Mature Seed Set Variation among PNW *Bromus tectorum* Accessions

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Background

Bromus tectorum **(downy brome) is an invasive winter annual grass species, widespread throughout the winter wheat production region of the Pacific Northwest (PNW). A previously published downy brome development model investigated the mature seed set of four downy brome accessions collected from the Pacific Northwest (PNW) and identified 1,000 growing degree days (GDD) as a relevant development threshold for the region (Ball et al. 2004). Study objectives were to validate and add greater spatial resolution to the previously published downy brome development model.**

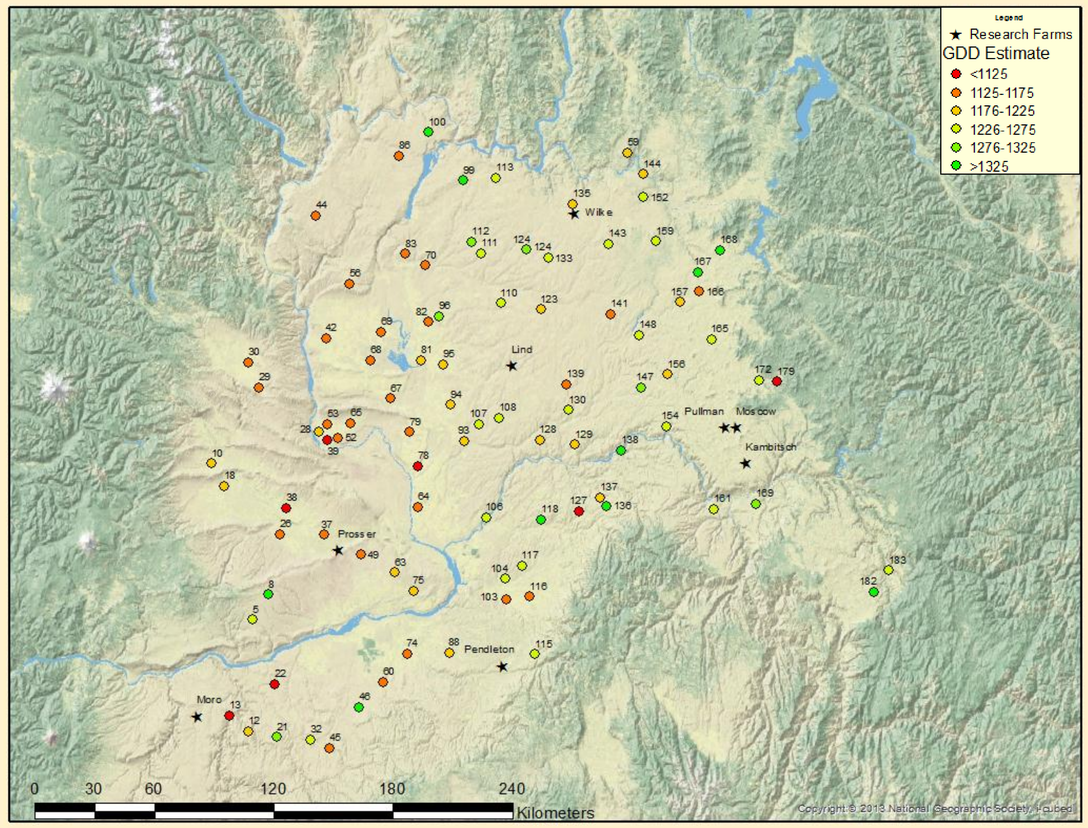

Figure 1. Locations of downy brome collections and GDD estimates of 50% germination.

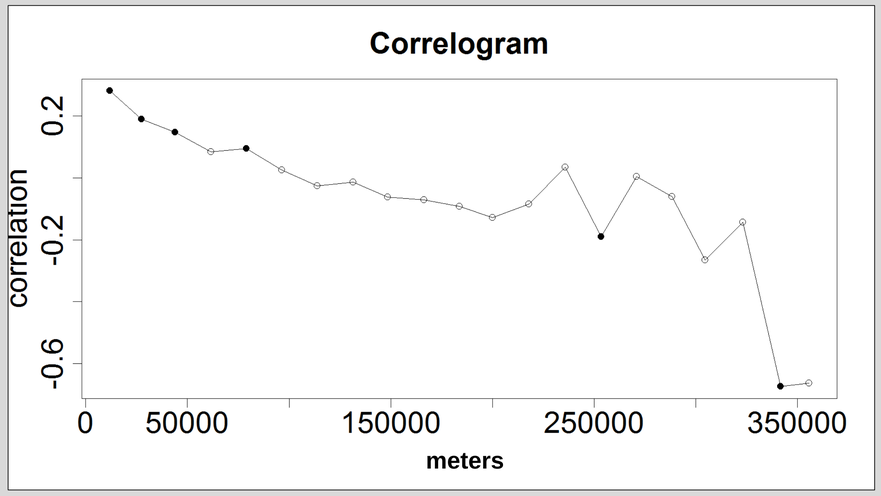

Figure 2. At scales less than 50 km the GDD estimates of 50% germination was positively autocorrelated with similar phenotypes clustered .

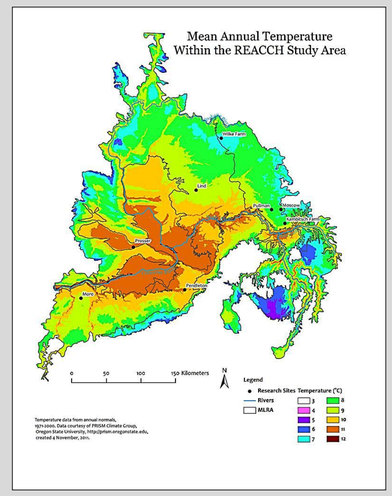

Figure 3. Average annual temperature, 1971-2000.

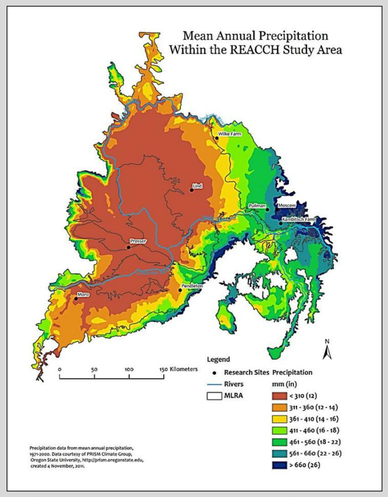

Figure 4. Average annual precipitation, 1971-2000.

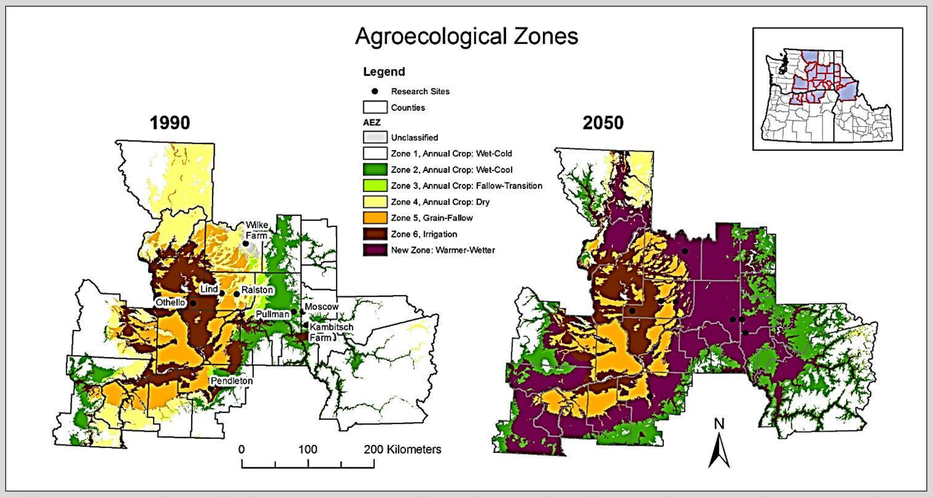

Figure 5. Projected changes to small grain production regions under scenarios of the Coupled Model Intercomparison Project 5.

Methods

- **Ninety-five downy brome accessions were collected in 2010 and 2011 from the small grain production region of the PNW (Figure 1).**
- **All accessions were planted in the greenhouse in early 2012 and allowed to complete one life cycle to reduce maternal effects on phenotype.**
- **Accessions were then transplanted as seedlings to a common garden located near Central Ferry, WA in November of 2012.**
- **Panicles were removed weekly from each individual in the common garden from the first observation of flowering (May 8th, 2013) until the conclusion of the experiment (June 26th, 2013).**
- **GDD, starting January 1st and with a 0°C base temperature, was assigned for each harvest date.**

$$GDD = \frac{Daily\ Max.Temp + Daily\ Min.Temp.}{2} - Base\ Temp$$

- **Sampled panicles were planted using a separate RCBD for each harvest date with six replicates per accession.**
- **Germination after two weeks was reported as a binary response.**
- **Non-linear regression was used to estimate the date of mature seed production by fitting a two-parameter loglogistic model for each accession and estimating the GDD at which 50, 25, 10, or 5 % germination occurs (R package 'drc').**

$$f(x) = \frac{1}{1 + exp[slope\ at\ inflection\{log(x) - 50\%\ reponse\}]}$$

- **The GDD estimate for 50% germination was used to construct a spatial correlogram based on Moran's I at discrete distances up to 350 km (R package 'ncf').**

Results

- **GDD Estimates for 50% germination (SE) ranged from 1077 (5) to 1375 (425) GDD and averaged 1207 (51) GDD (Figure 1).**
- **Positive spatial autocorrelation was observed at scales less than 50 km while negative spatial autocorrelation was observed at 350 km (Figure 2).**
- **The distribution of early and late maturing accessions is directionally significant with early maturing accessions predominantly found in the western portion of the PNW small grain production region (Figure 1).**
- **The western portion of the small grain production region is characterized by higher summer temperatures (Figure 3) and decreased summer precipitation (Figure 4).**
- **Projected changes in climate over the next five decades for the region include increased temperatures throughout the year and a shift in rainfall patterns resulting in decreased summer but increased winter precipitation (Figure 5).**
- **GDD estimates of mature seed set closely correlated with culm production, flowering time, and panicle ripening (Figure 6).**

Figure 6. Panicle maturity among four downy brome accessions representing the range of variation observed at the common garden on June 10th, 2013.

Conclusion

- **Future climate scenarios may favor range expansion of early maturing biotypes to the eastern portion of the PNW small grain production region in response to warmer temperatures and decreased summer precipitation.**
- **Accessions which produce seed earlier may require earlier control inputs.**

Works Cited

Anderson, R. L. 1998. Ecological characteristics of three winter annual grasses'. Weed Technol. 12:478-483.

Ball, D. A., S. M. Frost, and A. I. Gitelman. 2004. Predicting timing of downy brome (*Bromus tectorum*) seed production using growing days. Weed Science. 52(4):518-524.

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