Seed germination of Peck's penstemon

2018

Report to the Deschutes National Forest

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Institute for Applied Ecology

PREFACE

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ACKNOWLEDGMENTS

We are grateful for financial support from the Deschutes National Forest. Jenifer Ferriel and Jerry Hustafa helped develop the project and collect the seeds from wild populations. We are grateful for their support. We thank D. Brown, S. Elias and the Oregon State University Seed Lab for access to germination chambers, viability testing and consultation on the project. IAE Conservation Interns Sebastian McCauley and Zade Clark-Henry assisted with all germination tests.

Cover photograph: Germinated seeds of Peck's penstemon from the Canal 16 population. Photo by T.N. Kaye.

SUGGESTED CITATION

Kaye, T.N. and M.A. Bahm. 2018. Seed germination of Peck's penstemon. Institute for Applied Ecology, Corvallis, Oregon. iii + 5 pp.

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SEED GERMINATION OF PECK'S PENSTEMON

1. INTRODUCTION

Peck's penstemon (*Penstemon peckii*) is endemic to Oregon, occurring in only Deschutes and Jefferson counties. It is considered a Sensitive Species by the US Forest Service, and a Species of Concern by the US Fish and Wildlife Service. Most of its known occurrences are on the Deschutes National Forest. Previous research on the germination of the species has focused on the length of time seeds can remain viable in the seedbank (Guerrant 1993), genetic variation (King 1993), and the effects of light and darkness on seed germination (Fields 1985). Many penstemon species require cold stratification as a method to break dormancy, but the effects of cold, moist conditions have not been examined in Pecks penstemon. Here we evaluate the effects of different periods of cold stratification on seeds from several different populations.

2. GOALS AND OBJECTIVES

The goal of this project is to determine if the seeds of Peck's penstemon have dormancy that can be broken by cold stratification, and what duration of cold stratification is optimal for breaking dormancy.

3. METHODS

Seeds from eight populations of Peck's penstemon were collected in the August of 2017 by staff from the Deschutes National Forest (Table 1). Seeds were stored at -5°C until germination tests were performed in April, 2018. We tested seed viability at the Oregon State University Seed Lab to determine the full viability of seeds prior to germination tests. Seed viability was tested with tetrazolium (TZ) by the Oregon State University Seed Lab. The TZ test was used to estimate the percentage of live and dead seeds in each seed source, regardless of dormancy level (Baskin and Baskin 2001). TZ tests were performed with samples of 200-201 seeds per source population.

To determine if seeds from each species and source population required a period of cold stratification to release them from dormancy, we exposed seeds to a range of cold, moist periods following methods in Kaye, Bahm and Sandlin (2018). Dormancy was defined here as the inability of a seed to germinate in a specified period of time under combinations of normal physical factors (e.g., temperature, light, etc.) that are otherwise favorable for germination, following Baskin and Baskin (2004). Seeds were stratified for 0, 2, 4, or 6 wk at 5°C at the Oregon State University Seed Lab. We used five replicates of 50 seeds from each seed source. For all replicates, seeds were placed on moistened germination paper in 15 cm × 15 cm × 3 cm transparent plastic boxes with fitted lids. The paper was moistened weekly as needed with distilled water. After stratification treatments were applied, seeds were placed in a growth chamber with 15°C/25°C alternating temperatures, with 8 h of darkness at 15°C and 16 h of fluorescent light at 25°C. We defined germination as emergence of the radicle at least 3 mm, and counted germinated seeds after 14 days. We tested for effects of cold stratification and population with a general linear model of Analysis of Variance, with cold stratification treatment as a fixed effect and seed source as a random effect using NCSS statistical software (Hintze 2008).

Table 1. Seed collection locations.

Site #	Site Name	Date Collected	Latitude	Longitude	TZ viability
054	Riverside CG	8/9/2017	44.4388	-121.64112	89%
043	Jack Cr. CG	8/14/2017	44.48618	-121.70529	97%
065	Brush Creek	8/14/2017	44.51592	-121.66468	95%
018	Black Butte SW	8/9/2017	44.37909	-121.66595	98%
038	Canal 16 #7	9/15/2017	44.23833	-121.54220	97%
035	Cold Springs CG	9/8/2017	44.31104	-121.62290	97%
050	South Lake Creek	8/9/2017	44.44118	-121.65423	89%
071	Stevens Burn 2	8/1/2017	44.38035	-121.48483	82%

4. RESULTS & DISCUSSION

Seed viability tests suggested that viability was generally very high across all populations examined (Table 1), ranging from a low of 82% at Stevens Burn 2 to a high of 98% at Black Butte SW.

Seed germination varied considerably among populations, and the effects cold stratification were small but differed among sites. The statistical tests showed a significant interaction between seed source and cold stratification treatments (p=0.0003, Table 2). King (1993) also found considerable variation in germination across Peck's penstemon populations, despite using different germination test methods. She also found substantial genetic variation, suggesting that some aspects reproduction in this species may be under genetic control.

Despite high seed viability as indicated from the TZ test, germination was relatively low from some populations, and never as high as estimated viability from any sources (Figure 1). For example, seeds from Stevens Burn 2 had germination of only 20-26%, and were unaffected by cold stratification period. Germination was also at or below 50% for seeds from South Lake Creek and Riverside Camp Ground. In contrast, seeds from Cold Springs CG and Canal 16 #7 typically germinated to about 80% or more. In some cases where cold stratification periods changed germination relative to 0 weeks of cold, this was could have been due to development of pathogens or mold that reduced germination rather than enhanced it. But mold was nevertheless an uncommon problem (see photos in Figures 2 and 3).

The difference between germination and viability that we observed is not explained by dormancy that could be broken by cold stratification. It is possible that other dormancy mechanisms are involved, including smoke induced germination or other factors. It is also possible that the viability estimates are overly optimistic, and that actual viability is closer to our observed germination rates. Viability tests using TZ are sometimes incorrect, and the method is considered a helpful aid in most but not all seeds.

This project suggests that seeds of Peck's penstemon have high viability across populations, with the potential for substantial seed dormancy in from some but not all sites. We also show that seed germinability differs among populations, but that cold stratification for up to six weeks is not effective for releasing seeds from dormancy.

Many seeds of Peck's penstemon are easy to germinate and could support production of plugs to augment existing small populations, or establish new populations in order to enhance connectivity and overall population numbers for the species.

Table 2. Analysis of Variance table for the effects of population (seed source) and weeks of cold stratification.

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level
Population	7	4.61103	0.658719	105.2	0.000000*
Weeks of cold	3	0.266907	8.90E-02	5.16	0.007871*
Population * weeks of cold	21	0.361812	1.72E-02	2.75	0.000311*
S	115	0.720087	6.26E-03		
Total (Adjusted)	146	5.904016			
Total	147				

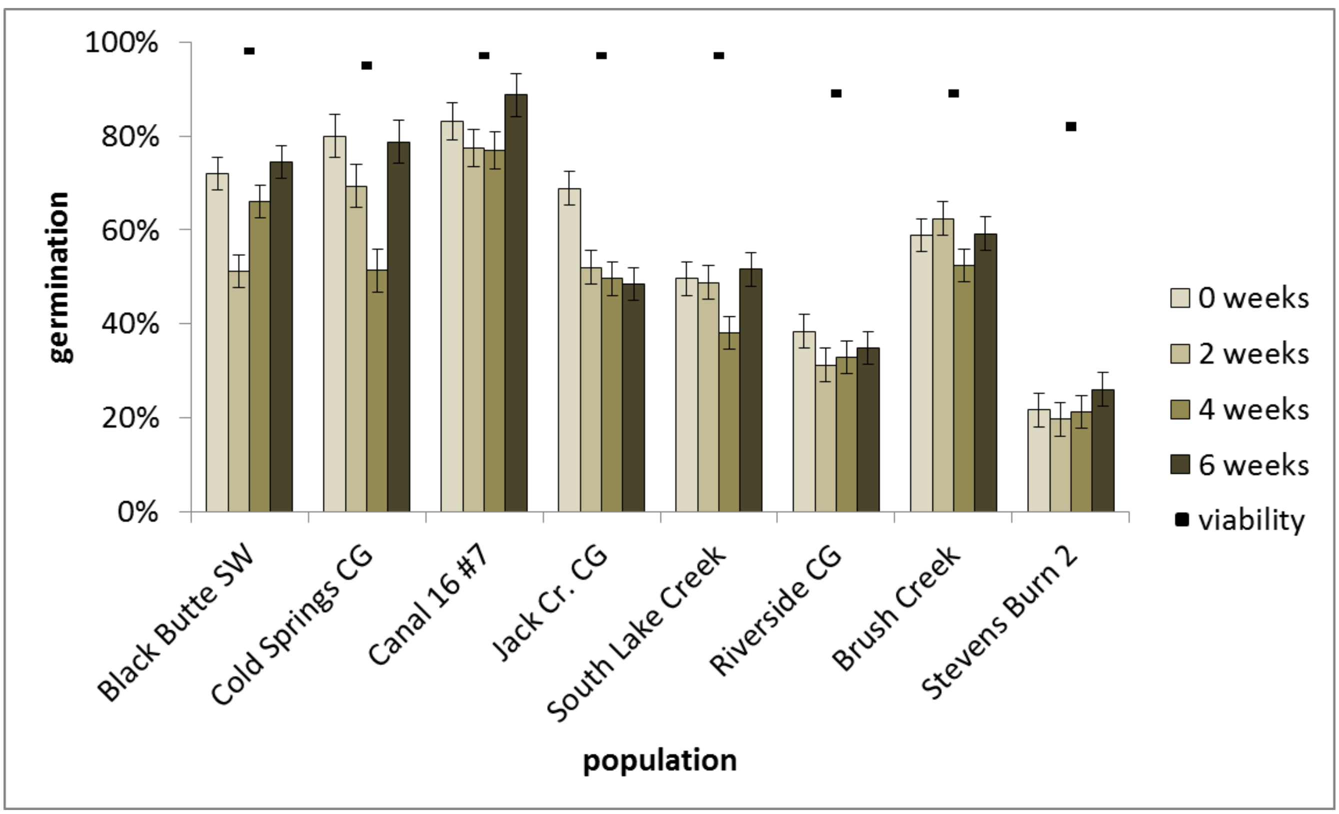

Figure 1. Seed germination among populations of Peck's penstemon after four periods of cold stratification.

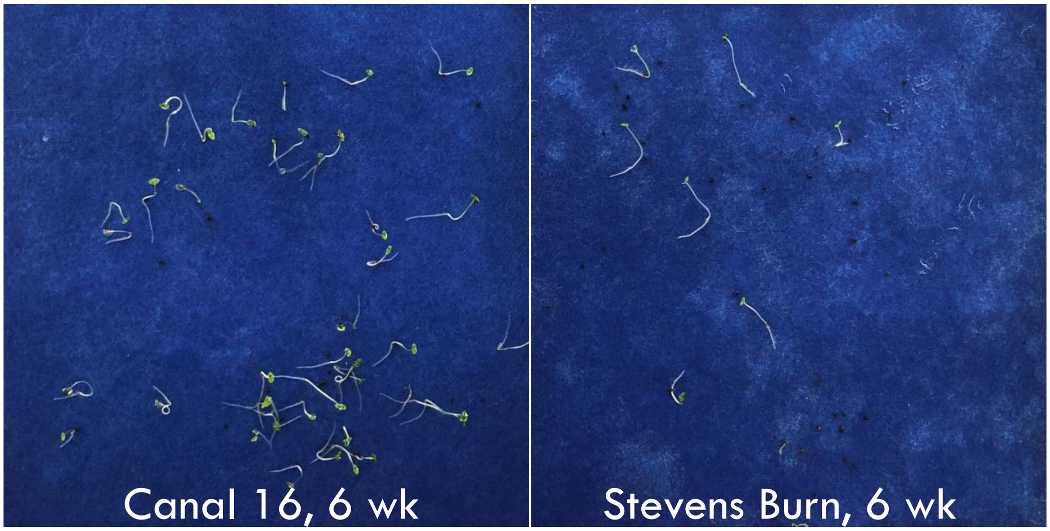

Figure 2. Seed germination differed substantially among populations of Pecks penstemon, even after six weeks of cold stratification. Seeds from Canal 16 (left) and Stevens Burn (right), for example, had 89% (±5%) vs 26% (±4%) germination, despite very high estimates of seed viability.

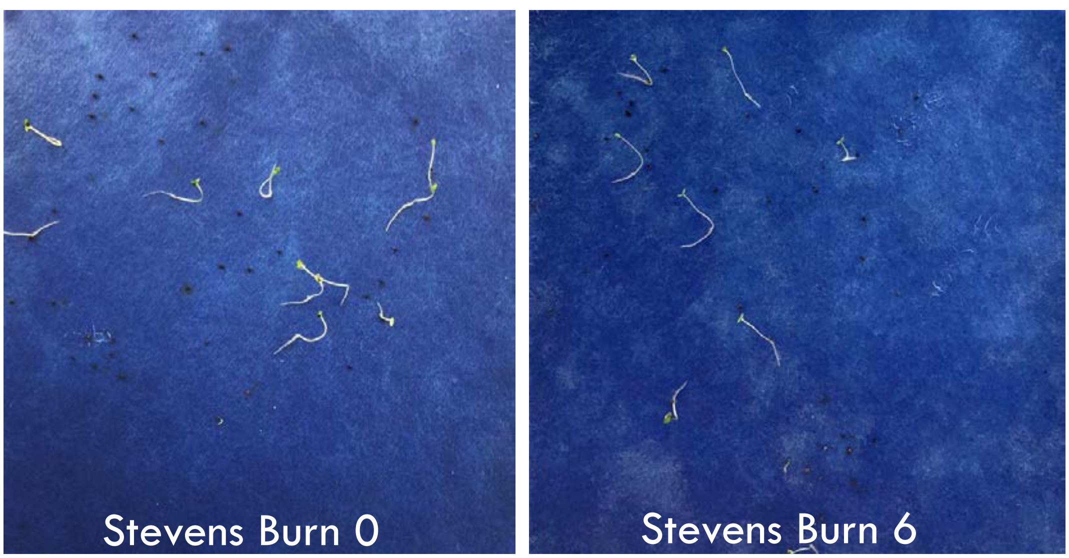

Figure 3. Cold stratification had no beneficial effects on Peck's penstemon. For example, although only 22% (±4%) of seeds germinated from Stevens Burn without cold stratification, after six weeks of cold germination was still only 26% (±4%).

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