Northern Red Oak Plantings Survive Well in Southern Appalachians

DAVID F. OLSON, JR., and RALPH M. HOOPER 1

Northern red . oak *(Quercus rubra* L.) is a rapidly growing, high-quality upland species. Under forest conditions, it develops a tall, straight columnar bole and prunes itself well. Foresters welcome its presence on sites adapted to its development, but they have observed that northern red oak is often scarce in young, natural stands of mixed-species composition.

Planting of seedlings is frequently suggested as a means for regenerating red oak. To determine the feasibility of planting, we began a study of survival and growth of graded seedlings planted on a range of sites in 1964. Results of the first 5 years (6 years from seed) are reported in this article.

Methods

In 1964, we grew seedlings from stratified acorns of northern red oak in a nursery at the Bent Creek Experimental Forest, near Asheville, N. C. The seedlings grew exceptionally well, and in March 1965 we lifted and sorted them by diameter of root collar into grade 1 (more than 9/32 of an inch), grade 2 (between 7/32 and 9/32 of an inch), and grade 3 (between 5/32 and 7/32 of an inch). Roots were pruned to 8 inches.

The graded seedlings were bar-planted on six plots that had been clearcut in the summer of 1964 and then sprayed with 2,4,5T in oil to control brush. Site index for northern red oak at each plot was determined by measuring dominant trees prior to logging (2). Site indices ranged from 76 to 98 feet at age 50. This range includes most of the commercially important sites for northern red oak in the region. We planted 60 seedlings of each grade on each plot at a spacing of 5 by 5 feet. They were divided into three 20-seedling subplots, and the subplots randomly arranged at each location.

The plots were cleaned annually after planting to reduce competition, and the seedlings were sprayed with a deer repellant consisting of one part Arasan 42-S, one part Plyac (adhesive), and two parts water for 2 years after planting.

1 Principal plant ecologist and forestry research technician, respectively, Southeastern For. Expt. Station, USDA Forest Service.

Previous Work

After 2 years we reported early survival and growth (3). Survival was excellent, but height growth averaged only 3 inches a year. There were no significant differences in survival among the three grades of seedlings, but those on the _lowest quality site (site index 76) had significantly lower survival than seedlings on the other five sites. Surprisingly, grade 2 and 3 seedlings exhibited significantly greater height growth than did grade 1 seedlings, but this superiority was more than offset by their smaller initial size.

Results and Discussion

Survival

After 5 years in the field, survival averages 87 percent, ranging from 68 to 100 percent among the three grades of seedlings at the various locations (table 1). Mortality rate from the third to the fifth year is comparable to the rate for the first 2 years. The overall mortality rate indicates that the seedlings are not yet fully established and are still under serious stress after 5 years. Some grades of seedlings on some planting sites showed sharp increases in mortality from the third to the fifth year, notably grade 1 on site index 76, and grades 2 and 3 on site index 98.

This period of establishment is long compared to that of southern pines. Mortality prior to crown closure in planted pines generally occurs in the first 2 years. Little mortality then occurs until crown competition results in further losses.

There are still significant differences in survival among the planting sites after 5 years. However, these differences are not

TABLE 1.—*Percentage of survival of planted northern red oak after 2 and 5 years by site index and seedling grade*

Site index	Grade 1		Grade 2		Grade 3		Mean	
	2 years	5 years	2 years	5 years	2 years	5 years	2 years	5 years
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
76	83	68	90	82	83	72	85	74
81	98	98	100	97	97	88	98	94
85	100	98	98	95	100	98	99	97
91	97	85	100	100	95	92	97	92
93	92	92	98	90	93	83	94	88
98	95	90	92	75	87	73	91	79
Mean	94	88	96	90	92	84	94	87

directly related to site index. The lowest site index (76) had the lowest survival, but the secondlowest survival occurred on the site with the highest site index (98). We conclude that site index alone is *not a* reliable guide for predicting early survival of planted northern red oak. It also appears that, for the range of site indices used in this study, early mortality will not present a serious problem.

Growth

If survival is acceptable, then what about growth? We noted earlier that height growth in the first 2 years averaged only 3 inches a year. At the end of 5 years, the mean height of all surviving trees is 3.8 feet (table 2). Because 1.1 feet of this growth occurred in the nursery, the average seedling grew only 2.7 feet in 5 years in the field, a rate certainly not acceptable to timber growers. Some individual seedlings actually exhibited negative growth because of dieback. At the other extreme, some trees are 10.5 feet high at 6 years from seed. These trees averaged about 1.7 feet of growth per year. Even this maximum height growth is barely comparable to what we can expect in natural oak stands, according to the site-index curves for oak in the region (2). The planted oak must grow about 2 feet per year for the first 20 years if it is to compete with natural stands.

The differences in height among grades after 6 years are due largely to differing rates of growth in the nursery beds. This result is unchanged since the earlier report.. There are statistically significant growth differences among grades in the field, with seedlings in grades 2 and 3 still showing more rapid height growth than those in grade 1. However, the better height growth of grade 2 and 3 seedlings in the field has not yet overcome the superiority which the top-grade seedlings developed in the nursery.

There are also significant differences in height growth among planting sites, and in the growth of the various grades of seedlings within planting sites. These results are almost certainly not related to differences in site index alone. Height growth at the lowest site index (76), was noticeably poorer than at any of the others, but growth at an intermediate site index (91), was also extremely poor and not significantly better than at the lowest index. Patterns of height growth in the plots were extremely variable because of wide differences in soil, microclimate, competition, and animal pressure on the areas. For example, the poor survival and growth at site index 91 may be at least partly due to a frost pocket in that locality. The fact that the seedlings on some of the subplots on site indices 93 and 98 did not

TABLE 2.—*Planted height, 5-year height growth, and total height from seed of planted northern red oak*

Site index	Planted height				5-year height growth				Total height from seed			
	Grade 1	Grade 2	Grade 3	Mean	Grade 1	Grade 2	Grade 3	Mean	Grade 1	Grade 2	Grade 3	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
76	1.64	1.06	0.58	1.09	0.37	0.70	0.90	0.66	2.01	1.76	1.48	1.75
81	1.59	1.02	0.59	1.07	3.74	2.89	3.78	3.47	5.33	3.91	4.37	4.54
85	1.75	0.94	0.60	1.10	1.62	2.60	2.39	2.20	3.37	3.54	2.99	3.30
91	1.71	0.90	0.60	1.07	0.96	2.37	1.91	1.75	2.67	3.27	2.51	2.82
93	1.87	1.01	0.60	1.16	4.22	4.22	4.00	4.15	6.09	5.23	4.60	5.31
98	2.05	1.01	0.58	1.21	3.50	4.35	3.57	3.81	5.55	5.36	4.15	5.02
Mean	1.77	0.99	0.59	1.12	2.40	2.86	2.76	2.67	4.17	3.85	3.35	3.79

grow as well as expected may reflect the severe competition that developed after cleaning on these locations. Regrowth of blackberry, black locust, and yellowpoplar was extremely dense on these plots.

There was considerable top kill and subsequent sprouting throughout the plots. Top kill was most common in grade 1 and 2 seedlings. Much of the loss was due to dieback of seedlings for no visible reason, but some can be attributed to deer, small animals, or frost. In many instances, the subsequent sprouts grew very rapidly and have exceeded the growth of unaffected seedlings. Multiple sprouts have resulted in several deformed trees with poor stem form.

If only four trees on each 20tree subplot in this study survive to maturity, the average stocking will be 348 trees per acre, more than adequate to produce an acceptable timber stand. Consequently, we examined the height growth exhibited by the four tallest seedlings on each subplot expecting an improved growth picture, but the improvement was not great. Statistical significance and ranking of means remained essentially the same. When the four tallest seedlings on each subplot were used as the population, the average tree attained 5.3 feet in 6 years from seed. Grade 1 seedlings averaged 5.8 feet, grade 2 seedlings averaged 5.4 feet, and grade 3 seedlings averaged 4.8 feet.

Conclusions

This planting experiment demonstrates that northern red oak can be successfully planted and adequate early survival obtained with no elaborate site preparation. However, planted northern red oak will evidently need more intensive culture in order to attain acceptable growth rates.

Throughout the first 5 years of this study, the development of natural hardwood regeneration has had to be curbed annually to maintain the oak plantations. Some of the regeneration originated from seed in the forest floor, some from new seed, and some as sprouts. Since cleaning was begun, vigorous sprouts have developed annually from all three kinds of regeneration, and, if left alone, these sprouts would soon develop into fully stocked hardwood stands.

Foster and Farmer (1) investigated the use of fertilizer and larger-than-average seedlings in a study of planted northern red oak in Tennessee. They found that both total height and 3-year height increment were greater with the larger seedlings than with randomly selected seedlings. Although fertilization with 150 pounds of N per acre resulted in nearly a twofold increase in height as compared to that with no fertilizer, the results offer little encouragement to tree planters and chiefly indicate possible directions for intensive research in the planting of oak.

The performance of these six plantings certainly suggests the need for more complete site preparation before planting, and more intensive culture afterward, to enable the planted oaks to outgrow their competitors.

Literature Cited

1. Foster, A. A., and R. E. Farmer, Jr.
1970. Juvenile growth of planted northern red oak: Effects of fertilization and size of planted stock. USDA Forest Serv. Tree Planters' Notes 21(1): 4-7.

2. Olson, D. F., Jr.
1959. Site index curves for upland oak in the southeast. U. S. Forest Serv. Southeast. Forest Exp. Sta. Res. Note 125, 2 p.

3. _____ , and R. M. Hooper.
1968. Early survival and growth of planted northern red oak in the Southern Appalachians. Southeast. Forest Exp. Sta., U.S. Forest Serv. Res. Note SE-89, 3 p.