Agronomic testing services can optimize production of containerized nursery crops

Michelle McGinnis  
Agronomist, NCDA&CS Agronomic Division  
Adjunct Assistant Professor, Horticultural Science, NCSU  

Catherine Stokes  
Information Specialist, NCDA&CS Agronomic Division

By the time nutrient problems become evident (by reduced plant growth and/or poor color), economic loss has already occurred. However, such problems can be easily averted by use of routine sample analysis to monitor nutrition throughout the course of crop production. The Agronomic Division of the N.C. Department of Agriculture and Consumer Services offers several laboratory testing services that are particularly appropriate for identifying nutrient-related problems of nursery and greenhouse crops before symptoms become visible. These tests include analysis of irrigation water, nutrient solutions, pour-through leachate samples, soilless media and plant tissue. The division can also assay media and plant tissue for presence of plant-parasitic nematodes.

The agronomic services most useful in routine monitoring of nursery and greenhouse crops are solution analysis and media analysis. Solution analysis can be used to analyze the chemical properties of irrigation water, nutrient solutions and pour-through leachate samples. Soilless media analysis is used to monitor nutrient levels in growing substrates. Plant tissue analysis and nematode assay are more often used when troubleshooting existing problems rather than for routine monitoring.
Solution Analysis

Solution analysis of irrigation water, nutrient solution and pour-through leachate samples provides
- measurements of concentrations of dissolved nitrogen (nitrate-nitrogen, ammonium-nitrogen, urea), phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, zinc, copper, boron, sodium and chloride in parts per million (ppm);
- values for pH and electrical conductivity (10⁻⁵ S/cm); and
- calculations of alkalinity (ppm CaCO₃), sodium adsorption ratio and hardness (ppm CaCO₃).

Irrigation Water. Since water quality can change over time, it is a good idea to submit samples for solution analysis twice a year. The best times are early spring and late summer. Samples should be collected from the irrigation system nozzles or emitters, not from tanks or retention ponds.

Sampling should always be done any time a new well is installed, after any extreme wet or dry period, or if a nutrient-related problem is suspected. When reading a Solution Analysis Report, be on the lookout for the following problems, which are common in North Carolina.

High alkalinity can limit plant growth by increasing substrate pH, coating plants with a white residue and/or plugging irrigation systems. This problem is most serious for plants grown in containers of one gallon or less. Adding battery acid to the water is a common corrective practice that is very effective. NCDA&CS solution analysis reports list the rate of sulfuric (battery) acid needed to reduce alkalinity by 80% for any irrigation water samples with an alkalinity greater than 100 ppm CaCO₃.

Iron in the water supply and the subsequent growth of iron-reducing bacteria may be of concern. The presence of iron leads to problems such as red stains on greenhouse and riser surfaces, a slime that clogs mist nozzles and irrigation emitters and/or a bluish film that coats plant surfaces. Concentrations of iron as low as 0.5 ppm can cause problems. Remedies include strategic placement of retention water basin intake pipes (1 foot below surface and 2 feet above base), aeration and/or chlorination.

High levels of sodium and/or chloride can reduce plant growth when taken up through roots or deposited on leaves and buds. The threshold of concern for both of these elements is 70 ppm; however, plant species vary in their tolerance. Symptoms of sodium and chloride toxicity include marginal necrosis and wilting.

When water contains high levels of sodium and/or chloride and is used in an overhead irrigation system, irrigate at night or early in the morning to reduce potential for leaf burn. The best remedy is to dilute the irrigation water that has high levels of sodium or chloride with water from a source with significantly lower levels of these elements.

Effects of sodium toxicity via root uptake can be counteracted by the presence of calcium in the water or media. Incorporation of gypsum (22% Ca) into the substrate provides calcium without any liming effect. The sodium adsorption ratio (SAR) is a calculation of the calcium, magnesium and sodium relationship. The likelihood of sodium-related problems increases with the SAR value. A value of 4 is generally the threshold of concern with regard to sodium toxicity in the root zone.

Finally, high levels of boron occur in some water supplies, primarily in shallow groundwater in eastern North Carolina. Thresholds for boron toxicity are species specific, and levels of sufficiency and toxicity are very narrow. Finding an alternative water source or diluting the existing one can prevent production problems.
**Nutrient Solutions.** When fertilizers are applied directly through the irrigation system, the process is called fertigation. Fertigation solution samples should be collected directly from the emitters or nozzles of an irrigation system. They should be collected periodically to verify nutrient concentrations, confirm whether fertilizers have been mixed properly and to check the efficacy of the drip system and/or the injectors.

Routine collection of leachate sample nutrient solutions using the pour-through extraction procedure is recommended to monitor electrical conductivity (EC) and pH. EC is an indication of nutrient levels available for plant uptake. Knowledge of EC facilitates efficient irrigation and nutrient management. The threshold of concern with regard to salt injury is $200 \times 10^{-5} \text{S/cm}$ ($2 \text{mS/cm}$).

Periodic laboratory chemical analysis of leachate samples is recommended to provide specific nutrient concentrations. Target ranges of nutrient concentrations in leachate samples are wide and will vary depending on site-specific conditions such as last rain event, volume of irrigation water applied, type of fertilizer used and time into production cycle. Site- and production-specific information is necessary for accurate interpretation of results.

**Soilless Media Analysis**

The saturated media extract (SME) procedure for analysis of soilless substrates is a new service offered by the NCDA&CS Agronomic Division. Media analysis provides the same types of data as solution analysis, with the exception of alkalinity. Currently, the results are issued on a Solution Analysis Report, but within a year, NCDA&CS plans to begin issuing media analysis results under the title of Media Analysis Report.

Media analysis is a good alternative to solution analysis when it is not possible or convenient to collect samples of leachate. It is not feasible, for example, to collect pour-through leachate from nursery stock in large containers. Similar information can be obtained, however, by collecting media from these containers and having it analyzed.

Furthermore, if sample collection cannot take place within 0.5 to 2.0 hours after an irrigation event (as required by the pour-through extraction procedure), submitting media samples may be the preferred method to monitor nutrient levels in the root zone. As with pour-through leachate results, nutrient concentrations of media samples will vary widely depending on site-specific conditions, and specific production information is necessary for reliable interpretation of results.

Additionally, media analysis of bulk substrates prior to potting may be beneficial to screen for potential problems and monitor consistency of the potting supply. For preplant bulk media samples, always moisten the sample prior to sending it to the lab. This important step activates the lime and facilitates a pH measurement more in keeping with the value to be expected during production.

**Plant Tissue Analysis**

Tissue analysis measures the concentrations of 11 essential elements within plant leaves and assigns each nutrient an index value. The use of index values makes it easy for clients to determine whether
the nutrient concentrations listed on the Plant Analysis Report are deficient, low, within the desired range, high or excessive. The report also gives recommendations for corrective action when necessary.

The most common use of tissue analysis for woody crops is to diagnose suspected deficiencies or toxicities and help determine the best corrective action. When plants exhibit abnormal growth or color, it is recommended practice to submit samples of both plant tissue and growth media (or pour-through leachate) for analysis. Use of accepted sampling procedures will yield the most meaningful test results.

Nematode Assay

Foliar nematodes can be a serious problem in the nursery. They are usually introduced in infected plants and disseminated in propagation material. Infected plants may display necrosis between veins, water-soaked areas and/or bud and stem distortion. To diagnose foliar nematodes, submit leaf samples to the Agronomic Division’s Nematode Assay Section.

Soil-inhabiting nematodes can be a problem if containers are placed on soil or come into contact with unsterilized soil. Proper sanitation is the best preventative measure. To diagnose nonfoliar nematode problems, submit a sample of the media and roots for nematode assay.

Troubleshooting and Obtaining Advice

At the first sign of a nutrient-related problem, obtain as much information as possible by submitting the following samples to the NCDA&CS Agronomic Division

- pour-through leachate or media sample(s),
- plant tissue sample(s),
- irrigation water sample(s) and
- fertigation solution sample(s) (if applicable).

If “good” and “bad” plants are present, collect separate samples from “good” and “bad” areas for comparison. Remember that the quality of laboratory results depends entirely on the quality of samples submitted.

Visit the NCDA&CS Agronomic Division Web page [www.ncagr.gov/agronomi/sampleinfo.htm](http://www.ncagr.gov/agronomi/sampleinfo.htm) for

- detailed instructions on how to collect and submit all the types of samples mentioned here,
- sample information forms,
- lists of sample processing fees and
- contact information for NCDA&CS regional agronomists, NCCES agricultural agents and other specialists.

NCDA&CS regional agronomists and NCCES agricultural agents can explain how to use agronomic testing services appropriately. They make on-site visits, provide advice on nutrient- and nematode-management issues, demonstrate sampling techniques and help troubleshoot problems. With the help of agronomists and agents, growers can incorporate uniquely appropriate agronomic tests into their own specialized production systems.
For more information about how NCDA&CS Agronomic Services can improve nursery crop production, call agronomist Michelle McGinnis of the Plant, Waste, Solution and Media Laboratory at (919) 733-2655.