COMPARISON OF GERMINATION AND VIABILITY TESTS FOR SOUTHERN HARDWOOD SEED

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This paper summarizes a 3-year evaluation of 10 methods for testing germinability and viability of the seed of six species of southern hardwood. In five of the methods, the seeds were germinated. In the others, visual, biochemical, or physical properties were the criteria.

Cutting tests were best for sweetgum and Nuttall oak seed, while cutting or water germination gave equally good results on sycamore seed. Floating was best for eliminating bad willow oak acorns, and floating combined with visual inspection of sunken acorns was best for cherrybark oak. No reliable test was discovered for green ash seed.

Procedure

Seed was collected near Stoneville, Miss., in the fall of 1962, 1963, and 1964 from sweetgum, green ash, sycamore, willow oak, Nuttall oak, and cherrybark oak. Each year, five or more trees from each species supplied seeds which were air-dried, cleaned, and stored for about 4 months at 35 to 40°F. When required, moist stratification was imposed for 30 days at the same temperature.

In each year approximately 3,000 seeds were randomly selected from each species, and 10 sublots of 50 seeds each were then drawn for replications of each test.

The methods and test periods varied with species, and were based on past experience at the Southern Hardwoods Laboratory.

Nursery bed germination (all species).—Each 50-seed sublot was sown in randomized row plots across the width of the bed. Seedlings germinating abnormally were disregarded. Normal seedlings lost to predators, disease, or accident were counted as germinated.

Greenhouse test (all species).—Seeds were sown in a sand-peat moss mixture in peat cups. Normal seedlings only were counted.

Germinator test (oaks excluded).—Seeds were placed between wet paper blotters in nonlighted laboratory germinators maintained at 80°F. They were considered germinated when their radicles pierced the seedcoat.

Cutting test (all species).—Seeds were soaked in distilled water for 24 hours at room temperature to soften their coats, and they were then cut with a sharp knife. A seed was considered viable if it was firm, plump, and not discolored.

Excised embryo test (sweetgum, green ash).—The procedures of Flemion (1948) were followed. The seeds were soaked for 24 hours in distilled water at room temperature. The embryos were then removed with scalpels and dissecting needles and placed on filter paper kept moist in petri dishes in the laboratory under approximately 200 foot-candles of fluorescent light. If embryos retained their firm, light-colored condition or produced chlorophyll and began growth after 5 days they were counted as viable. If they had turned dark or had been attacked by molds, they were considered nonviable.

Floating test (oaks only).—Acorns were immersed in tapwater, and all that sank were considered viable.

Visual inspection (oaks only).—Acorns showing weevil blemishes on the shell, or dark, dull cup scars, were considered nonviable (method of Lotti 1959).

Floating and visual test (oaks only).—After a floating test, the apparently viable acorns were given a visual inspection.

Tetrazolium salt (TTC) test (all species).—The embryos were exposed by a slight cut in the seedcoats, and the seeds were placed in 1-percent aqueous solutions of 2,3,5-triphenyltetrazolium chloride (TTC) in petri dishes. After 24 hours in darkness at room temperature, the seeds were considered viable if they were completely stained, or

[1] The authors are stationed at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Miss., by the Southern Forest Experiment Station in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

partially stained with the unstained portions firm and white. Seeds were considered nonviable if they showed no staining, or were partially stained with the unstained portion dark and discolored.

Water germination. (sycamore only).—Seeds were germinated in small beakers of distilled water at room temperature under approximately 200 foot-candles of light (method of Briscoe and DuBarry 1959).

Results and Discussion

Except for the germinator test values with green ash, mean nursery bed germination was significantly lower than means from all tests (table 1).

Yearly variation in seed quality was reflected by the significance of the year effect. Apparent seed quality was poor in at least one year out of three for each species, with the possible exception of Nuttall oak.

A significant relationship was observed between test methods and collection years: it may be partly explained by nursery bed and greenhouse germination conditions. Year-to-year variations in soil conditions, both natural and manmade, may strongly influence germination, especially in the nursery, and this influence often is independent of seed quality. Natural variation in seed maturity and human bias in seed handling may also be important.

The cutting test, easiest of all to conduct, was satisfactory for sweetgum and sycamore seed. For sweetgum it was apparently just as good as the TTC and excised embryo tests. There was also little difference between results of the four laboratory tests for sycamore. When laboratory test results

TABLE 1.—*Test results for germinability and viability of seed of six southern hardwoods. (Any two means not enclosed in the same bracket differ at the 0.05 level of significance.)*

Test	Test period	Year			Mean
		1962	1963	1964	
	Days	*Percent*	*Percent*	*Percent*	*Percent*
Sweetgum					
Nursery	30	28.2	68.2	72.2	56.2
Greenhouse	30	31.2	84.8	74.8	63.6
Germinator	14	27.4	93.4	88.8	69.9
TTC	1	34.0	94.6	93.2	73.9
Cutting	—	36.6	97.2	91.0	74.9
Excised embryo	5	—	95.8	92.2	—[1]
Green ash					
Germinator	28	1.2	.6	74.0	25.3
Nursery	30	20.8	16.8	70.0	35.9
Greenhouse	30	67.8	39.8	66.6	58.1
TTC	1	69.0	52.6	90.4	70.7
Excised embryo	5	82.4	51.2	91.0	74.9
Cutting	—	82.0	61.4	89.4	77.6
Sycamore					
Nursery	21	16.8	12.0	13.8	14.2
Greenhouse	21	27.4	21.6	40.8	29.9
Water germination	7	30.6	34.8	50.8	38.7
TTC	1	36.0	42.8	47.4	42.1
Germinator	14	39.0	40.6	51.2	43.6
Cutting	—	36.0	42.2	62.4	46.9

TABLE 1.—*Test results for germinability and viability of seed of six southern hardwoods. (Any two means not enclosed in the same bracket differ at the 0.05 level of significance.)*

Test	Test period	Year			Mean
		1962	1963	1964	
	Days	*Percent*	*Percent*	*Percent*	*Percent*
Willow oak					
Nursery	90	—[2]	41.4	15.8	28.6
Greenhouse	90	—	52.4	18.0	35.2
Floating plus visual	—	—	87.8	43.6	65.7
Floating	—	—	91.0	44.8	67.9
TTC	1	—	84.0	80.4	82.2
Cutting	—	—	86.2	84.6	85.4
Visual	—	—	89.8	89.4	89.6
Nuttall oak					
Nursery	60	54.6	52.6	49.2	52.1
Greenhouse	60	75.0	73.8	70.6	73.1
Floating plus visual	—	89.4	45.0	82.4	72.3
Cutting	—	74.0	78.2	77.6	76.6
Floating	—	90.8	45.8	91.6	76.1
TTC	1	89.8	81.8	87.2	86.3
Visual	—	92.0	92.6	90.6	91.7
Cherrybark oak					
Nursery	60	—	16.6	48.0	—[1]
Greenhouse	60	85.0	39.2	50.4	58.2
Cutting	—	65.5	90.4	81.4	79.1
TTC	1	93.6	74.4	84.8	84.3
Floating plus visual	—	97.2	77.8	81.0	85.3
Floating	—	98.8	79.2	85.6	87.9
Visual	—	95.8	90.0	87.4	91.1

[1] These tests excluded from comparison of means because 1962 results not available.

[2] No willow oak acorns available in 1962.

only were analyzed, the years × test method interaction was not significant for these two species.

Green ash seed consistently had been difficult to test, especially in germinators. The 1962 and 1964 seed was apparently of good quality, but 1962 germination in the germinator and nursery was very low. On the basis of this study and others at our laboratory, the TTC method offers promise for green ash, but more work is needed to relate the results to actual germination.

Floating appeared to be a good method for the small acorns (willow and cherrybark). Floating tests indicated an apparent drop in viability in 1964 for willow oak, whereas the other laboratory tests did not (table 1). The decrease in cherrybark acorn quality in 1963 was indicated by the TTC, floating, and floating-plus-visual tests. Visual inspection alone or cutting did not appear to be satisfactory for these species.

The cutting test gave good results for Nuttall acorns and did not differ significantly from greenhouse germination. Floating was considered unreliable for these large acorns, since in 1963 it led to underestimation of viability (table 1).

Acorn moisture contents must be considered in any floating test. If acorns are collected when the ground is dry or if excessively dry after collection, many good acorns will float, and viability will be underestimated. Conversely, if the ground is moist, many bad acorns will sink, and viability will be overestimated. We experienced this difficulty in our 1965 collections of cherrybark acorns.

The TTC test has been reliable with conifers (Parker 1953, Grano 1958), and it is not difficult to perform with any of the species used in this study. With sweetgum and sycamore, TTC results did not differ significantly from germinator tests.

Conclusions

Although no viability or germination test results correspond exactly with nursery germination, several methods provide means for rough estimates of nursery germination based on the data in table 1. Tentative recommendations for individual species are as follows:

Species	*Best test*	*Expected nursery germination (percent) considering test results from table 1 as 100 percent*
Sweetgum	Cutting	70–80
Sycamore	Cutting	25–40
	or	
	Water germination	30–50
Willow oak	Floating	35–45
Nuttall oak	Cutting	65–75
Cherrybark oak	Floating plus Visual	30–60
Green ash	No reliable test	—

Fully matured seed and proper drying, cleaning, storing, and stratifying are prerequisite to accurate results. The expected germination values tabulated above should not be taken as absolute without trials to delineate differences due to seed source or local nursery conditions.

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