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HARDWOOD SEED COLLECTION AND HANDLING

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INTRODUCTION

In a surprisingly few years a major proportion of the South's timber stands will be artificially regenerated with selected or genetically improved stock. Success with southern pines and high stumpage prices for certain species will spur efforts in hardwood stands. Intensive hardwood forestry will require better methods of seed production and handling than those available today.

The amount of time and money invested in producing improved lines dictates that all good seed be collected and that nothing happen during processing or treatment which will lower their quality. A lot is known about conifer seed but little about hardwood seed. Action, now, can solve some of the handling problems associated with hardwood seed before they become critical.

The following pages describe present handling procedures; we will learn which ones must be improved and which areas require additional knowledge.

SEED PRODUCTION

Seed yield data for hardwoods, either on a tree or on a site basis, are few and far between. The most comprehensive studies have been with oaks from the Appalachians (Beck and Olson 1968, Downs and McQuilkin 1944, Tryon and Carvell 1962) and elsewhere (Minckler and Janes 1965, Christisen 1955, Gysel 1957, Sharp and Sprague 1967, Cypert and Webster 1948, Heeren 1969). Data have also been published on sweetgum

(*Liquidambar styraciflua* L.) (Fenton 1964, Kearney and Bonner 1968), yellow-poplar (*Liriodendron tulipifera* L.) (Carvell and Korstian 1955), and swamp tupelo (*Nyssa sylvatica* var. *biflora* [Walt.] Sarg.) (DeBell and Hook 1969). All of these studies measured seed production in natural stands, and most of them revealed considerable variation in production between trees and between sites.

At the current level of hardwood seedling production in southern nurseries, a lack of seed production data is not extremely damaging. Collections from scattered and varying stands can usually furnish the relatively small amounts of seed required.

As hardwood tree improvement programs come into their own, new information on seed production will be increasingly important. We will need to know which sites should be used for seed orchards. Although there are no conclusive data for any species, seed production is probably best on the sites where growth is most rapid. We will also need more precise information on seed production per tree and on the influence of cultural practices, such as fertilization and irrigation, on production.

Most hardwood species seem to be more consistent seed bearers than the southern pines. Good seed crops are the rule for green ash (*Fraxinus pennsylvanica* Marsh.), sycamore (*Platanus occidentalis* L.), and sweetgum, for instance. On the other hand, large acorn crops in a particular locality may be spaced three or more years apart.

COLLECTION

The single most important rule for gathering seed in natural stands is to collect only from the best formed and most vigorous trees. Though well known, this rule bears frequent repeating, because seed collectors often are inadequately supervised. Another standard precaution is to avoid trees that are isolated from other members of their species, both in open areas and in stands. Isolated trees are likely to be self-pollinated and usually do not bear many good seed. Their fruit crop may be heavy, especially if they are growing in the open, but the number of filled seed is likely to be low. Full seed from these trees are just as good as other full seed but there usually are not as many of them.

In natural stands, the tops of recently logged trees are still the cheapest source of seed of most hardwood species. A little advanced scouting on timber sales is well worth the effort; the size of seed crop can be checked and the time of maturity can be estimated. Collecting just as the seed mature is most crucial for multiseeded fruits, such as sweetgum and

yellow-poplar, because once released from the fruit, these seed are almost impossible to gather.

Of course, larger, single-seeded fruit, such as acorns or tupelo drupes, can be gathered from the ground under standing trees. Nevertheless, acorns can usually be obtained more quickly and cheaply from tops of logged trees. The ideal tree top is one that was felled just prior to natural abscission of the acorns. Most acorns are jarred loose as the tree hits the ground, and they can be scooped from beneath the branches. Acorns that remain on the branches usually can be easily picked by hand after a day or so of drying.

Gathering of immature seed is a big problem, particularly where free-lance collectors and idle fire crews are depended upon. These people tend to pick early because they are anxious to fill their quotas as quickly as possible. Immature seed germinate poorly, if at all, and their use wastes nursery labor and bed space. Fortunately, there are good rules of thumb for timing collection of most species.

For sweetgum, collection is safest when the lustrous green color of the fruit head fades and the spines turn brown. These changes occur in September through October in central Mississippi. In southern Mississippi, fruit heads rarely change color (Wilcox 1966), but seed is good when collected early in September. We have found that seed from some trees are physiologically mature by mid-August, but I do not recommend collecting that early.

Acorns are generally ready for collection when the micropylar end turns brown, usually in October. Mature acorns are heavy and have a bright color. Cup scars of cherrybark oak (*Quercus falcata* var. *pagodaefolia* Ell.) acorns, for example, may be bright pink, orange, or white. If collections are made under standing trees, the first acorns to fall should be discarded, as they are usually immature or insect-damaged.

Oaks cut too far in advance of natural acorn maturity present a problem. A certain amount of ripening will occur in acorns still attached to branches, but no one knows how much. The best rule of thumb when collecting acorns from the branches of recently logged trees is to take only those that slip easily from the cups. If the acorn must be twisted or tugged from its cup, it is probably not mature.

The samaras of both green ash and white ash (*Fraxinus americana* L.) can be collected when their green color fades to brown, usually in October in central Mississippi. If collection is postponed until the samaras are completely dried, the clusters will shatter easily. Under these circumstances, collection from logged trees is difficult.

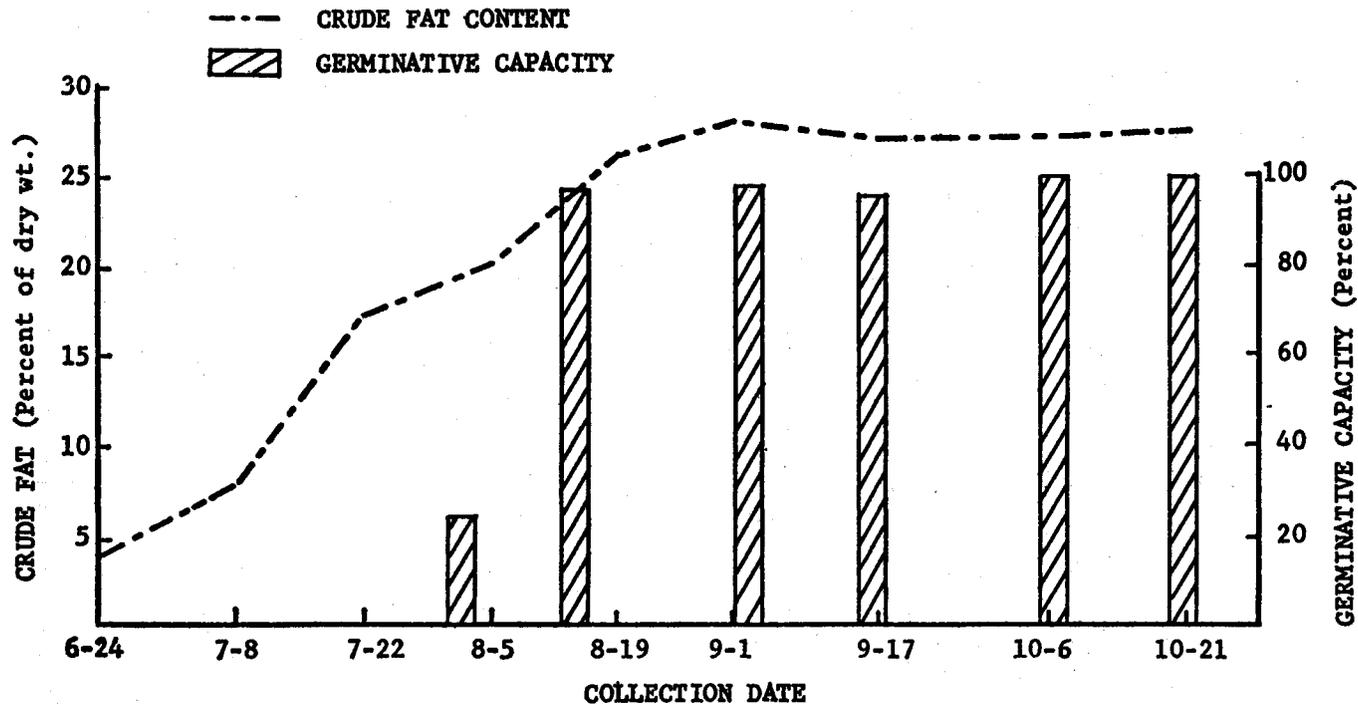


Figure 1. Changes in crude fat content and germinative capacity of sweetgum seed from a single tree in Oktibbeha County, Mississippi.

Yellow-poplar seed have been expensive to collect, because for every good seed, five to twenty empty ones are collected. Picking cones from the tops of logged trees has been the best method for yellow-poplar, but timing is important. Cones picked while still green yield immature seeds. When the exterior carpels turn tan to light brown—usually in October in the South—the cones are ripe. Yellow-poplar will also stand some ripening on the branches after trees are cut but we do not know how much. Because cones that were too green when picked tend to turn much darker when they dry than do cones that dry naturally on the standing tree, very dark cones on tops of logged trees should be avoided.

A change in color indicates maturity of swamp tupelo fruit. The skins on unripe fruit are green and they are deep black-purple or black when mature. In the mid-South, maturity occurs in late October and November. When depulped, swamp tupelo seed may be pink, white, or black; all colors germinate equally well.

Sycamore fruit can be collected late in the fall. They persist on the trees well into winter before they disintegrate, and there should be no difficulty in obtaining plenty of seed after all other species have been gathered. Fruit may be collected any time after turning brown; this is usually in late October in the mid-South. Some crews gather sycamore fruit early and I suspect that some poor seedling stands have resulted.

Avoidance of isolated trees is particularly important for sycamore. Individual trees vary widely in percentage of full seed per fruit, and the species is apparently highly self-incompatible (Beland and Jones 1967).

There are several new developments in tree seed collection that should be mentioned. At least in some species, seed maturity can be determined through chemical analyses. Crude fat content of noble fir (*Abies procera* Rehd.) seed and reducing sugar content of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) seed are being used to time cone collections by one company in the Northwest (Rediske 1967). Our research at State College indicates that crude fat content of sweetgum seed could be used to indicate maturity in this species. A concentration of about 25 percent is associated with good, complete germination (Fig. 1).

Another new development is artificial ripening of seed picked before maturity. This technique was first tested on conifers on the West Coast (Silen 1958, Krugman 1966) and was fairly successful. It will also work with sweetgum (Bonner 1970). Fruit heads picked as early as July 19 were artificially ripened by moist storage at about 41°F. until late September. Artificial ripening increased seed yields and seed quality for seed collected up until the middle of August. It is doubtful whether this

procedure would be practical for extending the collection season for sweetgum on a production scale, but it could be used to salvage some seed when inexperienced collectors deliver immature fruit heads.

We have also tried artificial ripening of sycamore, green ash, and water oak (*Quercus nigra* L.). Of these three, only sycamore has shown any response and the benefits were too little to justify the method.

EXTRACTION, CLEANING, AND PROCESSING

Hardwood fruit and seed should, in most cases, be dried immediately after collection to avoid damage from molds and from overheating in confined storage. Air drying in shallow layers is the standard method, but artificial drying would probably work for most species. We have successfully dried small lots of sweetgum and sycamore fruit in laboratory ovens at State College without any apparent damage.

Seed with naturally high moisture contents, such as acorns, pecans, and walnuts, can be placed directly into storage or stratification without drying. Excessive drying can be very damaging to acorns.

Mechanical macerators, either commercial or homemade, can be used to shake sweetgum seed from dried fruit heads, to break up sycamore fruit, and to shatter dried yellow-poplar cones. Some commercial models can be used with water to depulp fleshy drupes or break up fleshy, multi-seeded fruits, such as Osage orange (*Maclura pomifera* (Raf.) Schneid.). There are good published descriptions of devices for cleaning sycamore seed (Webb and Porterfield 1969) and hulling walnuts (Churchwell 1964).

It is desirable and sometimes necessary to remove trash, fruit remains, empty or defective seed, and unwanted seed appendages from seed lots. Seed extracted by wet maceration can usually be separated from unwanted materials by water flotation. Good acorns, walnuts, and hickory nuts should sink in water, and trash and empty seed can be easily removed by flotation. If large numbers of these seed float, then samples should be cut open to be sure the floating seed are empty. Excessive drying can cause many good seed to float. If this problem occurs, a day or two in water may be needed to allow good seed to imbibe enough moisture to sink.

Standard air-screen cleaners or aspirators for seed processing efficiently separate dry materials. Air-screen cleaners, for instance, are very effective for cleaning lots of sweetgum and sycamore seed.

Little attention has been given to processing hardwood seed to in-

crease the proportion of sound seed in the lot. Two important species, yellow-poplar and sycamore, are plagued by great variation in the percentage of sound seed. The all too familiar result is practically no control over nursery bed density. With the advice of agricultural seed processing specialists at the Mississippi State University Seed Technology Laboratory, we have developed a technique for upgrading yellow-poplar seed lots. Dried and separated carpels are first dewinged in an oat debearder, and dust and wing fragments are removed in a large aspirator. The slightly polished seed are then run through a gravity separator to isolate the heaviest fractions, which contain most of the full seed. In a pilot test this past winter, we took 20 bushels of separated carpels that a cutting test showed to be 6 percent full and reduced them to 1.5 bushels of dewinged seed approximately 50 percent full. The processing recovered over 90 percent of all the good seed in only 8 percent of the original volume. Attempts to upgrade sycamore lots have not yet been successful.

STORAGE

Seed of most hardwood species must be stored through the winter if they are to be planted in the spring, and holding them for this length of time is seldom difficult. Major problems arise with long-term storage (five years and more), which is often needed to stockpile against poor seed years and to preserve germ plasm for breeding research.

All southern pine seed can be stored for at least ten years at 0°F. and a moisture content of no more than 10 percent without significant losses in viability (Barnett and McLemore 1970). These same conditions should also be sufficient for at least five years and probably longer for sweetgum, sycamore, green ash, yellow-poplar, and most other seed which can be dried to about 10 percent moisture without loss of viability. An exception to this rule is eastern cottonwood, which requires, in addition, low oxygen levels. Fresh cottonwood seed will keep for only about one week at room temperature; however, at storage temperature of 35° to 40° F. their viability can be maintained for three to five weeks (Gamage and Maisenhelder 1960). Seed of cottonwood can be held for two to three years by reducing the moisture content to about 6 percent and storing at temperatures just above freezing under a partial vacuum (Holmes and Buszewicz 1958).

Seed with naturally high moisture content are very difficult to store for long periods. In acorns of the red oak group, for example, drying to

a moisture content below 25 to 30 percent kills the seed, and so do storage temperatures below freezing at any moisture content. Because red oaks are important timber species and good acorn crops are not produced every year, acorn storage studies have high priority at the Southern Forest Experiment Station. Our best results have been obtained by raising the moisture content of the acorns as much as possible (45 to 50 percent of dry weight), placing them in sealed plastic bags, and holding the temperature a few degrees above freezing. The acorns remain viable under these conditions, but they also tend to sprout in the storage container. Research is currently aimed at preventing this sprouting.

In many hardwood species, seed lots with identical initial germinative capacities vary in their storage potential. A test is needed that will reveal differences in storage potential, indicating to the nurseryman which lots should be used quickly and which should be stored. Research has developed some promising techniques for agricultural seed. (Helmer 1967) that may also be applicable to tree seed.

STRATIFICATION

Seed of many hardwood species exhibit internal dormancy, which is best overcome by moist stratification. This treatment does not turn a bad or empty seed into a good one; it merely brings good ones to the threshold of germination.

Most seed are now stratified in polyethylene bags without a moisture-holding medium, a method commonly called naked stratification. Before they are placed in bags their moisture content should be raised to the proper level by soaking in water, usually overnight, at room temperature. Excess moisture should be poured off prior to refrigeration. Three or four days of soaking are required for hickory nuts and the water should be changed daily (Eliason 1965).

To maintain good aeration, bag walls should be no more than four mils. As an added precaution, bags should be turned over at least weekly and opened for airing every two or three weeks. Experience is lacking on the quantity of hardwood seed placed in each bag. The upper limit usually given for southern pines—25 pounds—should be applied to hardwood seed also, until data for individual hardwood species are obtained.

The best stratification temperatures for southern hardwoods are between 33 to 40° F. Freezing temperatures should be avoided.

Seed that mature in the spring, such as cottonwood and silver maple (*Acer saccharinum* L.), do not require any pregermination treatment. Information in the *Woody Plant Seed Manual* suggests the stratification

of sycamore. We also recommended this procedure at one time. Recent tests have shown conclusively, however, that sycamore seed are not dormant and do not require pregermination treatment. Our current recommendations for length of stratification for some other hardwood species are:

Species	Days of stratification
Sweetgum	14-30
Green and white ash	90-120
Swamp tupelo	overwinter
Yellow-poplar	overwinter
Sweet pecan	30-60
Water and willow oaks	60-90
Shumard, cherrybark, and Nuttall oaks	30-60

If the stratification period is too long, seed of some species will germinate in the bags. Red oak acorns are prime examples.

Acorns of the white oak group should be sown in the fall. They put down a root system in the winter, and the shoot emerges the following spring. White oak acorns can be stored overwinter for spring planting but a loss in viability must be expected.

Stratification can be bypassed for all species by fall planting of untreated seed. If the seed can be protected against birds and animals during fall and winter, the method is good. It is commonly done in northern nurseries and it is effective for red oak acorns in the South. Fall planting of untreated seed should also be strongly considered for the direct-seeding of hardwoods.

Effective stratification methods are available for all important species, but it is to be hoped that more can be done than merely to circumvent seed dormancy. Ideally, dormancy would be turned off or on as desired. The ability to turn it off would mean quick, uniform germination in the nursery bed and quick field germination for direct seeding. The ability to turn it on could mean easy storage for long periods of all tree seed. Research can provide the techniques that are needed.

CONCLUSIONS

It seems clear that knowledge about and methods for collecting and handling southern hardwood seed are adequate only because hardwood nursery operations are relatively small. It is embarrassing to compare the methods applied to hardwood seed with those for conifer seed. While mechanical tree shakers are used in southern pine seed-production areas,

idle fire crews and free-lance collectors gather hardwood seed. Pine cones are processed with specially designed commercial equipment; hardwood fruit are spread on the ground to dry behind the barn and extracted and cleaned with homemade equipment. Nearly all equipment and operations in tree nurseries are keyed to pine seedling production. Hardwood operations are carried out on a hit-or-miss basis that often misses.

The situation demands a remedy. If we are serious about genetic improvement and intensive culture of hardwoods, we must improve our methods for producing, collecting, processing, and treating southern hardwood seed.

Discussion

- Question:* Is anyone collecting acorns on ground cloths?
Mr. Bonner: Yes, some nurserymen do this and it is a successful method if the cloths are put down at the right time.
- The state of Illinois has a unique collection system. Cloths are spread under the tree and a man is sent up the tree with a sledgehammer; he beats the limbs with the hammer and shakes down the acorns. A tree shaker will also bring down a lot of seed.

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