Survival and growth of bar-slit planted northern red oak studied in Tennessee

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Root pruning and top clipping evaluated

On forested sites of the Cumberland Plateau, bar-slit planting of northern red oak (Quercus rubra *L.) proved as successful as the slower, center-hole method. Seedlings whose tops and roots were clipped for ease in handling grew as well as ordinary nursery stock.*

Northern red oak, one of the more desirable Appalachian hardwoods, is seldom abundant in central Tennessee. Natural regeneration is difficult to obtain, even where the seed source is ample. Planting is apparently the only certain way to reproduce this species promptly after harvest cutting or to upgrade depleted stands. Dependable planting techniques will also be needed to replace existing forests with genetically superior stock.

The two studies reported in this note were made near Sewanee, Tenn. to determine if northern red oak could be planted successfully after clearcutting. One was established in 1962 on an average site; the other in 1963 on an excellent cove site. The" studies also investigated the effects of planting method, field root pruning, and top clipping on survival and early growth of 1-0 seedlings.

Methods

Both studies compared the mattock, center-hole method against conventional bar-slit planting. For all treatments, seedlings were set vertically and slightly deeper than they had grown in the nursery. Soil was firmed carefully around roots when mattock holes were refilled. In practice, root pruning would allow planting in smaller holes, but all mattock holes were dug to approximately the same depth to avoid confounding root-pruning effects with effect of planting hole size.

Tops were clipped and roots pruned at the time of planting. Roots were pruned to 5 or 8 inches in length; the check treatment consisted of nursery-run stock with tap roots averaging 11 inches. Leaders of top-clipped seedlings were cut back to 5 inches above ground line; unclipped seedlings provided a check.

Stock was grown in the Tennessee Valley Authority nursery, Clinton, Tenn., from acorns collected near Sewanee. Seedlings planted in 1962 averaged 0.25 inch in diameter at the rootcollar and 0.81 foot in height; in 1963 they averaged 0.24 inch and 0.84 foot. Treatment mean heights, before tops were clipped, deviated less than 0.1 foot from the overall means in either study.

The first study was carried out on top of the Cumberland Plateau at an elevation of 1,850 feet. Plots were on a gentle north slope in a shallow, U-shaped hollow. Soil is a deep, well-drained Hartsells loam. Before it was clearcut in February 1962, the stand had about 50 square feet of basal area per acre in mixed oak and hickory sawtimber. In addition to reproduction of overstory species, the moderately dense understory contained dogwood, sugar maple, red maple, sourwood, blackgum, black locust, and a variety of tolerant shrubs.

The second study was carried out on the plateau escarpment at about 1,600 feet elevation. Slopes average 40 percent, with a north to northeast aspect. Because they support high-grade stands of mixed-mesophytic hardwoods,
such topographic positions are referred to locally as coves, even though they may be far above the valley floor. Soils are of the Allen and Jefferson series developed in deep, bouldery colluvium derived from the sandstone and shale caprocks of the plateau top. The clearcutting in 1962 had removed all merchantable timber, but about 30 square feet of basal area per acre remained in cull trees of sawtimber size plus some scattered oak, hickory, sugar maple, and yellow-poplar poles. Advance reproduction, mainly sugar maple and white ash along with maple leaf and hobblebush viburnums, formed a dense understory.

Site index for northern red oak is estimated to be 65 to 75 feet at 50 years on the plateau and 80 to 90 feet on the cove site.

1' **Stationed** at Sewanee, Tenn.

Seedlings were planted on the plateau top in early April 1962 at a spacing of 4 by 5 feet and on the escarpment the following April at a spacing of 5 by 6 feet. Plots, which consisted of a row of 20 seedlings, were replicated four times in the first study and three times in the second, in randomized complete blocks. Within each site, differences in survival or growth were evaluated by analysis of variance with planned orthogonal comparisons.

Unwanted hardwoods larger than 0.5 inch d.b.h. were deadened before planting. In the cove, however, some trees from 2 to 4 inches d.b.h. were retained for 1 year to suppress herbaceous growth. These were cut early in the second growing season after planting and the stumps treated to minimize sprouting. For 2 years on the plateau top, and for 4 years in the cove, weedings were made to remove hardwoods or large shrubs that threatened to overtop the planted oaks.

Results

Survival averaged 98 percent on both sites after one growing season. Mortality increased in succeeding years, but did not reduce stocking below acceptable levels on either site (table 1). Survival ranged from 78 to 93 percent after five growing seasons on the plateau top and from 63 to 78 percent after six seasons in the cove. Differences among treatments were not significant (0.01 level) in either study.

Small mammals, primarily voles *(Microtus* spp.), were responsible for much early mortality on both sites, but their depredations declined sharply in later years. A definite cause of death could not always be determined, particularly for seedlings that died after the third year. Most of these were below average size and vigor and presumably succumbed to competition.

Almost 90 percent of the seedlings on the plateau top were clipped by rabbits during the winter of 1962-63. Although causing little mortality, this damage obscured the effects of planting treatments on subsequent growth. Browsing by animals was not a problem in the cove.

First-year growth on the cove site averaged 0.26 foot for seedlings planted in mattock holes, significantly better than the 0.21 foot for slit-planted seedlings. Careful center-hole planting failed to increase growth in later years on this site, or during any year on the plateau top.

Seedlings root-pruned to 8 inches, or left unpruned, grew equally well during the first year on the plateau top, averaging 0.33 foot. Pruning to 5 inches limited growth to 0.26 foot-the only significant effect of root-pruning in either study.

First-year growth on the plateau top averaged 0.35 foot for top-clipped and 0.26 foot for unclipped seedlings. In the cove, comparable growth was 0.28 and 0.19 foot. Top-clipping increased average second-year growth in the cove to 0.39 foot in contrast to 0.24 foot for normal seedlings.

These small differences in early growth, although statistically significant, had no effect on ultimate performance. Fifth-year total heights in the 1962 study ranged from 4.0 to 4.9 feet, averaging 4.4 (table 2). The heavy rabbit damage precluded analysis, but

TABLE 1.—*Survival of planted northern red oak on plateau top and on cove sites*

Site and planting method	Growing seasons since planting 1	2	3	4	5	6
	Percent					
Plateau						
Slit	98	96	92	90	89	–
Hole	98	94	88	86	84	–
Mean	98	95	90	88	86	–
Cove						
Slit	98	93	85	78	74	74
Hole	98	90	81	76	73	71
Mean	98	92	83	77	74	72

TABLE 2.—Total heights of top-clipped and normal northern oak seedlings on plateau and cove sites

Site and clipping treatment	Growing seasons since planting 1	2	3	4	5	6
	Feet					
Plateau						
Top-clipped	0.8	1.3	2.2	3.2	4 4	–
Normal	1.1	1.4	2.2	3.1	4.4	–
Mean	1.0	1.4	2.2	3.2	4.4	–
Cove						
Top-clipped	0.7	1.1	1.6	2.1	2.8	4.0
Normal	1.0	1.3	1.8	2.3	3.1	4.3
Mean	.8	1.2	1.7	2.2	3.0	4.2

the slight differences among treatments indicated that neither pruning nor clipping had any pronounced impact. After six growing seasons, seedlings in the cove averaged 4.2 feet, ranging from 3.7 to 4.6 feet among planting treatments. None of the differences in total height were statistically significant.

Growth of individual seedlings varied greatly. For example, the tallest 10 percent attained heights of 6.6 feet in 5 years on the plateau and 7.6 feet in 6 years on the cove site. A few seedlings had excellent form and growth, indicating some possibility of selection for superior strains (fig. 1).

Clipping tops stimulated the formation of multiple leaders but this had no serious long-term effects. By the end of the first growing season on the plateau, 42 percent of the clipped seedlings and 79 percent of the unclipped had a single, dominant leader. Browsing by rabbits ruled out further evaluation, but only 23 percent of the seedlings had forked stems after 3 years.

On the cove site, 75 percent of the unclipped and 60 percent of the clipped seedlings were single-stemmed after 1 year. After 3 years, the proportions of seedlings having a single dominant stem averaged 71 and 63 percent. Failure to develop a strong central leader seems to be characteristic of oaks. Some seedlings continued to form multiple leaders through six growing seasons, but in few cases could this effect be related to top clipping.

Figure 1.—Survival has been good on this clearcut site, but less than 10 percent of the planted northern red oak grew as well as this 7-year-old seedling.