TECHNOLOGY OF EASTERN TREE SEED--A 5-YEAR REPORT ON RESEARCH

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Approximately 5 years have passed since the Southern Forest Experiment Station's new tree seed research project got under way at State College, Mississippi. During these years a modern, 8,000-square-foot laboratory has been constructed; the staff of scientists has been doubled (to two), and research has been started on seed technology for eastern forest trees. I think that this group is entitled to a report on the third item--the research program. What have we learned in 5 years, and where should the greatest effort be directed in the future?

Some reading, some travel, and a great deal of thought was invested in our initial planning. We selected three areas where information was urgently needed and where research had some chance of at least partial success within 5 years or so. All three areas are in southern hardwoods, for gaps in knowledge are greatest with these species. Our problem areas are: (1) Maturity indices and methods of artificial maturation, (2) extended storage and measurement of storage potential for heavy-seeded hardwoods, and (3) methods for stimulating germination and for preventing or breaking dormancy. Taking them in order, let's see where we stand.

MATURITY INDICES AND ARTIFICIAL RIPENING

The greatest effort has been in describing seed maturation in the important southern hardwoods. We have proceeded by selecting four trees of each species and collecting seeds from them for 3 years, every 2 weeks from June until dispersal. Weight, size, moisture content, germinability, and in some cases specific gravity are measured. Extra fruits are taken from one tree of each species, and chemical analyses are performed for fat, carbohydrates, protein, phosphorus,, calcium, and magnesium.

These data give us a pretty good picture of seed maturation. Thus, we know that black cherry fruits increase in weight up into July, but that most of this increase is moisture (fig. 1). We know that cherrybark oak acorns do not start accumulating their storage carbohydrates until September (fig. 2). We have also been able to show tree-to-tree variation in date of seed maturity. In one trial, for example, acorns on some willow oaks were mature by September 21, while natural maturity on others did not occur until early or mid-October (table 1).

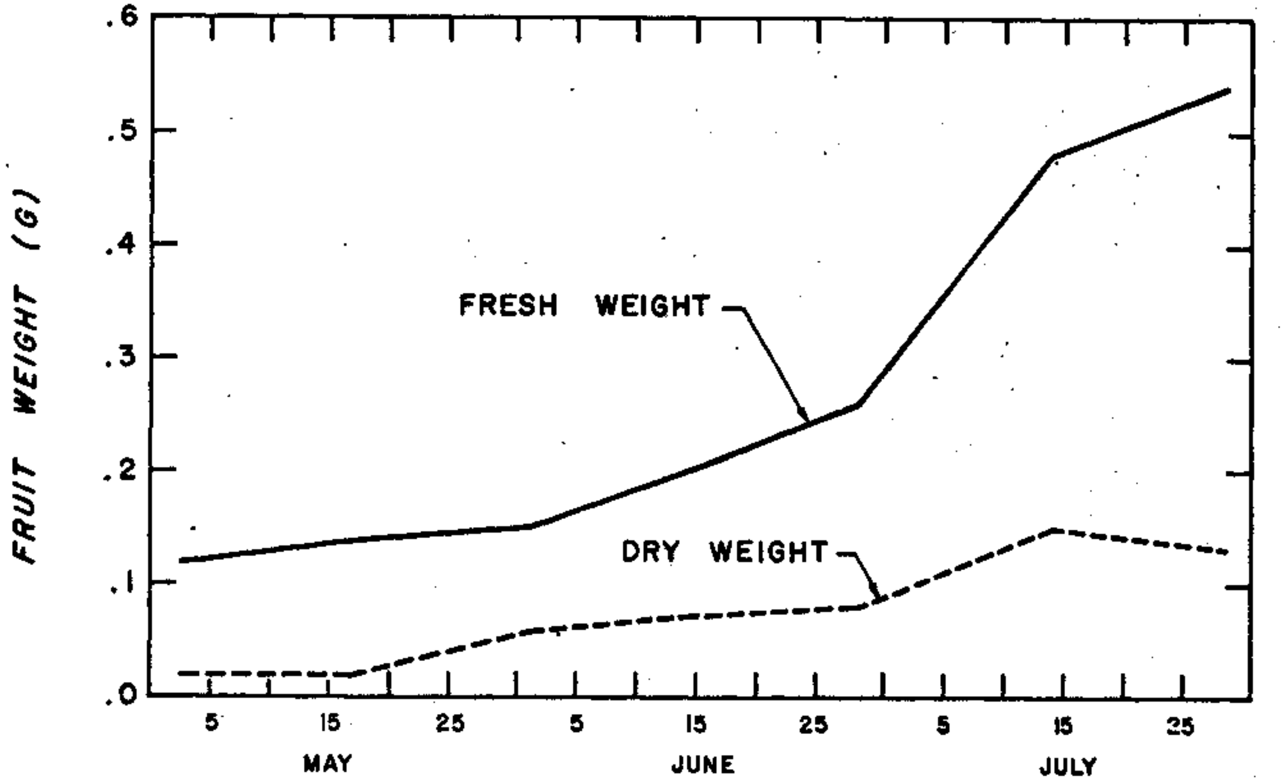

Figure 1.--Seasonal changes in fresh and dry weight for black cherry fruits in 1971. The data are averages for sour trees.

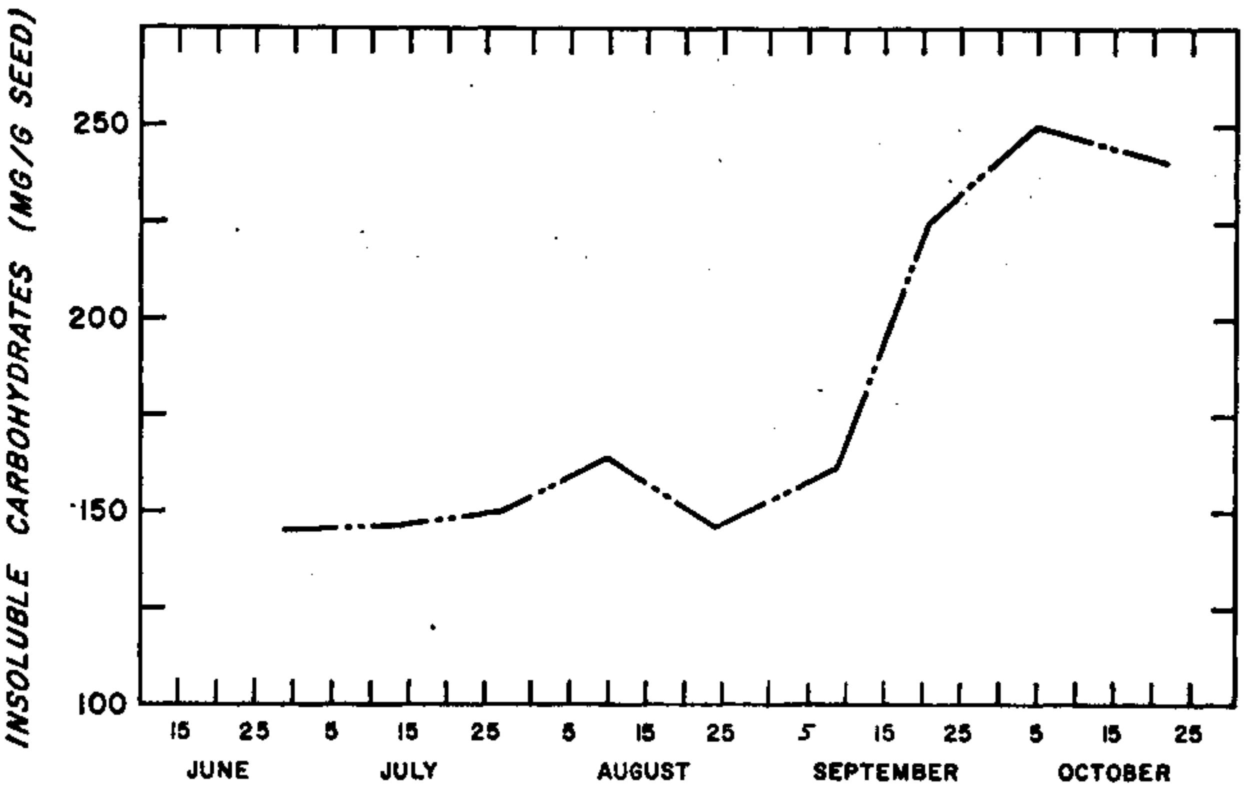

Figure 2.--Accumulation of insoluble carbohydrates in maturing cherrybark oak acorns.

Table 1.--Germination, after 60 days, for willow oak acorns collected during the fall from four trees. All samples were stratified for 30 days at 38°F.

Collection date	Sample tree 1	2	3	4
	- - - - - - -	- - *Percent*	- - - - - - -	
September 21	14.3	10.0	0	---
October 5	59.1	---	7.7	0
October 19	85.7	79.6	74.1	21.4
November 2	96.2	90.7	94.0	93.3

Data on maturation are complete for sweetgum, sycamore, green ash, water oak, willow oak, and cherrybark oak. Partial data are in hand for Shumard oak, yellow-poplar, white oak, and black cherry.

Our results suggest that color change is still the best indicator. When fruits lose their green vegetative color, they are ready for collection. Physiological maturity usually occurs before color alters much. Sycamore seeds, for example, germinate readily in early September, when the fruits are still quite green and have high moisture contents. Bulk collections should not be made at this time, however, because the moisture can easily lead to overheating in fruits.

Chemical indices of maturity for our priority species are available if we want them. At the present level of hardwood production in the South, however, the extra trouble required to perform these analyses does not seem justified. Specific gravity and moisture content of fruits have not been reliable indices.

Artificial ripening of fruits picked prior to maturity has proved possible with sweetgum. Moist, cool storage of fruit heads collected in mid-July preserves the seeds and allows some to mature. When natural germination was zero, sone artificially ripened fruits yielded up to 51 percent germination (Bonner 1970). Similar trials failed with green ash, water oak, and sycamore, but in tests last year yellow-poplar cones collected in early September yielded good seeds when processed after 2 months of moist storage at 38°F. This method may be more useful with yellow-poplar than with the easily collected hardwoods. Additional tests are planned.

Since seed moisture is important in collection and processing, we are working to improve ways of measuring it. One step is to calibrate drying in ovens with precise chemical methods, such as toluene distillation. Accurate oven methods have been established for sweetgum, sycamore, and green ash (Bonner 1972a). Work is currently under way on several oaks. The wide variation in moisture content between acorns in the same lot presents some difficulty, but can be overcome. At the same time, we are gathering data on equilibrium moisture contents of tree seeds held at various temperatures and relative humidities (table 2). This information is useful in making decisions on storage, and it is a good reminder that open Storage at high humidities can be very damaging.

Table 2.--Equilibrium moisture contents at 41° and 77°F. and various humidities. Data adapted from Bonner (1972a)

Temperature and relative humidity (percent)	Seed moisture content		
	Sycamore	Sweetgum	Green ash
	Percent		
77°F.			
39	8.0	7.1	7.7
57	10.5	8.5	9.1
76	12.8	11.1	12.6
91	19.3	15.9	20.1
41°F.			
40	9.2	8.3	8.3
95	20.8	19.5	23.0

Upgrading seed lots after collection has been successful with yellow-poplar. Dry carpels were dewinged in a debearder, then cleaned and separated into density fractions on a gravity separator. Lots originally 6 to 10 percent full were upgraded to 60 and 65 percent (Bonner and Switzer 1971). We have tried sycamore on the gravity separator, but with only moderate success. Starting with seed 33 percent full, we upgraded the lot to 53 percent full. More work is needed on this species.

Over the next few years we will finish our work on the maturation of fruits and seeds. During this time, we will investigate the potential of X-rays for determining maturity. After yellow-poplar, no other species will be studied for the potential of artificial ripening. Research on measurement of seed moisture will continue on the other important species. We will also continue work on mechanical upgrading of seed lots. The equipment and technology required for upgrading many species are on hand already. Nurserymen will just have to decide to take advantage of them.

STORAGE OF HEAVY-SEEDED HARDWOODS

How can acorns be stored from one year to the next? This question has been asked of us more frequently than any other. I believe we now have the answer, at least for red oaks. At the last Nurserymen's Conference, I reported 2-year results from our acorn storage study (Bonner 1971). Final data have shown good retention of viability in cherrybark, water, and Shumard oak acorns held for 3 years in polyethylene bags with walls 4 mils in thickness. Storage temperature was 38°F, and acorn moisture contents were 30 percent and higher (Bonner 1972b). Some sprouting occurred in the small test bags but is not likely to be troublesome in larger lots (3/4 to 1 bushel). We have installed a 5-year pilot study to confirm the success with larger amounts.

A test with sweet pecan and with shagbark and nutmeg hickories is still in progress, but early results suggest that storage requirements are not quite so rigorous as for red oaks. Moisture contents below 10 percent, for instance, can be used with these Carya seeds, and that means better storage. With all seeds, moisture content is the most important storage factor.

A 3-year study with water tupelo has just been completed. These seeds can be dried to 10 percent moisture and stored for 3 years at 37°F in polyethylene bags 4 mils thick. Even subfreezing temperatures of 14°F were satisfactory when seed moisture content was brought down to 10 percent.

Measurement of storage potential has progressed slowly. Agricultural methodology, such as the GADA test (Grabe 1965), looks good for small seeds (sycamore, sweetgum), but complications have arisen in application to red oak. We will increase our efforts, for here is where the greatest progress can be made in storage technology. Measurement of storage potential will allow the best utilization of all seed lots. In line with this work, we will initiate studies of physiological changes during storage and how they influence viability and vigor.

STIMULATING GERMINATION--DORMANCY

This third problem area has received the least attention, but some progress has been made nevertheless. We investigated the effect of gibberellic acid (GA) on germination of many major hardwoods. At concentrations of 100 to 1,000 p.p.m., GA was stimulative on every species tested, including sycamore, a nondormant seed. These levels are in line with published results for other tree seeds. We are now testing interactions of GA with chemical inhibitors on several red oaks. The data are interesting, but no secrets have been uncovered yet. I now believe that the payoff potential of research with chemical regulators is small.

In another study, we took a different approach by making extensive tests to determine the causes of dormancy in a single species--sweetgum. The results point to light-temperature effects as the key to delayed germination (Baker 1971). A spin-off from this work is a proposal for testing sweetgum germination at higher than normal temperatures.

To really make progress, we need to learn more about the very nature of seed dormancy and how to measure it. Recently completed work with water oak embryos has shown significant changes in cell ultrastructure during cold, moist stratification. Dormant embryos have the same organelles and plastids as stratified or germinating embryos do, but they are much less developed. The next step is to examine the seed coats of the embryo to see what changes stratification may be causing there. We have long felt that the covering structures of red oak acorns play a major role in the delayed germination of this group of species.

Within this approach, we will initiate research this year on vigor of tree seeds--how to define it, how to measure it, and how to improve it. The work will receive a lot of attention, and it holds great potential. The relationship of vigor to maturity, storage potential, and dormancy is ill-defined, but it is there.

SUMMARY

In summary, I would *say* that we have made very good progress in problem areas 1 and 2, and only fail progress in problem area 3. The highlights for nurserymen probably have been the method for upgrading yellow-poplar and the storage methods for red oak acorns, which look good at this point.

Over the next 5 years, we should gradually close out our work on maturity and decrease the empirical storage tests and the work with growth regulators. Research on measurement of seed moisture and processing will continue. We will expand our research on defining and testing seed vigor, storage potential, and dormancy. These problems present an exciting challenge, and their solutions should be useful to all nurserymen.

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