Spin-Drying Soaked Tree Seed Before Prechilling Improves Seed Handling

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The traditional nursery method for pretreating dormant tree seeds is to soak the seeds and incubate them under cold, moist conditions – a so-called prechill (or sometimes stratification). But wet seeds of many species germinate prematurely during pretreatment and/or clump together and foul sowing machinery. This study shows that spin-drying wet tree seed is a simple and harmless method for surface-drying soaked seed, After spin-drying, seeds were at a high enough moisture content to respond to dormancy breakage, and by the end of a 6-week prechill were surface dry, free flowing, and suitable for immediate sowing. None of the seeds germinated prematurely. Tree Planters' Notes 45(1):32-35; 1994.

Commercially available tree seeds usually exhibit dormancy. The seeds of most temperate broadleaved species are completely unable to germinate until dormancy is broken. They often require the application of a lengthy (3 to 18 months) moist chilling period – a so-called prechill or stratification. These seeds are said to be "deeply" dormant. In contrast, most temperate conifer and a few broadleaved species germinate without prechilling, but only slowly and over a narrow range of temperatures. These seeds are commonly described as "shallowly" dormant. Prechilling for much shorter durations (1 week to 3 months) improves the nursery emergence of shallowly dormant seeds because it speeds up germination rate, increases germination capacity, and widens the range of temperatures over which germination can occur (Allen 1960, Barnett 1979, Gosling 1988, McLemore 1966).

The traditional method of prechilling shallowly dormant seeds is to soak them in water for about 48 hours, drain off the excess water, and incubate the seeds in a loosely tied polyethylene bag at approximately 4/C (Allen and Bientjes 1954, Hosner et al. 1959, Edwards 1986). However, this method of prechilling leaves a thin film of water adhering to seeds, which can cause significant problems both during and after prechilling. For example, after prechilling, wet seeds clump together and cannot be sown without fouling sowing machines. The seeds must therefore be surface-dried. This not only occupies significant time at an extremely busy period in the nursery but must also be done carefully to avoid either killing the seeds or inducing secondary dormancy. In addition, during prechilling, some seeds lose their dormancy earlier than others and in the presence of surface moisture begin to germinate before the others have experienced the full benefits of dormancy breakage. Stopping pretreatment at the first signs of premature germination means that some seeds must be sown when they are still dormant. But if pretreatment is continued beyond the first signs of premature germination (which is unavoidable, for example, if sowing is delayed by bad weather) then even larger numbers of seeds will have their radicles broken and be killed by surface-drying or passage through the seed sower.

Clearly, the development of a harmless and preferably simple method of surface-drying wet tree seed is highly desirable. One that can be applied before prechilling would offer the advantage of reducing the chances of premature germination during an extended prechill period. Spin-drying has previously been successfully used in research studies on vegetables and vegetable seeds (McKee J. M., personal communication) and this paper reports on the use of a household spin-drier (clothing) to surface-dry soaked seeds and so improve the handling of seeds of eight shallowly dormant tree species during prechilling and sowing.

Materials and Methods

Seed. Seed of two broadleaved species [common alder (CAR), *Alnus glutinosa* (L.) Gaertn.; Italian alder (IAR), *Alnus cordata* Desf.] and five conifer species [Japanese larch (JL), *Larix kaempferi* (Lamb.) Carr.; Sitka spruce (SS), *Picea sitchensis* (Bongard) Carr.; Scots pine (SP), *Pinus sylvestris* L.; Douglas-fir (DF) *Pseudotsuga menziesii* (Mirbel) Franco.; western red cedar (RC), *Thuja plicata* Donn ex D.Don] were obtained from the Forestry Commission, Forest Management Division. The seed lots were selected for this study because International Seed Testing Association (ISTA) double tests had shown that germination rate and in some instances rate and germination percentage at the end of the prescribed period was increased by prechilling – therefore the seeds were shallowly dormant. (ISTA double tests are equivalent to AOSA paired tests, that is, germination rate and capacity are compared with and without prechilling for the same seed lot.)

Soak treatment. Forty-five to fifty-five grams of seed (depending on species) were soaked in 3 times their own volume of water at 4 /C for 48 hours.

Spin dry treatment. Soaked seeds of each species were placed in separate fine-net nylon bags, firmly secured by tying at the top. The bags containing seeds were spun in a household spin-drier (figure 1) at approximately 1,100 x g for 10 minutes (or until water stopped dripping from the spindrier).

Prechill treatment. Soaked, spun seeds were free flowing and did not clump together. Seed of each species was transferred to a separate 250-gauge polyethylene bag that was loosely tied (to prevent excessive moisture loss, but allow gaseous exchange through the neck) and incubated in the dark, at 4 /C for 6 weeks.

Combined treatments. Combinations of the above treatments included

1. Untreated control
2. Soak only
3. Soak and spin
4. Soak, spin, and 6-week prechill

Moisture content (MC) determination. Moisture contents were determined following the ISTA low-temperature oven method (ISTA 1985) and expressed on a fresh-weight basis. Two 5-g subsamples were taken for each determination.

Germination. Seeds were germinated on a Copenhagen tank following the ISTA prescription for each species. Four replicates of 100 seeds were sown on moist filter paper, randomized, and then incubated at an alternating 20/30 /C-20 /C for 16 hours in the dark and 30 /C for 8 hours illuminated with 11 Wm-2 light from warm white fluorescent tubes. Germination was assessed every other day, and seeds were counted as having germinated when the radicle was at least 3 times the length of the seed. The maximum germination percentage (germination capacity) was reached at 42 days.

Mean germination time (MGT) is a common method for expressing germination rate as a single figure. In this study we calculated it using a modification of the formula of Bewley and Black (1985) according to Jones and Gosling (1994). It is equivalent to the average time taken for an average seed to germinate.

Figure 1—*Using the spin-dryer to prepare soaked tree seeds.*

Statistical analysis. The effects of different treatments on germination capacity and MGT were tested by analysis of variance and when appropriate, Duncan's multiple range test. Each species was analyzed separately. An angular transformation was applied to all percentage data prior to analysis to homogenize variances.

Results and Discussion

Moisture contents. Preliminary trials showed that the seeds of all the species investigated attained their maximum moisture content (MC) after 48 hours. Only soaked seeds needed to be carefully surface-dried with paper towels before MC's were determined. Soaked and spun seeds; and soaked, spun and, prechilled seeds had dry surfaces, flowed freely and thus did not need further surface-drying before MC determination.

Table 1 shows the moisture content (MC) percentages (fresh-weight basis) of seeds exposed to different soak, spin, and prechill treatments. The initial MC of dry-stored conifer seeds (DF, SS, JL, SP, RC) was 6 to 8%. This rose to between 30 to 40% after 48 hours of soaking. Dry-stored broadleaved seeds (CAR, IAR) were at approximately 12% MC and increased to between 48 to 55% after a similar soak period. It would therefore appear that the seeds of the two species of broadleaved trees used in this study attain a higher moisture content at full imbibition than the seeds of the conifers.

Subsequent spin-drying did not cause the MC values for seeds of either conifers or broadleaved trees to vary. Even after spin-drying plus 6 weeks of prechill at 4 /C, there was no appreciable change in MC.

Clearly, spin-drying imbibed seed of the above seven species was a simple and effective method of removing surface water from soaked seed without reducing the seeds internal moisture content.

Germination. *Germination capacity.* The germination of most species reached a maximum under the conditions chosen between 14 to 21 days (not shown). However, SS and DF were slower to germinate than this. To ensure that germination capacity had been reached in all cases and for consistency between species, all germination tests are therefore measured and reported at 42 days.

Table 1-*Moisture content percentages (fresh-weight basis) for shallowly dormant tree seeds exposed to different soak, spin, and prechill treatments*

Treatment	Moisture content (%) DF	SS	CAR	JL	IAR	RC	SP
Untreated	8	6	13	9	12	6	7
Soak	33	32	55	36	48	39	31
Soak & spin	34	33	55	37	52	38	29
Soak, spin, & 6-wk prechill	34	33	55	37	52	37	28

DF = Douglas-fir, SS = Sitka spruce, CAR -= common alder, JL = Japanese larch, IAR = Italian alder, RC = Western redcedar , SP = Scots pine.

Table 2 shows the maximum percentage germination and mean germination times for seeds exposed to different soak, spin, and prechill treatments.

It can be seen that few of the treatments had a significant effect on maximum germination percentage (germination capacity) of any of the species, under the optimal germination conditions chosen. For example, soaking had no significant effect on the germination capacity of DF, CAR, JAR, RC, or SP in comparison to untreated seeds; but it did significantly increase the germination capacity of SS by 7% and significantly decrease the germination capacity of JL by 12%. Nevertheless, any harmful effects of soaking on JL disappeared after the spin or spin plus prechill procedures. The germination capacity of soaked plus spun seeds and soaked, spun, and prechilled seeds was either as good as, or better than, that of untreated seeds for all species. Of particular importance, it should be noted from a comparison of germination capacities between soaked and soaked plus spun seeds, that there were no instances of spin-drying significantly reducing germination capacity.

The overall effect of combining soak, spin, and prechill was, therefore, to bring about statistically significant improvements to the germination capacity of SS and IAR in comparison to untreated seeds. A combined soak, spin, and prechill did not significantly reduce the germination capacity of any of the remaining species (DF, CAR, JL, RC, or SP).

Germination rate (MGT). The germination rate of seeds has a significant effect on the establishment and survival of tree seedlings in nurseries (Haasis 1928). Early emergence lengthens the growing season, and more synchronous emergence leads to better seedling uniformity. In addition, an increase in germination rate under optimal conditions with prechilling indicates that prechilling will widen the range of temperatures over which many seeds will germinate. Together these three effects result in more useable seedlings at the end of the growing season. Mean germination time (MGT) is one method of expressing germination

Table 2-*Maximum percentage germination (MPG) and mean germination times (MGT) for shallowly dormant seeds of 7 tree species exposed to different prechill treatments*

	DF		SS		CAR		JL		IAR		RC		SP	
Treatment	MPG	MGT (days)	MPG	MGT (days)	MPG	MGT (days)	MPG	MGT (days)	MPG	MGT (days)	MPG	MGT (days)	MPG	MGT (days)
Untreated	9 a	13 a	80 b	15 a	71 a	8 a	39 a	10 a	27 b	12 a	86 a	12 a	95 a	7 a
Soak	94 a	13 a	87 a	12 b	71 a	7 b	27 b	9 b	23 b	12 a	84 a	11 b	92 a	5 b
Soak & spin	92 a	13 a	88 a	13 c	75 a	7 b	39 a	8 b	46 a	12 a	89 a	11 b	94 a	6 b
Soak, spin, & 6-wk prechill	92 a	5 a	86 a	5 d	73 a	4 c	42 a	4 c	41 a	5 b	94 a	6 c	95 a	4 c

For each species, treatments not sharing the same letter are significantly different at $P < 0.05$. MPG = maximum germination percentage, MGT = mean germination time; DF = Douglas-fir, SS = Sitka spruce , CAR = common alder, JL = Japanese larch, IAR =Italian alder, RC= western redcedar, SP = Scots pine.

rate as a single figure, and MGT is shown with the germination capacity figures in table 2. It is the average time taken for an average seed to germinate, hence a decrease in MGT indicates faster germination and therefore a beneficial effect.

The MGT of DF and IAR was unaffected by soaking compared to untreated control, whereas the MGT of all other species decreased significantly with soaking. Subsequent spinning had no significant effect on MGT for any of the species except SS, where it was increased by 1 day. However, even this increase was more than reversed by the 6-week prechill, so that for every species the combination of soak, spin, and prechill resulted in significantly faster germination than any other treatment, with MGT often reduced by over 50% .

Conclusion

Spin-drying wet tree seed of the two broadleaved tree and five conifer species used in this study is a simple and harmless method of surface-drying soaked seeds. The spun seeds are at a high-enough moisture content for germination capacity and rate to benefit from subsequent chilling. And at the end of the 6-week prechill the seeds are surface-dry, freeflowing, and suitable for immediate sowing.

Acknowledgments

The authors thank Andrew Peace and Jonathan Taylor for their help and advice on the statistical analysis; and John Morgan, Richard Jinks, and Mike McKee for their useful comments on the text.

References

Allen GS. 1960. Factors affecting the viability and germination behavior of conifer seeds. IV Stratification period and incubation temperature, *Pseudotsuga menziesii* (Mirb.) Franco. Forestry Chronicle 36:18-29.

Allen GS, Bientjes W. 1954. Studies on coniferous tree seed at UBC. Forestry Chronicle 30:183-196.

Barnett JP 1979. Germination temperatures for container culture of southern pines. Southern Journal of Applied Forestry 3:13-14.

Bewley JD, Black M. 1985. Seeds: Physiology of development and germination. New York: Plenum Press.

Edwards DGW. 1986. Special prechilling techniques for tree seeds. Journal of Seed Technology 10:151-157.

Gosling PG. 1988. The effect of moist chilling on the subsequent germination of some temperate conifer seeds over a range of temperatures. Journal of Seed Technology 12:90-98.

Haasis FW 1928. Germination energy of lots of coniferous tree seed, as related to incubation temperature and to duration of incubation. Plant Physiology 3:365-412.

Hosner JE Dickson RE, Kahler K. 1959. Storing loblolly pines in polythene bags as a substitute for stratification. Journal of Forestry 57:495-496.

International Seed Testing Association. 1985. International rules for seed testing. Seed Science and Technology 13:301-513.

Jones SK, Gosling PG. 1994. The benefits of using a target moisture content prechill method to overcome the dormancy of temperate conifer seeds. New Forests (In press).

McKee JM. 1994. Personal communication. Horticulture Research International, Wellesbourne, Warwick, United Kingdom.

McLemore BF. 1966. Temperature effects on dormancy and germination of loblolly pine seed. Forest Science 12:284-289.