Measuring pH and EC of Large Container Crops

By Ariana P. Torres, Michael V. Mickelbart and Roberto G. Lopez

> The PourThru method is widely accepted for small containers, but does it translate for larger containers? Purdue University researchers sought to find out.

Improper nutrient management is one of the primary causes of poor crop quality and plant losses in commercial greenhouses and nurseries. Nutrient deficiencies and toxicities are often related to high substrate pH due to the use of poor quality irrigation water. However, initial symptoms of nutrient deficiencies or toxicities are not always visible until they become a problem that increases costs and reduces quality (and, therefore, profitability). Monitoring the pH and electrical conductivity of growing substrates gives you the ability to correct issues before they become problems that damage crops.

The pH of the growing substrate affects the availability of nutrients (especially micronutrients such as iron). Most nutrients are available at a pH range of 5.4-6.2 in soilless substrates (Figure 1); however, for each plant species there is an optimal pH range. EC is a measure of the dissolved soluble salts concentration in a solution, such as the irrigation water in a growing substrate. Nutrients in solution exist as salts. Solutions that contain dissolved salts are able to conduct electricity, and the EC is directly related to the amount of dissolved salts in the solution. There are several units used to quantify EC. Table 1 shows target EC ranges in dS/m (which is equivalent to mmho/cm or mS/cm) for the PourThru method and the indication of nutritional status for most greenhouse and nursery crops; however, optimal ranges are also species-specific.

There are three accepted methods for monitoring substrate pH and EC onsite: the PT, the saturated media extract, and the 1:2 substrate to water dilution test. Among these, the PT method is a widely accepted practice that can be used for both greenhouse and nursery crops.

The PT method is a bulk solution displacement method that was developed as a simple, on-site, rapid, nondestructive, cost-effective method of monitoring pH, EC and nutrient availability of substrates. Growers can now monitor substrate pH and EC with easy-to-use, portable and reliable measuring devices that measure both pH and EC, and are automatically calibrated for temperature compensation. The PT method consists of the following steps:

1. Irrigate the crop as part of your normal irrigation program.
2. Wait for 30 to 60 minutes to make sure that the containers are drained.
3. Place a collection saucer under the containers.
4. Apply a sufficient amount of distilled water to collect 1.7 ounces of leachate.
5. Measure pH and EC with your meter.

Most published protocols suggest collecting 1.7 ounces of leachate for containers smaller than 1 gallon each time a PT test is conducted. However, as container size increases, the

The PourThru Method

EC (mS/cm)	Category	Nutrient management indication
0 to 0.9	Very low	Nutrient levels are not adequate for plant growth.
1.0 to 2.6	Low	Appropriate for bedding plants, seedlings and salt-sensitive plants.
2.7 to 4.6	Normal	Appropriate nutrient levels for most established plants. Upper level for salt-sensitive plants.
4.7 to 6.5	High	May result in reduced vigor and growth, especially during hot weather.
6.6 to 7.8	Very high	May result in salt injury and reduced growth. Marginal leaf burn and wilting may appear.
>7.8	Extreme	Salt injury to most crops. Immediate corrective actions required.

Table 1. EC interpretation values for the PourThru method and the indication of nutritional status. (Source: adapted from "Monitoring and Managing pH and EC Using the PourThru Extraction Method," North Carolina State University Horticulture Information Leaflet 590, by Todd J. Cavins, Brian E. Whipker, William C. Fonteno, Beth Harden, Ingram McCall, and James L. Gibson. 2000)

◄ *Figure 2. Boxwood plants transplanted into 1-, 3-, 5- and 10-gallon containers filled with a commercial soilless media composed of peat moss, perlite, and bark (Metro-Mix 510).*

1.7-ounce leachate sample that is collected is increasingly smaller, relative to the root volume. This may, in turn, result in pH and EC values that are significantly different from those collected in smaller containers, which could create increased variability among samples.

To our knowledge, there are few, if any, recommendations for what leachate volumes to collect for pH and EC measurements from containers larger than a gallon. So we conducted a study at Purdue University to determine whether the leachate volume affects pH and EC values obtained or the uniformity of results in large containers. We wanted to determine whether accurate and consistent results were better obtained with a 1.7-ounce sample regardless of container size, or the same leachate volume as a percent of container volume. We chose 2.5 percent of container volume to test because 2.5 percent of a 1-gallon container is 1.7 ounces.

The Study

We received boxwood (*Buxus × koreana* 'Green Velvet') plants from commercial nurseries (Figure 2). Existing substrate was washed from the roots and plants were transplanted into 1-, 3-, 5- and 10-gallon containers filled with a commercial soilless media composed of peat moss, perlite and bark. We irrigated plants as necessary with acidified water (pH = 6.2), supplemented with water-soluble fertilizer (Peters Excel 21N-2.2P-16.5K).

Leachate was collected weekly, during a four-week period, using the PT method one hour after irrigation. Distilled water was poured evenly over the surface of each container by hand and was allowed to drain for 10 minutes into saucers placed under the containers. From each of the container sizes, we collected two leachate targets: 1.7 ounces, based on exisiting protocols, or 2.5 percent of the container volume. Immediately after col-

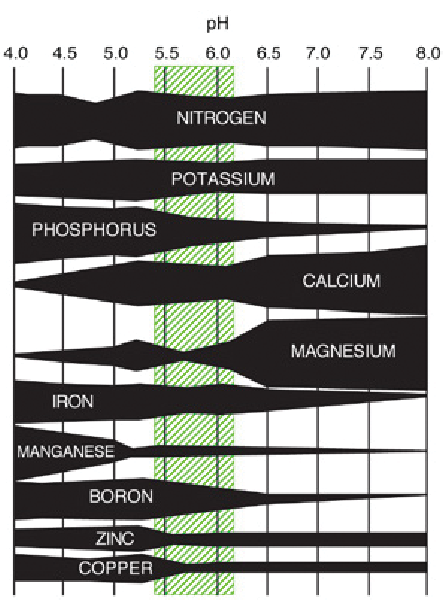

Figure 1. Recommended pH range (5.4 to 6.2), represented by the green area, for nutrient availability to plants. (Source: 1, 2, 3's of PourThru; Brian E. Whipker, Todd J. Cavins, and William C. Fonteno; North Carolina State University, 2001)

lection, we analyzed the pH and EC of the leachate using a handheld meter.

Figure 3 illustrates the amount of distilled water we poured over the containers to obtain a leachate volume of 1.7 ounces or 2.5 percent of the container volume. If collecting 1.7 ounces, as container volume increases, the leachate obtained represents a smaller percentage of the substrate volume. However, in the 2.5 percent treatment, the leachate increased proportionally in each container size.

Our evaluation of the PT method in large container sizes validates previous guidelines for this method, while providing a new insight into measuring pH and EC in large containers for nurseries and greenhouses.

Our Results

The pH was consistent over the four-week period and over all container sizes. There were no consistent differences in pH among container sizes, suggesting that current guidelines of the PT method for pH values can be used when monitoring pH and EC from leachate in large containers.

When 1.7 ounces of leachate were collected, pH was slightly higher than when 2.5 percent of the container volume was collected (Figure 4). The difference between the two treatments was not significant (about 0.2 pH units), and was statistically the same within a leachate volume treatment.

Figure 3. Container size and volume, target leachate (1.7 ounces total leachate or 2.5 percent of media volume), volume of distilled water applied, actual leachate volume, and the leachate (percent of media volume) of treatments in the experiment.

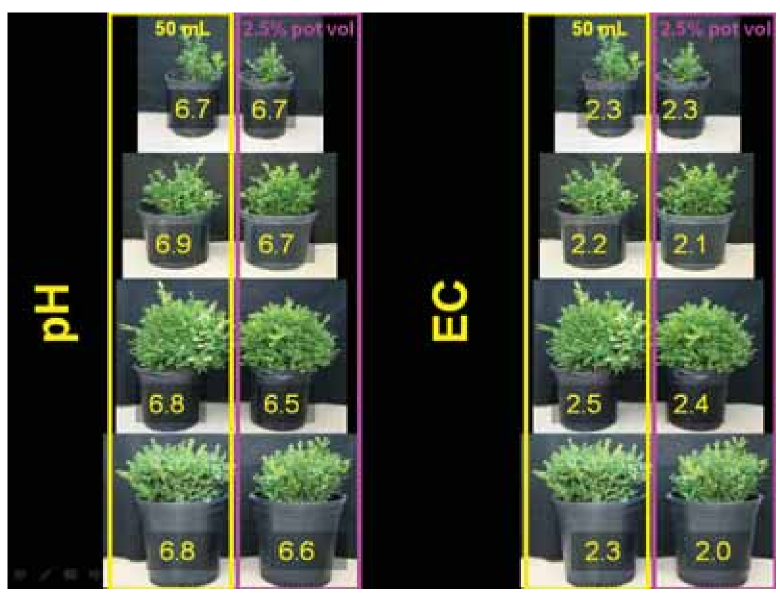

Figure 4. Leachate pH and EC (dS/m) collected from 1-, 3-, 5- and 10-gallon containers weekly for four weeks.

Previous research at North Carolina State University has shown that obtaining leachate volumes of more than 2 ounces in small containers can yield lower EC values. However, in studies with 1-gallon nursery containers, increasing the volume of water applied to the surface of the container from 1.4-3.4 ounces had no significant influence on substrate EC.

In our study, leachate EC values were similar for the 1.7-ounce samples and the 2.5 percent treatments in 1-, 3-, and 5-gallon containers (Figure 4). However, for 10-gallon containers, 1.7 ounces leachate resulted in a higher EC value than the 2.5 percent media volume leachate.

The average EC of the distilled water that we used in the experiment was 0.03 dS/m. In the 10-gallon containers, the volume of distilled water applied and collected was approximately 10 times higher in the 2.5 percent treatment than the 1.7-ounce treatment. Therefore, the large amount of low-EC distilled water likely resulted in a lower EC in the leachate for the 2.5 percent treatment. Hence, pouring a larger amount of distilled water over containers could have diluted the amount of dissolved salts in the collected leachate.

The Take-Home

Greenhouse and nursery growers should routinely monitor pH and EC of their growing substrates using the PT method. Our evaluation of the PT method in large container sizes validates previous guidelines for this method, while providing a new insight into measuring pH and EC in large containers for nurseries and greenhouses.

As we expected, when container size increases, the variability of the leachate, as well as pH and EC levels, increase. For all container sizes, both pH and EC values obtained from 1.7 ounces leachate were slightly more consistent than when 2.5 percent of the media volume was collected (Figure 4). For this reason and because of the convenience of collecting a smaller leachate volume, we recommend that growers apply approximately 2.4, 2.9, 4.1, and 5.1 ounces of distilled water evenly over the substrate surface of 1-, 3-, 5- and 10-gallon containers, respectively, to obtain 1.7 ounces of leachate for routine testing of pH and EC. This will provide growers with consistent results that can be compared to currently recommended values of pH and EC for greenhouse and nursery crops.

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