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Potassium Hydroxide Improves Seed Germination and Emergence in Five Native Plant Species

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Abstract. **The seeds of difficult-to-germinate native species of American licorice (*Glycyrrhiza lepidota* Pursh), angelica (*Angelica atropurpurea* L.), wild blueberry (*Vaccinium angustifolium* Ait.), wild mint (*Mentha arvensis* L.), and purple coneflower (*Echinacea angustifolia* D.C.), were soaked in 0, 2.5, 5.3, or 7.6 M KOH solutions for 0, 1, 5, 10, 15, or 20 minutes. After these treatments, germination was determined at 10 °C with a 14-hour photoperiod in petri dishes and seedling emergence was conducted at 14/10 °C with a 14-hour photoperiod in a sandy loam soil. In general, KOH treatment for only 1 min enhanced germination and seedling emergence. The optimal KOH concentration and soaking time in improving seed germination and seedling emergence varied with species, being 5.3 M and 10 min for purple coneflower, 5.3 M and 5 minutes for wild blueberry, 7.6 M and 5 minutes for angelica, 7.6 M and 1 minute for wild mint, and 5.3–7.6 M and 10 minutes for American licorice, respectively. Prolonged soaking, particularly in high concentrations, reduced germination and emergence.**

Due to the increased use of medicinal plants for health care (Wijesekera, 1991), destructive harvests are threatening the sustainability of native stands of such plants in Saskatchewan. This has promoted an increase in their cultivation. Among 57 native species studied (Gao and Gusta, 1996), American licorice, angelica, wild blueberry, wild mint, and purple coneflower were found to be difficult to germinate.

Sexual propagation from seeds, when possible, is considered the most efficient method of producing plants for commercial production, although these species also may be propagated by rhizome division, shoot and root cuttings, and micropropagation (Omidbaigi and Bernath, 1993; Zhang and Cheng, 1989; Zheljazkov et al., 1996). However, the seeds of many native plants, including the species listed above, have relatively complex dormancy systems that help plants survive harsh environments (Bewley and Black, 1982). Stratification may overcome seed dormancy for some native wildflower and herbaceous perennial species (Baskin et al., 1992; Bratcher et al., 1993; Smith-Jochum and Albrecht, 1987), but often weeks to months of treatment are required to obtain a desirable germination level. Priming has also been used to improve seed germination, particularly under stressful conditions (Bradford, 1986). Samfield et al. (1991), studying tickseed (*Coreopsis lanceolata* L.) and purple coneflower [*Echinacea purpurea* (L.) Moench], and Pill et al. (1994), working with purple coneflower, reported that both osmotic and matric priming of seeds for 5 to 10 d improved germination and emergence under laboratory or greenhouse conditions at suboptimal temperatures. Hou and Simpson (1994a, 1994b) recently reported that treating seeds of barley (*Hordeum vulgare* L.) and wild oat (*Avena fatua* L.) in concentrated alkaline solutions for 5 to 10 min broke dormancy and improved germination. The objective of this study was to determine if treating seeds in KOH could improve germination and subsequent emergence at low temperatures in five difficult-to-germinate native medicinal plants.

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Materials and Methods

Seed materials. Seeds of American licorice, wild blueberry, wild mint, and purple coneflower were collected from native stands in the central region of Saskatchewan, Canada (52–53 °N) in Fall 1994. Angelica seeds were purchased from a commercial herb seed supplier (Richter's, Goodwood, Ont., Canada). All seeds were stored dry at 23 °C for 6 to 10 months.

KOH treatment. Solutions of KOH (85% purity, from BDH, ACS certified grade, Edmonton, Alta.) were freshly prepared and cooled to room temperature prior to treating the seeds. One hundred dry seeds were immersed in 10 mL of solution in a 50-mL flask. Initially the seeds were gently stirred to remove air bubbles on the seed surface, and then the flasks were shaken on a reciprocating shaker at 100 rpm at 23 °C under fluorescent light. The seeds were treated with 2.5, 5.3, and 7.6 M KOH for 1, 5, 10, 15, or 20 min as described by Hou and Simpson (1994a). Control seeds, either dry (0 min treatment) or immersed in distilled water as described above for KOH, were used for comparison. Following treatment, the seeds were washed under running tap water for 10 min, blotted briefly with paper towels and then used immediately for germination or emergence tests.

Germination test. Twenty-five seeds were placed in a 9-cm petri dish lined with two layers of Whatman No. 1 filter paper wetted with 3 mL distilled water. Four dishes (replicates), each containing 25 seeds, were prepared for each treatment. The dishes were covered and randomly placed in plastic bags to reduce drying. To simulate spring soil conditions, the bags were placed in a constant 10 °C incubator with a 14-h photoperiod with fluorescent lights (300 $\mu mol \cdot m^{-2} \cdot s^{-1}$). Germinated seeds (radicle protruded 1 mm from the seed coat) were counted daily for 25 d. Final germination percentages and standard errors were calculated from four replications.

Seedling emergence test. Seeds of purple coneflower were sown at a depth of 10 mm, while seeds of American licorice, angelica, mint, and blueberry were sown on the surface of a sandy loam (Entic Haploboroll) soil in 15-cm-height × 12-cm-diameter plastic pots. Seeds sown on the surface were lightly covered with soil. The soil was pasteurized at 70 °C for 1 h and cooled to room temperature before use. The pots, in a completely randomized design, were placed in a controlled environment chamber at 14/10 °C with a 14-h photoperiod with fluorescent lights (750 $\mu mol \cdot m^{-2} \cdot s^{-1}$) and 60% relative humidity. Water equilibrated to 10 °C was added every 3 d to the tray on which the pots were placed. The cumulative total of seedling hypocotyl emergence was recorded daily for 30 d. Final emergence percentage and standard errors were calculated from four replications of 25 seeds each, giving 100 seeds for each species.

Results and Discussion

Nontreated seeds of wild blueberry and angelica did not germinate in either petri dishes or soil. Only 5% to 10% germination and 2% to 4% seedling emergence were observed for wild mint and American licorice, and 30% germination and 12% emergence for purple coneflower, respectively. Treating these seeds with water alone for 1–20 min had little effect on either seed germination or seedling emergence at 10 or 14/10 °C (Fig. 1).

Hou and Simpson (1994a) reported that KOH broke dormancy, resulting in a significant enhancement in seed germination of dormant lines of wild oat. The initial rate and amount of water uptake by seeds were en-

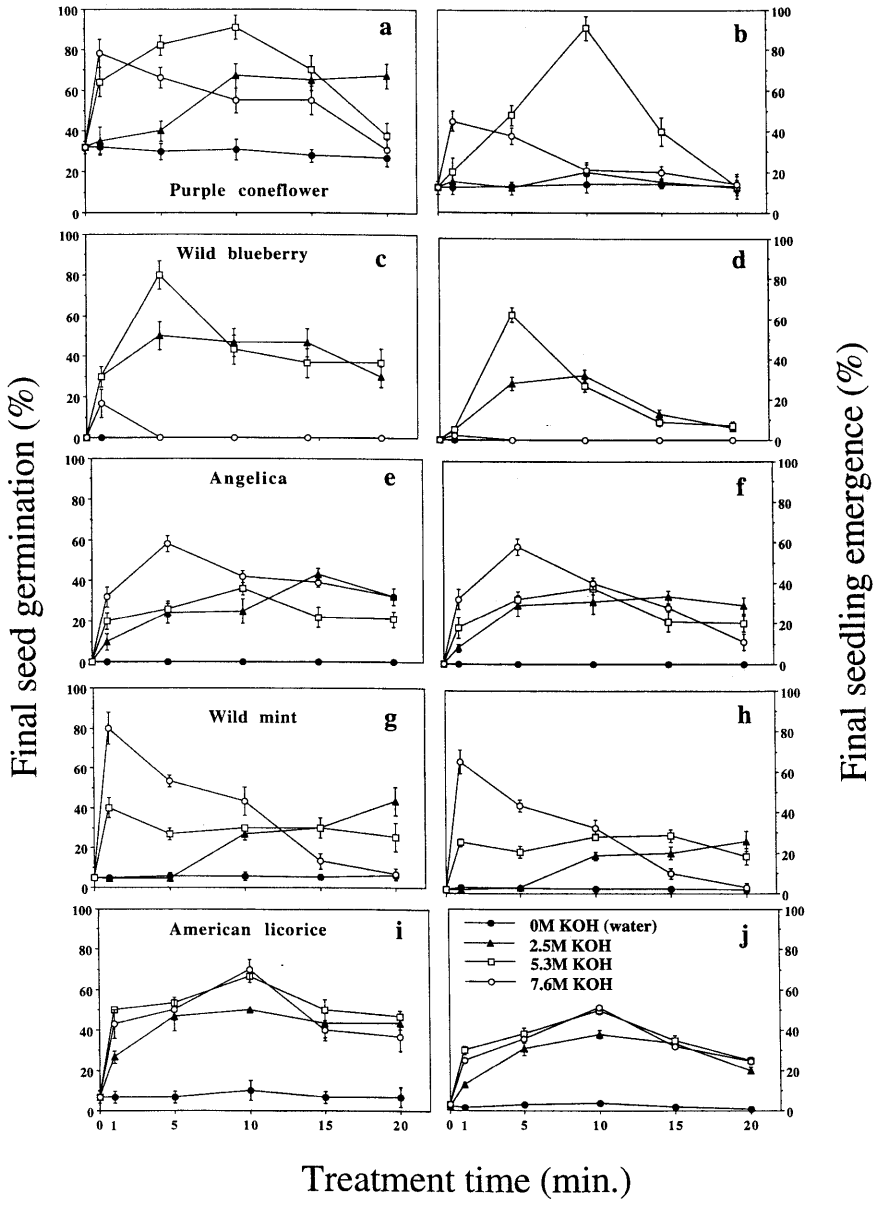

Fig. 1. The effects of duration and concentration of KOH treatment on seed germination (10°C, 14 h photoperiod, left) and emergence (14/10°C, 14 h photoperiod, right) of five native plant species.

hanced by the KOH treatment. In an earlier report, Murray et al. (1980) demonstrated that KOH solutions increased seed germination of Kentucky bluegrass (*Poa pratensis* L.). The cuticle and seed coat are considered to be permeability barriers to water and gases (Morrison and Dushnicky, 1982; Rolston, 1978). Kolattukudy (1981) suggested that the permeability of these barriers could be increased by alkaline hydrolysis. Alkaline solutions are also excellent solvents for the removal of natural germination inhibitors such as abscisic acid (Reaney et al., 1989).

In the present study, concentrated KOH was very effective in enhancing seed germination and seedling emergence of native species at low temperatures. The effect was measured after 1 minute of treatment, particularly at high concentrations. The optimal concentration and time of KOH treatment varied with plant species. For purple coneflower, the optimal treatment (5.3 M KOH for 10 min) increased germination and emergence to 90%, while treatment with 2.5 M KOH for 10–20 min resulted in only 70% germination without improving seedling emergence (Fig. 1a, b). Percent germination and emergence of purple coneflower decreased following treatment with 5.3 and 7.6 M KOH for more than 10 and 1 min, respectively.

Maximum germination and emergence for wild blueberry was achieved following a 5 min treatment with 5.3 M KOH (Fig. 1c, d). Increasing the treatment time reduced both germination and emergence at this concentration. Treatment with 2.5 M KOH for 5 to 15 min resulted in about 50% germination and 15% to 30% emergence, respectively. Although a 17% germination was achieved after treatment with 7.6 M KOH for 1 min, seedling emergence was very low.

Angelica and wild mint showed a similar response to KOH treatment, with the best results obtained with 7.6 M KOH for 5 and 1 min, respectively (Fig. 1e, f, g, h). Increasing treatment time at this concentration reduced both germination and emergence for both species; wild mint was the most affected. Germination and emergence of seeds of both species treated with 5.3 M KOH for 1–20 min was 20% to 40%. Treating angelica seeds with 2.5 M KOH for 5–20 min resulted in 20% to 40% germination and about 30% seedling emergence. Similar results were achieved for wild mint after 10–20 min treatments at the same concentration. Compared to the other species, American licorice seed tolerated a wide range of KOH concentrations, as shown by a relatively constant germination and emergence rate after 1–20 min treatments with 2.5–7.6 M KOH solutions (Fig. 1i, j).

The results of this study indicate that treating these selected difficult-to-germinate species with KOH provides a fast, simple and reliable means of improving germination and emergence. The optimal concentration and treatment duration varied with species, and preliminary tests are recommended on a particular seed lot before large-scale treatment. Prolonged exposure to KOH solutions, particularly at high concentrations, resulted in damage to seed and reduced germination and subsequent seedling emergence, as reported for oat and barley (Hou and Simpson, 1994a, 1994b).

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