Summary

Weed Management in Corn 2025.

Michael Flessner. Virginia Tech.

Weeds remain a constant challenge in Virginia corn production. In an effort to provide research-based information on the most effective herbicides and other weed management techniques, the Virginia Cooperative Extension Pest Management Guide for Field Crops and the Mid-Atlantic Field Crop Weed Management Guide was updated with the latest findings from herbicide evaluation research. Additionally, Dr. Flessner's extension program delivered 14 presentations reaching an audience of >650 with information derived from this funding as well as previous support from the Virginia Corn Board.

As new herbicides are introduced to the market and weeds' response to herbicides changes as resistance develops to existing herbicides, research must be conducted to evaluate and corroborate information provided in the guide. Based on studies conducted, Storen, a new herbicide pre-packaged mixture product from Syngenta, and Storen (from BASF) with tank-mix partners, provides similar or better control of weed species evaluated compared to Bicep II Magnum followed by Halex GT and other comparison treatments. In another study, it was found that Liberty Ultra should not be applied during the first 2 hours after sunrise, similar to Liberty 280SL. Based on these data and existing knowledge, it is also recommended to not apply Liberty Ultra after 2 hours prior to sunset or at night.

Research also evaluated capitalizing on cereal rye cost share and winter protection for hairy vetch before corn and concluded that Virginia farmers may be able to capitalize on state cover crop subsidies for cereal rye and mixtures while not risking hairy vetch biomass accumulation, N accumulation, or weed suppression with the use of this method.

While assessing reduced herbicide inputs with hairy vetch before corn, if was found that overall, 2-pass herbicide programs in hairy vetch optimized weed suppression, corn yield, and net returns.

When comparing black oats to cereal rye, both with and without hairy vetch, black oats were found to be comparable to cereal rye in terms of C:N ratio, lignin content, and green cover, but cereal rye accumulates more biomass resulting in greater weed suppression. Thus, farmers may still be inclined to utilize a cereal rye monoculture or mixture as a winter cover crop.

VIRGINIA CORN BOARD
PROJECT REPORT – 2025

Title: **Weed Management in Corn 2025**

Objectives:

1) Evaluate various preemergent and postemergent herbicides and programs for weed control in corn and burndown control of cover crops.
2) Capitalizing on cereal rye cost share and winter protection for hairy vetch before corn.
3) Determining reduced herbicide inputs with hairy vetch before corn.
4) Evaluate black oats as a cover crop for weed suppression in corn.
5) Disseminate findings and best practices through Extension.

Objective 1. Evaluate various preemergent and postemergent herbicides and programs for weed control in corn and burndown control of cover crops.

Background

The Weed Science Society of America considered corn yield in the US from 2007 to 2013 in the absence of herbicides. Without effective herbicides, they estimated that weeds would cause a 52% corn yield loss (https://doi.org/10.1614/WT-D-16-00046.1). In 1992, it was estimated that weeds caused a 1 to 15% loss in corn yield (http://www.jstor.org/stable/4045287). Among the most problematic weeds are those which are herbicide resistant. Clearly, effective weed management is necessary to maximize corn yield (https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/PPWS/ppws-101/PPWS-101.pdf). Notably, these include glyphosate (group 9) and ALS-inhibiting herbicide (group 2) resistant Palmer amaranth and common ragweed in Virginia.

In an effort to provide research-based information on the most effective herbicides, the Virginia Cooperative Extension Pest Management Guide for Field Crops (http://pubs.ext.vt.edu/456/456-016/456-016.html) and the Mid-Atlantic Field Crop Weed Management Guide (http://extension.udel.edu/ag/weed-science/weed-management-guides/) are updated annually with the latest findings from herbicide evaluation research conducted in the Mid-Atlantic region. Additionally, Dr. Flessner's extension program delivers over 30 presentations per year to various stakeholder groups across Virginia. As new herbicides are introduced to the market and weeds' response to herbicides changes as resistance develops to existing herbicides, research must be conducted to evaluate and corroborate information provided in the guide. Therefore, this proposal is for research directly tied to providing the latest research-based information to corn producers.

One way to help manage herbicide resistant weeds is through the use of cover crops, which have been shown to reduce summer annual weeds (https://doi.org/10.1017/S0890037X00040859). Research previously funded by the Virginia Corn Board indicates that approximately 7500 lbs of cover crop biomass per acre can result in 75% weed suppression for approximately 6 weeks after cover crop termination. This level of biomass means farmers must maximize cover crop biomass, which generally does not occur until approximately May 1. Since most grain corn is planted in April, corn farmers are not able to fully utilize cover crops for weed management. Planting into actively growing cover crops, known as "planting green," allows cover crop to continue to grow and acquire additional biomass until terminated by herbicides. Thus, weed suppression from cover crop residue should increase relative to termination prior to corn planting. Previous research funded by the Virginia Corn Board indicated exactly that by delaying termination of cover crops from 2 weeks prior to planting until at or 2 weeks after planting, cover crop biomass increased resulting in improved weed suppression while, importantly, maintaining corn yield. There are potential drawbacks to planting green, the most obviously of which is the cover crop competing with corn in the sensitive early establishment phase. Most producers are planting green and terminating the cover crop at the same time as planting such that by the time corn emerges, the cover crop is dead. This approach mitigates many of the potential drawbacks to planting green while capitalizing on the additional time for cover crop growth and associated benefit accumulation. Anecdotally, farmers are reporting reduced herbicide inputs and associated cost savings with cover crops. Replicated research is needed verify this and supply validated results to farmers.

Expansion of cover crop species utilized in Virginia continues to increase, notably black oats and berseem clover. To provide up-to-date recommendations, evaluation of these species in Virginia needs to be conducted. Pertinent to weed management, assessing preplant herbicide control options (i.e. burndown herbicides) and weed suppression of cover crop residues are needed.

Procedures

Herbicide efficacy studies were conducted to evaluate preemergence, postemergence, and program (pre- and post-emergence) treatments for weed control efficacy and corn tolerance. Weed species evaluated included pigweeds, foxtails, and morningglories and other weeds present at various research locations. Preemergence herbicides were applied immediately after planting. Postemergence herbicides were applied when weeds reach 4 inches in height or corn reaches 12 inches in height, typically 4 to 5 weeks after planting. For all experiments in this objective, the area was weed free at planting.

For all objectives: In all relevant experiments, visible weed control and yield (if possible) will be collected at appropriate intervals after treatments (approximately 2, 4, and 6 weeks after treatment). Treatments will be applied at 15 GPA. Appropriate adjuvants will be included in all herbicide treatments, as indicated by the product label. Herbicide rates will be based on label recommendations for weed size and/or soil type. A randomized complete block design with 3 to 4 replications per treatment will be utilized. Nontreated and treated checks will be included where appropriate. Digital images will be collected to document treatment effects. Data will be subjected to ANOVA and means separated using Fisher's protected LSD or other appropriate statistical analysis.

Results

Experiment 1. Comparison of Surtain and Storen containing herbicide programs to commercial standards – Blackstone location.

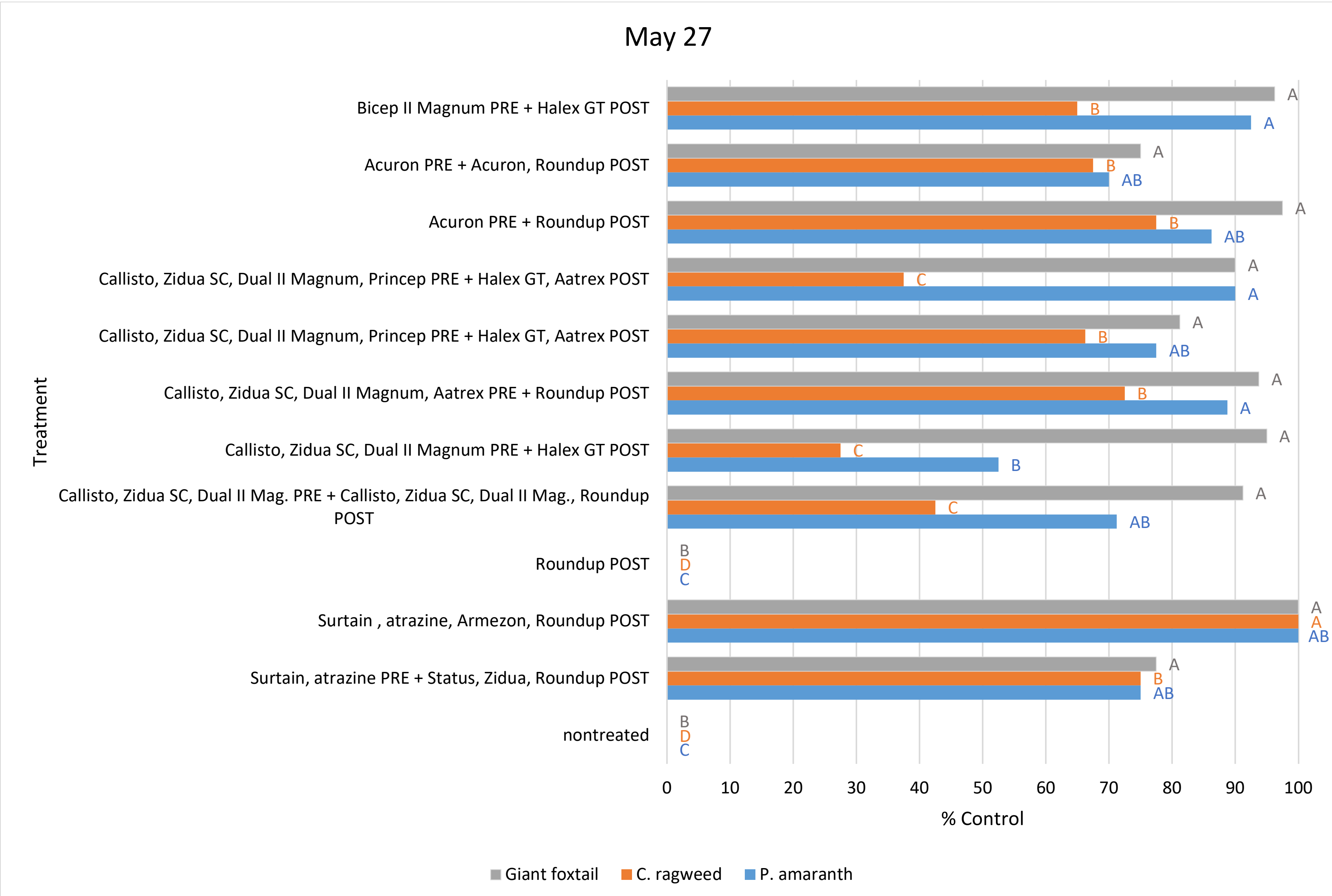


Figure 1. Weed control on May 27th, just prior to postemergent herbicide application in a field experiment in Blackstone, VA. Bars sharing a letter are not significantly different according to Fisher's Protected $LSD_{(0.05)}$ within weed species.

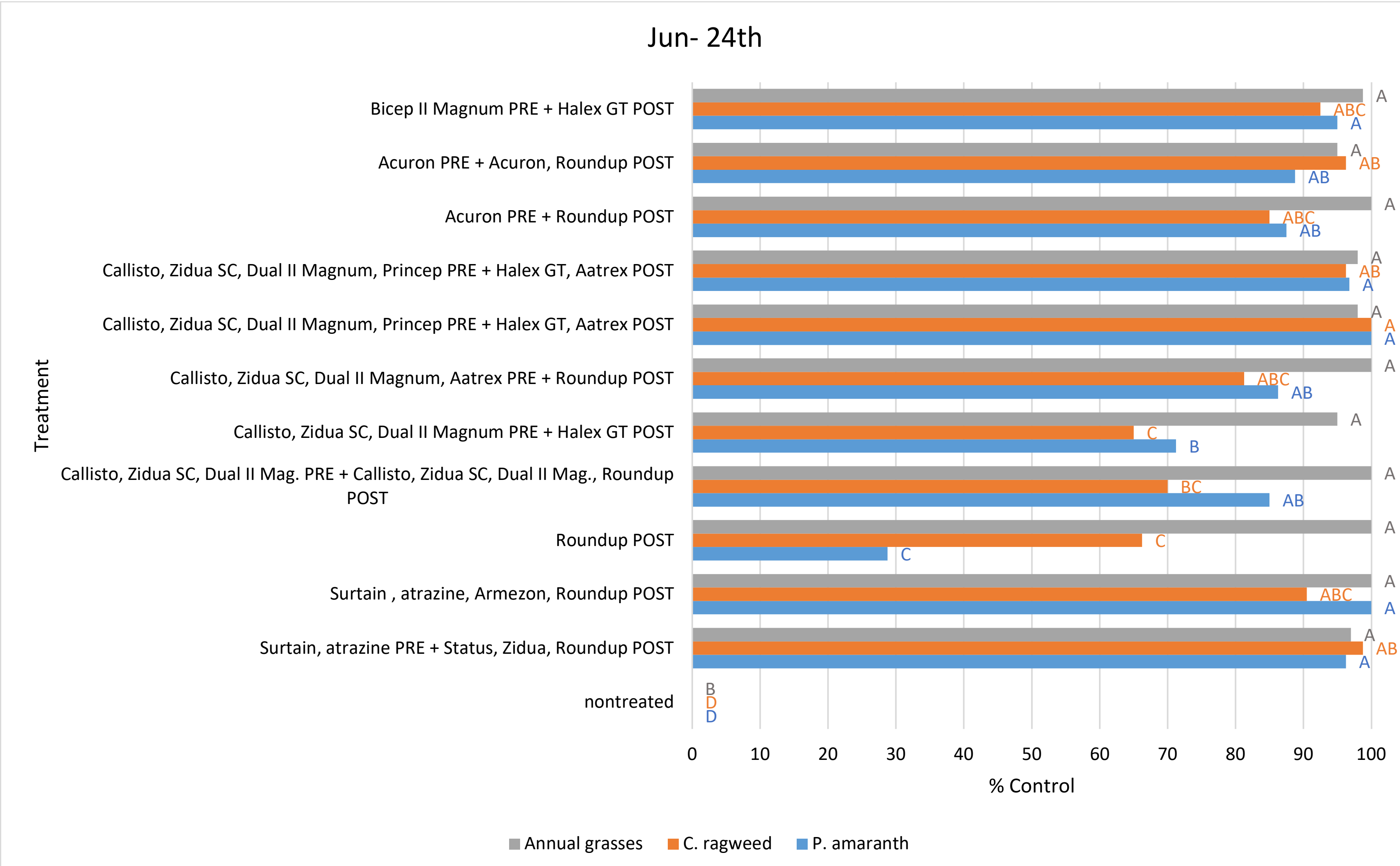


Figure 2. Weed control on June 24th, approximately 4 weeks after postemergent herbicide application in a field experiment in Blackstone, VA. Bars sharing a letter are not significantly different according to Fisher's Protected $LSD_{(0.05)}$ within weed species.

Yield was not different among treatments and ranged from 110 to 150 bu/A.

Experiment 2. Comparison of Surtain and Storen containing herbicide programs to commercial standards – Blacksburg location.

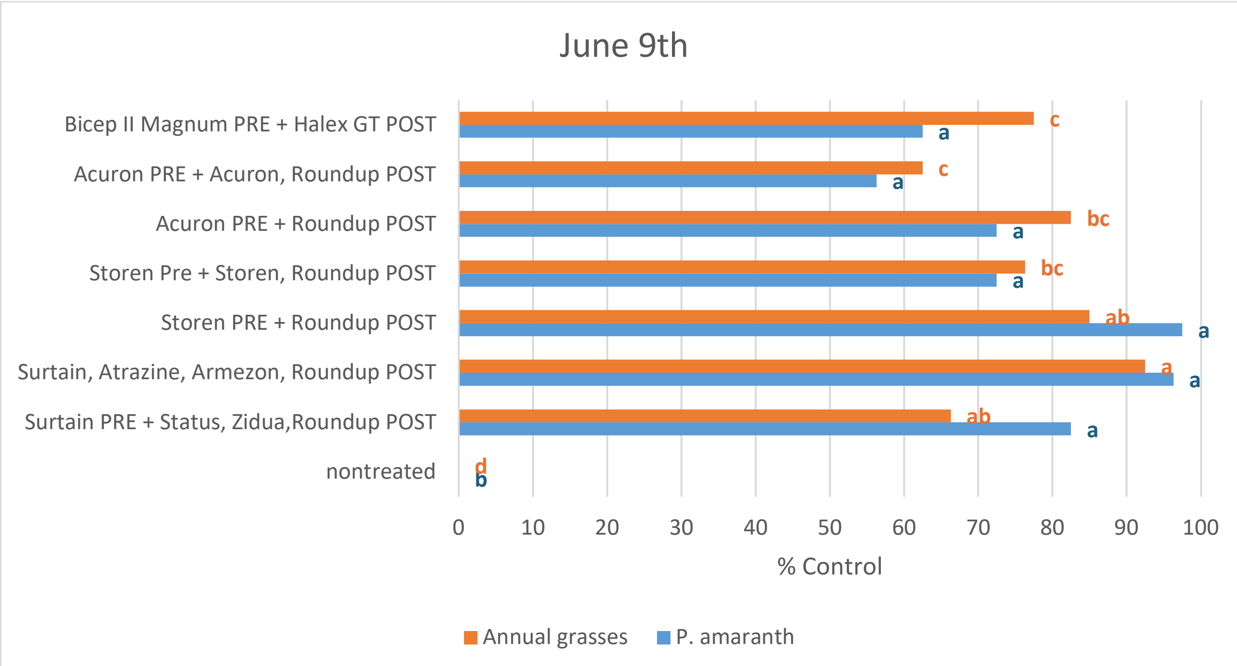


Figure 3. Weed control on June 9th, approximately 4 weeks prior to postemergent herbicide application in a field experiment in Blacksburg, VA. Bars sharing a letter are not significantly different according to Fisher's Protected $LSD_{(0.05)}$ within weed species.

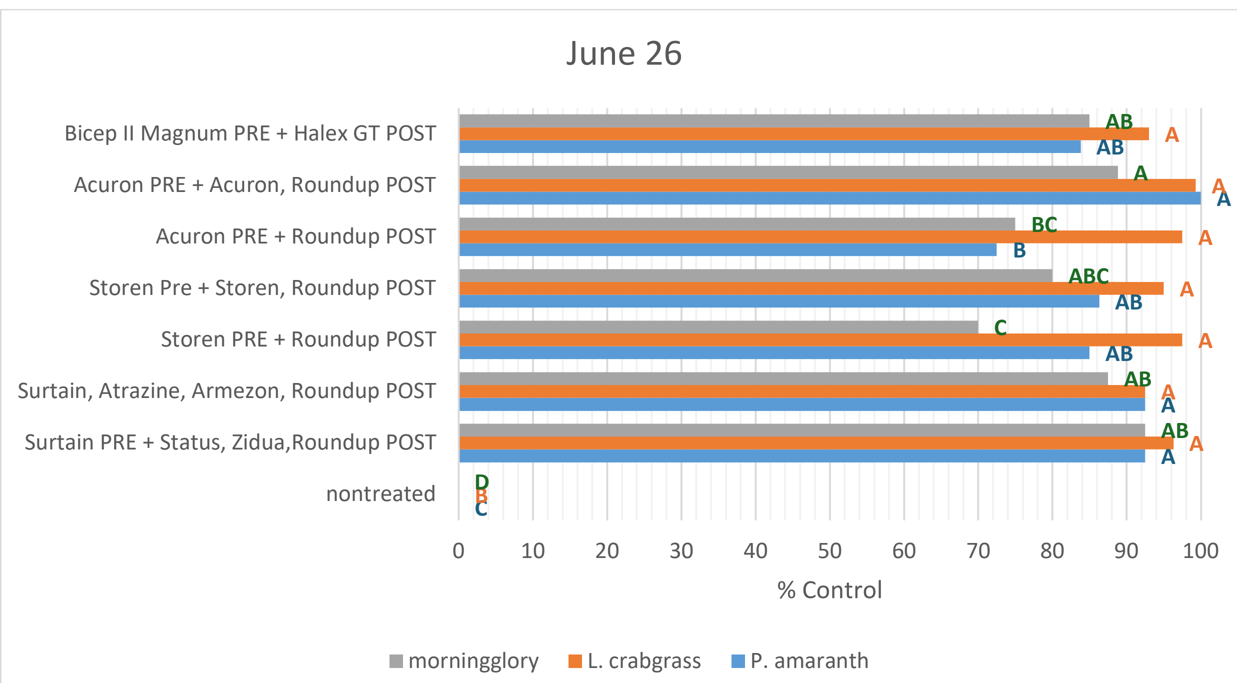


Figure 4. Weed control on June 26th, approximately 3 weeks after to postemergent herbicide application in a field experiment in Blacksburg, VA. Bars sharing a letter are not significantly different according to Fisher's Protected $LSD_{(0.05)}$ within weed species.

Yield was not different among treatments and ranged from 155 to 200 bu/A.

Conclusion

Results for experiments 1 and 2 indicate that Storen, a new herbicide pre-packaged mixture product from Syngenta, and Storen with tank-mix partners, provides similar or better control of weed species evaluated compared to Bicep II Magnum followed by Halex GT and other comparison treatments.

<u>Experiment 3. Time of day influences Liberty Ultra efficacy.</u>

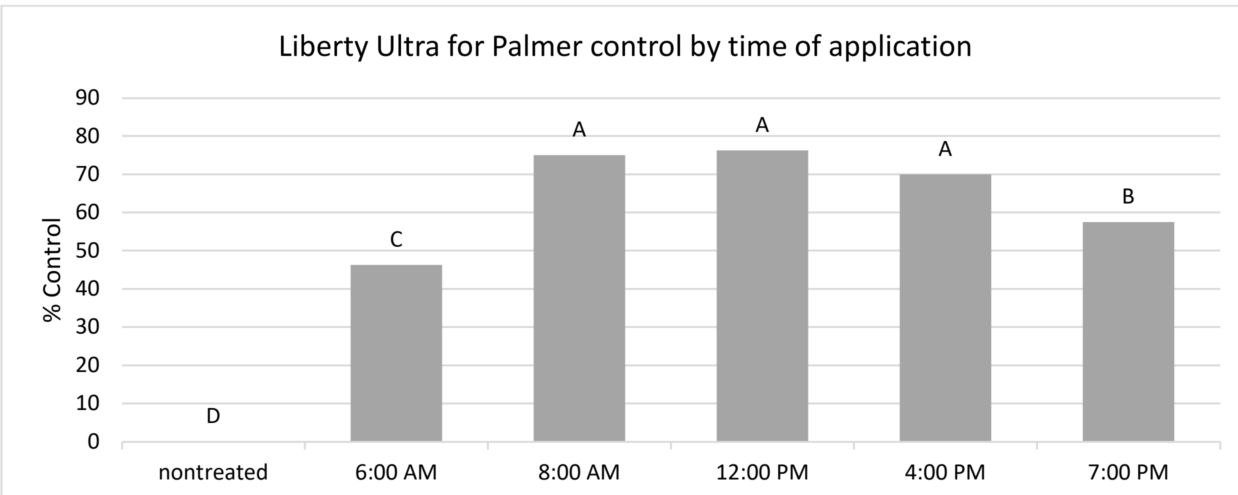


Figure 5. Palmer amaranth control approximately 3 weeks after treatment from applications at various times of day. Bars sharing a letter are not significantly different according to Fisher's Protected $LSD_{(0.05)}$ within weed species.

Conclusion

Just as with Liberty 280SL, Liberty Ultra should not be applied during the first 2 hours after sunrise. Based on these data and existing knowledge, it is also recommended to not apply Liberty Ultra after 2 hours prior to sunset or at night.

Objective 2. Capitalizing on cereal rye cost share and winter protection for hairy vetch before corn.

Background

This objective determined if cereal rye + hairy vetch, with cereal rye terminated in mid-March, is superior to hairy vetch alone before corn. The addition of cereal rye will allow for a larger cost-share payment in most areas of Virginia and may provide additional winter protection to the hairy vetch. However, there is additional costs and management when including cereal rye. The hypothesis is that the addition of cereal rye to hairy vetch will not improve outcomes (N-fixation, biomass, weed suppression) relative to hairy vetch alone, when cereal rye is terminated in mid-March.

Procedures

This experiment was a 4 by 3 factorial design with 4 cover crops and 3 cereal rye termination programs. Cover crops included (1) early maturing hairy vetch variety, (2) late maturing hairy vetch variety, (3) cereal rye + early maturing hairy vetch, and (4) cereal rye + late maturing hairy vetch. Cereal rye termination programs included (1) nontreated check, (2) 8 fl oz/a of Clethodim 2EC/Volunteer (or equivalent amount of clethodim) in 50/50 water/28% N (about 30 lbs of N per acre), and (3) 8 fl oz/a of Clethodim 2EC/Volunteer (or equivalent amount of clethodim) in water with surfactant according to label.

Cover crops were planted at Kentland Farm near Blacksburg, VA and at the Southern Piedmont Agricultural Research and Extension Center in Blackstone Virginia in Oct. 2024. Cereal rye termination programs occurred on or shortly after March 15^{th}, 2025. Corn was planted on or about April 15^{th} and glyphosate + 2,4-D will be applied at that time. A postemergent herbicide (Halex GT at 3.6 pt/a) was applied 4 weeks after corn planting.

Data collection included: hairy vetch biomass on or about Dec. 1^{st}, Mar. 15^{th}, and April 15^{th}. April 15^{th} (corn planting timing) data were also be subjected to N quantification. Data on weed suppression were collected 2 and 4 weeks after corn planting (i.e. May 1^{st} and 15^{th}). Corn yield was also collected.

Results

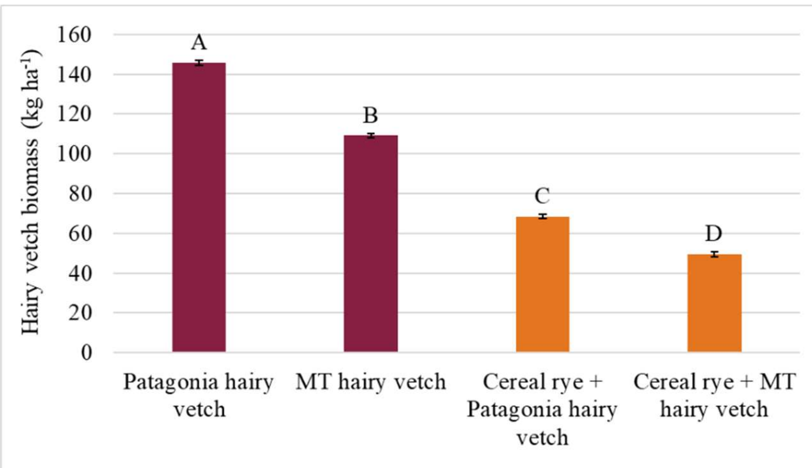


Figure 6. December hairy vetch biomass accumulation LS means (with SE bars) from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Orange bars indicate hairy vetch and cereal rye mixtures while maroon bars indicate hairy vetch monocultures.

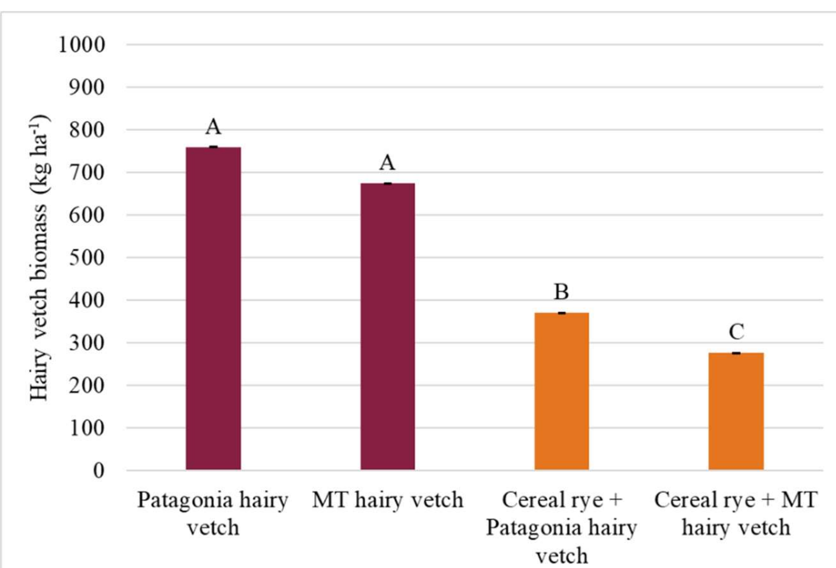
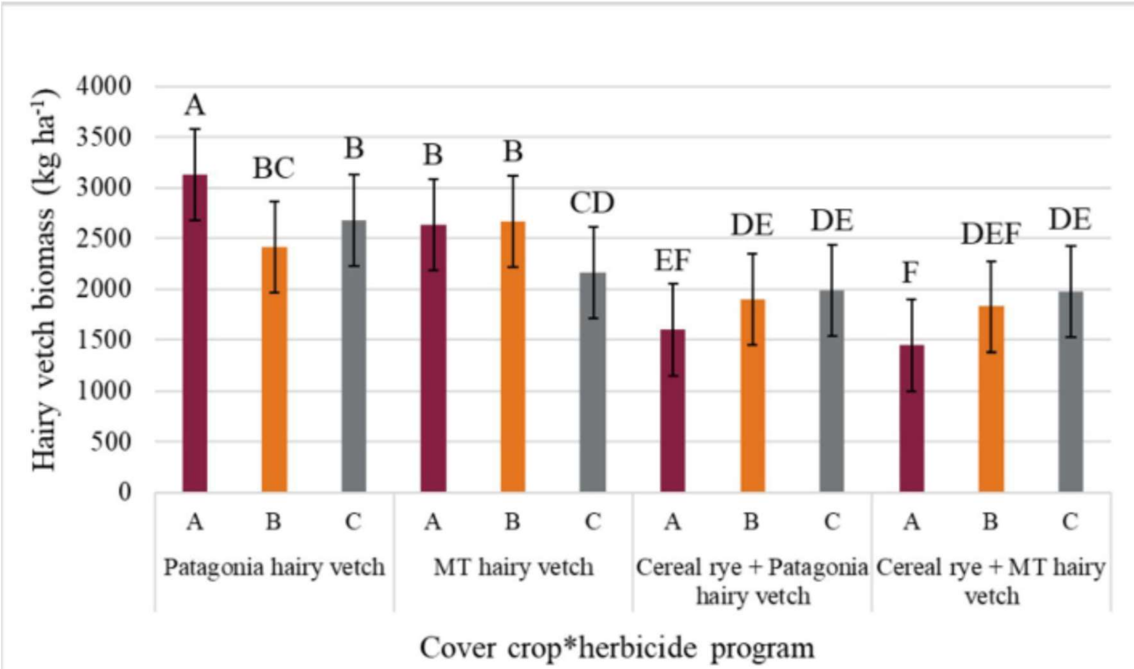
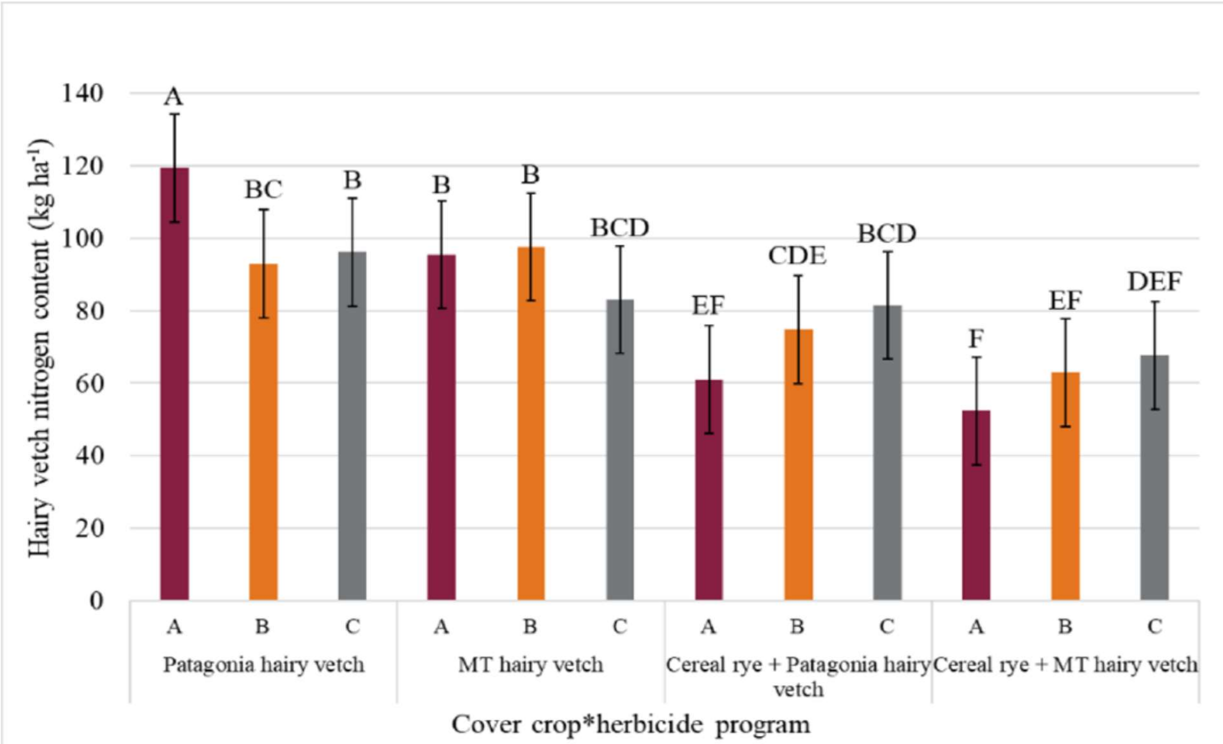


Figure 7. 1 month prior to corn planting hairy vetch biomass accumulation LS means (with SE bars) from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Orange bars indicate hairy vetch and cereal rye mixtures while maroon bars indicate hairy vetch monocultures.



Contrasts	Difference in Hairy Vetch Biomass	P value
	kg ha^{-1}	
Hairy vetch monocultures vs. hairy vetch + cereal rye mixtures	827	**< 0.001**
Monocultures with herbicide treatments B and C vs. mixtures with herbicide treatments B and C	560	**< 0.001**
Herbicide treatment B vs. herbicide treatment C	0	1.00
Mixtures with herbicide treatment B vs. mixtures with herbicide treatment C	-120	0.306
Monocultures with herbicide treatment B vs. monocultures with herbicide treatment C	120	0.306

Figure 8. At corn planting hairy vetch biomass LS means (with SE bars) for the interaction between cover crop and herbicide program and contrast statements from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Maroon bars indicate herbicide program A (no selective cereal rye termination), orange bars indicate herbicide program B (selective cereal rye termination clethodim in 50/50 water/28% UAN), and grey bars indicate herbicide program C (selective cereal rye termination with clethodim in water with non-ionic surfactant at 0.25% v v^{-1}).



Contrasts	Difference in Hairy Vetch Nitrogen Content	P value
	kg ha^{-1}	
Hairy vetch monocultures vs. hairy vetch + cereal rye mixtures	30.7	**< 0.001**
Monocultures with herbicide treatments B and C vs mixtures with herbicide treatments B and C	20.7	**< 0.001**
Herbicide treatment B vs herbicide treatment C	-5.4	0.275
Mixtures with herbicide treatment B vs mixtures with herbicide treatment C	-11.0	0.113
Monocultures with herbicide treatment B vs monocultures with herbicide treatment C	0.30	0.966

Figure 9. At corn planting hairy vetch nitrogen content LS means (with SE bars) for the interaction between cover crop and herbicide program and contrast statement from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Maroon bars indicate herbicide program A (no selective cereal rye termination), orange bars indicate herbicide program B (selective cereal rye termination clethodim in 50/50 water/28% UAN), and grey bars indicate herbicide program C (selective cereal rye termination with clethodim in water with non-ionic surfactant 0.25% at v v^{-1}).

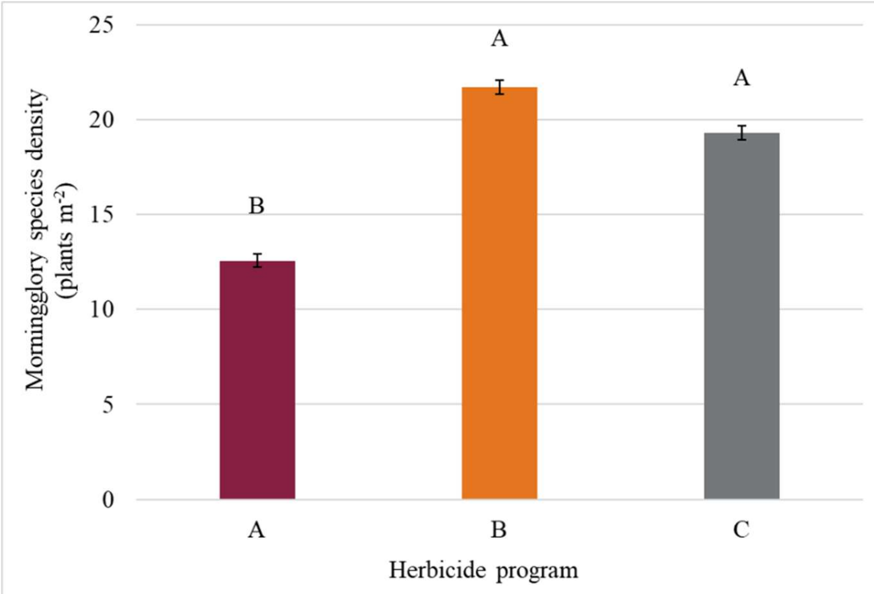


Figure 10. 1 month after corn planting morningglory species (ivyleaf and pitted morningglory) LS means (with SE bars) from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The maroon bar indicates herbicide program A (no selective cereal rye termination), the orange bar indicates herbicide program B (selective cereal rye termination clethodim in 50/50 water/28% UAN), and the grey bar indicates herbicide program C (selective cereal rye termination with clethodim in water with non-ionic surfactant at 0.25% v v^{-1}).

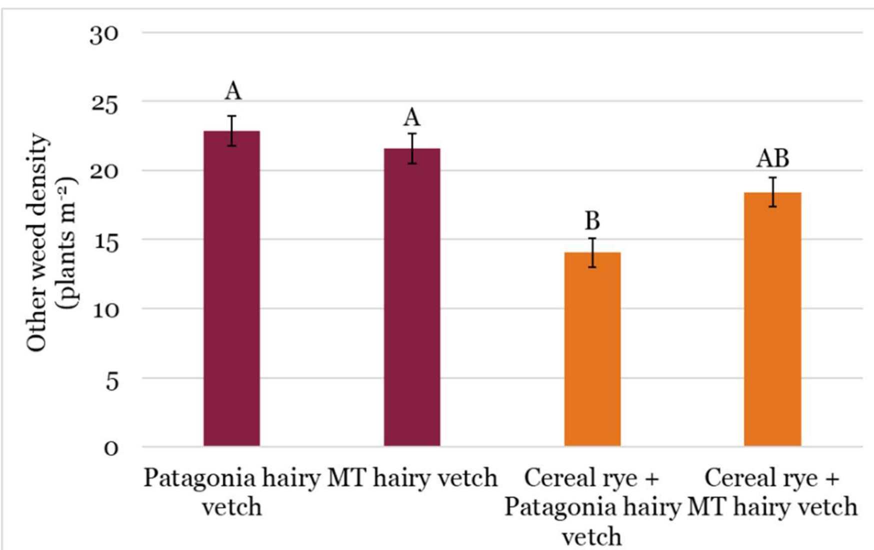
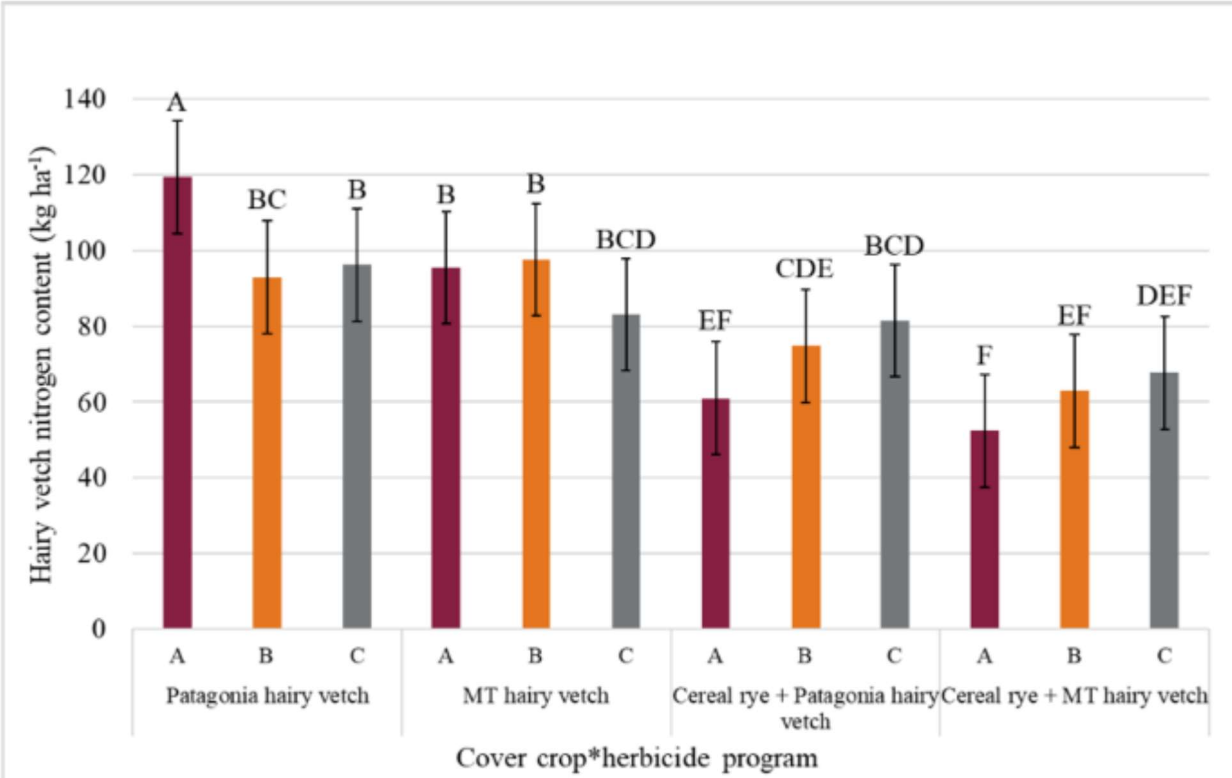


Figure 11. Other weed LS means (with SE bars) 1 month after corn planting from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Orange bars indicate hairy vetch and cereal rye mixtures while maroon bars indicate hairy vetch monocultures.



Contrasts	Difference in Total Weed Densities	P value
	Plants m^{-2}	
Hairy vetch monocultures vs. hairy vetch + cereal rye mixtures	0.00	1.00
Control vs selectively terminated treatments	0.54	**< 0.001**
Herbicide treatment B vs. herbicide treatment C	0.07	0.36
Mixtures with herbicide treatment B vs. mixtures with herbicide treatment C	0.09	0.37
Monocultures with herbicide treatment B vs. monocultures with herbicide treatment C	0.04	0.68

Figure 12. Total weed LS means (with SE bars) 1 month after corn planting for the interaction between cover crop and herbicide program from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Maroon bars indicate herbicide program A (no selective cereal rye termination), orange bars indicate herbicide program B (selective cereal rye termination clethodim in 50/50 water/28% UAN), and grey bars indicate herbicide program C (selective cereal rye termination with clethodim in water with non-ionic surfactant at 0.25% v v^{-1}).

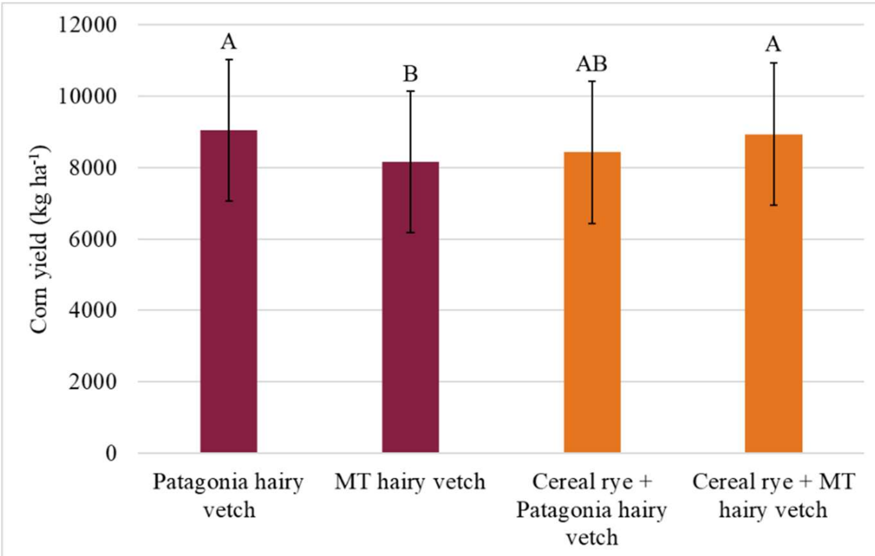


Figure 13. Corn yield LS means (with SE bars) from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Orange bars indicate hairy vetch and cereal rye mixtures while maroon bars indicate hairy vetch monocultures.

Discussion

At corn planting in mid-April, hairy vetch monocultures tended to have more hairy vetch biomass (2164 to 3123 kg ha^{-1}) compared to mixtures (1440 to 1986 kg ha^{-1}). Accordingly, hairy vetch monocultures typically accumulated greater N content (38.2 to 213 kg ha^{-1}) compared to mixtures (13.2 to 185 kg ha^{-1}). Weed densities were not influenced by cover crop for Palmer amaranth (*Amaranthus palmeri* S. Watson), common ragweed (*Ambrosia artemisiifolia* L.), morningglory (*Ipomoea* spp.), or large crabgrass (*Digitaria sanguinalis* L.) Scop.). However, for total weeds, contrast statements indicated no difference between hairy vetch in monoculture or mixture and that cover crop mixtures with selective termination of the cereal rye had greater weed density than those without selective termination. Corn yield did not show a difference between monocultures and mixtures. Ultimately, while the presence of cereal rye did not increase hairy vetch biomass or N content, weed densities and corn yield were similar regardless of cover crop or herbicide program.

Conclusion

Virginia farmers may be able to capitalize on state cover crop subsidies for cereal rye and mixtures while not risking hairy vetch biomass accumulation, N accumulation, or weed suppression with the use of this method.

Objective 3: Determining reduced herbicide inputs with hairy vetch before corn.

Background

This objective will evaluate the probability of success for 1, 2, or 3 pass corn herbicide programs in hairy vetch compared to cereal rye + hairy vetch and no cover crop. The hypothesis is that cereal rye will have the greatest probability for successful herbicide programs with fewer passes, followed by hairy vetch alone, followed by no cover.

Procedures

This experiment was a 4 by 3 factorial design with 3 cover crops and 5 herbicide programs. Cover crops included hairy vetch, cereal rye + hairy vetch, and a no cover crop. Herbicide programs included: (1) 1-pass Acuron + glyphosate 2 weeks prior to planting, (2) 1-pass Acuron + glyphosate at planting, (3) 2-pass Bicep II Magnum + glyphosate 2 weeks prior to planting followed by Halex GT when weeds are 4 inches or corn is 12 inches (whichever is earlier), (4) 2-pass Bicep II Magnum + glyphosate at planting followed by Halex GT when weeds are 4 inches or corn is 12 inches (whichever is earlier), and (5) 3-pass Glyphosate + 2,4-D 2 weeks prior to planting, Bicep II Magnum at planting, Halex GT when weeds are 4 inches or corn is 12 inches (whichever is earlier).

Cover crops were planted at Kentland Farm near Blacksburg, VA and at the Southern Piedmont Agricultural Research and Extension Center in Blackstone Virginia in Oct. 2023. On or about April 1st, 2 weeks prior to corn planting herbicide applications were made. Corn planting and at planting herbicide applications occurred on or about April 15th. On or about May 15th, herbicide applications were made as determined by weed height or corn size. On or about May 15th, weed density and number of weeds over 4 inches in height were quantified. On or about June 15th, the postemergent over-the-top herbicide applications were made and weed density and number of weeds >4 inches in height was quantified. Lastly, on or about Sept. 15th, corn harvest/yield data, weed density and number of weeds > 4 inches in height were quantified.

Table 1. Herbicide programs, timings, and rates for 1-, 2- and 3-pass programs evaluated in field experiments in Virginia in 2023 to 2025.

Time	Herbicide Programs				
	1: Planted Brown 1-pass	2: Planted Green 1-pass	3: Planted Brown 2-pass	4: Planted Green 2-pass	5: Planted Brown 3-pass
2 Weeks Prior to Planting	Acuron (*S*-metolachlor (1500 g ai ha^{-1}) + atrazine (701 g ai ha^{-1}) + mesotrione (168 g ai ha^{-1}) + bicyclopyrone (42 g ai ha^{-1}))[a]		Bicep II Magnum (atrazine (1826 g ai ha^{-1}) + *S*-metolachlor (1414 g ai ha^{-1}))[a]		Glyphosate (1262 g ae ha^{-1})
	Glyphosate (1262 g ae ha^{-1})[a]		Glyphosate (1262 ae g ha^{-1})		2,4-D LV4 (533 g ae ha^{-1})[a]
At Planting		Acuron (*S*-metolachlor (1500 g ai ha^{-1}) + atrazine (701 g ai ha^{-1}) + mesotrione (168 g ai ha^{-1}) + bicyclopyrone (42 g ai ha^{-1}))		Bicep II Magnum (atrazine (1826 g ai ha^{-1}) + *S*-metolachlor (1414 g ai ha^{-1}))	Bicep II Magnum (atrazine (1826 g ai ha^{-1}) + *S*-metolachlor (1414 g ai ha^{-1}))
		Glyphosate (1262 g ae ha^{-1})		Glyphosate (1262 ae g ha^{-1})	Glyphosate (1262 ae g ha^{-1})

Postemergence when corn is 30 cm tall			Halex GT (*S*-metolachlor (1055 g ai ha^{-1}) + glyphosate (1055 g ae ha^{-1}) + mesotrione (106 g ai ha^{-1}))[a]	Halex GT (*S*-metolachlor (1055 g ai ha^{-1}) + glyphosate (1055 g ae ha^{-1}) + mesotrione (106 g ai ha^{-1}))	Halex GT (-metolachlor (1055 g ai ha^{-1}) + glyphosate (1055 g ae ha^{-1}) + mesotrione (106 g ai ha^{-1}))

[a]Sources of manufacturing include Syngenta (Acuron, Bicep II Magnum, Halex GT), Bayer CropScience (Roundup Powermax 3), and Winfield United (2,4-D LV).

Results

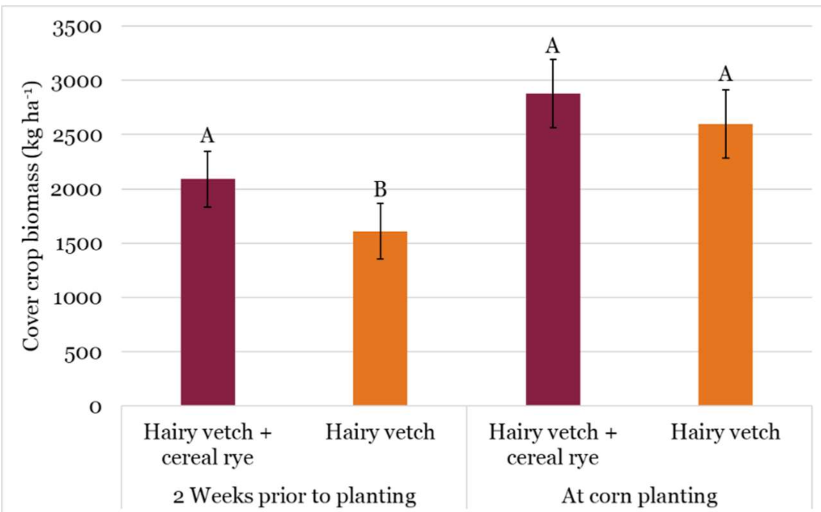


Figure 14. Cover crop biomass 2 weeks prior to corn planting ("planting brown") and at corn planting ("planting green") LS means (with SE bars) by sampling timing from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$) within each sample timing.

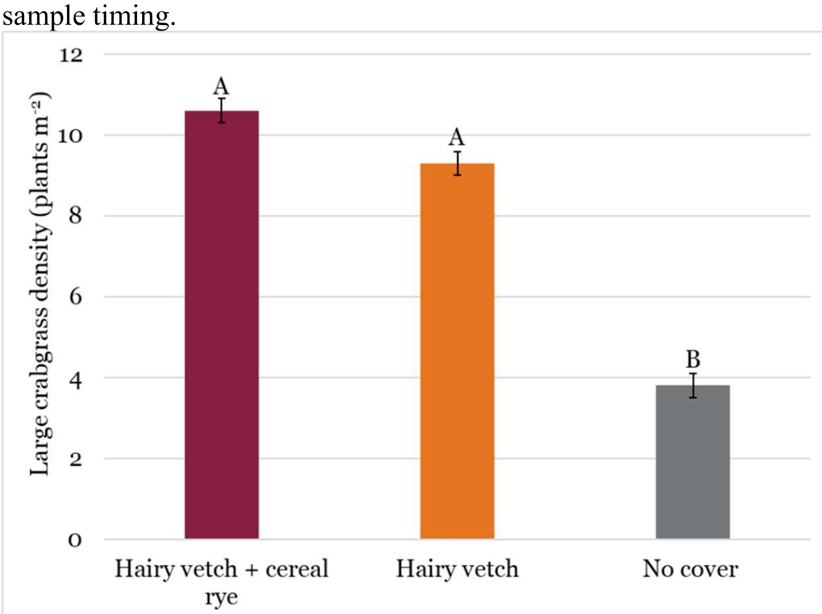


Figure 15. Large crabgrass LS means (with SE bars) 1 month after corn planting by cover crop from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test (p ≤ 0.05).

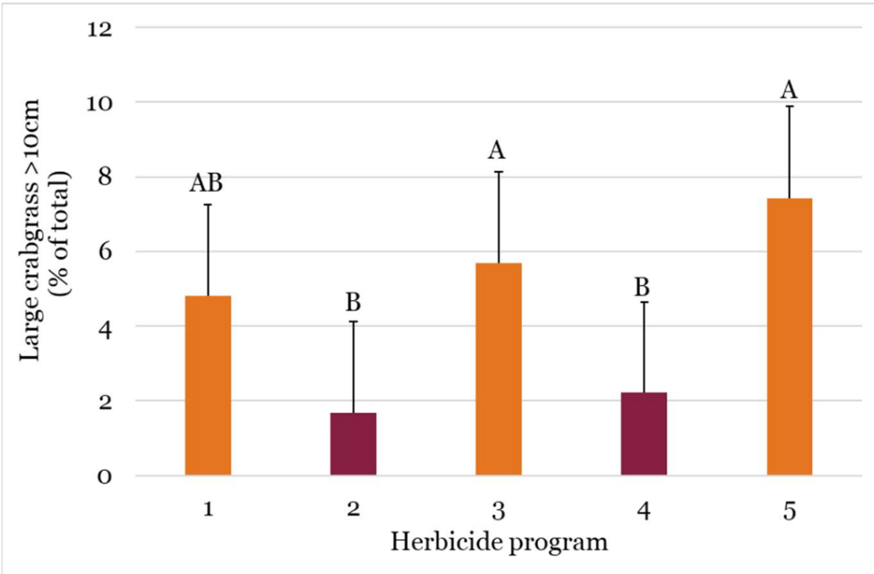


Figure 16. Proportion of large crabgrass >10 cm 1 month after corn planting by herbicide program. Data are LS means (with SE bars) from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test (p ≤ 0.05). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

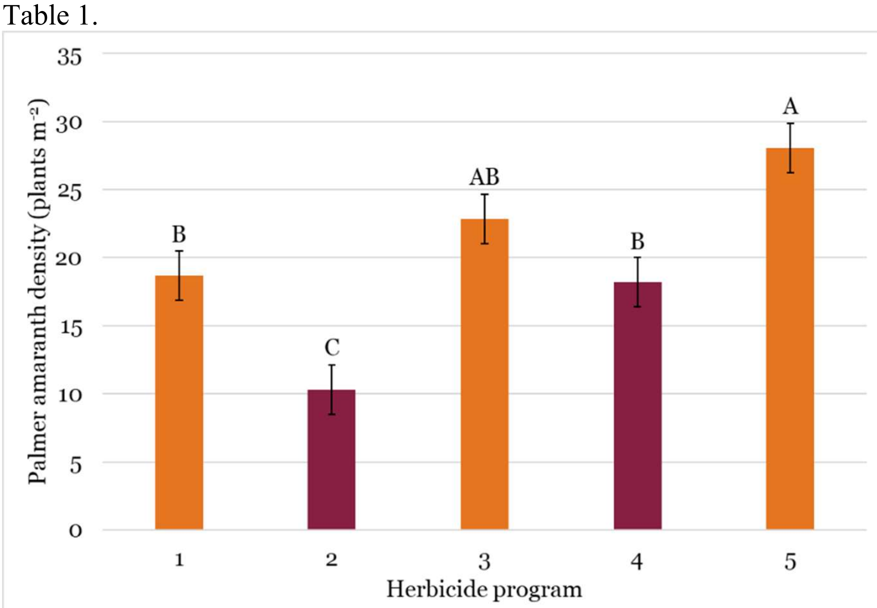


Figure 17. Palmer amaranth LS means (with SE bars) 1 month after corn planting by herbicide program. Data are from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test (p ≤ 0.05). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

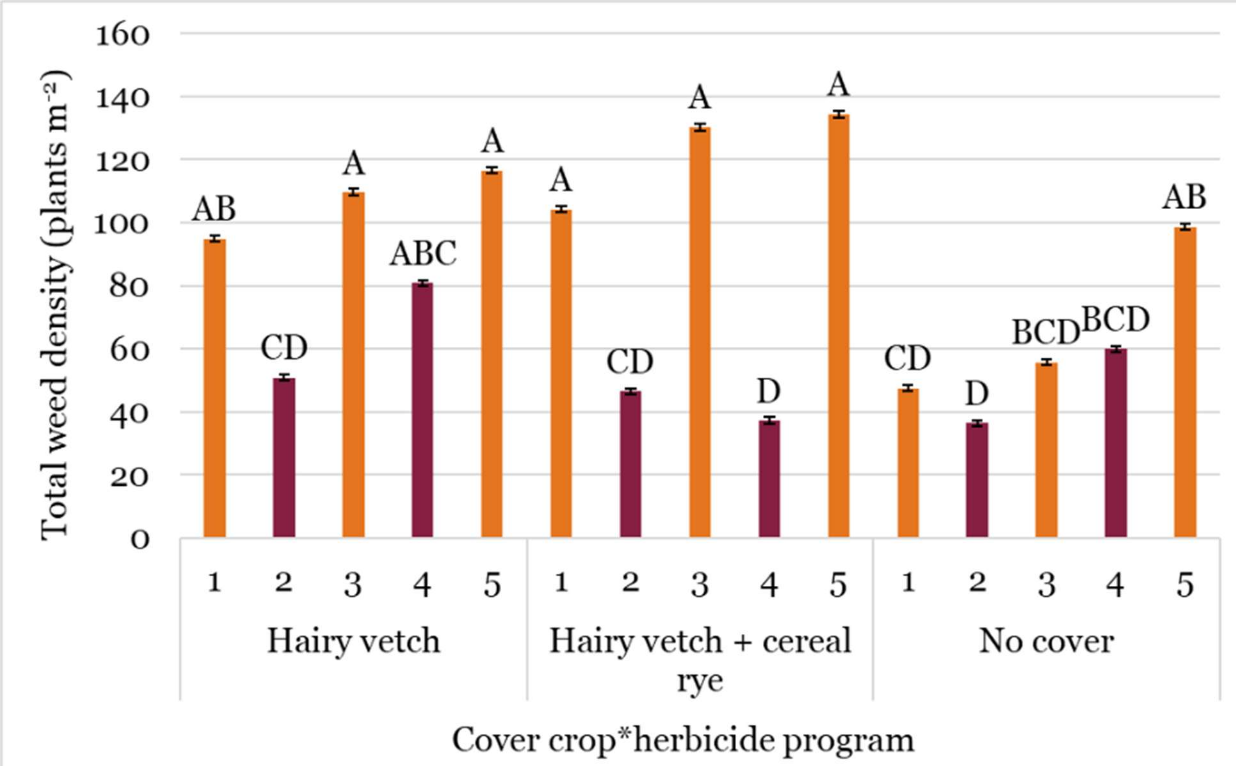


Figure 18. Total weed LS means (with SE bars) 1 month after corn planting by the interaction between cover crop and herbicide program. Data are from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

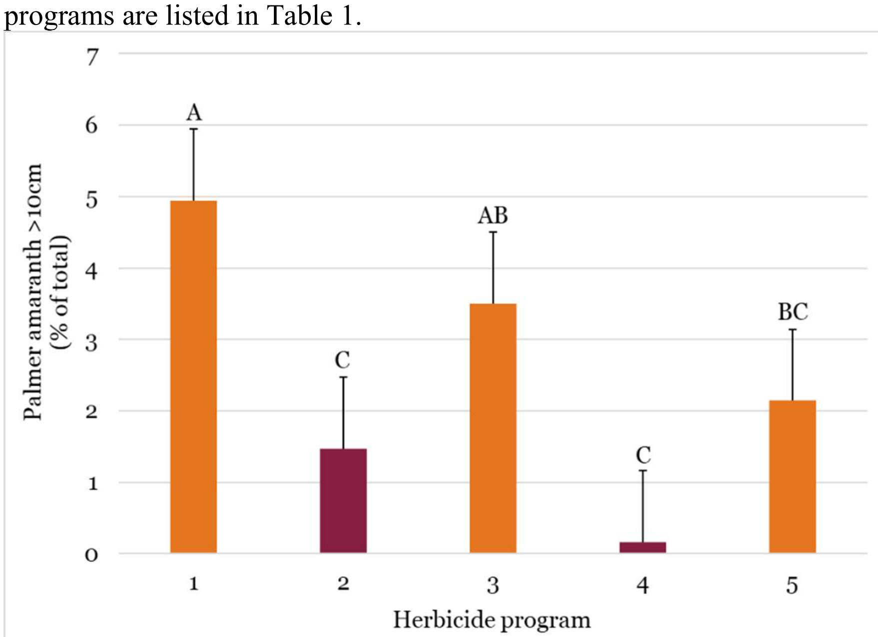


Figure 19. Proportion of Palmer amaranth >10 cm 1 month after corn planting by herbicide program. Data are LS means (with SE bars) from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

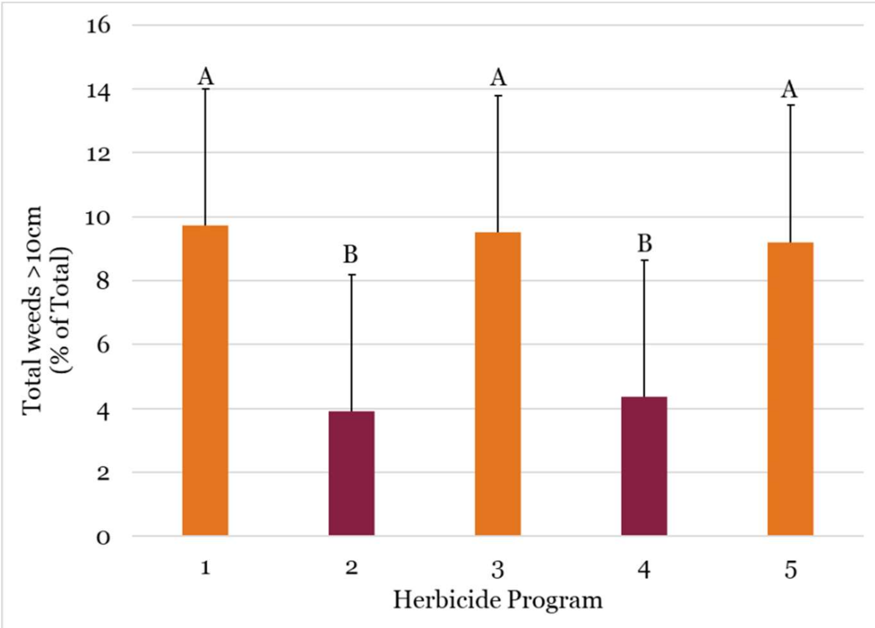


Figure 20. Proportion of total weeds >10 cm 1 month after corn planting by herbicide program Data are LS means (with SE bars) from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

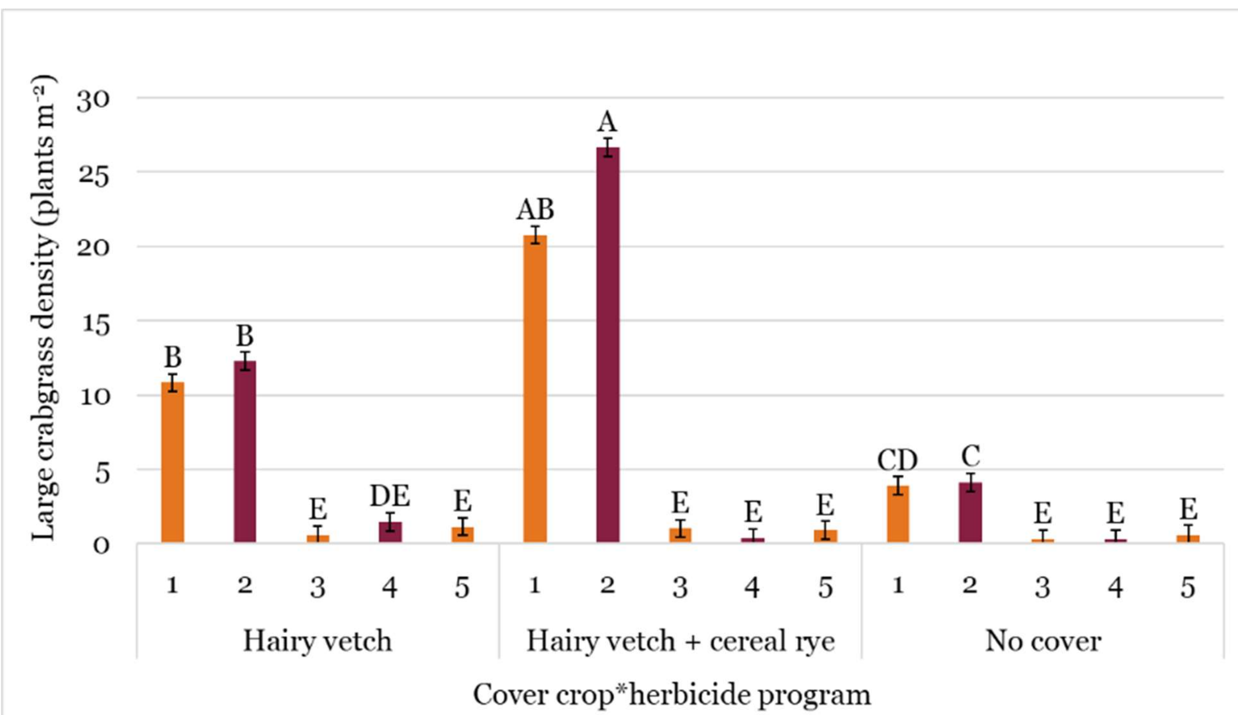


Figure 21. Large crabgrass density 2 months after corn planting by the interaction between cover crop and herbicide program. Data are LS means (with SE bars) from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

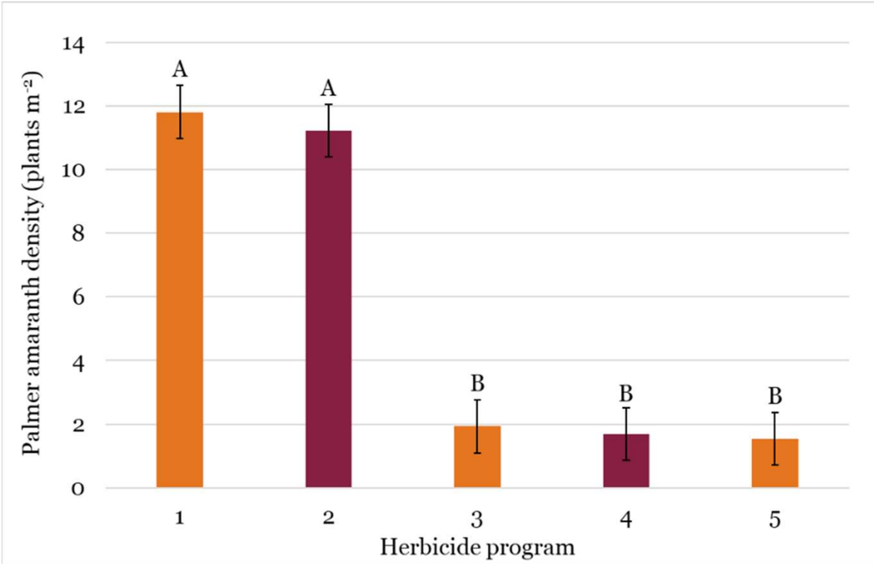


Figure 22. Palmer amaranth LS means (with SE bars) 2 months after corn planting by herbicide program. Data are from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

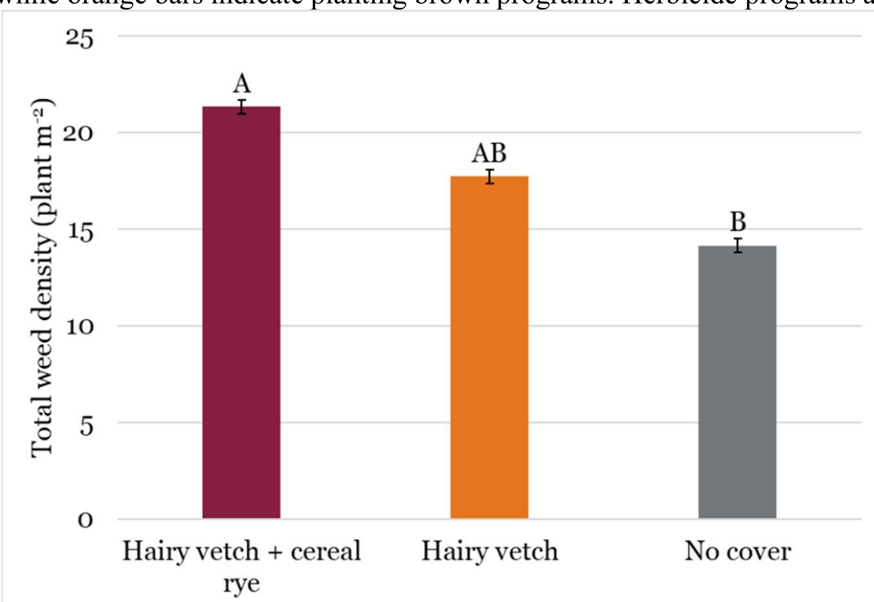


Figure 23. Total weed LS means (with SE bars) 2 months after planting from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$).

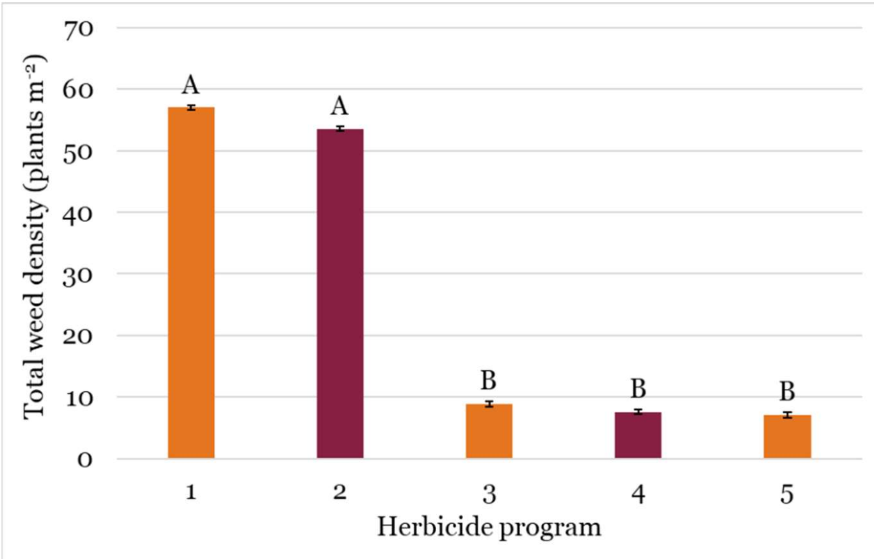


Figure 24. Total weed density (with SE bars) 2 months after corn planting by herbicide program. Data are from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

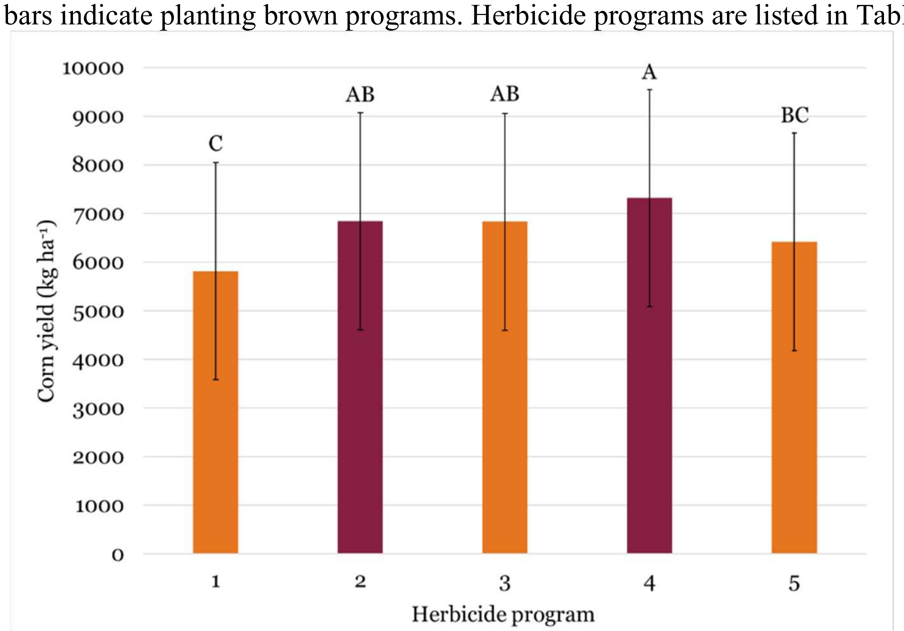


Figure 25. Corn yield LS means (with SE bars) by herbicide program from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The maroon bars indicate planting green herbicide programs while orange bars indicate planting brown programs. Herbicide programs are listed in Table 1.

Discussion

Across 4 site-years in Virginia, cover crop biomass levels ranged from 500 to 4620 kg ha^{-1} at corn planting. One month after corn planting, planting green herbicide programs were within the top performing groups for Palmer amaranth (*Amaranthus palmeri* S. Watson) density as well as the proportion of large crabgrass (*Digitaria sanguinalis* (L.) Scop.), Palmer amaranth, and total weeds >10 cm in height. Planting green programs also provided greater total weed suppression compared to planting brown programs, regardless of cover crop. But compared to either cover crop, no cover provided better large crabgrass density reduction. 2 months after corn planting, both 1-pass programs provided less weed control compared to the 2-pass and 3-pass programs. At this time, no cover had lower weed densities than cover crops. Corn yield was greatest from the 1-pass green and 2-pass herbicide programs and was not influenced by cover crop treatment.

Conclusion

Overall, 2-pass herbicide programs in hairy vetch optimized weed suppression, corn yield, and net returns.

Objective 4: Evaluate black oats as a cover crop for weed suppression in corn.

Background

This objective will compare black oats and cereal rye for cover crop characteristics (C:N and lignin content) as well as evaluate weed suppression in corn. The hypothesis is that there are not difference between these grass species for the stated purposes.

Procedures

This experiment evaluated 4 cover crop treatments: (1) black oats, (2) cereal rye, (3) black oats + hairy vetch, and (4) cereal rye + hairy vetch. Cover crops were planted at Kentland Farm near Blacksburg, VA and at the Southern Piedmont Agricultural Research and Extension Center in Blackstone Virginia in Oct. 2023. Cover crops were terminated on or about April 15th and corn planted on or about May 1st. 4 weeks after planting a postemergent herbicide were applied.

Data collection included ground cover on Dec. 1, April 1, April 15, and May 1. Cover crop biomass, C:N ratio, and lignin content on April 1, April 15, and May 1. Weed suppression in corn was evaluated 2 and 4 weeks after planting. Weed density, biomass and number of plants above 4 inches in height was quantified 4 weeks after planting.

Results

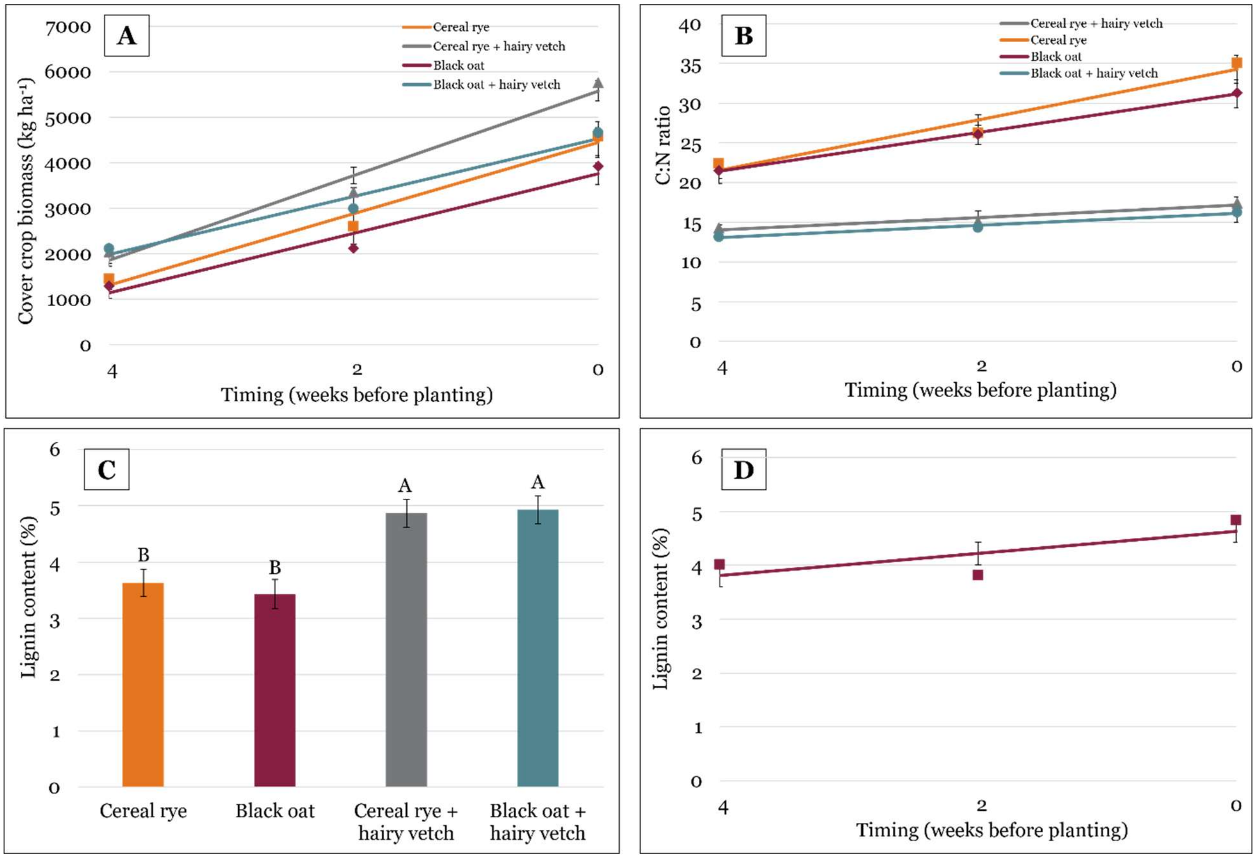


Figure 26. Cover crop biomass (A), C:N ratio (B), lignin content (C), and green cover (D) from field experiments in Virginia in 2023 to 2025. When a significant interaction of cover crop by sampling timing was significant, regression lines are displayed with LS means and SE bars at 4 weeks prior to, 2 weeks prior to, and at cash crop planting B.

A) Biomass regression equations are as follows: 1. cereal rye biomass = 4446 – 785*timing ($p<0.001$; $R^2=0.65$); 2. cereal rye + hairy vetch biomass = 5574 – 929*timing ($p<0.001$; $R^2=0.80$); 3.The black oat LS means from 4 weeks prior, 2 weeks prior, and at corn planting are 1313.9, 2207.9, and 3932.1 kg ha^{-1}, respectively. The biomass = 3759 – 655*timing ($p<0.001$; $R^2=0.67$); 4. black oat + hairy vetch LS means from 4 weeks prior, 2 weeks prior, and at corn planting are 2115, 2991, and 4660 kg ha^{-1}, respectively. = 4528 – 636*timing ($p<0.001$; $R^2=0.49$).

B) Significant regressions for C:N ratio by the three sample timings. C:N ratio regression equations are as follows: 1. cereal rye + hairy vetch's C:N ratio =34.2 – 3.18*timing ($p<0.001$; $R^2=0.49$); 2. cereal rye C:N ratio = 17.2 – 0.79*timing ($p=0.013$, $R^2=0.13$); black oat C:N ratio =31.2-1.35*timing ($p<0.001$; $R^2=0.32$); black oat + hairy vetch C:N ratio = 16.1 – 0.77*timing ($p = 0.005$; $R^2=0.16$).

C) Lignin content at corn planting LS means (with SE bars) by cover crop program. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$).

D) Lignin content (with SE bars) by time regression. Regression equation is as follows: Lignin content = 4.6 – 0.20*timing ($p=0.013$; $R^2=0.03$).

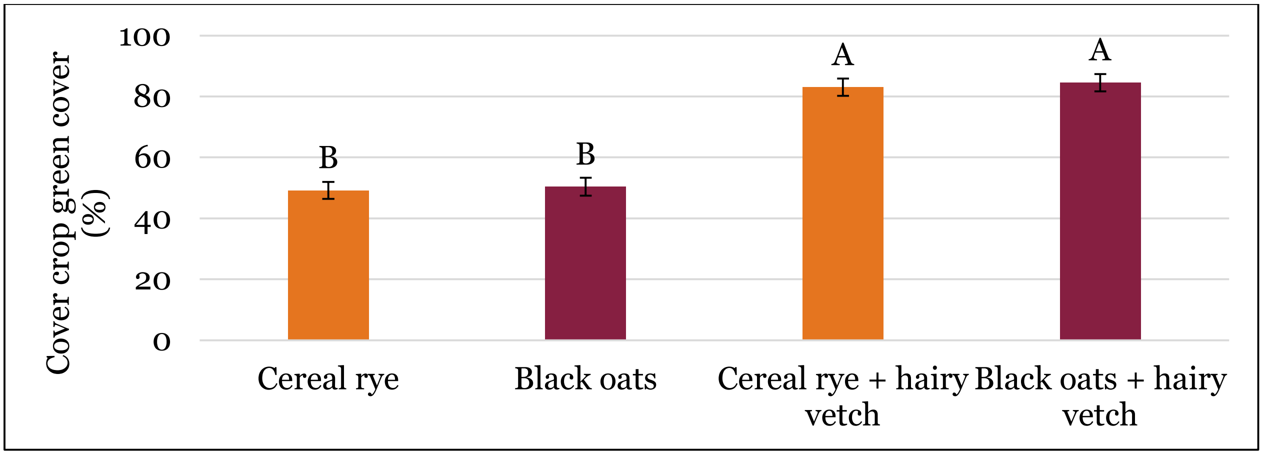


Figure 27. Green cover at corn planting LS means (with SE bars) by cover crop program. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Orange bars indicate cereal rye monocultures or mixtures while maroon bars indicate black oat monocultures or mixtures.

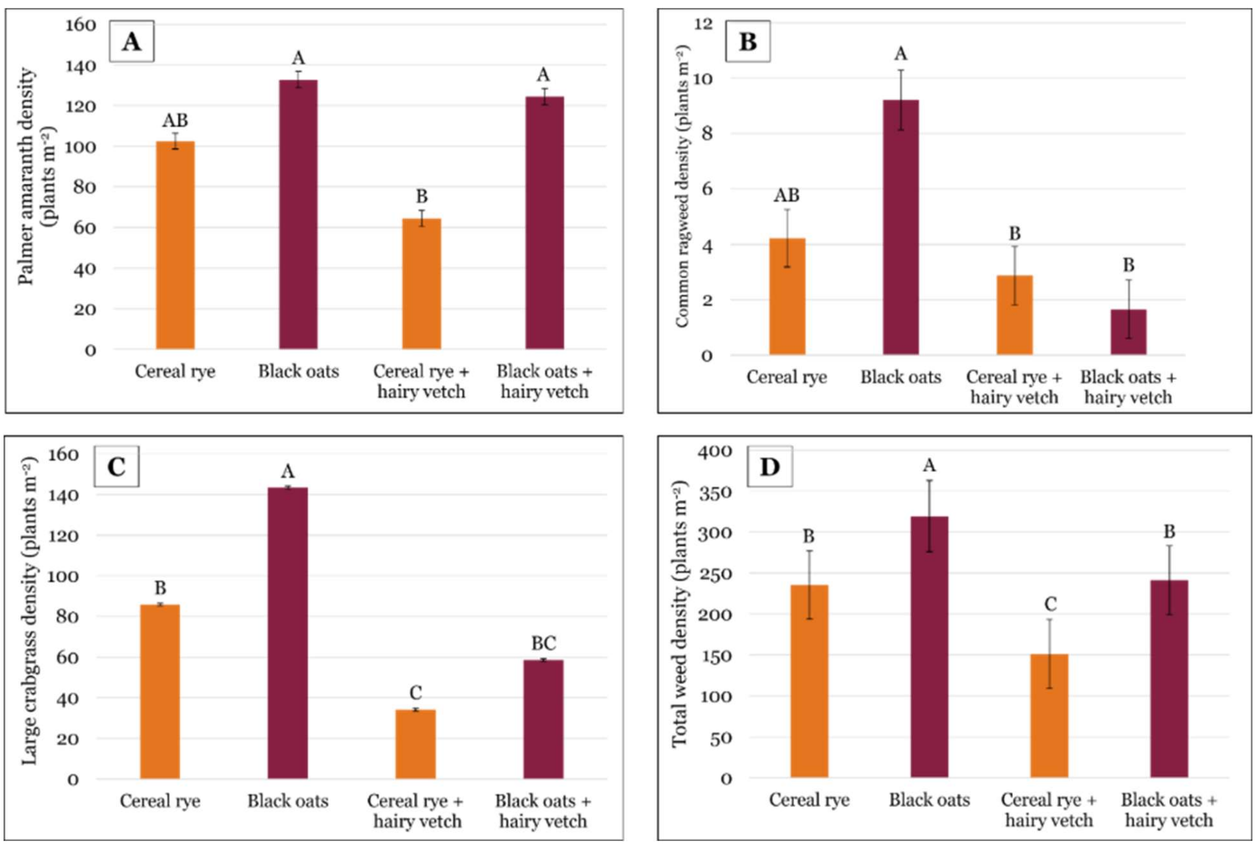


Figure 28. Significant LS means (with SE bars) by cover crop for Palmer amaranth (A), common ragweed (B), large crabgrass (C), and total weeds (D). Data from each graph were taken from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$) for each individual figure. Orange bars represent cereal rye monocultures or mixtures while maroon bars indicate black oat monocultures or mixtures.

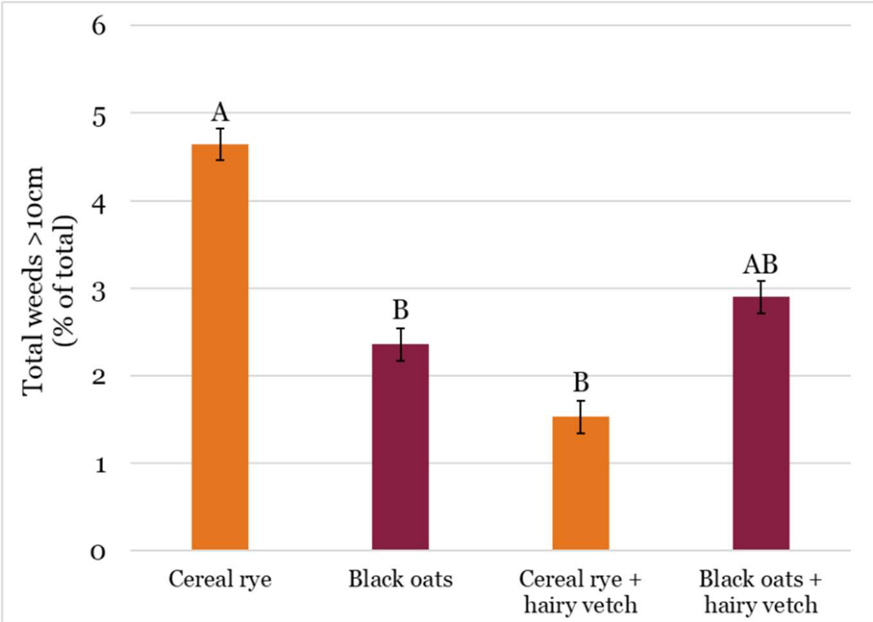


Figure 29. LS means (with SE bars) of total weeds >10 cm by cover crop program from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Orange bars indicate cereal rye monocultures or mixtures while maroon bars indicate black oat monocultures or mixtures.

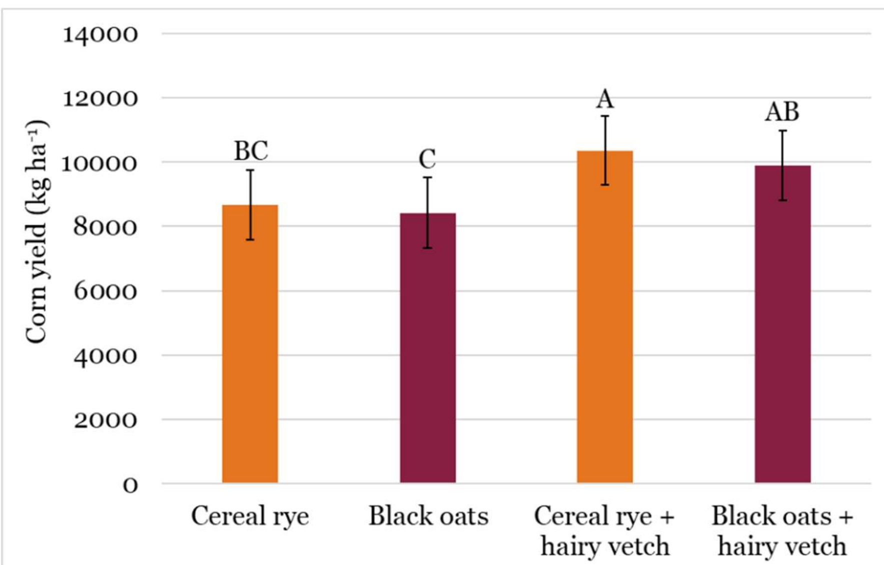


Figure 30. Corn yield LS means (with SE bars) by cover crop program from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). Orange bars indicate cereal rye monocultures or mixtures while maroon bars indicate black oat monocultures or mixtures.

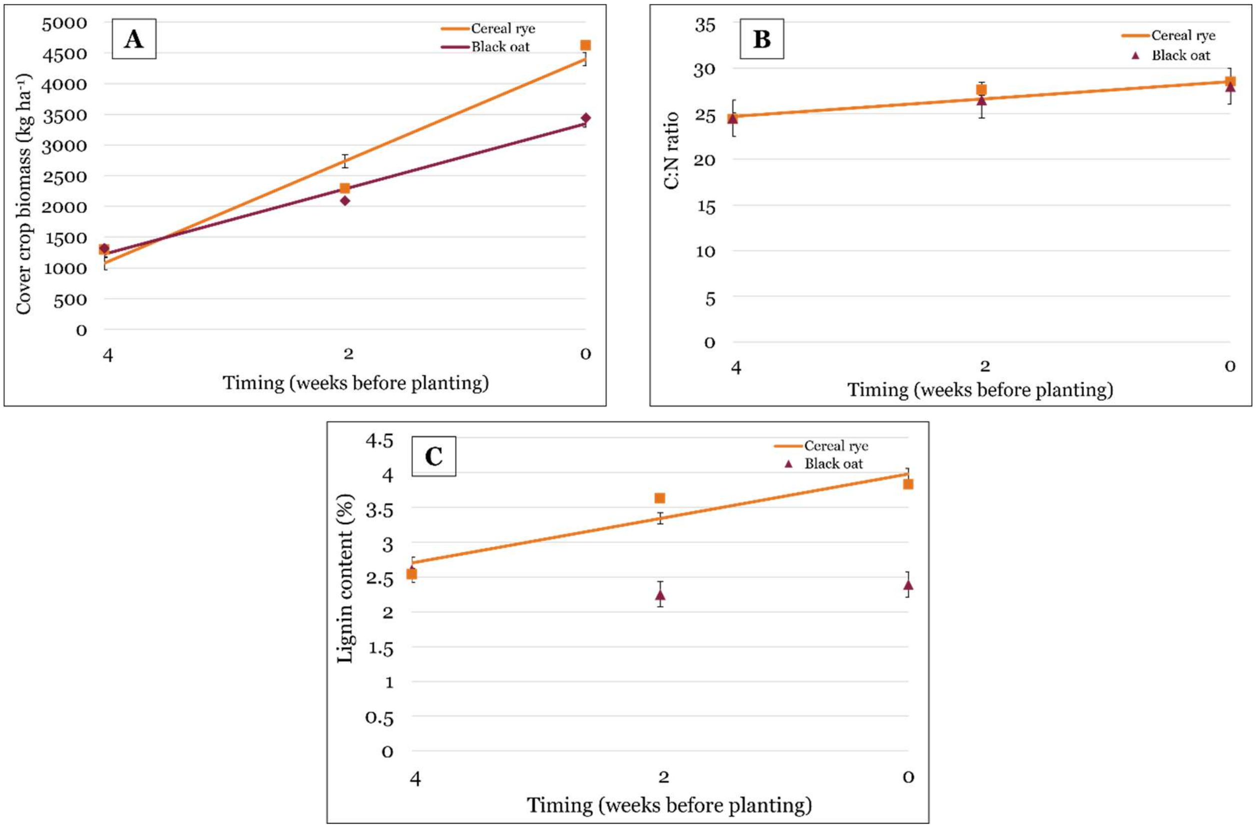


Figure 31. Significant regression lines (with SE bars) by 4 weeks prior to, 2 weeks prior to, and at cash crop planting. Data from each graph were taken from field experiments in Virginia in 2023 to 2025.
A) Cover crop biomass regression equations are as follows: 1. cereal rye biomass = 4400 - 831*timing ($p<0.001$; $R^2=0.57$); 2. black oat biomass = 3347 - 530*timing ($p<0.001$; R2=0.64).
B) Cover crop C:N ratio regression equation is as follows: cereal rye + hairy vetch biomass = 28.5 - 0.95*timing ($p=0.015$; $R^2=0.06$). Black oat LS means (with SE bars) are included in the figure and are as follows for 4 weeks prior to, 2 weeks prior to, and at soybean planting, respectively: 24.51, 26.5, and 28.
C) Significant cereal rye lignin content regression from field experiments in Virginia in 2023 to 2025. Timings are in weeks before planting. The cereal rye regression equation is as follows: cereal rye lignin content (%) =4.62-0.47*timing ($p=0.001$; $R^2=0.21$). Black oat LS means (with SE bars) are included in the figure and are as follows for 4 weeks prior to, 2 weeks prior to, and at soybean planting, respectively: 2.60%, 2.25%, and 2.40%.

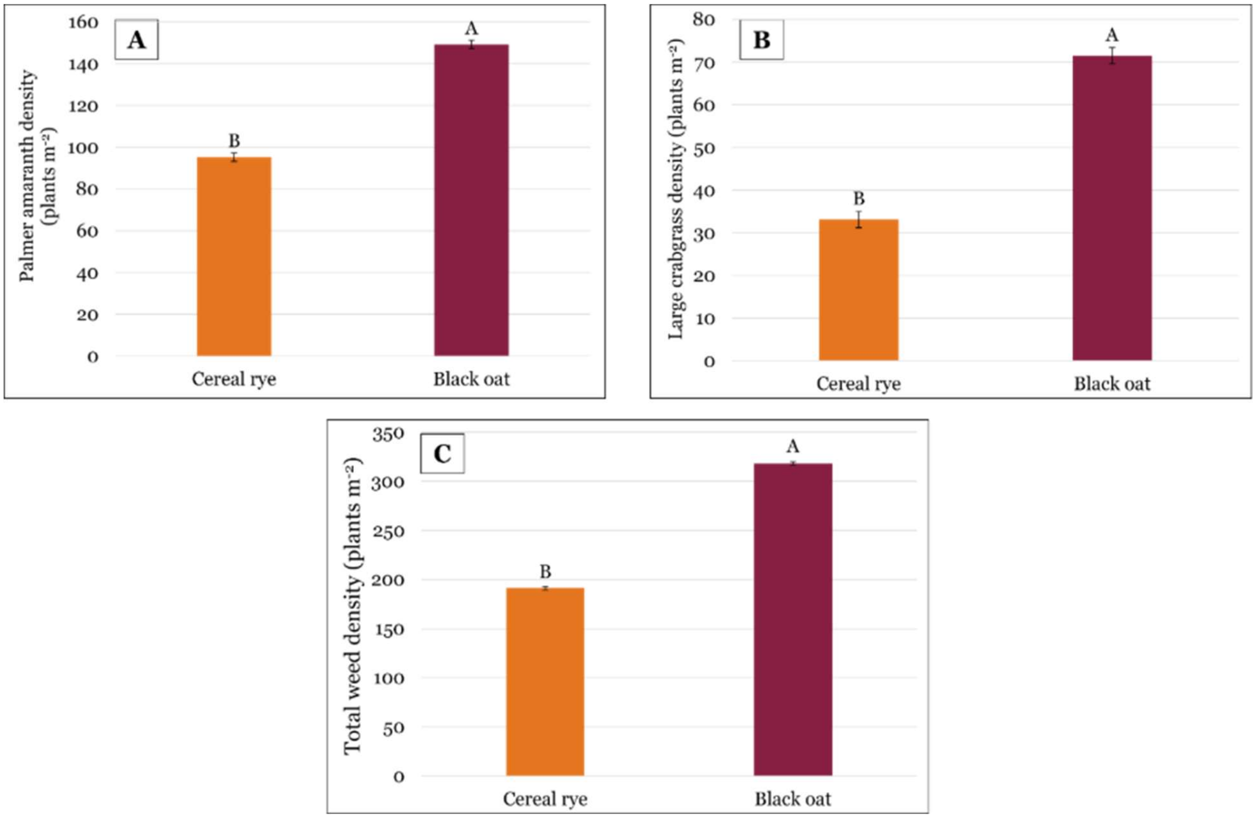


Figure 3.6. A). Palmer amaranth density averages by cover crop from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p \leq 0.05$). The orange bar indicates a cereal rye cover crop while the maroon bar indicates black oats cover crop.
B). Large crabgrass density averages by cover crop from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p<0.05$). The orange bar indicates a cereal rye cover crop while the maroon bar indicates black oats cover crop.
C). Total weed density averages by cover crop from field experiments in Virginia in 2023 to 2025. Letters indicate significant differences according to Student's T-test ($p<0.05$). The orange bar indicates a cereal rye cover crop while the maroon bar indicates black oats cover crop.

Discussion

Cover crop biomass data demonstrated that cereal rye containing treatments accumulated more biomass at cash crop planting compared to treatments containing black oats. Both grasses had similar C:N ratios at planting (around 28:1). However, when hairy vetch was added, the C:N ratios were <25:1. Cover crop lignin content followed a similar trend. Green cover results demonstrated that black oat and cereal rye provided comparable coverage, but mixtures had greater overall coverage. Black oat containing treatments typically provided less weed suppression than cereal rye containing treatments for Palmer amaranth (*Amaranthus palmeri* S. Watson), common ragweed (*Ambrosia artemisiifolia* L.), large crabgrass (*Digitaria sanguinalis* L. Scop.), and total weeds.

Conclusion

While black oats are comparable to cereal rye in terms of C:N ratio, lignin content, and green cover, cereal rye accumulates more biomass resulting in greater weed suppression. Thus, farmers may still be inclined to utilize a cereal rye monoculture or mixture as a winter cover crop.

Objective 5. Disseminate findings and best practices through Extension.

Research findings of this and previously funded work were disseminated to audiences throughout Virginia as relevant through Dr. Flessner's extension program. In 2025, this included 14 presentations reaching an audience of >650. Extension presentations per year, updating the Virginia Cooperative Extension Pest Management Guide for Field Crops and the Mid-Atlantic Field Crop Weed Management Guide, and numerous direct communications.

Personnel/Facilities:

Michael L. Flessner, Associate Professor and Extension Weed Science Specialist
Phone: 540-315-2954
Email: flessner@vt.edu
Jenna Beville, Graduate Research Assistant

Virginia Tech, School of Plant and Environmental Sciences
675 Old Glade Rd., Blacksburg, VA 24061

Facilities utilized and owned by Virginia Tech include Kentland Farm in Blacksburg, VA, and the Glade Road Research Facility in Blacksburg, VA. Grower fields and other Virginia Tech facilities will be used as necessary.

Other Entities and Sources of Funds: The Hatch Program of the National Institute of Food and Agriculture, U.S. Department of Agriculture will provide financial support in the form of Dr. Flessner's salary and the Virginia Agricultural Experiment Station. This work may also be supported by various agrochemical companies, federal grants, and commodity boards.

Submitted by:

Signature:
Printed Name: Michael Flessner
Title: Professor and Extension Weed Science Specialist
Virginia Tech (Virginia Polytechnic Institute and State University)