Basics Of Monitoring: Media pH, EC & Water Quality

Developing a comprehensive monitoring program is key to keeping your production on track, but only a handful of growers are as watchful as they should be. Now, you can borrow concepts presented in this series to produce quality plants on time for every season.

by **DIANE M. CAMBERATO** and **ROBERTO G. LOPEZ**

THE cover of an environmental monitoring company catalog contains a quote: "To measure is to know."

Monitoring is an attempt to quantify the invisible, to know before you see. We have become accustomed to this practice in human health and wellness and have our temperature and blood pressure taken. We understand the importance of the resulting values and what they mean, based on a scale resulting from scientific data.

Monitoring, as a tool in greenhouse production, has the same end. It can be an instructive learning tool, focusing attention on details that can otherwise go easily ignored until there is a "wellness" issue that commands your full attention and your wallet. Of benefit to greenhouse production over field production is greater environmental and cultural control of temperature, light, substrate, water and fertilizer. Published recommendations for these inputs are available for many of the crops commonly grown, and monitoring is the tool by which we assess our successful manipulation of the environment and cultural inputs and make adjustments accordingly.

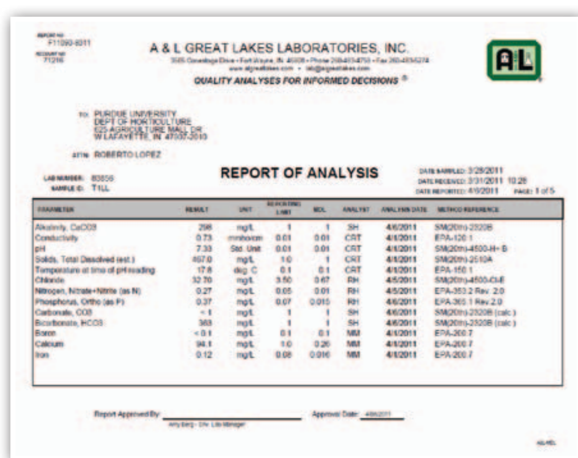
This third article in the Basics of Monitoring Series will focus on monitoring irrigation water quality and substrate pH and electrical conductivity (EC).

First Steps

The very first step in monitoring would be to submit an approximately 500-milliliter (16-ounce) sample of your irrigation water to a professional laboratory. This will cost approximately $75 and would be a good annual investment, as water quality can change over time depending on your water source. To submit a water sample, fill a clean plastic container to the top and secure a tight-fitting lid to avoid room for air. Mail early in the week so the sample arrives at the lab and analysis is performed with as little delay as possible for accuracy.

Aside from pH (values affect nutrient availability), EC (values indicate dissolved salt concentration) and alkalinity (values indicate buffering capacity), the analysis will include quantities of other important nutrients that affect plant growth and development (Figure 1). In addition, the presence of some elements can create maintenance issues in your system (calcium, magnesium and iron deposits), and high irrigation water pH and alkalinity of water can potentially decrease the effectiveness of the pesticides and plant growth regulators you depend on to control crop quality.

The resulting information will help you make decisions as to whether acidification is necessary, as well as enable you to choose a fertilizer formulation and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TO: PURDUE UNIVERSITY
DEPT OF HORTICULTURE
625 AGRICULTURE MALL DR
W LAFAYETTE, IN 47907-2010

ATTN: ROBERTO LOPEZ

REPORT OF ANALYSIS

LAB NUMBER: 83856
SAMPLE ID: TILL
DATE SAMPLED: 3/28/2011
DATE RECEIVED: 3/31/2011 10:28
DATE REPORTED: 4/6/2011
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PARAMETER	RESULT	UNIT	REPORTING LIMIT	MDL	ANALYST	ANALYSIS DATE	METHOD REFERENCE
Alkalinity, CaCO3	298	mg/L	1	1	SH	4/6/2011	SM(20th)-2320B
Conductivity	0.73	mmhos/cm	0.01	0.01	CRT	4/1/2011	EPA-120.1
pH	7.33	Std. Unit	0.01	0.01	CRT	4/1/2011	SM(20th)-4500-H+ B
Solids, Total Dissolved (est.)	467.0	mg/L	1.0	1	CRT	4/1/2011	SM(20th)-2510A
Temperature at time of pH reading	17.8	deg. C	0.1	0.1	CRT	4/1/2011	EPA-150.1
Chloride	32.70	mg/L	3.50	0.67	RH	4/5/2011	SM(20th)-4500-Cl-E
Nitrogen, Nitrate+Nitrite (as N)	0.27	mg/L	0.05	0.01	RH	4/5/2011	EPA-353.2 Rev. 2.0
Phosphorus, Ortho (as P)	0.37	mg/L	0.07	0.015	RH	4/6/2011	EPA-365.1 Rev 2.0
Carbonate, CO3	< 1	mg/L	1	1	SH	4/6/2011	SM(20th)-2320B (calc.)
Bicarbonate, HCO3	363	mg/L	1	1	SH	4/6/2011	SM(20th)-2320B (calc.)
Boron	< 0.1	mg/L	0.1	0.1	MM	4/1/2011	EPA-200.7
Calcium	94.1	mg/L	1.0	0.26	MM	4/1/2011	EPA-200.7
Iron	0.12	mg/L	0.08	0.016	MM	4/1/2011	EPA-200.7

Report Approved By: ______ Approval Date: ______

Figure. 1. Sample water quality analysis for Purdue University horticulture greenhouses.

Figure 2. Desirable characteristics of high-quality irrigation water.[1]

Characteristic	Desired Level
Soluble Salts (EC)	[2]0.2–0.5 dS/m
pH	5.4-6.8
Alkalinity (Carbonate, $CaCO_3$)	[2]40-65 ppm
(Bicarbonate, HCO_3)	40-65 ppm
Hardness ($CaCO_3$ equivalent)	<100 ppm
Sodium (Na)	<50 ppm
Chloride (Cl)	<71 ppm
Sodium Adsorption Ratio	<4

Characteristic	Desired Level
Nitrogen (N) -Nitrate (NO_3)	<5 ppm
- Ammonium (NH_4)	<5 ppm
Phosphorus (P)	<1 ppm
Potassium (K)	<10 ppm
Calcium (Ca)	<60 ppm
Sulfates (SO_4)	<30 ppm
Magnesium (Mg)	<5ppm
Manganese (Mn)	<1ppm

Characteristic	Desired Level
Iron (Fe)	<1 ppm
Boron (B)	<0.3 ppm
Copper (Cu)	<0.1 ppm
Zinc (Zn)	<0.2 ppm
Aluminum (Al)	<2 ppm
Chlorine (Cl)	<2 ppm
Fluoride (F)	<1 ppm

[1]Adapted from Floriculture Principles and Species, Dole and Wilkins 2004.
[2]Labs vary on the elements tested and the units for values listed, dS/m = mmhos/cm and ppm = mg/L.

prepare it at the right concentration. For example, here at Purdue University our irrigation water has a pH of 7.2 and 298 ppm alkalinity due to the presence of naturally occurring calcium and magnesium carbonates. We must either acidify the irrigation water with sulfuric or other acid to neutralize the alkalinity or use an acidifying fertilizer to maintain substrate pH in the suitable range (5.4 to 6.2) for most floricultural crops.

Remember substrate pH affects the availability of those expensive nutrients you are providing through fertilization, especially micronutrients. Do not be intimidated by all of the generated values on the analysis. Guidelines for high quality irrigation water are available to compare with your test results (Figure 2).

There are also published charts of suggested pH and EC ranges for specific greenhouse crops (**www.ces.ncsu.edu/depts/hort/floriculture/hils/HIL590.pdf**), and the values will be helpful to your consultant, fertilizer representative or Extension specialist.

Keep Monitoring

The irrigation water analysis gets you started. However, the ongoing monitoring of your substrate finishes the job. This is especially important for long-term crops like poinsettias, Easter lilies and stock plants, as the substrate lime charge will become exhausted and substrate solution pH will change. Monitoring substrate pH and EC on a weekly or biweekly basis allows you to see an upward or downward trend in these values, allowing corrections before nutrient deficiencies or high soluble salt issues affect your crop's growth and development.

As with irrigation water samples, you

can collect substrate samples to submit to a professional testing lab, which can cost $25 for a pH and EC analysis and have a three- to four-day turnaround time, depending on location. Alternatively, an in-house substrate solution test (PourThru) has been developed to achieve same-day results (Figure 3).

There are other accurate ways to obtain a sample of the substrate solution in order to assess the pH and EC of the root zone. The PourThru method was developed for greenhouse and field use. Instruments are reasonably priced and it is not costly (Figure 4). However, it is a time commitment and the person performing the analysis must know how to maintain and calibrate the pH/EC meter and perform this task with consistency. The basics of the PourThru consist of fertigation or irrigation as usual and waiting 30 to 60 minutes for substrate solution equilibration. A saucer is then placed under the pot, and a predetermined volume of distilled water is poured on the substrate surface to displace the solution in the root zone for pH and EC measurement.

Figure 3. Place saucer under plant to collect PourThru test solution.

Figure 4. A portable pH/EC meter.

Test values obtained from the test are then compared to those in the acceptable range for a given crop and informed production decisions can be made. For more information, the Purdue Extension bulletin (English and Spanish versions available) pH and Electrical Conductivity Measurements in Soilless Substrates (**www.extension.purdue.edu/extmedia/HO/HO-237-W.pdf**) includes details on how to perform this test and equipment needed.

Time must be allocated to obtain random samples, collect data and make an assessment of values. Each substrate, fertilizer and plant species requires separate sampling. Again, there are published values that tell you what the numbers you generate mean. Electrical conductivity measurement values do not tell you how much of a specific nutrient (i.e. nitrogen) is available, but it does indicate whether too much or too little fertilizer is being supplied. Plant tissue analysis is an additional tool that can provide this kind of detail and is often complimentary to the results of substrate analysis when trying to diagnose nutrient disorders.

Additionally, an EC measurement of your fertilized irrigation water can indicate whether you have mixed stock solutions correctly or if injectors are properly functioning. A chart on the fertilizer bag includes the target concentration (ppm N) after dilution and the resulting EC by injector rate. By comparing the EC value you obtain with the target listed on the fertilizer bag, you can know rather than assume how much nitrogen you are providing when you fertigate.

Takeaways

There is no way to sugar coat monitoring irrigation water and substrate pH and EC to the extent that it does not sound like work. Instead, we attempted to entice you with the low hanging fruit of the benefits, which is basically a "well check" on your crop. Think of the associated expense as an investment in your horticultural education, and like all education, an investment that pays you back.

A working knowledge of the important principles associated with plant irrigation and fertilization will make you a better grower and enhance your ability to be competitive in an industry that requires a high level of brain as well as brawn. **GG**

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