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After-ripening, Stratification, and Perigynia Removal Enhance Pennsylvania Sedge Germination

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SUMMARY. **Pennsylvania sedge (*Carex pensylvanica*) has horticultural and restoration potential, but the achenes are difficult to germinate due to complex dormancy requirements. This study identified treatments to overcome physiological dormancy and determined light and temperature requirements for optimum germination. We first tested the effects of perigynia removal and light on achene germination. In the second experiment, achenes were subjected to varying durations of dry-cold or dry-warm storage conditions and a presowing soak in gibberellic acid (GA_3). In a third experiment, we studied whether storage conditions, cold stratification, and sowing temperatures affected germination. Pennsylvania sedge germination was improved by dry-warm storage, perigynia removal, cold stratification, and germination in light.**

Pennsylvania sedge is commonly used for forest restoration (Mottl et al., 2006) and has horticultural potential as a shade-tolerant groundcover and low-maintenance lawn species (Darke, 2007). This herbaceous perennial is native to dry deciduous forests of the eastern half of temperate North America (Gleason and Cronquist, 1991). It produces attractive slender leaves that form a 12-inch mound of foliage that expands through long and short rhizomes (Bernard, 1990) to form mats of 3 m^2 (Mottl et al., 2006). Unlike most lawn species, it thrives in dry partial shade and is uniquely suited to the competitive environment under large trees. Pennsylvania sedge also provides spring interest because it blooms in mid-April to mid-May in southern Ontario and in the northern United States (Crins and Ball, 1983). Achenes ripen and dehisce in June in Minnesota (Table 1). Difficulties in achene germination limit the use of pennsylvania sedge for large horticultural and restoration projects. No germination protocol has been published, and native plant nurseries propagate plants by division. Overcoming dormancy and understanding germination requirements are essential for economically propagating pennsylvania sedge on a commercial basis.

Few *Carex* species exhibit physical dormancy or other germination barriers as a result of their unique morphology. *Carex* are distinguished from other genera within the Cyperaceae by a bladder-like sac called the perigynium (perigynia, plural) that tightly adheres to the hard pericarp of the achene (Amen and Bonde, 1964). The perigynium prevents germination in nebraska sedge (*Carex nebrascensis*) and northwest territory sedge (*Carex utriculata*) (Hoag et al., 2001; Jones et al., 2004). In other cases, *Carex* species respond to traditional physical dormancy treatments such as acidic scarification (Ishikawa et al., 1993) or pericarp nicking (Amen and Bonde, 1964). It is unknown whether pennsylvania sedge exhibits physical dormancy or other germination barriers.

Physiological dormancy is common in the Cyperaceae and may be overcome or reduced by one or more of the following treatments: 1) after-ripening (dry storage of seeds under ambient temperatures before sowing), 2) GA_3, and 3) cold stratification (Baskin and Baskin, 1998, 2004). Broom sedge (*Carex scoparia*) germination was enhanced by up to 2 years of after-ripening (Larson and Stearns, 1990). Elongated sedge (*Carex elongata*) and remote sedge (*Carex remota*) increased germination following after-ripening in comparison with fresh achenes (Schutz, 1997b). However, some wetland *Carex* species had higher germination percentages when stored cold and moist (Budelsky and Galatowitsch, 1999).

Although GA_3 failed to stimulate germination in black and white sedge (*Carex albonigra*), ebony sedge [*Carex ebenea* (Amen and Bonde, 1964)], and hood's sedge [*Carex hoodii* (McDonough, 1969)], it has been shown to increase germination for other monocots such as sand ryegrass [*Leymus arenarius* (Greipsson, 2001)], green needlegrass [*Stipa viridula* (Fulbright et al., 1983)], eastern gamagrass [*Tripsacum dactyloides* (Rogis et al., 2004)], and four Australian grass species (Hagon, 1976). In contrast to GA_3 pretreatment, cold stratification has been shown to successfully alleviate physiological dormancy in many *Carex* species (Hoag et al., 2001; Kettenring and Galatowitsch, 2007a, b; Schutz and Rave, 1999). Although the most effective stratification temperatures for *Carex* species can vary, temperatures below 12 °C are most effective (Brandel and Schutz, 2005). Optimum stratification duration may range from 0.5 to 6 months for *Carex* species (Kettenring and Galatowitsch, 2007a).

Pennsylvania sedge may have additional germination requirements. A light requirement enables woodland *Carex* species to take advantage of gaps in leaf litter on the forest floor

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.0929	ft^2	m^2	10.7639
3.7854	gal	L	0.2642
2.54	inch(es)	cm	0.3937
16.3871	$inch^3$	cm^3	0.0610
1	ppm	$mg \cdot L^{-1}$	1
(°F – 32) ÷ 1.8	°F	°C	(1.8 × °C) + 32