Drought Conditioning Influences Adventitious Rooting of Select Shrub Stem Cuttings©

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Numerous chemical compounds (plant growth regulators) have been found to promote adventitious rooting on stem cuttings. However, even with plant growth regulators (PGRs) stem cuttings of many plant species are difficult to root. Cultural practices (light levels, media temperatures, air temperatures, misting, etc.) on stock plants and during rooting have also been found to influence adventitious rooting of cuttings. This research investigated the influence of drought conditioning (DC) stock plants and an auxin-based PGR on adventitious root formation of two ornamental plant species. Species selected were firebush (*Hamelia patens*) and Fraser photinia (*Photinia* × *fraseri*). Plants were purchased May 2002 in 3.7-liter containers and maintained under normal nursery conditions. On 15 July 2002 plants were brought into a glass greenhouse and DC irrigation treatments initiated. Treatments included: irrigation every day (no DC), irrigation every other day (medium DC), and irrigation every fourth day (high DC). Plants were subjected to DC treatments for 16 consecutive days. Following DC treatments, all plants were irrigated and left overnight. Terminal stem cuttings were taken the following day. Cuttings were 15.2 to 20.3 cm (6.0 to 8.0 inches) long and leaves were removed from the basal 8.0 cm of each cutting. Hormodin 2 (0.3% auxin talc formulation) was used as the PGR. Cutting treatments included: no DC + no PGR, no DC + PGR, medium DC + no PGR, medium DC + PGR, high DC + no PGR, and high DC + PGR. One cutting was placed into a fiber pot and for each species, five cuttings of each treatment were placed in a fiberglass flat and each flat was replicated three times (total of 30 cuttings for each species × treatment combination). Flats were placed under intermittent mist and heating pads were used to maintain medium temperature near 32 °C (90 °F). On 22 Aug. (firebush) and 17 Oct. (*Fraser photinia*) cuttings were evaluated for rooting percentage, number of roots for each plant, length of longest root, and visual rating (0 = no rooting and 10 = profuse rooting). Analysis of variance suitable for a randomized complete block design was used and treatments means were separated by LSD. For firebush (considered an easy to root species), rooting percentage was greatest for all treatments except medium DC + no PGR and high DC + no PGR. Mean number of adventitious roots for each cutting was greatest for cuttings that had PGR treatments. Mean adventitious root length was greatest for cuttings with no DC + PGR and least for cuttings with medium DC + no PGR. Mean visual root ratings followed a similar trend as mean root length. Fraser photinia (considered a difficult-to-root species) mean rooting percentage was greatest for cuttings with high DC + no hormone and least for cuttings with no DC + PGR, medium DC + no PGR, and high DC + PGR. Mean number of roots for each cutting and mean root length were greatest for cuttings with medium DC + PGR. Mean visual root rating was greatest for cuttings treated with medium DC + PGR. Results indicate DC used in combination with PGRs may increase adventitious rooting of some ornamental plant species.

INTRODUCTION

Many woody plant species are difficult or slow to root when propagated vegetatively by cuttings (Dirr, 1990). Auxin-based plant growth regulators (PGRs) are known to promote adventitious rooting on stem cuttings of many ornamental plant species (Dirr, 1990). In addition, cultural practices, such as light level, media temperature, air temperature, and misting also influence adventitious rooting of stem cuttings (Hartmann et al., 2002; Rajagopal and Andersen, 1980). Exposing annual nursery transplants to nonlethal water-deficit stress conditions [drought conditioning (DC)] has been shown to harden off nursery plants and increase plant survival when plants are exposed to subsequent water deficit stress (Liptay et al., 1998). Research investigating rooting of cuttings taken from DC stock plants is variable and has not been conducted on horticultural plant species. Pea cuttings (*Pisum sativum* 'Alaska') showed reduced rooting when cuttings were taken from DC plants (Rajagopal and Andersen, 1980). However, Wilson (1998) reported rooting of eucalyptus (*Eucalyptus globulus*) cuttings were enhanced when compared to non-DC cuttings. This research investigated DC of stock plants and an auxin-based PGR as methods to increase adventitious rooting on cuttings taken from two ornamental plant species.

MATERIALS AND METHODS

Two containerized, ornamental shrub species were selected. Firebush (*Hamelia patens*) is an attractive, semiwoody, heat-tolerant plant with many bright, tubular orange-red flowers (Armitage, 1995). It is a perennial in warm regions (U.S.D.A. hardiness Zones 9 through 11), but is subject to frost damage in colder areas (Davis et al., 1991), where it can be used as an annual bedding plant (Salee, 1990). Firebush is considered to be easy to propagate by stem cuttings, especially when using bottom heat and an auxin-based PGR (Davis et al., 1991). Fraser photinia (*Photinia* × *fraseri*) is a popular, evergreen, woody shrub throughout the Southern portion of the United States. With shades of red on new growth, Fraser photinia is cold hardy to U.S.D.A. hardiness Zone 7 (Dirr, 1998). Even with the use of PGRs, photinia is considered to be difficult to propagate from stem cuttings (Bonaminio and Blazich, 1983).

Stock plants grown in 3.7-L (1-gal) containers were purchased May 2002 and maintained under normal nursery conditions at the Texas Tech University Greenhouse Complex in Lubbock, Texas. On 15 July 2002, plants were brought into a glass greenhouse and three DC treatments were initiated : irrigation every day to field capacity (non-DC), irrigation every other day to field capacity (medium DC), and irrigation every fourth day to field capacity (high DC). Plants were subjected to DC treatments for 16 consecutive days. Following day 16, all plants were irrigated and left overnight. Terminal stem cuttings (herbaceous for firebush and semihardwood for Fraser photinia), each 15.2 to 20.3 cm (6.0 to 8.0 inches) long, were taken the following morning. Leaves were removed from the basal 8.0 cm (3.2 inches) of each cutting, and existing flowers were pinched off. Hormodin 2 (0.3% auxin talc formulation, Olympic Horticultural Products, Mainland, Pennsylvania) was used as the PGR. The basal portion of each cutting treated with PGR was moistened with water, dipped into the PGR powder to a depth of 2.5 cm (1.0 inch) and gently tapped to remove excess. Treatment combinations included: non-DC + no PGR, non-DC + PGR, medium DC + no PGR, medium DC + PGR, high DC + no PGR, and high DC + PGR. Each cutting was inserted approximately 5.0 cm (2.0 inches) deep into a square, 256 cm^3 (15.6 $inch^3$) container filled with growing medium (Ball

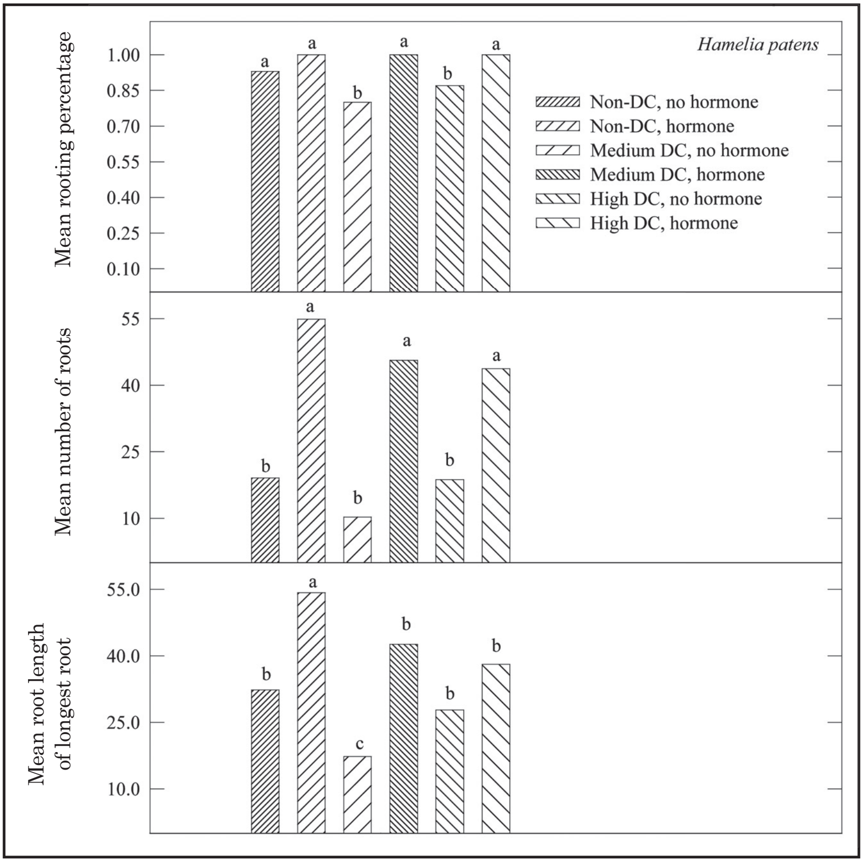

Figure. 1. Influence of drought conditioning (DC) and an auxin-based hormone on rooting percentage, number of roots, and length of longest root for firebush (*Hamelia patens*) cuttings [different letters indicate significant treatment effects ($P \leq 0.05$)].

Growing Mix #2, Ball Horticultural Company, West Chicago, Illinois). For each species, five cuttings of each treatment combination were placed in a fiberglass flat, and each flat was replicated three times (total of 30 cuttings for each flat and 15 cuttings for each treatment). Flats were placed under intermittent overhead mist, and bottom heat was applied with heating pads, which maintained medium temperature near 32 °C (90 °F).

Firebush and Fraser photinia cuttings were evaluated 22 Aug. (21 days after cutting) and 17 Oct. (78 days after cutting), respectively. Rooting percentage, number of roots for each cutting, and length of the longest root of each cutting were determined. A cutting was considered rooted if it had at least one visible adventitious root. Rooting data were subjected to analysis of variance suitable for a randomized complete block design. If significant differences were found, means were separated by Fisher's least significance difference procedure ($P \leq 0.05$) (SAS Institute Inc., 1999).

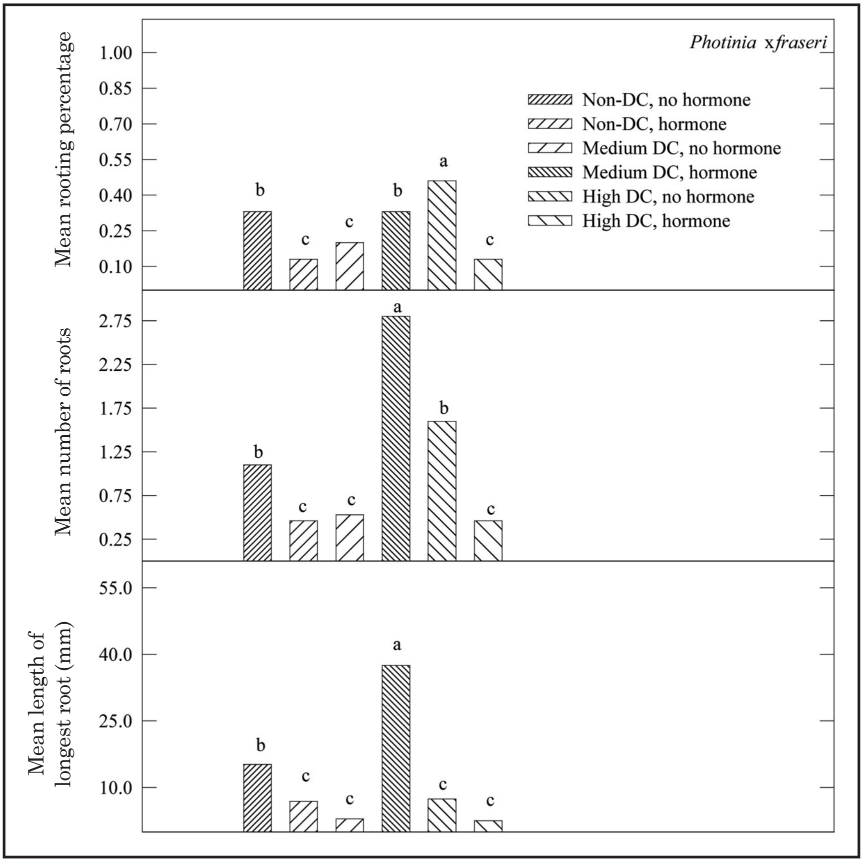

Figure 2. Influence of drought conditioning (DC) and an auxin-based hormone on rooting percentage, number of roots, and length of longest root for Fraser photinia (*Photinia* × *fraseri*) cuttings (different letters indicate significant treatment effects (P ≤0.05)).

RESULTS

For firebush, cuttings had rooting percentages near 100% except for medium DC + no PGR and high DC + no PGR treatments (Fig. 1). Mean number of adventitious roots was greatest for cuttings treated with the PGR regardless of DC treatment. Mean root length was greatest for non-DC + PGR cuttings, and least for cuttings with medium DC + no PGR. For Fraser photinia, mean rooting percentage was greatest for cuttings with high DC + no hormone and least for cuttings with no DC + PGR, medium DC + no PGR, and high DC + PGR (Fig. 2). Cuttings with medium DC + PGR had the greatest mean number of roots and greatest mean root length.

DISCUSSION

Exposing plants to drought conditions can alter plant physiological and biochemical processes (Hsiao, 1973; Ladjal et al., 2000), and these changes are often directly or indirectly related to the process of root regeneration. Stock plant stress-induced changes in stomatal conductance, photosynthesis, growth hormones, and carbohydrate levels have been shown to influence rooting of cuttings (Rajagopal and Andersen, 1980). In addition, due to lack of roots, stem cuttings are often exposed to high levels of water stress, which may influence rooting (Loach, 1977). Drought conditioning often influences osmotic adjustment, heat acclimation, and drought resistance, and hardens off plants such that when exposed to future drought, predisposed plants are able to maintain physiological processes and survive while nonpredisposed plants often die (Liptay et al., 1998; Ruiz-Sanchez et al., 2000; Zhang and Archbold, 1993).

Our results indicate when rooting firebush cuttings, DC alone generally reduced rooting when compared to treatments using an auxin-based PGR alone. We also found DC used in combination with an auxin-based PGR did not increase rooting of firebush cuttings when compared to cuttings rooted with an auxin-based PGR alone. However, when rooting Fraser photinia cuttings, moderate DC in combination with an auxin-based PGR increased rooting when compared to DC stock plants or an auxin-based PGR used alone. Our results confirm firebush stem cuttings tend to root quickly (Davis et al., 1991) and Fraser photinia stem cuttings do not root for an extended period of time (Blazich and Bonaminio, 1983). Our results also indicate DC is not necessary for increasing adventitious rooting of firebush stem cuttings. However, our results suggest when moderate DC is used in combination with an auxin-based PGR, adventitious rooting of Fraser stem cuttings photinia can be increased. For many ornamental plant species, an extended rooting period likely places great stress upon cuttings, even if precautions are taken to increase rooting and reduce stress (Hartmann et al., 2002). Drought-conditioning stock plants of difficult to root species may be a cultural practice which can increase tolerance to future stress events (Liptay et al., 1998; Ruiz-Sanchez, 2000) and result in greater rooting of hard-to-root ornamental plant species.

LITERATURE CITED

Armitage, A.M. 1995. Photoperiod, irradiance, and temperature influence flowering of *Hamelia patens* (Texas firebush). HortScience 30:255-256.

Blazich, F.A. and **V.P. Bonaminio**. 1983. Effects of wounding and auxin treatment on rooting stem cuttings of Fraser's Photinia. J. Environ. Hort. 1:104-106.

Bonaminio, V.P. and **F.A. Blazich**. 1983. Response of Fraser's photinia stem cuttings to selected rooting compounds. J. Environ. Hort. 1:9-11.

Davis, T.D., S.W. George, A. Upadhyaya, and **J. Parsons**. 1991. Propagation of firebush (*Hamelia patens*) by stem cuttings. J. Environ. Hort. 9(2):57-61.

Dirr, M.A. 1990. Effects of P-ITB and IBA on the rooting response of 19 landscape taxa. J. Environ. Hort. 8(2):83-85.

Dirr, M.A. 1998. Manual of woody landscape plants. Their identification, ornamental characteristics, culture, propagation and uses. 5th ed. Stipes Publ, Champaign, Illinois.

Hartmann, H.T., D.E. Kester, F.T. Davies, Jr., and **R.L. Geneve**. 2002. Hartmann and Kester's plant propagation. Principles and practices. 7th ed. Prentice Hall. Upper Saddle River, New Jersey.

Hsiao, T.C. 1973. Plant responses to water stress. Ann. Rev. Plant Physiol. 23:519-570.

Ladjal, M., D. Epron, and **M. Ducrey**. 2000. Effects of drought preconditioning on thermotolerance of photosystem II and susceptibility of photosynthesis to heat stress in cedar seedlings. Tree Physiol. 20:1235-1241.

Liptay, A., P. Sikkema, and **W. Fonteno**. 1998. Transplant growth control through water deficit stress – A review. HortTechnology 8:540-543.

Loach, K. 1977. Leaf water potential and the rooting of cuttings under mist and polythene. Physiol. Plant. 40:191-197.

Rajagopal, V. and **A.S. Andersen**. 1980. Water stress and root formation in pea cuttings. I. Influence of the degree and duration of water stress on stock plants grown under two levels of irradiance. Physiol. Plant. 48:144-149.

Ruiz-Sanchez, M.C., R. Domingo, A. Toreecilias, and **A. Perez-Pastor**. 2000. Water stress preconditioning to improve drought resistance in young apricot plants. Plant Science 156:245-251.

Salee, K. 1990. Texas firebush takes the heat. Nursery Manager 6:64, 66-69.

SAS, 1999. Version 8.0. SAS Institute Inc., Cary North Carolina.

Wilson, P.J. 1998. Environmental preferences of *Eucalyptus globulus* stem cuttings in one nursery. New Zealand J. For. Sci. 28:293-303.

Zhang, B. and **D.D. Archbold**. 1993. Water relations of *Fragaria chiloensis* and a *F. virginiana* selection during and after water deficit stress. J. Amer. Soc. Hort. Sci. 118: 274-279.

Slimy Friends and Foes: Understanding Slugs and Snails©

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Slugs and snails are common in almost any ecosystem and particularly in nurseries where ideal habitats are a given. As a general rule, slugs and snails are almost always considered as unwanted pests. Most slug and snail problems as horticultural pests are caused by invasive species. There are few educational resources available describing the great diversity of snails, many of which are beneficial and suffer unnecessary controls. Beneficial snails contribute to the organic fraction of the soil cycle while some species are predators of other snails. Many of the products currently used for slug and snail control kill nontarget arthropods and lead to an increase in mite populations and therefore, increased pesticide usage. Additional research is needed to identify more effective, affordable, and environmentally sound control of harmful slugs and snails. This paper presents an overview of slugs and snails, identifying harmful and beneficial species and providing web sites where color images of each can be viewed.

INTRODUCTION

Slugs and snails are Gastropods (class Gastropoda). Slugs and snails are typically met with the same negative reception as snakes — often expressed with the sentiment of "the only good snake is a dead snake". There are approximately 40,000 gastropod species inhabiting terrestrial, freshwater, and marine environments across the globe. Eastern North America has over 500 species of terrestrial snails and slugs (Hubricht, 1985). Morphologically, the great difference between slugs and snails is fairly simple; slugs lack the calcium carbonate shell common to snails. The shell provides increased protection from the environment; as most snails can seal themselves in their shell with a thin mucus layer at the opening (aperture). The shell can also make it difficult for a predator to reach a snail because of the structures (lamellae) in the aperture. A slug's lack of a shell increases its mobility and access to food. Most snails (henceforth referring to slugs and snails) eat detritus (decaying organic material) and fungi. Some of a snail's more important functions are to aid in the decay of organic material and act as a calcium source for the soil