Establishment of native perennial grasses in the presence of cheatgrass and imazapic

S. A. Burnett[1*] and B. A. Mealor[1]

[1] University of Wyoming, Department of Plant Sciences

* Contact: sburnet3@uwyo.edu

Scan here to download a pdf of this poster.

Introduction

Cheatgrass (*Bromus tectorum* L.)

- one of the most significant weeds in the western US[2,3]
- inhibits revegetation efforts following ecosystem disturbance[4,6]

Imazapic

- commonly used herbicide for cheatgrass management
- more information regarding application timing for restoration efforts is needed

Three native perennial grasses used in revegetation efforts

- western wheatgrass (*Pascopyrum smithii* (Rydb.) Á. Löve)
- needle and thread (*Hesperostipa comata* (Trin. & Rupr.) Barkworth)
- blue grama (*Bouteloua gracilis* (Willd. Ex Kunth) Lag. Ex Griffiths)

Objectives

1) Does native species establishment and early growth exhibit a tradeoff between cheatgrass competition and injury from herbicide application?
2) Does this differ between a PRE- or POST-emergent herbicide application?

Materials and Methods

For the three native grass species (western wheatgrass, needle and thread, and blue grama) a standard replacement series design was used including:

- 5 proportions of native species relative to cheatgrass
  - 0% (cheatgrass monoculture)
  - 25%
  - 50%
  - 75%
  - 100% (native monoculture)
- 3 herbicide treatments
  - no herbicide
  - 70 g ai ha^{-1} imazapic PRE-emergent
  - 70 g ai ha^{-1} imazapic POST-emergent

Fig 1. Herbicide damage on cheatgrass

The 39 treatment combinations were replicated 5 times in a randomized complete block design at the University of Wyoming greenhouse facilities at the Laramie Research and Extension Center.

Planting occurred on 29 January 2013 with the seeds in a 4 x 3 grid (Fig 2). Pots were thinned as needed over the course of the study to achieve the desired proportions. The PRE-emergent application occurred on 30 January following planting. The POST-emergent application occurred on 14 February 2013 when cheatgrass seedlings were at the 2-leaf stage. After 9 weeks, aboveground biomass was harvested and dried. Dried biomass values and calculated relative yield indices were used to assess performance and competitive ability.

Results

Biomass

1. Imazapic application, irrespective of timing, reduced cheatgrass biomass ($p < 0.05$; Fig 3).
2. Without imazapic, cheatgrass produced more biomass than native species, but this difference became less pronounced as proportion of native species increased ($p < 0.05$; Fig 3).
3. Imazapic impacts on native species varied by species and timing (Fig 4).
   a. Western wheatgrass and needle and thread biomass were reduced less by PRE-emergent than POST-emergent application. ($p < 0.05$)
   b. Blue grama biomass was equally reduced by either timing of imazapic application. ($p < 0.05$)

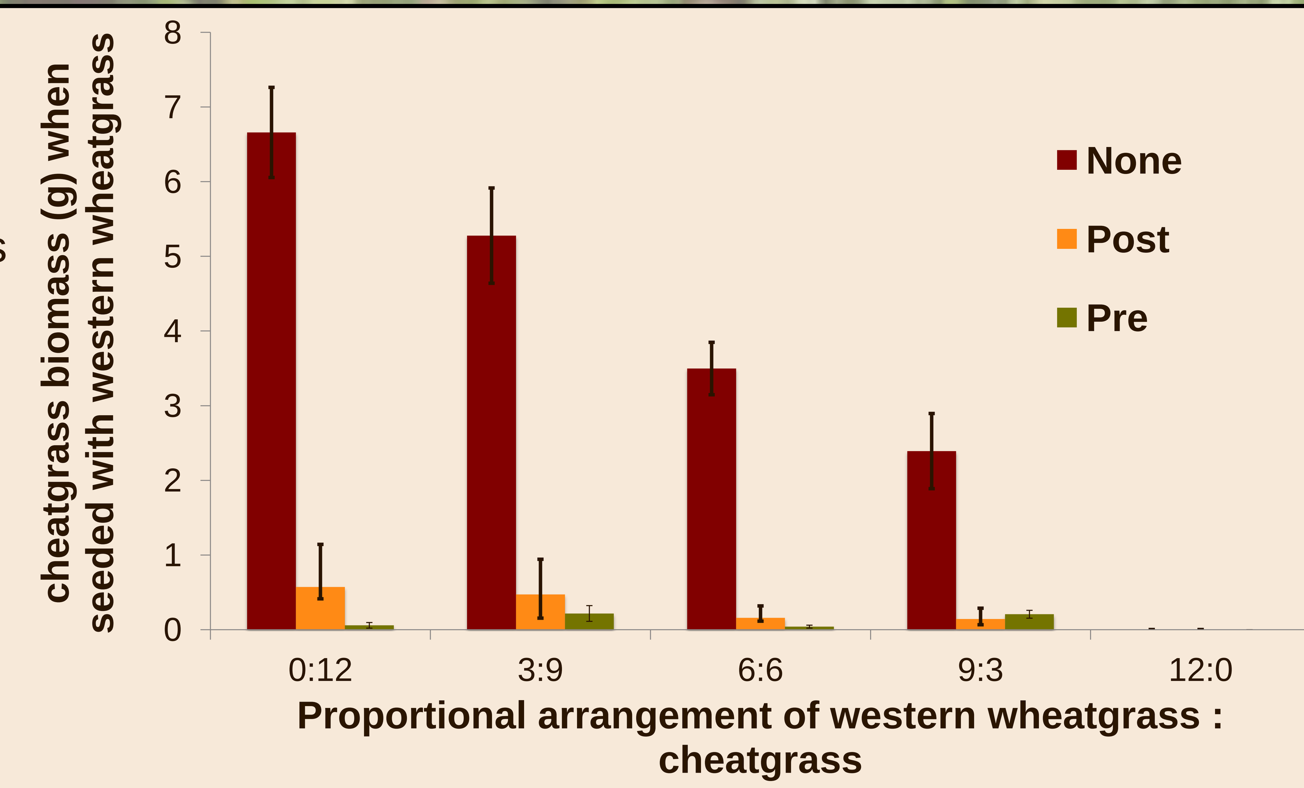

Fig 3. Mean cheatgrass biomass (±1 SE) when seeded with western wheatgrass by herbicide

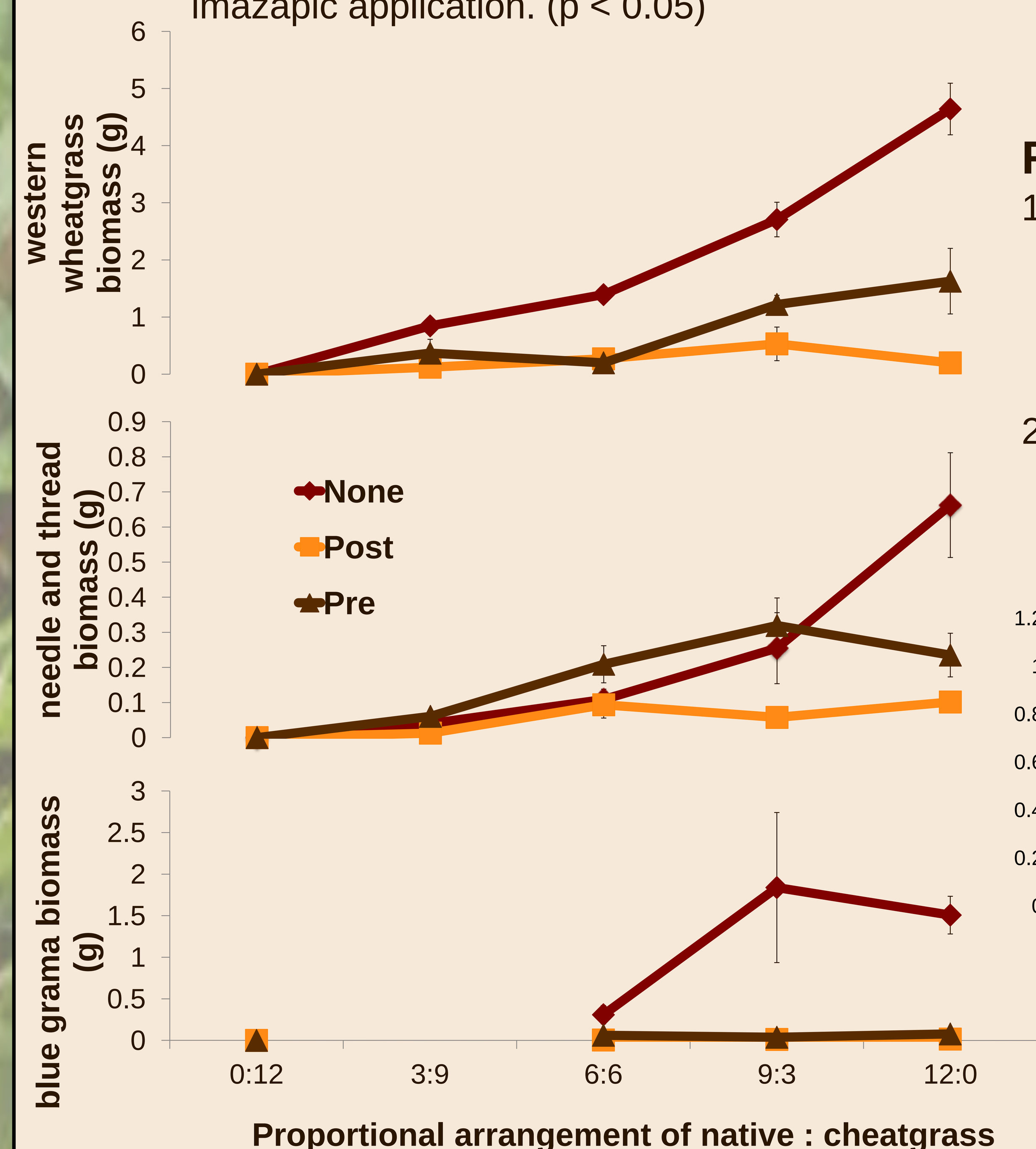

Fig 4. Mean biomass production (±1 SE) by herbicide

Relative Yield

1. Without imazapic
   a. RY's are lower than their expected values indicating that interspecific competition was more important than intraspecific ($p < 0.05$; Fig 5)
   b. RYT's < 1.0 indicating mutual antagonism between cheatgrass and the natives ($p < 0.05$; Fig 5)
2. With an imazapic application, whether PRE or POST, more RY values are not different from their expected values indicating a lack of competition between cheatgrass and the natives ($p < 0.05$).

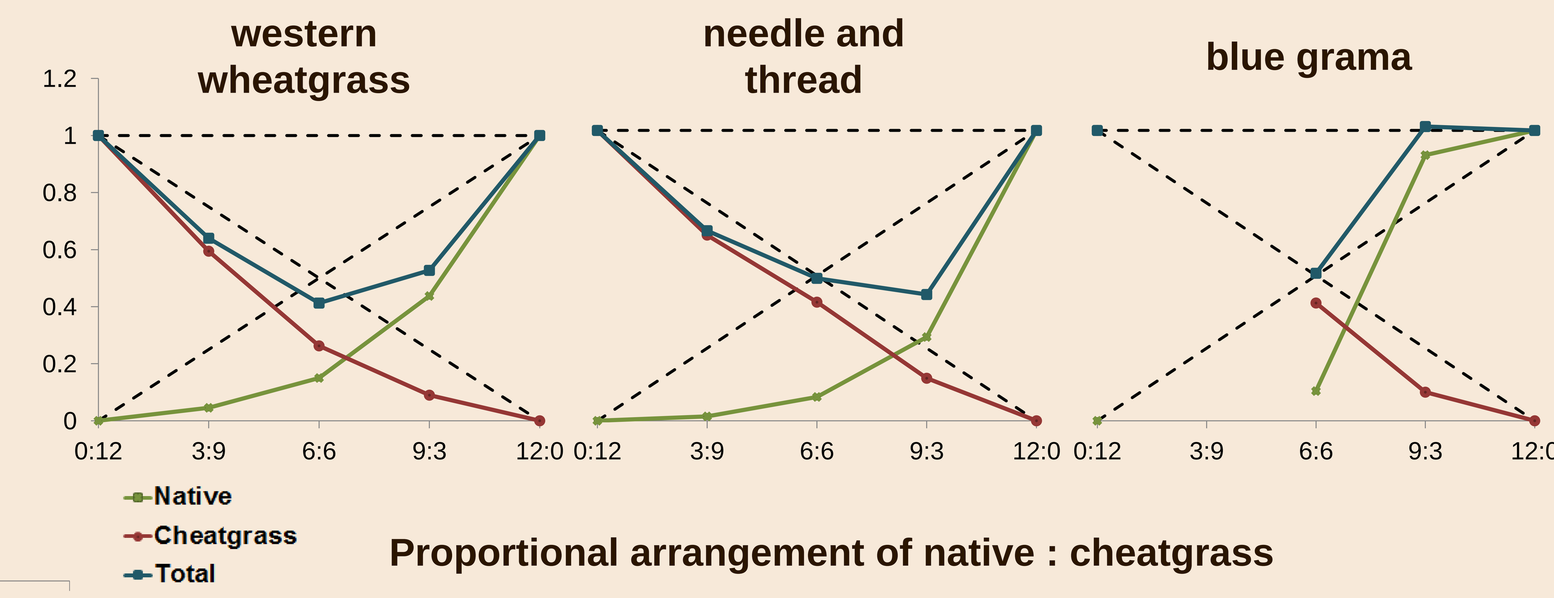

Fig 5. RY values (solid lines) for the no imazapic treatment by native species plotted against expected RY values (dashed lines)

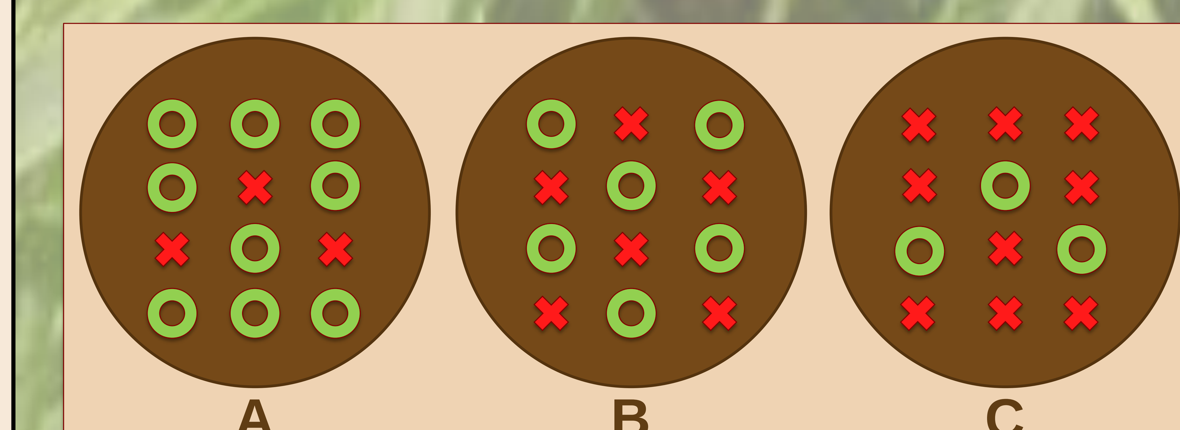

Fig 2. Seeding arrangement of proportions where ○ = perennial and ✖ = cheatgrass. A) 75% perennial and 25% cheatgrass; B) 50% perennial and cheatgrass; C) 25% perennial and 75% cheatgrass.

Relative Yield (RY) Calculation[1,5]

Relative Yield of Native Grass: $RY(\mathbf{N}) = \mathbf{P} * (\mathbf{N}_{mix} / \mathbf{N}_{mono})$

Relative Yield of Cheatgrass: $RY(\mathbf{C}) = (1 - \mathbf{P}) * (\mathbf{C}_{mix} / \mathbf{C}_{mono})$

where **P** is the proportion of the natives in each mixture; $\mathbf{N}_{mix}$ and $\mathbf{C}_{mix}$ are the yields of natives and cheatgrass in the mixture; and $\mathbf{N}_{mono}$ and $\mathbf{C}_{mono}$ are the yields of natives and cheatgrass in monoculture.

Relative yield total (RYT): $RYT = RY(\mathbf{N}) + RY(\mathbf{C})$

Conclusions

1. In situations where cheatgrass may impact restoration efforts, a PRE-emergent application of imazapic at 70 g ai ha^{-1} will reduce cheatgrass and have less negative impacts on newly-seeded native grasses than POST-emergent applications.
   a. PRE and POST applications impact cheatgrass biomass the same.
   b. A PRE application reduces native western wheatgrass and needle and thread biomass less than a POST application
2. Ensuring sufficient proportions of native species on the site may reduce cheatgrass in some situations.
   a. Without an imazapic application, cheatgrass biomass was still reduced by the increasing presence of native grasses.
   b. As indicated by the RY values, cheatgrass and the native grasses mutually antagonize each other.

References

1. Cousens, R., and M. O'Neill. 1993. Density dependence of replacement series experiments. Oikos 66: 347-352.
2. D' Antonio, C. M., and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology, Evolution and Systematics. 23:63-87.
3. Duncan, C. A., J. J. Jachetta, M. L. Brown, V. F. Carrithers, J. K. Clark, J. M. DiTomaso, R. G. Lym, K. C. McDaniel, M. J. Renz, and P. M. Rice. 2004. Assessing the Economic, Environmental, and Societal Losses from Invasive Plants on Rangeland and Wildlands. Weed Technology 18:1411-1416
4. Evans, R. A. 1961. Effects of different densities of downy brome (*Bromus tectorum*) on growth and survival of crested wheatgrass (*Agropyron desertorum*) in the greenhouse. Weeds 9: 216-223..
5. Harper, J. L. 1977. The Population Biology of Plants. Page 892. Academic Press, London.
6. Nelson, J. R., A. M. Wilson, and C. J. Goebel. 1970. Factors influencing broadcast seeding in bunchgrass range. Journal of Range Management 23:163-170.

Acknowledgments

We thank Dr. Peter D. Stahl, Andrew B. Smith, Cara E. Noseworthy, Beth Fowers, Travis W. Decker, the UW Laramie Research and Extension center staff for support on this project.