

## A NEW METHOD OF STORING NUTTALL OAK ACORNS OVER WINTER

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Among red oak acorns, those of the Nuttall oak (*Quercus nuttallii* Palmer) may present the fewest problems in storage over winter. But as Bonner (1) has shown, Nuttall acorns, like all red oak acorns, should not be allowed to drop below a moisture content of 43 (30) percent (all moisture content percentages are given by dry and then by wet weight). Storing Nuttall acorns dry in open containers kept at near freezing will lead to serious moisture loss and low germination rates. In the test reported here, acorns stored by the recommended method of sealed polyethylene bags (2) and acorns stored in water or wet sand were compared, and the results indicate that acorns can be successfully stored in water over winter and that subsequent germination percentages will equal or exceed those of other storage methods.

### Methods

Between November 5 and 15, acorns were collected from five different trees on the Delta Experimental Forest near Stoneville, Mississippi. The acorns from each tree were floated to remove bad acorns. For each tree, sublots containing an equal number of acorns were stored in a walk-in cooler at 35° to 40° F. The acorns were stored first in cloth bags for either 1, 2½, or 4½ months and then in either (1) a sealed poly-

ethylene bag 4 mils thick, (2) an open-topped cardboard ice cream carton, (3) moist sand covered with burlap, or (4) tap water in a metal coffee can. Total storage time was either 5½ or 7 months.

The acorns were taken from storage May 1 or June 15 and sown 2 inches deep in a 3-to-1 mixture of sandy loam soil and peat contained in 1¼ by 3-inch plastic tubes. There was one acorn per tube and 10 tubes per replication. Replications were placed in germinators set for either 65°, 80°, or 95° F.

The experiment had a split-plot design with 16 major and three minor (temperature) treatments (table 1). There were four replications of each storage treatment for each germination temperature. Germination counts were made three times weekly until October 6. An acorn was considered germinated when the epicotyl appeared above the soil-peat mixture. All acorns were examined after the final germination check to determine if they were sound or rotted.

To determine the moisture content of acorns before storage, 10 acorns from each tree were weighed before and after they were dried for 24 hours at 105° C. Another 20 acorns per tree, 10 with and 10 without a pericarp, were put into a germinator at 95° F to determine how quickly and completely they would germinate without storage.

Acorns submerged in water over winter germinated better over a 65° to 95° F temperature range than those stored in sealed polyethylene bags, the currently recommended treatment.

Twenty-five acorns were included with each stored subplot to allow sampling during storage. Ten were used for moisture determinations, and five with and 10 without pericarps were put into the germinator at 95° F.

### Results

At the time of collection, the moisture contents of acorns from the five trees ranged from 59 (37) to 69 (41) percent. During the first 5½ months of storage, acorns averaged between 50 (37) and 70 (41) percent moisture content, except for those stored in cartons, which dropped to about 40 (29) percent between 4½ and 5½ months, indicating that Nuttall acorns should not be stored in open containers for more than 3 months.

Of the 20 acorns per tree placed in germinators immediately after collection, many without pericarps started germinating (radicle at least ½-inch long) within 13 days. Total germination averaged 60 percent. Only 4 percent of the acorns with pericarps germinated. For all treatments, sample acorns taken after a month in storage and with pericarps removed germinated within 6 days. Those with pericarps generally germinated more quickly and completely with increased time in storage, but there was substantial variation within and among treatments.

There were considerable differences among treatments in the start of above-ground germination. The earliest germination for any treatment was 29 days, the latest was 104 days. Within treatments, germination was complete in from 40 to 132 days. Generally, treatments that stimulated the quickest germination also resulted in the most complete germination and thus had the highest germination values (3), an index that considers both speed and quantity of germination.

Statistical analysis revealed several interactions between major and minor treatments. However, three treatment combinations were significantly better than the others: (1) cloth bags for 2½ months, water for 4½ months, and 80° F germination temperature; (2) cloth bags for 4½ months, water for 2½ months, and 80° F germination temperature; and (3) cloth bags 2½ months, moist sand for 4½ months, and 80° F germination temperature (table 1). Averaged over all storage treatments, 80° F germination temperature produced significantly better germination percentages than 65° F or 95° F (table 2). At 65° F, acorns frequently produced a radicle and then died (table 2). At 95° F, those acorns ready to germinate did so, but the others appeared unable to tolerate such a high temperature for very long. Two storage treatments—cloth bags

for 2½ months with water for 4½ months and cloth bags for 2½ months with moist sand for 4½ months—caused acorns to germinate significantly better than other treatments

across the range of temperatures. Longer or shorter periods of water storage and a shorter period in moist sand significantly lowered germination over all temperatures.

**Table 1.**—*Germination above ground by treatments (each percent value is a mean of four replications)*

Treatment Number	Storage		Germination temperature			Mean		
	Container	Months	Container	Months	65° F		80° F	95° F
	-----percent-----							
1	Cloth bags	1	Water	4½	22	42	30	31
2	Cloth bags	1	Water	6	30	52	30	37
3	Cloth bags	2½	Water	3	22	52	35	37
4	Cloth bags	2½	Water	4½	48	78	62	63
5	Cloth bags	4½	Water	1	0	22	10	11
6	Cloth bags	4½	Water	2½	8	78	36	40
7	Cloth bags	1	Sealed poly-ethylene bags	4½	55	25	28	36
8	Cloth bags	1	Sealed poly-ethylene bags	6	28	58	30	39
9	Cloth bags	2½	Sealed poly-ethylene bags	3	8	26	25	19
10	Cloth bags	2½	Sealed poly-ethylene bags	4½	10	48	32	30
11	Cloth bags	4½	Sealed poly-ethylene bags	1	10	15	20	15
12	Cloth bags	4½	Sealed poly-ethylene bags	2½	10	48	32	30
13	Cloth bags	2½	Stratified in moist sand	3	40	46	28	38
14	Cloth bags	2½	Stratified in moist sand	4½	42	72	65	60
15	Cloth bags	1	Cartons	4½	7	6	3	5
16	Cloth bags	2½	Cartons	4½	3	21	3	9

## Conclusions

Nuttall oak acorns stored in water or moist sand for 4½ months at 35° to 40° F appear to germinate better than acorns stored in other ways across a 65° to 95° F range in temperature, a broad range found frequently in nurseries or in the field where conditions are less than optimum. However, storing acorns in moist sand consumes time and space, while storing them in water is simple and space efficient. Also, there is less chance for acorns to germinate in water than in any of the dry storage treatments. Since this study, large quantities of acorns have been successfully stored over winter in water-filled drums; longer water storage has not as yet been tested.

## Literature Cited

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**Table 2.**—Germination summary by type of storage and germination temperature (each percent value is a mean of 8 replications for cartons and sand or 24 replications for water and bags)

Type of storage and germination temp.	Germinated	Radicle only <sup>1</sup>	Ungerminated
	-----percent-----		
Cartons			
65° F	4.6	25.8	69.6
80° F	13.3	12.1	74.6
95° F	2.5	6.2	91.3
Water			
65° F	21.7	47.1	31.2
80° F	54.2	19.2	26.6
95° F	32.8	23.0	44.2
Polyethylene bags			
65° F	20.0	42.1	37.9
80° F	36.2	20.4	43.4
95° F	27.9	24.2	47.9
Moist sand			
65° F	41.2	41.2	17.5
80° F	58.8	25.6	16.2
95° F	46.2	23.8	30.0

<sup>1</sup>Values in this column refer to acorns that had formed a radicle but died. No epicotyl appeared above the soil-peat mixture.