A Novel System for Propagating *Acer rubrum* 'Franksred' Cuttings Without Mist©

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INTRODUCTION

Recirculating subirrigation is a new hybrid of existing techniques for propagating cuttings without mist that offers exceptional control of the rooting environment. The system under development offers a new technique that growers can use for winter propagation when bottom heat is desired. This recirculating subirrigation system maintains an optimum root zone temperature to successfully root cuttings in less than optimal greenhouse conditions. This economical, closed-loop system, could also increase ease of OSHA/EPA compliance by allowing workers to apply chemicals, such as fungicides or growth regulators, through the subirrigation water with minimal risk of exposure.

Recirculating subirrigation combines aspects of hydropropagation (Boland and Hanger, 1991) and subirrigation propagation systems (Holt et al., 1998). Subirrigation is a fairly new propagation innovation that has shown promising results for rooting several woody species (Aiello and Graves, 1998; Giroux et al., 1999), including *Acer rubrum*. Using subirrigation, stem cuttings are successfully propagated without mist by supplying water, through capillary action, from a water reservoir maintained in the propagation tray. Subirrigation propagation shows potential for alleviating problems associated with mist, such as nutrient leaching of leaves, poor medium drainage, foliar disease, and salt buildup (Wells, 1965). Subirrigation also reduces system maintenance requirements by eliminating the need for clocks, solenoids, and mist nozzles.

Recirculating subirrigation adds to subirrigation the advantages of hydropropagation, a nutrient-film-type system. The propagator has control of exogenous auxin concentrations, nutrients, root zone temperature, and aeration, each of which have been shown to affect root number and root length on cuttings (Wilkinson, 1993). Recirculating subirrigation requires little monitoring while allowing control of the rooting environment that may increase rooting success of hard-to-root species and reduce propagation costs.

Softwood stem cuttings of *A. rubrum* 'Franksred', Red Sunset® red maple, were used to evaluate the recirculating subirrigation system. Zhang and Graves (1995) reported greater root dry mass, higher rooting percent, increased leaf retention, and enhanced postharvest shoot development occurred in cuttings of red maple rooted in subirrigation versus mist. In follow up experiments, Zhang et al. (1997) examined other red maple cultivars and reported that rooting percent decreased, compared to traditional mist methods, when basal temperatures of 24°C and 33°C were maintained in subirrigation. Zhang and co-workers concluded that supra-optimal temperatures reduced rooting in the follow-up experiment. The objective of this experiment was to examine the response of stem cuttings to three root zone temperatures and three auxin concentrations in recirculating subirrigation units where no mist is used.

MATERIALS AND METHODS

Experimental recirculating subirrigation units were constructed using 125-liter (33-gal) Sterilite™ totes (Sterilite Corp., Townsend, MA) as the water reservoirs, and modified 26.4-liter (7-gal) Rubbermaid® storage boxes (Rubbermaid Inc., Wooster, OH) as propagation trays (Fig. 1). Water heated by 100-watt Rena Cal™ aquarium heaters (Aquarium Pharmaceuticals, Inc., Chalfont, PA) was recirculated using one 402 Powerhead™ pump (Rolf C. Hagen Corp., Mansfield, MA) through ½-inch polyethylene pipe. In the center of the propagation tray a 44.5-cm (17.5-inches) length of perforated schedule 80 PVC covered with screen (1-mm mesh) was suspended in the propagation tray to drain and control water table height. The rooting medium was water-saturated perlite (Whittemore Co., Inc., Lawrence, MA) sifted through 8-mesh hardware screen and degassed under a 15 psi vacuum for 6 h in a 50-gal steel drum filled with water. The use of perlite as the rooting medium is advantageous because it allows for greater water uptake by the cutting than in a peat-based medium (Grange and Loach, 1983).

Cuttings of Red Sunset® red maple were stuck in the system on 12 July 2000. The experiment was run for 33 days in a growth chamber with a day length of 11 h and 300 µmol · m^{-2} · s^{-1} PAR supplied by three 400 watt HPS lights. Air temperature was maintained at 12.6±0.2°C (55°F). One hundred thirty five 10 cm (4 inch) leafy stem cuttings of Red Sunset® red maple were collected, misted and placed in a 4°C (40°F) cooler for 24 h. Cuttings were prepared with a fresh basal stem cut, a 2.5-cm (1-inch) wound on one side of stem base, and then basal dipped to depth of 2 cm (1 inch) in water, 20 : 1 (500 ppm IBA, 250 ppm NAA), or 10 : 1 (1000 ppm IBA, 500 ppm NAA) Dip-N-Grow® (Astoria-Pacific, Inc., Clackamas, OR). Three replications of five cuttings were stuck 4 cm (1.5 inches) deep in three of nine recirculating subirrigation units that maintained a rooting medium temperature of 20±0.5°C (68°F), 23±0.5°C

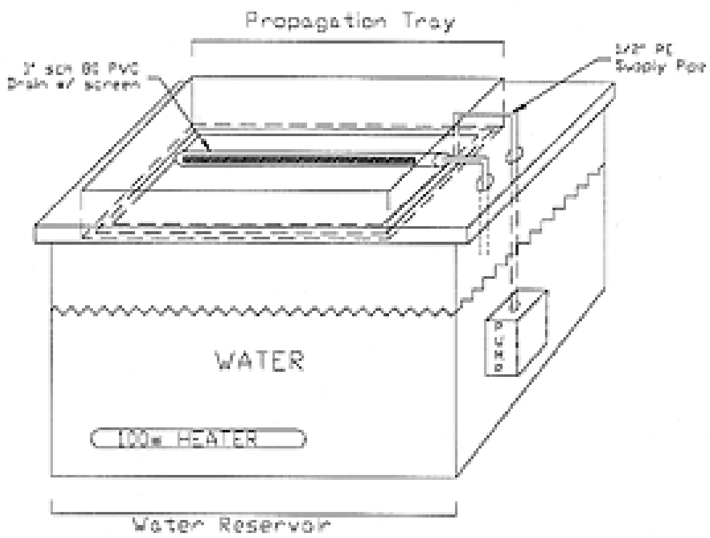

Figure 1. Three dimensional design of a recirculating subirrigation unit.

(73°F), or 26±1.5°C (79°F). The experimental design used was a completely randomized block 3 × 3 (temperature × auxin) factorial. At harvest, rooting was assessed as rooting percent, root number, and root length on rooted cuttings.

Water reservoir temperatures, rooting media temperatures, and the growth chamber environment were monitored throughout rooting trials using a 21X Micrologger™ (Campbell Scientific Inc., Logan, UT) with thermocouples, relative humidity, and quantum light sensors.

RESULTS AND DISCUSSION

As expected, increasing auxin concentration resulted in increased rooting percent, root number and length of rooted cuttings (Fig. 2). Optimal auxin response was obtained with 10 : 1 Dip-N-Grow®, the highest concentration evaluated. At this concentration, and a rooting medium temperature of 23°C, Red Sunset® red maple cuttings rooted 100% and had an optimal root length of 137 mm. Mean root number per rooted cutting at 20°C showed a large difference between the 10 : 1(14 roots), 20 : 1 (six roots) Dip-N-Grow® concentration, and the control (two roots). However, root numbers declined with increasing root zone temperature, which was unexpected based on previous reports (Dykeman, 1975). This decrease in root number could have resulted from the death of root initials due to continuous exposure to supra-optimal temperatures (Dykeman, 1975). Furthermore, root number showed no auxin response at a root medium temperature of 26°C. All rooting responses were reduced at 26°C, suggesting that this temperature may have been supra-optimal for the propagation of Red Sunset® red maple.

Optimal temperatures for root initiation and root elongation varies among species, and even among cultivars within a species. Experiments conducted by Zhang et al. (1997) demonstrated differences in heat tolerance between cuttings of ‘Autumn Flame’ red maple and those of ‘Indian Summer’ Freeman maple, the latter being notably less heat tolerant than the former.

A decrease in auxin concentration and either sub- or supra-optimal rooting medium temperatures resulted in a lower rooting percentages and root lengths (Fig. 2). Differences in mean root length and rooting percent of the control (0) and the 20 : 1 Dip-n-Grow® treatments at 20°C were much less pronounced at 26°C, again suggesting that 26°C in the rooting medium was supra-optimal. Increased metabolic activity and decreased chlorophyll concentration in the leaves of red maple cuttings rooted at higher temperatures, observed by Zhang and co-workers (1997), could explain the trend evident in the present study. It has been proposed that at high root zone temperatures carbohydrate reserves may be depleted, resulting in reduced rooting percentage and root length of rooted cuttings (Preece, 1993).

In the present work, the perlite rooting medium maintained a soil moisture content of approximately 55% ($0.55\ m^3 \cdot m^{-3}$), which is considered optimal for rooting (Grange and Loach, 1983). Giroux et al. (1999) reported that perlite, not vacuum infiltrated, used in subirrigation had a soil moisture content of 26% ($0.261\ m^3 \cdot m^{-3}$).

SUMMARY

Using recirculating subirrigation without mist, softwood stem cuttings of Red Sunset® red maple were successfully rooted in 33 days, using a basal temperature of 23°C, when wounded and treated with 10 : 1 Dip-N-Grow®. Rooting medium temperatures above or below 23°C were detrimental to rooting percentage and mean root length per rooted cutting. The highest root number was achieved when cuttings were rooted in a medium maintained at 20°C and treated with 10 : 1 Dip-N-Grow®, but under these conditions rooting percentage and root length were not optimized. The recirculating subirrigation propagation system presented here has the potential to lower production costs, reduce chemical handling risks, and eliminate problems due to mist while still successfully rooting cuttings.

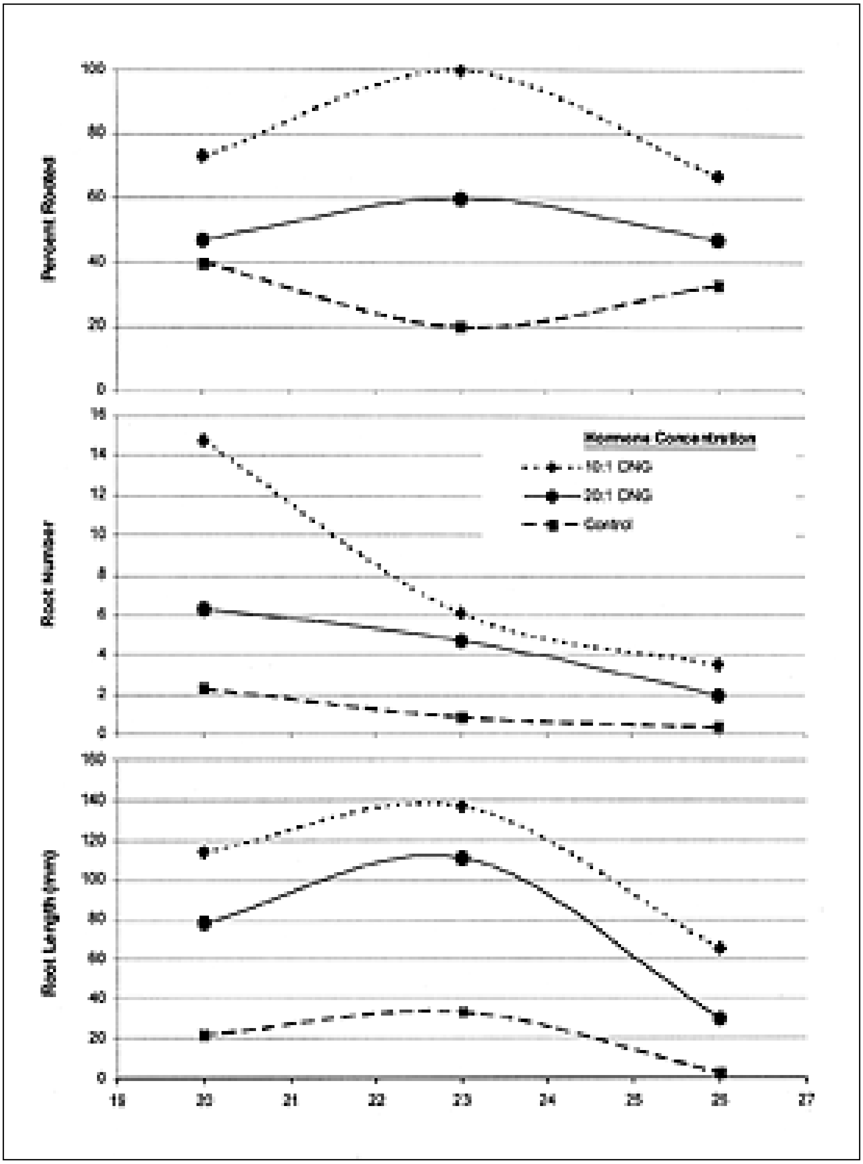

Figure 2. Rooting percent, root length (mm), and root number of *Acer rubrum* 'Franksred' after rooting for 33 days in a growth chamber.

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