Perfecting the pour-through


Pour-through testing of container crops is a good way to assess nutritional needs.

Avoid common pitfalls of this seemingly simple method for measuring container nutrition

Photos by James Altland and OSU interns

The pour-through technique is useful for monitoring the nutritional status of container crops. Previous Digger articles (July 2004, January 2005) have addressed the proper technique for performing a pour-through. The Internet abounds with articles and short publications describing the technique; however, problems and inconsistencies occur even when it is done correctly. Research by Oregon State University interns Mark Bus, Walter Briones and Mathijs Maes documented the causes of inconsistencies in the pour-through procedure. This article will describe these problems and methods for addressing them.

Water held by a container is called the *substrate solution.* Plants absorb nutrients that are dissolved in the substrate solution. The primary goal of the pour-through procedure is to use a small volume of water poured over the container surface to push-out part of the substrate solution into a collection plate beneath the container. Every step of the process should be conducted with the aim of extracting substrate solution without contamination from outside sources. An important factor is that we do NOT want to analyze any part of the water that is poured over the substrate surface. The sole purpose of the water poured on the surface is to push the substrate solution out of the container bottom. Hereafter, we will use the terms *applied-water* to refer to water poured over the container surface, and *extract-water* to refer to water collected from the bottom of the container.

The remainder of this article will focus on how to successfully conduct a pour-through and obtain extract-water without contamination.

The pour-through procedure

To be sure everyone is on the same page, here is a quick review of the pour-through procedure:

1. Irrigate plants thoroughly so they are saturated, and then wait 1 hour. This will allow excess water in containers to drain and will also allow the container solution to come into equilibrium with container salts.
2. One hour after irrigation, place the container in a clean, dry saucer. Be careful not to tilt the container; always hold it straight and upright.

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3. For a #1 container, pour approximately 100 ml (3 oz.) of water over the container surface.
4. Wait 15 minutes for water to drain from holes in the bottom of the container.
5. Pour the extract-water into a clean jar, and then measure pH and electrical conductivity.

A critical step in the pour-through procedure is to saturate containers up to 1 hour prior to conducting the procedure. This saturation step has two important consequences. First, it ensures that containers are at the same moisture content each time the procedure is conducted. Second, it reduces the probability that applied-water will drain quickly through the substrate and contaminate the extract-water in the collection plate.

Finding fault

The most common problem with the pour-through procedure occurs when the applied-water contaminates the extract-water. Bus, Macs and Briones set up a series of experiments to determine which factors most contribute to contamination. To do this, they created a spiked solution of sodium hydroxide with a pH of 13 and used it for the applied-water. Any contamination of the extract-water with the applied-water would yield erroneously high pH readings. If solution is extracted without contamination, p11 should be around 6 (for the containers we used). However, contamination with the spiked solution would cause pH of the extract to be as high as 8 to 12 (depending on the level of contamination). By conducting the pour-through with the spiked solution, the students could determine which application methods result in contaminated extracts.

Experiment 1

Figure 1 (on Page 102) illustrates the influence of substrate type, volume of applied-water and method of applying the water on contamination in the extract-water. Contamination occurred more often in the medium-grade Douglas fir bark than in the fine-grade Douglas fir bark. Conducting this procedure on containers with coarse substrates warrants more care. Most container substrates have between 70 percent and 80 percent pore space, with only 20 percent to 30 percent of the container filled with solid particles. Water can move rapidly through the substrate in a process called *channeling.* Substrate particle size, or the coarseness of the substrate, seems to he the most important factor in channeling.

Applying the water with the traditional "pour" technique resulted in contamination of all samples of medium-grade bark. Among containers with fine-grade bark, contamination occurred only when 200 ml of water was poured. Dripping the water on the container surface resulted in no contamination regardless of substrate type or water volume. Nurseries operate on the principal that faster is better. Speed and efficiency with respect to potting, pruning, fertilizing, etc., are important for producing a profitable Crop. This is had news for the pour-through procedure. Our tests show that dumping water on the substrate surface, which is a more accurate description of how most nurseries

Canopies of some crops make uniform and slow application of water difficult for the pour-through procedure.

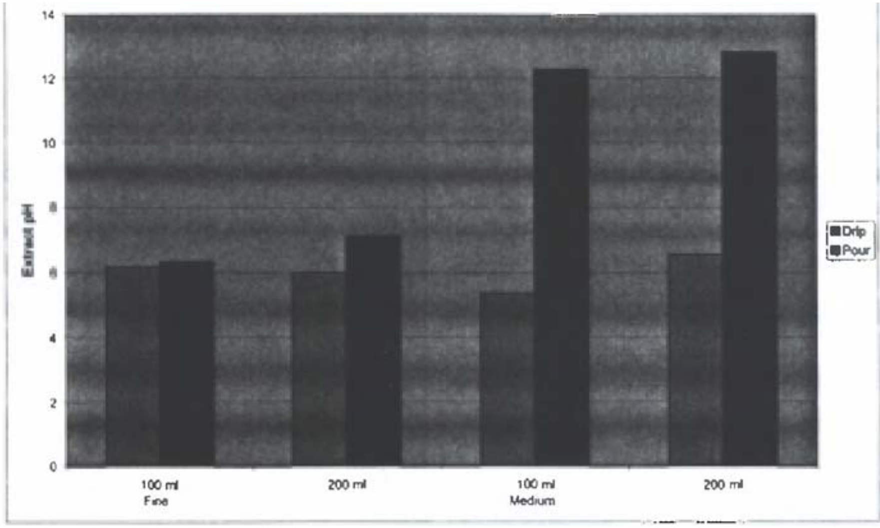


Fig. 1. Influence of substrate type, volume of applied water and method of applying water on extract contamination.

pour water, can result in channeling and contamination. Slow, steady application of water yields more consistent results. The speed of water pouring is more important in coarse substrates, where channeling is more likely.

We applied 100 or 200 ml of water to the substrate surface to see how water volume affects results. Applying 100 ml of water to the substrate surface yielded approximately 72 ml of extract; 200 ml of applied-water yielded approximately 140 ml of extract. As mentioned previously, the most important consideration in the pour-through procedure is to extract a sample representative of the substrate solution. With that said, it is also convenient and more reliable to work with larger samples. Larger samples are easier to handle, tend to be more representative of the substrate and offer inure confidence in the results. Applying and extracting a larger volume of water was always successful using a drip application method, but only marginally or occasionally successful with the pouring method.

Experiment 2

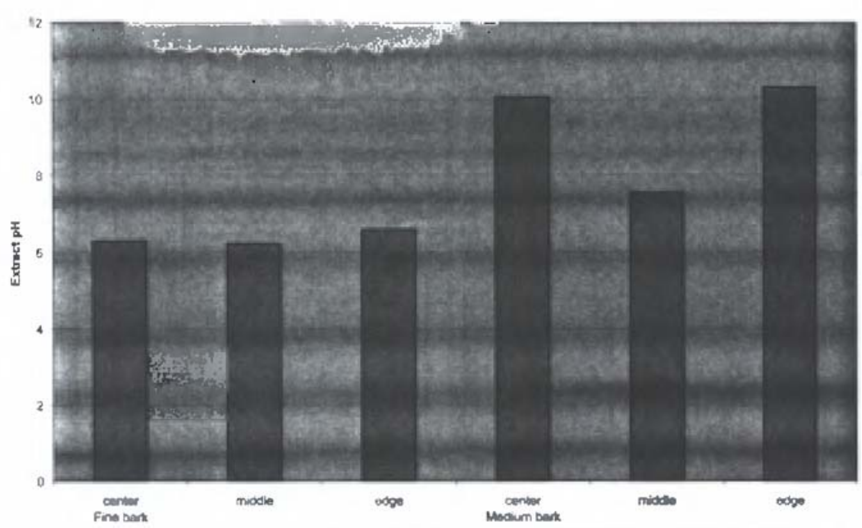
The objective of the second experiment was to determine the influence of water placement on contamination in the extract. The container was divided into three sections (as shown in the photo on Page 103). Containers with either medium-grade or fine-grade Douglas fir hark were used for the evaluation. A volume of 150 ml spiked water was poured over the container surface in one of the three regions. Extract pH was measured on each container and presented in Figure 2.

Among containers with fine-grade bark, pouring the water in the center of the container resulted in no contamination. Average extract pH appears similar for containers in which water was poured over the middle; however, there was one container in which the extract was slightly contaminated. Average extract pH when water was poured around the edge was noticeably higher.

Among containers filled with medium-grade bark, almost all extracts were contaminated regardless of where the water was poured. Similar to results in the first experiment, pouring water over medium-grade Douglas fir hark is prone to yield errant results from contaminated extract.

This particular experiment has a very important consequence. A major problem with the pour-through procedure is that the canopy of the shrub or tree often interferes with pouring.

Figure 2. Extract pH when water is poured in the center, middle or edge of a container with medium or fine-grade Douglas Fir bark.



Contamination from water poured in the center (green), middle (clear) and edge (red) of the container was evaluated by the interns.

Interference from the shrub canopy causes many practitioners to quickly and sloppily apply the water near the container edge. As our research has shown, and as one could imagine, this would almost certainly lead to channeling and contamination of the extract.

Problem solved

Bus, Macs and Briones did a great job documenting potential problems with the traditional pour-through procedure. But they didn't stop there. They also engineered a device that addresses each of the problems identified. This device allows a nursery grower to simultaneously conduct a pour-through on multiple containers with both accuracy and efficiency.

The machine was named the BAMB for its inventors: Bus, Altland, Macs and Briones. The BAMB connects to any garden hose. Water enters through the hose and passes through a pressure reducer and meter. The students determined the optimum operating pressure for our system was 10 psi.

The BAMB is composed primarily of PVC pipe (painted black by the students for style only). The PVC pipe branches to multiple outlets with micro-irrigation tubing. From the micro-irrigation tubing are attached four pressure-compensating drip emitters (0.5 gal/min) that slowly apply water to each container. Our model was designed to simultaneously apply water to 10 containers; however, this simple design can be expanded or reduced to fit the needs of any nursery. A single set of emitters at the end of the device applies water to a measuring cup so the operator knows how much water has been applied and when the machine should be stopped (remember, volume of applied-water is important!).

Many publications available on the Internet profess that distilled or deionized water should be used for the applied-water. The rationale is that distilled water will not affect readings in the extract. But this rationale is

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flawed, because contamination of the extract with distilled water will dilute your sample and cause false low readings. The BAMB uses tap water from a garden hose.

Remember, the sole purpose of the applied-water is to push the substrate solution out the bottom of the container so that it can be measured. If the procedure is clone correctly, it shouldn't matter what type of water is applied to the surface. Conversely, if the procedure is conducted in such a way that contamination occurs in the extract-water, the extract is contaminated and will yield a false reading no matter what type of water was applied to the surface.

Summary

The pour-through procedure is a valuable tool for nursery growers, but it is not as idiot-proof as some would like to believe. It requires consistency and attention to detail. For accurate results, apply water slowly to the substrate surface, avoid applying water near the container edge, and apply a uniform and appropriate volume of water. I would he happy to work with any Oregon growers who want more help with this procedure or who want assistance building their own version of the BAMB.

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The BAMB uses four pressure-compensating drip emitters to uniformly water around the center of the container (purple circles).