Plant Propagation

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Section Editor

Effect of Honey and Auxin during Propagation of ‘Red Cascade’ Miniature Rose

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Index Words: root-promoting compounds, IBA, *Rosa*

Significance to Industry Addition of honey to water-soluble IBA solutions had no influence on root number, growth index, or root quality rating. However, application of 1,000 ppm IBA as a 1-sec basal quick dip resulted in cuttings with a greater number of roots, greater average length of three longest roots, and a higher root quality rating when compared to cuttings that received no auxin. Application of 250 ppm IBA resulted in cuttings with a greater shoot height when compared to cuttings that received no auxin. These results suggest that cuttings from easy-to-root plants such as ‘Red Cascade’ miniature rose benefit from use of some level of auxin during propagation.

Nature of Work Sugars (as carbohydrates) are known to positively impact rooting of cuttings and are frequently used in Stage III of tissue culture as an energy source for micro-cuttings (2). Clinical studies have confirmed the broad-spectrum antimicrobial properties of honey which are theorized to be due to naturally low pH, osmotic effect, high sugar concentration, and presence of bacteriostatic and bactericidal factors (3). Antibacterial properties are attributed to the super- saturated solution of sugar (5). A typical batch of honey has a 15-21% and a solid fraction containing a ratio of monosaccharides (glucose and fructose) leaves very little free water available for growth of micro-organisms (5). Manuka honey possesses a degree of antibacterial properties which are determined with testing and the results used to calculate the unique Manuka factor (UMF) which ranges in potency from 1 -70+ (6).

Whalley (2009) of Taupo Native Plant Nursery in New Zealand conducted an on-nursery trial using honey as a stand-alone rooting hormone when their primary rooting hormone powder was discontinued. Whalley trialed Manuka honey (UMF 15+), a multiflora honey purchased from the supermarket, a commercially available root-promoting compound, and a nontreated control. These treatments were applied to cuttings of the following six New Zealand natives: *Brachyglottis* ‘Sunshine’, *Coprosma acerosa, Coprosma* x *kirkii* ‘Kirkii’, *Griselinia littoralis* ‘Broadway Mint’, *Myoporum laetum*, and *Olearia virgata var. lineata*. These plants were selected for various characteristics including ease of rooting (6). Both varieties of honey were used to prepare solutions containing honey and hot water (1:2 v:v) and solutions were refrigerated for 24 h before use (6). Cuttings were placed into solutions for 30 minutes before sticking and placed onto a mist bed with bottom heat (6). Cuttings treated with solutions containing general multiflora honey had the fewest unrooted cuttings across all four treatments and a high number of cuttings with a good (4+) and average (3 or less) root rating while Manuka solutions had the lowest number of roots with a good (4+) rating and a higher number of unrooted cuttings among all four tested treatments (6). The objective of this research was to evaluate whether addition of honey to water-soluble auxin solutions increased root growth and uniformity compared to auxin solutions without honey.

One-inch (2.5-cm), single node medial cuttings of *Rosa* ‘Red Cascade’ were harvested from containerized stock plants and stuck to a depth of 0.5 inch (1.3 cm) on 11 September 2019. Red Cascade rose was chosen as the model plant for preliminary studies since previous research has shown that it can be rooted successfully without the auxin although using an auxin-containing compound can result in an increased rooting response (1). Propagation medium was a mix of Canadian sphagnum peat, pine bark fines, coarse perlite, and medium vermiculite (Oldcastle Lawn and Garden Inc., Atlanta, GA) placed into 50-cell plug trays. Cuttings were placed under intermittent mist applied for 6 sec/10 min during daylight hours. Treatments consisted of four honey types (none, general multiflora, Manuka, or locally sourced), and five auxin levels [0, 250, 500, 750, or 1,000 ppm Indole-3-butyric acid (IBA) (Hortus Water Soluble Salts; Phytotronics Inc., Earth City, MO]. Water soluble IBA solutions were created using deionized water. Honey treatments consisted of a 2:1 solution created by dissolving honey in either deionized water (when auxin level equaled 0 ppm) or the IBA solutions. Once the solutions were made, cuttings were treated with a 1-sec basal quick-dip in one of the twenty solutions before being stuck into the rooting flat. A completely randomized design with a 4×5 factorial treatment arrangement was utilized with 15 cuttings per treatment. Data collected after 42 days included rooting percentage, shoot height, total root number, average root length (three longest roots), and root quality (1-5, with 1=no roots and 5= ≥ 10 roots). Data were analyzed using linear mixed models and generalized linear mixed models with the GLIMMIX procedure of SAS (ver. 9.4; SAS Institute Inc., Cary, N.C.)

Results and Discussion There was no interaction between honey type and auxin rate (Table 1). Utilization of honey during propagation of ‘Red Cascade’ miniature rose did not result in an increase in percent rooting, number of roots, average length of three longest roots, shoot height, or root quality rating (Table 1). Our results differ from Whalley (6). In their experiments, using a Manuka or a multiflora honey enhanced rooting, including a healthier or higher quality root system, when compared to a commercial root-promoting compound.

Auxin rate had an effect on total root number, average root length, shoot height, and root quality (Table 1). Total root number, average length of three longest roots, and root quality ratings were higher for cuttings that received a 1-sec basal quick dip with a 1,000 ppm IBA solution compared to cuttings that received no auxin treatment. However, cuttings that received auxin at 250 or 500 ppm had similar total roots, average length of three longest roots, and root quality ratings when compared to cuttings that received no auxin. Shoot height was greater for cuttings that received a 250 ppm auxin treatment compared to cuttings that received no auxin. Our results are similar to previous experiments on the effects of IBA rate on the rooting of Red Cascade miniature rose (1). While application of auxin did not impact rooting percentage, higher levels did lead to improved cutting performance for total root number, average length of three longest roots and root quality when compared to cuttings that rooted without auxin.

Further research will examine other woody ornamental plant species that vary in rooting difficulty to determine if addition of various honey types to water soluble IBA solutions enhances rooting responses. Cuttings that require longer propagation times may benefit from the addition of honey to auxin solutions as longer propagation time can allow for an extended time frame for soil pathogens to impact cutting health.

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Table 1: Results of three different honey sources and five auxin rates on rooting percentage, root number, average root length, root quality, and growth of single-node stem cuttings of a miniature climbing rose (*Rosa* 'Red Cascade').

	Rooting (%)	Roots (no.)	Avg. Length of three longest roots (cm)	Shoot Height (cm)	Root Quality Rating[z]
Honey Type					
No Honey	100.0a[y]	5.1a	7.7a	6.4a	3.4a
Local Honey	86.6a	5.1a	7.4a	6.3a	3.2a
Manuka Honey	86.6a	5.5a	7.8a	6.4a	3.4a
Multiflora Honey	93.3a	4.1a	7.6a	6.5a	3.2a
Auxin Rate					
0 ppm IBA	100.0a	4.2b	6.9b	5.7b	3.1b
250 ppm IBA	100.0a	4.9ab	7.4ab	6.8a	3.3ab
500 ppm IBA	86.6a	5.1ab	7.6ab	6.5ab	3.3ab
750 ppm IBA	93.3a	5.2a	8.0ab	6.6ab	3.4ab
1,000 ppm IBA	100.0a	5.4a	8.2a	6.5ab	3.5a
Significance[x]					
Honey Type	NS	NS	NS	NS	NS
Auxin Rate	NS	**	**	*	*
Honey Type × Auxin Rate	NS	NS	NS	NS	NS

[z]Root Quality (1-5, with 1 = no roots and 5 = ≥ 10 roots).

[y]Means within a column followed by the same letter were not different at α = 0.05 or 0.10.

[x]Significant at the $P \leq 0.10$ (*) or 0.05(**) level. NS = Not significant.

Spring Cutting Propagation of South Mississippi Native Azaleas

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Index Words *Rhododendron austrinum,* propagation, immersion, quick-dip, IBA, Hortus IBA Water Soluble Salts™

Significance to Industry Duration of cutting immersion effected rooting percentage, roots number, and average length of the three longest roots. There was an interaction between auxin concentration and immersion duration for root quality, cutting quality and growth indices. Results indicate that very soft Florida azalea cuttings had a better rooting response when treated with a 5 sec basal quick-dip and auxin concentration was 2500 compared to cuttings receiving higher auxin concentrations for longer immersion durations.

Nature of Work Florida azalea, (*Rhododendron austrinum* (Small) Rehder*)* was discovered by Dr. A. W. Chapman before 1865 and reported as a distinct species by Dr. John K. Small in 1913 (4). Flowers are fragrant and range from pale yellow to orange in color with clusters of 8 to 15 blooms appearing in early spring and generally preceding or coinciding with emergence of dark green leaves that turn a yellow to bronze-orange color in the fall (1, 6). Native range is across northern Florida, coastal Alabama, southern Georgia and southeastern Mississippi (USDA Hardiness zones 6b-10a) (10). It has been reported to be easy to propagate according to Galle (5) and Skinner (13). Treatment of Florida azalea softwood cuttings with 10000 ppm K-IBA resulted in successful rooting (10). Rooting with lower rates of K-IBA occurred, however higher rates increased root number, length, and quality. Knight et al. (9) also observed that while root ratings, lengths and numbers were similar for cuttings treated with 8000 ppm and 10000 ppm K-IBA, cuttings receiving 10000 ppm rooted 100%.

Developed in the 1940's, long soak immersions have been useful for some hard to root species (2, 11). Kroin (11) states that long soak immersions are used to "improve the rooting of hard to root cuttings". Skinner (12) applied a basal soak treatment from 8 to 48 hours on 45 different plants in the *Ericaceae* L. family, including *Rhododendron* L. Skinner (12) observed that "some plants rooted satisfactorily without auxin treatment, but most exhibited an increase in average rooting over nontreated cuttings". The objective of this study was to determine if different immersion durations across a range of IBA concentrations improves rooting response on very soft cuttings of Florida azalea.

A completely randomized experimental design was utilized with five cuttings per treatment. Florida azalea cuttings were taken on 19 April 2019 from a native population at Crosby Arboretum in Picayune, MS (USDA zone 8b). Cuttings were taken around 6:30 am after a recent rain to ensure they were turgid to aid in reduction of transpiration stress on the cuttings. Using the method that was described by Jenkins (7), cuttings were taken from tissue soft enough to be removed via pinching. This resulted in variable cutting sizes, however the average length of the cuttings was around 5 cm (2 inches) long. Immediately after pinching, cuttings were placed and stored in a cooler of water until being stuck in the respective treatments (7). At sticking, cuttings were turgid and showed no signs of wilting or stress.

Based on previous studies, Hortus (Hortus IBA Water Soluble Salts™) was chosen as the auxin. IBA rates were 0, 1000, 2500, 5000, 7500, or 10000 ppm. Immersion durations were 0, 1, 6, 12, or 24 hours with 0 receiving a 5 sec basal quick-dip. Cuttings were wounded then submerged for each time interval, removed, and stuck into 100% perlite substrate in a 6.4 cm (2.5 inch) container. They were then placed under intermittent mist for 4 seconds every 6 minutes during daylight hours. Sixty days after sticking, it was noted that most all cuttings had callused, but formed no roots. At this time, mist intervals were reduced to 2 seconds every 10 minutes and a liquid application of 20-10-20 (Peters® Professional, J.R. Peters, Allentown, PA, USA) general purpose fertilizer at the rate of 50 ppm nitrogen was applied to encourage root growth. Data collected after 120 days included rooting percentage, growth index (new shoots), cutting quality (1-5, with 1=dead and 5=transplant-ready cutting), total root number, average root length (of three longest roots), and root quality (1-5, with 1=no roots and 5=healthy, vigorous root system). Data were analyzed by JMP 14.1.0 Student Edition (SAS Institute, Inc., Cary, NC, USA). All parameters were analyzed by two-way mixed effects ANOVA using standard least squares.

Results and Discussion: There was an interaction between auxin concentration and immersion duration for root quality (P=0.0056), cutting quality (P<.0001) and growth indices (P<.0001) (Table 1). Cuttings treated with Hortus IBA at rates of 1000, 2500 or 7500 ppm IBA had a higher cutting quality when applied at 0 hour submersion duration compared to cuttings receiving IBA rates of 2500, 5000, 7500, or 10000 ppm applied at 6, 12, or 24 hour immersion durations. Cutting root quality was increased when 2500 ppm IBA was applied at 0 hour submersion duration in comparison to cuttings receiving IBA rates of 0, 1000, 2500, 5000, 7500, or 10000 ppm applied at 1, 6, 12, or 24 hour immersion durations. Two exceptions were cuttings receiving 1000 ppm applied at the 6 hour immersion duration and cuttings receiving 0 ppm applied at the 12 hour immersion duration. Growth indices also increased when 2500 ppm IBA was applied to cuttings at the 1 hour immersion timing compared to cuttings receiving IBA rates of 1000, 2500, 5000, 7500, or 10000 ppm applied at 6, 12, or 24 hour immersion timings, with the exception of cuttings receiving 1000 ppm applied at the 6 hour immersion duration.

Rooting percentage (P<.0001), number of roots (P=0.0101), and average length of the three longest roots (P=0.0415) responded negatively to immersion duration treatments except for average length of the three longest roots for cuttings submerged for 6 hours. (Table 2). For all three parameters, the 0 hour submersion timing resulted in better cuttings compared to the other four timing treatments. Auxin rate did not have an effect on these three data parameters.

Rooting percentages ranged to 0 to 30% depending on treatment with overall average rooting percentages of 9%. In other studies, Florida azalea rooting percentages have ranged from 60 to 90% (9, 10, 14). Differences between rooting results could partially be attributed to other studies using older, harder cuttings compared to this study. IBA rates for this study were determined based on studies using harder cutting types, but it appears that lower rates may be more beneficial with very soft cuttings or immersion treatments. Hortus recommends concentrations not exceeding 400 ppm IBA when using a basal long soak (11). Auxins, if applied in excess, can inhibit plant growth and ultimately cause plant death (3). Treatments using over 2500 ppm IBA or treatments submerged in higher concentrations for over one hour performed poorly in this study.

Based on the results found in this study, it would appear that young new plant tissue cuttings performed the best overall when subjected to Hortus at a rate of 2500 ppm IBA at a 0 hour submersion timing (5 second quick-dip).

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Table 1. Influence of auxin concentration and immersion duration and on root quality, cutting quality, and growth of Florida azalea.

Treatment	Root quality rating[z]	Cutting quality rating[y]	Growth index[x]
0 hr Immersion Control	1.5def[w]	3.2ab	4.6abc
0 hr Immersion Hortus 1000 ppm	1.6cde	3.6a	5.4ab
0 hr Immersion Hortus 2500 ppm	2.3a	3.6a	4.2abc
0 hr Immersion Hortus 5000 ppm	2.2ab	2.8bc	4.5abc
0 hr Immersion Hortus 7500 ppm	1.7bcde	3.6a	5.4ab
0 hr Immersion Hortus 10 000 ppm	1.6cde	3.0ab	5abc
1 hr Immersion Control	1.5def	3.2ab	5.3ab
1 hr Immersion Hortus 1000 ppm	1.5def	3.2ab	5.2abc
1 hr Immersion Hortus 2500 ppm	1.5def	3.0ab	5.7a
1 hr Immersion Hortus 5000 ppm	1.5def	3.0ab	5.1abc
1 hr Immersion Hortus 7500 ppm	1.4def	2.6bcd	3.8cd
1 hr Immersion Hortus 10 000 ppm	1.0f	1.4fg	0.8fg
6 hr Immersion Control	1.5def	2.6bcd	4.8abc
6 hr Immersion Hortus 1000 ppm	2.1abc	2.6bcd	4.3abc
6 hr Immersion Hortus 2500 ppm	1.3def	2.8bc	4.2bcd
6 hr Immersion Hortus 5000 ppm	1.0f	1.0g	0.0g
6 hr Immersion Hortus 7500 ppm	1.0f	1.0g	0.0g
6 hr Immersion Hortus 10 000 ppm	1.0f	1.0g	0.0g
12 hr Immersion Control	1.8abcd	3.2ab	5.5ab
12 hr Immersion Hortus 1000 ppm	1.6cde	2.8bc	4.2bc
12 hr Immersion Hortus 2500 ppm	1.2ef	1.8ef	1.9ef
12 hr Immersion Hortus 5000 ppm	1.0f	1.0g	0.0g
12 hr Immersion Hortus 7500 ppm	1.0f	1.0g	0.0g
12 hr Immersion Hortus 10 000 ppm	1.0f	1.0g	0.0g
24 hr Immersion Control	1.3def	2.2cde	2.7de
24 hr Immersion Hortus 1000 ppm	1.3def	2.0def	2.2ef
24 hr Immersion Hortus 2500 ppm	1.0f	1.0g	0.0g
24 hr Immersion Hortus 5000 ppm	1.0f	1.0g	0.0g
24 hr Immersion Hortus 7500 ppm	1.0f	1.0g	0.0g
24 hr Immersion Hortus 10 000 ppm	1.0f	1.0g	0.0g

[z]Root quality (1-5, with 1=no roots and 5=healthy, vigorous root system).
[y]Cutting quality (1-5, with 1=dead and 5=transplant ready cutting).
[x]Growth index=(width1+width2+height)/3.
[w]Means followed by the same letter are similar and not significantly different (α = 0.05).

Table 2. Influence of immersion duration on root percentage, number of roots, and average length of the three longest roots of Florida azalea.

Comparison	Rooting (%)	Roots (no.)	Avg. Length of 3 Longest Roots (cm)
0 hr Immersion	30.0a[z]	1.3a	0.6a
1 hr Immersion	0.0b	0.0b	0.0b
6 hr Immersion	10.0b	0.3b	0.2ab
12 hr Immersion	10.0b	0.1b	0.2b
24 hr Immersion	0.0b	0.0b	0.0b

[z]Means followed by the same letter are similar and not significantly different ($\alpha = 0.05$).

Spring Propagation of Pascagoula™ Crape Myrtle

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Index Words softwood, semi-hardwood, rooting, root-promoting compounds, auxin, IBA, NAA, Hortus IBA, Dip'N Grow, *Lagerstroemia*

Significance to Industry Root number of Pascagoula™ cuttings was improved when Hortus IBA was used at 1000 ppm on the oldest cuttings in this study, compared to when Hortus IBA was used at 500 ppm on cuttings taken from stem position 3 or when no auxin was used on cuttings taken from stem position 4. When direct comparisons were made, using Hortus IBA at 1000 ppm resulted in cuttings with more roots compared to root numbers on cuttings dipped in Hortus IBA 500 ppm. Utilization of semi-hardwood cuttings (position 1 & 2) also resulted in more roots compared to root numbers on softer cuttings (position 3 & 4). However, results suggest Pascagoula™ crape myrtle can be successfully rooted using semi-hardwood or softwood cuttings with or without the use of auxin compounds with no loss in quality.

Nature of Work In landscapes across the southern portion of the United States, crape myrtles provide a reliable source of color, often flowering for more than 100 days (2, 6). As the cultivar palette constantly expands, Mississippi State University is active in the development of new crape myrtle selections, including Pascagoula™. Pascagoula™ is a hybrid resulting from the cross of *Lagerstroemia* 'Arapaho' (7) and an unknown pollen donor. Pascagoula™ has a unique deep purple flower color and small to medium growth habit. Five-year-old plants in a research setting are 12-15 feet and have flowered from early June through late August.

Soft- or hardwood cutting propagation of crape myrtle is widely labeled as easy (2, 4). Byers (1983) reports using hardwood cuttings that have been taken after frost in 8-inch (20 cm) sections and stored over winter. Dirr and Heuser (1987) report early January or early March cuttings rooted more poorly than early February hardwood cuttings when using bottom heat and peat:perlite or bark. The objective of this research was to evaluate ease of rooting, determine best commercial auxin formulation and concentration, and optimal stem position for spring propagation of Pascagoula™.

Five-inch (12.7-cm), 3-4 node medial cuttings were harvested from the parent plant and stuck to a depth of 1-inch (2.5 cm) on 18 April 2018. Propagation medium was 100% perlite placed in 2.5-inch (6.4-cm) containers. Treatments included four stem positions (position 1=cutting nearest branch junction and position 4=cutting nearest terminal bud) two auxin formulations [Hortus IBA Water Soluble Salts™ (Hortus IBA) or Dip'N Gro® (DNG)], and three auxin levels [0, 500, or 1000 ppm Indole-3-butyric acid (IBA)]. DNG is a dual auxin compound containing 1-Naphthaleneacetic acid (NAA) at one-half the IBA rate. Experimental design was a randomized complete block design with five single cutting replications. Data collected after 60 days included rooting percentage, growth index (new shoots), cutting quality (0-5, with 0 = dead and 5 = transplant-ready cutting), total root number, average root length (of three longest roots), and root quality (0-5, with 0=no roots and 5=healthy, vigorous root system). Data were analyzed using linear mixed models and generalized linear mixed models with the GLIMMIX procedure of SAS (ver. 9.4; SAS Institute Inc., Cary, NC).

Results and Discussion Treatment had no effect on rooting percentage, average length of three longest roots, root or cutting quality rating, or growth indices (Table 1). Percent rooting ranged from 80-100% which was similar to percentages reported by Dirr (1990) for 'Natchez' crape myrtles propagated in the summer using 5000 ppm IBA. Percentages were also similar to the 90% rooting of 'Natchez' crape reported by Blythe et al. (2003) using 1000 ppm DNG. Rooting percentages in this study were higher than ones reported by Dirr and Heuser (1987) for hardwood cuttings. Cuttings that were taken from stem position 1 and dipped in Hortus IBA 1000 ppm had more roots compared to cuttings that were taken from stem position 3 and dipped in Hortus IBA 500 ppm or cuttings that were taken from stem position 4 and given no auxin treatment.

For additional information, selected treatment combinations were compared. Treatment comparisons were as follows: Hortus IBA versus no auxin, DNG versus no auxin, Hortus IBA versus DNG, Hortus IBA 1000 ppm versus Hortus IBA 500 ppm, DNG 1000 ppm versus DNG 500 ppm, stem position 1 & 2 versus stem position 3 & 4, and stem position 1 versus stem position 2. Rooting percentages, average length of three longest roots, root and cutting quality, and growth indices were similar regardless of treatment comparison (Table 2). Root number of cuttings was increased when Hortus IBA was used, regardless of rate, when compared to roots numbers of cuttings that received no auxin. Cuttings taken from stem position 1 & 2 had more roots than cuttings taken from stem position 3 & 4.

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Table 1. Summary of results using selected treatment combinations on rooting percentage, root number, average length of three longest roots, root quality, cutting quality, and growth of softwood and semi-hardwood cuttings of Pascagoula™ crape myrtle.

Treatment	Rooting (%)	Roots (no.)	Avg. length of 3 longest roots (cm)	Root quality rating[z]	Cutting quality rating[y]	Growth index[x]
Stem Pos. 1 control	80a[w]	6.8ab	10.7a	2.6a	2.9a	5.5a
Stem Pos. 1 Dip'N Grow® 500 ppm	100a	10.4ab	10.7a	2.9a	2.1a	5.6a
Stem Pos. 1 Dip'N Grow® 1000 ppm	100a	11.6ab	12.3a	3.8a	3.0a	6.4a
Stem Pos. 1 Hortus IBA™ 500 ppm	100a	11.6ab	11.4a	3.4a	2.3a	5.4a
Stem Pos. 1 Hortus IBA™ 1000 ppm	100a	14.6a	12.4a	3.0a	2.9a	6.6a
Stem Pos. 2 control	100a	7.6ab	9.7a	2.1a	2.7a	6.1a
Stem Pos. 2 Dip'N Grow® 500 ppm	100a	6.4ab	11.3a	2.3a	1.9a	3.1a
Stem Pos. 2 Dip'N Grow® 1000 ppm	100a	10.6ab	11.7a	2.3a	2.6a	5.1a
Stem Pos. 2 Hortus IBA™ 500 ppm	100a	11.6ab	14.0a	2.8a	2.7a	6.4a
Stem Pos. 2 Hortus IBA™ 1000 ppm	100a	12.8ab	12.3a	3.7a	2.4a	4.8a
Stem Pos. 3 control	100a	7.2ab	10.0a	1.8a	2.5a	4.9a
Stem Pos. 3 Dip'N Grow® 500 ppm	80a	8.8ab	11.3a	2.5a	2.7a	5.2a
Stem Pos. 3 Dip'N Grow® 1000 ppm	100a	10.6ab	12.1a	3.5a	3.2a	5.8a
Stem Pos. 3 Hortus IBA™ 500 ppm	100a	5.8b	9.4a	2.2a	2.3a	5.5a
Stem Pos. 3 Hortus IBA™ 1000 ppm	100a	9.0ab	10.4a	2.4a	2.9a	6.1a
Stem Pos. 4 control	100a	5.8b	8.7a	2.2a	2.1a	4.5a
Stem Pos. 4 Dip'N Grow® 500 ppm	100a	10.8ab	9.8a	3.8a	3.0a	5.7a
Stem Pos. 4 Dip'N Grow® 1000 ppm	100a	9.2ab	10.9a	2.9a	2.6a	4.7a
Stem Pos. 4 Hortus IBA™ 500 ppm	100a	6.2ab	9.6a	2.4a	2.1a	4.7a
Stem Pos. 4 Hortus IBA™ 1000 ppm	100a	9.4ab	9.5a	2.2a	2.9a	5.7a
Significance (F-test p-value)	1.000	0.0033	0.3131	0.0189	0.8972	0.4495

[z]Root quality (0-5, with 0=no roots and 5=healthy, vigorous root system).

[y]Cutting quality (0-5, with 0=dead and 5=transplant ready cutting).

[x]Growth index=(width1+width2+height)/3.

[w]Means followed by the same letter are similar according to Holm-Simulated (method for simultaneous comparisons (α = 0.05).

Table 2. Direct comparisons of selected treatment combinations on rooting percentage, root number, average length of three longest roots, root quality, cutting quality, and growth of Pascagoula™ crape myrtle.

Comparison	Rooting (%)	Roots (no.)	(Length of 3 longest roots)/3	Root quality rating[z]	Cutting quality rating[y]	Growth index[x]
Hortus IBA™ minus No Auxin	NS[w]	*	NS	NS	NS	NS
Dip'N Grow® minus No Auxin	NS	NS	NS	NS	NS	NS
Hortus IBA™ minus Dip'N Grow®	NS	NS	NS	NS	NS	NS
Hortus IBA™ 1000 ppm minus Hortus IBA™ 500 ppm	NS	NS	NS	NS	NS	NS
Dip'N Grow® 1000 ppm minus Dip'N Grow® 500 ppm	NS	NS	NS	NS	NS	NS
Stem Position 1 & 2 minus Stem Position 3 & 4	NS	*	NS	NS	NS	NS
Stem Position 1 minus Stem Position 2	NS	NS	NS	NS	NS	NS

[z]Root quality (0-5, with 0=no roots and 5=healthy, vigorous root system).
[y]Cutting quality (0-5, with 0=dead and 5=transplant ready cutting).
[x]Growth index=(width1+width2+height)/3.
[w]NS=Not significant or significant at α = 0.01 (**) or 0.05 (*) using the Shaffer-Simulated method for simultaneous comparisons,