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Assessment of quality contributing parameters of irrigation water by using standard formulae

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ABSTRACT

Occurrence of salts in irrigation water forms ions. The most common salts in water are table salt (Sodium Chloride NaCl), gypsum (Calcium Sulphate $CaSO_4$), Epsom salts (Magnesium Sulphate $MgSO_4$) and baking soda salt (Sodium Bicarbonate $NaHCO_3$). The dissolved cations are Calcium (Ca^{2+}), Magnesium (Mg^{2+}) and Sodium (Na^{+}), while the most common anions are Chloride (Cl^{-}), Sulfate (SO_4^{2-}) and Bicarbonate (HCO_3^{-}). The ratio of these ions however varies from one water supply to another. Potassium (K^{+}), Carbonate (CO_3^{2-}) and Nitrate (NO_3^{-}) also exist in water, but concentration of these constituents is comparatively low. Presence of these ions either in low or in high concentration would certainly affect the quality of irrigation water. Problematic irrigation water supply to the crop would damage it in different aspects. The quality parameters such as pH, Sodium hazard, Salt Index, Bicarbonate hazard (RSC), Chloride Hazard, Soluble Sodium Percentage (SSP) and Magnesium Hazards can be evaluated by using standard methods and formulae.

Key words: Irrigation, Water, Ions, Quality, Formulae

INTRODUCTION

Water is an important input required for growth in human and agriculture production. Bulk weight of all living organisms consist of 80-90% water. Water is very important for meeting the food and clothing needs of the world population. The extend of available water resource and the availability of ground water are critical at present. All water used by humans and Agriculture contains salts to a variable extent. High quality of irrigation water only be required for agriculture (Dhirendra Mohan Joshi *et al.,* 2009). Large quantities of salts are brought in to water of bad quality. Occurrence of salts in water forms ions. The most common salts in water are table salt (Sodium Chloride NaCl), gypsum (Calcium Sulphate $CaSO_4$), Epsom salts (Magnesium Sulphate $MgSO_4$) and baking soda salt (Sodium Bicarbonate $NaHCO_3$). The dissolved cations are Calcium (Ca^{2+}), Magnesium (Mg^{2+}) and Sodium (Na^{+}), while the most common anions are Chloride (Cl^{-}), Sulfate (SO_4^{2-}) and Bicarbonate (HCO_3^{-}). The ratio of these ions however varies from one water supply to another. Potassium (K^{+}), Carbonate (CO_3^{2-}) and Nitrate (NO_3^{-}) also exist in water, but concentration of these constituents is comparatively low. Keeping these points in mind the present investigation was taken up to put forth the standard formulae to assess the irrigation water quality.

Analysis of water samples for quality parameters

The water samples are mainly analysed for pH, total salts (EC), relative proportion of cations, anions like Calcium (Ca^{2+}), Magnesium (Mg^{2+}) and Sodium (Na^{+}), while the most common anions are Chloride (Cl^{-}), Sulfate (SO_4^{2-}) and Bicarbonate (HCO_3^{-}). The water samples are analysed by using standard procedures given in Table 1.

	Properties	Analytical method	Reference
A	**Physico-chemical properties**		
	pH	Potentimetric method	Jackson (1973)
	EC (Electrical Conductivity)	Conductivity Bridge method	Jackson (1973)
	Chemical Properties		
B	Chloride	Argentometric method	A.O.A.C (1950)
	Sulphate	Gravimetric method	Richards (1954)
	Carbonate	Titrimetric method	A.O.A.C (1950)
	Bicarbonate	Titrimetric method	A.O.A.C (1950)
	Calcium	Complexometric method	Jackson (1973)
	Magnesium	Complexometric method	Jackson (1973)
	Sodium	Flame photometric method	Stanford and English (1949)
	Potassium	Flame photometric method	Stanford and English (1949)

Evaluation of quality contributing parameters

The quality contributing parameters such as sodium hazard (SAR), salt index, bicarbonate hazard (RSC), chloride hazard, soluble sodium percentage (SSP), and magnesium hazards are evaluated using the following formulae

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

2. SSP = $$\frac{c\ Na \times 100}{c\ Ca + c\ Mg + c\ Na}$$

3. RSC = $(c\ CO_3 + c\ HCO_3) - (c\ Ca + c\ Mg)$

4. RSBC = $(c\ HCO_3 - c\ Ca)$

5. Chloride concentration = $$\frac{c\ Cl^-}{c\ CO_3^{2-} + c\ HCO_3^- + c\ SO_4^{2-} + c\ Cl^- + c\ NO_3^-}$$

6. Mg – Adsorption ratio = $$\frac{c\ Mg^{2+}}{c\ Ca^{2+} + c\ Mg^{2+}}$$

7. Potential salinity = $c\ Cl + ½\ c\ SO_4^{2-}$

8. ESR = $$\frac{c\ Na}{(c\ Ca + c\ Mg)} = \frac{(c\ Na)}{(CEC - c\ Na)}$$

9. ESP = $$\frac{100\ (-0.0126 + 0.01475\ SAR)}{1 + (-0.0126 + 0.01475\ SAR)}$$

10. Salt index = (Total sodium – 24.5) – [(Total c Ca – c Ca in $CaCO_3$) x 4.85]

Where "c" represents the concentration of elements given above.

Abbreviations

1. SAR - Sodium Adsorption Ratio
2. SSP – Soluble Sodium Percentage
3. RSC – Residual Sodium Carbonate
4. RSBC - Residual Sodium Bicarbonate
5. ESR – Exchangeable Sodium Ratio
6. ESP – Exchangeable Sodium Percentage

CONCLUSION

All water contains dissolved mineral salts, but the concentration and composition of those salts are given importance. The evaluation of water implies that the quality contributing parameters should be occurring with in the permissible limit as suggested by United States Salinity Laboratory Staff, 1954. As already mentioned in the Abstract part of this paper poor quality irrigation water augmentation would definitely affect the crop growth and its quality in certain ways.

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