

WATER QUALITY ASSESSMENT AND IMPROVEMENT

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In the upcoming months we will attempt to provide a series of articles dealing with what water chemistry is and how it can impact plant health. This is the first water quality article.

INTRODUCTION

The importance of irrigation water quality to assist in the production of high quality and high yield horticulture crops has been emphasized over the years through publications and various literature sources. Considerable research has resulted in significant strides for providing interpretive information and mitigation strategies for improvement of waters, the quality of which may be questionable. With the degradation of irrigation water quality and, at the same time increased water usage, the sources of high quality irrigation water are diminishing. This can, at times, result in the required use of irrigation water of variable and, at times, unsuitable quality. Irrigation water sources may include municipal reservoir waters, well waters, artisan and surface waters. In some instances, capturing of rain water is utilized for assistance in providing the volume and, through blending, quality of irrigation water required. Due to increased pressure on water resources and the environmental implications of excess water runoff, the introduction and use of irrigation water recapture/reuse or recirculation, has occurred over the last decade. The manner in which irrigation water quality is assessed does not differ significantly whether a grower is utilizing a recirculation system or conventional overhead/drip irrigation system.

Some of the major areas of concern which can impact quality and yield of horticulture crops include:

- Reaction/equilibrium reaction;
- Soluble salts;
- The presence of potentially toxic ions;
- Unightly precipitation deposits on foliage;
- Essential element concentrations impacting plant nutrition;
- The presence or proliferation of disease organisms.

Comprehensive irrigation water tests should provide information required to assess each of the above so that corrective action can be undertaken where needed. It is the intent of the information presented here to provide the grower with the tools necessary to characterize the quality of irrigation water and, where necessary, to develop and employ strategies for minimizing potential problems to further high quality crop production.

IRRIGATION WATER TESTING OF DISSOLVED MINERALS (IONS)

The testing of irrigation water chemistry is straightforward with laboratory norms well established. Irrigation water chemistry analyses should, ideally, provide the concentrations of ions which have an impact on plant growth. These ions may be of nutrition value to plants or may be potentially toxic at high enough concentrations. Let's define some terms as we "look at" ions in solution.

Ions: All irrigation waters contain dissolved salts which dissociate into ions. Ions are electrically charged particles made up of individual elements or combinations of elements which are taken up by plant roots. In the majority of Northwest irrigation waters these ions are quite dilute, but in low quality waters can be significant. The addition of fertilizers to irrigation waters increases the concentrations of positively charged ions (cations) and negatively charged ions (anions). Some of these ions which have the greatest impact on irrigation water quality and, hence, plant production are indicated in figure 1. Other ions of concern from the standpoint of plant nutrition include copper, zinc, manganese, iron, molybdenum and boron. Ions which may be potentially toxic to plants at high enough concentrations include flouride and lithium.

The expression of individual ion concentration is normally reported by laboratories as parts per million (ppm) or, for the sake of water chemistry calculations, milliequivalents per liter. "Parts per million" indicates the ion weight to solution weight ratio, and is approximately synonymous with milligrams per liter. The milliequivalent per liter (meq/l) designation reflects the capacity of ions to react with one another. The atomic or formula weight of an ion divided by its valence (number of +/- charges) is called the equivalent weight. 1000th of this weight is termed milliequivalent. Figure 1 provides calculated parts per million at 1 milliequivalent per liter concentrations for the various ions which should be included in laboratory analytical data. Using the information in figure 1, one can readily convert from parts per million to milliequivalents per liter. The meq/l unit of concentration expression is necessary for other water chemistry calculations important for assessing water quality impact on plant growth response. If only milliequivalents per liter are reported, the conversion to parts per million, if desired, is straightforward. By way of example, a reported level of 36 ppm magnesium divided by 12.2 ppm per milliequivalent per liter equals 2.95 milliequivalents per liter magnesium, or:

$$36 \text{ ppm Mg} \div 12.2 \text{ ppm/meq/l} = 2.95 \text{ meq/l Mg}$$

When added together, the meq/l concentrations of cations (positively charged ions) should approximately equal the total meq/l concentrations of anions (negatively charged ions) in solution. These two values are usually not exactly equal since other ions are present in the irrigation water. If the difference between cation total and anion total exceeds 1 meq/l, the inference is that other ions are present in solution which may not have been reported.

Figure 1

ION	SYMBOL	PPM @ 1 MEQ/L
Sodium	Na ⁺	23
Calcium	Ca ⁺⁺	20
Magnesium	Mg ⁺⁺	12.2
Potassium	K ⁺	39
Chloride	Cl ⁻	35.5
Sulfate	SO ₄ ⁼	48
Bicarbonate	HCO ₃ ⁻	61
Carbonate	CO ₃ ⁼	30
Nitrate	NO ₃ ⁻	62
Ammonium	NH ₄ ⁻	18
Phosphate	PO ₄ ⁼	31.7

Conductivity: Electrical conductivity of water (EC_w) is a measurement of the ability of solutions to conduct electricity. Generally speaking, the higher the mineral content (ions in solution) of irrigation water the the greater the capacity of the solution to conduct electricity, and the accompanying conductivity reading. Electrical conductivity, or salinity, is expressed in decisiemens per meter (dS/m) which is also equivalent to millimhos per centimeter (mmhos/cm) at 25 degrees Centigrade. The relative level of salinity or conductivity is sometimes expressed as total dissolved solids (TDS) in parts per million. The electrical conductivity can be estimated from the total dissolved solids reading according to the following formula:

$$\text{EC}_w \text{ (in dS/m or mmho/cm)} = \text{TDS (in ppm or mg/l)} \div 640$$

Next month we will look at ion concentrations and their impact on plant growth.