

Germinative Pretreatments and Seedcoat Impermeability for the Kentucky Coffeetree

Jimmie L. Yeiser¹

Assistant Professor of Forestry, University of Arkansas at Monticello and Arkansas Agricultural Experiment Station, Department of Forest Resources, Monticello, Ark.

A 150-minute acid scarification of Kentucky coffeetree seeds provided earlier and significantly greater germination than other treatments. Similar total germination resulted from water-soaked and unsoaked, acid-treated seeds. Unscarified seeds did not imbibe water.

Kentucky coffeetree (*Gymnocladus dioica* (L.) K. Koch), is a medium-to-large, dioecious species occurring throughout much of the central hardwood region. It produces seeds with a hard, water-impermeable seedcoat, which prevents or delays germination and probably accounts for the species' infrequent occurrence throughout its extensive range (2).

The current pregermination procedure is based on Weisehuegel's (4) only account of germinative energy and germinative capacity for water-soaked, acid-treated seeds. This pregermination treatment includes a 24-hour water soak followed by an approximately 2-hour soak in concentrated sulfuric acid (2). If the seedcoat is water impermeable, the water presoak appears unnecessary and inconsistent with seedcoat characteristics.

This paper is a report of a study to evaluate alternative pregerminative treatments and their effect on germination and seedling development.

Methods

Seeds used in this study were collected in 1978, 1979, and 1980 near Lexington, Ky. Seedlots were washed and mixed, and 50 seeds were selected to receive each of the following six pretreatments: a control, a 24-hour water soak only, a 24-hour water soak plus a 120-minute acid scarification, a 24-hour water soak plus a 150-minute acid scarification, a 120-minute acid scarification only, and a 150-minute acid scarification only. Concentrated sulfuric acid was used to scarify seeds. All water soaks were at room temperature. The study was replicated three times.

Number 8 styroblocks were filled with a 1:1 peat moss and vermiculite mixture containing 2 teaspoons of Osmocote 14-14-14 fertilizer per gallon of medium. Twenty seeds per square foot or one seed in alternate cavities were planted approximately 2.54 centimeters deep and were watered three times weekly. Germination was tallied when any part of the plumule was visible. Germination data were collected over 30 days, adjusted by an arcsine proportion transformation and statistically examined by a chi-square test (3).

Seedlings were grown in a greenhouse with photoperiods of 16 hours and temperatures ranging from 20° C at night to 30° C by day. The top of the medium was sprayed lightly each week with a complete fertilizer and immediately followed with ample water to move the fertilizer throughout the root zone. The complete fertilizer contained 50 parts per million N, K, Mg, S, and Ca; 100 parts per million Cl and Na; 150 parts per million P; 10 parts per million chelated Fe; and less than 1 part per million Mn, B, Zn, Cu, and Mo. Total height in centimeters and stem diameter 2.54 centimeters above the root collar in millimeters were measured 3 months after planting. Analyses of variance for height and diameter were adjusted for germination. Treatment means were tested with Duncan's multiple range test (3). Data were analyzed according to the statistical analysis system (1).

Results and Discussion

A desirable pretreatment provides consistent and rapid germination; thus, treatments were evaluated for efficacy on germinative energy and capacity (table 1). All acid treatments exhibited maximum daily germination by 8 days after planting and total germination after 19 days. Seeds receiving 150-minute acid scarification showed maximum daily germination 1 day before seeds treated for 120 minutes in acid. A 120-minute acid treatment

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Table 1.—Number of germinating seeds per day, with 150 seeds planted per treatment

Days after planting	Acid only		24-hour water soak plus acid	
	120 min.	150 min.	120 min.	150 min.
3	0	0	0	0
4	1	1	2	3
5	8	11	9	18
6	19	23	19	25
7	26	35	26	33
8	27	21	33	27
9	18	14	20	17
10	16	13	10	7
11	12	10	7	4
12	5	4	3	3
13	3	2	3	3
14	2	1	0	2
15	1	0	0	1
16	0	2	3	0
17	2	1	0	1
18	0	0	2	0
19	0	0	0	0
Total	140	139	137	144

yielded 54-percent germination after 8 days for unsoaked seeds, while 59 percent of presoaked seeds germinated during the same period. Seven days after planting, seeds receiving the 150-minute acid treatment had 47-percent germination for unsoaked seeds and 53-percent germination for presoaked seeds. A chi-square test of the proportion of germinated seeds after day 7 for 120-minute and 150-minute acid treatments was significant ($\chi^2 = 0.05$). There was no difference after day 7 in germination of unsoaked and water-soaked seeds. A chi-square test for the proportion of germinated seeds after day 7 for 120-minute and 150-minute

acid treatments was also significant for water-soaked seeds. Thus, early seed germination can be significantly increased by using a 150-minute acid treatment of seeds, and water presoaking appears unnecessary. The control and water-soaked only seedlots yielded 1-percent and 3-percent total germination. Total germination was complete after 19 days and was similar for all acid-treated seeds. Seedlings from acid-treated seeds appeared normal.

Analyses of variance were conducted on the percentage of total germination and seedling height and diameter. Significant differences were observed in treatment effects, and Duncan's multiple range tests

were conducted on means (table 2). Significant differences occurred only among acid-treated and un-treated seeds. Thus, there were no differences in the percentage of total germination and seedling development after 3 months for acid-treated seeds.

A second study examined seed-coat impermeability to water. Twenty-five hand-scarified seeds were weighed before and after a 24-hour water soak. Twenty-five unscarified seeds were weighed before and after soaking for 24, 36, and 48 hours. Unscarified, water-soaked seeds had an average weight of 1.95 grams, showed a nonsignificant increase in mean weight of 0.04 grams after 24 hours, and failed to germinate. Weight changes after 24 hours were not detectable. Hand-scarified seeds weighed, on the average, 1.96 grams and exhibited a highly significant 97-percent increase in mean weight from soaking. A 1125 seeds germinated. These data suggested that the seedcoat is water impermeable.

Results from these two studies indicated that 150-minute scarification of seeds with concentrated sulfuric acid can produce earlier and significantly greater germination of Kentucky coffeetrees than other treatments. All acid treatments produced normal seedlings. Water presoaking of seeds before acid treatment is unnecessary since seedcoats are water impermeable.

Table 2.—Duncan's multiple range tests for percentage of germination, height, and diameter (Means are adjusted for germination.)

Treatment	Germination	Height	Diameter
	%	<i>Cm</i>	<i>Mm</i>
Control	1b ¹	0.06b	0.02b
Water only	3b	.26b	.08b
120 minutes in acid	93a	7.53a	2.40a
150 minutes in acid	92a	7.84a	2.51a
Water soak plus			
120 minutes in acid	91a	7.87a	2.55a
Water soak plus			
150 minutes in acid	96a	7.92a	2.58a

¹The same letter within a column is not significantly different at $\alpha = 0.05$.

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