AGRICULTURAL IRRIGATION WATER QUALITY STANDARDS

The concentration of dissolved ions in the irrigation water determines the quality of the irrigation water. The four basic criteria for determining the quality of irrigation water are the conductivity of the water (EC), the sodium adsorption rate (SAR), residual sodium carbonates (RSC), and ion toxicity.

Sodium excess and ion toxicity are the most important problems in agricultural irrigation water. Especially in arid regions where rainfall is less, salt accumulation will occur in the root area of the crop. In such cases, the change in salt content in the soil and the quality of irrigation water should be closely monitored. An excess of sodium in irrigation water will cause deterioration of the soil structure and prevent water from penetrating into the soil.

Toxicity; sodium, chloride, boron etc. refers to the critical concentration of other trace elements.

There are four basic criteria for the assessment of water quality for irrigation purposes:

- Conductivity (EC): excess of total dissolved solids in water
- Sodium adsorption rate (SAR): The ratio of sodium (Na +) to calcium (Ca2 +) and magnesium (Mg2 +) ions
- Residual sodium carbonates (RSC): The concentration of bicarbonate (HCO3−) and carbonate (CO32−) anions.
- Excess of trace elements that cause toxicity in plants

The pH of the water is not a quality criterion in irrigation water. Because the pH parameter tends to be buffered by the soil and most agricultural products can tolerate a wide pH range.

SALINITY IN IRRIGATION WATER

High salinity in irrigation water increases the osmotic pressure of moisture in the soil and the access of plant roots to water becomes difficult. That is, although the soil in the field irrigated with salt water appears to be moist, the plants will wilt. This is because plant roots cannot absorb water from the soil due to high osmotic potential. Thus, water lost from the plant through perspiration cannot be reinforced from the soil and fading occurs.

CONDUCTIVITY HAZARD LEVEL

CONDUCTIVITY	HAZARD
<750 µs/cm	Water suitable for use as irrigation water and where harmful effects will not be noticed.
750 - 1500 µs/cm	Water that can have detrimental effects on sensitive crops.
1500 - 3000 µs/cm	Water that can have adverse effects on many products and therefore requires controlled application.
3000 - 7500 µs/cm	Water that can only be used for salt-resistant plants in permeable soils with controlled application.

SODIUM IN IRRIGATION WATER

The criterion for sodium in irrigation water is expressed as the "sodium adsorption rate (SAR)". Although sodium directly contributes to total salinity and can be toxic to delicate crops such as fruit trees, the main problem with high sodium concentration is its effect on the physical properties of the soil. In other words, high sodium water causes deterioration of the soil structure. Therefore, if soil quality deterioration is not desired in the medium and long term, it is recommended not to irrigate the soil with waters with a SAR value> 10 $(mmol/l)^{-0.5}$

Continuous use of water with high SAR values causes deterioration in the physical structure of the soil. This deterioration in the physical structure of the soil causes the soil clay to disperse and the soil hardens and compacts when it dries.

CARBONATES AND BICARBONATE CONCENTRATION

Water sources with high concentrations of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) will tend to precipitate calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$) when soil moisture evaporates. This means that the SAR value will increase and the relative proportion of sodium ions will also increase. In other words, it means that the sodium in the irrigation water will increase its damage potential to a level higher than stated in the SAR value.

SPECIFIC ION EFFECTS (TOXIC ELEMENTS)

In addition to salinity and sodium hazards, some crops may be sensitive to the presence of specific ions in irrigation water. Many trace elements are toxic to plants at very low concentrations. Direct toxicity on crops can be caused by some specific elements in the irrigation water. For example, boron, chloride and sodium are potentially toxic to plants.

An element added to the soil through irrigation can accumulate in the soil until it reaches a toxic level. An element at a certain concentration in water can be immediately toxic to a product, or it can take several years to accumulate in the soil until it becomes toxic.

Sodium Toxicity

Sodium toxicity can occur in the form of leaf burn and dead tissue along the outer edges of the leaves. In contrast, chloride toxicity is generally seen at the tip of the leaf. Correct diagnoses can be made from soil, water and plant tissue analysis.

Boron Toxicity

Boron is essential for normal growth of all plants, but the amount required is very low. Boron damages if it exceeds a certain tolerance level depending on the product. For many crops, the gap between boron deficiency and toxicity is narrow. At least 0.02 ppm boron may be required in irrigation water to maintain adequate boron supply to the plant. However, to avoid toxicity, boron levels in irrigation water should ideally be lower than <0.3 ppm. Higher boron concentrations require the type of crop to be produced to be evaluated against boron tolerance. There are boron-rich water resources in our country, especially in the Aegean Region and Western Central Anatolia.

Symptoms of boron toxicity are seen in old leaves as yellowing, spotting or drying of the leaf tissues at the tips and edges.

Chloride Toxicity

The most common crop toxicity is caused by chloride in irrigation water. The chloride (Cl−) anion is found in all waters. Chlorides are essential for plant growth, but at high concentrations they can inhibit plant growth and can be highly toxic to some plant species. Table 5.4 shows the Cl− levels in irrigation water and the effects of Cl on crops. In sensitive crops, symptoms occur when Cl− levels accumulate in the leaves (0.3-1.0% dry weight basis). Ayers and Westcot (1985) reported that Cl− toxicity on plants first appeared at the leaf tips (a very common symptom for chloride toxicity) and progressed from the leaf tip to the edges as the toxic effect increased in intensity. Excessive necrosis is often accompanied by early leaf fall and even total plant defoliation.

CHLORIDE	EFFECT LEVEL
<75 ppm	Suitable for use as irrigation water
75 - 150 ppm	May have detrimental effects on sensitive crops.
150 - 350 ppm	Harmful to sensitive and medium sensitive crops.
>350 ppm	Not suitable for irrigation.

CONDUCTIVITY CLASSIFICATION IN IRRIGATION WATER

CONDUCTIVITY	SALINITY CLASS
100 - 250 µs/cm	Low Salt Water (Salinity Class: C1) It can be used for irrigating most crops in the soil.
250 - 750 µs/cm	Medium Salt Water (Salinity Class C2) It can be used for irrigation of plants with moderate salt tolerance.
750 - 2250 µs/cm	High Salt Water (Salinity Class C3) Controlled use may be necessary for salinity control and can be used for irrigation of plants with good salt tolerance.
> 2250 µs/cm	Very High Salt Water (Salinity Class C4) It is not suitable for irrigation under normal conditions, but can be used occasionally in very special situations. It can only be used in a controlled way for irrigating very salt tolerant plants.

SODIUM CLASSIFICATION IN IRRIGATION WATER

SAR	SODIUM CLASS
< 10	Low Sodium Water (Sodium Grade S1) It can be used for irrigation in almost all soils with little danger of developing harmful modifiable sodium levels of the soil. However, sodium-sensitive products such as stone fruit trees and avocados can accumulate harmful sodium concentrations.
10 - 18	Medium Sodium Water (Sodium Class S2) In fine textured soils with clayey and high cation exchange capacity, it may pose a palpable sodium hazard. It can be used in coarse textured or organic soils with good permeability.
18 - 26	High Sodium Water (Sodium Grade S3) It can create harmful levels of sodium in most soil types. Its use will require special soil management, good drainage, high permeability and high organic matter conditions. However, gypsiferous soils may not generate harmful sodium levels from such waters. It may not be possible to use it in waters with very high salinity.
> 26	Very High Sodium Water (Sodium Grade S4) It is generally insufficient for irrigation purposes, except for low and medium salinity. Specifically, it can make it suitable for controlled irrigation water use when the soil is rich in calcium or if amendment agents such as gypsum are applied.

HIGH QUALITY IRRIGATION WATER SUPPLY WITH REVERSE OSMOSIS TECHNOLOGY

It is important that the water to be used in agricultural irrigation or landscape irrigation conforms to the irrigation water criteria, both in terms of obtaining yield from the soil to be irrigated for many years and in terms of growing the crop to be irrigated in a healthy way. The water source to be used in irrigation should be examined in detail in terms of conductivity, sodium, SAR, chloride, residual sodium carbonates and boron parameters at the first stage. If parameters that do not comply with the irrigation water criteria are determined among these parameters, it may be necessary to demineralize the water by reverse osmosis method.

Since the irrigation water will not need to be completely pure, partial demineralization with reverse osmosis technology will be sufficient. Partial blending of reverse osmosis product water and raw water may be required to achieve the desired irrigation water quality. The ratio of raw water to pure RO product water to be blended depends on the salinity of the raw water, the water quality required by the crop to be irrigated, and the soil analysis. After selecting the irrigation water class according to the condition of the soil and the condition of the crop to be grown, the raw water blending rate can be determined.