Post-Harvest Weed Competition in Perennial Grain Crops: A New Critical Period of Weed Control?

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Background

'Kernza®' intermediate wheatgrass[1] (*Thinopyrum intermedium*; IWG) and 'ACE-1' perennial cereal rye[2] (*Secale cereale x S. montanum*; PR) have been bred to exhibit perennial growth while producing grain for human consumption. Weed management has been a consistent issue during establishment and regrowth of these crops in both field experiments and on-farm trials in New York.

Pros:

- Potential to contribute to sustainable cropping systems by providing ecosystem services such as increased water use efficiency, soil erosion, and carbon storage[3]
- Reduced fossil fuel inputs due to the inherent lack of tillage, cultivation, and planting in years after establishment [3]
- Dual-purpose cropping for grain and forage[4]

Cons:

- Grain yields of IWG and PR are substantially lower than annual counterparts impacting economic viability[4]
- IWG grain yields decline as stands mature and densify[5]
- PR persistence is not consistent and appears to be strongly influenced by weed competition
- Limited development of management guidelines including planting and harvest methods

Methodology

This experiment was conducted in a mature stands of IWG and PR established September 2017 at Musgrave Research Farm, Aurora, NY to investigate intercropping with field peas (*Pisum sativum*).

- Experimental Design: Spatially balanced complete blocks
  - Four replicates
- Cropping System Treatments: IWG, PR, and field pea monocultures, IWG/pea and PR/pea polycultures

Four 1.5 m by 1.5 m subplots were delineated in each main plot for hand-weeding treatments following the first grain and forage harvest in August 2018.

- Weed Control Treatments: Fall, Spring, Fall and Spring, None/Control
  - Plots maintained every two weeks during the given seasons

At grain maturity in 2019, 0.5 m^2 quadrats were sampled in each subplot. All crop and weed biomass was clipped and separated by species. Crop stems and seed heads were counted, dried, weighed and threshed. Random 20-seedhead subsamples were hand-threshed to record components of yield: spikelet count, floret count, seed count, and seed weight. Data were analyzed using mixed-effect ANOVA in R.

Results

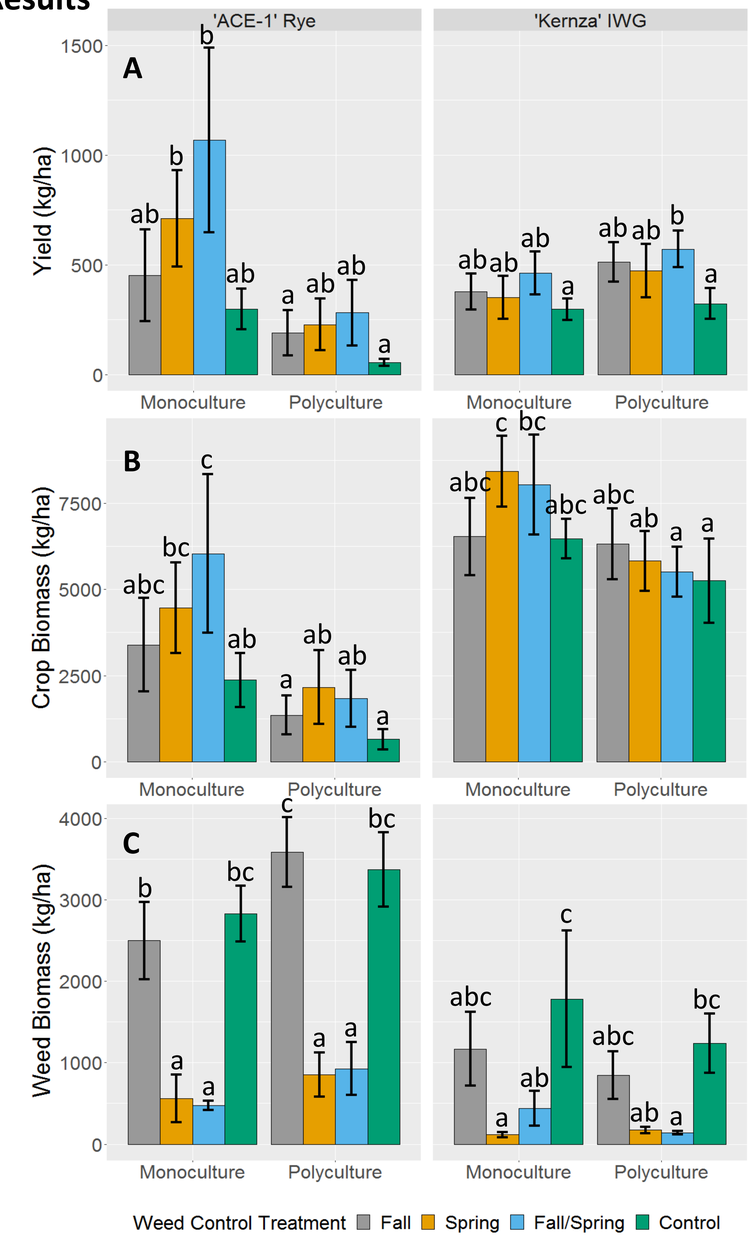

Figure 1: (A) Grain yield, (B) crop biomass, and (C) weed biomass harvested from second-year 'Kernza®' intermediate wheatgrass and 'ACE-1' perennial cereal rye crops grown in monoculture and polyculture with field peas with four weed removal period treatments. Treatments sharing a lower-case letter within a crop species/response variable combination are not significantly different at $\alpha = 0.05$.

Discussion and Future Work

- Differing timing of weed management provoked responses in grain yield, crop biomass, and weed biomass that varied by crop and cropping system (Figure 1).
- IWG inherently has more competitive ability to suppress weeds and is more resilient than PR under a polyculture cropping system. Although there was no statistical significance due to high variance, we note that IWG may have a critical period of weed control in the fall based on developing trends. We hypothesize that IWG may have a period of tiller initiation at this time that is disrupted by weed competition. Fall planted wheat, a close relative of IWG, initiates the majority of its tillers that will contribute to yield prior to winter dormancy[6].
- In contrast, PR exhibited its highest yields when spring weed control was included in the treatment and performed worse in polyculture.
- Understanding when weed competition has the largest impact on crop productivity will help determine optimum timing of weed control.

Future Research Questions:

1. When does initiation of reproductive tillers occur in each of these crops, and how does it correlate to yield?
2. How do planting density and row spacing impact weed competition and productivity in these crops?
3. What are the short- and long-term impacts of weed competition and control during the establishment year?
4. Is there a legacy effect of weed management during any of these periods on crop productivity in subsequent years?

Figure 2 (clockwise from top left): Intermediate wheatgrass nearing maturity; PhD candidate Eugene Law and I maintaining spring weeded plots; PR seedheads (photo credit: James Cagle); IWG seedheads and grain (photo credit: The Land Institute); quadrat sampling in an IWG subplot.

References

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Acknowledgements

This research was supported by NESARE Grant GNE17- 156, a SUNY Diversity Fellowship, and an Undergraduate Research Grant from the Schmittau-Novak Small Grants Program. In particular we want to thank the Schmittau-Novak program for providing a venue for undergraduate research mentorship. Special thanks to members of the Weed Ecology & Management and Sustainable Cropping Systems Labs for assistance in plot maintenance, data collection, and sample processing.