Prairie Dropseed Germination Highest with Warm, Moist Conditions

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SUMMARY. We tested prairie dropseed (*Sporobolus heterolepis*) using six different germination treatments and found the best results with cold (40 °F), dry storage followed by direct seeding into a commercial germination mix placed in a 75 °F glass-glazed greenhouse with intermittent mist (5 seconds of mist every 8 minutes), and 600-W high-pressure sodium lighting with a 16-hour daylength. We found commercial laboratory viability analysis from tetrazolium staining did not correspond to germination results. Cold (34 °F), moist (2.3 g seed moistened with 2.5 mL deionized water) treatment, also known as cold conditioning, produced significantly less germination and fewer transplantable seedlings, and is not recommended for prairie dropseed.

Prairie dropseed, a warm-season prairie bunchgrass, is native from Saskatchewan to Quebec and Massachusetts, south to Georgia, west to New Mexico and Montana (U.S. Department of Agriculture, 2019). New York and Ohio list prairie dropseed as threatened and five states list it as endangered: Connecticut, Kentucky, Maryland, North Carolina, and Pennsylvania (U.S. Department of Agriculture, 2019). Prairie dropseed is larval food for six species of butterflies/moths (Lepidoptera), including the federally listed endangered poweshiek skipperling (*Oarisma poweshiek*) and threatened dakota skipper (*Hesperia dacotae*) (Narem and Meyer, 2017). Prairie dropseed can be an important addition to managed landscapes because of its bunch growth habit, dense fibrous root system, medium size, and attractive, fragrant flowers. Seed or vegetative propagation and growth of prairie dropseed is slow (Diboll, 1997; Fedewa and Stewart, 2011; Schramm, 1978). Germination

has not been reported to be more than 53% (Greene and Curtis, 1950), making it a challenge for commercial production.

Cold dry (Nuzzo, 1978; Prairie Moon Nursery, 2019) or cold moist (equal parts moistened seed and vermiculite) (Blessman et al., 2001), as well as either cold dry or cold moist has been recommended for this species (Prairie Nursery, 2019; Steffen, 1997). However, Rock (1977) indicated this species needs no treatment before germination. Greene and Curtis (1950) concluded prairie dropseed had no benefit to cold stratification. Fedewa and Stewart (2009) found no more than 50% germination, and no significant difference using cold moist, cold dry, and lighting treatments. In the literature, only Greene and Curtis (1950) and Fedewa and Stewart (2009) conducted experiments and reported germination percentage results. Other citations made general comments or recommendations, but did not report actual experimental results to substantiate their recommendations.

An informal e-mail survey in 2018 of nine grass growers in the United States revealed that two used cold, moist stratification (3–4 weeks

at 38 to 45 °F), but seven growers used cold, dry storage before germination (M.H. Meyer, unpublished data). All growers stressed the importance of pure seed and using seed that was 1 or 2 years old, but acknowledged quality and germination vary annually. Oversowing seed, using 3 to 5 or even 12 to 15 seeds per plug cell is common (M.H. Meyer, unpublished data).

The objective of this project was to investigate different germination treatments on viable prairie dropseed seeds and to develop recommendations for commercial growers that would increase germination rates of prairie dropseed.

Methods and materials

All treatments were conducted at the Plant Growth Facilities at the University of Minnesota, St Paul (lat. 44°58'N, long. 93°14'W). Seeds were purchased from two commercial sources in Oct. 2017 with germination and purity information (Table 1). In Feb. 2018, this seed was tested in a commercial laboratory [Minnesota Crop Improvement Association (MNCIA), St. Paul, MN] for germination, purity, and tetrazolium staining (Table 1). All seeds were held in cold (40 °F), dry storage from Oct. 2017 through Mar. 2018, before the following six treatments were administered. Treatments took place from Jan. through Mar. 2018.

For germination treatments 1, 2, and 3, seeds were removed from 40 °F cold, dry storage and were sown in 128-cell (individual cell volume, 14 mL) propagation trays (T.O. Plastics, Clearwater, MN) with moistened germination mix (Sun Gro Horticulture, Agawam, MA). Two seeds (uncovered) were placed in each cell. For treatment 1, germination mix warm, seeds were lightly covered with medium-grade vermiculite (Sun Gro Horticulture), irrigated with a gentle mist of tap water not to dislodge the seeds, and placed in a 75 °F glass-glazed greenhouse with intermittent

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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
29.5735	fl oz	mL	0.0338
2.54	inch(es)	cm	0.3937
25.4	inch(es)	mm	0.0394
0.0254	mil(s)	mm	39.3701
28.3495	oz	g	0.0353
(°F – 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

Table 1. Results from two seed testing laboratories for two commercial sources of prairie dropseed used in experiments in 2018 at the University of Minnesota.

Seed source	Testing laboratory	Testing date	Pure seeds (%)	Germination (%)	Dormant seeds (%)	Tetrazolium stain for viable seeds (%)
A	IL	Nov. 2016	99.7	21	66	na
A	IL	Aug. 2017	99.0	93	na	na
A	MNCIA	Apr. 2018	99.5	1	0	82
B	IL	Feb. 2017	95.0	95	0	na
B	MNCIA	Apr. 2018	99.0	66	0	95

IL = independent laboratory hired by nursery or seed source; MNCIA = Minnesota Crop Improvement Association (St. Paul, MN); na = data not available.

mist (5 s mist every 8 min) and 600-W high-pressure sodium lighting (Gavita, Vancouver, WA; GE Lighting, Cleveland, OH) with a 16-h daylength. For treatment 2, germination mix cold, after seed placement, the trays were lightly covered with clear, 6-mm plastic to avoid drying and were placed in a 40 °F refrigerator for 4 weeks. Upon removal, seeds were lightly covered with medium-grade vermiculite, irrigated, and placed in the greenhouse conditions as described for treatment 1. For treatment 3, germination mix 34 °F, before placing seeds on the germination mix, 2.3 g seed was placed in a 3.0-inch-long × 7.7-inch-wide × 3.8-inch-high double-seal plastic bag (Ziploc; S.C. Johnson, Racine, WI) and moistened with 2.5 mL deionized water, then sealed and stored at 34 °F. Moisture amounts were based on the work of Schramm (1978). Seeds were aerated weekly (bags opened and ventilated for 10 to 15 min), and additional moisture of 1 to 2 mL was added if seeds were completely dry. After 4 weeks, seeds were sown as described for treatment 1 and were placed in the same greenhouse growing conditions. Two hundred fifty-six seeds from both sources were planted for one replicate. Treatments 1 and 2 were replicated three times; treatment 3 was replicated twice.

For germination treatments 4, 5, and 6, seeds were removed from 40 °F cold, dry storage and were placed on blotter paper moistened with deionized water in 60 × 15-mm petri dishes (Becton, Dickinson and Co., Franklin Lakes, NJ) sealed with flexible film (parafilm M; Bemis, Neenah, WI). For treatment 4, plates light, plates were set up as described and placed in the greenhouse conditions described for treatment 1. Petri plates were remoistened with deionized water when the blotter paper was dry. For

treatment 5, plates cold, plates were set up as described and placed in a 40 °F refrigerator for 4 weeks. Plates were checked for moisture; they did not need additional moisture during the 4 weeks. After 4 weeks, the plates were unsealed, lightly moistened with deionized water, resealed, and placed in the greenhouse conditions described for treatment 1. For treatment 6, plates dark, seeds were set up as described and plates were completely wrapped with aluminum foil to exclude light. They were then placed in the greenhouse conditions described for treatment 1. Plates were remoistened with deionized water when the blotter paper was dry. Forty seeds per plate with five plates (200 seeds total) per source consisted of one replicate. Each petri plate treatment was replicated three times using both seed sources.

Germination counts began at 7 d and continued for 4 weeks. Germination was defined as the visible emergence of plumule and radicle. Seedling counts were concluded after 4 weeks for all treatments (Table 2). Transplantable was defined as a healthy seedling large enough to handle (≈1 inch long).

A one-way analysis of variance was applied to the data using R (R Core Team, 2017). Mean separations were determined using Tukey's honestly significant difference test for pairwise means comparisons, with a significance level of $P < 0.05$.

Results and discussion

The commercial seeds purchased and used in these experiments came with viability and germination information, along with testing dates (Table 1). Both seed companies verified that they used a third-party independent laboratory to determine these results (B. Carter and N. Diboll, personal communication). Because

viability and germination were high (>90%) it appeared the seeds were suitable for these experiments. When the initial germination results were quite low, especially for one seed source, another laboratory (MNCIA) performed viability and germination tests about 8 months later than original testing dates. Viability reported from MNCIA was high, although germination was lower (Table 1). According to MNCIA-registered seed technologists, viability standards used in tetrazolium staining are sometimes not accurate in showing truly viable seed, yet they meet the standards set for staining that are determined to be live tissue (C. Mowry, personal communication). Any indication of staining in the endosperm, and various levels of stain, are used as indicators of viability and, in this example of prairie dropseed, it appears that although some viable tissue was within the seed, it was not enough for germination and growth.

Seeds sown at room temperature in dark petri plates (treatment 6), or sown in germination mix and then placed in standard greenhouse conditions with intermittent mist (treatment 1), had significantly greater germination than treatments 2, 3, and 5 (cold-conditioned; cold, moist germination mix; or cold, moist petri plates, respectively) (Table 2). Warm, moist growing conditions after cold, dry storage provided the greatest germination for prairie dropseed in our experiments. We found no significant benefit to treatments 2 and 5 [cold (40 °F), moist treatment of seeds in petri plates or germination mix, respectively]. Treatment 4 (cold, moist petri plates) had germination similar to the greatest germination results of treatments 1 and 6, but produced a significantly fewer number of transplants. We found the germination

Table 2. Mean number and percentage of germinated and transplantable seedlings from six seed treatments of prairie dropseed at the University of Minnesota in 2018.

Treatment ^a	Germination ^b		Transplants	
	(no.)	(%)	(no.)	(%)
T6 Plates dark	117	59 a ^x	65	33 ab
T1 Germination mix warm	125	49 a	109	43 a
T4 Plates light	88	44 abc	42	21 bc
T5 Plates moist cold	72	36 bcd	21	11 c
T2 Germination mix cold	76	31 d	56	22 bc
T3 Germination mix 34 °F (1.1 °C)	52	20 d	47	18 bc

^aTreatment 6 (T6 Plates dark) = covered petri plates 75 °F (23.9 °C); treatment 1 (T1 Germination mix warm) = commercial germination mix 75 °F, 16-h days, mist greenhouse; treatment 4 (T4 Plates light) = petri plates 75 °F, 16-h days, greenhouse; treatment 5 (T5 Plates moist cold) = petri plates 40 °F (4.4 °C) for 4 weeks, followed by 75 °F, 16-h days, greenhouse; treatment 2 (T2 Germination mix cold) = commercial germination mix 40 °F 4 weeks, followed by 75 °F, 16-h days, mist greenhouse; treatment 3 (T3 Germination mix 34 °F) = cold-conditioned for 4 weeks followed by commercial germination mix, 75 °F, 16-h days, mist greenhouse.

^bGermination was defined as the visible emergence of plumule and radicle. Transplantable was defined as a healthy seedling large enough to move, ≈1 inch (25.4 mm) long.

^xMeans followed by the same letter are not significantly different as determined by Tukey's honestly significant different test at $P < 0.05$.

mix in warm greenhouse conditions produced the most seedlings, of which 43% were viable transplants (Table 2). Throughout the 4 weeks of all treatments, some seedlings grew normally, but others declined and died, resulting in a reduced number of transplants when compared with germination results. This was expected in petri plates, where seedlings have compromised growing conditions, but not in germination mix. These results are disappointing and, in discussion with plant pathologists, fungal diseases are suspected (J. Beckerman, personal communication).

An often-cited reference for prairie grass seed germination is Schramm (1978), who advised cold, damp conditioning or moistening the seeds and holding them at 34 °F as a germination requirement. However, cold conditioning (treatment 3) did not improve germination in our experiments and produced significantly less germination than three other treatments. Therefore, we cannot recommend cold conditioning for commercial production of prairie dropseed. We advise growers to use caution when relying solely on tetrazolium staining as a guide to viable seeds when sowing prairie dropseed. Actual germination is a much better guide for knowing how viable a seed lot is.

Conclusion

We investigated six germination treatments using two commercial sources of prairie dropseed seed to develop recommendations for commercial growers to increase germination rates of

this North American native prairie species. We found tetrazolium staining results from commercial laboratories did not correspond to germination rates and may not be a reliable means to report or determine seed germination for prairie dropseed. We recommend growers use fresh seed, store it in 40 °F cold dry conditions, sow in germination mix covered with medium-grade vermiculite, irrigate with a gentle mist of tap water, and place seed trays in a 75 °F greenhouse with intermittent mist and a 16-h daylength.

Overall, our results were still low for prairie dropseed germination. Across six treatments, the average germination was 40%. Further experiments, including smoke, which has been shown to improve seed germination (Brown and van Staden, 1997), may have application for prairie dropseed because it evolved in a fire-prone environment. Changes in seed handling to reduce seedcoat breakage should be investigated to possibly improve prairie dropseed germination. Knowing that prairie dropseed is an important grass in the life cycle of several native butterflies/moths, further work is needed on propagation and growth of this species.

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