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Short Term Drought Conditioning Influences Adventitious Rooting of Firebush and Fraser's Photinia Stem Cuttings[1]

Lindsey Fox and Thayne Montague[2]
Department of Plant and Soil Science
Texas Tech University, Lubbock, TX 79409

Abstract

Experiments investigated the influence of drought conditioning stock plants and an auxin-based plant growth regulator (PGR) on adventitious root formation of terminal stem cuttings taken from containerized firebush and Fraser's photinia stock plants. Drought conditioning (DC) treatments were initiated in a glass greenhouse and included: irrigation every day (no DC), irrigation every other day (medium DC), and irrigation every fourth day (high DC). Plants were subjected to DC for 16 consecutive days. Following DC treatments, all plants were irrigated and left overnight. Terminal stem cuttings were taken the following day and an 0.3% auxin talc formulation was used as the PGR. Plant growth regulator/DC treatments included: no DC ± PGR, medium DC ± PGR, and high DC ± PGR. Cuttings were placed under intermittent mist and heating pads maintained media temperature. After 21 and 78 days cuttings were evaluated for rooting percentage, number of roots, and length of the longest root. For firebush, rooting percentage was near 100% for all treatments. Number of roots and length of longest root for firebush cuttings was greatest for cuttings treated with PGR. For Fraser's photinia cuttings, rooting percentage was highest for cuttings treated with high DC + no PGR treatments. Cuttings treated with medium DC or high DC ± PGR treatment produced the greatest number of roots, while mean root length was longest for cuttings treated with medium DC + PGR and high DC + no PGR.

Index words: firebush, Fraser's photinia, auxin, plant growth regulator, propagation.

Species used in this study: Firebush (*Hamelia patens* Jacq.); 'Red Robin' Frasher's photinia (*Photinia* x *fraseri* Dress 'Red Robin').

Chemicals used in this study: Hormodin 2 (IBA), 0.3% auxin talc formulation.

Significance to the Nursery Industry

With the advent of auxin-based plant growth regulators (PGRs), rooting of stem cuttings for many plant species is easily achieved. However, even with the use of PGRs cuttings of many plant species remain difficult to root and methods to increase rooting of cuttings are needed. We investigated the influence of drought conditioning (exposing containerized stock plants to non-lethal water deficit stress conditions) and an auxin-based PGR on rooting of firebush and Fraser's photinia cuttings. Our results indicate drought conditioning (DC) used in combination with a PGR increased adventitious rooting of Fraser's photinia cuttings, but tended to decrease rooting of firebush cuttings. Drought conditioning used in conjunction with an auxin-based PGR may be a propagation technique which can increase rooting of difficult to root ornamental plant species.

Introduction

Many plant species are difficult or slow to root when propagated vegetatively by stem cuttings (8). Auxin-based plant growth regulators (PGRs) are known to promote adventitious rooting (roots which arise from any plant part other than by the normal development and ontogeny of the seedling root and its branches (10)) on stem cuttings of many ornamental plant species (8). In addition, cultural practices such as time of year, media temperature, light level, air temperature, and misting have been found to promote adventitious rooting of stem cuttings (10, 15). Exposing annual nursery transplants to non-lethal water deficit stress conditions (drought conditioning) has been shown to harden off nursery plants, which increases plant survival when drought conditioning (DC) plants are exposed to subsequent water deficit stress (13). Research investigating rooting of cuttings taken from DC stock plants has produced variable results and has not been conducted on many plant species. Rooting was reduced when stem tip cuttings of pea (*Pisum sativum* 'Alaska') were taken from DC stock plants (15). However, Wilson (19) reports rooting of eucalyptus (*Eucalyptus globus*) DC stem tip cuttings was enhanced.

This research investigated DC of stock plants used in combination with an auxin-based PGR as methods to possibly increase adventitious rooting on cuttings taken from one easy to root and one difficult to root ornamental plant species. Firebush (*Hamelia patens*) is an attractive, semi-woody, heat-tolerant plant with many bright, tubular orange-red flowers (1). Firebush is a perennial in warm regions (USDA hardiness zones 9 through 11), but is subject to frost damage in colder areas (5). Therefore, in colder regions firebush is often used as an annual bedding plant (17). Firebush is considered to be easily propagated by stem cuttings, especially when using bottom heat and an auxin-based PGR (5). Fraser's photinia (*Photinia* x *fraseri*) is a popular, evergreen, woody shrub, with shades of red on new growth. Fraser's photinia is a common ornamental species throughout many areas of the United States, and is cold hardy to USDA hardiness zone 7 (9). Because Fraser's photinia is difficult to root without an exogenous root promoting PGR (4), Fraser's photinia is considered an excellent plant to investigate adventitious rooting studies (6).

Materials and Methods

In May 2002 and August 2003 18 stock plants each of Fraser's photinia (*Photinia* x *fraseri* 'Red Robin) and firebush

[1]Received for publication February 24, 2004; In revised form May 3, 2004. Manuscript No. T-4-552 of the College of Agricultural Sciences and Natural Resources. Support for this project was provided in part by a grant from the State of Texas Higher Education Coordinating Board.

[2]Graduate Teaching Assistant and Assistant Professor, respectively.

(*Hamelia patens*) grown in 3.8 liter (# 1) containers were obtained from a local nursery. Until experiments began, stock plants were held outdoors at the Texas Tech University Greenhouse Complex (Lubbock, TX) under shade-cloth (black polypropylene, 30% light exclusion) using nursery procedures common for the area. On July 15, 2002, and October 17, 2003, plants were brought into a glass greenhouse and three DC treatments were applied for 16 consecutive days (6 plants of each species subjected to each treatment each year): irrigation every day to container capacity (non DC), irrigation every other day to container capacity (medium DC), and irrigation every fourth day to container capacity (high DC). Every fourth day prior to irrigation (first experiment only), pre-dawn leaf water potential (ψ_L) was measured on two randomly selected leaves from each plant. Leaves were excised before dawn, immediately sealed in a plastic bag and placed in a cooler (12). Water potential was measured within a half-hour of excision with a pressure chamber (Soilmoisture Corp., Model 3005, Santa Barbara, CA). Following day 16, all plants were irrigated to container capacity and left to drain overnight. Terminal stem cuttings (herbaceous for firebush and semi-hardwood for Fraser's photinia), each approximately 15.2 cm (6.0 in) long, were taken the following morning. Leaves were removed from the basal 8.0 cm (3.2 in) of each cutting, and existing flowers were removed. Hormodin 2 (0.3% IBA auxin talc formulation, Olympic Horticultural Products, Mainland, PA) was used as the PGR. The basal portion of each cutting treated with PGR was first moistened with water, dipped into the PGR powder to a depth of 2.5 cm (1.0 in), and gently tapped to remove excess. Treatment combinations included: no DC ± PGR, medium DC ± PGR, and high DC ± PGR. Each cutting was inserted approximately 5.0 cm (2.0 in) deep into a square, 256 ml (8.7 oz) plastic, propagating container filled with Ball Growing Mix #2 (Ball Horticultural Company, West Chicago, IL). For each species, five cuttings (five containers) 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 total cuttings for each treatment). Cuttings were rooted in a greenhouse under intermittent overhead mist (10 sec/3.0 min) during daylight hours. Heating pads maintained media temperature near 32C (90F) (5), fans for the fan/pad cooling system were set to run at ≥ 26.7C (80F), and natural photoperiod was used.

Daily, mean pre-dawn ψ_L and standard errors for each DC treatment and species combination were plotted against number of days in DC treatment. Pre-dawn ψ_L data were subjected to analysis of variance suitable for a complete block design. If significant differences were found, means were separated by Fisher's least significance difference procedure ($P \leq 0.05$) (18). Firebush cuttings were evaluated August 22, 2002, and November 25, 2003 (21 days after cuttings were removed from stock plants). Fraser's photinia cuttings were evaluated October 17, 2002, and January 3, 2004 (78 days after cuttings were removed from stock plants). Rooting percentage, number of roots for each cutting, and length of the longest root of each cutting were recorded. 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 ($P \leq 0.05$) (18).

Results and Discussion

Pre-dawn ψ_L data from 2002 indicate that by the termination of the 16 day treatment period, high DC firebush stock plants were under greater water deficit stress (more negative ψ_L) than medium DC stock plants, and medium DC stock plants were under greater water deficit stress than non DC stock plants (Fig. 1). A similar trend occurred for Fraser's photinia stock plants, however by the termination of DC treatments, pre-dawn ψ_L for medium and non DC stock plants was similar (Fig 1). For firebush, all 2002 cuttings had rooting percentages near 100% except for medium DC + no PGR and high DC + no PGR treatments (Fig. 2). During 2003, regardless of treatment all firebush cuttings had rooting percentages at or near 100% (Fig 2). For 2002, mean number of adventitious roots was greatest for firebush cuttings treated with PGR regardless of DC treatment. However, during 2003 mean number of adventitious roots was greatest for firebush cuttings treated with non DC + PGR. Each year, mean root length for firebush was greatest for non DC + PGR treated cuttings. For Fraser's photinia cuttings, mean rooting percentage each year was greatest for cuttings exposed to the high DC + no PGR treatment (Fig. 3). In 2002, Fraser's photinia cuttings treated with medium DC + PGR had the greatest mean number of roots and greatest mean root length. However, in 2003 Fraser's photinia cuttings exposed to high DC ± PGR had the greatest mean number of roots and Fraser's photinia cuttings treated with high DC + no PGR had the greatest mean root length (Fig. 3).

Exposing plants to non-lethal DC can alter plant physiological and biochemical processes (11), and these changes

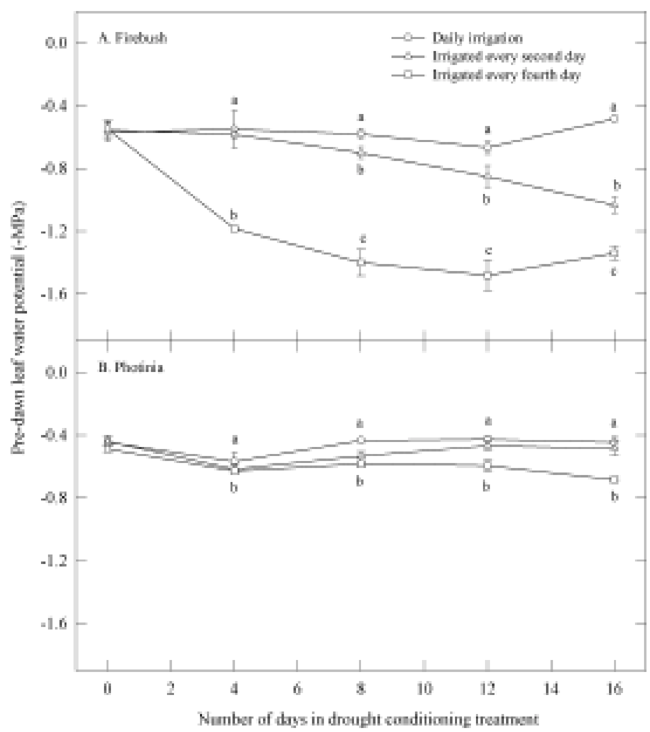

Fig. 1. Influence of drought conditioning on pre-dawn leaf water potential of containerized firebush (*Hamelia patens*) (A) and Fraser's photinia (B) stock plants beginning July 15, 2002 (day 0). Each point is the mean of 12 measurements. Vertical bars represent standard errors of the mean. Different letters near symbols indicate significant treatment effects (P ≤ 0.05) within each day.

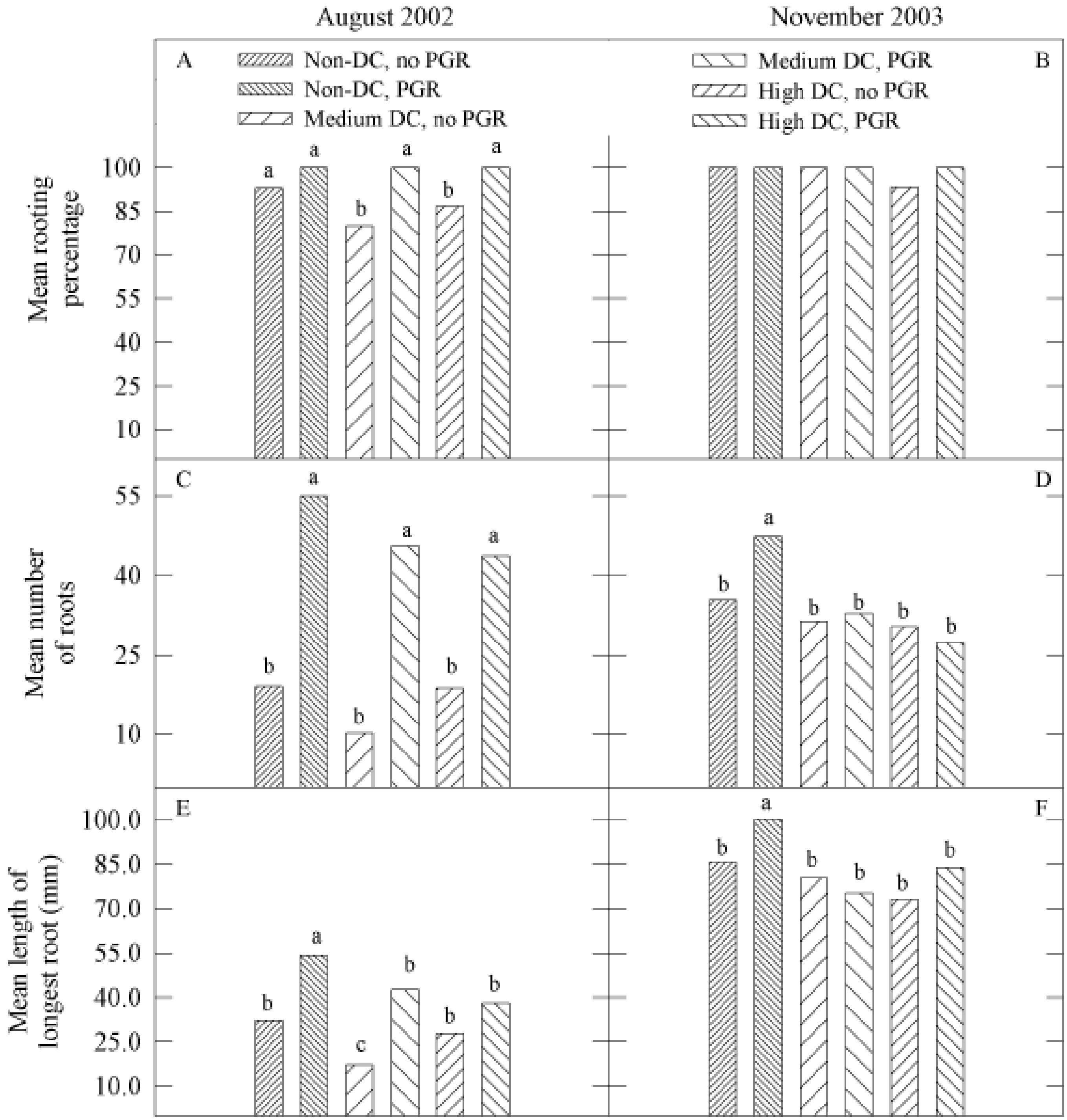

Fig. 2. Influence of drought conditioning and an auxin-based plant growth regulator on rooting percentage (A,B), mean number of roots (C, D), and mean length of longest root (E, F) for firebush (*Hamelia patens*) cuttings evaluated August 2002 and November 2003. Each bar is the mean of 15 measurements. Different letters above bars indicate significant treatment effects ($P \leq 0.05$) within each year.

are often related to the process of root regeneration. Stock plant stress-induced changes in stomatal conductance, photosynthesis, hormone and carbohydrate levels have been shown to influence rooting of cuttings (15). In addition, due to the lack of a root system, water uptake for stem cuttings is limited and difficult to root stem cuttings are often exposed to high levels of water stress which may also influence rooting (14). Drought conditioning may influence osmotic adjustment, heat acclimation, drought resistance, and harden off plants subjected to DC. When DC plants are exposed to future drought, predisposed DC plants are able to maintain physiological processes and survive while non-predisposed DC plants often die (13, 16).

Results indicate when rooting firebush cuttings, DC treatments alone generally reduced mean number of roots and mean root length when compared to treatments using an auxin-based PGR alone. We also found DC treatments used in combination with an auxin-based PGR did not increase

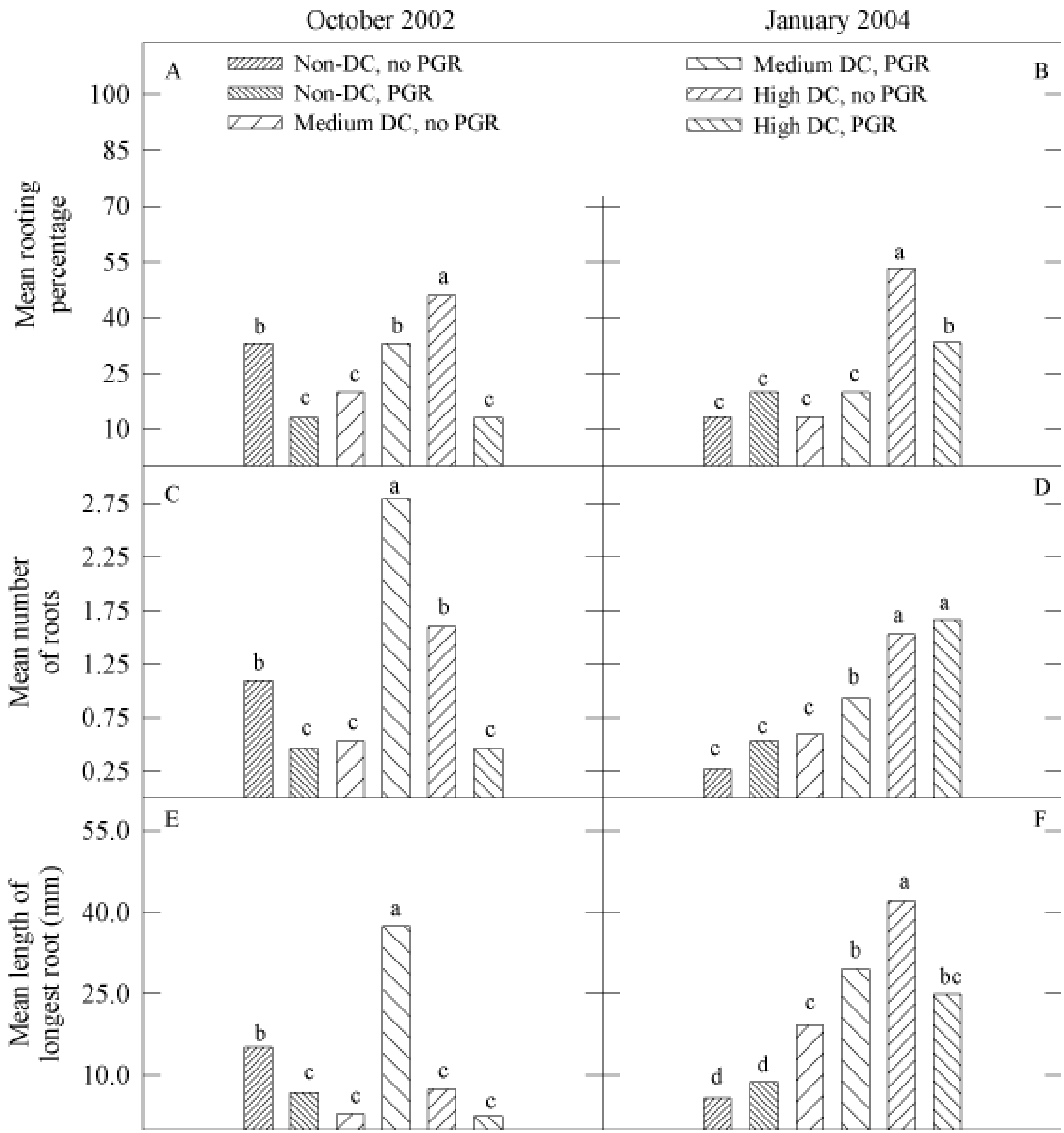

Fig. 3. Influence of drought conditioning and an auxin-based plant growth regulator on rooting percentage (A, B), mean number of roots (C, D), and mean length of longest root (E, F) for Fraser's photinia (*Photinia* x *fraseri* 'Red Robin') cuttings evaluated October 2002 and January 2004. Each bar is the mean of 15 measurements. Different letters above bars indicate significant treatment effects (P ≤ 0.05) within each year.

rooting of firebush cuttings when compared to cuttings treated with an auxin-based PGR alone (Fig. 2). When rooting Fraser's photinia cuttings, moderate or high DC in combination with an auxin-based PGR increased rooting when compared to DC stock plants or an auxin-based PGR used alone (Fig. 3).

In addition, for each species results suggest time of year in which cuttings are taken may influence rooting. Analysis of variance data comparing rooting and experiment dates indicate firebush cuttings taken in August 2002 had a lower rooting percentage and shorter roots when compared to firebush cuttings propagated in November 2003 (comparisons not shown). This experiment confirms research by Davis et al. (5) who report rooting of firebush cuttings to be influenced by time of year. Rooting percentage and mean number of roots for Fraser's photinia cuttings did not differ between August 2002 and November 2003 (comparisons not shown). However, Fraser's photinia cuttings propagated in 2003 had greater root length when compared to Fraser's photinia cuttings propagated in 2002 (comparisons not shown). Previous research regarding rooting of Fraser's photinia cuttings has been conducted in regions of the Southern United States during Spring (2) and Summer (3, 4, 7). However, this research indicates rooting Fraser's photinia cuttings in Lubbock, TX (USDA hardiness zone 7a) during November may improve rooting when compared to rooting of Fraser's photinia cuttings taken in August. Our results also confirm firebush stem cuttings tend to root quickly (5) and Fraser's photinia stem cuttings do not root for an extended period of time (3). In addition, these results indicate DC had an adverse affect on adventitious rooting of firebush stem cuttings. Because firebush cuttings root easily without a DC treatment, this research indicates care should be taken to avoid water stress of firebush stock plants when propagating firebush from cuttings. However, our results also indicates when moderate or high DC is used in combination with an auxin-based PGR, adventitious rooting of Fraser's photinia stem cuttings can be increased when compared to cuttings taken from non DC stock plants.

For ornamental plant species, cultural practices (time of year, media temperature, light level, air temperature, misting, etc.) are often used to stimulate rooting and reduce the length of time needed to root stem cuttings (10). This research indicates drought conditioning Fraser's photinia stock plants may be a cultural practice which increases tolerance of stem cuttings to future stress events (13, 14) and therefore resulted in greater rooting of Fraser's photinia stem cuttings. However, results also indicate drought conditioning may have adverse affects on rooting of firebush cuttings. Therefore, research and caution should be used prior to subjecting drought conditioning to untested plant species.

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