

## PLANT MATERIALS TECHNICAL NOTE

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### REDUCING SEED DORMANCY IN SILVERLEAF PHACELIA (*Phacelia hastata*)

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Silverleaf Phacelia (*Phacelia hastata*), photo by NRCS

### ABSTRACT

Silverleaf phacelia (*Phacelia hastata*) is a native forb with several beneficial conservation uses for native plant community restoration including pollinator habitat restoration and mined land reclamation. Seeds of silverleaf phacelia exhibit dormancy that significantly limits germination without pretreatment. As a species of interest in restoring lands in western Montana impacted by acid and heavy metal fallout from historic smelting operations, and as an important species for pollinator habitat enhancement, a replicated study was initiated to investigate potential dormancy breaking pretreatments. A Randomized Complete Block design of four replicates, each with 100 seeds, was sown in containers comparing two durations of seed coat scarification (none versus 360 seconds) and three intervals of cold:moist chilling (stratification) (none, 30-day, 60-day). In this study, best results (mean germination of 65%) was attained with scarified seeds stratified for 30 days. At this time, seed coat scarification with 40 grit sand paper in a commercial seed scarifier for at least 90 but not more than 360 seconds is recommended prior to late winter or early sowing of silverleaf phacelia, whereas dormant fall planting of non-scarified seeds is recommended.

### INTRODUCTION

In the spring of 2003, the Stucky Ridge Comparative Evaluation Planting (CEP) was installed near Anaconda, Montana, to determine if indigenous plant accessions exhibited superior tolerance to low pH and heavy metal contaminated soils than non-local seed sources. The forb

silverleaf phacelia (*Phacelia hastata*) was included in the forb/subshrub part of the trial at Stucky Ridge and performed relatively well.

There was a lack of forb emergence the year of planting. It may have been due to the May 13 planting date. To overcome seed dormancy and germinate, there is evidence that silverleaf phacelia may require a period of cold:moist stratification (chilling). Other sources indicate seed coat scarification may also improve germination (Dougher, 2012). A greenhouse study was conducted to determine if cold:moist stratification and/or seed coat scarification, and their interaction, improved germination of silverleaf phacelia. The variables to be tested are the length of the cold:moist stratification period, and the effect mechanical seed coat scarification has on germination of silverleaf phacelia.

## **MATERIALS AND METHODS**

### **Accession Tested**

Silverleaf phacelia, accession 9081632, originally collected from the Anaconda Smelter site near Anaconda, Montana, was chosen for the study. The seeds used in the test were from seed lot SFD-13-DATRF2. A tetrazolium viability test (TZ) performed on 11 April 2014 indicated a total seed viability of 86%. None of the seeds used in this study were surface-sterilized.

### **Experimental Design**

To examine the effect of cold, moist stratification, 400 scarified seeds, and 400 non-scarified seeds were planted in cones in a commercial peat-based potting mix and placed in a cooler maintained at 3°C (37.4°F) for 60 days. Another 400 scarified seeds, and 400 non-scarified seeds, were planted in cones, and cooled for 30 days. A third group of 400 scarified and 400 non-scarified seeds were planted in cones, and were not exposed to any chilling. To test the effects of mechanical scarification, scarified seeds were treated for 360 seconds using a Seedburo® electric seed scarifier with 40 grit sandpaper. After treatment, trays of 100 cones of each scarification treatment and one stratification treatment were arranged in a Randomized Complete Block design in a greenhouse so there were four replications of 100 treatment combination cones. The position of each tray of cones was changed each week to avoid an edge effect biasing the results. The greenhouse was maintained at 75 to 80°F for 16 hours and 65 to 70°F nights for 8 hours. The experiment was run for 30 days. Germination was recorded as a percentage seedling emergence of the 100 cones in each of the treatment combinations before the cones were placed in the greenhouse (i.e., during stratification) and as they emerged over the 30-day period in the greenhouse. Percent germination of the tetrazolium-viable seeds was calculated as the percent germination divided by the percent tetrazolium viability.

### **Statistical Analysis**

The effects of scarification, stratification, and their interaction were analyzed using Analysis of Variance. The interaction was significant ( $P < 0.05$ ) and Tukey HSD mean separation was used to ascertain significant differences among treatment means ( $\alpha = 0.05$ , Table 1).

## **RESULTS**

Mean (N=4) percentage germination of tetrazolium-viable seeds by treatment appears in Figure 1. The highest mean percentage germinations were 65 and 46% for the 30-day chilling plus scarification treatment and 60-day chilling plus scarification, respectively. The lowest total percentage germinations of tetrazolium-viable seeds were 1% and 13% for the no-chilling plus scarification and the no-chilling without scarification, respectively. The ANOVA found a significant chilling X scarification interaction, with 30-day chilling plus scarification resulting in the highest percentage of germinating seeds (see Table 1).

Total cumulative percentage germination of tetrazolium-viable seeds over time is presented in Figure 2. The 60-day chilling plus scarification had the highest percentages of germination before placement in the greenhouse with 25% of tetrazolium-viable seeds, followed by 10% for 30-day chilling plus scarification. No no-chill seeds and only 1 non-scarified seed germinated before placement in the greenhouse. Ninety percent of all germinating seeds had germinated within 7 days of placement in the greenhouse.

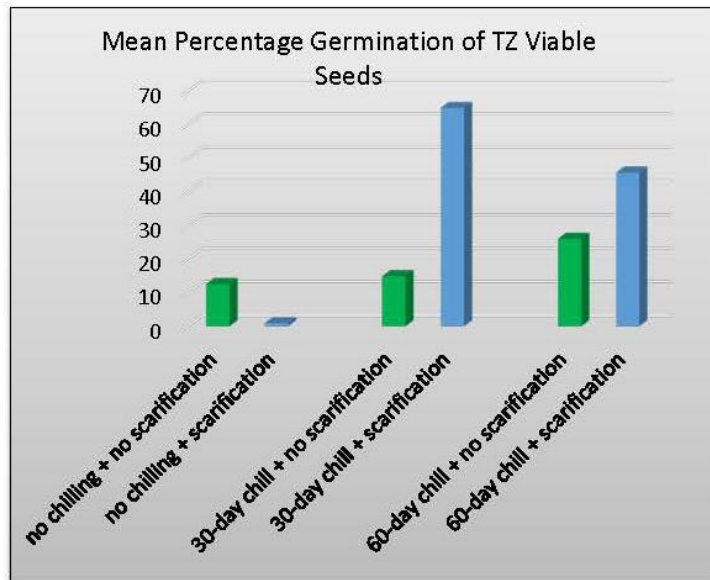


Figure 1. Total Mean Percentage Germination of Tetrazolium-Viable Seeds by Treatment.

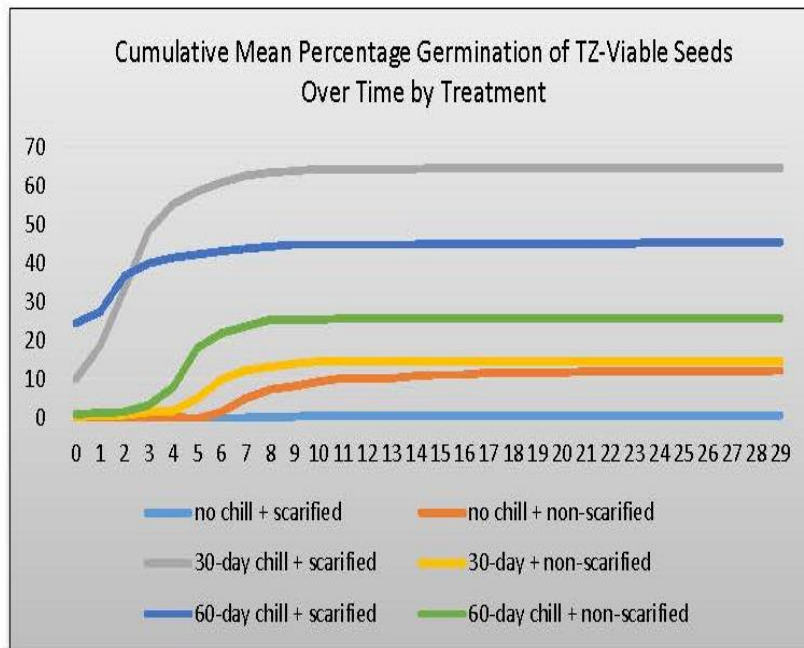


Figure 2. Cumulative Mean Percentage Germination of Tetrazolium-Viable Seeds Over Time by Treatment.

## Statistical Analysis

Table 1. Germination percentage of silverleaf phacelia by seed treatments. USDA-NRCS Bridger Plant Materials Center, Bridger, MT.

Chill Period	Scarification Duration	Germination
days	seconds	%
30	360	65 a*
60	360	47 b
60	0	26 c
30	0	15 cd
0	0	13 cd
0	360	1 d

\* Means in columns followed by the same letters are significantly different according to Tukey's HSD at  $P < 0.05$ .

## CONCLUSION/DISCUSSION

The greatest mean percentage germination of all treatments was with the 30-day cold:moist stratification plus scarification treatment (64.8%). It is not known why mean germination decreased with increasing duration of chilling plus scarification, but it may be possible that seeds deteriorated in cold storage from desiccation, disease, or other factors. It is a significant result because it argues against scarification before a fall dormant seeding. The significant cold chilling X scarification interaction suggests that germination is not optimized without seed coat scarification plus cold chilling, that the effects of cold chilling are largely dependent on seed coat scarification, and conversely, that the effects of scarification depend on the duration of cold chilling.

In a similar study conducted by Bujak (2015) mechanical scarification for at least 90 seconds with new sandpaper (40-grit) provided a final germination of  $87\% \pm 5\%$  in 4 days (Bujak, 2015). Upon examination of the classification of silverleaf phacelia seed dormancy to the specific level and type of dormancy, non-deep physiological dormancy, types 1, 2, and 5, and intermediate dormancy types 1 and 2, were determined. For propagation purposes, Bujak found addressing seed dormancy-release requirements of non-deep physiological dormancy type 5 would be the most effective by seed coat scarification. The seeds in the Bujak study had been stored under a variety of undetermined conditions for approximately 4 months, then stored dry at approximately  $41^{\circ}\text{F}$  for a one year period prior to sowing.

It is unclear why the unchilled, scarified seeds in the Bujak study germinated so well without a cold:moist stratification, but the differences between our results and Bujak's suggest other factors such as after-ripening, storage conditions, handling, or possibly surface sterilization may be involved.

Dormant season (late fall) sowing of silverleaf phacelia in fields at the Plant Materials Center near Bridger, Montana, results in good stand establishment the following year. These fields are sown with non-scarified seeds, suggesting a sufficiently long, in-situ cold:moist stratification can be used in lieu of seed coat scarification. Without scarification, this study suggests more than 60 days of cold:moist chilling are required to substantially improve germination percentage.

The results of the two studies suggest that late spring to early summer sowing of silverleaf phacelia seeds without seed coat scarification and/or cold chilling pretreatment will result in negligible germination. Seed coat scarification was essential for high germination in both

studies. Adequate germination of dormant season planted, non-scarified seeds the year after planting suggest this technique provides adequate success as well, although actual percentage germination is unknown. In an outdoor setting, dormant fall (after approximately November 1) sowing of non-scarified seeds, or late winter (February through March) to early spring sowing of scarified (90 to 360 seconds with 40 grit sandpaper) seeds of silverleaf phacelia, appears to be the best seed dormancy breaking treatment for field applications.

## References

Dougher, Tracy. 2012. Personal communication. Montana State University, Bozeman, MT.

Bujak, C. 2015. Seed dormancy and greenhouse propagation of arrowleaf balsamroot (*Balsamorhiza sagittata*) and silverleaf phacelia (*Phacelia hastata* var. *hastata*). Master's Thesis. Montana State University, Bozeman, MT.