Weed Seedbank Control in Rotational Crops for Proactive Herbicide Resistance Management

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INTRODUCTION

Herbicide-resistant weed populations are evolving rapidly and threatening the sustainability of crop production[1,2]. Crop rotations and herbicide mixtures are continually recommended as best practices for proactive and reactive herbicide resistance management[3]. For crop rotations to be effective weed management tools, the selection of crops must take into account the biology and ecology of weeds present. Thus, assessing how competitive crops (e.g., small grains), perennial forages (e.g., alfalfa), and rotational crop diversity impact the weed seedbank is important to provide the necessary information to growers wishing to diversify their weed management program and reduce the selection for herbicide-resistant weeds.

Objective:

Evaluate crop rotation diversity and herbicide programs for weed seedbank management wheat rotations.

Hypothesis:

Crop rotation and herbicide will influence weed density and seedbank dynamics.

MATERIALS AND METHODS

- **Study locations:** University of Idaho Kimberly Research and Extension Center, Kimberly, ID.
- **Study design:** Split-plot, randomized complete block, with four replications. ***Main plot:*** crop rotation (Figure 2). ***Split-plot:*** postemergence only (POST), preemergence (PRE) + POST, no herbicide (untreated).
- **Herbicide application:** CO2 -pressurized bicycle sprayer, 115 L/ha at 207 kPa with TeeJet 11002DG nozzles.
- **Data collection:** Weed density within crops was determined by counting each species and the amount of each species within a 0.5 square meter quadrat. Crops were harvested at maturity to determine yield. Ten soil samples were collected in each plot to a depth of 20 cm after harvest to evaluate seedbank density.
- **Weed seedbank analysis:** An exhaustive germination study was conducted in the greenhouse using soil samples from the previous year (Figure 1). Weed seedlings were counted and removed biweekly until no seedlings emerged for two consecutive weeks.
- **Data analysis:** Linear mixed-effects ANOVA in R Software. Herbicide treatments and crops were considered fixed effects. Block and year were considered random effects. Means were separated using Tukey's HSD at alpha=0.05.

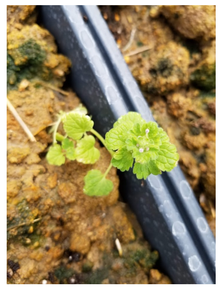

Figure 1: Weed seedlings emerging in the exhaustive germinating study

Crop rotation	Year 1 J F M A M J J A S O N D	Year 2 J F M A M J J A S O N D	Year 3 J F M A M J J A S O N D	Year 4 J F M A M J J A S O N D
Rotation 1	Spring wheat	Alfalfa		
Rotation 2	Spring wheat	Dry bean	Spring wheat	Dry bean
Rotation 3	Spring wheat	Corn	Spring wheat	Corn
Rotation 4	Spring wheat	Corn	Dry bean	Spring wheat

Figure 2: Crop rotation including spring wheat, alfalfa, corn, and dry beans for the next four years of this study.

RESULTS AND DISCUSSION

- There no effect of herbicide treatments on weed seedbank density one–year after study initiation (Figure 3).
- Weed density within each crop during the growing season was affected by the type of crop and the herbicide treatment used (Figures 4 & 5).
- POST and PRE + POST treatments reduced the weed density compared to the untreated check (Figures 4 & 5).
- Even without herbicide application, alfalfa significantly reduced weed density compared to corn and dry bean (Figure 5).
- Weed control had no effect on the alfalfa yield (Figure 6), however, the herbicide treatments improved the yields of both the corn and dry bean (Figure 6)
- Including alfalfa in wheat rotation may be an effective resistance management strategy through the reduction in weed and seedbank density.
- A combination of higher crop yields with PRE + POST herbicide treatments and a reduction of the weed seedbank would make this an economical proactive resistance management practice.

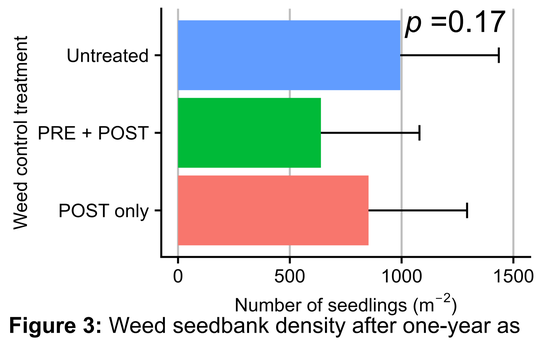

Figure 3: Weed seedbank density after one-year as influenced by herbicide treatments

Figure 4. Weed density in corn in 2022. From left to right: untreated, postemergence (POST) only, and preemergence (PRE) + POST).

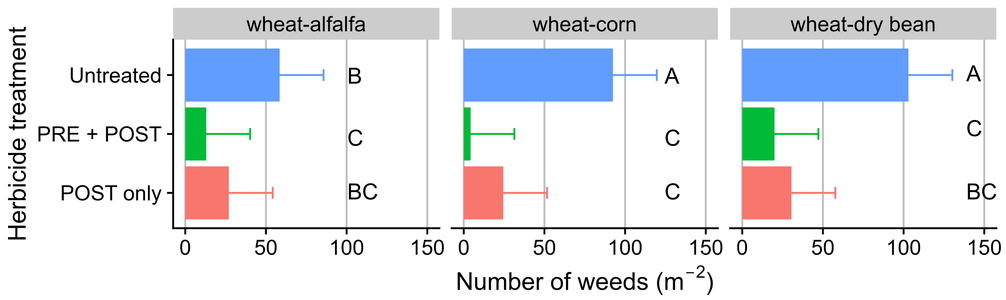

Figure 5: Weed density as influenced by crop rotation and herbicide programs in 2022. Letters represent the treatment groupings. Bars with same letters depict no significant difference according to Tukey's HSD at the 0.05 probability level.

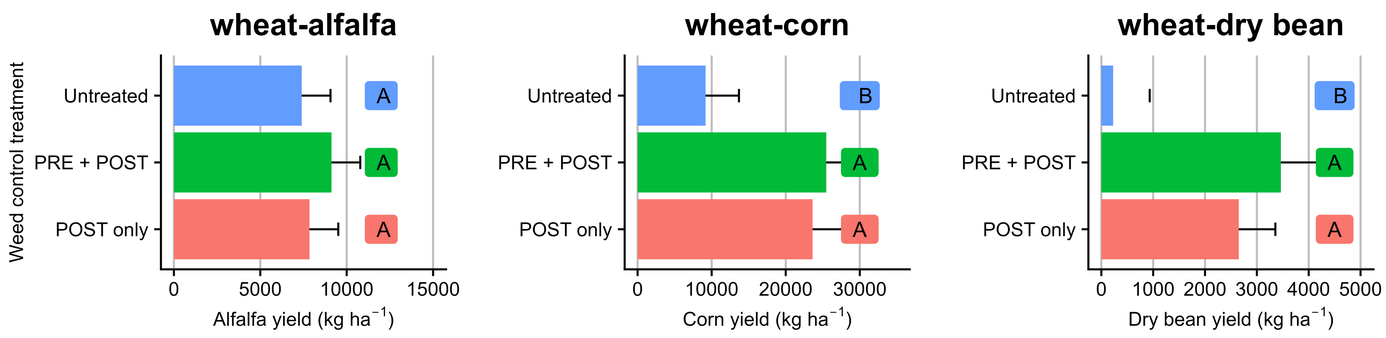

Figure 6: Crop yield as influenced by crop rotation and herbicide programs in 2022. Letters represent the treatment groupings. For each crop, bars with same letters depict no significant difference according to Tukey's HSD at the 0.05 probability level.

FUTURE RESEARCH

- Continue study to obtain year 3 and 4 data.
- Exhaustive germination in spring of 2023 to evaluate weed density from soils collected in 2022.
- Compare results from exhaustive germination with elutriator method for weed seedbank analysis.
- Economic analysis of the crop rotations and herbicide treatments.

REFERENCES

1.Brainard, D. C., Bellinder, R. R., Hahn, R. R., & Shah, D. A. (2008). Weed Science, 56(3), 434–441. https://doi.org/10.1614/WS-07-107.1.

2.Gardarin, A., Dürr, C., & Colbach, N. (2011). Ecological Modelling, 222(3), 626–636. https://doi.org/10.1016/j.ecolmodel.2010.10.005.

3. Mosqueda, E., Lim, C., Sbatella, G., Jha, P., Lawrence, N., & Kniss, A. (2020). Weed Science, 68(3), 278-284. doi:10.1017/wsc.2020.23