The Use of Suction Cup Lysimeters for Monitoring EC, pH, and Nutrients in Large Containers©

Robert D. Wright[1], Mary Stanley, and Roger Harris
Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061

INTRODUCTION

The production of landscape plants in large containers [57, 95, and 170 liter (15, 25, and 45 gal) is becoming commonplace in the nursery industry. The growth rate of these plants is directly related to the level of nutrients in the substrate solution (the water that remains in the container following irrigation and drainage). A means of extracting this solution from the container for analysis is thus necessary. The most common procedure used for this purpose is the pour-through method developed for container-grown nursery and greenhouse crops at Virginia Tech (Wright, 1986; Yeager et al., 1983). This procedure consists of elevating a container above a collection vessel and pouring water on the surface of the container. The displaced substrate solution that leaches out the bottom of the container is then analyzed for nutrient content, electrical conductivity (EC), and pH. This procedure is very convenient for small containers [up to 11 liter (3 gal)] but becomes difficult with larger containers since it is a laborious and difficult task to elevate the relatively heavy containers [some weighing over 45 kg (100 lb)] over a collection vessel.

SUCTION-CUP LYSIMETERS

Technique. Studies have shown that suction-cup lysimeters hold promise for extracting the substrate solution from large containers without removing soil from

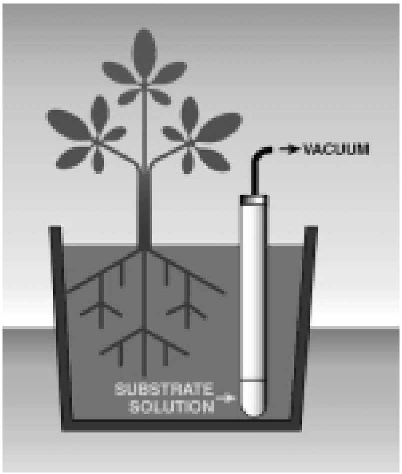

Figure 1. Diagram of a suction cup lysimeter in place.

[1] Research supported in part by NE Virginia Agricultural Council and the Virginia Landscape Association.

Figure 2. Vacuum being drawn on a suction cup lysimeter in a 57-liter (15-gal) in-ground container.

the containers or elevating the containers over a collection vessel (Waldon and Niemiera, 1997). The lysimeter consists of a tube connected to a porous ceramic tip that is inserted into the container so that the tip rests on the bottom of the container (Fig. 1). It is recommended that lysimeters be installed for the whole course of a growing season in large containers. To facilitate installation of the lysimeter, make a pilot hole approximately one-half the diameter of the lysimeter vertically through the substrate to the bottom of the container to guide insertion of the lysimeter. A 0.6-m-long (2 ft) piece of 2.5 cm (1 inch) re-bar is good for this purpose. The difference in diameter between the pilot hole and the lysimeter ensures a tight fit between the substrate and the lysimeter.

One to two hours following irrigation—after making sure any existing water is removed from the lysimeter—use a vacuum pump to create a vacuum of approximately 50 centibars (15 inches of mercury) in the lysimeter. Clamp the evacuation tube so that the vacuum remains for 5 to 15 min, providing sufficient time for the substrate solution to be drawn into the lysimeter. Release the vacuum, remove the port opening at the top of lysimeter, and draw out the substrate solution with a syringe from the lysimeter. The volume extracted may vary from lysimeter to lysimeter, but our research has shown that volumes extracted ranging from 10 cc up to 120 cc do not affect nutrient levels of the extracted solution. The substrate solution collected can then be analyzed for EC, pH, or a complete nutrient analysis. Three or four lysimeters should be installed within a block of plants of similar size and nutritional program.

Interpretation of Results. The EC values—a relative measure of the nutrient level in the container—as well as pH and other nutrient values, obtained with this procedure correlate well with plant growth. Since the container solution extracted with a lysimeter is essentially the same as that obtained with the pour-through method, the EC, pH and other nutrient values associated with optimal growth for the lysimeter are the same as those established for the pour-through procedure (Table 1). It is important that each nursery develop its own set of values because of differences in nutritional programs, plants grown, and irrigation practices among nurseries.

Equipment Availability. Suction cup lysimeters (soil water samplers) and associated equipment can be purchased from Soil Moisture Equipment Corp., P.O. Box 30025, Santa Barbara, California 03105. An on-line catalog can be viewed at: <www.soilmoisture.com>. Soil water sampler model 1900 L24 with a one-half bar air-entry value, vacuum pump 2005G2, and 1000K2 extraction kit are recommended. The ceramic cups are manufactured in different sizes and with different porosities to accommodate different conditions and uses. Our research has shown that the model 1900 L24, one-half bar air-entry value works best with large nursery containers.

Table 1. Desirable nutrient levels to be maintained in the container substrate extracted with either pour-through or suction cup lysimeters. The range in values represents levels for plants with low to high nutrient requirements.

Analysis	Desirable levels*	
	Fertigation	Controlled release
pH	4.5 to 6.0	4.5 to 6.0
Electrical conductivity, $dS \cdot m^{-1}$ ($mmhos \cdot cm^{-1}$)	0.5 to 1.0	0.3 to 0.5
Nitrate-N, $N0_3$ N $mg \cdot liter^{-1}$ (ppm)	50 to 100	15 to 25
Phosphorus, P $mg \cdot liter^{-1}$	10 to 15	5 to 10
Potassium, K $mg \cdot liter^{-1}$	30 to 50	10 to 20
Calcium, Ca $mg \cdot liter^{-1}$	20 to 40	20 to 40
Magnesium, Mg $mg \cdot liter^{-1}$	15 to 20	15 to 20
Manganese, Mn $mg \cdot liter^{-1}$	0.3	0.3
Iron, Fe $mg \cdot liter^{-1}$	0.5	0.5
Zinc, Zn $mg \cdot liter^{-1}$	0.2	0.2
Copper, Cu $mg \cdot liter^{-1}$	0.02	0.02
Boron, B $mg \cdot liter^{-1}$	0.05	0.05

*Levels should not drop below these during periods of active growth.

LITERARTURE CITED

Walden, R. and **A. Niemiera**. 1997. A method of monitoring the nutritional status of pine bark substrate in large containers. Proc. Southern Nurs. Assoc. Res. Conf. 42:165-168.

Wright, **R.D.** 1986. The pour-through nutrient extraction procedure. HortScience 21:227-229.

Yeager, T.H., **R.D. Wright**, and **S.S. Donohue**. 1983. Comparison of pour-through and saturated pine bark extract, N, P, K, and pH levels. J. Amer. Soc. Hort. Sci. 108:112-114.