Vegetative Propagation of Gordonieae Trees by Stem Cuttings[1]

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Abstract

The Theaceae tribe Gordonieae contains trees with desirable ornamental characteristics and adaptability to a broad range of environmental conditions. To develop an effective protocol for vegetative propagation of five taxa in the tribe, terminal softwood, semi-hardwood, and hardwood cuttings were collected from these trees and treated with either 0, 2500, 5000, 7500, or 10000 ppm of the potassium salt of indolebutyric acid (K-IBA). The concentration of K-IBA only affected rooting percentage of hardwood cuttings of *Franklinia alatamaha*, *Gordonia lasianthus*, and *Schima remotiserrata* and had varying effects on root number and length of longest root amongst the taxa and cutting types. *Franklinia alatamaha* and *G. lasianthus* were rooted at high percentages (> 50%) from hardwood, semihardwood, and softwood cuttings, and *S. khasiana* rooted at high percentages (72%) from softwood cuttings. Despite poor rooting from all types of stem cuttings (< 23%), *Schima remotiserrata* and *S. wallichii* exhibited the highest rooting percentages from hardwood cuttings. Rooting percentage, root number, and length of longest root differed greatly in response to K-IBA concentration amongst the five taxa observed and the cutting types within each taxa.

Index words: potassium salt of indolebutyric acid (K-IBA), vegetative propagation, *Gordonieae*.

Species used in this study: Franklin tree (*Franklinia alatamaha* Bart. ex Marshall); loblolly bay (*Gordonia lasianthus* (L.) Ellis); *Schima khasiana* Dyer; *Schima remotiserrata* Hung T. Chang; *Schima wallichii* Choisy.

Significance to the Nursery Industry

Trees in the Theaceae tribe Gordonieae have exceptional ornamental merit and considerable potential for breeding and improvement due to their broad diversity and crossability. However, some taxa in this tribe can be difficult to propagate from stem cuttings. For these taxa to be produced in nurseries or included in programs for breeding and improvement, reliable protocols for their propagation must be developed. Adventitious roots were induced with varying levels of success in taxa of *Franklinia*, *Gordonia*, and *Schima* by using different growth stages of cuttings and concentrations of K-IBA. Treatment with K-IBA provided little benefit for improving rooting percentages for these taxa and was beneficial only at 2500 ppm for hardwood cuttings of *G. lasianthus.* All taxa could be propagated using hardwood cuttings (maximum

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rooting ranged from 19 to 69%), however, semi-hardwood cuttings of *G. lasianthus* rooted well at 84% and softwood cuttings of *S. khasiana* rooted well at 72%.

Introduction

The Theaceae tribe Gordonieae contains three genera of trees (7). Two genera, *Franklinia* and *Gordonia*, are native to warm temperate and subtropical regions of the New World (including the southeastern United States) while the third, *Schima*, is restricted to warm temperate to tropical regions of the Old World. Trees in all three genera have large white flowers that vary in bloom time from mid-summer to early fall (4, 9). Each genus has desirable foliar characteristics including the bright red fall foliage of *F. alatamaha* (4), evergreen and sometimes variegated foliage of *Gordonia lasianthus* (4, 8), and glossy, bright red new foliage of some *Schima* species (6). Trees in the Gordonieae also are adaptable to a wide range of environmental conditions. *Franklinia alatamaha* has been reported to be cold-hardy at –38C (–36F) (2), and *Schima* can withstand fire (5) and tolerate soils that are dry (13), wet (6), or infertile (1).

Previous work on vegetative propagation of these genera is limited. For *F. alatamaha*, Dirr and Heuser (3) recommended that softwood cuttings taken from June to August be treated with a basal dip of 1000 ppm indolebutyric acid (IBA). Concentrations of IBA lower than 1000 ppm were less effective for rooting softwood cuttings of *F. alatamaha*, and concentrations higher than 1000 ppm inhibited rooting (11). For *G. lasianthus*, Dirr and Heuser (3) indicated that cuttings may be taken in March or from June until August and treated with a solution of 3000 ppm IBA. Limited efforts to propagate *Schima* spp. from stem cuttings were unsuccessful (12), and observations by the authors at the Mountain Horticultural Crops Research and Extension Center in Mills River, NC, have indicated that *Schima* spp. are difficult to root from softwood cuttings. The objective of this study was to evaluate the influence of tissue type and the concentration of the potassium salt of indolebutyric acid (K-IBA) on rooting of stem cuttings of *Franklinia*, *Gordonia*, and *Schima* spp.

Materials and Methods

Terminal stem cuttings from *F. alatamaha*, *G. lasianthus*, *Schima wallichii*, *S. khasiana*, and *S. remotiserrata* were collected at the hardwood, softwood, and semihardwood stage of growth on February 1, June 30, and September 26, 2008, respectively. Cuttings were classified as semihardwood when a resting bud had been set, regardless of the rigidity of the stem tissue. Cuttings were taken from ten stock plants of each taxa, with the exception of hardwood cuttings of *F. alatamaha*, which were taken from one stock plant. Stock plants were located either in containers or field plots. Containerized stock plants were top-dressed with 15N-9P-12K controlled-release fertilizer (15-9-12 Osmocote Plus® 5–6 months, The Scott's Co., Marysville, OH) at a rate of 1.3 $g \cdot liter^{-1}$, and field-grown stock were fertilized according to a soil test. Stock plants of all taxa ranged from two to twelve years of age.

At each date, cuttings from each taxon were trimmed to 3 to 4 in (7.5 to 10 cm) in length and the basal 0.4 in (1 cm) was dipped for 3 seconds in either 0, 2500, 5000, 7500 or 10000 ppm K-IBA dissolved in water. The cuttings were then inserted to a depth of 1.0 in (2.5 cm) in plastic flats (40 cm L × 40 cm W × 15.2 cm D) filled with a rooting substrate of sphagnum peat:coarse perlite (2:3 by vol) and placed in a greenhouse. Cuttings were misted intermittently for 8 sec every 10 minutes between 0600 and 1800 HR. Night temperatures were set at 20–22C (68–72F) and day temperatures were set to 22–26C (72–78F). Fifty percent shade covered the greenhouse during softwood cutting propagation. The experimental design was a randomized complete block with five K-IBA treatments and six replicates per treatment combination. Each replicate consisted of six cuttings (subsamples). For statistical analysis, each taxon was considered a separate experiment. Cuttings were harvested and data collected after 12 weeks, with the exception of data for hardwood cuttings of *S. remotiserrata*, which was recorded after 24 weeks due to slow rooting. At harvest, rooting percentage, number of roots, and length of longest root were determined.

Data for some species were not normally distributed nor had equal variances. This was due to the presence of 0% rooting for *S. khasiana* and *S. wallichii*. Nevertheless, transformation using the arcsine square root of rooting percentage did not improve either variable, and parallel analyses using both nontransformed and transformed data were similar for both species. All data were subjected to analysis of variance to test the main effect of K-IBA concentration. When appropriate, data were also subjected to regression analysis to determine if there was a relationship between each variable and K-IBA concentration (Proc GLM, SAS v. 9.1.3; SAS Institute, Cary, NC). Main effects and regression models were considered significant if the probability of a greater F value was less than 0.10 ($P < 0.10$).

Results and Discussion

Hardwood cuttings. Rooting percentage of hardwood cuttings was influenced by K-IBA concentration for *F. alatamaha*, *G. lasianthus*, and *S. remotiserrata*, but not for *S. wallichii* or *S. khasiana* (Fig. 1). In *F. alatamaha*, the highest

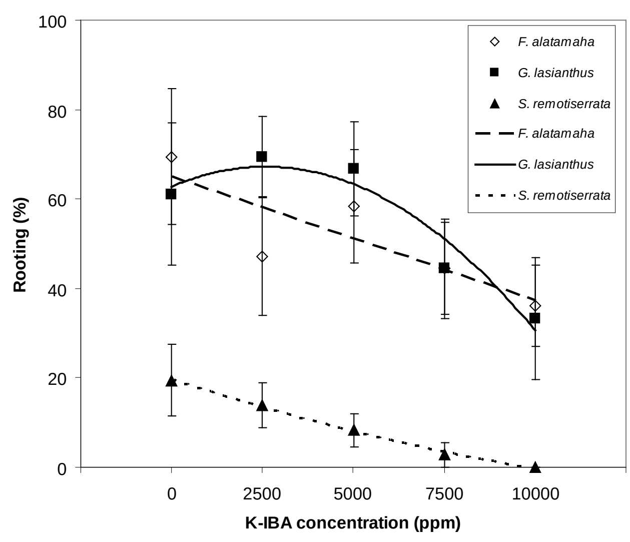

Fig. 1. Effect of K-IBA concentration on rooting percentage (± SEM) of hardwood cuttings of *F. alatamaha* (dashed line, $y = 65.0 - 0.003x$, $r^2 = 0.72$, $P < 0.10$), *G. lasianthus* (solid line, $y = 62.8 + 0.003x - (6.7 \times 10^{-7})x^2$, $r^2 = 0.93$, $P < 0.10$), and *S. remotiserrata* (dotted line, $y = 19.4 - 0.002x$, $r^2 = 0.99$, $P < 0.10$). There were no trends for rooting percentage of *S. wallichii* (mean = 23%) or *S. khasiana* (mean = 43%).

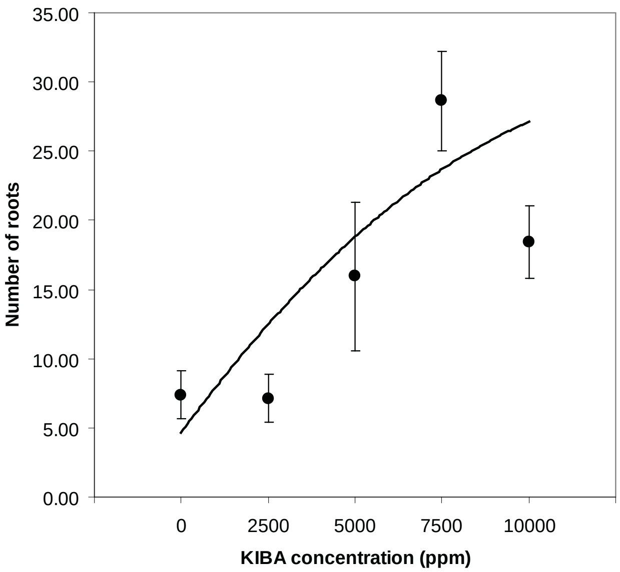

Fig. 2. **Effect of K-IBA concentration on number of roots (± SEM) of hardwood cuttings of *S. khasiana* (y = 4.7 + 0.003x – (1.7 × 10^{-7})x^2, r^2 = 0.43, *P* < 0.10). There were no trends for number of roots of *F. alatamaha* (mean = 9), *G. lasianthus* (mean = 33), *S. wallichii* (mean = 4), or *S. remotiserrata* (mean = 3).**

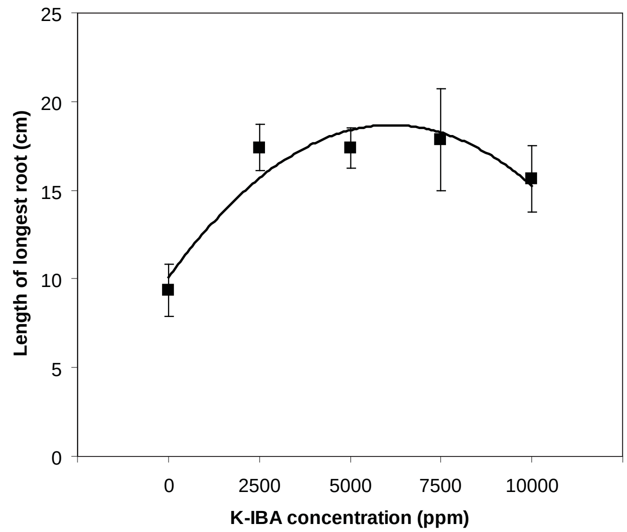

Fig. 3. **Effect of K-IBA concentration on length of longest root (± SEM) of softwood cuttings of *G. lasianthus* (y = 10.1 + 0.003x – (2.3 × 10^{-7})x^2, r^2 = 0.90, *P* < 0.10). There were no trends for length of longest root of *F. alatamaha* (mean = 17 cm), *S. wallichii* (mean = 1 cm), *S. khasiana* (mean = 9 cm), or *S. remotiserrata* (mean = 4 cm).**

rooting percentage (69%) occurred for non-treated control cuttings and decreased linearly with increasing concentrations of K-IBA (Fig. 1). *Gordonia lasianthus* demonstrated a quadratic response to increasing concentrations of K-IBA, with a predicted maximum rooting percentage at 2500 ppm K-IBA (69%). Like *F. alatamaha*, *S. remotiserrata* exhibited the highest rooting percentage (19%) in the non-treated control, and expressed a negative linear relationship with increasing concentrations of K-IBA. K-IBA did not affect rooting percentage of cuttings of *S. wallichii* or *S. khasiana*, which had mean rooting percentages of 23 and 43%, respectively.

Root number was affected by K-IBA concentration for *S. khasiana*, but not the other taxa (Fig. 2). Rooted cuttings of *S. khasiana* had a quadratic response to K-IBA concentration with the optimum of 22 roots per cutting occurring at 7500 ppm. Mean root number did vary among the other species. *Gordonia lasianthus* had the largest mean root number at 33, followed by *S. khasiana* (mean = 15), *F. alatamaha* (mean = 9), *S. wallichii* (mean = 4), and *S. remotiserrata* (mean = 3). For *S. wallichii* and *S. khasiana*, length of longest root was affected by K-IBA concentration. In treated stem cuttings of *S. wallichii*, the lengths were equivalent [mean = 8 cm (3.1 in)] but longer than nontreated cuttings [mean = 3 cm (1.2 in)]. In *S. khasiana*, cuttings treated with 2500 ppm K-IBA had shorter roots [mean = 10 cm (3.9 in)] than all other rooted cuttings [mean = 16 cm (6.3 in)]. There was no trend between length of longest root and K-IBA concentration for either species.

Softwood cuttings. There was no effect of K-IBA concentration on rooting percentage in softwood cuttings of any taxa. The taxa exhibited a wide range of mean rooting percentages from a high of 72% in *S. khasiana* to a low of 0.6% in *S. wallichii.* The mean rooting percentages of the other species were 52% for *F. alatamaha*, 51% for *G. lasianthus*, and 6% for *S. remotiserrata*. Number of roots was not affected by K-IBA concentration in any of the taxa. *Franklinia alatamaha* had the largest mean root number at 46 roots per cutting, followed by *G. lasianthus* (mean = 19), *S. khasiana* (mean = 7), *S. remotiserrata* (mean = 2), and *S. wallichii* (mean = 1).

The only case in which a rooting variable was affected by K-IBA concentration for softwood cuttings was that of length

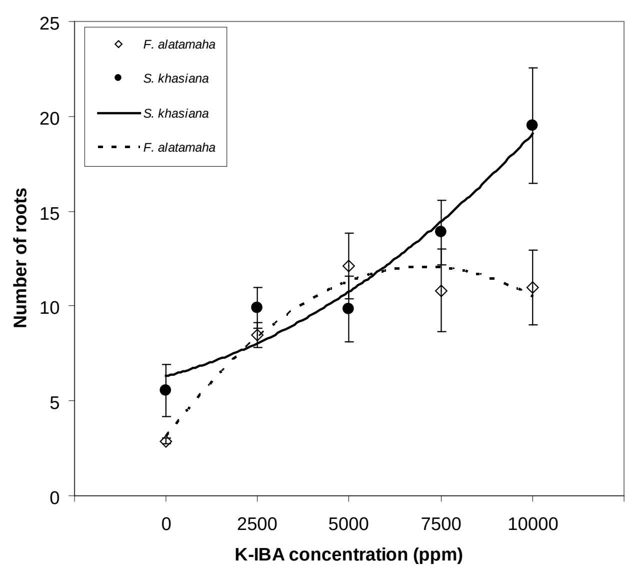

Fig. 4. **Effect of K-IBA concentration on number of roots (± SEM) in semihardwood cuttings of *F. alatamaha* (dotted line, y = 3.1 + 0.003x – (1.8 × 10^{-7})x^2, r^2 = 0.96, *P* < 0.10) and *S. khasiana* (solid line, y = 6.3 + 0.0005x + (7.7 × 10^{-8})x^2, r^2 = 0.95, *P* < 0.10). There were no trends for number of roots in *G. lasianthus* (mean = 21), *S. wallichii* (mean = 4), or *S. remotiserrata* (mean = 2).**

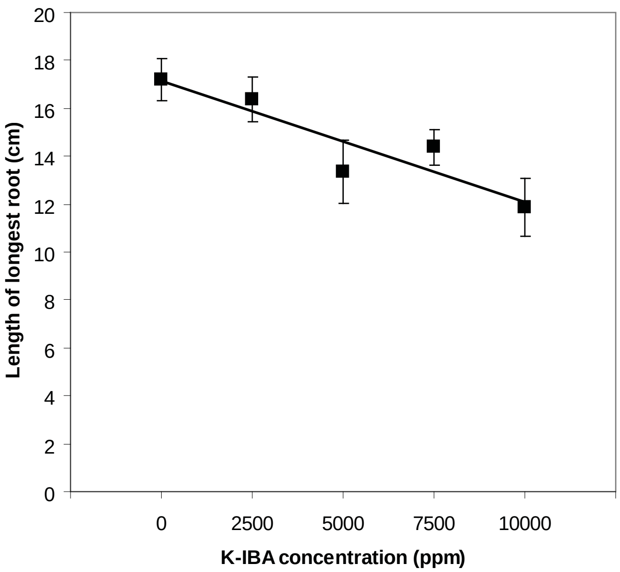

Fig. 5. Effect of K-IBA concentration on length of longest root (± SEM) in semihardwood cuttings of *G. lasianthus* (y = 17.2 – 0.0005x, r^2 = 0.84, *P* < 0.10). There were no trends for length of longest root for *F. alatamaha* (mean = 6 cm), *S. wallichii* (mean = 8 cm), *S. khasiana* (mean = 11 cm), and *S. remotiserrata* (mean = 2 cm).

of longest root in *G. lasianthus* (Fig. 3). Length of longest root in *G. lasianthus* demonstrated a quadratic response to K-IBA concentration with a predicted maximum root length of 18 cm (7.1 in) at 7500 ppm K-IBA.

Semihardwood cuttings. There was no effect of K-IBA concentration on rooting percentage in semihardwood cuttings of any taxa. The highest mean rooting percentage occurred for *G. lasianthus* (84%), followed by *F. alatamaha* (62%), *S. khasiana* (43%), *S. wallichii* (3%), and *S. remotiserrata* (3%).

Mean root number was affected by K-IBA concentration in *F. alatamaha*, *G. lasianthus*, and *S. khasiana* (Fig. 4). Rooted cuttings of *F. alatamaha* had a quadratic response to K-IBA concentration with the optimum of 12 roots per cutting occurring at 5000 ppm. In *G. lasianthus*, root number exhibited no trend in relation to K-IBA concentration, though there were more roots in cuttings treated with K-IBA than in the non-treated control cuttings. The mean root number for all semihardood cuttings of *G. lasianthus* was 21 roots per cutting. Cuttings of *S. khasiana* demonstrated a quadratic response to K-IBA concentration with a predicted maximum of 20 roots per cutting at 10000 ppm. *Schima wallichii* and *S. remotiserrata* did not respond to K-IBA concentration and had mean root numbers of 4 and 2 roots per cutting, respectively. Length of longest root was significantly affected by K-IBA concentration in *G. lasianthus* only, where it decreased linearly with increasing K-IBA (Fig. 5).

Based on the data presented here, *F. alatamaha* successfully rooted at 52% from softwood cuttings, 62% from semi-hardwood cuttings, and 69% from hardwood cuttings with K-IBA treatments providing no benefit. Although these rooting percentages are lower than previously reported, the results are consistent with previous work which showed that *F. alatamaha* rooted at 85–100% at IBA concentrations of 1000 ppm or less but experienced inhibited rooting at concentrations greater than 1000 ppm (3, 11). Similarly, *G. lasianthus* was successfully rooted at 51% from softwood cuttings, 84% from semihardwood cuttings, and 69% from hardwood cuttings and only benefited from treatment with K-IBA at a low rate of 2500 ppm at the hardwood stage. Studies of the related taxon *Stewartia pseudocamellia* Maxim. have shown a similar ability to root from different physiological growth stages of cuttings (10). The *Schima* species included in this study varied considerably in their rooting percentages. *Schima khasiana* rooted at 72% from softwood cuttings and 43% for both semi-hardwood and hardwood cuttings with no benefit from K-IBA treatments. *Schima wallichii* only had a mean rooting percentage of 23%, and *S. remotiserrata* never exceeded 19% rooting. Both of these maximum rooting percentages were attained from hardwood cuttings, and there was no benefit of K-IBA treatment. Hedging (i.e., severe pruning) stock plants has been reported to increase rooting percentage in stem cuttings collected from *Franklinia* (3), so this method might increase rooting percentage for other species in Gordonieae. Other approaches to enhance rooting percentage might include etiolation, increased fertility of stock plants, using different formulations and strengths of growth regulators, or applying post-severance treatments of peroxidase inhibitors and competitors to the cuttings (10).

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