Variation in Phenology of Downy Brome

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Introduction

Downy brome (*Bromus tectorum* L.) is an invasive winter annual grass species, widespread throughout the small grain production region of the Pacific Northwest (PNW)[1]. Study objectives were to identify differences in phenology among downy brome accessions and relate phenology to genotypic, spatial, and climatic variables.

Methods

- Ninety four downy brome and one ripgut brome (*Bromus diandrus* Roth.) accession were collected in 2010 and 2011 from within small grain fields in the PNW (Figure 1).
- Accessions were transplanted as seedlings to a common garden located near Central Ferry, WA and at the Cook Agronomy farm near Pullman, WA in November of 2012.
- An on-site weather station was used at both locations to calculate cumulative growing degree days (GDD), base=0°C, (Figure 2) starting January 1st.

$$GDD = \sum \frac{Daily\ Max\ Temp + Daily\ Min\ Temp}{2}$$

- Phenotypic observations and measurements were recorded weekly from April through June with a focus on development traits.
- As soon as flowering was observed, panicles were collected from each replicate weekly until early July.
- Seed were removed from panicles and planted in a greenhouse three months after collection to determine if seed was mature at the time of collections.
- Germination was regressed against GDD at time of collection using a two-parameter log-logistic model to estimate the GDD required to produce mature seed.

$$f(x) = \frac{1}{1 + exp^{b[\log(x) - e)]}}$$

- In November of 2013 a study replicate was planted at the Central Ferry, WA location.
- After a genotype-by-sequencing approach was used to call SNPs, accessions were assigned to clusters using discriminant analysis of principle components.

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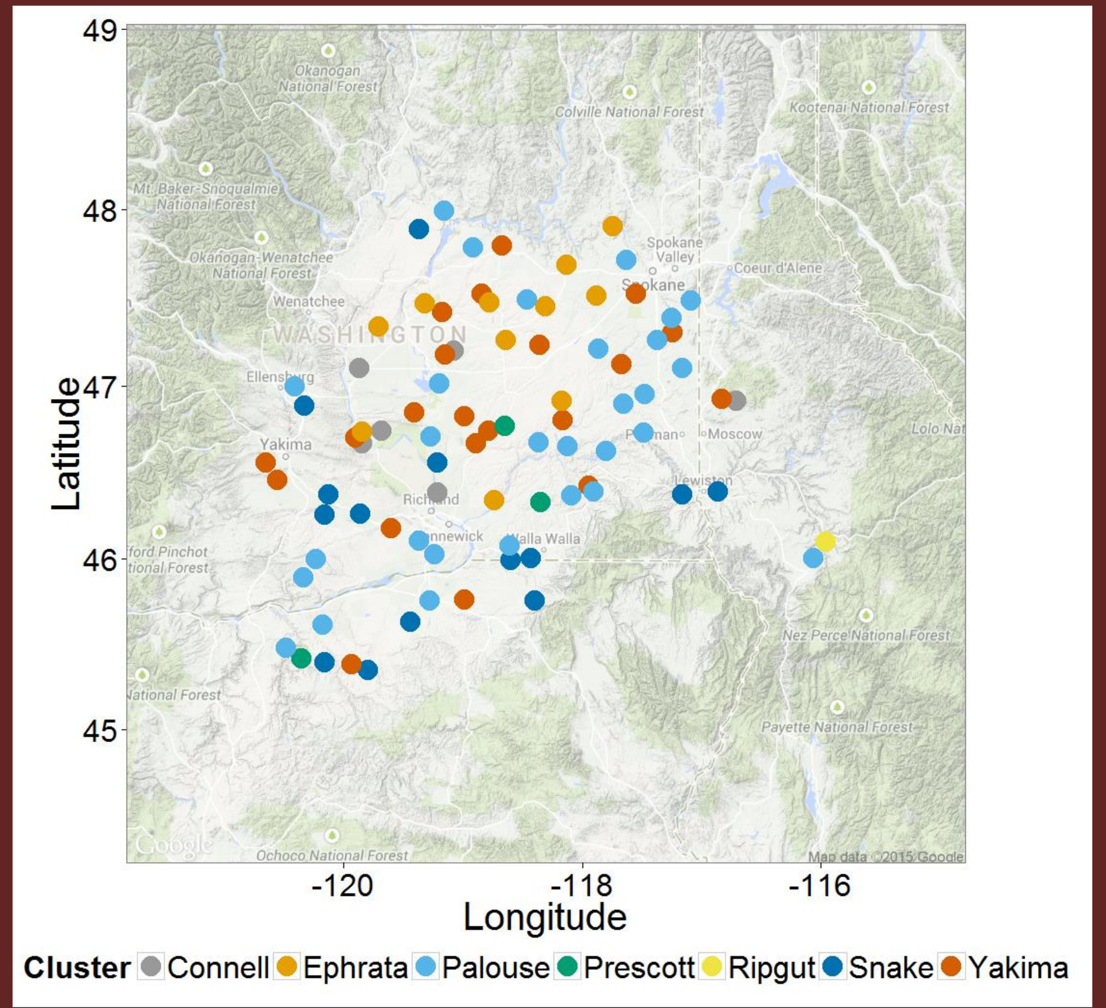

Figure 1. Distribution of downy brome clusters.

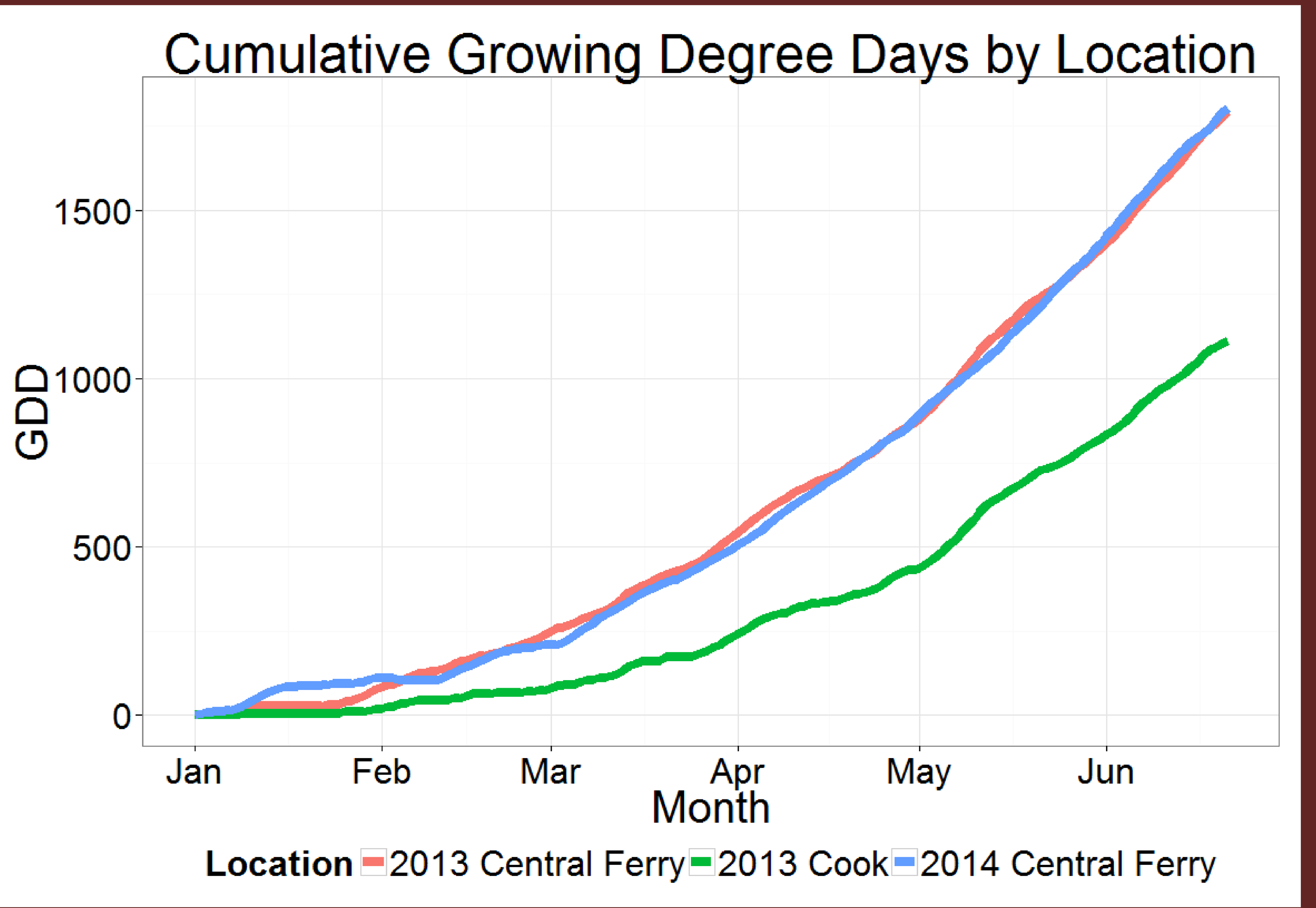

Figure 2. GDD accumulation by month and location.

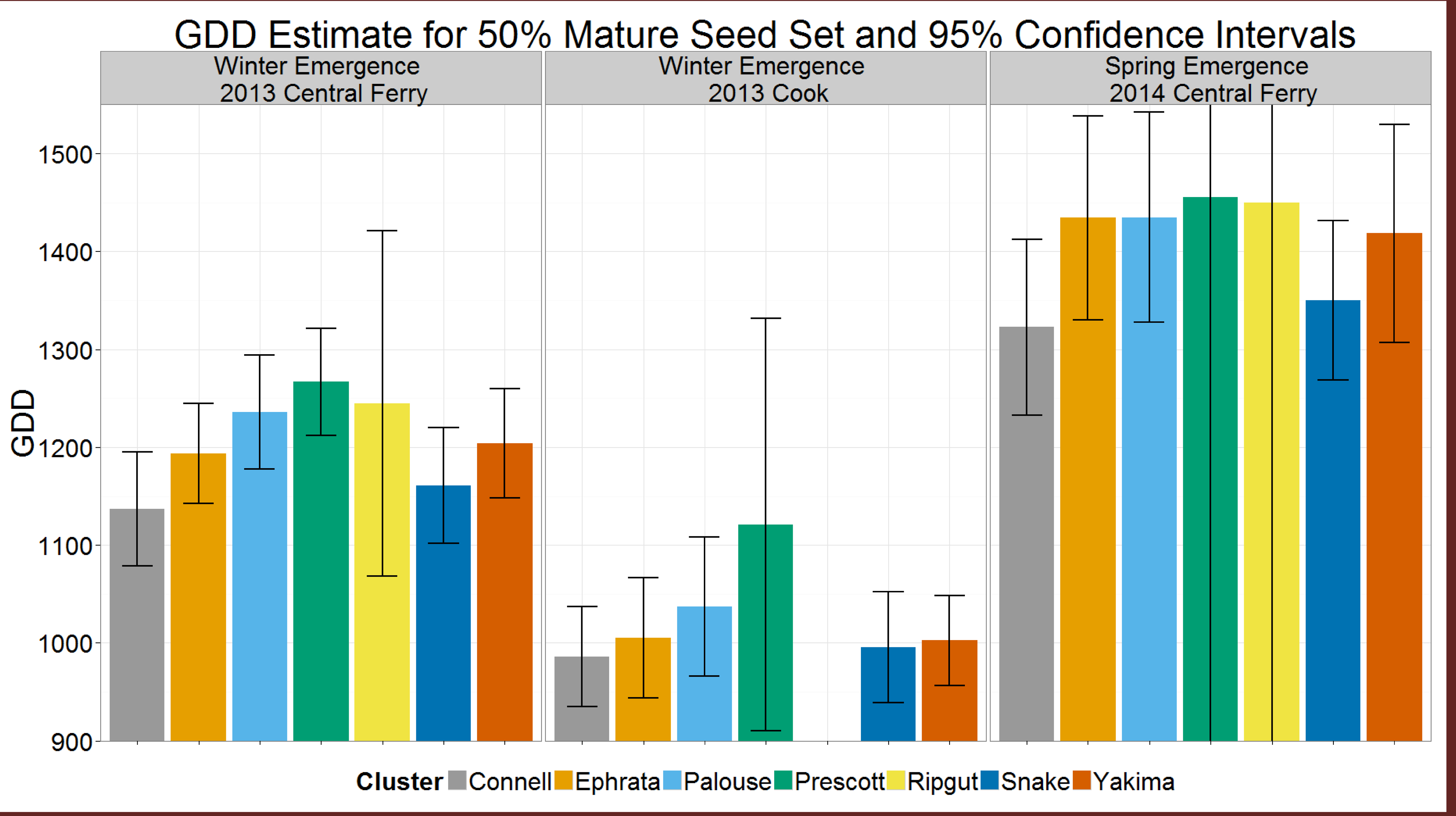

Figure3. Estimates of GDD required to produce 50% mature seed in different downy brome population clusters. Missing bars indicate no surviving genotype replicates.

Figure 4. Replicates of each population cluster from the 2013 Central Ferry common garden. Photos taken on May 8th at 1014 GDD. From left to right clusters are: Connell, Ephrata, Palouse, Prescott, Ripgut, Snake, and Yakima.

Results

- Spatial distribution of downy brome clusters and GDD estimates are not spatially significant (Figure 1).
- GDD estimates were dissimilar by location, all locations were analyzed separately.
- Variation in GDD estimates was greatest at the 2013 Central Ferry location (Figure 3 & 4).
- GDD accumulated slower at the 2013 Cook location (Figure 2).
- Individuals matured earliest at the 2013 Cook location.
- All replicates were winter killed by an early cold snap at the 2014 Central Ferry location.
- Subsequent trips in March and April observed plants emerging from seed that had not germinated in November.
- Individuals produced mature seed later at the 2014 Central Ferry Location.

Discussion

- GDD estimates for mature seed set are similar to what was reported by Ball et al. (2004)[2].
- The second flush of seed germination observed in the spring at the 2014 Central Ferry location is similar to previously reported patterns of downy brome emergence[3].
- GDD estimates from the 2014 Central Ferry location, compared to the other locations, may be indicative of fall vs spring emergence.
- The variation between locations and population clusters may be best explained by the degree of cold exposure and vernalization response[4].
- As downy brome maturity has implications for herbicide efficacy[5], earlier control operations may be warranted after a harsh winter.

Future Research

Research is ongoing to investigate the role of vernalization response and differences in maturation time under greenhouse conditions.

Literature Cited

[1]Forcella F, and Harvey SJ. 1988. Patterns of Weed Migration in Northwestern U.S.A. Weed Sci. 36 (2): 194-201.

[2]Ball DA, Frost SM, and Gitelman AI. 2004. Predicting downy brome (*Bromus tectorum*) seed production using growing degree days. Weed Sci. 52 (4): 518-524.

[3]Mack RN, Pyke DA. 1983. The Demography of *Bromus tectorum*: Variation in Time and Space. J Ecol. 71: 60-93.

[4]Meyer SE, Nelson DL, and Carlson. SL. 2004. Ecological Genetics of Vernalization Response in *Bromus tectorum* L. (Poaceae). Ann Bot. 91: 653-663.

[5]Blackshaw RE. 1993. Downy brome (*Bromus tectorum*) control in winter wheat and winter rye. Can J Bot. 74: 185-191.