Priming Black Spruce Seeds Accelerates Container Stocking in Techniculture Single-Seed Sowing System

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Black spruce (Picea mariana (Mill.) B.S. P.) seedling emergence and container stocking in Techniculture containers was accelerated by about 1 week by priming seeds in aerated water for up to 6 days. Priming in polyethylene glycol 8000 was less effective than priming in aerated water, and priming in a salt mixture killed the seeds. Tree Planters' Notes 43(1):11-13; 1992.

In container nurseries, successful use of automatic single-seed sowing systems depends on technology to automatically deliver one seed per container and to ensure that each seed germinates and grows, thus stocking each container in the tray or rack. Various methods are being developed in attempts to achieve these requirements. For example in Sweden, that country's entire tree seed production is currently sorted to remove dead and unfilled seeds (Andersson 1991). Attempts are also in progress to integrate sorting (Simak 1984) with germination acceleration treatments (Bergsten 1987), which have the potential to achieve a more rapid and uniform crop emergence. Seed priming (soaking in water or osmotic solutions) has the potential to accelerate germination and seedling establishment.

Seed priming is a well-established practice for some horticultural crops, providing faster and more uniform germination (Heydecker and Coolbear 1977, Coolbear *et al*. 1980, Ellis and Butcher 1988). Primed seeds of black spruce *(Picea mariana* (Mill.) B.S.P.) and slash pine (*Pinus elliottii* Engelm.) were also shown to germinate more rapidly, particularly under less favorable environmental conditions such as temperature extremes (Fleming and Lister 1984, Haridi 1985). However, priming tree seed is not a widespread practice in North America. Some benefit is likely to be derived from using primed seeds in a greenhouse situation due to the shortened germination and culture period and the more uniform crop emergence. We tested various priming treatments on a sorted and stratified seedlot of black spruce seed with a high germination rate (98%) that were planted by hand in Techniculture (formerly Castle and Cooke) containers. Here we report on the optimal priming conditions for black spruce seed, an important commercial boreal species.

Materials and Methods

Black spruce seeds that were stratified for 30 days were obtained from the Ontario Ministry of Natural Resources' seed plant at Angus, Ontario. The seeds were sorted according to the method of Skeates (1972)-first they were sieved, then each size class was sorted in a wind tunnel into 60 size/density classes. The 40 classes corresponding to average weights between 0.85 and 1.2 mg were combined. Total germination of this sorted seedlot was 98%. Skeates (1972) has shown that germination can be affected by weight; by not using heavy or light seed, this confounding effect was minimized.

Preliminary trials were done in 1.6-liter narrow beakers covered loosely with a plastic lid through which passed a tube bringing air to the bottom of the beaker through an airstone. Cotton wad-filtered air was supplied by a large air pump so as not to cause excessive foaming. Seeds were primed at room temperature (18 to 22 °C) in 3 different regimes: 400 ml of autoclaved water; polyethylene glycol 8000 (PEG 8000) at concentrations of 10 to 30% (w/w); or a salt mixture of 0.105 M K_3P0 + 0.209 M $KN0_3$, according to the method of Haigh *et al*. (1986). At the end of the priming treatment, the seeds were collected through a strainer, rinsed with deionized water, surface-dried on paper towels, and sown directly. In one set of preliminary experiments, primed seeds were air-dried overnight on several layers of paper towels and then sown on the next morning. Control seeds were not treated in a priming solution before sowing.

To ensure that each of the 400 containers (cavities) in each tray was loaded, seeds were sown manually with a Plexiglas® template that precisely matched the containers (Techniculture, Inc., Salinas, California;

formerly Castle and Cooke). Trays were placed in a misting chamber for 1 week under natural photoperiods at day/night temperatures of 24 to 27 °C/18 to 23 °C. The trays were then removed from the misting chamber and placed in a greenhouse under natural day-length supplemented with sodium lights set at 16-h photoperiod at day/night temperatures of 25 to 30 °C/15 to 18 °C. Seedlings were fertilized once a week (unless otherwise indicated) to field capacity with 20-20-20 Plant products (Brampton) fertilizer, which also contained Mg, S, and micronutrients and watered twice daily with an automatic watering system (Andpro, Waterford, ON).

The final priming protocol was the outcome of several preliminary, similarly designed experiments. Seeds were primed for 6 days in aerated water, washed, surface-dried, and sown. The experiment was repeated three times, with three trays sown per treatment, resulting in 9 replicates (3,600 cavities). The control treatment was unprimed.

Seedlings were counted as "emerged," and thus a container was considered filled, when the seedling had grown up above the edge of the container, about 3 to 4 cm. Albino or ageotropic mutant seedlings (about 1 %) were counted initially but were deleted from total container stocking values as they died off.

Results and Discussion

Preliminary experiments. There appeared to be no benefit to using PEG 8000 at 10, 20, or 30% (w/w) over simple priming with aerated water. PEG 8000 slowed down germination, lengthening needlessly the duration of the priming treatment. Priming in the aerated mixture of salts (0.105 M K_3PO_4 + 0.209 M KNO_3) killed the black spruce seeds after about 2 days' exposure to the salts, which readily penetrated the seeds. Movement of seeds due to aeration appeared to dissolve and extract seed proteins and fats, causing foaming and killing the seeds. Less vigorous aeration led to anaerobiosis and fungal attack of the dying seeds.

Overnight drying of the seeds after priming in water or PEG 8000 set back the germinative metabolism and resulted in decreasing the effectiveness of the priming treatment. Therefore, in the final protocol, seeds were only surface-dried after priming and sown immediately.

Final experiment. In terms of accelerating seedling emergence, priming followed by surface drying and immediate sowing was superior to the control (figures 1 and 2). Under these conditions, all water-primed seeds had germinated prior to placement into

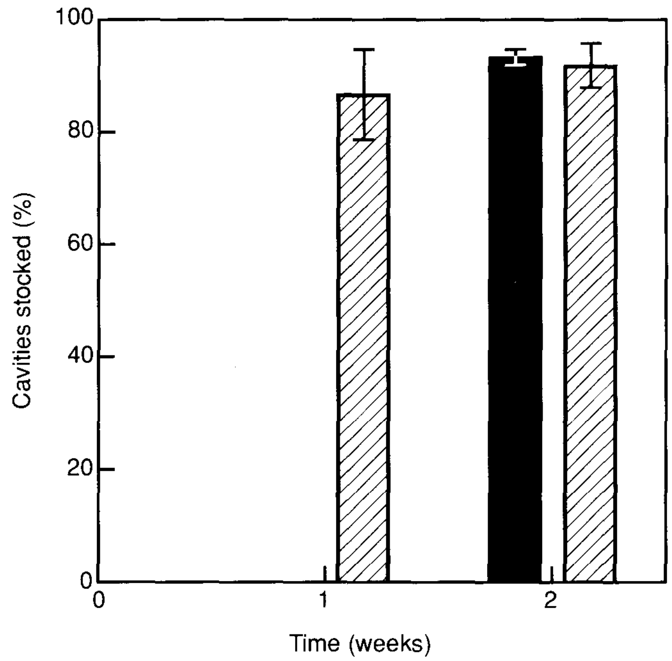

Figure 1—*Percent emergence of black spruce seeds primed for 6 days in aerated water (hatched columns) and untreated controls (solid columns). Standard deviation included in brackets. None of the controls had emerged during the first week.*

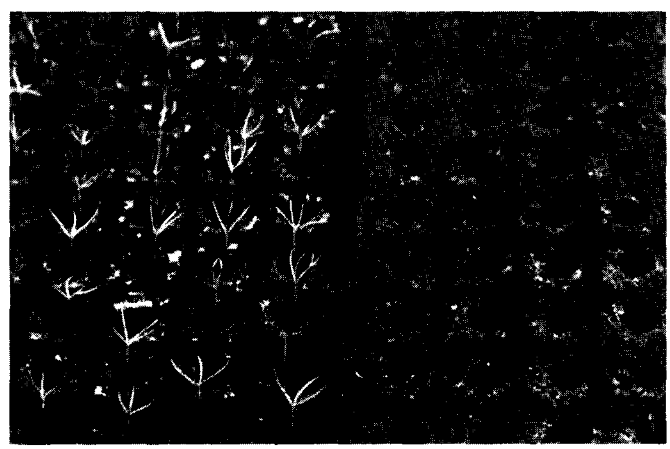

Figure 2—*Difference in emergence at 2 weeks after sowing of primed (***left***) and control (***right***) black spruce seedlings.*

the cavities. This resulted in an increased portion (about 1%) of the seedlings growing ageotropically, that is root up, and dying. Seedlings emerged 1 week faster with water-priming than without (controls). It appears that for black spruce, priming in water for 5 to 6 days, that is, bringing the seeds to the point where the radicles were about to emerge, immediately followed by surface-drying and sowing may be best for accelerating seedling emergence and container stocking on a commercial scale.

In summary, priming black spruce seeds in water rather than not priming them or priming them in osmotic solutions appears to have merit for single seed sowing into containers. It may shorten production time by about a week, thus lowering greenhouse heating costs. However, this treatment alone cannot increase absolute container stocking. Further efforts are in progress to integrate the priming treatment with flotation-based removal of nonviable seed (Bergsten 1987). By far the greatest economic gains in terms of single-seed sowing systems will be made by using seeds as close to 100% germination rate and cavity stocking rate as possible (figure 3).

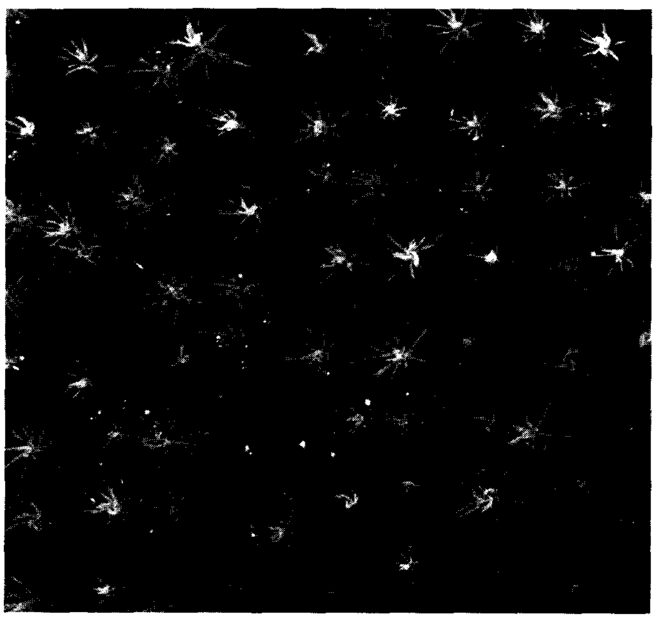

Figure 3—*Nearly perfect cavity-stocking of black spruce using the Techniculture container system.*

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