Bromus tectorum: Temperature regulated germination of three seed maturity stages collected from five plant communities in northwestern Nevada

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Introduction

In the rangelands of the intermountain west cheatgrass (Bomus tectorum) has changed the appearance, productivity, and plant secession on millions of hectares of the landscape. The inherent potential of cheatgrass as an opportunistic weed has led to its invasion into numerous plant communities from salt desert shrublands to sagebrush habitats and pine forests. Initially it was assumed that cheatgrass did not develop seedbanks on rangelands (Klemmedson and Smith 1964) because of its highly viable seed that readily germinates during multiple seasons and under harsh conditions. Early research efforts however determined that cheatgrass does build seedbanks through seed dormancy (Young et al. 1969) and its micro site germination requirements. We conducted germination tests to compare cheatgrass seed dormancy of seed collected from five distinctly different plant communities with differing cheatgrass seedbank sizes, plant phenology and phenotype in order to determine similarities and differences between sites. All sites were within a similar geographic region in northeastern Nevada along the Truckee River watershed.

SITE 1

Site 1. A Wyoming sagebrush (*Atimesia tridentata*) dominated site with transitions to winterfat (*Krascheninnikovia lanata*). It has a loamy soil with some gravel content and moderate plant litter. Cheatgrass with very few forbs exists in the interspaces and understory of the Wyoming sagebrush at the third highest density of all sites (291 m²) (Figure 1). The cheatgrass plants are short in stature (10cm) with low seed production (54 seeds/ plant).

SITE 2

Site 2. A sandy loam deposit with sparse surface litter that is dominated by spotted dalea (*Psorothamnus freemontii*) with a few four wing salt bush (*Atriplex canescens*) plants mixed in. The interspace and understory are sparse with mainly two native annuals dominating , white-stem stick leaf (*Menzelia albicaulis*) and fan-leaf crinkle mat (*Tiquilia plicata*). The cheatgrass plants are at the lowest density (17 m²) and are tall statured (19cm) with the highest seed production (599 seeds/ plant).

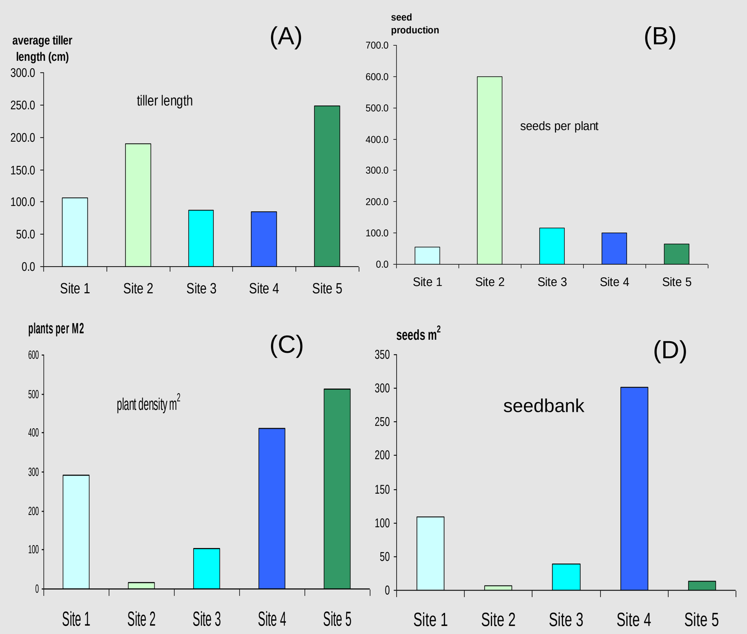


Figure 1. Site comparisons: A) tiller length, B) seeds per plant, C) plants per m², D) *seed bank per m² of surface soil (*results from bioassay test)

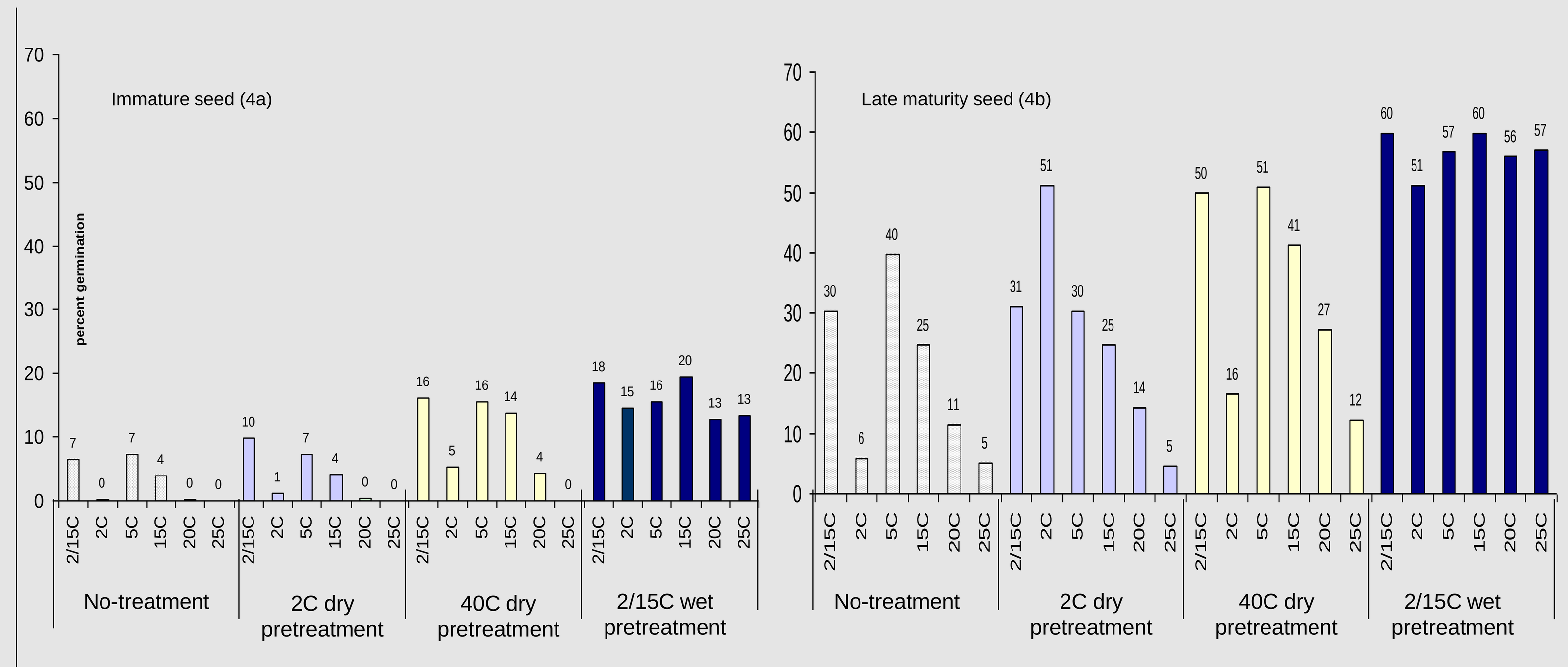
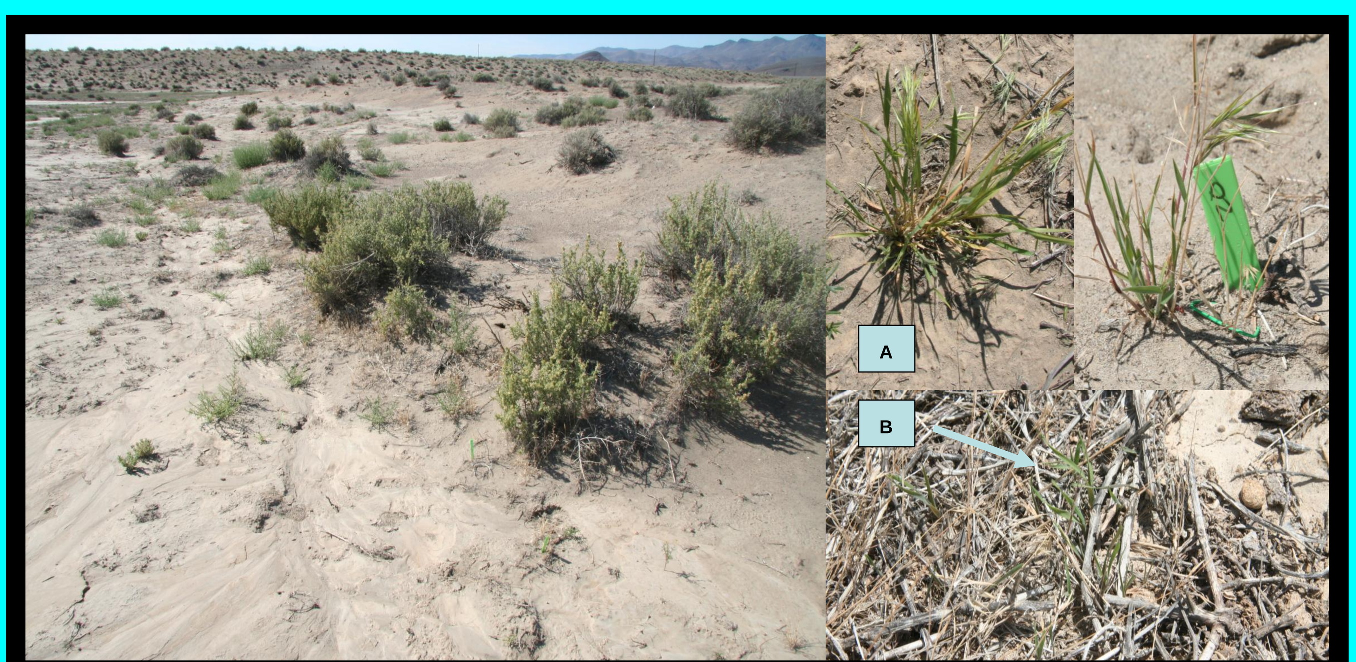


Figure 4. Percent germination of immature seed (4a) and late maturity seed (4b), results of all collection dates and sites combined.

Results

All seed maturity stages exhibited some germination. Immature seed, however had much lower germination in general than mature seed. (ex: 2C wet pretreatment: 15C=20% immature, 60% late maturity)(Figure 4). Fully mature seed from site five (Jeffery Pine) had the highest germination percent prior to after-ripening and with no-pretreatments (2/15C=68%)(Figure 5a). Site two (Sand-Spotted Dalea) had the second highest germination by site (5C=53%). Site four (Bromus tectorum dominated-post burn) had much lower germination by comparison (2/15C=10%, 5C=15%). Even after 24 weeks of after-ripening, site differences remained for germination at warmer temperatures such as 25C (Figure 5b), with only site two and five having germination greater than 10% (25C:site 2=70%, site 5=96%). The moist 2C pre-chill treatment had the greatest effect overall for all sites on increasing germination.

SITE 3



Site 3. A black greasewood (Sarcobatus vermiculatus) dominated site with a very fine sandy loam soil. Very little interspace or understory herbaceous vegetation or plant litter occurs here, with the cheatgrass growing in patches were some litter has accumulated to allow germination (Figure 4). The cheatgrass plants exist at the second lowest density (104 m²) and are short statured (8cm) with moderate seed production (115 seeds / plant). This site was the only site to have a re-green up of matured plants (A) and a second crop of new plants (B) in late June after unusual June rain events. This extended the season of green "immature" seed production at this site (Figure 2).

SITE 4

Site 4. A burned Wyoming sagebrush, post fire, cheatgrass dominated site, with very little else existing on the site (Figure 5). It has a loamy soil with a great amount of surface plant litter and it is located adjacent to site one which was not burned in the fire. Cheatgrass density is the second highest (512m²) with short statured plants (8cm) and moderate seed production (99 seeds/ plant). This site matured and senesced the earliest with very little green material past May 1st (Figure 2). This site had a very visible amount of smut infecting the plants.

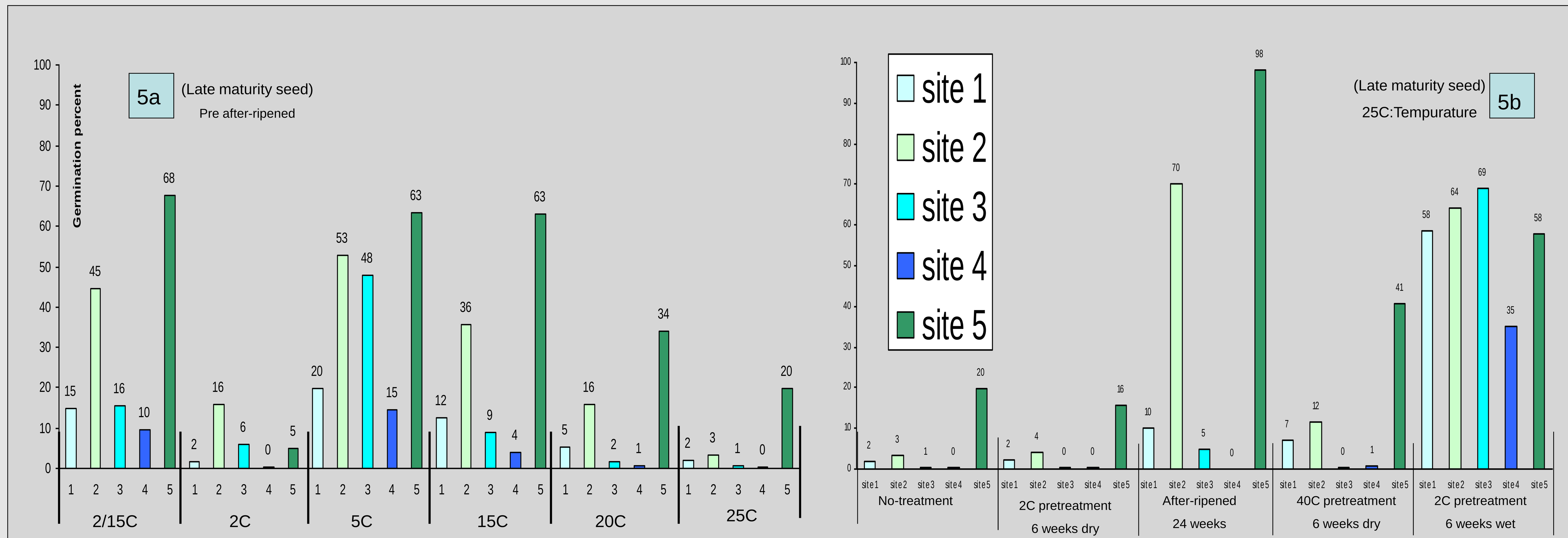


Figure 5. A) germination percent of No-treatment late maturity seed combining results of all collection dates for each site. B) Germination percent of late maturity seed combining results from all collection dates for all treatments as well as after ripened seed tested at 25C. * all sites had at least 95% viable mature and late maturity seed for collections tested based on Tetrazolium tests.

Methods

Cheatgrass seed from the five sites was collected every 2 weeks from May through July 2009. Twenty plants were collected from each site and all seed was combined into one sample. Seeds were put into three phenotype categories; immature, mature and late maturity seed (Figure 3). All germination tests were conducted at the Reno Nevada ARS wild land seed laboratory using Precision Incubators. Tests were conducted in Petri dishes on top of germination paper. Seeds were germinated 1 week after collection at six temperature regimes (2C, 5C, 15C, 20C, 25C and *2/15C (*8hr/16hr day cycle)). Seeds were also put into three pre-treatment temperatures (dry 40C, dry 2C, and moist 2C) for six weeks prior to germination tests. We also tested after ripened seed 24 weeks after seed harvest.

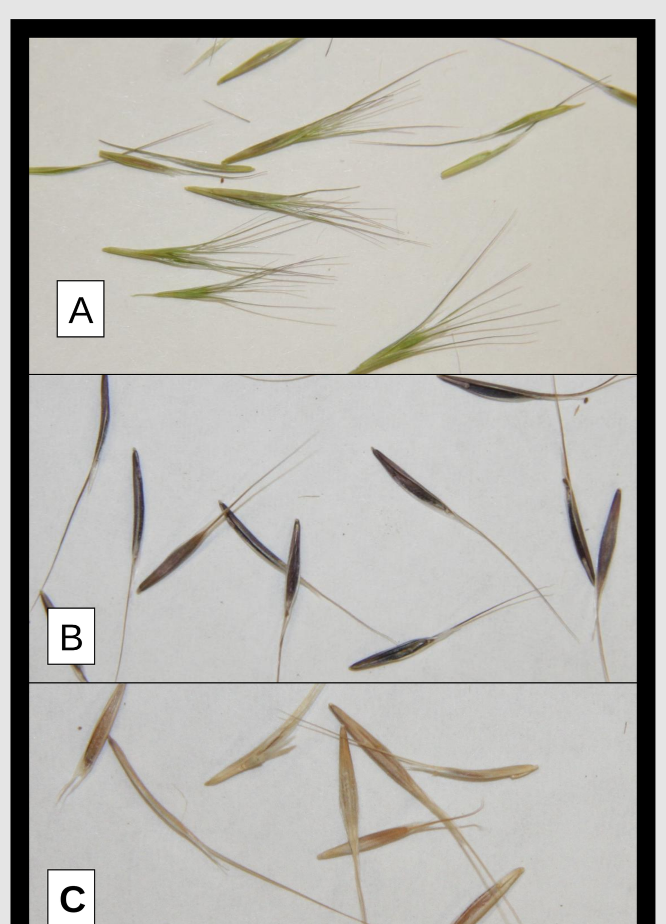


Figure 3. Three seed maturity stages based on visual appearance
A) immature B) mature C) late maturity

SITE 5

Site 5. An upper elevation Jeffery pine (*Pinus jefferyi*) site with a sandy loam soil and large amounts of surface plant litter (Figure 6). The cheatgrass at this site exists in the greatest density (512 M²) and has the tallest stature (24 cm) but with low seed production (64 seeds/ plant). The low seed production was probably related to the stature of each plant which consisted of less than two tillers per plant on average. The high density is not visually observed because of the unique stature of these plants with virtually no rosettes and just one or two tall tillers rising from the dense litter.

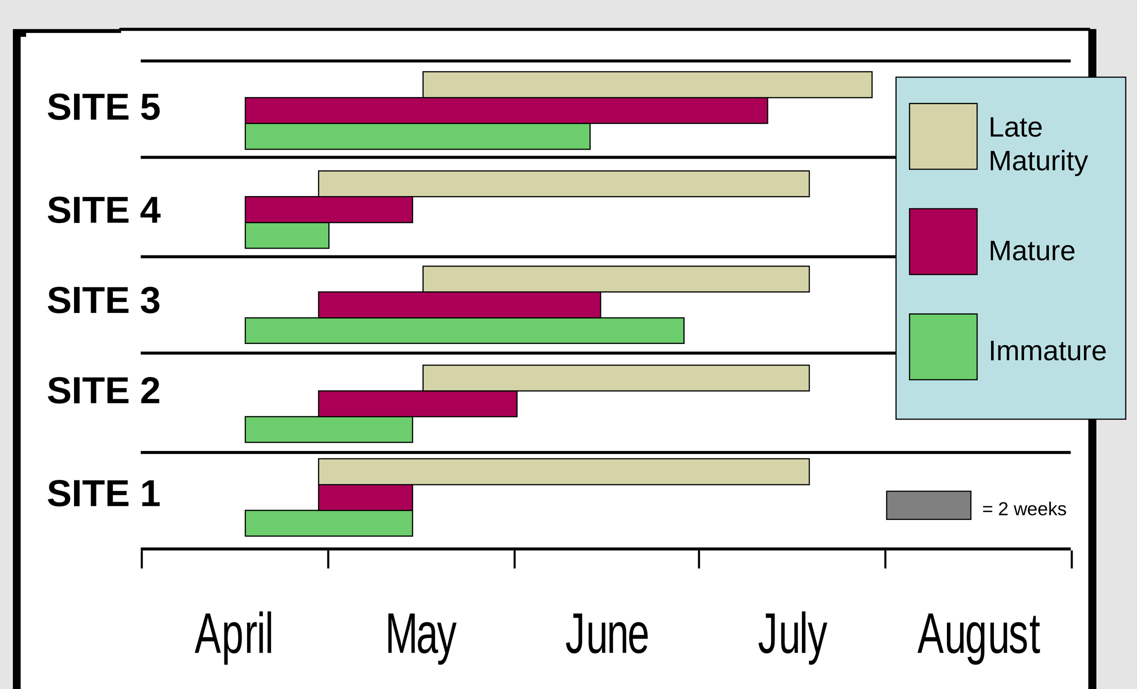


Figure 2. Seed maturity timeline of three seed phenotypes for collection dates in 2009.

LITERATURE CITED

Klemmedson, J. O. and J. G. Smith. 1964. Cheatgrass (*Bromus tectorum*). Botanical Review April-June:226-262.

Young, J. A., R. A. Evans, and R. E. Eckert, Jr. 1969. Population dynamics of downy brome. Weed Science 17:20-26.

Discussion

In general we find that this research emphasizes the importance of not underestimating the duration of viable seed production for cheatgrass and the plasticity of seed dormancy characteristics among all the vast environments cheatgrass exists. While it is an early maturing fast reproducing annual, we collected viable seed for at least a 12 week period at multiple sites. The very early viable seed produced even before May has important implications for foliar herbicide applications which are not effective until warmer temperatures later in the season possibly after some early seed production. Any mechanical or grazing treatment would also have to consider this early germinable seed production.

Even though the "immature" seed only had a 20% maximum germination compared to near 100% for mature seed, it is more than enough to maintain an increasing cheatgrass population. We are currently researching further on what site characteristics may be related to expression of seed dormancy. Is there an 'easy to use' visual cue to habitat and cheatgrass appearance that relates to seed dormancy and seedbank threats that could provide insight into the future of site specific cheatgrass populations? Further, how quick is the response of seed dormancy and plant phenology to the environmental signals?

This research demonstrates the inherent potential of cheatgrass to have multiple strategies to have continuous germination and build seed banks in response to various ever-changing environmental conditions.