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Propagation of *Castanopsis sclerophylla* by Stem Cuttings[1]

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Abstract

Two experiments were conducted to develop a protocol for propagation of *Castanopsis sclerophylla* (Lindley & Paxton) Schottky by stem cuttings. In the first experiment completed in 2000, stem cuttings were taken on three dates representing three growth stages (softwood, semi-hardwood, or hardwood). Semi-hardwood and hardwood cuttings were treated with 0, 2500 (0.25%), 5000 (0.5%), 7500 (0.75%), or 10,000 (1.0%) ppm of the free acid of indolebutyric acid (IBA) dissolved in 50% isopropyl alcohol, whereas softwood cuttings were treated with the same concentrations of the potassium (K) salt of IBA (K-IBA) dissolved in distilled water. Cuttings were placed in a raised greenhouse bench and rooted under intermittent mist. Cuttings taken at the semi-hardwood and hardwood stages began to drop their leaves after approximately 2 weeks and the majority eventually died, with negligible rooting of surviving cuttings. The response of the softwood cuttings to K-IBA was quadratic with the greatest rooting (63%) at 7500 ppm K-IBA. Seventy softwood cuttings that rooted were potted for observance of overwinter survival. Of these, 90% produced a flush of growth during the summer, with 80% overwinter survival. In the second experiment conducted in 2001, semi-hardwood cuttings were taken and treated with 0, 2500 (0.25%), 5000 (0.5%), 7500 (0.75%), or 10,000 (1.0%) ppm K-IBA and placed in a raised greenhouse bench with intermittent mist for rooting as in the first experiment. Results were similar to the semi-hardwood cuttings treated in the first experiment with the free acid of IBA, indicating semi-hardwood cuttings do not root and that the auxin and/or isopropyl alcohol were not toxic to the cuttings.

Index words: auxin, indolebutyric acid, adventitious rooting, Fagaceae.

Significance to the Nursery Industry

Castanopsis sclerophylla is a medium sized, rounded, evergreen tree, with considerable landscape potential for the southeastern United States. Although this plant can be readily propagated by seed, propagation by stem cuttings would allow cloning of desirable genotypes. Results of this study demonstrated that stem cuttings of *Castanopsis sclerophylla* can be rooted at percentages > 60% when taken at the softwood stage and treated with 7500 ppm K-IBA.

Introduction

Castanopsis sclerophylla is an evergreen tree in the Fagaceae and is indigenous to broadleaf-evergreen forests covering a wide area of central to eastern China. In its native habitat, the species grows to a height of 9 to 12 m (30 to 40 ft), and the nuts are gathered and eaten by humans (13). In addition, the ornamental characteristics of this plant may pique the interest of plant enthusiasts and the nursery industry alike. With 10 to 18 cm (3.9 to 7.1 in) long by 4 to 8 cm (1.6 to 3.1 in) wide, glossy evergreen leaves and white flowers covering the tree in spring, this is truly a desirable ornamental plant with potential to become a popular landscape species.

At maturity, *C. sclerophylla* becomes a rounded, medium height tree with dense evergreen foliage and attractive exfoliating gray bark. The species is adaptable to a wide range of environmental conditions, as demonstrated by the success of 50+ year-old trees growing in full sun and sandy loam soil at the University of Georgia Bamboo Farm, Savannah, GA, and a 15-year-old tree thriving in shade and heavy clay soil at the JC Raulston Arboretum, Raleigh, NC. Related evergreen oaks have also been used successfully as ornamentals for the southeast United States (7), and are gaining popularity in the nursery trade.

Although there are over 110 species of *Castanopsis* (D. Don) Spach growing in China, south and east Asia, and one in North America, only a few species are in cultivation with *C. sclerophylla* not even listed among those few (4, 9). *Castanopsis sclerophylla* is very rare in the nursery industry, and no information has been reported on its propagation. However, Bob McCartney of Woodlanders Nursery, Aiken, SC, has propagated it from seed (personal communication), as is the case for propagating most oak (*Quercus* L.) species (5), which are closely related to *C. sclerophylla.* Related evergreen members of the Fagaceae, ubame oak (*Quercus phillyreoides* A. Gray) (11) and Chinese evergreen oak (*Q. myrsinifolia* Bl.) (10), have been propagated in high percentages utilizing softwood cuttings treated with indolebutyric acid (IBA). Thus, it may be possible to propagate *C. sclerophylla* by stem cuttings, which would allow cloning of select genotypes. Sexual propagation often results in progeny with unpredictable phenotypes as a result of heterozygosity, whereas propagation by cuttings would ensure the grower clones of desirable genotypes. Therefore, the following research was conducted to develop a protocol for propagating *C. sclerophylla* by stem cuttings.

Materials and Methods

Experiment 1. Determination of an optimum growth stage and auxin concentration for rooting. Terminal stem cuttings were taken at the hardwood (February 24, 2000), softwood

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(May 25, 2000), or semi-hardwood (September 28, 2000) stages from a 15-year-old tree in the adult growth phase growing at the JC Raulston Arboretum, Raleigh. For the softwood stage, cuttings were taken when the new leaves were fully expanded and the stems were just firm enough to snap when bent.

Following collection of cuttings, they were placed in plastic bags and kept on ice while being transported to the Horticultural Science Greenhouses, Raleigh. The cuttings were then trimmed from the bases to a 13 cm (5.1 in) length, and all leaves were removed from the lower third of each cutting. The basal 1 cm (0.4 in) of each cutting was treated for 1 sec with 0, 2500 (0.25%), 5000 (0.5%), 7500 (0.75%), or 10,000 (1.0%) ppm IBA. Semi-hardwood and hardwood cuttings were treated with the free acid of IBA dissolved in 50% isopropyl alcohol whereas the softwood cuttings were treated with the potassium (K) salt of IBA (K-IBA) dissolved in distilled water. After auxin treatment, the cuttings were air dried for 20 min before insertion into a raised greenhouse bench containing a steam pasteurized medium of peat:perlite (1:1, by vol). Greenhouse air temperatures ranged from 18C (65F) to 29C (85F) and natural photoperiod and irradiance were provided. Bottom heat was utilized to maintain the temperature of the rooting medium at a minimum of 21C (70F). Intermittent mist operated 5 sec every 5 min from sunrise to dusk, and chlorothalonil (Daconil, Syngenta, Inc., Greensboro, NC), a preventative fungicide treatment, was applied weekly as a spray to runoff, at a concentration of 4 ml/liter (1.0 tsp/gal).

For each growth stage, the experimental design in the mist bed was a randomized complete block with eight cuttings per treatment, replicated six times. After 10 weeks, the cuttings were harvested and various data recorded to include percentage rooting, and number and length of primary roots ≥ 1 mm (0.04 in). A cutting having one root ≥ 1 mm (0.04 in) was considered rooted. Data for each growth stage were subjected to analysis of variance and regression analysis.

Experiment 2. Test effectiveness of K-IBA on rooting semi-hardwood cuttings. In September 2001, semi-hardwood cuttings were collected from the same tree as in Experiment 1. Following collection, the cuttings were prepared for rooting identical to those in the first experiment and treated with 0, 2500 (0.25%), 5000 (0.5%), 7500 (0.75%), or 10,000 (1.0%) ppm K-IBA. After auxin treatment, the cuttings were handled in a manner similar to those in Experiment 1, which included the same experimental design.

Results and Discussion

In the first experiment, hardwood and semi-hardwood cuttings began to drop their leaves after 2 weeks, and the majority of the cuttings died by the end of 10 weeks. Total rooting across all treatments was negligible at both the hardwood and semi-hardwood stages, with 3% and 1% rooting, respectively. Therefore, only data from the softwood stage are presented.

Softwood cuttings rooted at much higher percentages with auxin treatment being essential (Table 1). Without K-IBA treatment, rooting was negligible. Auxin treatment stimulated rooting and the response was quadratic with the greatest rooting (63%) for cuttings treated with 7500 ppm K-IBA. Root number was not affected significantly by auxin treatment ($P = 0.07$) although root number increased from 2.0 for cuttings treated with 2500 ppm K-IBA to 4.1 for cuttings treated with 10,000 ppm K-IBA (Table 1). Similarly, average root length was not influenced by auxin treatment and ranged from 4.6 to 8.0 cm (1.8 to 3.1 in).

Table 1. Effects of K-IBA treatments on rooting of softwood cuttings of *Castanopsis sclerophylla*.

Treatment (ppm K-IBA)	Rooting[z] (%)	Mean root no.[y]	Mean root length[y] (mm)
Nontreated[x]	2.5	2.0	3.5
2500	15.0	2.0	80.4
5000	37.5	2.1	46.2
7500	62.5	3.5	60.7
10,000	47.5	4.1	63.8
Linear	NS	NS	NS
Quadratic	*	NS	NS

[z]Each value is based on 48 cuttings.

[y]Each value is based on the number of cuttings which rooted for a particular treatment.

[x]Nontreated cuttings were not included in the statistical analysis.

NS, * Nonsignificant or significant at $P < 0.05$, respectively.

The possibility of the isopropyl alcohol being injurious to the cuttings is the reason why the softwood cuttings in Experiment 1 were treated with K-IBA. Also, the question could be raised that the isopropyl alcohol used to dissolve the free acid of IBA, or the IBA itself, was toxic to the semi-hardwood and hardwood cuttings, resulting in high mortality and negligible rooting. However, the nontreated semi-hardwood and hardwood cuttings also died during the course of Experiment 1, suggesting this was not the case. To investigate this further, Experiment 2 was conducted which utilized semi-hardwood cuttings treated with K-IBA. These cuttings responded in a similar manner to semi-hardwood and hardwood cuttings in Experiment 1 that were treated with the free acid of IBA dissolved in isopropyl alcohol, with leaf drop and the onset of necrosis of the basal portions by the second week, and death of most cuttings by 5 weeks. This indicated semi-hardwood cuttings do not root and that the auxin and/or isopropyl alcohol were not toxic to the cuttings.

Results clearly indicate that rooting stem cuttings of *C. sclerophylla* can only be achieved with softwood cuttings and that auxin treatment is imperative. These results agree with previous reports by McGuigan et al. (10, 11) in which evergreen oaks were propagated in high percentages using softwood cuttings. Although in the present investigation, the best rooting (63%) was achieved with 7500 ppm K-IBA, the authors feel rooting can be increased further by manipulating various environmental conditions [e.g., water relations (mist)] during rooting. Roots of the rooted cuttings were observed to be brittle and easily broken by routine handling. Based on this, the authors recommend rooting *C. sclerophylla* cuttings in small individual containers or in flats with individual cells to avoid damage to roots during transplanting which can result in transplant shock.

Following rooting of the softwood cuttings in Experiment 1, 70 rooted cuttings were transplanted into individual 3.8-liter (1 gal) containers using a medium of pine bark:sand (8:1, by vol). Each container was top-dressed with an 8–9 month controlled-release fertilizer having an analysis of 18N–$6P_2O_5$–$12K_2O$ plus micronutrients (Wilbro, Inc., Norway, SC) at the rate of 9.0 g (0.32 oz) per container, and placed in a

lathe house at the Horticulture Field Laboratory, Raleigh, where they received daily overhead irrigation. Ninety precent of the plants produced a flush of new growth during the summer with 80% overwinter survival. Whether or not a growth flush following rooting is essential for overwinter survival of rooted stem cuttings of *C. sclerophylla* is unknown, although other studies of various woody species have reported increased over-winter survival of rooted cuttings which initiated a flush of growth following rooting (1, 10, 14, 15).

Results of this study were based on stem cuttings taken from a single tree (clone) of *C sclerophylla.* However, the possibility exists that tree-to-tree variation in rooting may exist for this species in which case rooting would vary depending on the particular clone from which cuttings were taken. This would not be surprising since clonal differences in rooting have been reported for many woody species (2, 3, 6, 8, 11, 12), and based on these reports, there is a high probability that the same phenomenon exists for *C. sclerophylla.*

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