STRATIFICATION IMPROVES GERMINATION AND GROWTH OF WATER OAK AND WILLOW OAK

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Stratification of red oak acorns has been recommended *(1, 4, 5)* since it hastens germination and shortens the germination period. However, the effect of stratification on the height and diameter growth of the subsequent seedlings has not been investigated. The effect of quicker germination should be to increase the size and uniformity of the planting stock, particularly if the germination period is shortened. Both factors may be important in determining the percentage of acorns that will produce plantable seedlings. In general, these expectations were confirmed.

This study was initiated to compare the effects of stratification and cold storage on germination and seedling performance of water oak *(Quercus nigra* L.) and willow oak *(Q. phellos L.).* The difference in response between the two species was also investigated.

Acorns were collected from water oaks in Columbia County, Fla., Brazos County, Tex., and Wake County, N.C.; and from willow oaks in Spotsylvania County, Va., Butler County, Mo., and Wake County, N.C. Three trees were sampled in each stand. The fruits were collected with traps modified from those recommended by Thompson and McGinnes (3). Two traps were placed on opposite sides of each tree, one-third the distance from the bole to the crown edge. Acorns were removed from the traps at intervals of 3 to 7 days between Sept. 15 and early November; those collected first were kept cool and moist until about 200 acorns were gathered, or until they ceased to fall. All acorns were then stored at 34°F. and 70 to 80 percent relative humidity.

Treatments and Procedure

In January 1965, acorns were floated in cold water to isolate the sound fruits. Only those that sank were used in this study. As a check on the flotation method, the floating fruits were planted; about 2 percent germinated, indicating that this method removes only insignificant numbers of viable fruits. Of the acorns that sank, about 3 percent showed external evidence of damage by weevils. The rest were considered sound. Acorns from each tree were then divided into lots of 25 and each lot weighed.

Two lots from each tree were randomly selected for each of the two pre-sowing treatments (except for the Missouri collection, for which only one lot per treatment was available from each tree) . The two treatments were:

1. Cold storage in plastic bags at 34° F. with rel ative humidity of 35 to 45 percent.
2. Stratification in moist peat moss at 34° F.

The essential difference between the two treatments was the amount of moisture available (luring the 120-day storage period before sowing.

Furrows 1 inch deep and 3 inches apart were made across the nursery bed in the nursery of the North Carolina State University School of Forestry. One acorn lot was sown per furrow in a completely random design on May 30, 1965. The acorns were planted at depths of 1 inch and densities of 24 fruits per square foot (2, 4). Irrigation and weeding were done as necessary. Because of heavy leaching rains in June, one light application of 10-10-10 fertilizer was applied in early July.

Germination counts were started on June 15, and extended through Oct. 27. Seedling height and diameter measurements were made in late February 1966. Numbers of seedlings measured at this time

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were used to calculate survival percentages.

For analyzing the germination counts for a given day, a transformation, $\sqrt{x + 1}$, was used. The mean lot values were used for the analysis of height and diameter growth and for fruit weight. The limits placed around the means are 95 percent confidence statements.

Results and Discussion

The mean lot weight (gms/25 acorns) of water oak was 28.75 ± 3.38, while for willow oak it was 15.88± 3.73 (table 1, Col. 1). The difference between species was statistically significant as was the difference among trees within areas, but no other statistically significant sources of variation were found. Since the acorns were stored at high humidity before weighing, it was assumed that moisture contents were comparable in all fruits and, therefore, that weights portrayed species differences.

No significant statistical difference among areas within a single species was found for acorn weight, germination, or growth. The implication is that geographic source has no effect on the responses measured, and can be ignored in the interpretation of this particular set of data.

The analyses of the number of fruit germinating over time showed that: (1) stratified acorns germinate faster, (2) stratified fruit have a higher percent germination, (3) stratified willow oak acorns germinate and survive better than stratified water oak acorns, and (4) total germination of both species is approximately equal. These results are shown in figure 1.

Fifty-six percent of the stratified willow oats acorns had at least 60 days to grow before Aug. 28 (90 (lays after planting), whereas only 13 percent of the unstratified acorns had this opportunity. The additional growing period could account for the additional size and uniformity of plants from stratified acorns. The percent of plantable seedlings (ta-

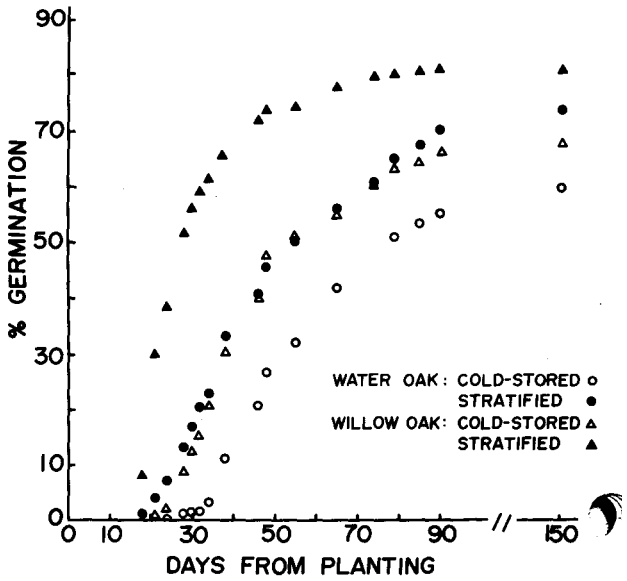

Figure 1.—Percent germination from May 30 to Oct. 27, 1965 of water and willow oak acorns for two pre-sowing treatments.

TABLE 1.—*Response of water and willow oak acor*

Treatment	(1)	(2)				
	Acorn wt.	Germination	Survival	Plantable Seedlings	Height	Diameter
	gms/25 fruit	*Pct.*	*Pct.*	*Pct.*	*cm*	*mm.*
WATER OAK						
Cold-stored	28.80	60.4	90.4	54.6	9.2	2.2
Stratified	28.69	74.4	90.8	67.6	11.5	2.2
WILLOW OAK						
Cold-stored	15.78	68.3	96.5	65.9	10.6	2.3
Stratified	15.98	81.6	93.1	76.0	11.7	2.6
Confidence limits	±.30	—	—	—	±.7	±.1

ble 1,col. 4) was calculated as the product of percent germination and percent survival. Assuming that all seedlings that survived were plantable, stratification resulted in at least 10 percent more plantable seedlings.

Although no statistically significant difference was found between species or among areas in height and diameter growth, such differences at the 1 percent level of probability were found between pretreatments (table 1, col. 5,6) and among trees within an area. Seedlings from stratified acorns were superior in both height and diameter growth. This may result from the earlier germination of these fruits.

Seedlings from stratified acorns were approximately 18 percent taller and 15 percent larger in diameter. The advantage of these height and diameter differentials may or may not be economically important; their value will be dependent on the outplanting conditions and facilities available for stratifying the acorns. Generally though, this increase in performance, in addition to the large increase in total germination, should make stratification worthwhile.

Summary and Conclusions

Stratification and cold storage pretreatments were evaluated on fruits from nine water oak and nine willow oak trees. Stratified acorns germinated earlier and had a higher level of germination than cold-stored but unstratified acorns, and, in addition, seedlings from stratified fruits were larger in height and diameter. Survival for both pretreatments was above 90 percent. No losses were sustained after the first growing season.

Willow oak acorns were lighter. They germinated faster, however, and the resultant seedlings were slightly taller.

The basic conclusion, considering only these two pretreatments, is that stratification is necessary for production of the greatest number of largest and most uniform seedlings in the shortest time.

Literature Cited

1. Korstian, C. F.
1927. Factors controlling germination and early survival in oaks. Yale Univ. School of For. Bull. 19. 115 pp.

2. Shipman, R. 1).
1962. Nursery-seeded hardwoods-influenced by depth and density of sowing. Tree Planters' Notes 54: 27-32.

3. Thompson, R. L. and B. S. McGinnes.
1963. A comparison of eight types of mast traps. Jour. For. 61: 679-680.

4. Vande Linde, Frank.
1964. Nursery practices for southern oaks and gums. Tree Planters' Notes 65: 24-26.

5. Woody Plant Seed Manual.
1948. U.S. Dept. of Agr. Misc. Publ. 654. 416 pp.