GERMINATION OF CHERRYBARK AND NUTTAL OAK ACORNS FOLLOWING FLOODING[1]

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Frequency and duration of flooding is undoubtedly one of the most important environmental factors affecting species distribution in bottomland forests. In the life of a tree this influence is first exerted on the seed, and the capacity of seeds to retain viability after submergence by flood water may well be an important factor in determining the success of a species in a particular ecological niche.

Bare sandbars and mud flats are colonized by cottonwood (*Populus deltoides* Bartr.), willow (*Salix nigra* Marsh.), and sycamore (*Platanus occidentalis* L.).[2] Seeds blow onto these sites immediately after flood waters have receded or are stranded by the receding waters. These seeds will remain viable many days in water and will actually germinate under water (Hosner 1957, Briscoe and DuBarry 1959).

Areas almost continuously flooded typically support stands of bald-cypress (*Taxodium distichum* [L.] Rich.) and water tupelo (*Nyssa aquatica* L.). The seed of these species has shown no capacity to germinate under water, but their germination percentage does not drop to zero even after months of submersion (Demaree 1932, Shunk 1939, Briscoe 1959, Applequist 1959).

Two other physiographic sites common in the bottomlands are (1) wet flats and (2) well-drained flats or low ridges. A species typical of the former is Nuttall oak (*Quercus nuttallii* Palmer); cherrybark oak (*Q. falcata* var. *pagodaefolia* Ell.) is rare except on the latter. Acorns of these two species were submerged for various periods to determine whether their responses differed.

Procedure

Acorns previously kept 4 months in moist stratification at 33-35°F were counted in 100-seed lots and randomly assigned to treatments, 4 lots to each treatment indicated in Table I. The cherrybark oak acorns and one lot of Nuttall oak acorns were collected near Baton Rouge, Louisiana. The other two lots of Nuttall acorns were collected near Plaquemine, Louisiana, and near Stoneville, Mississippi. All submersion treatments were terminated on April 16, 1958, and were begun prior to that date by the length of treatment indicated.

In selecting the length of periods for submerging the acorns one week was adopted as the basic unit. It was judged to be longer than the normal period of flooding on well-drained sites yet common on the poorly drained areas. Because the study was exploratory, the second length of period was twice the first, and the third was twice the second; with the check, these called for flooding periods of 0, 1, 2, and 4 wks. For operational convenience, the actual periods used were 0, 8, 18, and 34 days.

As pointed out by Bergman (1920) flooding effects can be studied much more economically in ordinary tap water than in swamp water. Therefore, seeds were submerged in both types to determine whether the results were the same, and thus whether future studies need be made in the swamp.

Table I. Germination of cherrybark and Nuttall oak acorns following flooding treatments

Water	Days flooded	Germination Percentages	
		Cherrybark oak	Nuttall oak
None	0	43	39
Swamp	8	42	45
	18	37	43
	34	24	40
Tap	8	44	44
	18	42	44
	34	26	42
Airless tap	8	43	
	18	38	
	34	28	
All waters	8	44	41
	18	41	44
	34	26	42

Submersion of acorns in the assigned water was in bags of saran screening, except that airless treatments were in sealed bottles of tap water sunk intermixed with the corresponding bags.

The swamp water was in a natural slough in the first bottom of the Mississippi River, but outside the mainline levee. The water was not stagnant during the test period; it contained a great deal of suspended organic material but was not muddy. Tap water was in tanks of galvanized iron anchored in the slough. Temperature of both waters varied from 37° to 40°F during the experiment, but they did not vary from each other on any given date by as much as one degree.

All germination tests were in a steam-heated building, in wooden flats filled with vermiculite. Each test was terminated at the end of 10 successive days without germination.

Results

As indicated above, individual germination percentages shown in Table I are the mean of four 100-seed samples.

The combined analysis of variance, Table II, showed the Species x Days interaction to be highly significant, but no comparison involving type of water approached significance. Neither Species nor Days was significant when tested against the mean square of their interaction.

In order to make a more sensitive comparison between flooding periods, as well as to test the airless tap water results which could not be included in the combined analysis, results for each species were then analyzed separately.

For cherrybark oak the mean square attributable to type of water and to Water x Days interaction failed to approach significance, but differences among flooding periods were highly significant (variance ratio of 67.379). Further tests showed that the difference between 8 and

[1] The data on which this note is based were collected while the writer was Assistant Professor of Forestry, Louisiana State University.

[2] Additional tree species colonize such sites, but—to the writer's knowledge—no studies have been reported on whether their seeds germinate under water. *Tamarix pentandra* Pall. germinated floating on water (Horton et. al., 1960).

TABLE II. Combined-species analysis of variance

Variable	Degrees of Freedom	Sum of Squares	Mean Square	Variance Ratio₁	Variance Ratio₂
Species.......	1	4,302.10	4,302.10		3.008 NS
Days.........	2	6,009.29	3,004.64		2.101 NS
Species x Days.	2	2,859.97	1,429.98	12.423 HS	
Water.........	1	157.69	157.69	1.370	
Water x Species	1	2.94	2.94	0.026	
Water x Days..	2	60.12	30.06	0.261	
Water x Species x Days....	2	143.62	71.81	0.624	
Residual......	36	4,143.75	115.10		
Total......	47	17,679.48			

Variance ratio₁ is based on the residual mean square.
Variance ratio₂ is based on the mean square of the Species x Days interaction.

18 submersion was not significant (t-value of 1.733), but that germination following 34 days submersion was significantly lower than following 18 days (t-value of 9.085).

An unplanned variable in the Nuttall oak tests was that the acorns collected near Plaquemine, Louisiana, were noticeably larger than those collected near Baton Rouge, Louisiana, and Stoneville, Mississippi. Inspection of the data indicated that the large acorns had a higher germination percentage than the smaller ones, and limitation in numbers available had prevented their being equally apportioned among treatments (Table III).

TABLE III. Germination of Nuttall oak acorns by seed source

Seed source	Number of seed lots	Mean germination percentage
Baton Rouge, La........	4	38
Stoneville, Miss..........	9	39
Plaquemine, La...........	15	45

In order to prevent the partial confounding of treatment with seed source, the data were treated by regression analysis of 6 balanced comparisons: small acorns (Baton Rouge and Stoneville) versus large ones (Plaquemine), Baton Rouge acorns versus Stoneville, swamp water versus tap water, flooded versus controls, 8 & 18 days submersion versus 34 days, and 8 days submersion versus 18. Only the comparison of small acorns versus large ones was significant (variance ratio of 19.538).

Although germination of the small Nuttall oak acorns decreased with length of submersion period, Table IV, the difference did not approach significance.

Conclusions

Type of water used for submersion did not affect germination of either species.

Germination percentage of cherrybark oak acorns was significantly lowered by 34-day submersion.

Submersion for periods up to 34 days did not significantly affect germination percentage of Nuttall oak acorns.

Large acorns of Nuttall oak had a significantly higher germination percentage than did small acorns.

TABLE IV. Germination of large and small Nuttall oak acorns by flooding duration

Days flooded	Mean Germination Percentage	
	Large	Small
8..............	47	42
18..............	44	41
34..............	45	36

The large Nuttall oak acorns showed no indication of being affected by the submersion treatments; small Nuttall acorns appeared to be affected, but were not significantly so; germination of the smallest acorns tested, cherrybark oak, was apparently reduced slightly by 18-day submersion and was highly significantly reduced by 34-day submersion.

The same apparent correlation of size with tolerance of flooding was previously reported for *Nyssa* seed (Briscoe 1957, p. 50). Among seeds of essentially the same structure larger seeds appear to survive flooding better than smaller seeds.

Summary

Acorns of cherrybark and Nuttall oaks were enclosed in open-mesh bags and submerged in swamp water and in tap water for periods up to 34 days; cherrybark acorns were also submerged in sealed bottles of tap water.

Type of water or container did not affect germination of either species.

Cherrybark oak typically grows on sites seldom or never flooded; germination percentage of its acorns was significantly lowered by prolonged submersion.

Nuttall oak is common on sites flooded annually; submersion for periods up to 34 days did not reduce germination percentage of its acorns.

There was some indication that resistance to flooding effects was associated with size of acorn.

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