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Herbicide Program Alternatives for Managing Weeds in Double-crop Soybean Scenarios in Northeast Kansas

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Summary

Managing economically problematic weeds in double-crop soybean systems is often challenging for producers in northeastern Kansas. This study aims to evaluate weed control and the economics of herbicide programs in various scenarios. The first experiment compared regular and premium herbicide programs at PRE and POST application timings. Premium soil-residual and foliar herbicide programs had greater weed control after both PRE and POST application timings, but did not lead to a higher gross margin. The second experiment consisted of four herbicide programs applied at POST timing at the V4 soybean growth stage. Increasing the herbicide rate in late applications did not improve overall weed control. In general, two-pass programs had better weed control than one-pass programs for late applications.

Introduction

Double-cropping soybeans in northeastern Kansas is already a common practice, that is, planting soybeans immediately after winter wheat harvest. Its adoption by farmers is promoted by crop insurance coverage, greater incomes from the wheat-soybean sequence, and increasing costs for summer chemical fallow (Ciampitti and Lancaster, 2022). A tight harvesting-planting window, combined with frequent periods of dry conditions and high temperatures, increases the risk of crop failure and often leads to inconsistent weed control (Landau et al., 2025; Ciampitti et al., 2024). Weeds are the main pest in this agricultural system, and their impact on yield becomes greater as resources become scarcer. The objectives of this study were to (1) compare weed control and gross margin between premium and regular herbicide programs and (2) evaluate weed control in late foliar herbicide programs within double-crop soybean scenarios.

Procedures

In 2024, two on-farm experiments were established on a field near Clay Center, KS (39° 13'52.04" N; 97°12'19.55" W). Double-crop soybean (OHLDE 2337 variety) was planted on July 5 following a harvest of winter wheat that produced on average 70 bu/a. Soybean was planted using a John Deere 1750 Max Emerge XP planter in rows spaced 30 inches apart, equipped with a vDrive precision planting system set to a target population of 115,000 seeds/a.

Herbicide applications in both experiments used a two tank-two broadcast boom system on an ATV plot sprayer (Kubota) equipped with TT11003 and 50E03 TeeJet nozzles calibrated to deliver 15 gallons per acre for residual and foliar herbicides, respectively. The main weed species was Palmer amaranth (*Amaranthus palmeri*) with some velvetleaf (*Abutilon theophrasti*), waterhemp (*Amaranthus tuberculatus*), and volunteer wheat present.

In experiment 1, two main herbicide programs were compared: regular vs. premium including soil-residual and foliar herbicides in an overlapping residual approach (Table 1). The two treatments were set up as a randomized complete block design (RCBD) with five replications. Plots were 10 feet wide (four 30-inch rows) by 125 feet long. The first application (PRE) was sprayed after planting but before crop emergence on July 8, and the second application (POST) was sprayed 23 days after PRE application on August 2. Weed control was visually assessed on a scale of 0 (no control) to 100% (complete control) at 21 days after PRE treatment and 18 days after POST treatment. Soybean grain was harvested, and yields were calculated at 13.5% moisture. Gross margins were calculated based on $9.50/bu, the average reported price from grain elevators nearby.

In experiment 2, four late foliar herbicide programs were evaluated (Table 2). Treatments were set up in an RCBD with four replications. Plots were 10 feet wide (4 by 30-inch rows) by 125 feet long. Treatments were applied on August 7 at the V4 soybean growth stage, and a second pass was applied for treatments 3 and 4 on August 15. Weed control was visually assessed on a scale of 0 to 100% control at 38 days after treatment (DAT) for treatments 1 and 2 and 28 DAT for treatments 3 and 4. The assessment focused on already-established weeds prior to spraying.

Percent weed control was evaluated through an analysis of variance (ANOVA) and pairwise comparisons were conducted by using t-tests (p-value = 0.05). Means and standard error of the mean (SE, ±) will be reported for each experiment.

Results and Discussion

Double-crop season in this area received 6.1 inches of rainfall between soybean planting and physiological maturity. The average maximum daily air temperature ranged from 78 to 80°F during the weed control period, that is, from PRE to POST applications in experiment 1 and from the first to second pass in experiment 2.

Experiment 1: regular vs. premium soil-residual and foliar herbicide programs

Initial weed infestation in wheat stubble was low with Palmer amaranth (less than 0.5 plants/100 feet and 4 inches tall on average) as the driver weed. Weed control was greater in the premium program with 96% control as compared to the regular herbicide program with 71% control after PRE application (Figure 1 left). Differences in weed control were mainly observed in Palmer amaranth, where the regular herbicide program had less control, likely due to resistance to the mode of action employed and/or weed size. Both programs effectively controlled already established velvetleaf and volunteer wheat species; however, neither provided sufficient control of newly emerging individuals (Figure 2A).

At the time of POST application, the weed infestation ranged from low to very low volunteer wheat in premium herbicide plots and from medium to high density of

Palmer amaranth plants that were flowering in regular herbicide plots (Figure 2B). A new flush of velvetleaf seedlings was observed in plots for both herbicide programs. At this timing, similar weed control results were noticed, with 95% control for the premium program as compared to 75% control for the regular program (Figure 1 right).

Soybean yield did not differ between herbicide programs with 22.2 (± 2.2) bu/a in the premium program and 20.9 (± 2.3) bu/a for the regular program. Therefore, gross margins were $211 (±20.7)/a and $198 (±22.2)/a for the premium herbicide and the regular herbicide program, respectively.

Experiment 2: late foliar herbicide programs

Initial weed condition was characterized by medium to high Palmer amaranth infestation (2-3 plants/100 feet and 3 feet tall on average that was flowering) as the key driver with some presence of waterhemp (Figure 3A). Both weeds and soybean plants showed noticeable drought-stress symptoms.

Weed control was greater in herbicide programs using a two-pass approach, combining systemic herbicides (Roundup Power Max 3 and Enlist One) in the first pass with a contact herbicide (Liberty) in the second pass. These programs achieved 93 and 95% weed control in treatments 3 and 4, respectively. However, no differences in control were observed between these treatments as the rate of Enlist One increased (Figure 4).

In contrast, one-pass programs relying solely on a foliar contact herbicide showed significantly lower control, with only 16 and 36% in treatments 1 and 2, respectively (Figure 4). Although increasing the Liberty rate between these two treatments led to greater visible defoliation, it did not result in improved overall weed control.

Final assessments revealed surviving Palmer amaranth plants in one-pass programs that were still growing and producing seed (Figure 3B). In the two-pass programs, surviving plants showed symptoms such as twisted or bent stems, while others were completely dead (Figure 3C). Across all treatments, soybean plants exhibited leaf burn symptoms, likely due to the inclusion of spray-grade ammonium sulfate (AMS).

Conclusion

The premium herbicide program demonstrated greater weed control versus the regular program, though it did not lead to higher revenues. Soil residual herbicides should be reviewed and selected according to the key weed species of the system; neither herbicide programs were designed for good control of velvetleaf and volunteer wheat. In late foliar herbicide programs, the two-pass had the greatest weed control. Weather conditions frequently present in double-crop soybean systems across Kansas, such as extended periods of drought and high daily temperatures, can have a non-negligible impact on the effectiveness of the herbicide program employed. Thus, factors like application timing and adjuvant use may be important for further research.

Acknowledgments

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Table 1. Treatments experiment 1: regular vs. premium soil residual and foliar herbicide programs

Herbicide program (treatment)	Tank	PRE spray	Rate/acre	POST spray	Rate/acre	Cost/acre ($)
Regular	Residual	Metribuzin 75DG				
	0.5 lb	-	-	23.20		
	Foliar	Roundup Power Max3	30 fl oz	Liberty	43 fl oz	
		AMS 2%				
	2.5 lb	AMS 2%	2.5 lb			
Premium						
	Residual	Zidua	1.5 fl oz	Zidua	1.5 fl oz	42.10
	Foliar	Roundup Power Max3	30 fl oz	Roundup Power Max3	20 fl oz	
		Enlist One	32 fl oz			
		Sharpen	1 fl oz	AMS 2%	2.5 lb	
		AMS 2%	2.5 lb			
		MSO 1%	19.2 fl oz			

AMS: spray-grade ammonium sulfate; MSO: methylated seed oil.

Table 2. Treatments experiment 2: late foliar herbicide programs

Herbicide program (treatment-approach)	Tank	First pass	Rate/acre	Second pass	Rate/acre	Cost/ acre ($)
1	Residual	Zidua SC	3 fl oz	-	-	24.00
One pass	Foliar	Liberty	32 fl oz	-	-	
		AMS 5%	6.25 lb	-	-	
		Interlock 1%	19.2 fl oz	-	-	
2	Residual	Zidua SC	3 fl oz	-	-	26.30
One pass	Foliar	Liberty	43 fl	-	-	
		AMS 5%	6.25 lb	-	-	
		Interlock 1%	19.2 fl oz	-	-	
3	Residual	Zidua SC	1.5 fl oz	Zidua SC	1.5 fl oz	42.10
Two-pass	Foliar	Roundup Power Max3	30 fl oz	Liberty	32 fl oz	
		Enlist One	24 fl oz	AMS 5%	6.25 lb	
		AMS 2%	2.5 lb	Interlock 1%	19.2 fl oz	
		Interlock 1%	19.2 fl oz			
4	Residual	Zidua SC	1.5 fl oz	Zidua SC	1.5 fl oz	44.80
Two-pass	Foliar	Roundup Power Max3	30 fl oz	Liberty	32 fl oz	
		Enlist One	32 fl oz	AMS 5%	6.25 lb	
		AMS 2%	2.5 lb	Interlock 1%	19.2 fl oz	
		Interlock 1%		19.2 fl oz		

AMS: spray-grade ammonium sulfate; Interlock: Drift reduction agent, deposition aid, and canopy penetrant.

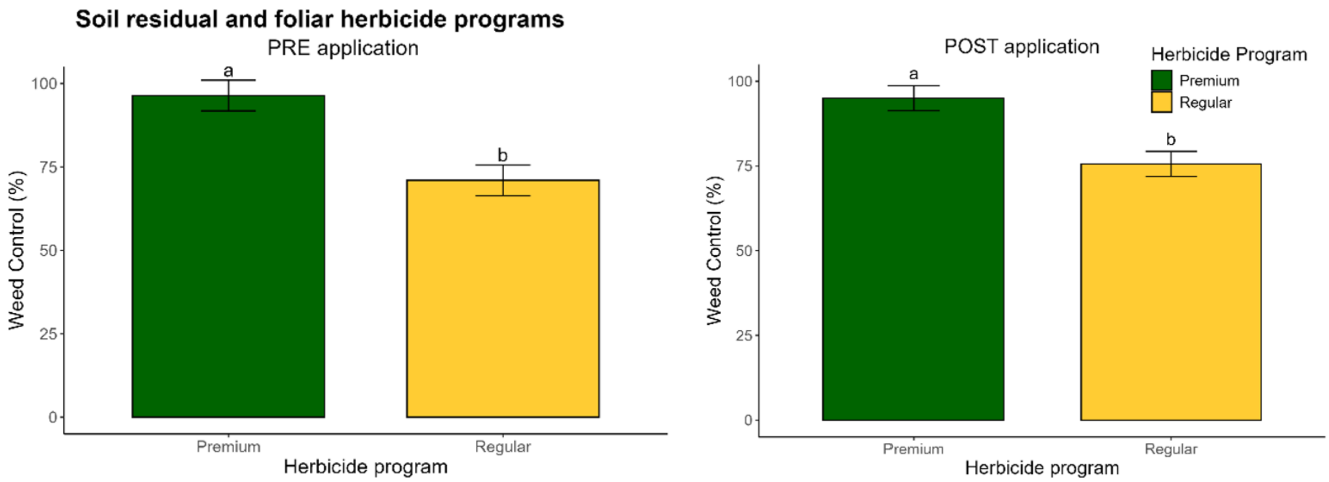

Figure 1. Experiment 1: Weed control PRE application (left) and POST application (right). Different letters indicate differences in weed control according to Tukey's HSD (Honestly Significant Difference) (α = 0.05). (Premium herbicide program = dark green, Regular herbicide program= yellow).

Figure 2. Experiment 1: A) 21 DA PRE application, herbicide premium plot (center) and herbicide regular program plots (edges). B) 18 DA POST application herbicide regular control program achieved.

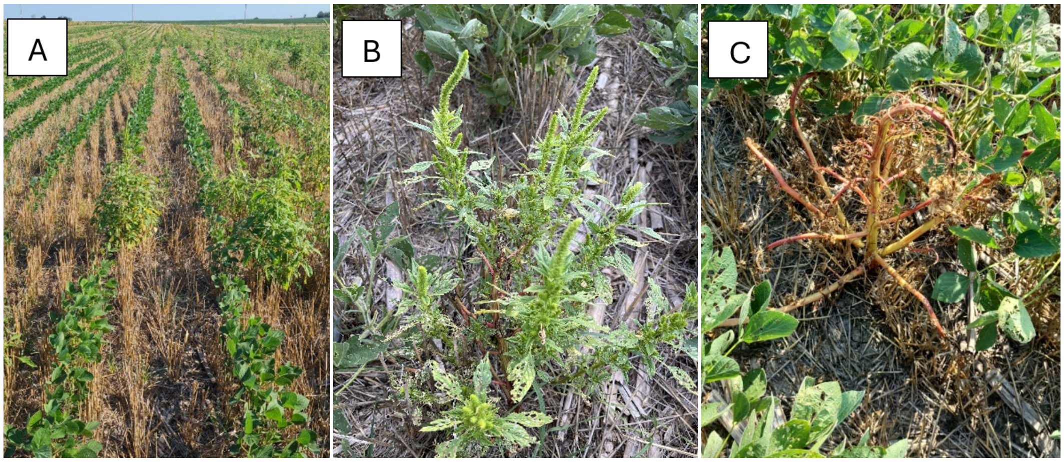

Figure 3. Experiment 2: A) Initial weed condition; B) PA control reached in herbicide program 2; C) PA control reached in herbicide program 4. PA= Palmer amaranth.

Figure 4. Experiment 2: Weed control by herbicide program. Different letters indicate differences in weed control according to Tukey's HSD ($\alpha = 0.05$). (Herbicide program 1 = coral, Herbicide program 2 = light green, Herbicide program 3 = aqua, Herbicide program 4= purple)