Long-Term Growth of Live Oak Propagated from Rhizomic Shoot Cuttings or Seeds[1]

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Abstract

Rhizomic shoot cuttings of live oak (*Quercus virginiana* Mill.) were taken from a single tree about 50 years old in late August 1990, rooted, and planted into 2.6 liter (#1) plastic pots. Concurrently, acorns were collected from the same tree and germinated. Trees from both sources were planted into 13 liter (#5) plastic pots in July 1991 and then to the field in July 1992 either directly in the ground, in 37 or 46 cm (14 and 18 in) diameter polypropylene fabric bags buried in the ground, or in 13 liter pots (#5) placed on the surface. Trunk circumference 10 cm (4 in) above the soil line was measured yearly between 1993 and 1999. Initially, trees from rhizomic shoot cuttings grew slower than seedlings based on trunk circumference, diameter, and cross-sectional area. However, there were no statistical differences after 1996 in trunk circumference, diameter and cross-sectional area between the trees propagated from rhizomic shoot cuttings and seeds. Only in 1993, trees in 37 cm (14 in) bags and plastic pots had greater growth than trees in the ground. About one-third of the seedling trees produced rhizomic shoots in comparison to none of the trees from rhizomic shoot cuttings.

Index words: cuttings, nursery crops, propagation, seed.

Significance to the Nursery Industry

Live oak trees (*Quercus virginiana*) are in high demand in the Southeast United States. When propagated by acorns, seedling trees are extremely variable in their form and growth rate. Although not documented, we have observed that live oak trees do not exhibit their true tree form until they have been grown for five to seven years. By then, so much investment has incurred, it is difficult to discard undesirable trees. Although some nurseries claim that they have selected clones or cultivars of live oaks, in actuality, they have not because the species is open pollinated. Research demonstrates that live oaks can be propagated from rhizomic shoot cuttings with 100% success. In addition, seedling trees produce undesirable rhizomic shoots while trees propagated from rhizomic shoot cuttings do not. Although trees propagated by rhizomic shoot cuttings grew slightly slower than those propagated by seeds during the first 4 years, there were no significant differences after 4 years in tree size between the two sources in four production systems. Thus, this research provides commercial nurseries an alternative protocol for propagating clones of live oaks year around.

Introduction

Live oak is an important landscape and shade tree species native to the southeastern United States. This species is distributed naturally from Texas east to Florida and north to Virginia (10). Leave fall in early spring is followed immediately by new foliage, making it an evergreen. Currently, it is propagated principally by planting acorns collected in the fall. Because live oak is open pollinated by wind, seedling trees exhibit tremendous variability in leaf morphology, tree form, and growth rate. Rooting shoot cuttings taken from established trees of *Q. virginiana* has been largely unsuccessful (4, 7, 8, 11). Seedling trees of live oak are highly variable in growth rate and form. In addition, many seedling trees produce numerous undesirable rhizomic shoots once the underground rhizomes reach the soil surface. These undesirable rhizomes cause maintenance problems. However, these rhizomic shoots are in the juvenile growth phase, root readily, and could be used for producing clones with desirable traits (11). Although cuttings from rhizomic shoots can be rooted easily year round, there has been no documentation on their growth rate in comparison to that of seedlings. Also, it is not clear whether live oak trees propagated by rhizomic shoot cuttings would produce rhizomic shoots like seedling trees.

Nurserymen use many production systems for various species. Many woody species, requiring years to produce, are often grown directly in the ground. Some producers grow trees in containers for ease of transplanting. For those in the ground, trees are sometimes planted in polypropylene fabric bags buried in the ground. These bags allow for containment and trapping of roots, making it easier to dig and transplant (3, 9). The growth rate of trees in various planting systems must be evaluated. Therefore, the objectives of this study were to A) compare the growth rate of seedlings of live oak with that of trees propagated by rhizomic shoot cuttings in four production systems and B) determine if trees propagated from rhizomic shoot cuttings would produce rhizomic shoots.

Materials and Methods

Rhizomic shoot cuttings 25 to 30 cm (10 to 12 in) in length were collected in late August 1990 from a single live oak tree about 150 years old, dipped briefly in a solution of 50% ethanol and 5000 ppm (0.5%) indole-3-butyric acid (IBA). Cuttings were rooted in a medium of 1 to 1 (by vol) perlite and peat in a mist propagation bed in a greenhouse. Uniform rooted cuttings were selected and planted in 2.6 liter plastic pots (#1) filled with Sunshine Mix #1 (Fisons Horticulture, Seattle, WA) 2 months after cuttings were collected. Acorns were collected from the same tree during the same week when shoot cuttings were taken and were germinated in similar

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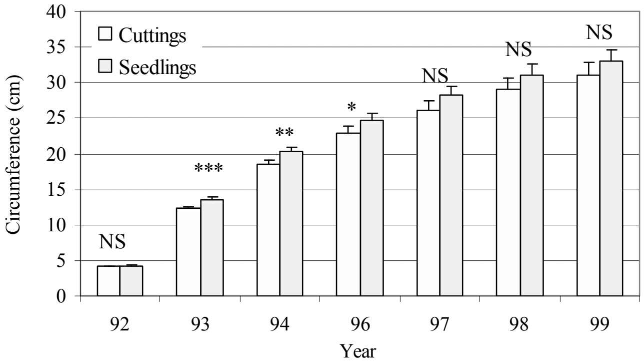

Fig. 1. **Circumference of live oak trees propagated by seeds or rhizomic shoot cuttings. Data were pooled from four production systems. Vertical bars indicate 95% confidence intervals. ^{NS}, *, **, and *** indicate nonsignificant, significantly different at 5%, 1% or 0.1% level, respectively.**

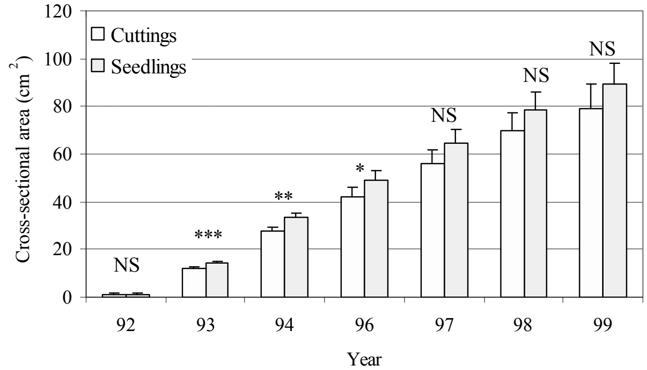

Fig. 2 **Trunk cross-sectional area of live oak trees propagated by seeds or rhizomic shoot cuttings. Data were pooled from four production systems. Vertical bars indicate 95% confidence intervals. ^{NS}, *, **, and *** indicate nonsignificant, significantly different at 5%, 1% or 0.1% level, respectively.**

pots filled with Sunshine Mix #1. Trees propagated by both seedlings and rhizomic shoot cuttings were planted into 13 liter plastic pots (#5) in July 1991 containing a substrate of 1 to 1 (by vol) peat and composted pine bark (Landscapers Pride, New Waverly, TX) and then transplanted to the field in July 1992 at 1.8 m (6 ft) spacing.

For trees from either source, four production systems were used: planting directly in the ground, in 13 liter (#5) plastic pots placed on the ground, or in 37 or 46 cm (14 or 18 in) diameter polypropylene fabric bags (Root Control, Inc., Oklahoma City, OK), which were filled with approximately 27 and 50 liters (7 and 13 gal) soil, and buried in the ground. The 13 liter (#5) pots were anchored using four iron rods with a hook on top. All pots and bags were filled with Willacy loamy field soil. Osmocote 14–14–14 (14N–6.4P–11.6P, Grace-Sierra) was applied at a rate of 30 g (1.06 oz) per tree in the spring and ammonium sulfate at the same rate was applied in mid-summer. Fertilizer rate was increased to 60 g (2.12 oz) in March 1994 and continued for the duration of the experiment. Drip irrigation was applied when necessary and was more frequent during the first 4 years. Trees were pruned 3 times per year during the first three years to promote one strong leader for each tree.

This experiment was a split-plot design with plant source being the main plot. There were eight replications with two sub samples in each treatment. Since measuring the height every year was not possible, trunk circumference 10 cm (4 in) above the soil line was measured immediately after planting in 1992 and then yearly at the beginning of the year from 1993 to 1999. The trunk cross-sectional area was calculated from circumference (cross-sectional area = circumference^2/4 pi). Statistical Analysis System's (SAS Institute, Cary, NC) PROC MEAN was used to calculate the means and 95% confidence intervals and PROC GLM (General Linear Model) was used to test the significance of the treatments. Duncan's multiple comparisons were used to test the significance of the four culture systems on tree growth. Data were analyzed separately by year.

Results and Discussion

For all years, there were no interactions for trunk circumference between plant source and production system. During the initial 4 years following field planting, trees from cuttings grew slightly slower than seedlings based on trunk circumference and cross-sectional area (Figs.1 and 2). There were significant differences in trunk circumference in 1993 and 1994 ($P < 0.01$) and 1996 ($P < 0.05$). Although trees from rhizomic shoot cuttings had smaller trunks throughout the entire duration of this study, differences were not statistically significant after 1996 (Fig. 1).

There were no significant differences in circumference, diameter and cross-sectional area among the culture systems except for 1992 and 1993. In 1993, trees in pots had significantly greater growth than those in the ground and the 46 cm (18 in) fabric containers (Fig. 3), possibly due to the higher fertilizer concentration in pots as a result of the smaller soil volume. After 1996, all trees had similar circumferences to the end of the study (Fig. 3), possibly because roots had extended beyond the bags and pots into the surrounding soil. Yearly increases in trunk cross-sectional area were similar among trees during the last 3 years, regardless of the source and production system (data not presented).

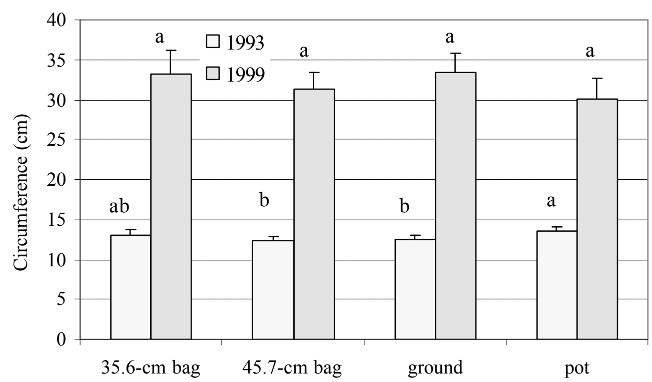

Fig. 3. **Circumference of live oak trees in1993 and 1999 pooled from two sources (seeds and rhizomic shoot cuttings) in four production systems. Vertical bars indicate 95% confidence intervals. For the same year, bars with the same letters are not significantly different tested by Duncan's multiple comparison at 5% level.**

Cloned trees from rhizomic shoot cuttings were uniform in tree form and none produced rhizomic shoots. In contrast, growth habit and form of many seedling trees were highly undesirable. About one-third of seedling trees produced rhizomic shoots. Rhizomic shoots of trees in pots and in-ground fabric bags were contained within the pot or bag, and none emerged from the ground nearby. Therefore, when planting seedling trees, placing a barrier around the base of the trunk may prevent the spread of rhizomes.

Seedling trees have nodes at the base of the stem that is often buried in the ground. When the buds on these nodes become active following planting, they develop into underground rhizomes. After the tips have emerged from the soil and are exposed to light, they produce shoots. Trees from rhizomic shoot cuttings did not have these nodes and did not produce rhizomic shoots by the time this experiment was terminated in 1999. When rooting cuttings, disbudding the lower nodes will further ensure the resulting trees do not produce rhizomic shoots.

In-ground fabric bags have been promoted for field production of woody ornamental plants for root control and ease of digging and transplanting (3, 9). However, the response of woody ornamentals to fabric bags is species dependant (3, 6). In a short-term, year-long study, Ingram et al. (6) found *Q. virginiana* grew taller when planted in in-ground fabric containers or directly in the ground than those in plastic pots. However, there were no differences in trunk diameters. Several other species tested did not benefit from in-ground fabric containers. Chong et al. (2) reported that root-control bags did not allow *Populus deltoides* Bartr. ex Marsh x *nigra* L. to gain any advantage in a 4.5-month study. However, Whitcomb (10) found that plants were 5% to 15% larger when grown in bags due to more fibrous root systems compared to plants in rigid containers. In addition, trees grown in in-ground fabric bags appear to be subject to more severe water stress during periods of low rainfall without irrigation (6).

Even for species which respond favorably to in-ground fabric containers, this favorable response may be limited to the period before a significant amount of roots grow beyond the bags. In our 9-year study, initial growth of *Q. virginiana* was greater for those in the 37 cm (14 in) bags and above-ground containers (Fig. 3). This may have been the result of higher nutrient concentrations in the smaller volume of soil in these two production systems (1). Over the years, roots extended to the surrounding soil regardless of the production system, which may have resulted in similar tree growth after 1996.

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