Increased Germination Rates of Baldcypress and Pondcypress Seed Following Treatments Affecting the Seed Coat

By

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Abstract

The effects of seed-coat removal, warm-water soaking, cold stratification, dry-cold storage and acid treatment on the germination of baldcypress (*Taxodium distichum* (L.) Rich.) and pondcypress (*Taxodium distichum* var. *mutans* (Ait.) Sweet) seed were studied.

Removal of the hard seed coat resulted in a prompt and high percent germination, indicating that there was no physiological embryo dormancy. Cold stratification, warm-water soaking and acid treatment did not increase percent germination over the control after a 60-day germination period. They did promote the rate of germination however, having a significantly higher germination at 30 days. Dry-cold storage promoted the initial rate of germination, but resulted in a decreased percent germination below the control after 60 days.

The above results suggest that moisture, and not cold, was the crucial component of stratification. The improved germination rate following acid treatment further suggests that any treatment which rendered the seed coat more permeable or softened it was more effective in increasing the rate of germination of baldcypress and pondcypress seed.

Introduction

Germination of baldcypress seed is generally poor. Control lots often do not exceed 10% germination even after 60 days (Toumey and Stevens 1928, Barton 1930, Toumey 1930). Early attempts to improve germination simulated natural conditions, *i.e.* prolonged soaking of the seed. A 30-day soaking treatment had no effect on germination (Toumey and Durland 1923), while soaking for six months increased germination from less than 10 to 59% (Toumey 1930).

Germination was stimulated by cold stratification, reaching 39% following a one-month stratification at 5°C (Barton 1930). This led to the generally held assumption that baldcypress seed exhibit an embryo dormancy and require a 60- to 90-day cold-stratification period for good germination (USDA Woody Plant Seed Manual 1948; USDA Yearbook of Agriculture 1961). This treatment is still recommended in the newly revised Seeds of Woody Plants in the United States (1974). Current attempts to improve germination have therefore focused on methods purported to break physiological dormancy, *i.e.* cold stratification, growth hormones, and chemicals such as thiourea and potassium nitrate (Biswas *et al.* 1972).

Apparently no investigations have tested whether the low germination in baldcypress seed is indeed due to physiological dormancy or is the result of some other germination barrier, such as a hard and impermeable seed coat. The USDA Forest Service (1948) noted that washing baldcypress seed in ethyl ether doubled the amount of water absorbed over a 96-h period. However, the effect of this treatment on subsequent germination was apparently not determined.

In previous studies, baldcypress seed were obtained from only a single source (which was often not identified). As baldcypress grows over a wide geographic range, it seemed desirable to investigate the variation in germinability from widely divergent sources. Also, inasmuch as most previous work was performed with only the seed of baldcypress, the same series of treatments were applied to seed of pondcypress from various sources. Germination of pondcypress seed has probably been ignored by investigators due to its smaller range and the fact that it is not distinguished commercially from baldcypress (Kennedy 1972).

The current study was undertaken to investigate the effects of seed-coat removal, warm-water soaking, cold stratification, dry-cold storage and acid treatment on the germination of baldcypress and pondcypress seed.
Materials and Methods

Fresh seed of baldcypress (Taxodium distichum (L.) Rich.) were obtained from South Carolina (BCSC), Louisiana (BCLA) and Florida (BCFL). Fresh seed of pondcypress (Taxodium distichum var. nutans (Ait.) Sweet) were obtained from South Carolina (two sources, PCSC1, PCSC2) and Florida (PCFL). Germination tests and treatments were begun shortly after collection or receipt of the seed in November-December 1973.

Intact female gametophytes (containing the mature embryo) were excised by lightly tapping the highly irregular-shaped seed with a plastic-headed hammer, then removing the gametophyte from the cracked seed coat. The intact, undamaged gametophytes were surface-sterilized by 5-s immersion in 10% clorox and then pure ethanol, followed by two rinses in sterilized double-distilled water. They were then transferred to moist filter paper pads in sterilized Petri dishes and placed in an incubator at 30°C with continuous light. Four 50-seed replications were used for each of the six sources. Germination was assessed daily for two weeks; protrusion of the radicle from the gametophyte (c. 1 cm) was used as a criterion of germination.

For the various whole-seed treatments, four 50-seed replicates from each source were used. For cold stratification, the seed were embedded in peat in plastic bags, thoroughly moistened, sealed and placed in a cold room at 2 to 4°C for 30 days. Seed for dry-cold storage were sealed in plastic bags and placed in the cold room for 30 days. Seed which received a warm-water (room temperature, c. 22°C) soaking were placed in pint jars which were then filled with water and covered with aluminum foil. The seed were stirred occasionally over the 30-day period to assure equal wetting of all seed. For acid treatment, the seed were placed in pint jars, and a two- to three-fold volume of technical grade concentrated sulfuric acid (Curtin) was added. The seed were stirred occasionally during the 4-h treatment period, then thoroughly rinsed. Seed from all treatments plus a control were sown in flats in a 3:1 peat/sand mix. The flats were held in a greenhouse under ambient light and temperature conditions.

Germination (emergence of the hypocotyl above ground) was tallied daily for the first 30 days, then weekly until 60 days. Ungerminated seed were then cut open, and percent germination calculated from total filled seed. The data also were expressed as germination values which give a measure of both the speed and completeness of germination, i.e. the product of the mean daily percent germination and the highest daily percent germination obtained (Czabator 1962). Germination results were statistically analyzed by Duncan’s New Multiple Range Test (Steel and Torie 1960).

Results

Following removal of the thick, hard seed coat, initial signs of germination were observed as soon as 24 h after incubation. This usually entailed longitudinal splitting of the female gametophyte or a slight protrusion of the white cotyledon tips at the apex. Germination was essentially complete within the first week, with final germination (at 2 weeks) ranging from 60 to 89%. Average germination for the 6 sources was 72%. There were no significant differences (at 1% level) between sources or varieties.

For all sources combined, germination of the intact seed began within a 2-week period in all treatments. Except for the control, the initial germination rates were quite rapid in each treatment. At the end of 30 days, seed in the cold stratification, warm-water soaking and acid treatment had essentially completed germination and had attained over 80% germination (Figure 1). These three treatments differed significantly (at 5% level) from the control and the dry-cold storage treatment. Dry-cold storage also differed significantly from the control. Although the initial germination rate of the control was low, it increased rapidly after 1 month and by 60 days had attained the same final percent germination as the cold stratification, warm-water soaking and acid treatment. Only the dry-cold storage treatment had a significantly lower percent germination at this time.

Figure 1. Combined cumulative germination curves for three sources each of baldcypress and pondcypress. Treatments: cold stratification (○), room-temperature soak (■), dry-cold storage (▲), acid treated (□), and untreated control (●). Each point is the average of four 50-seed replications of each source.
Table 1. Variation due to treatment in percent germination at 30 and 60 days within bald- and pondcypress seed sources. Seed source: PCSC1, PCSC2, PCFL, BCSC, BCLA, and BCFL. Based on total filled seed. Each value is the average of four 50-seed replications. Values within each source followed by the same letter do not differ significantly at the 5% level (as determined by Duncan’s Multiple Range Test).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Germination, %</th>
<th>Germination, %</th>
<th>Germination, %</th>
<th>Germination, %</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>30-day</td>
<td>60-day</td>
<td>30-day</td>
<td>60-day</td>
</tr>
<tr>
<td>Control</td>
<td>10.4a 83.0b</td>
<td>0.0a 79.5b</td>
<td>14.6a 100b</td>
<td>9.0a 71.0b</td>
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<tr>
<td>Cold stratification</td>
<td>77.6b 81.1b</td>
<td>79.4b 87.4b</td>
<td>94.4b 100b</td>
<td>85.7b 94.0b</td>
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<tr>
<td>Warm-water soak</td>
<td>81.4b 82.0b</td>
<td>79.4b 87.8b</td>
<td>100b 100b</td>
<td>85.0b 89.9b</td>
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<tr>
<td>Acid treatment</td>
<td>73.5b 73.5b</td>
<td>86.2b 87.4b</td>
<td>92.5b 95.4b</td>
<td>97.9b 87.9b</td>
</tr>
<tr>
<td>Dry-cold storage</td>
<td>53.6c 61.7c</td>
<td>5.4a 58.7c</td>
<td>51.6c 74.0d</td>
<td>59.4e 72.0d</td>
</tr>
</tbody>
</table>

Individual seed sources followed the same general pattern of germination with minor variations (Table 1). One baldcypress seed source (BCFL) responded as well to the dry-cold storage treatment as it did to the other treatments (which was significantly better than the other sources did at both 30 and 60 days). This same source also had significantly higher germination in the control after 30 days than did the other sources. Two sources (PCSC2 and BCLA) showed no germination during the first 30 days in the control and significantly lower germination than the other sources during the first 30 days following dry-cold storage treatment. Other than these few differences, there was very little variation among the seed sources in response to any of the treatments.

Although only the dry-cold storage treatment (all sources combined) differed significantly from the other treatments in percent germination after 60 days, the germination values give a more precise indication of the effectiveness of the various treatments. As the final percent germination figures were equivalent (except for dry-cold storage), differences in the rate at which germination occurred. As seen in Table 2 (all sources combined) acid treatment was significantly better than any other treatment for stimulating the rate of germination. Cold stratification and warm-water soaking had about the same effect, and dry-cold storage did not differ significantly from the control due to the former’s more rapid initial germination rate.

Within each individual seed source, the treatments showed about the same ranking. All three baldcypress sources responded slightly better to cold stratification than warm-water soaking, while the opposite was found for all three pondcypress sources. The germination values for BCFL, PCSC2 and BCLA following dry-cold storage clearly indicate seed source variation in response to this treatment (Table 2).

**Discussion**

The results of this study indicate that there is no embryo dormancy in baldcypress or pondcypress seed, and that

Table 2. Germination values in relation to treatment of different seed sources of bald- and pondcypress. Seed source: PCSC1, PCSC2, PCFL, BCSC, BCLA, and BCFL. Germination value equals the product of mean daily percent germination times the highest daily percent germination (Czabator 1962). Each value is the average of four 50-seed replications. Values within each source followed by the same letter do not differ significantly at the 5% level (as determined by Duncan’s Multiple Range Test).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Germination values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PCSC1</td>
</tr>
<tr>
<td>Cold stratification</td>
<td>3.553a</td>
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<tr>
<td>Warm-water soak</td>
<td>4.040a</td>
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<tr>
<td>Control</td>
<td>2.082b</td>
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<tr>
<td>Dry-cold storage</td>
<td>1.959b</td>
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</table>
low germination results from the physical barrier of a hard, impermeable seed coat.

After 60 days germination time, cold stratification, warm-water soaking and acid treatment had failed to increase the percent germination of baldcypress and pondcypress seed over the control. A dry-cold storage treatment resulted in a significantly lower germination at this time. After only 30 days however, the picture was quite different. All treatments had significantly increased percent germination over the control. Thus, the length of the germination test period was critical to the interpretation of treatment effectiveness. The claim of Biswas et al. (1972), based on a 30-day germination period, that cold stratification promoted germination of baldcypress seed, should be viewed as a matter of rate rather than degree.

Furthermore, the present results indicated that any treatment which rendered the seed coat more permeable or softened it was effective in increasing the rate of germination. Indeed, complete removal of the seed coat resulted in the most rapid germination. While cold stratification increased the rate of germination appreciably, a dry-cold treatment did not, indicating that it was probably the softening of the seed coat which was the critical component of stratification. In fact, dry-cold storage caused a significant decrease in germination at 60 days, indicating that cold alone had an inhibitory effect on germination. This was hardly what one would expect if the seed of baldcypress possessed a physiological embryo dormancy. The importance of the moisture factor was substantiated by the hastened germination following soaking at room temperature.

Biswas et al. (1972) found that gibberellic acid, potassium nitrate and thiourea increased the germination of unstratified baldcypress seed (after 30 days). Their seed source had a high control germination of 46%. This was the same value as found for the Florida seed source (BCFL) used in the present study. This source responded equally well to all treatments, even dry-cold storage, whereas this was not the case in the other seed sources. If the above investigators had used several sources, including ones such as PCSC2 and BCLA, in which neither the control nor dry-cold storage treatment had any appreciable germination during the first 30 days, a better idea of the effectiveness of growth hormones and other dormancy-breaking chemicals might have been obtained.

As a practical means of hastening germination of baldcypress seed, a 4-h soak in concentrated sulfuric acid is the easiest, most efficient method. This is shown in Figure 2, where the germination results are expressed over total elapsed time (treatment time plus germination period). Within 20 to 30 days one can obtain a uniform population of seedlings following acid treatment. Cold stratification and warm-water soaking are no more effective than the control, as the same final germination is reached at about the same time (53 to 60 days). The only advantage of either treatment over the control is in producing a more uniform popu-

Figure 2. Combined cumulative germination curve over total elapsed time for three sources each of baldcypress and pondcypress. Legend: same as Figure 1. Each point is the average of four 50-seed replications of each source.

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References


— & Stevens, C. L. 1928. The testing of coniferous tree seeds at the School of Forestry, Yale University. — Yale School of Forestry Bull. 21, p. 41.


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