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Irrigation Water Quality and Suitability

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Water quality is a crucial factor in determining its suitability for irrigation use, as it affects the concentration and composition of dissolved constituents in the water. The presence of salts is a common feature in all irrigation waters, but their concentration and nature can vary. The quality of irrigation water primarily depends on the total amount of salt present and the ratio of Na to other cations, along with other relevant parameters.

Two main sources of moisture for agricultural crops are rainwater and irrigation water. Rainwater is generally devoid of mineral content, although it does contain dissolved gases such as N, Ar, O2, CO2, and NH3 obtained from the atmosphere. On the other hand, irrigation water comprises surface water and groundwater.

Criteria for Evaluation of Irrigation Water

The quality of water is evaluated based on its intended use, and for irrigation purposes, it is commonly assessed in terms of salinity, sodicity, and potential toxicities of certain elements. In contrast, when considering water quality for other purposes, various factors such as taste, colour, odour, turbidity, temperature, hardness, pH, BOD (biological oxygen demand), COD (chemical oxygen demand), nutrient content (such as N, P), and the presence of pathogens are important considerations. However, these parameters may not always be relevant in assessing the quality of irrigation water.

Various criteria are considered in evaluating the quality of irrigation water namely

1. Salinity hazard or total concentration of soluble salts or Electrical Conductivity (EC),
2. Sodium hazard or relative sodium concentration,
3. Bicarbonate hazard-Residual Sodium Carbonate (RSC),
4. Boron concentration,
5. Chloride concentration,
6. Soluble Sodium Percentage (SSP),
7. Magnesium hazard,
8. Salt index,
9. Nitrate concentration and
10. Lithium.

1) **Salinity hazard or total soluble salt concentration:** The concentration of soluble salts in irrigation water can be classified in terms of electrical conductivity (EC) and expressed as dS/m (decisiemens per meter).

Water class	Electrical conductivity (dS m^{-1})	Salt concentration (g/l)	Remarks
C1 : Low Salinity	0 – 0.25	Less than 0.16	Can be used safely
C2 : Medium salinity	0.25 – 0.75	0.16 – 0.5	Can be used with moderate leaching
C3 : High salinity	0.75 – 2.25	0.5 – 1.5	Cannot be used on soils with restricted drainage
C4 : Very high salinity	2.25 – 5.00	1.5 – 3.00	Cannot be used for irrigation purposes

2) **Sodium hazard:** Excessive amounts of sodium in water can have adverse effects on soil quality. When sodium accumulates on the cation exchange sites in soil, it can cause the breakdown of soil aggregates (deflocculation), which leads to the sealing of soil pores and reduced permeability to water flow. The potential for sodium to displace other cations and increase its proportion on the cation exchange sites can be estimated using a ratio of sodium content to the combined content of calcium and magnesium in irrigation water. This ratio is known as the sodium adsorption ratio (SAR).

$$\text{SAR} = \frac{Na^{+}}{\sqrt{(Ca^{2+} + Mg^{2+})/2}}$$

Water class	SAR	Remarks
S1 : Low sodium	0 – 10	Little or no hazard
S2 : Medium sodium	10 – 18	Appreciable hazard, but can be used with appropriate manag ement.
S3 : High sodium	18 – 26	Unsatisfactory for most of the crops
S4 : Very high sodium	more than 26	Unsatisfactory for most of the crops

3) **Based on Residual sodium carbonate (RSC):** The bicarbonate (HCO3-) anion is an important in irrigation water as regards calcium and to a lesser degree also of magnesium as their carbonates in the soil. This brings about a change in the soluble sodium percentage (SSP) in the irrigation water and therefore, an increase of the sodium hazard.

RSC = (CO 32- + HCO3-) + (Ca^{2+} + Mg $^{2+}$)

RSC is Expressed as milli equivalents per litre (me/1)

Water class	RSC (me/1)	Remark
Low RSC	Less than 1.25	Safe for irrigation
Medium RSC	1.25 – 2.50	Marginally safe with certain management.
High RSC	More than 2.5	Unsuitable for irrigation

4) **Concentration of Boron:** It is evident that boron is essential for the normal growth the plant, but the amount required is very small.

Boron class	Boron Concentration (ppm)			Remarks
	Sensitive crop	Semi tolerant crops	Tolerant crops	
Very low	< 0.33	< 0.67	< 1.00	Can be used safely
Low	0.33 – 0.67	0 – 1.33	1.00 – 2.00	Can be used with management
Medium	0.67 – 1.00	1 – 2.00	2.00 – 3.00	Marginally safe with certain management.
High	1.00 – 1.25	2 – 2.50	3.00 – 3.75	Unsuitable for irrigation
Very high	>1.25	> 2.50	> 3.75	Unsuitable for irrigation

5) **Chloride Concentration:** Since the chloride ion has no effect on the physical properties of a soil and is not adsorbed on the soil complex and so it has generally not been included in modern classification system. However, it can be used as a factor in some regional water classification.

Water class	Chloride concentration (meq/1)	Water quality
1.	Less than 4	Excellent water
2.	4 – 7	Moderately good water
3.	7 – 12	Slightly usable
4.	12 – 20	Unsuitable for irrigation
5.	More than 20	Unsuitable for irrigation

6) **Soluble sodium percentage (SSP):**

$$\text{SSP} = \frac{Na^{+} X100}{Ca^{2+}+Mg^{2+}+Na^{+}}$$

Water class	SSP	Water quality
1.	Less than 60	Good quality and suitable for irrigation
2.	Greater than 60	Poor quality water and unsuitable for irrigation

7) **Magnesium hazard**: It is believed that one of the important qualitative criteria in judging the irrigation water is its magnesium content in relation to total divalent cations, since high magnesium adsorption by soils affects their physical properties. A harmful effect on soils appears when Ca: Mg ratio declines below 50.

$$\text{Mg-adsorption ratio} = \frac{Mg^{2+}}{Ca^{2+} + Mg^{2+}}$$

8) **Salt index:** It is also used for predicting sodium hazard. It is the relation between Na+, Ca2+ and CaCO3 present in irrigation water.

Salt index = (Total Na - 24.5) - [(Total Ca-Ca in + CaCO3) x 4.85]

Where, all quantities being expressed in ppm and all values of magnesium being reckoned as calcium.

The salt index is negative (-24.5 to 0) for irrigation water of high quality and any positive value of the salt index is harmful for irrigation purposes.

9) **Nitrate concentration**: Very frequently ground waters contain high amount of nitrate. When such type of irrigation water is applied on soils continuously various physical properties will be affected very badly which causes poor growth of the plants.

10) **Lithium:** Lithium is an important trace element which may be found in most of saline ground-waters and irrigated soils. It has been found that small concentrations (0.05 to 0.1 ppm) of lithium in irrigation water produced toxic effects on the growth of citrus crops. It has also been reported that saline soils of varying degrees found in India contain lithium upto 2.5 ppm. Fortunately the germination of majority of crops including rice, wheat, barley etc. are not affected with this level of lithium content in soils.

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