Research Reports:

Propagation of Firebush (*Hamelia patens*) by Stem Cuttings[1]

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Abstract

The influence of bottom heat, rooting medium, type of cutting (i.e. terminal vs. subterminal), and commercial auxin formulations on greenhouse propagation of firebush (*Hamelia patens* Jacq.) by leafy stem cuttings during winter was investigated. Without bottom heat, mid-day rooting medium temperature averaged about 22 ± 3°C (72 ± 5°F). Percent rooting of auxin-treated cuttings without bottom heat was 50% and mean length of the longest root and visual rating scores of root development were low. Maintaining the rooting medium at 29–39°C (85–101°F) increased percent rooting for auxin-treated cuttings to 96–100% and increased root length and visual rating scores several-fold. Rooting percentage, root length, and visual rating scores were consistently high in perlite and low in peat moss. Terminal stem-tip cuttings and subterminal stem segment cuttings with basal stem diameters of 3–5 mm (0.13–0.20 in) rooted slightly better than subterminal stem segment cuttings which had basal stem diameters of 6–8 mm (0.25–0.32 in.). Terminal stem-tip cuttings not treated with auxin but with bottom heat had rooting percentages of 81–86%. Treatment of terminal stem-tip cuttings with Rootone F or Wood's Rooting Compound (1:20 or 1:5 dilution) generally resulted in rooting percentages above 90%. Some of the auxin treatments also resulted in increased root length and visual rating scores. Despite these differences, none of the plants grown from auxin-treated cuttings were distinguishable from plants grown from nontreated cuttings two months after the rooting period. Of the variables studied, bottom heat had the most dramatic effect on rooting of stem cuttings during winter months.

Index words: adventitious root formation, auxin, bottom heat, rooting medium, vegetative propagation

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Significance to the Nursery Industry

Firebush (*Hamelia patens* Jacq.) is a heat-tolerant species that has potential value as a resource-efficient landscape plant. Unfortunately, the plant has proven difficult to propagate by cuttings during winter months, a time when propagules are needed for bedding plant production. Results of this study indicated that bottom heat is a critical factor in stimulating rooting of firebush cuttings during winter.

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Rooting medium temperatures maintained at 34 ± 5°C (93 ± 9°F) resulted in rooting percentages greater than 90% for auxin-treated cuttings. Perlite appeared to be the best medium for mist propagation. Terminal tip or subterminal stem segment cuttings up to 5 mm (0.19 in) in diameter rooted well, while larger stem segment cuttings exhibited reduced rooting. Auxins were of marginal value in improving rooting of stem cuttings.

Introduction

Firebush is a shrub native to southern Florida, the West Indies, and portions of Central and South America (7). The plant has attractive foliage and brilliant orange-red tubular flowers that are produced in abundance throughout the growing season. Firebush is highly heat tolerant and, once established, is relatively drought tolerant. Furthermore, the plant can be grown in a variety of soils. Because of these characteristics, firebush has potential value as a resource-efficient, landscape plant. Firebush is not tolerant of heavy freezes, and as a result can only be used as a shrub or root-hardy perennial in the southernmost portions of the U.S. In more northern climates, firebush appears to have considerable potential as a bedding plant (6).

Further development and utilization of firebush as a bedding plant is hindered by lack of knowledge regarding propagation and cultural requirements during production. Although the plant generally is easily propagated by stem cuttings, growers have experienced considerable difficulty in obtaining good adventitious rooting during winter months in the greenhouse. To produce saleable bedding plants of firebush for spring planting, cuttings must be taken in January through early March. Thus, there is a need to improve rooting during this time to facilitate production. This investigation was conducted to evaluate the effects of several factors known to influence adventitious rooting on the propagation of firebush by stem cuttings during winter months in the greenhouse.

Materials and Methods

All cuttings were obtained from actively growing stock plants maintained in a commercial greenhouse in San Antonio, Texas. Immediately after excision from the stock plant, the cuttings were placed in moist burlap bags and kept cool until they were prepared, treated, and stuck for rooting the following day. Leaves were removed from the basal 8 cm (3 in) of the cuttings and the bases were inserted 5 cm (2 in) deep into the rooting medium. Cuttings were rooted in an unshaded greenhouse under mist controlled by an electronic leaf (Mist-A-Matic, E.C. Geiger, Harleysville, PA 19438). Air temperature in the greenhouse was about 20–26°C (68–79°F) during the day and 16–20°C (61–68°F) during the night. Four separate rooting experiments were conducted as described below.

Bottom heat experiment. Terminal stem-tip cuttings 10–15 cm (4–6 in) in length were dipped for 2–3 sec in a 1:20 dilution (equivalent to 520 ppm indolebutyric acid [IBA] + 260 ppm napthaleneacetic acid [NAA]) of Wood's Rooting Compound which is composed of 1.03% IBA and 0.51% NAA and immediately planted in perlite with or without bottom heat provided by rubberized mats with thermostatically-controlled electric heating cables. Dilution of the Wood's Rooting Compound was chosen based upon label recommendations. Rooting medium temperature was monitored using thermometers inserted 5 cm deep into the rooting medium.

Media experiment. Terminal stem-tip cuttings 10–15 cm (4–6 in) in length were dipped for 2–3 sec in a 1:20 dilution of Wood's Rooting Compound and immediately inserted into rooting medium consisting of either perlite, perlite-sphagnum peat moss (1:1 by vol.), perlite-sphagnum peat moss-vermiculite (1:2:1 by vol.) or sphagnum peat moss. All treatments had bottom heat.

Cutting type experiment. Three types of cuttings (terminal stem-tip, medium-sized subterminal stem segment with a basal diameter of 3–5 mm [0.125–0.187 in], and large-sized subterminal stem segment with a basal diameter of 6–8 mm [0.25–0.32 in]) were dipped for 2–3 sec in a 1:20 dilution of Wood's Rooting Compound and immediately inserted into perlite with bottom heat.

Auxin experiment. Terminal stem-tip cuttings 10–15 cm (4–6 in) in length were dipped in water (control), treated with Rootone F (0.2% 1-naphthalenacetamide, 0.1% indole-3-butyric acid, and 4.04% tetramethylthiuramdisulfide), or dipped in a 1:20 (equivalent to 520 ppm IBA + 260 ppm NAA) or 1:5 (equivalent to 2080 ppm IBA + 1040 ppm NAA) dilution of Wood's Rooting Compound and immediately inserted into perlite with bottom heat.

Recording of data, post-propagation growth, experimental design and statistical analysis. After three weeks, percent rooting and the length of the longest root on each cutting were determined. A cutting which had one or more visible adventitious roots was considered rooted. In addition, rooting of each cutting was qualitatively rated by two persons on a scale of 0–10 where 0 = no rooting and 10 = profuse rooting. Rooted cuttings from each treatment in the cutting type and auxin experiments were planted in 10 cm (4 in) pots filled with a peat-perlite growing medium. The plants were grown in the greenhouse without shade and were watered daily. A water soluble fertilizer (Peter's 20N-4.3P-16.6 K (20-10-20),) was applied weekly. Post-propagation growth and flowering were evaluated after two months.

All experiments were conducted twice during a period from late January to early April. Exact dates are given in the respective tables. At least 22 cuttings per treatment were used in a randomized complete block experimental design with a total of at least 22 blocks. Statistical inferences regarding rooting percentages were made based upon 95% confidence limits after calculation of z values (8). Mean separation of root length and visual rating data was accomplished using Scheffe tests conducted with statistical software (Abstat, Release 6, Anderson-Bell Corp., Parker, CO 80134). There were at least six plants per treatment in the post-propagation growth and flowering evaluations. Plants were arranged in a randomized complete block design with six blocks and mean separation of growth and flowering data was accomplished using Scheffe tests.

Results and Discussion

Bottom heat experiment. Bottom heat raised the mid-day rooting medium temperature by 10–15°C (about 18–27°F) (Fig. 1). The temperature of the unheated rooting medium averaged 22 ± 3°C (72 ± 5°F) while the average temperature with bottom heat was 34 ± 5°C (93 ± 9°F). Bottom

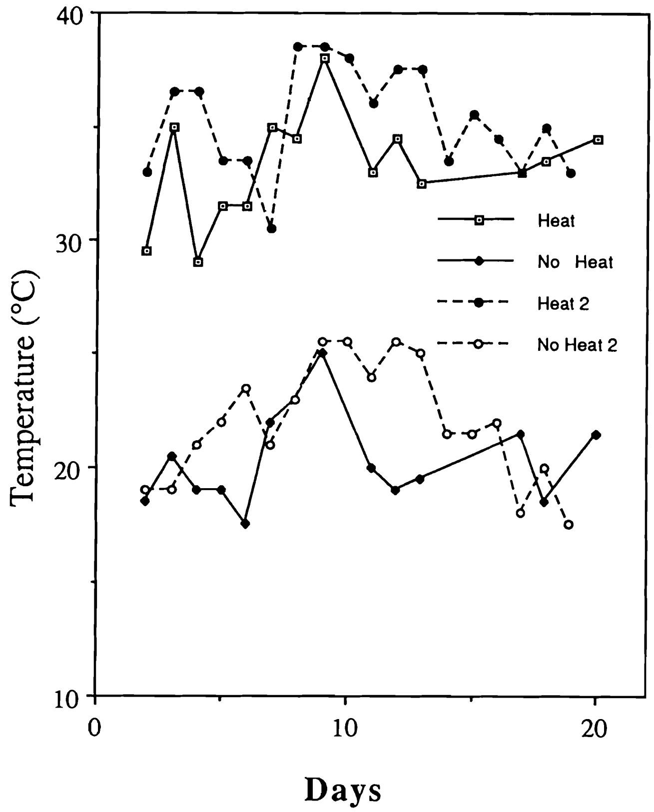

Fig. 1. Mid-day rooting medium temperatures during bottom heat experiment. Rep. 1 (designated Heat and No Heat) was conducted from January 25 to February 16, 1990 and Rep. 2 (designated Heat 2 and No Heat 2) was conducted from February 28 to March 19, 1990.

heat dramatically increased percent rooting and resulted in 96 and 100% rooting in the two replicate experiments, respectively (Table 1). Without bottom heat, only 42 and 58% rooting was achieved in the two replicate experiments. In addition to increasing percent rooting, bottom heat dramatically increased root length and visual rating scores (Table 1). Thus, both the quantity and quality of rooted cuttings were increased by bottom heat. It has previously

Table 1. Influence of bottom heat on rooting of stem cuttings of firebush.[z]

	Treatment	
Rooting characteristic	**No bottom heat**	**Bottom heat**
Rooting percentage		
Rep. 1	42	96*[y]
Rep. 2	58	100*
Root length (cm)		
Rep. 1	0.5	4.1*
Rep. 2	1.0	5.7*
Visual ratings[x]		
Rep. 1	1.7	6.0*
Rep. 2	2.2	6.1*

[z]Replication 1 was conducted from January 25 to February 16, 1990; Replication 2 was conducted from February 28 to March 19, 1990.

[y]Asterisk indicates that bottom heat mean is significantly different than the control at the 5% level of probability (n = 36).

[x]0 = no rooting, 10 = profuse rooting.

been recommended that rooting medium temperatures for cuttings of plants native to warm regions be maintained between 25 and 32°C (77–90°F) (5). In contrast, plants native to temperate regions have recommended rooting media temperatures of 18–25°C (65–77°F). For firebush, the latter temperatures resulted in relatively poor rooting and are likely the primary cause of the poor propagation results reported by growers during winter months.

Media experiment. Rooting cuttings in perlite resulted in 96 and 100% rooting in the two replicates, respectively (Table 2). Rooting in peat moss was poor, particularly in the first replicate where only 32% rooting was observed. Likewise, peat moss decreased root length and visual rating scores compared to perlite. Rooting in the peat-perlite and peat-perlite-vermiculite media varied between the two replicate experiments. In the first replicate, rooting was less in these media than in perlite. In the second replicate, rooting was the same as in perlite. The reason for this discrepancy is not clear, but may be related to the slightly lower temperatures during the first replicate than during the second which was conducted one month later. Loach (5) noted a similar seasonal rooting response to propagation media and observed the best propagation medium varied depending on the time of year. Based on our findings, it appears that perlite yields the most consistent rooting of firebush under mist during winter months. Addition of peat moss to the medium resulted in more variable rooting. Hence, the commonly recommended peat-perlite rooting media (4, 5) may not be satisfactory for mist propagation of firebush during winter. A common concern regarding use of pure perlite as a propagation medium is that the resultant roots will be coarse and brittle. This was not observed with rooted cuttings of firebush.

Cutting type experiment. Both terminal stem-tip and medium-sized subterminal stem segment (3–5 mm basal diameter) cuttings had rooting percentages above 90% (Table 3). Large stem segments (6–8 mm basal diameter) exhibited about 80% rooting and had root lengths and visual rating scores that were generally lower than for the other cutting types. Despite differences in root length and visual rating scores, plants grown from the different cutting types were indistinguishable after two months. Plant height, plant diameter, and the date of anthesis were the same regardless of the type of cutting used for propagation (data not presented). Thus, the only disadvantage of using large-sized stem segment cuttings was that about 15–20% fewer cuttings rooted compared to the other cutting types. Unfortunately, post-propagation growth of cuttings from different treatments is often not evaluated in rooting studies (1, 2, 3). Our results with firebush indicate that although cutting type can affect root length and visual rating scores at the end of the rooting period, there is no long-term effect on subsequent plant size or flowering.

Auxin experiment. Rooting of nontreated cuttings was 86 and 81% in the two replicate auxin experiments, respectively (Table 4). Nontreated cuttings that did not root were still alive after three weeks and may have eventually rooted if left for a longer period. Treatment of the cuttings with the 1:5 dilution of Wood's Rooting Compound increased rooting to 100%. Thus cuttings of firebush, like those of many other species (1), respond to auxin treatment with improved rooting. Rootone F and the 1:20 dilution of Wood's Rooting

Table 2. Influence of selected rooting media on rooting of stem cuttings of firebush[z].

Rooting characteristic	Rooting medium			
	Perlite	Perlite-Peat (1:1)	Perlite-Peat-Vermiculite (1:2:1)	Peat
Rooting Percentage				
Rep. 1	96 a[y]	72 b	52 bc	32 c
Rep. 2	100 a	100 a	93 ab	78 b
Root length (cm)				
Rep. 1	4.7 a	2.8 ab	2.1 b	1.1 b
Rep. 2	5.5 a	5.3 a	4.6 ab	4.2 b
Visual ratings[x]				
Rep. 1	6.5 a	3.1 b	2.3 bc	1.1 c
Rep. 2	6.5 a	5.3 ab	4.9 ab	4.2 b

[z]Replication 1 was conducted from January 25 to February 16, 1990; Replication 2 was conducted from February 28 to March 19, 1990.

[y]Means within a row with a common lower case letter are not significantly different at the 5% level of probability ($n \geq 25$).

[x]0 = no rooting, 10 = profuse rooting.

Table 3. Influence of cutting type on rooting of firebush[z].

Rooting characteristic	Type of cutting		
	Terminal stem-tip	Medium subterminal stem segment[y]	Large subterminal stem segment[x]
Rooting percentage			
Rep. 1	100 a[w]	92 ab	79 b
Rep. 2	96 ab	100 a	83 b
Root length (cm)			
Rep. 1	3.6 a	3.2 ab	2.0 b
Rep. 2	3.9 ab	4.2 a	2.5 b
Visual rating[v]			
Rep. 1	5.0 a	4.4 a	3.0 b
Rep. 2	6.9 a	6.3 ab	3.7 b

[z]Replication 1 conducted from February 28 to March 19, 1990; Replication 2 conducted from March 28 to April 16, 1990.

[y]Basal diameter of 3–5 mm (0.125–0.187 in).

[x]Basal diameter of 6–8 mm (0.25–0.32 in).

[w]Means within a row with a common lower case letter are not significantly different at the 5% level of probability ($n = 24$)

[v]0 = no rooting, 10 = profuse rooting.

Compound only marginally increased percent rooting. The higher concentration of Wood's Rooting Compound was the only auxin treatment that consistently resulted in increased root length and visual rating scores. Despite these differences in rooting, none of the plants grown from auxin-treated cuttings were distinguishable from plants grown from nontreated control cuttings two months after the rooting period. Plant height, plant diameter, and flowering were the same for all plants at this time (data not presented). Thus, it is questionable as to whether auxin treatment of stem cuttings of firebush would be beneficial for commercial production of bedding plants. The modest improvement in rooting obtained by use of auxin must be weighed against the expense of application.

Conclusion. Of the variables studied, bottom heat had the most dramatic effect on rooting of stem cuttings of firebush during winter propagation in the greenhouse. Without bottom heat, only 50% rooting was obtained. Other variables such as auxins, rooting media, and cutting type had less striking effects on rooting, with the exception that pure peat moss clearly reduced rooting and should be avoided as a propagation medium. As a result, one of the primary concerns during winter propagation of firebush by stem

Table 4. Influence of selected commercial rooting formulations on rooting of stem cuttings of firebush[z].

Rooting characteristic	Rooting Formulation[y]			
	Control	RF	Wood's (1:5 dilution)	Wood's (1:20 dilution)
Rooting percentage				
Rep. 1	86 b[x]	100 a	100 a	95 ab
Rep. 2	81 b	89 b	100 a	93 ab
Root length (cm)				
Rep. 1	2.4 b	4.2 a	4.3 a	4.0 ab
Rep. 2	3.1 a	3.6 a	4.6 a	3.5 a
Visual ratings[w]				
Rep. 1	3.4 b	5.8 a	7.2 a	5.7 a
Rep. 2	3.9 b	5.3 ab	6.2 a	4.5 ab

[z]Replication 1 was conducted from January 25 to February 16, 1990; Replication 2 was conducted from February 28 to March 19, 1990.

[y](RF = Rootone F; Wood's = Wood's Rooting Compound)

[x]Means within a row with a common lower case letter are not significantly different at the 5% level of probability ($n \geq 22$).

[w]0 = no rooting, 10 = profuse rooting

cuttings should be maintenance of high rooting medium temperatures. Although the optimum medium temperature for adventitious rooting often cannot be rigidly defined (5), results reported herein for firebush indicate that maintaining the medium temperature between 29–39°C (85–101°F) yields excellent rooting.

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Anomalous Root Structure on Woody Plants *in vitro*[1]

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Abstract

The anatomical structure of *in vitro*-generated roots contrasted sharply with *ex vitro* roots produced on parallel treatments of micropropagated woody plant clones. *In vitro* roots contained enlarged, irregular, frequently pigmented cortical cells with numerous intercellular spaces, and only primary vascular system 4–5 weeks after initiation, while *ex vitro* roots of the same age were comprised of smaller, uniformly arranged cell layers and were developmentally further advanced (exhibited secondary vascular system development). Light exposure was not a major influence on anomalous structure of *in vitro* roots, other than pigmented cell frequency. *Ex vitro* rooting hormone stimulated production of thicker, more frequent root initials, although root structure beyond the point of emergence from the stem quickly transformed to the slender, compact character typical of *ex vitro* production.

Index words: auxin, Indole-3-butyric acid (IBA), Naphthalene acetic acid (NAA), photosynthetic photon flux (PPF), rhizogenesis, tissue culture

Species used in this study: Red Sunset Red maple (*Acer rubrum* L. 'Red Sunset'); River birch (*Betula nigra* L.); Sunrise border forsythia (*Forsythia* × *intermedia* Zab. 'Sunrise'), McIntosh apple (*Malus* × *domestica* Borkh 'McIntosh'); Red Ace miniature rose (*Rosa chinensis minima* 'Red Ace')

Significance to the Nursery Industry

In vitro rooting is sometimes preferred by tissue culture producers for two reasons: 1) it maximizes grower control over rooting conditions; and, 2) it simplifies shipping and transport of micropropagated plants to the nursery, since unrooted microcuttings are extremely tender. Alternatively, many large micropropagation labs have found that *ex vitro* rhizogenesis confers increased production efficiency, and lower costs. Often in the nursery industry, a grower may purchase micropropagated liners or young plants without knowledge of the method used during rhizogenesis of the microcutting at an earlier stage of production. Because the agar medium rooting environment is quite different than the transplant environment, the quality of the initial adventitious roots and framework root system on a woody plant may hinge on the method selected to induce rooting. Nursery growers should realize that acclimatization timing and subsequent handling procedures may be conditioned by the rooting method.

Introduction

The ability to propagate a superior woody plant clonal selection, by tissue culture or any other method, is a critical advantage in the nursery industry. The value of a cutting propagation method, however, hinges on the ability to successfully root and adapt new plantlets to field conditions. The decision to root woody microcuttings *in vitro* (while still in agar medium) or, alternatively, *ex vitro* (in high humidity and in soilless mix) can lead to significant differ-

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