The Effect of Scarification and Stratification Treatments on the Germination of *Danthonia californica* Seed from Three Populations

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Introduction

Danthonia californica Bolander (California oatgrass) is an important cool season perennial grass for prairie restoration as well as rangeland and wildlife habitat improvement in Pacific Coastal States USA. However, establishment is often confounded by delayed germination attributed to one or more types of seed dormancy. Dormancy varies from low to high among populations and among and within seed lots of the same population. Hulling/scarification (Trask 1996) or the use of concentrated sulfuric acid to erode the pericarp (Laude 1949) have been among the most successful methods promoting germination, but cold moist stratification or a combination of treatments have worked as well. This suggests the possibility of combined dormancy in some seed lots (Darris et al. 2008). In order to break dormancy, a series of four experiments were conducted to compare the effects of single and multiple treatments on the germination of *Danthonia californica*, including cold moist stratification (moist chilling), warm moist stratification, hulling, and acid or mechanical scarification of the seed coat.

Methods

Seed from three natural populations of *Danthonia californica* [Polk Co, OR (747), Douglas Co., OR (415), and California (030)] were used in a series of four germination experiments. All experimental samples consisted of a random mix of terminal inflorescence seed and cleistogenes, typical of machine harvested *Danthonia* seed lots that have been aggressively threshed. Seed was stored under ambient air conditions in the office until used. All tests used standard germination boxes and paper placed in a growth room with a photoperiod of 16 hr light/8 hr dark at 20°C/15°C (Tables 1-2) or 25°C/20°C (Tables 3-4). Germination was recorded weekly for 21 days. Experimental design consisted of a completely randomized design with four replications and 50 seeds per replication. All data were transformed with an angular transformation and means compared using analysis of variance and LSD test at the alpha 0.05 level of significance.

Cold moist stratification occurred for 90 days at 3°C (Table 1) or 60 days at 3°C plus 30 days at 11°C (Table 3). Warm moist stratification was conducted in the dark by wrapping germination boxes in aluminum foil and placing them in a growth room at 25°C/20°C for 14 or 28 days prior to being uncovered (Table 4). Seeds were manually hulled by rubbing and peeling off the lemma and palea by hand to minimize any damage to the pericarp, and mechanically hulled by moving the seed between two rubber belts travelling at slightly different speeds (called a belt thresher). Scarification of the pericarp was accomplished with concentrated sulfuric acid (sp. gr. 1.84, as per Laude 1949), with a 50% dilute solution of sulfuric acid, or with a Forsberg seed scarifier using 320 grit sandpaper, all at varying time intervals (Tables 1-2). Seed was “nicked” by making a cut with a scalpel over the endosperm on the dorsal side of manually hulled seed (Laude 1949) (Tables 2-3).

Results and Conclusions

Means with the same letter are not significantly different (P=.05) (Tables 1-4). Manually hulled then nicked seed germinated within 2% of total viability as determined by tetrazolium test (Tables 2-3), but manually hulling alone did not significantly improve germination over the controls for two of three populations. This suggests that for at least some populations, delayed germination is the result of a

single, seed coat imposed dormancy. This result concurs with work by others (Laude 1949, Trask 1996), and does not indicate a combined dormancy mechanism. While the hull may still impose partial dormancy in some seed lots, manual removal is impractical and mechanical removal did not improve germination over no treatment. Mechanical hulling also increased the number of abnormal seedlings (Table 2). The fact that the embryo is in a vulnerable position and subject to physical injury (Laude 1949) probably explains the highly reduced germination from all sandpaper scarification treatments by a machine. In sharp contrast to Laude (1949), concentrated sulfuric acid treatments did not improve germination but were instead detrimental, if not lethal to the seed. In this study, 90 days of cold moist stratification alone or 28 days of warm moist stratification in the dark were virtually equivalent. They probably involve biochemical degradation or physical changes to the pericarp allowing for a higher percent germination. A change in moisture imbibition is not likely the reason (Laude 1949). Cold moist or warm moist stratification are the simplest and most practical means to maximize germination of some populations of *Danthonia californica* without undue damage to the seed.

References

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Laude H. (1949) Delayed germination of California oatgrass, *Danthonia californica*. *Agronomy Journal*. **41**: 404-408.

Trask M. (1996) Breaking dormancy in three Western Oregon grasses. Master of Science Thesis. Oregon State University, Corvallis, OR. 69 p.

Table 1. Effect of mechanical hulling, moist chilling, and scarification on germination of two populations of *Danthonia californica*

Treatment	% germination by population	
	415	747
Total viability (TZ test)	96	93
90 d	88 a	81 a
Hulled + 90 d	53 b	52 b
None (control)	52 bc	39 c
90 d + 15 sec sand	50 bc	47 bc
Hulled	44 c	50 bc
90 d + 5 min acid	31 d	18 e
Hulled + 15 sec sand	17 e	8 f
Hulled + 90 d + 5 sec sand	8 f	28 d
Hulled + 90 d + 10 sec sand	8 fg	7 f
Hulled + 90 d + 15 sec sand	4 fgh	1 g
Hulled + 90 d + 20 sec sand	4 gh	7 f
20 min acid	2 h	20 de
Hulled + 90 d + 5 min acid	0 i	0 g
Hulled + 90 d + 10 min acid	0 i	0 g
Hulled + 90 d + 20 min acid	0 i	0 g
Hulled + 90 d + 30 min acid	0 i	0 g
Hulled + 90 d + 40 min acid	0 i	0 g
Hulled + 20 min acid	0 i	0 g
90 d + 20 min acid	0 i	0 g

Table 2. Effect of hulling and scarification treatments on germination of *Danthonia californica* (population 030)

Treatment	% germination	
	abnorm	normal
Total viability (TZ test)		96
Manually hulled + nicked	2	97 a
Manually hulled	0	82 b
20 min 50% dilute acid	0	80 bc
5 min 50% dilute acid	0	76 bcd
Machine hulled	7	71 cd
None (control)	0	65 de
Mach. hulled + 5 sec sand	21	57 ef
5 min acid	5	48 f
Mach. hulled + 20 sec sand	24	19 g
Mach. hulled + 5 min acid	3	18 gh
20 min acid	8	10 h
Mach. hulled + 20 min acid	2	0.5 i

Table 3. Effect of manual hulling and moist chilling on germination of *Danthonia californica*

Treatment	% germination by population		
	030	415	747
Total viability (TZ test)	96	96	93
Man. hulled + nicked coat	---	95 a	91 a
Man. hulled + 90 d cold/cool	85 a	---	---
90 d cold/cool	70 b	83 b	59 b
Manually hulled	---	23 c	20 c
None (control)	53 c	15 c	14 c

Table 4. Effect of warm moist stratification on germination of *Danthonia californica*

Treatment	% germ. by population		
	030	415	747
Total viability (TZ test)	96	96	93
28 d warm	72 a	88 a	81 a
None (control)	68 a	75 b	47 b
14 d warm	44 b	42 c	46 b