Brigham Young University Department of Integrative Biology

Project Report

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Environmentally Induced Dormancy in Cheatgrass Seed and Seed-Banking Dynamics

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Background

Dormancy in cheatgrass *(Bromus tectorum)* seed is known to exist as a factor in the process of after-ripening (Allen and Meyer 2002). Variation in germination response relative to the degree of after-ripening and seed origin has been amply demonstrated (Meyer etal. 1997). This line of study has led some researchers to postulate a relationship between the invasive success of cheatgrass and an ability of seed to persist in the seed bank over successive years due to seed dormancy. Given that all ripened cheatgrass seed readily germinates under adequate moisture, and that after-ripening occurs universally under natural conditions in the wild, the existence of ecologically meaningful dormancy must refer to something else. Bauer et al. (1998) mention an ability of seed to enter a second dormancy.

Methods

Four habitat variables were selected representing different phenologies of cheatgrass invasion and local environments. Habitats represent; 1) post-burn, cheatgrass monoculture, 2) non-burn, cheatgrass dominant, south facing slope, 3) non-burn, sagebrush understory, and 4) non-burn, sagebrush interspace. All sites were within 5 miles of each other.

Site one: Valley floor; cheatgrass monoculture; previously burned, sandy loam soil; roadside along state highway 6, near junction of road leading to Long Canyon, Gilson Mountains, Juab Co., UT; 1500 m.
Site two: Hillside, south facing slope; sparse sagebrush with abundant cheatgrass; not previously burned; rocky soil; Long Canyon, Gilson Mountains, Juab Co., UT;
Site three & four: Canyon bottom; basin big sage community; moderate cheatgrass in shrub understory, minimal cheatgrass in shrub interspace; not previously burned, clay loam soil; Long Canyon, Gilson Mountains, Juab Co., UT; 1700m.

At each habitat site, the seed bank was collected at five random locations. A square nose shovel was used to remove existing vegetation and litter away from the sample unit, leaving and eight-inch square patch of vegetation, litter, and soil for removal. Vegetation was cut just above ground level and bagged. The remaining sample unit was bonded using the tackifier *Ecology Control M-Binder* which was sprayed onto the substrate surface. Upon drying, the sample unit was lifted by slicing the soil layer one-inch below the soil surface with the flat nose shovel, and placing the resultant eight-inch square sample onto a tray. This process was repeated for all sample units.

Separation of seed from respective litter horizons was conducted in the laboratory. Cheatgrass seed from the canopy layer was hand separated from total vegetation. The top litter layer consisted of that portion of litter bonded by the tackifier. Average depth of the top, tackified litter layer was about 5 mm. A subsample of the total portion was randomly removed for analysis. Since the top litter had congealed, the sub-sample was broken apart into its principal constituents by careful hand maceration. Seed was separated from the litter by a process of successive screenings and hand removal with the aid of macroscopes. In similar fashion, sub-samples of seed were isolated from the sub-litter layer. Due to small quantity of seed found in the soil horizon, the entire soil portion was screened for seed.

Seed was then classified according to its age. Three ages groups were identified, those being; 1) new – current year, 2) previous year, and 3) older than previous year fig.1). The third classification included all seed older than the two most recent years of seed production. We were not able to distinguish characteristics that separated seed age beyond the second year. For each age classification, counts were made and extrapolated for the entire sample.

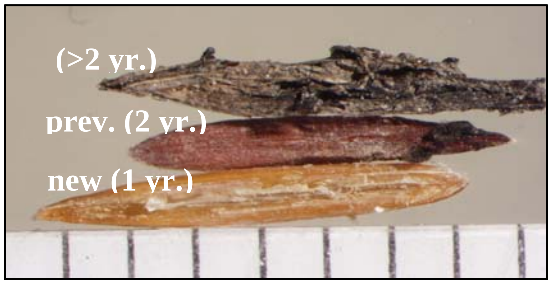


fig. 1. characteristics of seed age

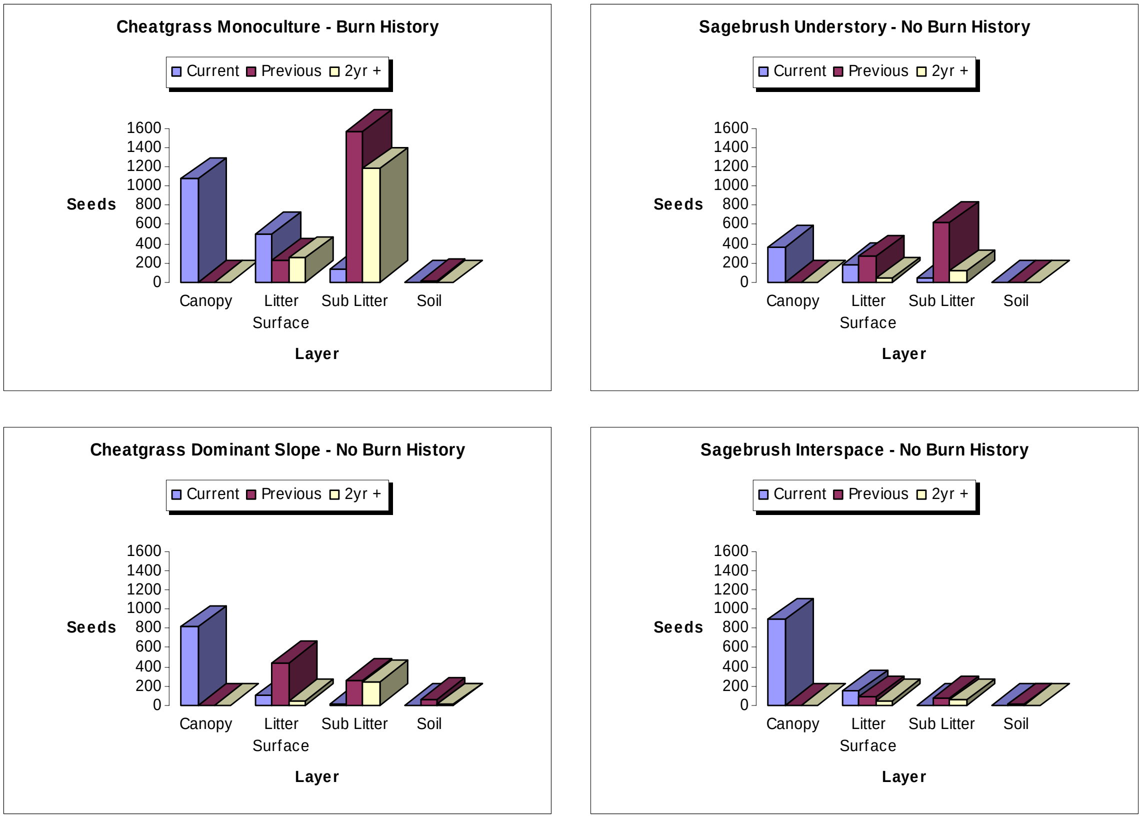
Seed samples were subjected to germination testing following a sufficient after-ripening period to ensure sufficient germination of new seed. Seed was soaked in a 1 tablespoon Clorox to 1 gallon water for 10 seconds as disinfectant. As seeds germinated, they were removed from the Petri-dish. Counts were conducted over a one-month period. Ungerminated seeds were evaluated under a microscope to determine seed integrity. Seed that was neither firm nor obviously viable was discarded. Any remaining seed was subjected to a tetrazolium test to determine viability.

1750m.

Results

The presence of cheatgrass seed was most abundant in the sub-litter layer in both the cheatgrass monoculture site and in the sagebrush understory (fig. 2). The contribution of old seed to the seed bank in these two groups is greater than the annual contribution of new seed. Alternately, new seed was the greatest contribution to the seed bank on the slope site and the sagebrush interspace. Both these sites lacked adequate litter to refuge seed over time. The presence of new seed in layers besides the canopy is an artifact of seed dissemination prior to canopy harvest and contamination during excision of the litter layer and transport to the laboratory.

Overall, the cheatgrass monoculture site produced the greatest quantity of new seed, followed by the sagebrush interspace (fig. 3). The cheatgrass monoculture also had an abundance of seed older than two years.


Cheatgrass Monoculture - Burn History

Sagebrush Understory - No Burn History

Cheatgrass Dominant Slope - No Burn History

Sagebrush Interspace - No Burn History

fig. 2. seed abundance by habitat and litter horizon

Percent germination was highest in new seed. Seed older than 2 yrs. had very poor germination. Each age class was significantly different in germination response.

Germination of the canopy layer was significantly different than all other layers, though germination over time occurred uniformly between all litter horizons and all sites. The bulk of germination occurred within a two week time period. All germination ended within a three weeks. Visual inspection and application of the tetrazolium test revealed no ungerminated viable seed.

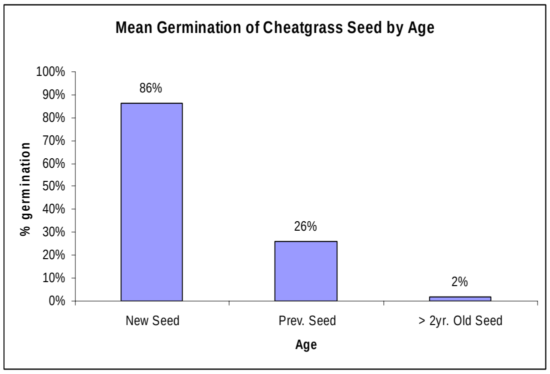


fig. 3. germination by seed age

Grouping all seed from all litter horizons reveals that the bulk of seed present at any site is non-viable (fig. 4). If a seed bank is represented by only viable seed, then new seed (current season) is the primary seedbank constituent. Old, nonviable seed is by definition relegated to litter.

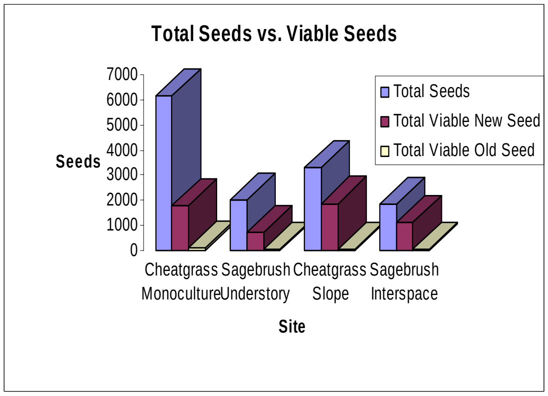


fig. 4. comparison of viable seed vs. total seed by site

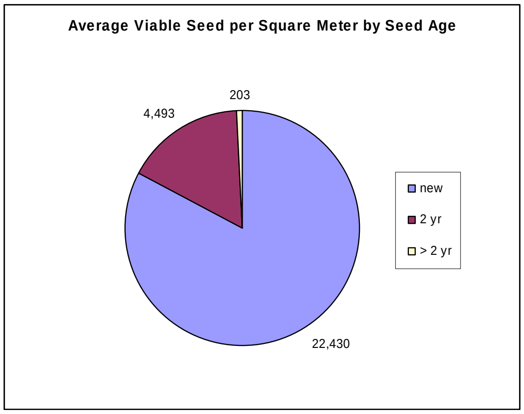


fig. 5.

Extrapolating seed abundance revealed that on average 27,125 viable seeds were present per square meter. Proportionally (fig. 5), 83% of viable seed is contributed by new seed, 17% by two year old seed, and 1% by seed older than two years.

Conclusions

In this study, no delayed germination responses were encountered. All viable seed germinated within a three week time frame. The induction of a state of secondary dormancy in cheatgrass does not appear to occur as a result of seed position in the litter layer, or lateral placement in shrub understory or interspace, nor was there an affect associated with burn history and slope. Secondary dormancy may yet be a phenomenon at other sites where different environmental factor exist or where diverse genotypes exist.

From a cheatgrass management perspective, it becomes apparent that the cheatgrass seedbank does not persist to any great degree longer than two years in the environment studied as indicated by the rapid annual decline in seed viability. The presence of 1% viability in seed older than 2 years may seem insignificant, however; it is important to recognized that 1% viability in seed older than two years equates to 203 viable seed per square meter (on average). That quantity is still sufficient to carry the seedbank to the third growing season, suggesting that projects aimed at reducing the re-invasion potential of cheatgrass following reclamation practices, need to consider at least a 3 season seedbank capacity.

Further Study

We are planning to replicate this project in 2004 as well as add some additional habitat variables. Because we have quantified some baseline seedbank parameters, we will be able apply greater focus on germinations responses across micro-habitats.

Citations

Allen, P.S. and S.E., Meyer. 2002. Ecology and ecological genetics of seed dormancy in downy brome. Weed Science 50:241-247.

Bauer, M.C., S.E. Meyer, and P.S. Allen. 1998. A simulation model to predict seed dormancy loss in the field for Bromus tectorum L. Journal of Experimental Botany Vol. 49, No. 324, pp. 1235-1244

Meyer, S.E., P.S., Allen, and J. Beckstead. 1997. Seed germination regulation in Bromus tectorum (Poaceae) and its ecological significance. Oikos 78:475-485