Evaluation of Variable Input Level Weed Control Programs in Wheat

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Introduction

Winter annual weeds including common chickweed, henbit, purple deadnettle, marestail, and Italian (annual) ryegrass pose continuous threats to Kentucky wheat acres. Several of these weeds have become herbicide resistant in Kentucky wheat acres including recent confirmations of glyphosate and pinoxaden resistance in Italian (annual) ryegrass. Depending on the level of weed infestation the number of herbicide inputs can be variable, and number of herbicide applications can range from one to three applications.

Kentucky wheat growers strive to grow the highest yielding and quality wheat, and this includes maximizing their herbicide inputs. Although, with current commodity prices and poor weather conditions producers are continually looking to spend less on inputs while maintaining the level of high yielding wheat traditionally grown in Kentucky. The numerous options and timing of herbicide applications in wheat brings about the question of how to maximize weed control while reducing inputs, all while minimizing risk of herbicide resistance selection.

Materials and Methods

The experiment was established at the University of Kentucky Research and Education Center in Princeton, Kentucky in 2019. The field site had a natural infestation of winter annual broadleaves as well as an annual ryegrass population that was introduced in the fall of 2018. Pioneer 26R10 wheat was planted on October 25, 2019 at a rate of 109 lb/a at a depth of 1 inch.

Application Timing [*Application Date*]	Herbicide(s)	Rate
Preemergence (PRE) [*Oct 25, 2019*]	Roundup Powermax (No Residual)	32 fl oz/A
	Roundup PowerMax + Finesse Cereal and Fallow	32 fl oz/A + 0.5 oz/A
	Roundup PowerMax + Anthem Flex	32 fl oz/A + 3 oz/A
Early Postemergence (EPOST) [*Dec 20, 2019*]	No EPOST Application	-
	Axial XL	16.4 fl oz/A
Spring Postemergence (SPRING) [*Mar 10, 2020*]	No SPRING Application	-
	Harmony Extra	0.9 oz/A
	Quelex	0.75 oz/A

The research trial design was a factorial design with three factors laid out in a randomized complete block with four replications. The three factors included preemergence application, early postemergence application, and spring postemergence application. Herbicides and herbicide rates that were applied for each factor are listed in Table 1. The preemergence herbicide application was applied on Oct 25, 2019, the early postemergence herbicide application was applied on Dec 20, 2019, and the spring postemergence application was made on March 10, 2020. All treatments were applied with compressed CO_2 pressurized hand booms calibrated to deliver an output of 15 gallons per acre.

Table 1. Herbicide trade name products and rates for each application timing factor as well as application date.

Densities of all weed species per ft^2 were taken on March 31, 2020 or three weeks after the spring herbicide applications. Ryegrass seed head density per m^2 was taken on June 10, 2020 prior to wheat harvest. Seed heads were collected during the density counts and then thrashed, cleaned, and finally counted resulting in ryegrass seed production per m^2. Wheat yield was collected using a small plot research combine on June 25, 2020.

Results

Winter Annual Density

The density of winter annual weed species excluding Italian (annual) ryegrass was collected three weeks after the spring herbicide application. Densities within the treatments ranged from zero to seven plants per ft^2 (Figure 1). The selection of preemergence herbicide had the greatest influence on winter annual weed density in the spring (P=0.0004), while all other factors and interactions of factors did not show a significant influence on densities. The use of Finesse Cereal and Fallow preemergence resulted in the lowest overall densities, 0.5 plants / ft^2, and was significantly lower than Roundup PowerMax or no residual herbicide (Table 2). The effectiveness of Finesse Cereal and Fallow for season long weed control can be further emphasized when observing Figure 1 and comparing all Finesse C&F treatments with and without postemergence applications. The other residual herbicide evaluated, Anthem Flex, had similar winter annual densities to the Finesse C&F, but also similar densities in the Roundup PowerMax (no residual) treatments (Table 2).

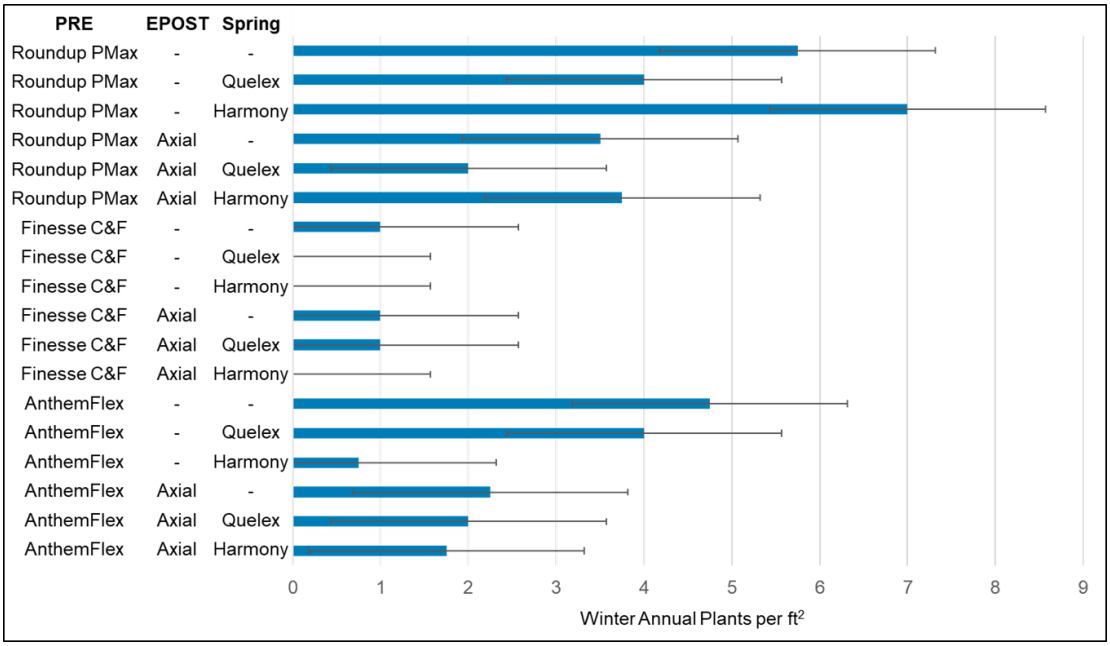

Figure 1. Winter annual weed density (excluding Italian ryegrass) in the spring as influenced by preemergence, early postemergence, and spring postemergence herbicide applications.

Preemergence Herbicide	Winter Annuals / ft^{2a}
Roundup PowerMax (No Residual)	4 A
Anthem Flex	3 AB
Finesse C&F	0.5 B

[a] Means followed by the same letter are NOT significantly different.

Table 2. Influence of preemergence herbicide application on winter annual weed density (excluding Italian ryegrass) in the spring.

Italian (Annual) Ryegrass Density and Seed Production

Italian ryegrass or annual ryegrass density per 1ft^2 was collected three weeks after the spring applications on March 31, 2020. Treatment densities ranged from 0.5 to 15 ryegrass plants per ft^2 (Figure 2). Analysis of variance of all factors and interactions of factors showed that only the early postemergence application had significant impact on density in the spring (P<0.0001). The application of Axial XL at the early postemergence application resulted in 2 plants per ft^2 as compared to plots not receiving an early postemergence application at 7 plants per ft^2 (Table 3).

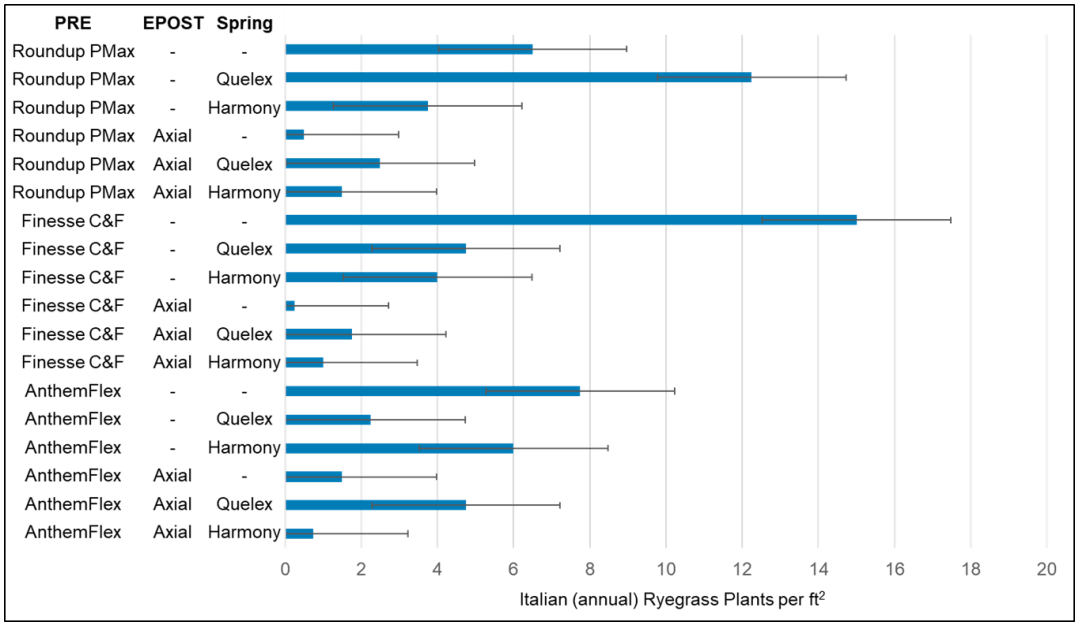

Figure 2. Italian (annual) ryegrass density in the spring as influenced by preemergence, early postemergence, and spring postemergence herbicide applications.

Early Postemergence Herbicide	Ryegrass Plants/ ft^{2a}
No EPOST	7 A
Axial XL	2 B

[a] Means followed by the same letter are NOT significantly different. Tukey HSD α=0.05.

Table 3. Influence of early postemergence herbicide application on Italian (annual) ryegrass density in the spring.

Ryegrass seed production at the end of the season was taken prior to harvest on June 10, 2020. Seed production ranged from 14 to 11,000 ryegrass seeds per m^2. A significant interaction of preemergence and early postemergence factors was found when conducting an analysis of variance (P<0.0001). Further analysis of the two factors revealed, as would be expected, that Roundup PowerMax (No residual) with no early postemergence application resulted in the greatest seed production at 10,000 seeds per m^2 (Figure 3). In comparison all treatments receiving an early postemergence application of Axial XL resulted in the lowest seed production, which again would be expected and aligns with the spring density results. Additionally, the use of Anthem Flex preemergence without Axial XL at early postemergence resulted in a significant reduction of seed as compared to the Roundup PowerMax (no residual) without an early postemergence application (Figure 3). The application of Anthem Flex preemergence was also similar to all treatments receiving an early postemergence application of Axial XL, regardless of preemergence herbicide applied (Figure 3).

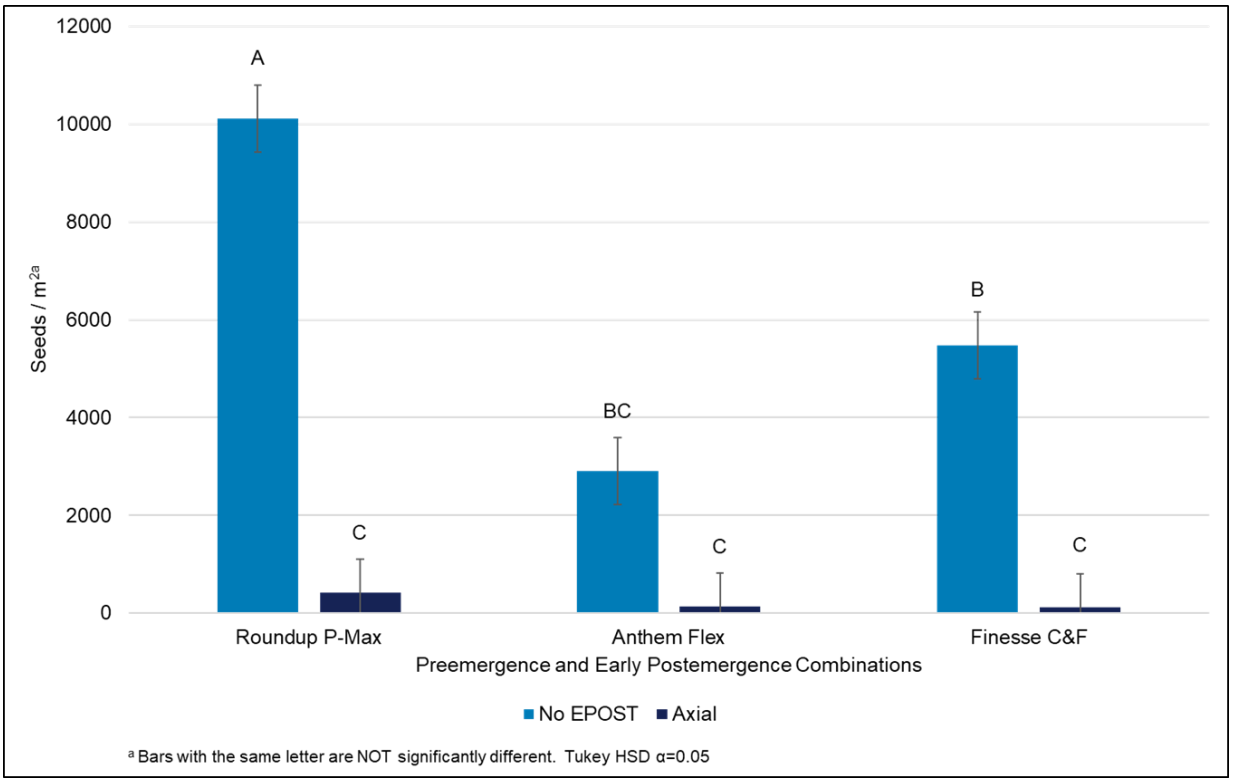

Figure 3. Italian (annual) Ryegrass seed production as influenced by preemergence and early postemergence herbicide applications.

Wheat Yield

Wheat yield ranged from 54 to 86 bu/a across all treatments. Analysis of all factors and their interactions resulted in a significant interaction of preemergence and early postemergence applications (P=0.0019). Analysis of the two factor interaction revealed the Roundup PowerMax or no residual plots that did not receive an early postemergence application of Axial XL had the lowest yields and were similar to plots receiving Finesse Cereal and Fallow preemergence without an early postemergence application (Figure 4). Plots with the greatest wheat yield either received an early postemergence application of Axial XL and/or received Anthem Flex preemergence (Figure 4). These results align closely with the annual ryegrass density and seed production results indicating ryegrass competition was likely the overall contributing factor to wheat yield in this research.

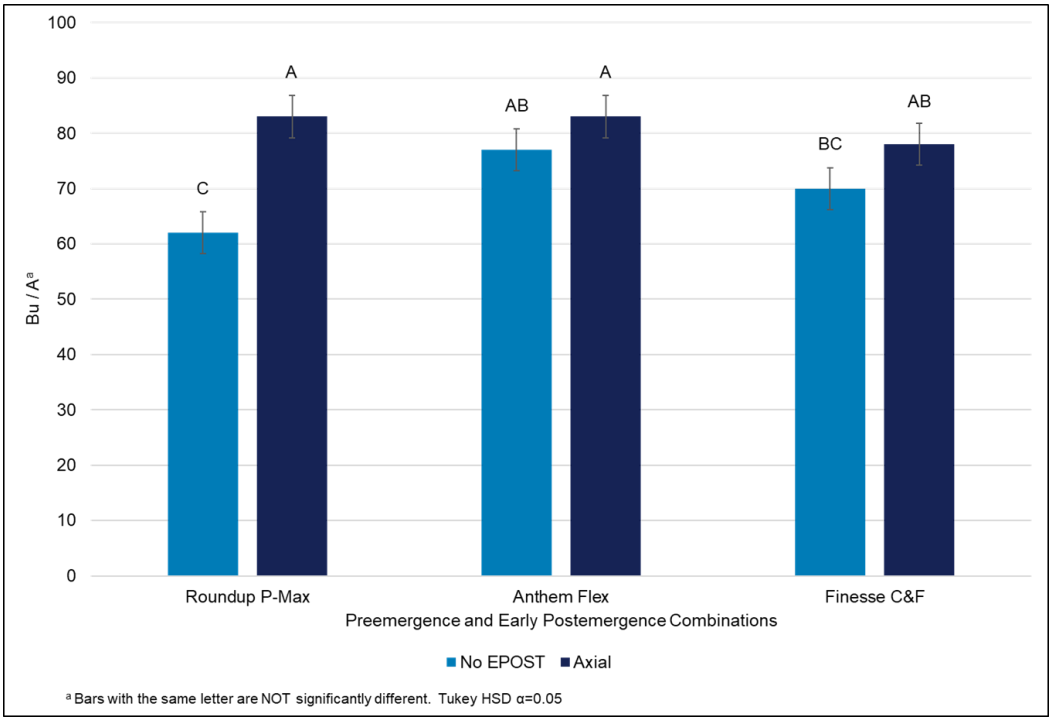

Figure 4. Wheat yield as influenced by preemergence and early postemergence herbicide applications.

Discussion and Conclusions

Overall analysis of both winter annuals and ryegrass data from this research has shown that preemergence or residual herbicides and early postemergence applications have the biggest influence on overall weed control and wheat yield.

Focusing in on winter annual weed control and excluding annual ryegrass, it is apparent that preemergence herbicides such as Finesse Cereal and Fallow play a significant role in weed control in wheat. In this specific research the use of this product alone without any further herbicide treatments resulted in more than acceptable season long weed control. This can be a very attractive herbicide program for those wheat producers who are not dealing with annual ryegrass, although the additional application of an alternative site of action in the spring would be beneficial for overall herbicide resistance management.

Analyzing all the data related to Italian (annual) ryegrass it is clear that the use Axial XL (Now replaced with Axial Bold) has the most significant influence on ryegrass control. When looking at both ryegrass density and seed production the simple application of Axial XL early postemergence with no other applications other than a Roundup PowerMax at burndown resulted in acceptable ryegrass control. It must be mentioned though, that this particular population of ryegrass is still susceptible to pinoxaden (active in Axial XL), while many populations in Kentucky are now resistant to this herbicide active ingredient. Furthermore, the continued practice of only using Axial XL (or pinoxaden based products) for ryegrass control will only further select for herbicide resistance that is already rapidly spreading in Kentucky wheat acres.

When delving further into this data set it can be observed that the use of a preemergence product like Anthem Flex that contains pyroxasulfone can also reduce ryegrass densities and seed production that is similar to Axial XL applied early postemergence. Additionally, the combination of this preemergence and early postemergence combination resulted in the most consistent treatment for overall control of ryegrass and reduction of seed production at harvest. The use of this combination will also result in not only short-term weed control, but long-term herbicide resistance management with the use of multiple sites of action.

In conclusion the use of residual herbicides in wheat show significant utility for not only management of Italian (annual) ryegrass, but also winter annual weeds in general. The selection of herbicide and timing of application will largely depend on the presence or absence of annual ryegrass as it poses the greatest threat to wheat yields. Those dealing with annul ryegrass should be applying a pyroxasulfone based residual herbicide, while those not dealing with annual ryegrass can build a fairly complete program with a robust residual like Finesse Cereal and Fallow.