Propagation of *Quercus* L. Species by Cuttings[1]

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Abstract

Ten species of oak, *Quercus* L., were used to determine the feasibility of rooting oak cuttings. Cuttings were taken from the first, second, and third growth flushes from seedling stock plants (2 to 3-year-old) and treated with 1.0% potassium 1H-indole-3-butanoic acid (K-IBA), 5-sec. dip and placed under mist. Rooting ranged from 0% to 80% with *Q. phellos* L., *Q. robur* L., and *Q. lyrata* Walter rooting 80%, 69%, and 43%, respectively, on the first date. Generally, rooting decreased with progressive flushes. *Quercus alba* L. and *Q. suber* L. rooted 2% or less over all dates. No consistent pattern of rooting was observed for white oak compared to red oak groups. Rooting was strongly species specific.

Index words: oak, vegetative, rooting, propagation

Species used in this study: White Oak (*Quercus alba* L.); Scarlet Oak (*Q. coccinea* Muenchh.); Overcup Oak (*Q. lyrata* Walter); Pin Oak (*Q. palustris* Muenchh.); Willow Oak (*Q. phellos* L.); English Oak (*Q. robur* L.); Red Oak (*Q. rubra* L.); Shumard Oak (*Q. shumardii* Buckley); Cork Oak (*Q. suber* L.); and Live Oak (*Q. virginiana* Miller).

Introduction

At present, most oaks produced for landscape use are grown from seed with resultant variable traits (4, 11). A commercially efficient method of rooting *Quercus* would eventually lead to the introduction of superior clones. Vegetative propagation through grafting (3, 10, 13), tissue culture (2, 12, 20), and cuttings (5, 6, 8, 9, 16, 17, 18) has produced limited success. Juvenility, timing, etiolation (1), and growth regulator were the principal factors affecting successful rooting. Cutting propagation for broad spectrum production of woody plants is the most efficient and economical (7). If a reproducible rooting process could be developed, it might result in the introduction of new selections.

Quercus virginiana L., live oak, cuttings have been rooted using a 1.0% K-IBA quick dip. Cuttings were taken between May and August and again in October and placed under mist for twelve weeks (no percentages provided) (16). Morgan (16) reported that juvenility was a key factor in rooting live oaks. Cuttings from trees over five-years-old rooted at reduced rates (17). However, juvenility could be reintroduced into the stock plants by hedging. Cuttings collected from previously rooted cuttings rooted 92% (17). Morgan noted significant variation in rooting among different clones of *Q. virginiana* with results varying from 0.0% to 71% (18).

No systematic studies have been published in which a broad range of *Quercus* species have been evaluated under uniform rooting conditions. This study determined the rootability of 10 deciduous and evergreen oak species that represent both the red and white groups.

Materials and Methods

Two-year-old seedlings of *Q. coccinea* Muenchh., scarlet oak; *Q. shumardii* Buckley, shumard oak; and three-year-old seedlings of *Q. alba* L., white oak; *Q. lyrata* Walter, overcup oak; *Q. palustris* Muenchh., pin oak; *Q. phellos* L., willow oak; *Q. robur* L., English oak; *Q. rubra* L., red oak; *Q. suber* L., cork oak; and *Q. virginiana* Miller, live oak, were used as stock plants.

Dormant seedlings of the above species were transplanted into a pine bark medium in 11.3 l (3 gal) black plastic containers. Five seedlings of each species were placed in each container. Ten containers were used per species for a total stock block of 50 plants. Plants were fertilized on April 8, 1987 with a combination slow release Osmocote 18N-2.6P-9.9K (18-6-12) fertilizer applied as a top dressing at a rate of 30 grams per container (half the recommended rate), and with a water soluble fertilizer (20N-8.7P-16.6K) (1gm/l) applied to saturation and runoff once per week from April 8, 1987 to August 22, 1987.

Plants were grown under 55% shade cloth and were sprayed with Triforine EC (N,N'-[1,4-piperazinedyylbis (2,2,2-trichloroethylidene)] bis[formamide]) at a rate of 1.3 ml/l every two weeks to control powdery mildew.

Terminal cuttings were collected on each date (May 15, June 18, and August 22, 1987) from firm growth with the leaves fully expanded. Ten to 15 cm (4–6 in) long cuttings were collected, one-half of all leaves removed from the lower one-half of cuttings, and the basal 2.5 cm (1 in) of the stems provided a 5-sec dip in 1.0% K-IBA. Cuttings were air dried before placement in the medium.

Each cutting was placed in a 9 × 9 × 12.5 cm (3.5 × 3.5 × 5 in) plastic rooting container containing a perlite and Canadian sphagnum peat moss (2:1 by vol) medium. Containers were placed under intermittent mist (5 sec/6 minutes) from 0800–1800 hours. The bench was shrouded on the sides with clear polyethylene film and the top covered with 55% Saran shade cloth. Greenhouse temperatures ranged from 18–24°C (65–70°F) at night and 30–35°C (85–95°F) during the day.

Cuttings were arranged in a randomized complete block design with 10 blocks and 10 cuttings of each species per block. The cuttings were drenched every 2 weeks with benomyl [Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate] at a rate of 3.9 ml/l to prevent disease problems. Dead leaves were regularly removed to prevent disease.

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The above procedure was repeated for the second group with the following exceptions. It was not possible to obtain 100 cuttings of every species, therefore, *Q. coccinea* and *Q. robur* had only 8 cuttings per block and *Q. palustris* and *Q. shumardii* nine.

The third group of cuttings was more restricted with only 5 cuttings of each species used per block.

After observing results from the first date, 40 cuttings were collected on June 20, 1987 from a 15-year-old tree of *Q. phellos* on the University of Georgia campus and treated as described above.

At the end of each 10 week rooting period, the mist was turned off, the plastic lifted, and cuttings were not watered for one week. The unrooted cuttings withered and those that rooted could be easily determined. For overwinter studies, it was necessary to leave the cuttings undisturbed.

Statistics showed that there were no significant differences among the ten blocks in each group, but there were significant differences among species. Statistical analysis consisted of ANOVA and Duncan's New Multiple Range Test (SAS Institute, Cary, NC). An arcsin transformation was conducted on the data.

Results and Discussion

Cutting propagation of selected species is feasible (Table 1). *Quercus phellos* and *Q. robur* rooted in the highest percentages. Tug tests midway between the 10 week rooting period indicated that most cuttings rooted within 4 to 5 weeks. Often the rooted cuttings of willow oak and overcup oak would send out new shoots under mist. Cuttings were healthy throughout the 10 week period even when they had not rooted.

Only one cutting of *Q. alba* rooted over all sample dates. The cuttings were green and healthy throughout each rooting period. Only a few formed callus tissue.

Quercus coccinea rooted slightly better during the second date and worse during the third. Although 31% is low by commercial standards, there is promise for rooting cuttings from superior trees and re-introducing a measure of juvenility (17). Cuttings from the first rooted cuttings should root in higher percentages (17). Scarlet oak displays great diversity of habit, summer foliage and especially fall color. Clonal selections would prove economically valuable in the marketplace.

Table 1. Rooting percentages of 10 oak species sampled over three dates.

	Rooting percentage		
Species	**May 15**	**June 18**	**Aug. 20**
Quercus alba	1 e[z]	0 d	0 e
Quercus coccinea	24 d	31 c	10 de
Quercus lyrata	43 c	46 b	40 b
Quercus palustris	20 d	20 c	6 e
Quercus phellos	80 a	76 a	64 a
Quercus robur	67 b	62 a	30 bc
Quercus rubra	19 d	69 a	2 e
Quercus shumardii	17 d	15 c	22 dc
Quercus suber	2 e	2 d	2 e
Quercus virginiana	13 d	45 b	34 bc

[z]Mean separation within columns by Duncan's New Multiple Range test, $p \geq 0.05$.

Rooting percentages for *Q. lyrata* were consistent over all three dates and ranged between 40 to 46%. This species grew vigorously and often new flushes of growth emerged while under the mist. After 10 weeks, the cuttings were well rooted as evidenced by the roots emerging from the base of the containers.

Quercus palustris rooted at 20% for the first two dates, and 6% at the third date. This species is one of the most important shade and street trees in eastern North America. 'Sovereign' and 'Crownright,' without the weeping branches of the species, have been extremely difficult to propagate by grafting (7).

Cuttings of *Q. phellos* rooted rapidly and extensively as evidenced by the roots at the base of the containers and the roots emerging from the stem portion above the medium. On the last sample date, cuttings rooted in high percentages. Cuttings from the 15 year-old tree rooted 40%, indicating that the rooting potential in juvenile seedling material was present in more mature trees.

Rooting of *Q. robur* was evident 4 to 5 weeks after sticking. Many important cultivars are known (15) including weeping, cut-leaf, and upright forms. The most important is *Q. robur* 'Fastigiata'. Currently, most cultivars are propagated by grafting with *Q. robur* 'Fastigiata' produced from seed. The results show that cutting propagation may be feasible. This would permit the introduction of a mildew resistant clone and, in fact, 'Attention' is the first named columnar mildew resistant clone introduced by Discov-Tree Research and Development, Ltd., Oquawka, IL 61469. Results from *Q. robur* were higher than those obtained by Flemmer (9) on *Q. robur* 'Fastigiata' (50%); however, this may have resulted from clonal variations or age of the stock plants.

Red oak, *Q. rubra*, rooted 19% on the first date, but increased to 69% on the second date and decreased to 2% the third date. This was the only species that showed a variable rooting profile.

Shumard oak, *Q. shumardii*, rooted between 15% and 20% over the three dates. This species is closely related to *Q. coccinea* and *Q. palustris*. A recent report (5) noted that this species was rooted, but provided no percentages. *Q. shumardii* is widely distributed throughout the southeast from Florida to Texas. The species displays excellent tolerance to extremes of climate and soil. Unfortunately, the growth habit and fall color are tremendously variable from seed. This species offers unique opportunities for selection and subsequent vegetative propagation.

Quercus suber, an evergreen species, rooted 2% on each date. However, previous work with the evergreen species *Q. ilex* and *Q. virginiana* reported good rooting (6, 16, 17, 18).

The *Q. virginiana* cuttings rooted 13% on the first date which could have been related to powdery mildew infection on the May 15 cuttings. Rooting improved on the second and third dates, but results were not as high as reported by Morgan (71% on certain clones) (16, 17, 18).

Rooting percentages for *Q. coccinea* and *Q. palustris* were slightly lower, while those for *Q. robur* and *Q. rubra* were equal to or higher than those reported by Maynard and Bassuk even though they used banding and etiolation, a more labor intensive process (14).

Cost comparisons by Bassuk et al. (1) show that a budded liner can be produced for about $0.92, assuming a 15%

loss, and an etiolated cutting can be produced for $0.49 in the field and $0.55 in the greenhouse, assuming a 15% loss for both. The cost of producing a cutting in the South by traditional means is estimated at $0.08 to $0.15 depending on the efficiency of rooting (7).

This work provides a map for future propagation research and indicates that species specificity is important. A consistent rooting relationship among oaks does not appear to exist since English and white oaks, members of the white group, rooted in the highest and lowest percentages respectively. This relationship was true for the evergreen species as well. Live oak rooted well, while the cork oak rooted 2%.

Selection of clones with desirable traits among the easy and moderately easy to root species should be the next step. Selections within a species should be screened for clonal rootability. The eventual introduction will embody quality attributes and ease of rooting. Based on the rooting results with *Q. alba* and *Q. suber*, there is little opportunity for combining desirable aesthetic characteristics with ease of rooting. However, the other 8 species show promise.

There is another factor that must be considered when producing oaks from cuttings. Oak cuttings which do not flush before fall may not survive the winter (19). Extended photoperiod and fertilizer are the most important factors affecting additional shoot growth after rooting. Rooted cuttings of the above species will be subjected to photoperiod and fertilizer treatments. Resultant overwinter survival will be correlated with the treatments in order to determine the best procedure for successful handling of oak cuttings.

Significance to the Nursery Industry

The possibility of producing oaks through cuttings exists. Nurserymen should look for superior selections in nursery blocks where young trees with a measure of juvenility would be easier to propagate. Based on this study *Q. lyrata*, *Q. phellos* and *Q. robur* are the easiest to root. *Quercus coccinea*, *Q. palustris*, *Q. rubra*, *Q. shumardii* and *Q. virginiana* can be rooted, although in low percentages. Newly rooted stock can then be maintained in a juvenile condition by hedging. Nurserymen should strive to select several clones within a species that offer desirable characteristics and propagate the easiest to root clone. The possibility of introducing superior cutting produced oaks exists and the results of the study provide a guideline for nurserymen and researchers to follow.

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