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Indian Standard

GUIDELINES FOR THE QUALITY OF IRRIGATION WATER

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GUIDELINES FOR THE QUALITY OF IRRIGATION WATER

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Indian Standard
GUIDELINES FOR THE QUALITY OF IRRIGATION WATER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 27 March 1986, after the draft finalized by the Irrigation Equipment and Systems Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 The quality of irrigation water is to be evaluated in terms of degree of harmful effects on soil properties with respect to the soluble salts it contains in different concentrations and crop yield. To evaluate the quality of irrigation water, this standard has been prepared as a guideline for advisory purposes.

0.3 In the preparation of this standard, considerable assistance has been derived from the Central Soil Salinity Research Institute, Karnal and Water Technology Centre, Indian Agricultural Research Institute, New Delhi.

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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1. SCOPE

1.1 This standard prescribes the guidelines for assessing the quality of irrigation water.

2. TERMINOLOGY

2.1 For the purpose of this standard the definitions given in IS : 7022-1973† and IS : 11077-1984‡ shall apply.

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*Rules for rounding off numerical values (*revised*).

†Glossary of terms relating to water, sewage, industrial effluents.

‡Glossary of terms on soil and water.

3. SUITABILITY CRITERIA

3.1 The suitability of an irrigation water depends upon several factors, such as, water quality, soil type, plant characteristics, irrigation method, drainage, climate and the local conditions. The integrated effect of these factors on the suitability of irrigation water (SI) can be expressed by the relationship given below:

$$SI = \int QSPCD$$

where

Q = quality of irrigation water, that is, total salt concentration, relative proportion of cations, etc;

S = soil type, texture, structure, permeability, fertility, calcium carbonate content, type of clay minerals and initial level of salinity and alkalinity before irrigation;

P = salt tolerance characteristics of the crop to be grown, its variety and growth stage;

C = climate, that is, total rainfall, its distribution and evaporation characteristics; and

D = drainage conditions, depth of water table, nature of soil profile, presence of hard pan or lime concentration and management practices.

3.1.1 These factors act interactively such that a single suitable criteria is hard to be adopted for widely varying conditions. However, a general broad guideline has been developed here.

3.2 Besides these factors, the presence of potassium and nitrate ions in water, is favourable for crop growth, as water of more salinity can be used in presence of these ions. In a particular climate, all the factors enumerated in **3.1**, are likely to vary and interact either positively or negatively in relation to salt accumulation and degree of harmful effect on soil properties and crop growth.

4. WATER QUALITY CRITERIA FOR IRRIGATION

4.1 The following chemical properties shall be considered for developing water quality criteria for irrigation:

a) Total salt concentration,

b) Sodium adsorption ratio,

c) Residual sodium carbonate or bicarbonate ion concentration, and

d) Boron content.

4.1.1 *Total Salt Concentration* — It is expressed as the electrical conductivity (EC). In relation to hazardous effects of the total salt concentration, the irrigation water can be classified into four major groups as given in Table 1.

TABLE 1 WATER QUALITY RATING BASED ON THE TOTAL SALT CONCENTRATION

Sl No.	Class	Range of EC (Micromhos/cm)
(1)	(2)	(3)
i)	Low	Below 1 500
ii)	Medium	1 500-3 000
iii)	High	3 000-6 000
iv)	Very high	Above 6 000

4.1.2 *Sodium Adsorption Ratio (SAR)* — shall be calculated from the following formula:

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

where

SAR = sodium adsorption ratio $\sqrt{(\text{millimole/litre})}$

Na = sodium ion concentration, me/l

Ca = calcium ion concentration, me/l

Mg = magnesium ion concentration, me/l

Note — me/l = milliequivalent/litre.

In relation to the hazardous effects of sodium adsorption ratio, the irrigation water quality rating is given in Table 2.

TABLE 2 WATER QUALITY RATING BASED ON SODIUM ADSORPTION RATIO

Sl No.	Class	SAR Range $\sqrt{(\text{millimole/litre})}$
(1)	(2)	(3)
i)	Low	Below 10
ii)	Medium	10-18
iii)	High	18-26
iv)	Very high	Above 26

4.1.3 Residual sodium carbonate (RSC) shall be determined by the equation:

$$RSC = (CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+})$$

where

RSC = residual sodium carbonate (me/l),

CO^{2-} = carbonate ion concentration (me/l),

HCO_3^- = bicarbonate ion concentration (me/l),

Ca^{2+} = calcium ion concentration (me/l), and

Mg^{2+} = magnesium ion concentration (me/l).

NOTE — me/l = milliequivalent/litre.

In relation to the hazardous effects of high bicarbonate ion concentration expressed as residual sodium carbonate, the irrigation water quality rating is given in Table 3.

TABLE 3 WATER QUALITY RATING BASED ON RESIDUAL SODIUM CARBONATE

SL NO.	CLASS	RSC RANGE (me/l)
(1)	(2)	(3)
i)	Low	Below 1·5
ii)	Medium	1·5-3·0
iii)	High	3·0-6·0
iv)	Very high	Above 6·0

4.1.4 *Boron Content* — Boron, though a nutrient, becomes toxic if present in water beyond a particular level. In relation to boron toxicity, the irrigation water quality rating is given in Table 4.

TABLE 4 WATER QUALITY RATING BASED ON BORON CONTENT

SL NO.	CLASS	BORON (ppm)
(1)	(2)	(3)
i)	Low	Below 1·0
ii)	Medium	1·0-2·0
iii)	High	2·0-4·0
iv)	Very high	Above 4·0

4.2 Though all the chemical characteristics have been classified separately, they are present in each irrigation water, and the chemical characteristics

of a particular class of water is independent of the chemical characteristics of different classes of water. For example, a water of high EC may or may not have high SAR or RSC or boron. These chemical characteristics interact with each other and cause hazardous effects on soil properties and crop growth.

5. WATER QUALITY RATING IN RELATION TO SOIL TYPE AND CROP TOLERANCE TO SALTS

5.1 Keeping in view the soil types and quality of ground water, the upper permissible limit of electrical conductivity (EC), sodium adsorption ratio (SAR), residual sodium carbonate (RSC) and boron content for the semi-tolerant and tolerant crops are given in Table 5, while tolerance of crops to salinity, sodicity and boron are given in Table 6.

TABLE 5 SUITABILITY OF IRRIGATION WATER FOR SEMI-TOLERANT AND TOLERANT CROPS IN DIFFERENT SOIL TYPES

Sl No.	Soil Textural Group	Upper Permissible Limit of							
		Salinity EC (micromhos/cm)		Sodicity SAR $\sqrt{(\text{milli mole/l})}$		Boron RSC (me/l)		B (ppm)	
		S. T.*	T.†	S.T.*	T.†	S.T.*	T.†	S.T.*	T.†
i)	*Above 30 Percent Clay* Sandy clay clay loam, silty clay loam, silty clay, clay	1 500	2 000	10	15	2	3	2	3
ii)	*20-30 Percent Clay* Sandy clay loam, loam, silty loam	4 000	6 000	15	20	3	4	2	3
iii)	*10-20 Percent Clay* Sandy loam, loam, silty loam	6 000	8 000	20	25	4	5	2	3
iv)	*Below 10 Percent Clay* Sand, loamy sand, sandy loam, silty loam, silt	8 000	10 000	25	30	5	6	1	2

NOTE — The use of waters of 4 000 micromhos/cm EC and above be confined to winter season crops only. They should not be used during the summer season. Even during emergencies not more than one or two protective irrigations be given to the Kharif season crops.

*Semi-tolerant crops.
†Tolerant crops.

5.1.1 These limits are for specific conditions where the rainfall is below 600 mm/annum, no other source of water is available, drainage and water table is not a serious limitation. Presence of nitrate in water and gypsum in soil is favourable. Similarly, sulphate : chloride and calcium : magnesium ratio above 2·0 in water is also beneficial.

TABLE 6 TOLERANCE OF FIELD AND VEGETABLE CROPS TO SALINITY, SODICITY AND BORON

(*Clause* 5.1)

Crops	Salinity		Sodicity		Boron	
	S. T.*	T.†	S.T.*	T.†	S.T.*	T.†
Wheat	X		X		X	
Barley		X	X		X	
Cotton	X		X		X	
Oil seed crops	X		X		X	
Maize	X		X		X	
Jowar	X		X		X	
Bajra	X		X		X	
Rice	X		X		X	
Sugarcane	X		X		X	
Sugar beet		X		X		X
Tomato	X		X		X	
Cauliflower	X		X			X
Cabbage	X		X			X
Onion	X		X			X
Carrot	X		X			X
Radish	X		X		X	
Grasses	X			X		X
Berseem	X		X		X	

*Semi-tolerant.
†Tolerant.