

GOOD SEED QUALITY- HOW TO OBTAIN IT AND KEEP IT

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All sound artificial regeneration programs (with the exception of *Populus*) start with the same raw material: seeds. Seeds are the "bottom line", and yet they are often poorly understood and poorly treated. To produce high-quality seedlings, one must start with high-quality seeds. This paper reviews current knowledge on how to obtain and keep good seed quality for eastern hardwoods. Although most of my research experience has been with southern hardwoods, the principles of good seed handling are largely universal.

OAKS

Oaks present seed problems because they do not behave like other temperate-zone trees. Unlike the seeds of most other species, acorns cannot be dried for handling and storing. If the moisture content of acorns drops below a minimum level (35 percent for white oaks, and 25 percent for red oaks), the acorns will die. We call such species "recalcitrants", as opposed to the "orthodox" species, which behave nicely when dried to a moisture content below 10 percent.

Collecting and Cleaning

Acorns should be collected when absolutely mature and not before. The best maturity indices are: (1) pericarp color change from green to brown or black in red oaks, and green to brown or mottled yellow-brown in white oaks; (2) easy separation of acorns from their cups without pressure.

There are also other signs of good acorn quality to look for. Cup scars should be bright in color, not dull or dark, when the cups are first removed. In acorns collected from the ground, the bright color fades after a few days; when this occurs, this characteristic is no longer as useful. Acorns should also be checked for evidence of infestation by *Curculio* or other insect pests. Numerous larval exit holes are a bad sign, and, if present, these acorns should be cut open to check for internal infestation. Infested acorns can still produce seedlings if the embryonic axes are not destroyed before planting. Evidence of heavy infestation means that collection should be extended to replace the damaged acorns.

The moisture content of acorns is the key to maintaining acorn quality. At full maturity when they are ready to fall, red oak acorns contain about 40 percent moisture, and white oak acorns, about 50 percent. A loss of about 5 percent moisture can be tolerated, but further drying will lower acorn quality. A drop of 15 percent usually means loss of viability. During collection of acorns from the ground, cutting tests should be carried out to check the moisture condition. If the cotyledons are dry and/or shrunken, the acorns should be put in water as soon as possible.

Rehydration and cleaning of desiccated acorns can be done in one step: flotation in water. Collections should be floated in water at the end of the day to remove leaves, trash, and insect-damaged acorns. If the acorns are very dry, all may float. In that case, they should be left in the water for up to 24 hours and stirred frequently. This extra time will allow the good acorns to imbibe enough moisture to sink. Floaters should be discarded, but they should always be checked by cutting tests to assess the condition of both fractions.

Storing

Immediately following flotation, acorns should be drained of excess moisture and placed in cold storage at *above freezing* temperature. They should never be stored at subfreezing temperatures, because at their high level of hydration, freezing would kill them. Surface moisture should be dried from acorns, but they should go into the cooler in a *moist* condition. After about a week, one should check to see whether moisture has collected in the bottom of the containers; if so, they should be drained.

Fiberboard drums with polyethylene bag liners make excellent storage containers. Polyethylene bags alone are fine, but they should have a wall thickness of 4 to 10 mils. No container or bag of acorns should be shut completely airtight. Moist acorns respire heavily and need to take in oxygen and expel carbon dioxide. Most nurserymen collect only enough acorns for one year's crop and do not attempt to hold any over in storage. Acorns store poorly and are prone to germinate in storage and grow long radicles, even at 2° C. Most red oak acorns can be stored for 3 years, but viability may fall to 50 percent in this period. White oak acorns (at least southern species) can be stored over just one winter before viability is lost.

The three key points about acorn storage are:

1. Keep them moist: 35 percent for red oaks; 45 percent for white oaks.
2. Keep them cool: 1° to 3° C.
3. Keep them "breathing": do not seal in airtight containers.

Stratification and Planting

Because acorns do not store well, fall planting is best, if possible. If not, red oaks should be stratified for spring planting. Species vary in their stratification requirements (Table 1), and there are also differences among geographic sources. Southern white oak acorns are not dormant and need no stratification, but acorns from extreme northern sources may benefit from several weeks of stratification.

Stratification is identical to storage, if proper imbibition, temperature, and containers are used. But to be sure, acorns should be imbibed overnight again, then put back into cold storage to start the stratification process.

In stratification as well as in storage, pregermination occurs frequently, and radicles up to 4 inches long are not uncommon when one is ready to plant. Although these radicles are easily broken in planting, that occurrence is not necessarily undesirable. Secondary bud primordia readily produce other roots to "replace" the broken ones, and thus no harm is done. In a study at our laboratory with pregerminated Shumard and cherrybark oaks, seedlings grown from acorns with broken radicles were just as big as those grown from acorns on which radicle damage was carefully avoided at sowing.

Table 1. Recommended stratification periods for southern red oaks in the Midsouth*

Species	Stratification period
	days
Q. <i>coccinea</i> - scarlet	30 - 60
Q. <i>falcata</i> var. <i>falcata</i> - southern red	30 - 60
Q. <i>falcata</i> var. <i>pagodaefolia</i> - cherrybark	30 - 45
Q. <i>nigra</i> - water	60 - 90
Q. <i>nuttallii</i> - Nuttall	30 - 60
Q. <i>phellos</i> - willow	30 - 60
Q. <i>rubra</i> - northern red	30 - 45
Q. <i>shumardii</i> - Shumard	60 - 90
Q. <i>velutina</i> - black	30 - 60

*Acorns should be fully hydrated at 2°C, with some exchange possible.

SMALL ORTHODOX SEEDS

These species present few problems in collecting, handling, and storing, because they are normally dried to low moisture contents for extraction and storage. The group includes sweetgum, sycamore, yellow-poplar, green and white ash, and black cherry. Key steps are collecting at the proper stage of maturity and careful drying of fruits or seeds for extraction and storage.

Collecting, Drying and Extracting

With the exception of black cherry, these species reach physiological maturity in early fall when the moisture contents of the fruit are still quite high. If collected and tested, they would germinate at this stage. The high moisture contents, however, make collection risky because large quantities of these moist fruits together are subject to overheating from respiration. As moisture contents decrease naturally, fruit color provides the key as to when to collect (Table 2).

If seed dissemination is not a problem, collectors can wait for minimum moisture contents. For example, because sycamore fruits do not start breaking up until after Christmas, their collection can be delayed. We recommend in the South that sycamore fruits be collected after all other seeds are collected.

Once collected, the fruits should be spread in a single layer for drying. Piles of green fruits overheat very quickly, and seed quality is lost rapidly. If dried outdoors on sheets, full sunlight is sufficient for these species. Indoors drying on screens or shelves is also satisfactory, but good air movement with fans may be necessary for proper drying.

Black cherry seeds should not be dried but should be depulped immediately. Then the seeds should be dried to 10 percent or lower moisture for storage. The drying should proceed slowly, especially at first when seed moisture is high. Air-drying is best, but low heat application (not over 30°C) can be used as seed moisture decreases.

Once the multiple fruits are open or disintegrating, they should be tumbled (sweetgum) or broken up by maceration (sycamore and yellow-poplar). For the latter two, a Dybvig macerator does a good job. The seeds must be dry for fruit maceration, because they do not separate well when moist. Poor separation encourages one to keep the machine running too long, which may result in seeds being damaged.

Dewinging and Cleaning

Yellow-poplar seeds can be handled better and upgraded if they are dewinged. Dybvig macerators can do a pretty good job on small lots. Large quantities can be dewinged in oat debearders.

Some people like to dewing ash samaras. If dewinging helps one to sow for good bed density, then it should be done. One should be careful with the seeds, however, because they are not protected too well against mechanical damage.

Table 2. Maturity indices based on changing fruit color.

Species	Fruit or cone color at maturity
<i>Fraxinus americana</i> - white ash	Yellow
<i>Fraxinus pennsylvanica</i> - green ash	Greenish-yellow or yellow
<i>Liquidambar styraciflua</i> - sweetgum	Greenish-yellow or yellow
<i>Liriodendron tulipifera</i> - yellow-poplar	Greenish-yellow or yellow
<i>Platanus occidentalis</i> - sycamore	Greenish-yellow or yellow
<i>Prunus serotina</i> - black cherry	Red-purple to dark purple

Cleaning seeds of this orthodox group is relatively easy. Air-screen cleaners do a very nice job. Upgrading of sycamore and dewinged yellow-poplar is possible to some degree on gravity separators.

Storing

These seeds are called "orthodox", because they do well in storage. Orthodox seeds should be dried to moisture contents of 6 to 10 percent and stored at -18° C to maintain good quality for at least 10 years. There may be a slight loss of quality after 7 or 8 years, which will be manifested by slower germination, but germination capacity should stay the same. Germination rate is always affected before germination capacity as seed quality declines.

These species may stay viable for 20 years or more, if conditions are precisely controlled; we don't really know the limits. Most nurserymen, however, will settle for 5 years of storage without major losses of seed quality.

One must be careful to prevent increased moisture contents in storage. Seed moisture contents will reach a state of equilibrium with the ambient humidity. At 4° C storage and with no humidity control, these orthodox hardwood seeds will equilibrate at about 20-percent moisture—much too high for proper storage. Under these conditions, seeds dried to moisture contents of 6 to 10 percent must be stored in airtight containers. If one's seed cooler has humidity control and relative humidity is kept down around 50 percent, airtight containers are not needed. In that humidity at 4° C, the orthodox seeds will reach equilibrium at 8 percent, a good level. Humidity control can be expensive, however, and using airtight containers is much cheaper.

Stratification and Planting

Sycamore has no dormancy and does not require stratification for spring planting. Like many non-dormant species, however, a short 1- to 2-week period of cold, moist stratification will improve rate and uniformity of emergence in the nursery.

Sweetgum has only shallow dormancy, although it increases from south to north. We recommend 30 days of stratification prior to spring sowing.

White ash, green ash, and yellow-poplar exhibit medium to deep dormancy, primarily from south to north. Fall sowing is probably best, if it can be scheduled, especially for northern sources. If spring sowing is necessary, green ash and yellow-poplar should be stratified 60 to 150 days. For southern sources, 60 days is long enough. White ash is tougher, so we recommend 30 days of warm stratification at 20° to 30° C, then 60 to 90 days of cold stratification at 2°.

Black cherry is another tough species. Along with latitudinal differences, dormancy also increases as source altitude increases. Even with fall sowing, stratification of up to 90 days is thought to be helpful. For spring sowing, stratification of 120 days is recommended. Some northern sources from low altitudes may start germinating within 120 days during stratification. If this occurs, the seed should be sown as soon as possible.

GENERAL CONSIDERATIONS

No matter which type of seed one is dealing with, some important general considerations are:

1. Scout the seed crop in advance to know its potential and plan accordingly.
2. Know seed maturity when you see it; do not collect too early just because it is convenient.
3. Be aware of seed moisture! Do not let acorns get too dry, and be sure that orthodox seeds are dry before subjecting them to further treatment.
4. Know the seed moisture level at crucial stages. Get an electric moisture meter for small seeds. Learn what a moist, high-quality acorn looks like and use cutting tests to check them.
5. Remove trash and bad seeds from the good ones.
6. Before storing or sowing, have the seeds tested for germination capacity and rate of germination, the best indicators of seed quality. If there is no time for a germination test, get a quick-test, the next best thing (leachate conductivity, tetrazolium staining, X-ray). Know the quality of the seeds!
7. For storage, get the moisture content correct, then store the seeds at proper temperature in proper containers.
8. For storage longer than 2 years, retest for both moisture and germination at intervals of 1 or 2 years.
9. Remember above all else: seeds are living plants that require proper care for survival.

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