CONTAINERIZATION OF WHITE AND RED OAK SEEDLINGS[1]/

by

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Abstract. --Plantable containerized oak seedlings were produced over winter in a greenhouse from current year acorns of white, chestnut, northern red and scarlet oak. Earlier seeding dates giving a longer growth period in the greenhouse produced seedlings with sturdier root plugs and enhanced handling characteristics. Container size did not affect size or plantability of seedlings. Survival after the first growing season of seedlings outplanted 1 June 1986 averaged 88% and ranged from 100% for white oak seeded 15 November 1985 to 77.8% for northern red and shumard oak seeded 15 March 1986.

Keywords: oaks, containerized seedlings, greenhouse culture, seed germination

INTRODUCTION

Three-fourths of the forested area in Tennessee is the upland hardwood (oak-hickory) type in which various oaks are the dominant species. Although numerous other species occur in this type, the oaks are the most valuable for timber and wildlife. The frequent failure of oaks to regenerate following timber harvest operations (Janzen and Hodges 1984; McGee and Bivens 1984) has resulted in composition shifts toward less desirable species.

Attempts to establish oaks by planting have usually failed (Wright et al 1984). Benefits from forest genetics research on oaks are dependent upon the ability to successfully establish oak plantings. These regeneration problems are a matter of serious concern to foresters responsible for managing upland hardwood forests.

Containerized planting stock offers a number of advantages over bareroot seedlings. Container-grown seedlings are planted with their root systems dispersed throughout a rooting medium. This provides better soil contact for a much larger root mass than is the case for bareroot stock and results in better water absorption, which largely accounts for superior survival and initial growth (Dixon et al 1981; Dixon et al 1983; Tinus, 1974). This also permits a much longer planting season as, in contrast to experience with barerooted seedlings, mortality in late plantings is generally acceptable. Containerized loblolly, longleaf, and white pine seedlings have been successfully planted throughout the summer (Goodwin 1974). Two crops per year of containerized bur oak seedlings have been produced in North Dakota using greenhouse culture (Tinus and McDonald, 1979).

The objective of this study was to produce, from acorns collected the previous fall, plantable oak seedlings for outplanting the following spring using containerized stock and greenhouse cultural practices.

METHODS

Four species of oak, two sizes of Spencer Lemaire "rootrainers," and three stratification period (seeding date) combinations were tested in this experiment.

Two white oaks, white oak (Quercus alba L.) and chestnut oak (Q. prinus L.), and two red oaks, northern red oak (Q. rubra L.) and Shumard oak (Q. shumandii Buckl.) were collected by personnel from the Tennessee Division of Forestry from Green County, Tennessee in September 1985. Malformed and weevil-damaged acorns were

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separated by floatation (Olson 1974) and discarded. Sound acorns were placed in plastic bags and stored in cool moist stratification at 33-36 F.

Hillson (10 cubic inches) and Tinus (20 cubic inches) "rootrainers" were used to evaluate the effects of container volume on seedling size and root development. Equal volumes of peat moss and horticultural vermiculite were mixed in a commercial soil blender and moistened with a wetting agent to facilitate filling the container cavities evenly. All rootrainers were arranged to provide equal above ground growing space for each seedling.

All acorns were held in cool, moist stratification until the designated seeding date 15 November 1985, 15 January 1986, and 15 March 1986, respectively. These seeding dates provided stratification periods of 35, 95, and 155 days and greenhouse growing periods of 195, 135, and 35 days before they were outplanted on June 1-2, 1986.

White oak acorns germinate in the fall soon after maturation (Olson 1974). Elongating radicals were evident when the acorns were collected and continued even at the cool temperatures maintained during stratification/storage. Germinated acorns of white and chestnut oaks were transplanted directly into the rootrainer cavities on each seeding date, many with radicals 1.0 to 1.5 in. long.

Embryo dormancy is characteristic of members of the red oak group. The recommended cool, moist stratification period for the red oak group is 30 to 90 days (Bonner 1971; Olson 1974). On the seeding dates listed previously, northern red and Shumard oak acorns were removed from stratification, divided into four replications of 40 acorns each, placed on moist peat moss in germination trays, covered with moist paper towels, and placed in the greenhouse. Germination counts were made periodically, and, as acorns germinated, they were transplanted into rootrainers. This insured complete stocking of container cavities.

Four replications of a split-block design were used for each seeding date. The seedlings were grown in the greenhouse under supplemental light to provide an 18-hour-day length. The growing media was kept moist, using a 50-ppm solution of 20-20-20 water-soluble fertilizer at alternate waterings throughout the growing period. The total height (from surface of rooting medium in rootrainers) of seedlings was measured on 28-29 April 1986.

Seedlings were outplanted on 2-3 June 1986 at the Oak Ridge Forestry Field Station, Oak Ridge, Tennessee. Survival and total height was measured in November, 1986. Statistical analysis was accomplished using the Proc GLM Procedure of the Statistical Analysis System (Goodnight, 1979).

RESULTS

Germination

Stratification was required to overcome embryo dormacy before the red oaks would germinate (table 1). After 35 days of stratification (seeded on 15 November 1985) northern red oak and Shumard oak acorns were slow to germinate and the percent that germinated was low. After 90 days in germination trays 20% of the northern red and 7% of the Shumard oak acorns had rotted. Total germination was only 26 and 32 %, respectively.

Table 1. Cumulative percent germination of northern red oak and Shumard oaks after seeding in germination trays.

Seeding date / Stratification period	Species	Days after seeding: 0	7	15	30	40	60	90
		Percent germination						
15 Nov. 1985 (35 days)	NRO	0	4	8	12	14	16	26
	Shumard	0	0	6	18	20	21	32
15 Jan. 1986 (95 days)	NRO	0	51	83	83	83		
	Shumard	0	10	47	80	86		
15 Mar. 1986 (155 days)	NRO	78	86	87				
	Shumard	60	85	86				

The germination rate and total germination of red oak acorns seeded on 15 January 1986 were higher than for those seeded on 15 November. The slower germination rate for the Shumard oak seeded on this date (table 1) verifies the longer stratification period this species requires to overcome dormacy (Olson 1974).

By the 15 March seeding date 60% of the Shumard and 78% of the northern red oak acorns had started to germinate while in stratification (table 1). However, the stratification temperature was cool enough to prevent development of the epicotyl (Olson 1974). Within 7 days after seeding essentially all of the viable acorns had germinated and were transplanted into rootrainers.

Seedling Development

There were significant (.05 level) differences in seedling height growth among species within each seeding date (growing period) (table 2). Northern red oak seedlings were the tallest and white oak the shortest. Container size had no measurable effect on the height growth of seedlings. Mean heights were 0.38 foot for both container sizes.

Table 2. Mean height of oak seedlings as influenced by seeding date, (growing period), container size and species.

Seeding Date Growing Period	Container Size	Species NRO	Shumard	White	Chestnut	$\bar{X}$ Ht.
		Seedling height (feet)				
15 Nov. 1985 (165 days)	Tinus	.54	.41	.27	.40	.39
	Hillison	na[1]	na	.30	.42	
5 Jan. 1986 (105 days)	Tinus	.44	.33	.28	.39	.37
	Hillison	.54	.34	.31	.40	
5 Mar. 1986 (45 days)	Tinus	.40	.42	.34	.41	.38
	Hillison	.40	.35	.33	.41	
$\bar{X}$ Species		.43(a)[2]	.37(b)	.31(d)	.41(b)	.38

[1] na=not available
[2] means followed by same letter are not significantly different at P=.05.

A longer growing period provided by the early seeding date did appear to stimulate greater height growth in northern red oak (fig. 1). Northern red oak acorns seeded on 15 November 1985 and 15 January 1986 generally initiated a second growth flush that produced progressively taller seedlings with longer growth periods.

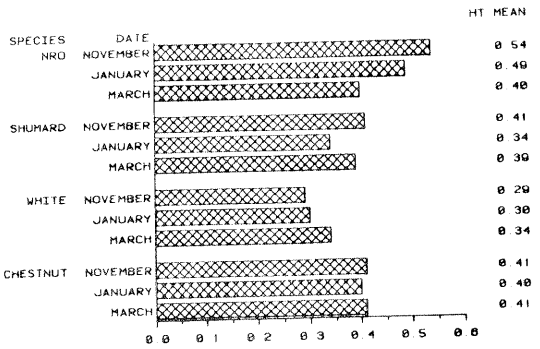

Figure 1. Mean seedling height at the time of outplanting by species and seeding date.

This was not true for the other oaks (fig. 1). Only occasionally did Shumard oak seedlings produce a second growth flush. White oak even showed decreasing height with a longer growing period. There is no apparent reason why these oaks failed to continue growing in the greenhouse. It may be related to the photoperiod and/or the fertilizer schedule used.

Outplanting

Seedlings were graded prior to outplanting by how well their roots held the growing medium when they were removed from the rootrainer. Seedlings produced from the 15 November 1985 and 15 January 1986 seeding dates had satisfactory root plugs that withstood normal planting procedures. The 15 November seedlings had the best root development which had formed sturdy plugs. The 15 January seedlings also handled well during planting. However, seedlings from the 15 March 1986 seeding lacked sufficent root development to hold root plugs together.

Outplanting was accomplished as a record drought for this region was continuing to develop. The promise of rain prompted outplanting on 1 June 1986 although a 16-inch deficit had accumulated over the previous year. However, drought conditions continued through June and July culminating in an all-time record for the region.

Despite these poor growing conditions the average survival was 88%. Survival did decrease with a decreasing growth period in the greenhouse: 94%, 89% and 81% for the 15 November 1985, 15 January 1986, and 15 March 1986 seeding dates, respectively (table 3). Gaining the survival advantage afforded by longer growing periods in the greenhouse can be achieved for the red oaks only as ways are found to break the seed dormacy that tends to force later seeding.

Table 3. Percent survival after the first growing session in the field of containerized oak seedlings according to seeding dates.

Species	Seeding Dates 15 Nov 85	15 Jan 86	15 March 86
	Percent survival		
Chestnut oak	94.4	91.7	83.3
White oak	100.0	86.1	83.3
Northern red oak	88.9	93.1	77.8
Shumard oak	94.4	86.1	77.8
Seeding date mean	94.4	89.3	80.6

This study indicates that acceptable white and red oak seedlings can be produced, over winter, in greenhouses for outplanting in the spring. Three months of greenhouse culture will produce a "plantable" seedling having a root plug that is sufficiently firm for outplanting. Additional time in the greenhouse will improve the handling quality and survival of the seedlings produced.

The stratification time required to break embryo dormancy in red oaks will limit how early they can be seeded thus restricting the period available for greenhouse culture. Because the white oaks do not require stratification they can be seeded immediately following acorn collection in the fall to provide a longer growing period. They can also be satisfactorly stored for short periods, even over winter (Jones 1962).

Container size did not affect the size or the plantability of the seedlings produced in this study. Seedlings produced in the Hillison rootrainers can be planted with a standard wedge planting bar while those produced in the larger Tinus rootrainers require the use of the KCB hardwood planting bar to achieve satisafactory planting. Until improvments in cultural technique enable production of larger seedlings, the smaller containers are adequate for growing oak seedlings over winter for early spring outplanting.

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