Water Quality

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The quality of irrigation water plays a vital role in the successful production of greenhouse crops. Your irrigation water should be tested periodically to determine its quality. It may contain essential nutrients necessitating a reduction in the levels applied in the fertilization program. It may also contain harmful elements which require corrective procedures. Listed in Table 1 are some of the more important factors to consider in irrigation water.

The soluble salt level, often referred to as EC (electrical conductivity), should ideally be under 0.75 millimhos/cm (mho × 10^{-3}/cm). Younger seedlings tend to be more sensitive to high salt levels than other crops, so EC monitoring is especially important for a plug grower. When a high salt level builds up in the substrate it prevents water from entering the roots. This results in the normal desiccation symptoms of wilting, stunting, and burning of leaf margins.

Among the specific nutrients found in water, boron can be particularly troublesome. A concentration of 0.5 ppm (mg/l) is very safe. A level of 1.0 ppm is at the upper limit and should be avoided. A toxicity of boron is generally exhibited as orange-brown necrosis along the margins of older leaves. Other micronutrients that can be excessive in irrigation water are iron, manganese, zinc, and copper. Check levels and assure that concentrations are below the levels listed in Table 1 prior to using water. Micronutrient toxicities are more probable when the pH of the water is low, rendering the micronutrients more available for plant uptake.

Fluoride is often added to municipal water at a concentration of 1 ppm to prevent tooth decay. This level is safe for most crops but not for members of the lilies, *Chamaedorea*, *Chlorophytum*, *Ctenanthe*, *Dracaena*, *Marantha*, *Spathiphyllum* and a few other plants. Toxic levels of fluoride causes scorch of the tips of older leaves.

Alkalinity can be a major problem. Levels of 1.5 milliequivalents/liter (meq/l) and lower are safe. Plug seedlings are most sensitive to alkalinity because the small volume of substrate provides little buffering against a rise in pH. Problems can occur in plug production if using an irrigation water with a level of 2.0 meq/l and in many crops at 3.0 meq/l. Alkalinity refers to the bicarbonate plus carbonate concentration in the water (*See the following article on water acidification for more details on alkalinity and pH control).* These two substances are usually associated with a high water pH. However, alkalinity and pH are not necessarily linked together and should not be considered the same. It is possible to grow a good crop with water having a pH level of 7.6. In this case the alkalinity level is low, perhaps less than 1.0 meq/l. On the other hand, it may not be possible to grow a decent crop with water at a pH level of 7.4 if the alkalinity level is 4.0 meq/l. The pH level of water should be checked. If it is over 7.0, this is a sign to look closely at the alkalinity level to see if acid treatment is necessary to lower the bicarbonate level.

Consideration of alkalinity naturally leads to hardness. Hardness is not alkalinity! Hardness refers to the amount of calcium and magnesium in water, generally expressed as if it were all calcium carbonate. Hardness can be expressed as "meq/l" or "ppm" of calcium carbonate. Since 50.04 ppm calcium carbonate is equivalent to 1 meq/l of calcium carbonate it is easy to convert from one form to the other. It is acceptable to have hardness levels of 3 meq/l and higher if compensations are made in the use of calcium and magnesium in the fertilizer program and if the balance of calcium and magnesium is proper in your water source. High levels of calcium and magnesium in the water will generally accompany similarly high levels of bicarbonate. This bicarbonate will generally be associated with a rise in substrate pH over time. Thus, it is wise to use less limestone in the substrate when high hardness water is encountered. The calcium and magnesium bicarbonates you are adding with the water are equivalent to "liquid limestone."

Turning now to ratio; calcium and magnesium in the substrate should be in the ratio of 3 calcium to 1 magnesium if expressed as meq/l and in the

Table 1. Water quality guidelines.

Type of problem	Upper acceptable limit
Salinity	
EC (mmho/cm)	
for plug production	0.75 (480 ppm)
for general production	2.0 (1,280 ppm)
sodium (ppm Na)	50
chloride (ppm Cl)	70
Micro Elements (ppm of each)	
boron (B)	0.5
copper (Cu)	0.2
fluoride (F)	1.0*
iron (Fe)	4.0
manganese (Mn)	1.0
zinc (Zn)	0.3
Alkalinity - pH - Hardness	
Alkalinity (meq/l)**	1.5 (75 ppm)
pH	5.8 is ideal; 5.4 to 6.8 is usually acceptable, depending on the alkalinity and micronutrient levels in the water
hardness (meq/l)***	2 to 4; depends upon the balance of calcium and magnesium (should be 3 meq Ca to 1 meq Mg) and on the balancing ions associated with the Ca and Mg, i.e. chloride vs bicarbonate

*Safe for most crops but toxic for many members of the lily family (see text for complete list).

**Alkalinity is expressed as the milliequivalents of calcium carbonate or as ppm calcium carbonate. The conversion between the two is 1 meq/l = 50.04 ppm. Water with high levels of alkalinity can be used safely if it is treated with acid.

***Hardness is the combined number of milliequivalents of calcium and magnesium in a liter of water expressed as if it were all calcium carbonate.

ratio of 5 calcium to 1 magnesium if expressed as ppm. There is a fairly wide latitude of variance around these ratios. However, if the ratio shifts a great deal from this, a deficiency of the nutrient which is undesirably low in the ratio will occur. The more common problem would be a low level of magnesium relative to calcium. In this case it would be necessary to supplement occasionally with a Mg source such as magnesium sulfate (Epsom salts). Examine the ratio of calcium to magnesium (Ca : Mg) in your water to anticipate whether the substrate Ca : Mg will tend to shift out of the desired range.