Hardwood Seed

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Abstract

New Government programs are driving a renewed interest in planting southern hardwoods. Efficient production of planting stock requires an adequate supply of high-quality seeds. Current recommendations for collecting, extracting, cleaning, storing, and stratifying seeds of southern hardwoods are reviewed. Oaks are emphasized, but information is also presented for small-seeded hardwoods, drupes, and large nuts.

Introduction

Another big push for hardwoods—that's what we are hearing these days. Increased demand for seedlings of southern hardwoods is driven by Federal programs in wetlands rehabilitation and restoration, urban tree plantings, and stewardship programs. Some will say that there has been strong interest in hardwood seed technology and seedling production all along. But is that true? I reviewed the published proceedings of the southern (formerly southeastern) nursery conferences

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from 1964 to 1990 for talks on hardwood seeds. The last formal presentation to include hardwood seeds was in 1978, and that was only half a page in a talk on nursery production of hardwoods. In contrast, from 1964 to 1976, at least one paper on hardwood seed problems was given at one of the split sessions. The record was set in 1966 with four. If technical papers at our nursery conferences are good indicators of subject matter interest, peak interest in hardwoods occurred in the late sixties and early seventies, with a long drought since 1978. I think that we are overdue for a presentation on hardwood seeds.

I would like to approach this topic by grouping hardwood species by fruit or seed type, then reviewing current practices and recommendations. For some species, recommendations made in 1964 still hold true, either because the solutions of the sixties are still the best, or because a lack of interest in a particular species or problem has allowed researchers to ignore it without arousing protests from nursery workers.

Oaks

The best indications of maturity in acorns are their physical characteristics (Bonner and Vozzo 1987). Among red oaks, the following are indices of a mature acorn:

1. The pericarp loses its green color and turns primarily dark brown or black.
2. The acorn can be easily separated from its cup without being forced or without leaving pieces of the cup attached to the pericarp.
3. The cup scar is bright in appearance. In southern red and cherrybark oaks, the cup scar may be pink or orange. Yellow or orange is common in some other red oaks.
4. A cross-section cut of the acorn will show the following colors: high-fat species (water, willow, cherrybark), dark yellow to orange; low-fat species (Shumard), light yellow.

Among white oaks, the following are indices of mature acorns:

1. For most species, the pericarp loses its green color and turns primarily brown or black. White oak and swamp chestnut oak are sometimes exceptions to this rule, since acorns from many trees are physiologically mature while still yellow or even a mottled yellow and green.
2. The acorn can be easily separated from the cup as in the red oak group. Overcup oak is an exception to this rule, because the acorns retain their cups when they fall.
3. Acorn cross-sections will show the cotyledon to be firm and white to yellow in color.

For post-collection care, moisture condition is all-important. At maturity, red oak acorns contain about 40-percent moisture and white oak acorns about 50 percent (Bonner 1974b, 1976b). It is very important to prevent excessive drying. A 5-percent loss of moisture can be tolerated, but further drying will lower acorn quality. Viability will be completely lost when

moisture content drops to about 25 percent and remains there. Laboratory tests have indicated that water oak acorns will survive temporary desiccation in the 15- to 18-percent moisture range if they are rehydrated quickly (Agmata 1982). During collection, however, the key to obtaining high-quality acorns is avoiding any desiccation.

On the day of collection, acorns should be floated in water to remove leaves, acorn cups, insect-damaged acorns, and other trash. Sound, healthy acorns should sink in water. This step also is a major aid to maintaining desirable moisture levels. If conditions are extremely dry at collection, the acorns should be left in water for 16 to 24 hours to raise their moisture content. This step is critical for acorns collected from the ground, because many sound acorns will float at first. Acorns collected during wet weather are usually moist enough to permit good separation without a soak period. With large batches (a bushel or more), some stirring is needed to give all acorns a chance to float.

After flotation, the trash should be skimmed off and the water drained away. Acorns should then be

placed in cold storage, even if they are to be planted in a few days. Surface drying before storage is not necessary as long as there is not enough water present to form a pool at the bottom of the container. If cold storage is not available, use the coolest alternative: an air-conditioned room, a basement, or a shady spot with breezes.

Flotation should remove most of the acorns infested by weevils. If additional steps are desired, there are two possible methods: hot water dips and chemical fumigation. Hot water is the simplest; immerse acorns in water at 50 °C (120 ^{0}F) for 40 minutes. Several fumigants will do the job, but their use is risky because of the high moisture content of acorns. It is best to do nothing except flotation. Many surviving larvae will emerge when the acorns are placed in cold storage and die in the bottom of the storage container. They do not attack mature acorns, so infestation cannot increase.

Because acorns are so sensitive to desiccation, they cannot be dried for storage. Because they cannot be dried, they cannot be stored below freezing. For red oaks, the best storage method is one that maintains

acorn moisture content above 30 percent, allows some gas exchange with the atmosphere, and keeps the temperature at 1 to 3 °C (34 to 37 °F). Gas exchange can be controlled by storing the acorns in polyethylene bags 4 to 6 mils thick. Under these conditions, southern species such as water, Nuttall, and cherrybark oaks will maintain good viability (60 percent or more) for at least 3 years (Bonner 1973). Very similar methods have proven successful for northern red oak and scarlet oak (Farmer 1975; Suszka and Tylkowski 1982). Shumard and willow oak acorns do not seem to store as well.

With rare exceptions, acorns of the white oak group cannot be stored more than 4 to 6 months (over winter). These nondormant species sprout very readily in storage and die rapidly. The best recommendation for white oaks is to "store" them in the ground by planting in the fall.

If white oaks are held over winter for spring planting, the best conditions are almost the same as those recommended for red oaks: temperatures at 1 to 3 °C (34 to 37 °F), maximum acorn moisture content (45 to 50 percent), and containers that allow gas exchange.

There is good evidence that cloth bags or thinner polyethylene bags (1.75 mil) are better for white oak, because of the need for greater aeration (Rink and Williams 1984). The preceding recommendations for flotation and for ignoring weevil larvae apply to white oaks also.

Red oak species vary in their degree of dormancy and in the amount of stratification required to overcome it. Proper storage conditions usually serve as a substitute for stratification, but it is useful to know the recommended stratification periods (table 1).

Many red oaks will begin germinating during the stratification period, as they do in storage. The higher the stratification temperature, the greater the amount of presprouting that will occur. Although presprouting can make sowing more difficult in nurseries, it does not necessarily decrease the chances of a good seedling crop (Bonner 1982). If red oaks are planted in the fall or winter without stratification, presprouting can be avoided, but uniformity of emergence in the spring may suffer.

Table 1.—*Recommended stratification lengths for southern red oaks in the Midsouth*[1] *(Bonner and Vozzo 1987)*

Species	Stratification period (Weeks)
scarlet	4-8
southern red	4-8
cherrybark	4-6
water	8-12
Nuttall	4-8
willow	4-8
northern red	4-6
Shumard	8-12
black	4-8

[1]Should be fully hydrated at 2 °C (36 °F), with some gas exchange possible.

Sweetgum, Sycamore, and Yellow-poplar

These species all have multiseeded fruits that must be dried for seed extraction. While the seeds are immature, all three fruits have green exteriors that turn various shades of yellow-green to yellow when the seeds are ripe enough for collection (Bonner 1972, 1976a). Completely brown exteriors may indicate full natural maturity, but delaying collections to this point means risking losing most of the seeds to natural dissemination. There is little danger of this happening to sycamore, since these fruits seldom break up before January. Fruits of all three species can be collected when the dark green color fades to greenish yellow or yellow. The seeds are physiologically mature at this point, but they also still contain enough moisture to present problems in transport and drying.

Solar drying on large canvas or plastic sheets is suitable for all three species. They can be dried more rapidly in the stack-tray driers commonly used for pine cones. In this system, supplemental heat usually is not needed; the blowers can do the job alone.

Sweetgum seeds can be extracted with any tumbling system once the fruits open. The aborted seeds, commonly called "frass," can be easily removed by screening, and light seeds can be removed by air

separation (Bonner 1987). Water flotation is an alternative cleaning process that works well on small lots.

Dried sycamore and yellow-poplar fruits can be broken apart in macerators, such as the Dybvig. Another system for sycamore is to run fruits through a fertilizer spreader that is turning with wheels elevated above the ground. On a windy day the fertilizer spreader also does a good job of removing the tiny hairs from sycamore seeds. These hairs are a safety hazard, and all workers cleaning sycamore seeds should wear masks. Air-screen cleaners also do a good job of cleaning sycamore. Many empty sycamore seeds can be removed with gravity tables after the fine dust and hairs have been removed (Bonner and Switzer 1974).

Everyone should consider dewinging yellow-poplar. A Dybvig macerator can be used on small lots, and oat debearders can be used on large lots. Once dewinged, a sizable proportion of empty seeds can be removed with gravity tables, effecting considerable upgrading of seed lots (Bonner and Switzer 1971). These steps provide much better control of bed densities and considerable savings in storage space.

All three of these species are considered orthodox in their seed storage behavior, which means that they are easy to store. Moisture contents should be reduced to 6 to 10 percent and maintained at this level during storage. Temperatures within a few degrees of freezing are satisfactory for short-term storage (1 to 3 years), but subfreezing temperatures should be used for longer storage.

Sycamore seeds are not dormant, and pretreatments are not necessary before sowing (Bonner 1974d). Sweetgum has only shallow dormancy that can be overcome with 2 to 4 weeks of stratification at 3 °C (37 °F) (Bonner 1987). Yellow-poplar, the most dormant of the three, typically requires 60 to 90 days of stratification at 2 °C (36 °F) for timely germination (Bonner and Russell 1974).

Ashes and Maples

Green ash, white ash, red maple, and silver maple seeds are all winged samaras that change from green when immature to greenish yellow or reddish brown when mature. These color changes are good maturity indices for collection. Ash maturity is also indicated by a

white to creamy-white embryo that will break when bent between two fingers (Bonner 1974a).

Following collection, the samaras of red maple and the two ashes should be spread to dry. They are orthodox in storage behavior and should be dried to moisture contents of 6 to 10 percent for handling and storage, even for periods as short as 1 or 2 months. Silver maple seeds are intolerant of desiccation (recalcitrant) and, like acorns, they should not be dried at all. They are also extremely difficult to store and should be sown immediately without pretreatment when they are collected in the spring (Olson and Gabriel 1974).

While the two ashes can be dewinged in macerators if desired, maple seeds are more tender. Dewinging of maples is generally not recommended.

Both maples germinate readily without any pretreatment, but the ashes are dormant at maturity. Green ash should be stratified for 60 to 90 days at 1 to 3 °C (34 to 37 °F), and white ash generally requires the same conditions for about 8 weeks (southern sources) to 20 weeks (northern sources) (Bonner 1974a, 1975). Sowing in the fall is a

convenient alternative to stratification and sowing in the spring for white ash.

Dogwood, Black Cherry, Tupelos, and Magnolia

The fruits of these species are all classified as drupes: fleshy indehiscent fruits with seeds enclosed in hard endocarps. Exterior fruit colors are the desired maturity indices: red for magnolia and dogwood, purple for the tupelos and black cherry. These fruits should not be dried after collection, because drying the pulpy exterior makes seed extraction more difficult. The fleshy coverings should be removed with macerators or by hand rubbing over hardware cloth. The fragmented material can be removed with running water, allowing full clean seeds to sink.

The cleaned seeds should be spread in a single layer for drying. Additional cleaning, if necessary, can be done at this point by gentle dry maceration followed by air or screen cleaning. All of these species are orthodox in storage behavior, so storage conditions should be the same as those used for sweetgum, sycamore, and green ash.

All of these species exhibit seed dormancy, and

various lengths of stratification are required to overcome it (table 2). In laboratory tests, we have obtained very good results with aerated water soaks at 3 °C (37 °F) as a substitute for stratification for black cherry. Scarification of the bony endocarp is sometimes used on dogwood (Brinkman 1974a).

Walnut and Hickories

Maturity indices are no problem for the single-seeded fruits (nuts) of this group. They should be collected quickly when they fall to avoid losses to rodents. Water flotation can be used to remove empty nuts of most hickory species as well as black walnuts that have been dehusked. Removal is easiest when the husk material is firm but still slightly soft. Small lots can be cleaned in Dybvig macerators or corn shellers; large lots require mechanical huskers. No matter which method is used, cleaning is difficult if the husks are allowed to dry completely (Brinkman 1974b).

Most nurseries sow unstratified nuts in the fall, but sowing stratified nuts in the spring is feasible. Black walnut requires 90 to 120 days of moist stratification at 3 °C (37 °F) (Brinkman 1974b). Most hickories require 90 to 150 days, although pecan's lesser dormancy usually can be overcome in only 30 to

Table 2.—*Recommended germination pretreatments for drupaceous seeds*

Species	Stratification period (Months)	References
black tupelo	1	Bonner 1974c
water tupelo	1	Bonner 1974c
magnolia	3 to 6, or fall sowing	Olson and others, 1974
flowering dogwood	4, or fall sowing	Brinkman 1974a
black cherry	4 to 6	Grisez 1974

90 days (Bonner and Maisenhelder 1974).

Walnuts and hickories are seldom stored over long periods, and experiments on storage techniques have been few. Pecan and shagbark hickory store best at low moisture (5 to 10 percent) at temperatures just above freezing (Bonner 1976c). Successful storage of black walnut for 4 years in outdoor pits has been reported in Indiana (Williams 1971). The seeds of all of these species belong to the group described as sub-orthodox in storage behavior (Bonner 1990). They can be dried to low moisture levels, but their high oil content prevents long-term storage like that of sweetgum or ash.

Summary

This has been a brief review of seed handling procedures for 12 hardwood genera. I hope that we don't have to wait another 14 years before the subject is discussed again! Let me close with a few key points for each group:

* Oaks - Moisture is the key; avoid drying.
* Sweetgum, etc. - Don't collect fruits until

the bright green color fades.

* Ash, maple - Color changes indicate maturity.
* Dogwood, other drupes - Remove pulp.
* Walnut, hickories - Consider sowing in the fall.

Some of you may be growing other hardwoods that I have not mentioned. My best recommendation is to refer to Agricultural Handbook No. 450, "Seeds of Woody Plants in the United States" (Schopmeyer 1974). This book was published in 1974 and needs revision badly. Until that happens, however, the 1974 edition will have to do.

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