STORAGE OF ACORNS AND OTHER LARGE HARDWOOD SEEDS--PROBLEMS AND POSSIBILITIES

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Extended storage of heavy, high-moisture seeds is a problem the world over. Conifers and most hardwoods bear small seeds that can be stored for considerable periods at low moisture contents and low temperatures. But some of the big hardwood seeds can at best be kep+ overwinter; they are damaged or killed if dried to the levels commonly utilized for long-term storage.

The problem is especially important for the genus Quercus, because good seed crops are irregular. To protect themselves from crop failures, nurserymen would like to be able to store acorns at least 3 years, and preferably 5. Tree improvement programs would also benefit greatly from a solution to the problem.

POSSIBLE APPROACHES

There are several possible approaches:

1. Rapid freezing at super-low temperatures in liquid nitrogen or similar coolants. Animal semen for artificial breeding is commonly stored for many years in this manner, and some tree seeds have been reported to survive 3 months of storage in liquid nitrogen 2/. The possible application of this technique seems limited to small quantities of seed, but use in tree breeding work cannot be ruled out.

2. New combinations of temperature, moisture content, atmosphere, and storage container. While this approach may traverse oft-plowed ground, there are still possibilities, especially with improved cold storage facilities and packaging materials.

1/ Stationed at the Forest Tree Seed laboratory, maintained at State College, Mississippi, in cooperation with Mississippi State University.

2/ Engstrom, A. 1966. Will super deep freeze damage tree seed? USDA Forest Service, Tree Planters' Notes 77:28-29.

3. Storage at high moisture contents and low temperatures, with chemical inhibition of sprouting. This approach is essentially what is used in the storage of potato tubers. Chemical control is supplied by maleic hydrazide or other growth retardants.

RESULTS TO DATE

Let's see where we stand in our research effort and what the chances for success are.

In a study initiated in the fall of 1965 at the Southern Hardwoods Laboratory in Stoneville, cherrybark oak acorns were stored under all combinations of four variables:

Temperature: 39° and 23° F.

Initial acorn moisture content: 18, 31, and 48 percent of dry weight.

Container: sealed 4-mil polyethylene bags and non-sealed cardboard cartons.

Length of storage: 6, 18, and 30 months,

This study was concluded in the spring of 1969. The major findings were: 3/

Storage at 23° was not successful under any of the test conditions.

Retention of viability appeared to be directly related to acorn moisture content. Acorns with the highest moisture content averaged 64 percent germinative capacity after 30 months of storage at 39° in sealed bags. Many of the acorns germinated during storage and stratification.

Sealed polyethylene bags were the best containers, apparently because they maintained high acorn moisture content. Non-sealed cartons were unsatisfactory.

To extend this line of research a similar study with cherrybark oak was installed at State College in the fall of 1968, The variables were:

3/ Gammage, J. L. and R. L. Johnson. 1969. Unpublished data on file at the Southern Hardwoods Laboratory, Stoneville, Miss.

Temperature: 46°, 37, and 14° F.

Initial acorn moisture content: 31, 45, and 50 percent of dry weight.

Container: sealed 4-mil polyethylene bags and non-sealed cotton bags.

Length of storage: 6, 18, and 30 months.

Shumard and water oak acorns were also stored under these conditions, except that only two initial acorn moisture levels were tried: 26 and 46 percent for water oak and 32 and 52 percent for Shumard.

Germination after 18 months of storage has just been evaluated, and the results for cherrybark resemble those of the first study (table 1). Shumard and water oak acorns did not store nearly as well (tables 2 and 3). All successful treatments retained high acorn moisture contents. Thus, viability can be maintained to some degree for more than 6 months by raising moisture content to 45 or 50 percent and storing the acorns in sealed polyethylene bags at temperatures a few degrees above freezing. There is a problem connected with this method, which I will come back to.

A 2-year test of seed packaging materials was also installed with cherrybark, water, and Shumard acorns. Two moisture levels were tested in 46° storage with several heat-sealable foil and plastic materials as well as with glass jars and cloth bags. Germination and moisture content data suggest that polyethylene about 4 mils in thickness is the best packaging for all three species. Thicker 10-mil polyethylene sometimes performed just as well or even better, but results were inconsistent. Thinner polyethylene bags and sealed glass jars were very poor. Some foil-plastic laminates (2.5 mils) were good but not outstanding. Polyethylene that allows some oxygen diffusion appears to be best. A similar conclusion has been reached by Dr. Schonborn of Germany in his research on acorn storage.4/

The drawback to this method of storage is that sprouting in the bags is common. A majority of the sprouting acorns survive and grow in germinators, but might not do so under field conditions. A possible solution is to inhibit the sprouting chemically and then reverse the inhibition with a second chemical when sowing time arrives. The third possible attack on the acorn storage problem, as mentioned previously, is based on this reasoning.

4/ Schonborn, A. von. 1964. Die Aufbewahrung des Saatgutes der Waldbaume. BLV Verlagsgesellschaft, Munich. 168 pp.

Table 1.--Germinative capacity of cherrybark oak acorns after 6 and 18 months of storage

Storage temperature (°F.)	Container	Original moisture content					
		31 percent		45 percent		50 percent	
		6 mo.	18 mo.	6 mo.	18 mo.	6 mo.	18 mo.
		Percent					
37	Cloth	0	0	0	0	0	0
	Polyethylene	80	9	99	99	100	93
46	Cloth	0	0	0	0	0	0
	Polyethylene	76	0	99	96	98	95

Table 2.--Germinative capacity of Shumard oak acorns after 6 and 18 months of storage

Storage Temperature (°F.)	Container	Original moisture content			
		32 percent		52 percent	
		6 mo.	18 mo.	6 mo.	18 mo.
		Percent			
37	Cloth	0	0	0	0
	Polyethylene	90	4	100	68
46	Cloth	39	0	87	0
	Polethylene	28	15	94	0

Table 3.--Germinative capacity of water oak acorns after 6 and 18 months of storage

Storage temperature (°F)	Container	Original moisture content			
		26 percent		46 percent	
		6 mo.	18 mo.	6 mo.	18 mo.
		Percent			
37	Cloth	0	0	0	0
	Polyethylene	14	0	76	20
46	Cloth	0	0	0	0
	Polyethylene	22	0	64	61

The first step in this direction at the State College Taboratory was to test a group of germination inhibitors on cherrybark acorns. Abscisic acid, coumarin, maleic hydrazide, CICP, and CCC were tried, but only CCC at 10^{-1}M strength in the germination dish inhibited germination. A study was installed in the fall of 1969 with Nuttall oak acorns to see if CCC will prevent sprouting during storage. It will probably be repeated with cherrybark acorns this fall.

A difficulty, though not a major one, is damage from microorganisms.

OTHER SPECIES

In the past, I have generally grouped Carya species with the oaks when discussing storage requirements, but there now are indications that pecan and the hickories can survive much lower seed moisture contents. If so, long-term storage should be easier than for oaks. I have a small study under way with black walnut and a more extensive one with sweet pecan, shagbark hickory, and nutmeg hickory.

I also formerly included water tupelo seeds in the high-moisture group. In a water tupelo test that is almost identical to the acorn studies described earlier, data after 6 months indicated that drying to moisture contents as low as 10 to 15 percent does not destroy viability. This result, and the absence of sprouting in the containers, lead me to hope that long-term storage of water tupelo will not be difficult.

SUMMARY

To summarize, I would say that red oak acorns perhaps can be stored by raising their moisture content to 45 to 50 percent and holding them a few degrees above freezing in polyethylene bags with a wall thickness of at least 4 and not more than 10 mils. Sprouting in storage will occur with some species. I am currently testing chemical methods of preventing this sprouting.

Pecan, hickory, walnut, and tupelo seeds can probably be stored under similar, but less stringent, conditions.