

**P**resentation on  
**QUALITY OF IRRIGATION WATER**



# **QUALITY OF IRRIGATION WATER AND MANAGEMENT OF SALINE WATER FOR IRRIGATION**

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- Management Of Saline Water**
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# INTRODUCTION

**The suitability of irrigation water is mainly depends on the amounts and type of salts present in water. The main soluble constituents are calcium, magnesium, sodium as cations and chloride, sulphate, bicarbonate as anions. The other ions are present in minute quantities are boron, selenium, molybdenum and fluorine which are harmful to animals fed on plants grown with excess concentration of these ions**



# Irrigation Water Quality Criteria

- **Water quality is determined according to the purpose for which it will be used. For irrigation water, the usual criteria include salinity, sodicity, and ion toxicities.**
- **Various criteria are considered in evaluating the quality of irrigation water namely:**
  - **Salinity hazard**
  - **Sodium hazard**
  - **Salt index**
  - **Alkalinity hazard**
  - **Permeability hazard**
  - **Specific ion toxicity hazards**

# SALINITY HAZARD

- ❖ The concentration of soluble salts in irrigation water can be classified in terms of Electrical Conductivity (EC) and expressed as  $\text{dS m}^{-1}$ .
- ❖ There are four classes of salinity viz., C1, C2 and C3, C4.
- ❖ The classes C1 and C2 of water are considered suitable for irrigation purposes (no problem). C3 and C4 classes of water are not suitable for irrigation purpose (severe problems).



<b><i>Water class</i></b>	<b><i>EC (dS m<sup>1</sup>)</i></b>	<b><i>Remarks</i></b>
<b>C<sub>1</sub> - Low salinity</b>	<b>0-0.25</b>	<b>Can be used safely</b>
<b>C<sub>2</sub> - Medium salinity</b>	<b>0.25-0.75</b>	<b>Can be used with moderate leaching</b>
<b>C<sub>3</sub> - High salinity</b>	<b>0.75-2.25</b>	<b>Can be used for irrigation purposes with some management practices</b>
<b>C<sub>4</sub> - Very high</b>	<b>2.25-5.00</b>	<b>Can not be used for irrigation purposes</b>

# SODICITY HAZARD

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- **High concentrations of sodium are undesirable in water because sodium adsorbs on to the soil cation exchange sites, causing soil aggregates to break down (deflocculation), sealing the pores of the soil and making it impermeable to water flow. The sodicity hazard of irrigation water is usually evaluated by:**
  - **Sodium Adsorption Ratio (SAR)**
  - **Adjusted SAR**
  - **Sodium to calcium activity ratio (SCAR)**
  - **Sodium ratio**
  - **Figure of merit**



# *Sodium adsorption ratio (SAR)*

- **United States Salinity Laboratory (USSL) staff introduced the concept of sodium adsorption ratio (SAR) to predict sodium hazard. It is calculated as**

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

- **The sodium hazard of irrigation water expressed through SAR does not take into account the effect of anionic composition. Sodicity hazard also classified as S1, S2, S3 and S4.**



<b>Water class</b>	<b>SAR</b>	<b>Remarks</b>
<b>S<sub>1</sub> low sodium hazard</b>	<b>0-10</b>	<b>Little or no hazard</b>
<b>S<sub>2</sub> medium sodium hazard</b>	<b>10-18</b>	<b>Appreciable hazard but can be used with appropriate management</b>
<b>S<sub>3</sub> High sodium hazard</b>	<b>18-26</b>	<b>Unsatisfactory for most of the crops</b>
<b>S<sub>4</sub> Very high sodium hazard</b>	<b>&gt; 26</b>	<b>Unsatisfactory for most of the crops</b>

# Sodium to Calcium Activity Ratio (SCAR)

- The application of SAR to the group of water, which have  $EC > 5 \text{ dS m}^{-1}$  and  $Mg/Ca \text{ ratio} > 1$  is obviously questionable. For the ground water having  $EC > 5 \text{ dS m}^{-1}$  and dominance of magnesium over calcium, the SAR value should be calculated as  $Na^+ / \sqrt{Ca^{2+}}$ .
- The classification of SAR/ SCAR ratio was given by Gupta (1986) by following 6 classes of sodicity.
  - Non-sodic water ( $\leq 5$ )
  - Normal water (5-10)
  - Low sodicity water (10-20)
  - Medium sodicity water (20-30)
  - High sodicity water (30-40)
  - Very high sodicity water ( $>40$ )

# Alkalinity hazard

- **Residual Sodium Carbonate (RSC)**
- **Residual Sodium Bicarbonate (RSBC)**
- **Bicarbonates ( $\text{HCO}_3^-$ )** occur in low salinity water and its concentration usually decreases with an increase in EC. The proportion of bicarbonate ion is higher than calcium ions are considered undesirable, because after evaporation of irrigation water bicarbonate ions tend to precipitate calcium ions. Hence, the effect of bicarbonate together with carbonates evaluated through RSC.
- **$\text{RSC} \equiv (\text{CO}_3^{2-} + \text{HCO}_3^-) - (\text{Ca}^{2+} + \text{Mg}^{2+})$** , all ions expressed as me L<sup>-1</sup>

## Residual Sodium Carbonate (RSC)

<i>RSC (me r<sup>1</sup>)</i>	<i>Water quality</i>
<b>&lt; 1.25</b>	<b>Water can be used safely</b>
<b>1.25 - 2.5</b>	<b>Water can be used with certain management</b>
<b>&gt; 2.5</b>	<b>Unsuitable for irrigation purposes</b>

Since carbonate ions do not occur very frequently in appreciable concentrations, and as bicarbonate ions do not precipitate magnesium ions, Gupta suggested that alkalinity hazard should be determined through the index called Residual Sodium Bicarbonate (RSBC) to be calculated as below.

**RSBC  $\equiv$  HCO<sub>3</sub><sup>-</sup> - Ca<sup>2+</sup>, all ions expressed as me L<sup>-1</sup>. Based on RSC/ RSBC ratio**



# MAGNESIUM

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

$$\text{Mg Adsorption Ratio} = \frac{\text{Mg}^{2+}}{\text{Ca}^{2+} + \text{Mg}^{2+}}$$



## Chlorides:

- **Chlorides:** The occurrence of chloride ions in irrigation water increases with increase in EC and sodium ions. Therefore, these ions are most dominant in very high salinity water. Unlike sodium ions, the chloride ions neither affect on the physical properties of the soil, nor are adsorbed by the soil. Therefore, it has generally not been included in modern classification system. However, it is used as a factor in some regional water classification.

$$\text{Chloride Concentration (me L}^{-1}\text{)} = \frac{\text{Cl}^{-} + \text{NO}_3^{-}}{\text{CO}_3^{--} + \text{HCO}_3^{-} + \text{SO}_4^{--} + \text{Cl}^{-} + \text{NO}_3^{-}}$$

# Chlorides:

<b>Chloride concentration (me r<sup>1</sup>)</b>	<b>Water quality</b>
<b>4</b>	<b>Excellent water</b>
<b>4-7</b>	<b>Good water</b>
<b>7-12</b>	<b>Slightly usable</b>
<b>12-20</b>	<b>Not suitable</b>
<b>&gt; 20</b>	<b>Not suitable</b>

# Sulphate

- **Sulphate:** Sulphate salts are less harmful when compared to chlorides. This is because when both the ions occur in this concentration, only half of the sulphate ions contribute to salinity due to the fact that approximately half
- of the sulphates gets precipitated as  $\text{CaSO}_4$  while the other half remains in soluble form as  $\text{Na-MgSO}_4$  in the soil. That is the reason, the potential salinity of irrigation is calculated as  $\text{Cl}^- + \frac{1}{2} \text{SO}_4^-$ .

**Eaton proposed three classes for sulphate**

**< 4 me l-1 - Excellent water**

**4-12 me l-1 - Good to injurious**

**> 12 me l-1 - Injurious to unsatisfactory**

# Potential salinity

- It can be worked out by using the formula  $Cl + 1/2 SO_4^{2-}$  where ions are expressed in me l-1.

Potential salinity (me L-1)	Remarks
3-15	Can be recommended for medium permeability soils
3-7	Recommended for soils of low permeability

# Boron

**Boron:** It is evident that boron is essential for the normal growth of the plant, but the amount required is very small. The occurrence of boron in toxic concentration in certain irrigation water makes it necessary to consider this element in assessing the water quality. The permissible limits of boron in irrigation water are:

<b>Class</b>	<b>Crops</b>			<b>Remark</b>
	<b>Sensitive</b>	<b>Semi tolerant</b>	<b>Tolerant</b>	
<b>Very low</b>	<b>&lt; 0.33</b>	<b>&lt; 0.67</b>	<b>&lt; 1.00</b>	<b>For safely use</b>
<b>Low</b>	<b>0.33-0.67</b>	<b>0.67-1.33</b>	<b>1-2.0</b>	<b>Can be managed</b>
<b>Medium</b>	<b>0.67-1.00</b>	<b>1.33-2.00</b>	<b>2.0-3.0</b>	<b>Unsuitable</b>
<b>Very high</b>	<b>&gt; 1.25</b>	<b>&gt; 2.50</b>	<b>&gt; 3.75</b>	<b>Unsuitable</b>



# Fluorine

- **Fluorine: fluorides are only sparingly soluble and are in only small amounts. The concentration of fluoride ranges from traces to more than 10 mg L<sup>-1</sup> in natural water, and surface water do not exceed 0.3 mg L<sup>-1</sup> unless they are polluted. Irrigation with fluoride saline water (upto 25 mg L<sup>-1</sup>) has not been found to affect yield of wheat. Therefore, it is doubtful if fluoride requires any monitoring in India. At present, the average concentration of fluoride has not been observed to be very high (10 mg l<sup>-1</sup>).**

# Nitrate:

- **Nitrate: Very frequently ground water contain high amount of nitrate. When such type of irrigation water is applied on soils continuously, various properties of soils are affected.**

<b>NO<sub>3</sub> me l-1</b>	<b>≤ 5 No problem</b>
	<b>5-30 Intensity of problem is moderate</b>
	<b>&gt; 30 Intensity of problem is severe</b>

# Lithium

- **Lithium :** Lithium is a trace element may be found in most of saline ground water and irrigated soils. It has been found that 0.05-0.1 ppm of lithium in water produce toxic effects on growth of citrus.
- 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 is not affected with this level of lithium content.



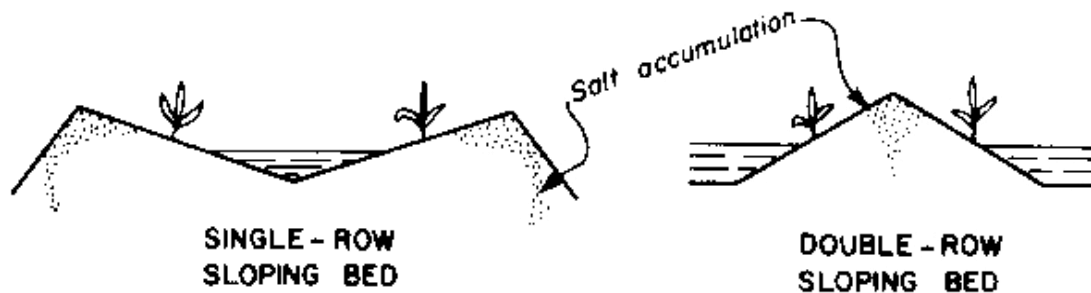
# MANAGEMENT PRACTICES FOR USING POOR QUALITY WATER

- **Application of gypsum**
- **Alternate irrigation strategy:**
- **Fertilizer application**
- **Methods of irrigation**
- **Crop tolerance:**
- **Method of sowing:**
- **Drainage**



# Other management practices

- Over aged seedlings in rice:
- Mulching
- Soil management:
- Crop rotation:



Salinity control with sloping beds



# Crop Tolerance:

- The crops differ in their tolerance to poor quality waters. Growing tolerant crops when poor quality water is used for irrigation helps to obtain reasonable crops yields. Relative salt tolerance of crops is given in Table



## Crop Tolerance:

<p><b>Tolerant</b></p>	<p><b>Field crops: Cotton, Safflower, Sugarbeet &amp; Barley</b>  <b>Fruit crops: Date palm &amp; Guava</b></p> <p><b>Vegetables: Turnip &amp; Spinach</b>  <b>Forage crops: Berseem &amp; Rhodes grass</b></p>
<p><b>Semi tolerant</b></p>	<p><b>Field crops: Sorghum, Maize, Sunflower, Mustard, Rice &amp; Bajra, M</b>  <b>Wheat</b></p> <p><b>Fruit crops: Fig, Grape &amp; Mango</b>  <b>Vegetables: Tomato, Cabbage, Cauliflower, Pumpkin, Carrot &amp; Cucumber</b>  <b>Potato</b>  <b>Forage crops: Senji &amp; Oats</b></p>
<p><b>Sensitive</b></p>	<p><b>Field crops: Chick pea, Linseed, Beans, Greengram &amp; Blackgram</b>  <b>Fruit crops: Apple, Orange, Almond, Peach, Strawberry, Lemon &amp; Plum</b>  <b>Vegetables: Radish, Peas &amp; Lady's finger</b></p>



# Text book and web sources

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- ***[www.agriinfo.in](http://www.agriinfo.in)***
- ***[ecourses.iasri.res.in](http://ecourses.iasri.res.in)***
- ***Panda SC. 2003. Principles and Practices of Water Management. Agrobios.***
- ***Michael AM. 1978. Irrigation Theory and Practice. Vikas Publ.***
- ***Paliwal KV. 1972. Irrigation with Saline Water. IARI Monograph, New Delhi.***
- ***Lenka D. 1999. Irrigation and Drainage. Kalyani***



# Any Question ?

View my slides from anywhere in internet slideshare web page !

<https://www.slideshare.net/GovardhanLodha/cropping-systems-and-farming-systemsppt-lodha-intro>





*Thank you very much*