The Secret Is in the Sauce: Monitoring EC, pH, and Nutrients in Container Leachates©

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INTRODUCTION

Every nursery needs to have someone who routinely checks electrical conductivity (EC) also called soluble salts, and pH of container crops, potting inventories, and irrigation water. Checking EC and pH should be considered part of the quality control and scouting program in the nursery. Results from testing three to five containers in an irrigation zone each week can be used to schedule irrigation the following week. Comparing leachate solution collected from containers to water collected from irrigation nozzles provides a good insight into nutrient levels in the containers. Checking EC and pH of nursery crops grown in containers doesn't have to be time consuming, complicated, or difficult. The intention of this presentation is to review the procedure and update growers on the Virginia Tech Extraction Method (VTEM), also called the PourThru extraction procedure (Wright, 1986; Yeager et al., 2007).

EQUIPMENT AND COSTS

A range of equipment can be purchased to monitor pH and EC. If you purchase a pH meter or pen, you should also order a bottle of pH 4 or 7 buffer (standardizing) solution. A standard solution should also be purchased when you purchase EC pens and meters to assure your equipment is calibrated and working properly. An EC / pH combination unit may cost $150 to $600. Individual EC and pH pens are generally inexpensive (approximately $45 to $95). Most pens and meters are temperature compensating, however read the information that comes with the equipment to determine if any adjustments are necessary related to temperature or other environmental conditions. Pens and meters with a cable require wide-bottomed cups, beakers, or jars to hold test samples to avoid spilling on uneven surfaces. Otherwise, if you don't keep your hand on the pen or electrode the sample may tip over and spill. Glass pH electrodes are usually necessary for dependable pH readings. When a pH pen or meter will no longer standardize using the pH 4 or 7 buffer, it's time to replace the pen or the electrode. They last longer if they are left in pH buffer (4 or 7) and not left dry when stored.

Conductivity and pH equipment should be readily available to key employees. Keeping equipment in work vehicles or in work areas provides an opportunity to check EC and pH as part of the routine nursery scouting program. Portable meters and pens can be set up and samples tested on a truck tail gate or wagon bed in the same manner as a lab bench. If equipment is kept in a truck cab, place it in an insulated cold drink cooler. The cooler will modify temperatures and reduce exposure of the equipment to extreme heat, cold, and evaporative conditions, thus extending the useful life of electrodes. Employees should be trained to use and calibrate the equipment using clean, fresh standards. Calibrating both pH and EC should be done daily before use or each time before testing a group of solutions, and between samples, if critical decisions are going to be made on results or the readings seem questionable.

WHAT DO THE NUMBERS MEAN?

One of the most difficult parts of the testing (EC) is understanding what the numbers mean when you read them from a meter or pen. Older conductivity meters (often called solubridges) provided readings as mhos $\times 10^{-5}$. Most new conductivity meters give results using the international unit milli-Siemens (mS·cm $\times 10^{-3}$) [equivalent to milli-mhos·cm^{-1} $\times 10^{-3}$]. Research publications use another unit dS/M (deci-Siemens·m^{-1}) which has the same unit value as mS·cm $\times 10^{-3}$ or mmhos $\times 10^{-3}$. A reading of 0.5 mS·cm x 10^{-3} (mmhos·cm^{-1}) equates to a reading of 50 mhos·cm^{-1} on a Beckman solubridge. The unit of measure for conductivity pens and some meters is micro-siemens $\times 10^{-6}$ (µS $\times 10^{-6}$) which is the international unit of measure and comparable to micro-mhos/cm $\times 10^{-6}$. This means that the decimal place for µS $\times 10^{-6}$ is three places to right when comparing to mS $\times 10^{-3}$ (0.5 mS·cm^{-3} (milli-mhos) = 500 micro-siemens $\times 10^{-6}$ = 50 mhos $\times 10^{-5}$). Total dissolved salts (TDS) pens are also sold by some horticulture supply companies and they read in parts per million (ppm). Reading in parts per million may be more difficult to relate to information you read about conductivity, but dividing the total dissolved salts reading in parts per million by 700 should place the reading in an approximate mS·cm^{-3} conductivity range [2.0 mS·cm^{-3} $\times$ 700 = 1400 ppm]. A reading of 1400 ppm total dissolved salts is equivalent to 2.0 mS·cm^{-3}, both readings considered high soluble salts for pine-bark-based nursery potting mixes.

THE POURTHRU PROCEDURE

The biggest advantage of the PourThru extraction procedure compared to procedures that require taking substrate samples to a lab is that the PourThru can be used in the nursery and results can be interpreted immediately. The procedure is as follows: 30 min to 2 h after irrigation, pour approximately ½ cup (120 ml; 4.0 fl.oz.) of water over the surface of a 1-gal container or 1.5 cups (360 ml; 12 fl. oz.) over a 3-gal container for pine bark and sand potting mixes. More water may be required if the container mix contains sphagnum peat moss or other materials with high water-holding capacity. Distilled water is recommended for determining existing leachate concentrations; however using water from irrigation risers is acceptable since the irrigation water contributes to the pH, EC, and nutrient levels in the container. Reading the EC of the irrigation water and subtracting its EC value from the container leachate indicates soluble salt concentrations derived from fertilizer in the container.

Leachate solution can also be obtained by picking up containers and tipping the container to drain leachate from drainage holes. The "tip and collect" method would seem to represent a true observation of the EC, pH, and nutrient levels experience by roots at that specific point in time. Moisture levels in the container are close to container capacity or no drainage would be collected when containers are lifted. Therefore, "tip and collecting" samples 30 to 60 min. after irrigation of containers is appropriate. It is important to remember that the PourThru extraction procedure provides an average of EC and pH concentrations in the container. If fertilizer is placed in one spot on one side of the plant in the container, the PourThru will not provide an accurate reading for the concentrated zone around the fertilizer; it will provide an average reading for the container.

GROWING RANGES FOR ELECTRO CONDUCTIVITY IN CONTAINERS

The Southern Nursery Association Best Management Practices (SNA BMP) manual recommends that growers monitor EC at least once a month (Yeager et al, 2007). Minimal levels for EC should range from 0.2 to 0.5 $Ms \cdot cm^{-1} \times 10^{-3}$ ($dS \cdot m^{-1}$) for controlled-release fertilizers (CRFs) and 0.5 to 1.0 $mS \cdot cm^{-1} \times 10^{-3}$ for liquid feed or combinations of CRFs and liquid feed applications. Maximum levels for most pine-bark-based substrates should not exceed 2.0 $mS \cdot cm^{-1} \times 10^{-3}$. Desirable nutrient levels are listed in Table 1. Having leachates analyzed during hot and dry periods during the growing season is a good idea. Electrical conductivity (EC) can build up in the irrigation water. The EC may be chlorides and sulfates, not essential nutrients.

CHECK POTTING MIX COMPONENTS

Organic potting components such as pine bark, or composts are very biologically active. If moisture, temperature and oxygen in inventories are not managed, inventories can become anaerobic which usually is accompanied by low pH and high EC and can damage nursery crops. Aged pine bark generally has a pH of 4.0 to 4.2. If the pH is below 3.8, growers should defer use of the inventory. Anaerobic bark may also have very high EC levels. Electrical conductivity readings as high as 1.5 $mS \cdot cm^{-1}$ to 2.5 $mS \cdot cm^{-1} \times 10^{-3}$ has been reported. Pine bark with these pH and EC characteristics should be irrigated to leach organic acids from the inventory, followed by turning the inventory. Several days and leaching irrigations may be required before acceptable pH readings in the 4.0 to 4.2 range and EC readings below 0.5 $mS \cdot cm \times 10^{-3}$ are measured. In some cases where pH and EC readings seem marginal for use, growers may want to blend affected inventory with other inventories in a 1 : 1 mix to reduce risk of damaging nursery crops.

CHECK IRRIGATION SUPPLIES

A comprehensive nutrient application program at a nursery must include analysis and recognition of what nutrients are contributed by the irrigation water. Surface and groundwater can have mineral and nutrient levels that affect plant growth and irrigation systems. Recycled irrigation supplies frequently contain significant amounts of soluble nutrients. Many irrigation supplies contain enough calcium for plant growth without addition of supplements such as dolomitic limestone. Iron, boron, sodium, and chloride are occasionally high enough in water supplies to make them unsuitable for growing nursery container crops. In addition to checking irrigation supplies for pH and EC, nurseries can avoid major nutritional disorders in crops by sending water samples to analytical laboratories for determination of nutrient content in irrigation water.

LITERATURE CITED

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