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RESEARCH NOTE

Growing Native Seeds for Restoration: Seed Dormancy and Germination of *Sidalcea malviflora* ssp. *virgata* (Malvaceae)

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ABSTRACT: *Sidalcea malviflora* ssp. *virgata* (rose checkermallow) is a native forb in the Pacific Northwest, USA; it is a common species in upland prairies of the Willamette Valley, Oregon, and is a state listed endangered species in Washington State. This species provides a high value nectar supply for butterflies in this region, including the endangered *Icaricia icarioides fenderi* (Fender's blue butterfly), and is therefore targeted for inclusion in habitat restoration projects throughout the region. In past propagation efforts, *S. malviflora* ssp. *virgata* has demonstrated poor germination, indicating that there may be some dormancy in seeds of this species. We characterized dormancy and developed germination protocols to support greenhouse propagation of plants for habitat restoration projects. *Sidalcea malviflora* ssp. *virgata* has physical dormancy and may have some physiological dormancy as well. Highest germination (55%) was achieved by scarification followed by four weeks or more of cold moist stratification at 5 °C.

Index terms: germination, physical dormancy, physiological dormancy, rose checkermallow

INTRODUCTION

Habitat restoration efforts in upland prairies of the Pacific Northwest of North America focus on invasive species removal and restoration of native plant and animal communities (Stanley et al. 2008; Schultz et al. 2011). Populations of some rare insects, such as the endangered *Icaricia icarioides fenderi* Macy (Fender's blue butterfly), increase with the abundance of nectar plants used by adults (Schultz and Dlugosch 1999). Therefore, restoration of native plants is necessary to meet habitat needs for the Fenders blue butterfly (Schultz 2001) and other insect species, and to increase diversity in native plant communities (Stanley et al. 2011).

Sidalcea malviflora (DC.) A. Gray ex Benth. ssp. *virgata* (Howell) C.L. Hitchc. (rose checkermallow) is an important nectar plant for Fender's blue butterfly (plant nomenclature follows Oregon Flora Project Checklist, Cook and Sundberg 2011). In one study, 34% of flower visitation by adult Fenders occurred on *S. malviflora* ssp. *virgata,* though native plants only accounted for 5% of the available flowers (Schultz and Dlugosch 1999). This species is, therefore, a likely candidate for butterfly habitat restoration efforts in the Willamette Valley, Oregon. Additionally, *S. malviflora* ssp. *virgata* is a state listed endangered species in Washington State and is, therefore, a candidate for conservation in its own right. This species has often exhibited poor germination in past propagation efforts (Kaye, pers. obs.), suggesting that its seeds may possess some type of seed dormancy.

Other species in the family Malvaceae have exogenous physical dormancy caused by an impermeable seed coat (Winter 1960; Rolston 1978; Halse and Mishaga 1988; Baskin and Baskin 1998). The chalaza region of the seed appears to be the location where, in nature, the seed coat is weakened and dormancy is most often overcome (Rolston 1978). The chalaza plug is a structure in the seed located opposite the micropyle that, under the correct conditions, dislodges and allows water to enter the seed and initiate germination (Winter 1960; Baskin et al. 2000). Physical dormancy is overcome in manipulative experiments (and often in nature) through scarification (breaking) of the seed coat.

To support the development of plant materials for restoration projects using *S. malviflora* ssp. *virgata*, we conducted a series of laboratory experiments to characterize the specific type of dormancy in this species and develop dormancy breaking protocols. Our working hypothesis was that *S. malviflora* ssp. *virgata* has physical dormancy as well as physiological dormancy. Other species of *Sidalcea* have documented physical dormancy, and physiological dormancy is common in the prairie flora of our region (Russell 2011). Additionally, germination for commercial propagation is achieved through acid scarification followed by a short period of stratification (Lynda Boyer and Eric Hammond, Heritage Seedlings Inc., pers. comm. 2013). Therefore, we performed experimental scarification and stratification of seeds alone and in combination.

METHODS

Our experimental design was based on methods described in Baskin and Baskin (1998) for the dormancy types described in the literature for related species. All laboratory experiments were conducted at the Oregon State University Seed Laboratory. We tested the effects of scarification and wet stratification on germination of *Sidalcea malviflora* ssp. *virgata*. Seeds for this experiment were obtained from a commercial source, where they had been produced in a propagation bed from a diversity of wild source populations collected in the Willamette Valley. The seed lot used for these experiments had an estimated 84% live seedas reported by the commercial supplier.

Stratification was achieved by placing seeds on wet germination paper in sealed clear boxes placed in a temperature controlled room held at a constant 5 °C. Seeds were scarified by nicking off a piece of the seed coat of each seed with a razor blade; each seed was scarified by hand to ensure the seed coat was broken. Following treatments, seeds were placed in a germination chamber with alternating 15/25 °C temperatures and 8/16 hour photoperiods (8 hours of warm light, 16 hours of cold dark). Germination of seeds was recorded weekly for two weeks; we determined a seed to have germinated if the radicle emerged at least 2 mm beyond the seed coat.

We tested scarification in combination with cold moist stratification as methods for breaking dormancy in *Sidalcea malviflora* ssp. *virgata* in a 2 × 7 factorial design to determine the optimal treatment combination for breaking dormancy. Specifically, two levels of scarification, scarified vs. unmanipulated seeds, were crossed with seven cold stratification periods (0, 2, 4, 6, 8, 10, and 12 wk). Each of the 14 treatment combinations included 4 replicates of 50 seeds each. We used two-way analysis of variance (ANOVA) to test for the effects of scarification and stratification on mean germination of *Sidalcea malviflora* ssp. *virgata*. We also conducted pairwise comparisons between each treatment group using Tukey HSD tests. All analyses were conducted using R statistical software, version 2.14.

RESULTS

Germination of *S. malviflora* ssp. *virgata* seeds was strongly and significantly affected by scarification ($F(1,52) = 47.46$, $P < 0.0001$) and stratification ($F(1,52) = 32.128$, $P < 0.0001$) , and there was no statistically significant interaction between treatments ($F(1,1) = 0.1917$, $P = 0.6634$). Mean germination of unscarified seeds ranged from 3% (±1 SD 1.2%) for seeds that did not receive any stratification to a maximum germination of 35.5% (±1 SD 8.7%) for seeds that received 12 weeks of cold stratification (Figure 1). Scarified seeds had highest mean germination after four (54.5% ± 1 SD 8.5%) or more weeks of cold stratification.

DISCUSSION

Sidalcea malviflora ssp. *virgata* has a hard seed coat that appears to be the primary barrier to imbibition and germination. In addition to an impermeable seed coat, seeds of this species also appear to possess physiological dormancy; germination was highest when scarification and cold stratification were combined. Hard seededness has also been documented in a related wetland species from the Willamette Valley, *Sidalcea nelsoniana* Piper, which had increased germination after scarification of the seed coat (Halse and Mishaga 1988). Physiological dormancy in *S. malviflora* ssp. *virgata* may be caused by germination-inhibiting compounds in the seed, which were leached from the seed during cold stratification. Another explanation for the effect of cold stratification is simply that the seed coat is only mildly impermeable; the extended period of moist conditions may have softened the external lipid layers sufficiently to dislodge the chalazal plug, allowing water into the seed. Russell (2011) also found that cold stratification increased germination of *Sidalcea campestris* Greene, but concluded that this effect may be a result of slow degradation of the seed coat of a physically dormant species rather than evidence of physiological dormancy.

Under naturally occurring environmental conditions, the chalazal plug of *S. malviflora* ssp. *virgata* may be dislodged by extreme temperature fluctuations, wet-dry or freeze-thaw cycles, or even fire (Winter 1960; Baskin and Baskin 2003; Daws et al. 2006). In the Willamette Valley, seeds sown in the fall successfully overcome dormancy when they are subjected to normal winter conditions in the soil (Jones 2012), with few seeds remaining dormant for two winters (K. Jones, pers. obs.). For greenhouse propagation, when germination must occur quickly and consistently for all viable seeds, we recommend scarification followed by four weeks of cold wet stratification. By following the dormancy breaking techniques described here, land managers can produce the necessary plant materials of *S. malviflora* ssp. *virgata* for habitat restoration projects in native grassland plant and animal communities in the Pacific Northwest.

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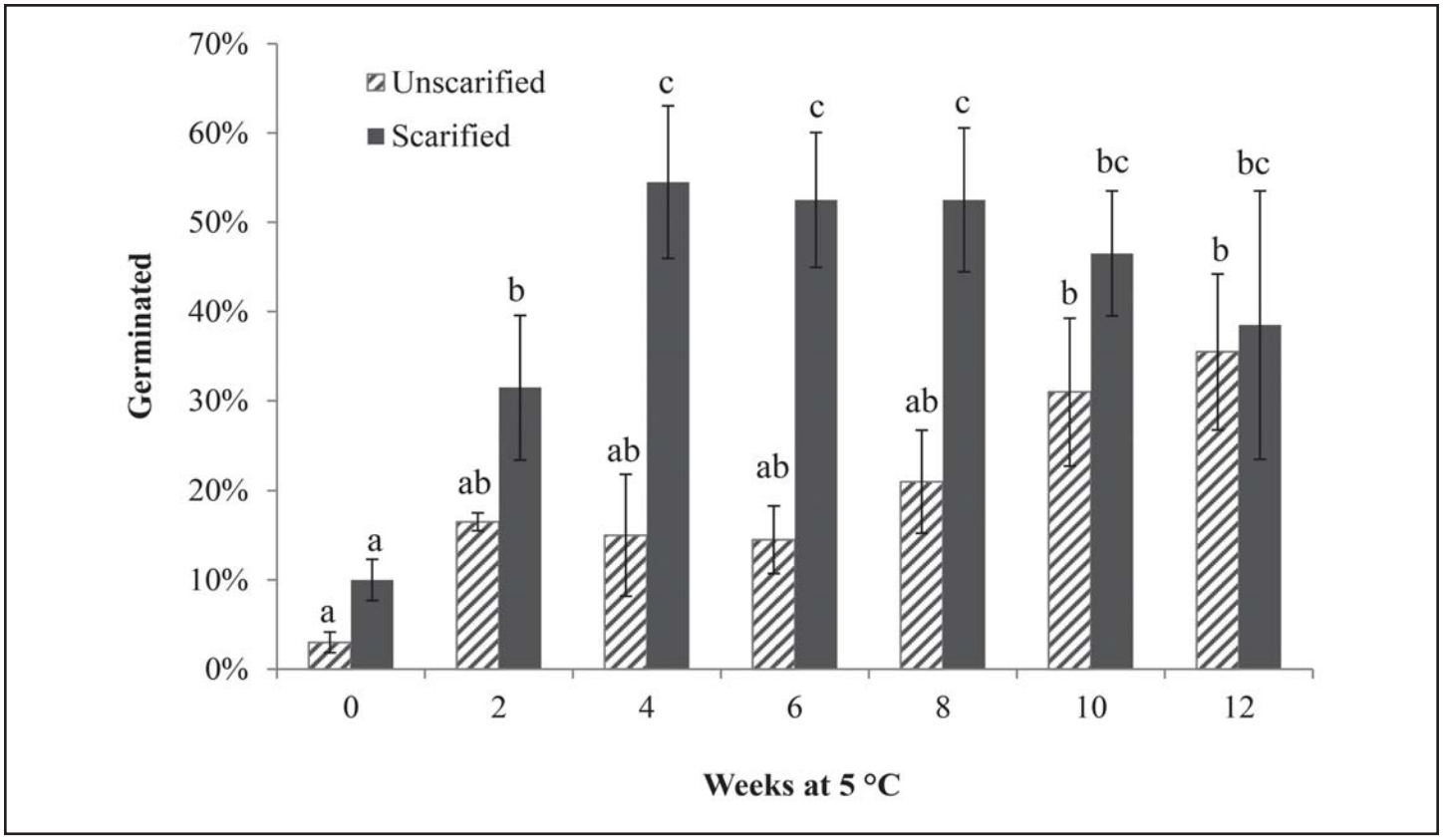

Figure 1. Average (±1 SD) germination of scarified and unscarified *S. malviflora* ssp. *virgata* seeds exposed to a range of cold stratification periods. Bars with different letters represent significantly different means ($P \leq 0.05$).

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