Tree Planter's Notes, Vol. 33, No. 4 (1982)

Growth and Survival of Black Oak Seedlings Under Different Germination, Watering, and Planting Regimes

T. A. Roberts and C. H. Smith
Wildlife Biologist and YACC Foreman, USDA Forest Service, San Bernardino National Forest, Idyllwild, Calif.

Fall-planted black oak seedlings grew and survived better than spring plantations. Summer watering at 2 liters per seedling per week had no effect. Stratified acorns may have a higher survival rate than nonstratified ones and are more synchronized in their germination, making potting more efficient.

The importance of the California black oak *(Quercus kelloggii* Newb.), both as a component of wildlife habitat (*1*) and as a commercial species (*2*), is now widely recognized, but there has been insufficient practical information to develop a formal silvicultural program. Differing views on germination techniques (*3*) and a total absence of direction on planting regimes led us to conduct a study to prepare basic guidelines for oak silviculture on the San Bernardino National Forest. Our interest centered on finding the most effective germination strategy, determining the importance of summer watering of spring-planted seedings, and comparing spring and fall planting relative to growth and survival.

Study Area

The two experimental plantations were located on southwestern slopes at a 1,400-meter elevation approximately 8 kilometers northwest of Idyllwild, Calif. In general, natural reproduction on prime black oak sites in our area is adequate. Since extension of hardwoods into more marginal (but once forested) habitats was one of our long-range goals, test sites were chosen in chaparral, with predominantly chamise-ceanothus vegetation and coarse granitic soils. Southern California has a characteristic Mediterranean climate with hot, dry summers and cool, wet winters. Rainfall averages 56 centimeters per year.

Materials and Methods

To minimize the effects of genetic variation, all acorns used in the data (N = 192) were collected from a single parent tree on September 14, 1979. We picked only acorns that had matured without falling and were visibly free of insect damage.

Acorns were air-cured for 10 days outside in shade, examined again, and sorted for signs of insect attack. Three different germination techniques were tested. The first and second groups were placed in plastic garbage bags along with an equal volume of commercial potting soil and approximately 10 grams of a broad spectrum fungicide (Physan 20). The tips of the acorns (about 3 mm) in the second group were removed, and both groups were kept at room temperature (18° to 24° C) for 90 to 120 days until potting. The third group was similar to the first, but acorns were stratified at 6° C for 45 days and then stored at 18° to 24° C for 45 to 75 days until potting. Each germination group included 21 acorns.

During January 1980, the sprouted acorns were transplanted into 8- by 46-centimeter, open-ended tar-paper pots made from asphalt-saturated roofing felt. The pots had been filled with soil gathered from beneath the parent tree. The filled pots were placed on hardware cloth mesh racks under a 12-hour artificial light regime at room temperature for approximately 100 days until planted or moved outside.

We planted 90 randomly selected seedlings, 30 from each germination treatment, on our two experimental sites between April 28 and May 5, 1980. On the average, seedlings were 7.4 centimeters tall at planting and were not dormant. The spring-planted trees were divided into three watering regimes. The first treatment used a circular berm around the seedling for surface watering. The second, which was developed to minimize evaporation, used a 5- by 60-centimeter black plastic pipe buried with the seedling with the end 5 centimeters above ground and extending at a 45° angle to just below the end of the tar-paper pot. The third group was an unwatered control. Each watering treatment group included 30 individuals.

Spring-planted trees were watered once each week until September with approximately 2 liters per tree per week poured onto the berm or into the watering tube. The amount and interval of watering was deter

mined by our estimate of what we could integrate into a permanent silvicultural program. We assume that intensive watering will produce bigger trees, but only weekly watering with relatively small amounts is practicable in the field, given existing staffing.

The remainder of the seedlings (102 individuals) were kept in partial shade through the summer and watered liberally at least once per week. They were planted on the experimental sites on September 26, 1980. On the average, they were 7.0 centimeters tall at planting. No leaves had dropped, but slight browning on the edges indicated that dormancy had just begun. Fall-planted trees were not watered.

All trees were protected by 8- by 91-centimeter, plastic mesh (Vexar) tubes covering the entire tar-paper pot and extending 48 centimeters above ground to minimize deer and rodent damage. Spacing between trees averaged 10 meters square on both sites.

Height growth was measured, to the nearest 2/10 centimeter, from the ground's firm surface to the tip of the terminal bud. Readings were taken at planting, at 6 months after planting, and (for spring-planted trees) at 1 year.

Results and Discussion

Germination techniques had no apparent effect on the total percentage of acorns germinated at 7 months after collection and no significant effect (ANOVA test) on mean height at 12 months after planting (table 1). Careful selection of acorns and germination in airtight plastic bags gave a germination percentage in excess of 90 percent in all three treatments. Stratification, recommended by earlier sources (*4*), appears to be unnecessary for black oak germination. However, seedlings from stratified acorns had somewhat higher survival rates; and stratification concentrated germination into a shorter period of time, which made the potting operation more efficient.

Watering made no significant difference (ANOVA test) in growth (table 2). This "negative finding" may be of some importance to hardwood silviculturalists. It may be that

Table 1.—*Effect of germination technique on California black oak seed germination percentage, seedling mean height, and seedling survival*[1]

Seed treatment	Seed germination (after collection)		Seedling mean height (12 mo. after planting) [2]	Seedling survival (12 mo. after planting)
	2 mo.	7 mo.		
	- - - Percent - - -		*Cm*	*Percent*
Nonstratified, tips removed	30	90+	6.83	80
Nonstratified, tips Intact	0	90+	7.5	71
Stratified, tips intact	0	90+	6.9	95

[1]Data Include spring-planted trees only.
[2]Mean heights Included dead trees as 0, and totals are sometimes lower than mean height at planting.
[3]No significant difference in means (P>.1), ANOVA test.

Table 2.—*Effect of watering on California black oak seedling mean height and seedling survival*[1]

Treatment	Seedling mean height (12 mo. after planting)	Seedling survival (12 mo. after planting)
	Cm	*Percent*
No watering	6.462	77
Surface watering	7.00	86
Tube watering	6.30	82

[1]Data Include spring-planted trees only.
[2]No significant difference In means (P>.1), ANOVA test.

watering was not sufficient to achieve an effect. More extensive watering, however, would be too expensive to maintain, whether or not it was successful. In any case, an overall average survival rate of 75 percent suggests that we can grow oaks in chaparral.

Table 3 gives data for height, growth, and survival relative to spring and fall plantings. Fall-planted trees fared significantly better. Fall-planted trees also attained a final average height 12 percent greater. Unpublished data from oak plantations on the Angeles National Forest show a very similar trend.

Since spring and fall trees were the same height at planting, the differences in growth in the field are probably not attributable simply to the added vigor of older trees. It may be that planting just before dormancy allows the trees to adjust more easily to field conditions.

Pending generation of further data, our efforts with black oaks will involve fall collection of acorns, stratification to insure time efficiency in early spring potting, oversummering under shadehouse conditions, and fall planting without watering.

Table 3.—*Mean winter growth, height, and survival of spring- and fall-planted California black oak seedlings*

Planting season	Seedling mean growth Nov. 1980 to Apr. 1981			Seedling survival to Apr. 1981	Seedling mean height to Apr. 1981		
	Site 1	Site 2	Both	Both	Site 1	Site 2	Both
	Cm	*Cm*	*Cm*	*Percent*	*Cm*	*Cm*	*Cm*
Spring	0.681	0.67	0.68[1]	77[2]	8.70	5.20[1]	8.90
Fall	1.50	0.93	1.20	94	7.80	7.60	7.70

[1]Difference between spring and fall means significant (P<.01), t-test.

[2]Difference between spring and fall survival significant (P<01), chi-square test.

Literature Cited

1. Martin, A. C.; Zim, H. S.; Nelson, A. L. American wildlife and plants—a guide to wildlife food habits. New York: McGraw-Hill;1951. 500 p.
2. McDonald, P. M.; Sundahl, W. E. California black oak . . . a general bibliography on an increasingly valuable species. Res. Note 134. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1967.
3. Schettler, S.; Smith, M. N. Nursery propagation of California oaks. In: Plumb, T.R., ed. Proceedings of the symposium on the ecology, management, and utilization of California oaks. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1980. 368 p.
4. Schopmeyer, C. S., coordinator. Seeds of woody plants in the United States. Agric. Handb. 450. Washington, DC: U.S. Department of Agriculture; 1974. 883 p.