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## Comparison of Weed Management Strategies with Roundup Ready<sup>®</sup> Corn

J. A. Ferrell  
*University of Kentucky*

William W. Witt  
*University of Kentucky, [william.witt1@uky.edu](mailto:william.witt1@uky.edu)*

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## Comparison of Weed Management Strategies with Roundup Ready® Corn.

J. A. Ferrell and W. W. Witt

### Introduction

Corn weed management during the past several years in Kentucky has centered around two herbicide families, the chloroacetamides (Dual, Frontier, Harness, Micro-Tech, Surpass) and the s-triazines (AAtrex, Bladex, Princep). These products have been used widely because they offer acceptable, full season control of many common warm season annual weeds at a reasonable price. This combination has been so popular that several mixtures that contain these types of herbicides (Bicep II, Bullet, Guardsman, Harness Xtra, Surpass 100, FulTime) are used commonly used in Kentucky. The key to this efficacious and economic program is atrazine because it controls most annual broadleaf species that exist in Kentucky corn production with minimal economic investment.

In addition to a good foundation soil-applied herbicide program for controlling annual weeds, a postemergence application of nicosulfuron (Accent) is often needed to help manage johnsongrass (*Sorghum halepense*). Including nicosulfuron as a part of a weed control program increases costs and may increase risk of corn injury due to antagonism with certain insecticides or untimely applications.

Monsanto released Roundup Ready® corn, which is a transgenic crop that is tolerant to glyphosate, in the spring of 1998. Glyphosate is the active ingredient in several products including Roundup Ultra and has long been used as a non-selective burndown herbicide for no-till production of grain crops. The Roundup Ready® technology allows corn growers the opportunity to use Roundup Ultra as a tool for managing most annual grass and broadleaf weeds as well as johnsongrass and other perennial species.

Although Roundup Ultra was known to control a wide range of weedy species, there were questions regarding the economics of this technology relative to traditional standard herbicide programs for controlling warm-season annual weeds. The technology fee of \$6 per acre for the Roundup Ready® seed was an expense associated with a Roundup weed control program. Furthermore, it was not known if one or two applications of Roundup Ultra would be needed to provide weed control comparable to other products.

The first objective of this research was to compare the effectiveness of Roundup Ready® technology with other herbicide options for managing johnsongrass. A second objective



was to compare the profitability of Roundup Ready® technology with traditional herbicide programs for managing warm-season annual weeds.

## Methods

**Johnsongrass Control.** Experiments were conducted in Princeton and Lexington in 1998 and 1999. Three genetically modified hybrids, each representing a specific herbicide technology, and one non-transformed hybrid were planted at all locations. The hybrids were Garst 8541 IT (for imidazolinone tolerant), Garst 8342 (non-transformed), DeKalb 683 SR (for sethoxydim resistance) and DeKalb 591 RR or DeKalb 626 RR (for glyphosate resistance) in 1998 and 1999, respectively. Plots were 10 feet wide (4 rows) by 30 feet long with four replications. The entire experiment site was treated the day of planting with 4.8 pints of Bicep II to manage weeds other than johnsongrass.

Johnsongrass control was determined visually on a 0 to 100-point scale where 0 represented no control while 100 signified 100% control. Visual ratings were collected 2, 4 and 8 weeks after herbicide application.

**Annual Weed Control and Economic Analysis.** Experiments were conducted in Princeton and Lexington in 1998 and 1999 to evaluate and compare weed control and net returns that resulted from Roundup Ultra and several commonly used herbicide programs. Each experiment contained 13 herbicide treatments and a weedy check. Herbicide applications were made to the soil surface (PRE) the day of planting, to 2-4 inch weeds (MP), to 2-4 inch weed regrowth (REG), or as needed (ASN) to late emerging weeds. DeKalb 591RR and DeKalb 626RR were planted in late April or early May for all locations in 1998 and 1999, respectively. Plots were 10 feet wide (4 rows) by 30 feet long with four replications.

Weed control was evaluated visually 2, 4, and 8 weeks after application. The plots were hand harvested by collecting 30 linear feet of row and yields adjusted to 15.5% moisture. Return above fixed and variable costs was calculated by the formula:  $[\text{yield}(\text{bu}/\text{ac}) * \$2.06] - [\text{herbicide cost} + \text{fixed and variable cost}]$ . Herbicide costs included cost of the herbicide(s) plus a \$6 technology fee for Roundup Ready® treatments and an application charge of \$4/ac for each herbicide treatment. A value of \$264.54/ac, for variable and fixed costs, was obtained from the University of Kentucky Agriculture Economics Department.

## Results and Discussion

**Johnsongrass Control.** Johnsongrass control two weeks after treatment ranged from 88 to 100% and was consistent for 1998 and 1999 (Table 1). Roundup Ultra at 2 pt/A applied to 12 or 18-inch johnsongrass provided 100% control while Lightning at 1.28 oz/A provided 88% control both years.

Johnsongrass control ratings four and eight weeks after treatment were variable within treatments and across years. Lightning appeared to be most inconsistent at the four- and eight- week ratings, particularly when its application was made to 8-inch johnsongrass. The level of control observed with Lightning at four and eight weeks after treatment appeared to be better when johnsongrass was 12 inches tall than when plants were 8 inches in height. Inconsistency of control between years was also observed with Accent. Poast Plus and Roundup Ultra provided more consistent control. Only at the eight-week observation date in 1998 did Roundup Ultra or Poast Plus treatments provide less than 90% control. Generally, johnsongrass control in 1998 was less than in 1999 and was attributed to the large rainfall, 20 inches, in June of 1998. Precipitation encouraged further johnsongrass seed germination and emergence and/or regrowth from treated johnsongrass plants.

These data demonstrate that Poast Plus and Roundup Ultra provided superior johnsongrass control compared to Lightning or Accent. Lightning and Accent can deliver acceptable control in any given year, or at any spray timing; however, Roundup Ultra and Poast Plus controlled johnsongrass more consistently.

**Annual Weed Control and Economic Analysis.** Several weeds were evaluated at the various study locations including giant foxtail, common lambsquarters, and giant ragweed. Control of these three species exceeded 90% for all treatments in both 1998 and 1999 (data not shown). In Lexington, the dominant weed species were entireleaf morningglory and common cocklebur. Data are presented for these weed species due to their common occurrence in Kentucky corn production and because they are difficult to control. For entireleaf morningglory and common cocklebur, control ranged between 66 and 100% over both years (Table 2). Sequential Roundup Ultra treatments were highly effective and were not significantly different from the highest control treatment in either year. The chloracetamide + atrazine treatments, not followed by postemergence applications (trts 3, 7, 12), usually had the least control. Treatments consisting of PRE followed by MP combinations consistently were the most efficacious. For all locations and both years, the ASN treatment was required in the form of a single application to 2-4 inch weed regrowth. These data indicate that a single Roundup Ultra application will rarely be sufficient, however a third application will not be required.

Although significant differences in weed control were detected between treatments, no significant differences were observed in yield or return above fixed and variable costs for any treatment (Table 3). These data clearly demonstrate that 100% weed control was not necessary to obtain top yields. It was also readily noticed that a great disparity between

yield and net return existed between 1998 and 1999 (Table 3). This was due to the lack of rainfall during the growing season of 1999 that led to low corn yields and negative net return values.

### Summary

These results demonstrated that Roundup Ultra can be used alone, or sequentially with other products, to deliver effective and consistent weed control over a range of weed species and environmental conditions. There were no differences in return above fixed and variable costs between Roundup Ultra and any of the other herbicide programs compared in this study. Roundup Ready® technology provides another weed management alternative for Kentucky corn growers.

The two years in which these studies were conducted were very different. Growing conditions in 1998 were excellent for corn production resulting in excellent yields in Lexington and Princeton while rainfall was lacking at both locations in 1999 and corn yield was reduced greatly. The extremes in growing conditions provided an opportunity to evaluate Roundup Ready® technology under the "best" and "worst" cases that will be encountered in Kentucky. Consistent weed control was obtained with all herbicide treatments in both years.

### Acknowledgements

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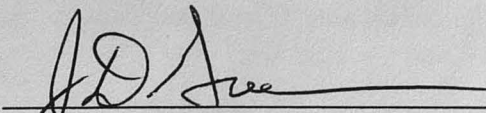
  
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Table 1. Johnsongrass control in corn in 1998 and 1999 in Princeton KY.

Treatment <sup>1</sup>	Rate/A	Johnsongrass size (inches)	Weeks after treatment					
			2		4		8	
			1998	1999	1998	1999	1998	1999
			-----% Control <sup>2</sup> -----					
1. Poast Plus	2.25 pt	12	95 b	95 b	92 ab	95 a	78 d	95 a
2. Poast Plus	2.25 pt	16	95 b	95 b	92 ab	90 a	80 cd	90 a
3. Roundup Ultra	2.00 pt	12	100 a	100 a	91 bc	95 a	84 bc	94 a
4. Roundup Ultra	2.00 pt	18	100 a	100 a	96 a	95 a	88 abc	95 a
5. Lightning	1.28 oz	8	88 b	88 b	84 e	38 c	25 f	15 d
6. Lightning	1.28 oz	12	95 b	95 b	85 e	95 a	64 e	94 a
7. Accent	0.66 oz	12	95 b	95 b	86 de	55 b	88 abc	45 bc

<sup>1</sup> All postemergent treatments contained adjuvants recommended on the label.

<sup>2</sup> Treatment means with the same letter are not statistically different (P=0.05).

Table 2. Entireleaf morningglory and common cocklebur control eight weeks after treatment in 1998 and 1999 at Lexington KY.

Treatment <sup>1</sup>	Rate/A	Time of treatment <sup>2</sup>	Entireleaf Morningglory		Common Cocklebur	
			1998	1999	1998	1999
			----- % Control <sup>3</sup> -----			
1. Roundup Ultra	2.0 pt	MP	90 ab	96 a	93 a	100 a
+ Roundup Ultra	2.0 pt	REG				
2. Roundup Ultra	2.0 pt	MP	90 ab	98 a	94 a	98 a
+ Roundup Ultra	2.0 pt	ASN				
3. Harness Xtra	4.8 pt	PRE	66 c	76 b	70 b	86 ab
4. Harness Xtra	3.4 pt	PRE	89 ab	100 a	91 a	100 a
+ Roundup Ultra	2.0 pt	MP				
5. Harness Xtra	3.2 pt	PRE	79 b	95 a	80 ab	100 a
+ Roundup Ultra	2.0 pt	MP				
6. FieldMaster	8.0 pt	MP	94 ab	100 a	93 a	100 a
7. Bicep II	4.8 pt	PRE	65 c	71 b	68 b	73 bc
8. Bicep II	4.8 pt	PRE	97 a	100 a	98 a	100 a
+ Exceed	1.0 oz	MP				
9. AAtrex	2.0 pt	PRE	96 ab	100 a	97 a	100 a
+ Princep	2.0 pt	PRE				
+ Exceed	1.0 oz	MP				
10 AAtrex	2.0 pt	PRE	90 ab	100 a	89 a	100 a
+ Princep	2.0 pt	PRE				
+ Roundup Ultra	2.0 pt	MP				
11. AAtrex	2.0 pt	PRE	86 ab	100 a	89 a	100 a
+ Roundup Ultra	2.0 pt	MP				
12. Guardsman	4.5 pt	PRE	81 ab	71 b	80 ab	71 c
13. Guardsman	4.5 pt	PRE	93 ab	100 a	96 a	100 a
+ Banvel	0.25pt	MP				

<sup>1</sup> All postemergent treatments contained adjuvants recommended on the label.

<sup>2</sup> PRE = applied day of planting, ASN = as needed, MP = 2-4 inch weeds, REG = 2-4 inch weed regrowth.

<sup>3</sup> Treatment means with the same letter are not statistically different (P=0.05).



Table 3. Corn yield and net return in 1998 and 1999 at Lexington KY. No statistical differences among yield or net return occurred.

Treatment <sup>1</sup>	Rate/A	Time of treatment <sup>2</sup>	Yield		Return <sup>3</sup>	
			1998	1999	1998	1999
			Bu/ac		\$/ac	
1. Roundup Ultra + Roundup Ultra	2.0 pt 2.0 pt	MP MPR	195	66	\$104.84	-\$159.42
2. Roundup Ultra + Roundup Ultra	2.0 pt 2.0 pt	MP ASN	225	61	166.43	-169.63
3. Harness Xtra	4.8 pt	PRE	180	60	78.66	-168.79
4. Harness Xtra + Roundup Ultra	3.4 pt 2.0 pt	PRE MP	206	64	133.99	-158.44
5. Harness Xtra + Roundup Ultra	3.2 pt 2.0 pt	PRE MP	217	72	143.36	-155.63
6. FieldMaster	8.0 pt	MP	198	84	112.06	-124.17
7. Bicep II	4.8 pt	PRE	188	61	99.46	-163.36
8. Bicep II + Exceed	4.8 pt 1.0 oz	PRE MP	226	59	160.19	-183.61
9. AAtrex + Princep + Exceed	2.0 pt 2.0 pt 1.0 oz	PRE PRE MP	210	56	139.73	-175.75
10. AAtrex + Princep + Roundup Ultra	2.0 pt 2.0 pt 2.0 pt	PRE PRE MP	218	66	154.13	-158.90
11. AAtrex + Roundup Ultra	2.0 pt 2.0 pt	PRE MP	202	66	124.65	-154.95
12. Guardsman	4.5 pt	PRE	192	48	107.45	-188.63
13. Guardsman + Banvel	4.5 pt 0.25 pt	PRE MP	213	57	144.65	-177.28
LSD (P=0.05)			NS	NS	NS	NS

<sup>1</sup> All postemergent treatments contained adjuvants recommended on the label.

<sup>2</sup> PRE = applied day of planting, ASN = as needed, MP = 2-4 inch weeds, REG = 2-4 inch weed regrowth.

<sup>3</sup> Return above fixed and variable costs = [yield(bu/ac)\*\$2.06] - [herbicide cost + fixed and variable cost].

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