/ litre (m moles/l) of respective ions. The amount of rain, type of soil, and the specific plant types to be cultivated are major factors in determining the tolerance limits of RSC for water suitability in a given region. An illustration is studies conducted by CSSRI have found that water with RSC 5.0 meq/l is feasible in areas with 70 to 90 cm of rainfall annually.

Table no. 03. The standard for RSC as given by USSSL as follows:

RSC (meq/lit)	Quality of irrigation water
Less than 1.25	Mostly safe for most of the crops
1.25-2.50	Can be used in light textured soils with adequate leaching and application of gypsum
More than 2.50	Not suitable for irrigation purposes

Concentration of Boron in Irrigation Water

Boron is necessary for plants to grow, but can be highly harmful at levels just slightly higher than what is ideal. The presence of high levels of boron in specific irrigation water requires taking this element into account when evaluating water quality. Boron cannot be easily eliminated or precipitated from water. The sole solution that is currently acknowledged is to either dilute water with high boron levels or cultivate crops that are tolerant to boron. If the level of water-soluble boron exceeds 1 ppm, it is deemed unsuitable for irrigation purposes. The USDA has recommended specific crops to be cultivated based on the level of boron found in the irrigation water. The boundaries are set as in table no. 04.

Table no. 04

Boron content of irrigation water (ppm)	Boron tolerance of crops	Crops to be grown
0.3-1.0	Sensitive	Citrus, Apricot, Peach, Apple, Pear, Plum, walnut
1.0-2.0	Semi-tolerant	Sweet potato, Oats, Sorghum, Maize, Wheat, Barley, Radish, Peas, Tomato, Cotton, Potato, Sunflower
2.0-4.0	Tolerant	Carrot, Cabbage, Onion, Beans, Sugar beet, Alfalfa.

Chloride Concentration

Chloride is present in soils in the form of chloride ion (Cl-), which is a highly soluble and mobile ion. Toxic levels of chloride may build up. Chloride is one of the most abundant anions found in soluble salts that can impede plant growth. Irrigation water with elevated levels of chloride can lead to salt damage on the leaves. It can serve as a parameter in determining the classification of water in different regions.

Table no. 05

Chloride concentration (meq/lit)	Class
0-4	Excellent
4-7	Good

7-12	Permissible
>12	Not suitable for irrigation

Concentration of Lithium

Research has shown that low levels (0.05 - 1.0 ppm) of lithium in irrigation water negatively impacted the growth of citrus crops. Reports have shown that India has saline soils with different levels of lithium content, reaching up to 2.5 ppm.

CONCLUSION

The importance of irrigation water quality cannot be understated in ensuring sustainable agricultural productivity. Important factors for evaluating the quality of irrigation water are salinity, sodium risk, and the existence of certain ions such as chloride, boron. Comprehending these factors aids in making well-informed choices regarding water management methods, ultimately resulting in improved crop yields and soil preservation. Hence, it is crucial to consistently monitor and manage the quality of irrigation water for the purpose of achieving agricultural success and environmental sustainability.

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