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FIELD GERMINATION OF NUTTALL OAK ACORNS

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SOUTHERN FOREST EXPERIMENT STATION

*In newly cleared plots on Sharkey clay near Stoneville, Mississippi, germination was as high as 79 percent for Nuttall oak (*Quercus nuttallii* Palmer) acorns sown unstratified in January and 86 percent for those stratified and sown in April. Most seedlings appeared in June and July, when soil temperatures were usually between 80° and 90° F. Germination was faster and more complete among acorns sown 1 and 2 inches deep than among those sown 4 inches deep. Rodents, mainly chipmunks, dug up and ate some acorns at all three depths.*

A recent nursery study² showed that Nuttall oak (*Quercus nuttallii* Palmer) acorns germinate and establish seedlings very well when sown 1 inch below the surface of soil that is covered with litter and partially shaded. Reported here are results of field tests of this and other combinations of conditions. The

tests indicate that rodents are the only major barrier to successful direct-seeding of Nuttall oak in many areas.

METHODS

Acorns from three trees near Stoneville, Mississippi, were collected in November 1967 and immediately placed in a walk-in cooler where relative humidity was about 90 percent and temperatures ranged from 35° to 40° F. One week after collection, 50 from each tree were cut and examined; 95 percent were sound, free of insects, and apparently viable.

Nuts from the three trees were mixed in January 1968 and about half the composite was sown in the field. The rest were kept in dry, cold storage in open wooden baskets until February 2. They were then stratified at 35° to 40° F. for 3 months in cloth bags between layers of moist sphagnum and sand. Stratified acorns were sown between April 24 and 30.

In October 1967, all trees 1 inch d.b.h. and larger were cut and removed from 12 strips on a low Sharkey clay flat. Litter was not removed and was only slightly disturbed during cutting and clearing. Strips ran either east-west or north-south and were either 20 or

¹ The author is Silviculturist at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station, USDA Forest Service, in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

² Johnson, R. L. Improving germination of Nuttall oak acorns. USDA Forest Serv. Res. Note SO-66, 3 pp. South. Forest Exp. Sta., New Orleans, La. 1967.

40 by 90 feet. Widths and directions were replicated three times. Each replication was divided into six 15-foot subplots along the 90-foot side. Each subplot was randomly assigned a combination of one of the two sowing dates and one of three sowing depths, 1, 2, or 4 inches below the soil surface.

There were 10 seed spots in the 15- by 20-foot subplots and 20 in the 15- by 40-foot subplots. Five acorns were sown at each spot.

The effects of pericarp removal were determined on additional sample seed spots representing each of the 24 combinations of environment, stratification treatment, and sowing depth. These seed spots contained both intact and depericarped acorns. One seed spot of each combination was dug up monthly through July. Half the ungerminated acorns were weighed and oven-dried at 105° C. for 24 hours to determine moisture content; the other half were put into petri dishes in laboratory germinators at 80° F.

In January 1968, a three-pronged mercury-in-steel distance thermograph was installed near the center of one 40-foot-wide strip which was oriented east and west. Soil temperatures at 1, 2, and 4 inches were recorded continuously through August. Moisture in approximately the surface 3 inches of soil was measured from May to July with a combination surface moisture-density gage. Daily readings and monthly averages for air temperature and rainfall were taken from records kept by the Stoneville weather station, which is about 2 miles south of the study plots.

Weekly from May through mid-July and then every 2 or 3 weeks through September, seedlings appearing above the soil surface were counted at each seed spot. The percentage of acorns that produced seedlings is called germination throughout this note. Final counts were obtained in early October.

RESULTS

As in earlier studies,^{3,4} rodent depredation was a major deterrent to successful oak seedling. Since most plots were flooded until late

spring, rodent activity was not apparent until May or June. Evidence of digging became pronounced in July. Even acorns at the 4-inch depth were taken. Damage was greater in, though not restricted to, rows adjacent to the woods. In some subplots, almost every seed spot was disturbed. It was not possible to determine the amount of pilferage without terminating the main tests, but it was apparent that plots in which germination was very low were hard hit by rodents. Data from 13 of the 24 treatment combinations were believed to be influenced greatly by pilferage (table 1).

A trap baited with surface-sown Nuttall acorns was set in an area of heavy pilferage in July. A fox squirrel was captured 2 days later. Then a trap was baited with acorns sown 4 inches deep. On two occasions, a chipmunk and a wood rat were captured together. The same two animals were not captured twice; the first pair was still being held when the second pair was caught. Observation of the animals in captivity indicated that only the chipmunk was digging.

Acorns removed from supplementary seed spots did not differ in moisture content or germinability by sowing depths. But the average moisture content of depericarped acorns was 6 percentage points higher in March and April and 20 points higher in May than that of intact acorns. Whole acorns dug up in March and April germinated in the laboratory in from 2 to 6 weeks; those removed in May germinated in 1 to 4 weeks. Depericarped acorns germinated within a week, regardless of when they were removed. Acorns dug up in June and July had either germinated or were rotten.

Over 90 percent of the germination on plots occurred in May, June, and July. Environmental conditions during these months are therefore important.

During May, daily air temperature averaged 71.4° F., or near normal. Average soil temperature was 68° F. 4 inches below the surface and 85° F. at the 1-inch depth (fig. 1). Rain fell 12 different times. Total rainfall was 5.31 inches, 1.10 inches above normal. Soil moisture was always above 50 percent by volume in all plots. The wilting point on Sharkey clay is usually near 30 percent. On May 22, three acorns sown 1 inch deep in January germinated. No further germination was noted in May.

³ Mignery, A. L. Oak direct seeding in Tennessee. USDA Forest Serv. South. Forest Exp. Sta. South. Forest. Notes 137. 1962.

⁴ Sluder, E. R. Direct seeding scarlet oak in the North Carolina mountains. USDA Forest Serv. Res. Note SE-41, 2 pp. Southeast. Forest Exp. Sta., Asheville, N. C. 1965.

Table 1.—Proportion of sown acorns that produced seedlings on individual plots, by orientation, month of sowing, and depth in soil

Month of sowing and depth	Narrow plots				Wide plots			
	1	2	3	Average	1	2	3	Average
----- Percent ¹ -----								
----- Percent ² -----								
EAST-WEST								
January								
1 inch	90	84	42	72	76	70	76	74
2 inches	18	84	68	57	79	13	10	34
4 inches	92	42	50	61	41	16	14	24
April								
1 inch	80	84	0	55	83	82	92	86
2 inches	22	76	0	33	77	74	0	50
4 inches	4	40	0	15	58	57	0	38
NORTH-SOUTH								
January								
1 inch	78	74	84	79	0	0	53	18
2 inches	52	76	78	69	74	0	57	44
4 inches	44	56	34	45	32	0	46	26
April								
1 inch	72	74	78	75	86	90	52	76
2 inches	62	72	94	76	75	83	68	75
4 inches	50	52	90	64	35	60	39	45

¹ Based on 50 seeds per plot.

² Based on 100 seeds per plot.

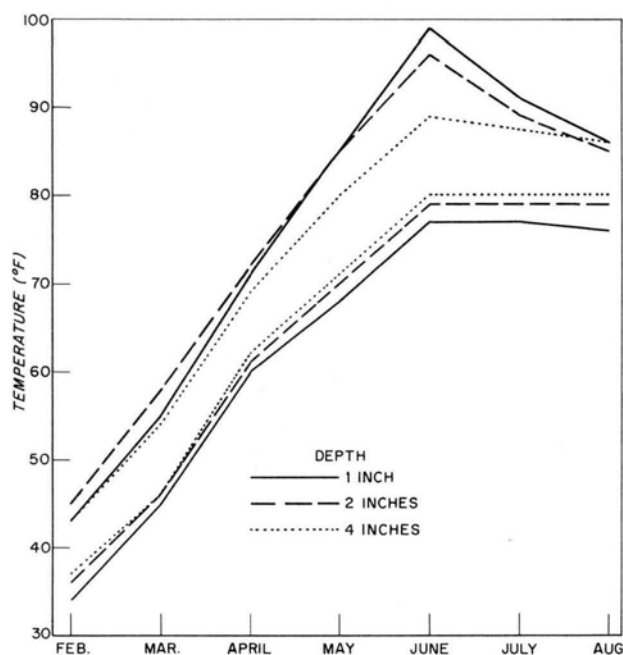


Figure 1.—Average daily high and low temperatures, by months, at depths of 1, 2, and 4 inches in the soil.

The temperature in June was 1.9° above normal, and rainfall was 1.57 inches less than

normal. Soil temperature stayed above 70° F. at all three depths. This temperature is probably near the minimum for rapid germination. Temperature soared briefly to 114° F. at the 1-inch depth. At the 4-inch depth it was usually between 80° and 90° F. Between May 27 and June 19 there was no rain and surface soil moisture ranged from 30 to 50 percent. Nearly 1/5 of the total germination recorded at the 1-inch depth occurred during this period. A 1.56-inch rain, more than half the 2.30 inches recorded for June, fell on June 20. The rain seemed to stimulate germination or, more likely, growth of the epicotyl. By June 30 germination was about 50 percent complete for acorns 1 inch deep (fig. 2).

July was cooler and wetter than June. Air temperature was 1.1° below normal; rainfall was 5.57 inches, or 1.54 inches above normal. Soil temperature was usually between 80° and 90° F. at all three depths. Over an inch of rain fell on each of three dates, the 3rd, 9th, and 20th, and soil moisture throughout July was above 40 percent. By the end of July, germination was at least 90 percent complete at all depths.

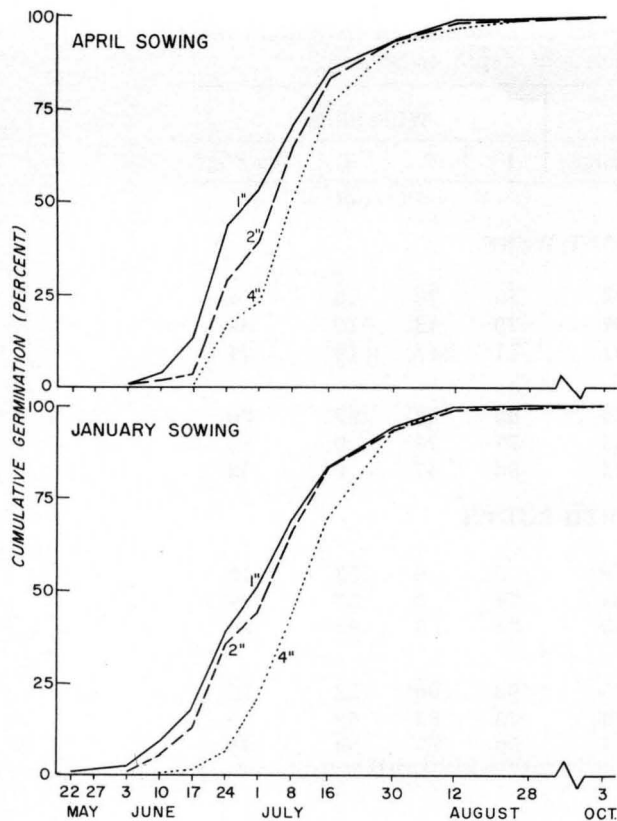


Figure 2.—Cumulative percents of total germination for acorns sown in spring (above) and winter (below), by measurement date and sowing depth.

No new seedlings appeared after mid-August. Rains on August 13, 14, and 16 totaled 2.41 inches. Low mortality of germinated seedlings—about 5 percent—is probably attributable to these rains.

A few seedlings died back to ground level and resprouted during the growing season. An occasional one died back and resprouted two

or three times. Most seedlings were 8 to 12 inches tall in October.

DISCUSSION

The Sharkey clay flat on which the study was done is typical of the areas where Nuttall oak abounds. The results indicate that direct-seeding of the species is feasible on such areas. Eight of the 24 treatment combinations resulted in germination percents of 70 or more. Severe rodent damage in the plots prevents reliable conclusions about season of sowing or size and orientation of opening. Differences due to these factors did not appear to be great, however.

Three significant conclusions about environment are possible. First, acorns can tolerate standing water from January into May and at least 2 weeks of 30- to 40-percent soil moisture during the germination period. Second, acorns sown 4 inches deep produce acceptable seedlings, but germination is faster and more complete for acorns sown 1 or 2 inches deep. Third, acorns will usually germinate from late May to late July, whether they are sown unstratified in January or stratified and sown in late April.

Although the amount of damage done by rodents was not accurately determined, it is clear that pilferage, particularly by chipmunks, can be a major problem in direct-seeding Nuttall oak. In the study, these animals dug up acorns buried 4 inches beneath the surface. Losses appeared to be greatest near the edges of the cleared strips. If the animals are reluctant to venture far into clearings, an increase in strip length and width may reduce pilferage.