ECONOMICS OF RESIDUAL HERBICIDES IN ROUNDUP READY CROPS

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Roundup Ready crops have become very popular in the short time that this technology has existed. In particular, Roundup Ready soybeans accounted for 75% of U.S. soybean acres in 2002 and the percentage in Wisconsin is likely higher. Adoption of Roundup Ready corn has been slower because of several factors such as international marketing and the potential that the weed management system is not as simple as in soybeans. Because glyphosate (e.g., Roundup, Touchdown, etc.) lacks residual activity, it is logical to presume that a residual herbicide either applied at planting or tank mixed with the glyphosate may improve weed control in both Roundup Ready soybeans and corn. However, this residual herbicide would add cost for the product and possibly for an added application. Does the weed control and associated yield differ enough to justify this expense?

Biologically, soybeans may benefit less from the addition of a residual herbicide because they tolerate early season weed competition longer before yields are affected. They also canopy more completely, especially drilled soybeans, than corn. This lessens the risk that late emerging weeds will become competitive enough to affect the soybean's yield. In an attempt to determine if residual herbicides have an economic benefit in soybeans, I summarized treatments made in 16 experiments conducted over 5 years by Dr. Harvey or myself where I could make a direct comparison between two treatments that had the same rate of glyphosate applied at the same stage of growth. The only difference between the treatments was that one treatment had a preemergence (or preplant) residual herbicide applied before postemergence glyphosate and the other treatment only had glyphosate applied postemergence. There were 75 sets of treatments that could be compared (Table 1). In these Roundup Ready soybeans, the glyphosate was typically applied at the V2 or V3 growth stage. Because the actual yields in the experiments differed, I expressed the yields as a percentage of the yield of the soybeans that were only treated with glyphosate for simplicity. Therefore, if soybeans that were treated with both residual herbicide and glyphosate yielded more than soybeans only treated with glyphosate, the percentage would be greater than 100%.

There is always variation in yields harvested from small plots, so a person cannot just look at the percentage and know that a number higher or lower than 100 is a truly different or just chance. In these experiments, there were only four comparisons that differed statistically. In each case, the treatment with the residual herbicide had a lower yield than the soybeans treated only with glyphosate. Interestingly, the grand average of the 75 comparisons resulted in a yield percentage of 99.5%, indicating that the residual herbicides did not increase or decrease yield. When glyphosate applications are properly timed for common annual weeds, it is unlikely that there is an economic benefit of using a residual herbicide in soybeans. However, there were a few other examples in these experiments when the glyphosate was applied late (4 to 5 trifoliate stage). When Command 3ME or Prowl were applied at or before planting and the soybeans were sprayed late, these residual herbicides controlled the early weed competition. As a result, the yields with the residual treatments were 12 to 19% higher than when the soybeans were only sprayed with glyphosate.

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Table 1. Roundup Ready soybean yields when treated with a preemergence residual herbicide prior to postemergence glyphosate as compared to soybeans only treated postemergence with glyphosate. Yields are expressed as a percentage of glyphosate-only treated soybean yield.

		RR soybean yield Glyphosate rate (lb ae/a)		
Herbicide	Rate	0.38	0.56	0.75
	product/a	(% of glyphosate only)		
Authority	4.5 oz		98	
Authority	5.3 oz	105		
Authority	8 oz	96	90	
Authority	8 oz	92	111	
Authority + Sencor			8 oz + 5 oz	86*
Authority	5.3 oz		100	
+ FirstRate	+ 0.6 oz			
Authority	6.7 oz	93		
+ FirstRate	+ 0.76 oz			
Authority	6.7 oz	104		
+ FirstRate	+ 0.76 oz			
Axiom	10 oz		96	
Boundary	1.25 pt		95	
Boundary	2 pt		102	
Boundary	1 pt (V3)		104	
Boundary	1 pt (V4)		100	
Boundary	1 pt (V5)		104	
Broadstrike+Dual	2 pt	91		
Command 3ME	1.3 pt	92	105	
Command 3ME	1.3 pt		96	
Command 3ME	2 pt		100	
Command 3ME	2 pt		109	
Command 3ME	2 pt			100
Command 3ME	2 pt	102		
Command 3ME	1.3 pt	92	104	
Cover	4 oz		105	
Cover	4 oz		94	
Domain	9 oz		98	
Domain	10 oz		98	
Dual II Magnum	0.5 pt	100		
Dual II + Pursuit	2 pt + 4 oz		104	
FirstRate	0.3 oz	97		
FirstRate	0.45 oz	107		
FirstRate	0.6 oz		100	
FirstRate	0.6 oz		93	
FirstRate	0.6 oz	97		
FirstRate	0.75 oz		100	

		RR soybean yield Glyphosate rate (lb ae/a)		
Herbicide	Rate	0.38	0.56	0.75
	product/a	(% of glyphosate only)		
Frontier	20 oz		99	
Frontier	20 oz		107	
Frontier + Pursuit	20 oz + 4 oz		89*	
Prowl	2 pt	111		
Prowl	2 pt	97	107	
Prowl	2.4 pt	100	111	
Prowl	2.4 pt	94	94	
Prowl	2.4 pt		98	
Prowl	3 pt		105	
Prowl	3.6 pt			107
Pursuit	4 oz	93		
Pursuit Plus	2.5 pt		96	
Pursuit Plus	2.5 pt	89*		
Pursuit Plus	2.5 pt	102		
Pursuit Plus	2.5 pt		114	
Pursuit Plus	2.5 pt		96	
Pursuit Plus	2.5 pt		114	
+ Prowl	+ 1 pt			
Python	0.5 oz	105		
Python	0.75 oz	95		
Python	0.8 oz		95	
Python	0.8 oz	87		
Python	0.8 oz	88		
Python	0.8 oz		109	
Python	1.0 oz	100		
Python	1.0 oz		109	
Python	1.0 oz	95		
Python	0.75 oz	89*		
+ Prowl	+ 2.4 pt			
Sencor	3 oz		99	
Sencor	4 oz	101		
Turbo	0.75 pt	101		
Turbo	1.5 pt			91
Valor	2 oz		112	
Valor	2 oz		95	
Valor	3 oz		105	

* Denotes that the yield differed from the yield of soybean treated only with glyphosate within the original experiment at a LSD of p=0.10.

I summarized a similar set of experiments for Roundup Ready corn (Table 2). However, there were only 10 experiments conducted over 4 years were I could select valid comparisons. There were a total of 31 comparisons of a residual preemergence herbicide followed by glyphosate versus

glyphosate applied alone postemergence. There were fewer treatments to compare because Roundup Ready corn has not be tested as long and more of the Roundup Ready corn was treated twice with glyphosate as compared to soybeans that were more often only treated once.

Statistically, only two of the individual comparisons between "with" and "without" the residual herbicide differed. One was greater with Harness applied preemergence and another was less with Harness applied preemergence. The grand average across the 31 comparisons was a surprising 100.4%. Similar to soybeans, this suggests that a single properly timed glyphosate application can protect Roundup Ready corn yields. Most of the glyphosate applications in these experiments were made near the V2 or V3 growth stage. Weeds that emerged later were not competitive enough to reduce the average yield of the corn that was only treated with glyphosate. It also could be questioned whether or not any of the preemergence residual herbicides affected the corn's yield potential. Similar to the soybeans, there were other treatments where the residual herbicide allowed glyphosate to be applied later without having the corn suffer a yield loss.

Table 2. Roundup Ready corn yields when treated with a preemergence residual herbicide prior to postemergence glyphosate as compared to corn only treated postemergence with glyphosate. Yields are expressed as a percentage of glyphosate-only treated corn yield.

		RR corn yield Glyphosate rate (lb ae/a)					RR corn yield Glyphosate rate (lb ae/a)		
Herbicide	Rate	0.38	0.56	0.75	Herbicide	Rate	0.38	0.56	0.75
	product/a	(% of glyphosate only)				product/a	(% of glyphosate only)		
Axiom	9 oz			95	Harness	1.8 pt		120*	
Bicep II Magnum	1.9 qt			103	Harness	1.8 pt		124	
Bicep Lite II Mag	1.5 qt			92	Harness	2 pt	100		
Broadstrike + Dual	1.1 pt		93		Harness Xtra	1.6 qt			101
Dual II Magnum	1.67 pt			99	Harness Xtra	1.8 pt			115
Dual II Magnum	1.67 pt		99		Harness Xtra 5.6	1.7 qt			94
Harness	1.1 pt			101	Harness Xtra 5.6	2.8 pt		100	
Harness	1.1 pt			119	Harness Xtra 5.6	2.8 pt		104	
Harness	1.1 pt			100	+ Python	0.8 oz			
Harness	1.2 pt		93		Harness + Hornet	1.33 pt + 3 oz	96	102	
Harness	1.25 pt			91	Harness + Python	1.3 pt + 1 oz			93
Harness	1.3 pt			90	Prowl	2 pt		92	
Harness	1.33 pt		91*		Prowl	3.6 pt			90
Harness	1.7 pt			102	Python	0.8 oz		106	
Harness	1.7 pt			102	Python	0.8 oz		96	
					Python	1.0 oz		109	

* Denotes that the yield differed from the yield of corn treated only with glyphosate within the original experiment at a LSD of p=0.10.

Perhaps the most significant value of a residual herbicide is to provide risk management against delayed applications of glyphosate. It may be easier for us to manage application timing in research plots than in grower fields. This may make these results look more favorable than what would occur commercially. The residual herbicide also has a value in resistance management, although it is difficult to place a value on this aspect. Another effect that is not accounted for in this summary are potential differences in weed seed production. A single early postemergence application of

glyphosate may protect corn yield, but it is more likely that there will be a few more late season weeds in corn if a residual herbicide is not used. Late season weeds and seed production are likely a lesser concern in soybeans, especially those planted in narrow rows. The economic impact of these weeds on the long-term cost of weed management are difficult to measure, but should be considered.