PRACTICE MAKES PROFIT

by Shannen Ferry, Ron Adams, Dan Jacques, Bill McElhannon, Paul Schill and Bob Steinkamp

Salts are chemical compounds consisting of positively and negatively charged particles called cations and anions. These ions can be strongly or weakly held together, which is what determines salt solubility. Common examples of salts are sodium chloride (table salt), magnesium sulfate (epsom salt) and potassium nitrate (saltpeter).

Soluble salts in horticulture are usually measured by their electrical conductivity (EC). The values are expressed as millimhos per centimeter (mmhos/cm), deciSiemens per meter (dS/m), or milliSiemens per centimeter (mS/cm). They are equivalent units of measure.

The EC measurement alone does not indicate the types of salts in irrigation water. But this measurement can provide a good indication of the total amount of fertilizer being applied.

TESTING THE WATERS

Water used for crop production is the first place to look for salts. There is tremendous variability in North American water quality - from very alkaline water with high mineral content to water that is almost as pure as rain. The first example might have an EC of 1.2 mS/cm, while the latter might be less than 0.2 mS/cm.

Water from different sources on the same property can be just as different. In general, surface water - a pond, river, or shallow well - will have lower salt content unless it contains runoff salts from agricultural fields or greenhouses. Deep well water quality depends on the aquifer or water source. Shallow wells and rivers near the coast might have high levels of sodium, chloride, and alkalinity. The only way to know is to test the water regularly.

Testing the water more than once is important because water quality can change often.
Check any of these variables that apply:

- wet season vs. dry season;
- high vs. low usage periods;
- unusual droughts; and
- city water that comes from various sources.

Ask the water authority to provide notification of changes and analysis.

Also, be sure to consider the water's EC when interpreting EC values for crops. If the salts in the water are unacceptably high for the crops grown, there are several possible remedies. Find another water source, such as city water. Install a reverse osmosis system to purify the water, or use a more open media and leach more thoroughly.

The last SUREVISION contained:

Part 1 - "Five major media components and their properties".

Part 2 - "Media selection and storage"

Part 3 - in this issue is "EC, water quality and pH management"

Part 4 - "Media testing" will follow in the next SUREVISION issue.

GROWING MEDIA MATTERS

Whether commercially manufactured or homemade, growing media usually contains relatively low levels of most nutrients. Typically, the EC is 0.75-2.0 mS/cm. Growing media also contains small amounts of nonnutrient minerals, such as sodium and chloride. And there are a few elements - calcium, magnesium, and sulfur - which could be fairly abundant.

Calcium comes from lime or dolomitic lime in most media. While it is the carbonate portion of this salt that provides pH buffering to the mix, calcium is a major nutrient that is often lacking in growers' water and fertilization programs.

Lime dissolves slowly, so calcium might not be readily available to the plant. Since solubility is low, conductivity due to lime will be low. Dolomitic lime also will release magnesium.

Gypsum, another source of calcium, is much more soluble than lime, and it provides a more readily available source of calcium. It is also a good source of sulfur. Because of its solubility and the conductivity of sulfate, gypsum contributes more to the EC of the mix.

DISSECTING FERTILIZER

Fertilizer is one of the most significant sources of salts. Ideally, fertilizer should add only the nutrients the plant needs and in the exact proportions required. Unfortunately, this is seldom the case.

Many formulations contain excess amounts of phosphorus. Also, some fertilizers contain salts like potassium chloride or sodium nitrate, which supply undesirable elements along with the nutrients. Plants use very little sodium or chloride.

All the salts from water, fertilizer, or media that are not used by the plant will be left in the soil solution. If they are not leached out regularly, they will accumulate.

Accumulated salts pose several problems. They make interpretations of EC values unreliable. The grower doesn't know whether the salts present are useful nutrients or undesirable elements. Also, high amounts of sodium and chloride contribute to plant stress and disease susceptibility.

The key to managing salts in media is choosing fertilizers that complement the water supply and provide the right balance of nutrients. Then feed constantly at a low to moderate rate to minimize the amount of fertilizer that might be leached into the environment.

If high salts in the water are a problem, more leaching will be required. In that case, choose a medium that leaches easily, and do not allow it to dry excessively.

INTERPRETING ECS

There are several methods commonly used to measure soluble salts, each with advantages and disadvantages. All require using distilled water to prepare the sample.

Most university and commercial horticulture laboratories use the Saturated Media Extract method (SME). One clear advantage of SME is that direct comparisons can be made to the results of a professional lab. This has been the standard for peat-lite media for many years, and it works equally well for bark-based and other soilless mixes. It is sometimes thought of as a 1:1 ratio of water to media, but this may not always be correct.

The method most widely used by growers is the 2:1 extract. In this technique, 2 parts of water are added to 1 part dried media. Since there is nearly twice as much water added to the media, the EC for the 2:1 sample will be roughly half that of the SME sample.

The 5:1 sample preparation is not widely used, but it reduces the need for a totally dry sample due to greater dilutions.

ECs for samples prepared using different methods must be interpreted using different standards. Since there is a difference in conductivity meters and preparation methods, correlation of onsite tests with those from commercial or university laboratories is necessary for best interpretation.

Table 1, prepared from various sources, presents comparisons between SME, 2:1, and 5:1 dilutions. Results may vary because of human error, so the comparisons are approximate. Make allowances according to the plant grown, the irrigation water EC, and the sampling interval following fertigation.

Certainly, watering in with a dilute, soluble fertilizer gets plants off to a faster start and evens out some of the media fertility differences.

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Comparisons between Saturated Media Extract (SME), 2:1 extract, and 5:1 extract methods.

Dilution Method			***Interpretation*** *Depends on plant growth, water quality, and interval following fertigation.*
SME	**2 Water : 1 Media** *Values given in mS/cm, mmhos/cm & dS/m*	**5 Water : 1 Media**	
0.74mS/cm	0.24 mS/cm	0.11 mS/cm	Low
0.75 - 2.00	0.25 - 0.75	0.12 - 0.35	Generally good for seedlings and salt-sensitive plants.
2.00 - 3.50	0.75 - 1.75	0.35 - 0.65	Good for established plants. Upper ranges may reduce growth of sensitive varieties.
3.50 - 5.00	1.75 - 2.25	0.9 - 1.1	Somewhat high, upper ranges might result in marginal burn. Do not allow to dry out.
Higher than 5.0	Higher than 2.25	Higher than 1.1	Very high potential for burn, root damage, and stunting. Wilt is likely.

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WATERING FREQUENCY VERSUS VOLUME

Overwatering media causes oxygen depletion to the root zone. Overwatering occurs when water is applied too frequently. It should not be confused with thorough watering.

Thorough watering dissolves excess soluble salts and flushes them out while drawing air into the media from the top. Sometimes referred to as leaching, thorough watering establishes a healthy root environment. Depending on media EC, leaching can be done with or without fertilizer.

While growers in pure water areas may be able to practice "no leach" fertigation techniques, most growers who irrigate from the top of the container need to leach periodically to prevent soluble salt buildup. In particular, chloride and sodium salts may accumulate to damaging levels if thorough watering is not done.

Typically, 10%-15% of the volume applied should leach through the bottom of the container. In reality, growers may actually be leaching by 30% or more. Try not to waste water and fertilizer during this process.

Subirrigation via ebb and flood systems should typically use lower concentrations of fertilizer since the media is not often leached. The salts accumulate at a slower rate if water quality is good. If water quality is marginal, try periodic top watering on long-term crops to leach out accumulated salts.

Crop, season, media type, and greenhouse environment affect water and fertilizer solution applications. Avoid watering during late afternoons unless the plants can dry off before nightfall. This helps discourage diseases.

Values for common greenhouse fertilizers with potential acidity or basicity

Formulation	Potential Acidity or Basicity
21-7-7 Acid Spec.	1556 acidic
9-45-15	977 acidic
20-20-20	547 acidic
20-9-20	510 acidic
20-10-20	394 acidic
21-5-20	389 acidic
15-16-17	196 acidic
17-5-24	125 acidic
15-5-25	37 acidic
15-5-15	141 basic
13-2-13	220 basic
14-0-14	220 basic
15-0-15	380 basic
15.5-0-0	400 basic
13-0-44	460 basic

Avoid severe wet / dry cycles. Disease expression and micronutrient toxicities are greater when plants are stressed in this manner.

Also, avoid withholding water for height control. Use total environmental control to accomplish this task. And check the weather forecast before watering during dark or cloudy weather. If media is not dry enough, overwatering may occur.

EXAMINING PH

Media pH management is fundamental in greenhouse fertility programs. Container mixes have very limited buffering, and media pH values can change rapidly.

Solubility of mineral nutrients, particularly micronutrients, is dramatically affected by media pH. Iron, manganese, boron, copper, and zinc are most soluble below pH 5.5 and may be available at toxic levels if the pH is below 5.0. For example, bronzing and chlorosis of geraniums and marigolds are closely correlated with the high levels of iron and manganese that occur with low pH values.

Molybdenum's solubility is different from other micronutrients. Molybdenum availability decreases at low pH and increases at higher pH values. In fact, molybedenum deficiencies are more frequently observed at low pH values.

Even though optimum solubility of most micronutrients occurs at low pH, micronutrient deficiencies can also occur. Conditions that promote optimum solubility are also conditions that promote rapid nutrient leaching from the container. At low pH, hydrogen ions saturate media exchange sites and increase the potential for leaching losses of nutrient cations such as calcium, magnesium, potassium, and ammonium.

As pH values increase, the availability of iron, manganese, boron, copper, and zinc decrease, and micronutrient deficiency symptoms may occur. There is a great deal of variation in plant response to high pH, but a number of plant species will begin to exhibit high pH-induced micronutrient deficiencies when media pH is above 6.5. Chlorosis (yellowing) of the upper portion of the plant is often caused by high media pH.

Simply lowering the media pH, rather than adding supplemental micronutrients, is often sufficient to alleviate this problem. Many plants can be grown across a pH range of 5.0-7.0, but optimum nutrient availability is achieved by maintaining media pH between 5.6 and 6.3.

ASSESSING ALKALINITY

The alkalinity of irrigation water greatly influences media pH in greenhouse environments. Alkalinity makes irrigation water resist changes in pH. Irrigation waters with medium to high alkalinity may cause the media pH to increase over time.

But how much alkalinity is too much? Unfortunately, there is no consistent answer for this question. Acceptable alkalinity limits vary with plant species, media, irrigation methods, and fertilization programs.

If growers have difficulty preventing media pH from increasing to problem levels, then the alkalinity is probably too high for the species, media, and fertility program used. If media pH is consistently too low for the crops grown, alkalinity may be too low for the media and fertilizers used.

Acid injection is the only economical method of controlling high water alkalinity. An excellent computer program for calculating the appropriate amount and type of acid to use is available through Allen Hammer, of Purdue University's Department of Horticulture, or Douglas Bailey, of North Carolina State University's Department of Horticulture.

MANAGING MEDIA PH

Frequently, growers effectively manage media pH values with their fertility programs. Fertilizers can have either an acidic or basic residual effect.
The acidifying effect of ammonium - or urea-containing fertilizers can be used to lower media pH. Nitrification of ammonium and urea to nitrate nitrogen releases hydrogen ions that can reduce media pH.

Additionally, when plants absorb ammonium, a surplus of hydrogen ions is generated inside the plant and released into the media solution. This causes media pH to decrease.

Basic fertilizers, which contain high levels of nitrate nitrogen, calcium, and / or magnesium, can be used to increase media pH. But some fertilizers, like poinsettia finishers, may have a neutral reaction. The potential acidity or basicity is stated on the fertilizer label. Values for some common greenhouse fertilizers are listed in Table 2.

Other variables affecting media pH are mix components and the amount and particle size of limestone amendments. Most professional mix companies have determined the amount of lime required to get target pH ranges with the components used. National mix producers, though, must target pH ranges that are acceptable for most crops in most locations.

But limestone amendments may be too much or too little when growers have very high or very low water alkalinity or grow crops that require pH values differing from typical plants. Particle size and solubility of added lime have a significant effect on the rate of reaction once the mix is wet.

Some limestone sources are very insoluble. Generally, the finer the lime, the faster pH adjusts. Very fine limestone works well with most short-term greenhouse crops. Many growers who want to make long-term improvements use blends of fine and coarser limestone to maintain desired pH levels with long-term crops.

Some pH problems can be avoided by choosing the appropriate preplant mix amendments. Limestone is added to soilless media to raise the pH and add calcium and magnesium. Growers with very high water alkalinity may benefit from the addition of no or low levels of limestone.

Gypsum can be used to add calcium with no effect on media pH. Magnesium can be incorporated in the fertility program. Stock plants or other long term crops may require more limestone than is necessary for production of the same plants with a shorter production cycle.

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POSTPLANT MANAGEMENT OF MEDIA PH

To Lower pH

1. Use more acidifying fertilizers.
2. Acidify irrigation water to pH 5.8-6.2 using acid injection.
3. Iron Sulfate: 4-6 pounds per 100 gallons of water. Apply 1 quart per square foot or 8 fluid ounces per 6-inch pot. Be careful not to use this on crops subject to iron toxicity.
4. Elemental Sulfur: 0.75 pounds per cubic yard or 1/3 teaspoon per 6- inch pot. Use media biological activity to make this solution work.

To Raise pH

1. Discontinue acid injection and allow water alkalinity to increase media pH.
2. Use fertilizers with lower potential acidity or higher potential basicity.
3. Flowable limestone drench: (a) calculate the number of flats or pots filled per cubic yard and drench with 2-3 pounds. Works best with a 1:15 proportioner; or (b) mix the container of flowable limestone with water in equal parts and apply using a 1:100 injector ratio. This should cover 135 square foot to a 4-inch depth.
4. Potassium bicarbonate drench: 1 - 1.5 pounds per 100 gallons of water.
5. Top dress with a fine grind of dolomitic limestone.
6. Calcium hydroxide drench.