Irrigation Water QualityProblems and their Management

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***Abstract*—Irrigated agriculture is dependent on an adequate water supply of usable quality. Water quality concerns have often been neglected because good quality water supplies have been plentiful and readily available but with an ever increasing demand of water (Drinking, Industrial) supplies, agriculture area is now frequently facing the scarcity of good quality irrigation water. Wells, ponds, streams, and waste treatment plants are common water sources for irrigation. Problem levels of salinity, sodium, carbonates, and pH can occur in any of these sources, especially near the seashore. The continued application of poor quality irrigation water and its detrimental effects on soil properties can reduce the quality and growth of crop. However, with proper precautions and altered management practices, poor quality irrigation water may be used to produce high quality crop. In this review paper, the main discussion is on the various characteristics of irrigation water and their effect on agriculture growth and quality. Various management strategies (Agronomic, better irrigation scheduling) for remediating irrigation water quality are using for controlling the problems associated with irrigation water. The another objective of this review is to help to a better understanding of the effect of water quality upon soil and crops and to assist in selecting suitable alternatives to cope with potential water quality.**

Key words- Sodicity, Toxicity, Sodium Adsorption Ratio, RSC, Trace Elements.

I. INTRODUCTION

Irrigation water quality refers to the characteristics of a water supply that will influence its suitability for a specific use, i.e. how well the quality meets the needs of the user. Quality is defined by certain physical, chemical and biological characteristics. Even a personal preference such as taste is a simple evaluation of acceptability. For example, if two drinking waters of equally good quality are available, people may express a preference for one supply rather than the other; the better tasting water becomes the preferred supply. In irrigation water evaluation, emphases are placed on the chemical and physical characteristics of the water and only rarely are any other factors considered important.

II. IRRIGATION WATER QUALITY

The water quality used for irrigation is essential for the yield and quantity of crops, maintenance of soil productivity, and protection of the environment. For example, the physical and mechanical properties of the soil, soil structure (stability of aggregates) and permeability are very sensitive to the type of exchangeable ions present in irrigation waters. The quality of the irrigation water may affect both crop yields and soil physical conditions, even if all other conditions and cultural practices are favorable/ optimal. In addition, different crops require different irrigation water qualities.

The parameters which determine the irrigation water quality are divided to three categories: chemical, physical and biological. The chemical characteristics of irrigation water refer to the content of salts in the water as well as to parameters derived from the composition of salts in the water; parameters such as EC/ TDS, SAR, alkalinity and hardness. Irrigation water quality can best be determined by chemical analysis. The most important factors to determine the suitability of water use in agriculture are the following:

- pH
- Salinity hazard
- Sodium hazard (Sodium Adsorption Ratio or SAR)
- Carbonate and bicarbonates in relation with the Ca & Mg content,
- Other trace elements
- Toxic anions
- Nutrients
- Free chlorine

III. MAJOR WATER QUALITY RELATED PROBLEMS

Water used for irrigation can vary greatly in quality depending upon type and quantity of dissolved salts. Salts are present in irrigation water in relatively small but significant amounts. They originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals. These salts are carried with the water to wherever it is used. In the case of irrigation, the salts are applied with the water and remain behind in the soil as water evaporates or is used by the crop.

The problems that result vary both in kind and degree, and are modified by soil, climate and crop, as well as by the skill and knowledge of the water user. As a result, there is no set

limit on water quality; rather, its suitability for use is determined by the conditions of use which affect the accumulation of the water constituents and which may restrict crop yield. The soil problems most commonly encountered and used as a basis to evaluate water quality are those related to salinity, water infiltration rate, toxicity and a group of other miscellaneous problems.

A. Irrigation water salinity:

The main problem related to irrigation water quality is the water salinity. Water salinity refers to the total amount of salts dissolved in the water but it does not indicate which salts are present in it. High level of salts in the irrigation water reduces water availability to the crop (because of osmotic pressure) and causes yield reduction. Above a certain threshold, reduction in crop yield is proportional to the increase in salinity level. Different crops vary in their tolerance to salinity and therefore have different thresholds and yield reduction rates. The most common parameter used for determining the irrigation water quality in relation with its salinity is EC and TDS.

TDS(mg/l)	EC (Ds/m)	Salinity Hazard
Below 500	.8	Low
500-1000	.8-1.6	Medium
1000-2000	1.6-3.0	High
Above 2000	Above 3	Very high.

Table-1(Irrigation Water Quality Parameter & Hazardous)

In case the irrigation water salinity exceeds the threshold for the crop, yield reduction occurs. Equations were developed to estimate the yield potential, based on the irrigation water salinity.

% Yield (of maximum) = *100 - b (ECe - a)*

Where *b*, is the percent loss in relative yield per unit increase in salinity,

a is the EC threshold the crop can tolerate and

ECe is the electrical conductivity of the saturated soil paste, which is measured in the laboratory.

B. Sodium hazard and irrigation water infiltration:

The parameter used to determine the sodium hazard is SAR - Sodium Adsorption Ratio. This parameter indicates the amount of sodium in the irrigation water, in relation to calcium and magnesium. Calcium and magnesium tend to counter the negative effect of sodium. High SAR levels might result in a breakdown of soil structure and water infiltration problems. Soil tends to seal and to become hard and compact when dry. Ironically, higher salinity reduces the negative effect of sodium on soil structure. When sodium levels in the soil are high in relation with calcium and magnesium, i.e. SAR is high; flushing the soil with good irrigation water quality will only worsen the problem.

C. Toxicity of specific ions:

The irrigation water quality can be also determined by toxicity of specific ions. The difference between a salinity problem and a toxicity problem is that toxicity occurs within the plant itself, as a result of accumulation of a specific ion in the leaves. The most common ions which might cause a toxicity problem are chloride, sodium and boron ion. The same as with salinity, crops differ in their sensitivity to these ions. Special attention should be given to boron because toxicity occurs in very low concentrations, even though it is an essential plant nutrient. Toxic levels of even a single ion in the irrigation water might make the water unsuitable for irrigation. Nevertheless, there are some management practices that can help in reducing the damage. These practices include proper leaching, increasing the frequency of irrigations, avoiding overhead irrigation, avoiding the use of fertilizers containing chloride or boron, selecting the right crops, etc.

D. Alkalinity and pH:

Alkalinity is the sum of the amounts of bicarbonates (HCO_3^-), carbonates (CO_3^{2-}) and hydroxide (OH^-) ion in water. It is expressed as mg/l or m.eq/l $CaCO_3$.Alkalinity buffers the water against sudden changes in pH. If the alkalinity is too low, any addition of acidic fertilizers will immediately lower the pH. In container plants and hydroponics, ions released by plant roots may also rapidly change the pH if alkalinity is low.

IV. MANAGEMENT FOR IMPROVING IRRIGATION WATER QUALITY

Poor quality of irrigated water leading to many problems in soil as well as crop productivity so it is very necessary to achieve the quality of irrigated water by various method of managing either by technical or by agronomic as well as managerial approaches the main features of various strategies are:

A. Technical

- Land leveling to apply water more uniformly
- Surge irrigation to improve water distribution
- Efficient sprinklers to apply water more uniformly
- Low energy precision application sprinklers to cut evaporation and wind drift losses
- Drip irrigation to cut evaporation and other water losses and to increase crop yields

B. Managerial

- Better irrigation scheduling
- Improving canal operation for timely deliveries
- Applying water when most crucial to a crop's yield
- Water-conserving tillage and field preparation methods
- Better maintenance of canals and equipment
- Recycling drainage and tail water

C. Institutional

- Establishing water user organizations for better involvement of farmers and collection of fees

- Reducing irrigation subsidies and/or introducing conservation-oriented pricing
- Establishing legal framework for efficient and equitable water markets
- Fostering rural infrastructure for private-sector dissemination of efficient technologies
- Better training and extension efforts

D. Agronomic

- Selecting crop varieties with high yields per liter of transpired water
- Intercropping to maximize use of soil moisture
- Better matching crops to climate conditions and the quality of water available
- Sequencing crops to maximize output under conditions of soil and water salinity
- Selecting drought-tolerant crops where water is scarce or unreliable
- Breeding water-efficient crop varieties

E. Other management practicesaffecting the quality of irrigation water

1) Infiltration Problems: SAR (Sodium Adsorption Ratio) is an irrigation water parameter, which is used to predict problems of water infiltration into soil. Various measures can be taken to overcome water infiltration problems, which include soil or water amendments, reducing the SAR of the water supply, cultivation and tillage, addition of organic residues and irrigation management.

2) Soil amendments and irrigation water quality: The purpose of soil amendments is to counter the effect of sodium, by increasing the soluble calcium content or by increasing the salinity of the irrigation water.

3) Gypsum and other calcium supplying materials are the most commonly used soil amendment. Since water infiltration problems caused by sodium affect mainly the upper few centimeters of soil, repeated small applications of gypsum, incorporated at lower rates into a shallow depth, and are preferred over a single large application. If the salinity of the irrigation water is low (EC<0.5 Ds/m), gypsum can be added to the irrigation water at rates of 1-4 meq/l of dissolved calcium.

4) Other amendments: when lime (CaCO3) is present in soil, some acids or acid-forming amendments can be used. These amendments cause calcium to be released to soil solution. Examples for such amendments are elemental sulfur, sulfuric acid and ferric sulfate.

5) Organic residues: These amendments improve soil structure and water infiltration, by keeping the soil porous.

6) Blending Irrigation Water Sources-Water infiltration can be improved by reducing the SAR By diluting the irrigation water source with water of lower sodium concentration; the SAR of the irrigation water is reduced, even if Ca and Mg concentrations are higher.

V. Conclusion

Throughout the world, irrigation (water for agriculture, or growing crops) is probably the most important use of water (except for drinking). Almost 60% of all the world's freshwater withdrawals go towards irrigation uses. Large-scale farming could not provide food for the world's large populations without the irrigation of crop fields by water gotten from rivers, lakes, reservoirs, and wells. Without irrigation, crops could never be grown in the deserts of various parts of world. This review conclude a better understanding of the effect of water quality upon soil and crops and to assist in selecting suitable alternatives to cope with potential water quality related problems that might reduce production under prevailing conditions of use so it is very important to apply various conservative and preservative type of management system by which we can reduces the load on fresh natural resources as well the maintenance of available irrigation water, which further enhance crop productivity and soil flora &fauna.

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