

# HERBICIDE-RESISTANT CORN FOR REDUCING USE OF RESIDUAL HERBICIDES AND FOR WIRESTEM MUHLY CONTROL

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## ABSTRACT

The introduction of Roundup Ready (glyphosate-resistant) and Liberty Link (glufosinate-resistant) corn hybrids has the potential to reduce the use of residual herbicides that may contaminate surface and groundwater and to provide control options for perennial weeds such as wirestem muhly in corn. The maximum environmental benefit of these weed control programs will only be recognized if it is known how much residual herbicide, if any, is required to make these programs dependable. In addition, the potential yield losses associated with total postemergence weed control programs must be understood if these programs are to be successful. Four experiments were conducted at several locations across NY state in 2000 to collect additional data concerning these issues.

In experiments conducted in Cayuga and Livingston Counties, the addition of residual herbicides to early and mid-postemergence (EPO and MPO) Roundup Ultra applications did not improve weed control ratings or result in significantly different grain corn yields than when Roundup Ultra was sprayed alone. Time-of-application of the Roundup Ultra treatments had no impact on grain corn yields with moderate weed pressure and a highly productive soil in Livingston County. In Cayuga County, with heavy common ragweed and green foxtail pressure, late postemergence (LPO) Roundup Ultra application did result in a significant yield reduction (134 bu/A) compared with an average yield of 148 bu/A for the EPO and MPO Roundup Ultra treatments. When giant foxtail was suppressed with a preemergence (PRE) application of Dual II Magnum in Columbia County, the timing of sequential Roundup Ultra applications had little influence on grain corn yields. With Roundup Ultra only applications, grain corn yields were reduced from 133 bu/A for EPO application to 112 and 110 bu/A for the MPO and LPO applications. As in 1998 and 1999 there is still little evidence that residual soil applied herbicides are needed in Roundup Ready corn weed control programs. The 2000 results provided additional evidence that delayed application of these non-residual postemergence herbicides can result in significant yield losses. These potential yield losses are influenced by several factors including weed pressure, amount and timing of rainfall events, and the water holding capacity of the soil, as well as time of application. Clearly, it would be a mistake to ignore the potential importance of application timing since this is a factor that can, to a large extent, be controlled. Corn growers who use Roundup Ready corn hybrids should plan to spray EPO when weeds are 2 to 4 inches tall. If residual herbicides are used in these programs, no more than a one-half rate should be used.

As in previous years, LPO application of Roundup Ultra provided excellent (99%) wirestem muhly control. LPO application of Liberty herbicide provided good (90%) in-season wirestem muhly control but may not provide long-term control since there is little or no translocation of Liberty into the underground reproductive structures (rhizomes) as there is with Roundup Ultra. This research supports the recommendation in the *Cornell Guide for Integrated Field Crop Management* for use of a one-half rate of an appropriate PRE residual herbicide program followed by a sequential application of Roundup Ultra for wirestem muhly control. The PRE residual herbicide(s) suppress annual weeds and the postemergence application of Roundup Ultra can be timed for maximum effect on the wirestem muhly.

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## INTRODUCTION

Corn hybrids resistant to the non-selective, non-residual herbicides, Liberty (glufosinate) and Roundup Ultra (glyphosate) have the potential to reduce or eliminate residual herbicides in corn weed control programs and to provide new control options for hard-to-control perennial weeds. Although it is generally accepted that timing of these total postemergence weed control programs is critical for corn, research results on the need for residual herbicides in these programs remain mixed in the Northeast. If weed control and corn yields with no residual or reduced rates of residual herbicides with Liberty and Roundup Ultra would be equal to or better than those with preemergence (PRE) programs, there would be a major reduction in the use of soil-applied (residual) herbicides that have the potential to contaminate surface and groundwater. Determining how much, if any, residual herbicide is needed in these postemergence programs is key to determining how this new technology might be recommended to NY corn growers. In addition, demonstrating the importance of timely application in corn will be valuable in educating growers on the risks of these postemergence weed control programs.

Wirestem muhly [*Muhlenbergia frondosa* (Poir.) Fern.] is a warm-season, perennial grass for which there were no good control recommendations in field corn until the introduction of herbicide-resistant corn hybrids. As a result, this weed has become increasingly problematic across the Northeast. Although the sulfonylurea herbicides Accent (nicosulfuron) and Beacon (primisulfuron) were sometimes used for this weed, the level of control was inadequate. The introduction of Roundup Ready corn hybrids provided the possibility of a good control recommendation for this perennial grass in field corn. There is also the possibility that the use of Liberty herbicide with Liberty Link corn hybrids might provide acceptable control. Documenting the efficacy of these non-selective herbicides for control of wirestem muhly would clearly benefit New York corn growers.

## MATERIALS AND METHODS

### Time of Application/Residual Herbicides

Field experiments were established at the Musgrave Research Farm in Cayuga County, near Mt. Morris in Livingston County, and at the Valatie Research Farm in Columbia County to determine the effect of residual herbicides and time of application on efficacy of Roundup Ready corn weed control programs in 2000. Corn 'DK520RR' was planted May 5 and May 31 in Cayuga and Livingston Counties respectively. Herbicide treatments were applied to 10 by 25 foot plots in a randomized complete block design with four replications. A PRE standard of 4 qt/A of Bullet (alachlor and atrazine) was applied the day of planting at each location. Early and mid-postemergence (EPO and MPO) applications of 2 pt/A of Roundup Ultra alone and with 2.7 qt/A of Bullet were made when corn was in the V2-V3 and V4-V6 stages of development respectively. In addition, there was a late postemergence (LPO) application of 2 pt/A of Roundup Ultra alone when corn was in the V7 stage. In Columbia County, corn 'DK387RR' was planted on May 27, 2000. Again, herbicide treatments were applied to 10 by 25 foot plots in a randomized complete block design with four replications. A PRE standard of 1.1 qt/A of Bicep Lite II Magnum (*S*-metolachlor

and atrazine) and other PRE treatments were applied the following day. EPO, MPO, and LPO applications of 1.5 pt/A of Roundup Ultra alone and following PRE applications of 1 pt/A of Dual II Magnum (*S-metolachlor*) were made when corn was in the V5, V6, and V7 stages of development respectively. In each experiment, visual weed control ratings were made and grain corn yields from the center two rows harvested.

#### Wirestem Muhly Control

An experiment was established near Genoa, NY in Cayuga County to evaluate Roundup Ultra and Liberty herbicides for wirestem muhly control. Corn hybrids 'AG4597RR' and 'P37H26LL' were planted May 29, 2000 in a split plot design with hybrids as main plots and herbicide treatments as subplots. A PRE application of 1.5 qt/A of Bicep Lite II Magnum plus 3.6 pt/A of Prowl (pendimethalin) served as the check. LPO applications of 2 pt/A of Roundup Ultra or 28 oz/A of Liberty were applied following PRE applications of 1/2X (0.75 qt/A) of the PRE standard. In addition, MPO applications of Roundup Ultra or Liberty were made in combination with the 1/2X rate of the PRE standard. Visual control ratings of wirestem muhly were made on August 31 and silage corn yields from the center two rows of each plot harvested on October 12.

## RESULTS AND DISCUSSION

#### Time of Application/Residual Herbicides

The dominant weeds at the Cayuga County site were common ragweed (*Ambrosia artemisiifolia* L.) and green foxtail [*Setaria viridis* (L.) Beauv.]. Rainfall following PRE herbicide application was more than adequate for herbicide activation. In fact with 4.12 inches of rain during the month following PRE application, PRE activity may have been reduced due to dilution. The standard PRE treatment of 4 qt/A of Bullet provided 70 and 77% ragweed and foxtail control respectively (Table 1). EPO applications of 2 pt/A of Roundup Ultra alone or in combination with a 2.7 qt/A (2/3X rate) of Bullet provided similar control of these annual weeds. In contrast, MPO Roundup Ultra alone and with 2.7 qt/A of Bullet provided excellent weed control as did the LPO application of Roundup Ultra alone. Grain corn yield from the PRE standard was 140 bu/A and was similar to the yields from the EPO Roundup Ultra (alone and combination) treatments. The MPO Roundup Ultra treatments averaged 150 bu/A which was significantly higher than the 134 bu/A yield from the LPO Roundup Ultra only treatment. The untreated check yielded only 34 bu/A. These results indicate that the EPO and MPO Roundup Ultra only treatments performed as well as when Roundup Ultra was sprayed with the reduced rate of Bullet. Although the LPO Roundup Ultra only treatment provided excellent weed control, the delayed application resulted in significant yield loss compared with MPO application. With moderate redroot pigweed (*Amaranthus retroflexus* L.) and common lambsquarters (*Chenopodium album* L.) pressure in Livingston County, weed control was good to excellent with all treatments (Table 2). The untreated check yielded 179 bu/A on this highly productive soil. There were few differences in yield among the other treatments, except for the apparent difference between the EPO (199 bu/A) and MPO (169 bu/A) Roundup Ultra plus the 2.7 qt/A rate of Bullet treatments. There is no obvious explanation for this difference. It cannot be attributed to the time-of-application alone since there were no significant differences among the EPO, MPO, and LPO applications of Roundup Ultra alone.

Table 1. Common ragweed (AMBEL) and green foxtail (SETVI) control ratings and grain corn yields with a PRE Bullet application and with Roundup Ultra applied alone and in tank-mixes with a 2/3X rate of Bullet in Cayuga County in 2000.

Herbicides	Rate	When	Control (%)		Yield
	Amt/A	Appl.	AMBEL	SETVI	bu/A
Bullet	4.0 qt	PRE	70	77	140
Bullet	2.7 qt	EPO	70	73	141
Roundup Ultra*	2.0 pt	EPO			
Bullet	2.7 qt	MPO	97	99	151
Roundup Ultra*	2.0 pt	MPO			
Roundup Ultra	2.0 pt	EPO	75	70	147
Roundup Ultra	2.0 pt	MPO	94	95	149
Roundup Ultra	2.0 pt	LPO	99	99	134
Untreated Check	-	-	0	0	34
LSD (0.05)			7	6	14
*Applied with 2 lb/A of ammonium sulfate (AMS).					

Table 2. Redroot pigweed (AMARE) and common lambsquarters (CHEAL) control ratings and grain corn yields with a PRE Bullet application and with Roundup Ultra applied alone and in tank-mixes with a 2/3X rate of Bullet in Livingston County in 2000.

Herbicides	Rate	When	Control (%)		Yield
	Amt/A	Appl.	AMARE	CHEAL	bu/A
Bullet	4.0 qt	PRE	100	100	184
Bullet	2.7 qt	EPO	100	100	199
Roundup Ultra*	2.0 pt	EPO			
Bullet	2.7 qt	MPO	100	100	169
Roundup Ultra*	2.0 pt	MPO			
Roundup Ultra	2.0 pt	EPO	97	85	180
Roundup Ultra	2.0 pt	MPO	100	100	179
Roundup Ultra	2.0 pt	LPO	99	93	177
Untreated Check	-	-	0	0	179
LSD (0.05)			2	7	23
*Applied with 2 lb/A of ammonium sulfate (AMS).					

In the Columbia County experiment, a PRE application of Dual II Magnum (1 pt/A) provided an extended window-of-application for the Roundup Ultra treatments. The PRE standard of 1.1 qt/A of Bicep Lite II Magnum controlled 91 and 90% of the wild radish (*Raphanus raphanistrum* L.) and giant foxtail (*Setaria faberi* Herrm.) and resulted in a yield of 133 bu/A (Table 3). Giant foxtail control was excellent (99%) with the PRE application of 1 pt/A of Dual II Magnum but wild radish was not controlled. EPO, MPO, and LPO applications of 1.5 pt/A of Roundup Ultra alone or following PRE Dual II Magnum application provided good to excellent weed control. Yields with EPO Roundup Ultra applications, alone or following the PRE treatment, were similar to the PRE standard. There were no significant yield reductions with MPO and LPO Roundup Ultra applications following the PRE treatment. On the other hand, yields with MPO and LPO Roundup Ultra only treatments were 112 and 110 bu/A respectively and were lower than the EPO application (133 bu/A). Once again, there was no benefit to having a residual herbicide with EPO Roundup Ultra applications, however a PRE application of residual herbicides did benefit the MPO and LPO Roundup Ultra applications.

Table 3. Wild radish (RAPRA) and giant foxtail (SETFA) control ratings and grain corn yields with a PRE application of Bicep Lite II Magnum and with Roundup Ultra applied alone and following PRE Dual II Magnum applications in Columbia County in 2000.

Herbicides	Rate	When	Control (%)		Yield
	Amt/A	Appl.	RAPRA	SETFA	bu/A
Bicep Lite II Mag	1.1 qt	PRE	91	90	133
Dual II Magnum	1.0 pt	PRE	0	99	110
+ Roundup Ultra*	1.5 pt	EPO	97	100	134
+ Roundup Ultra*	1.5 pt	MPO	85	99	128
+ Roundup Ultra*	1.5 pt	LPO	95	100	124
Roundup Ultra*	1.5 pt	EPO	95	96	133
Roundup Ultra*	1.5 pt	MPO	92	99	112
Roundup Ultra*	1.5 pt	LPO	98	100	110
Untreated Check	-	-	0	0	89
LSD (0.05)			7	4	13

\*Applied with 3 lb/A of ammonium sulfate (AMS).

### Wirestem Muhly Control

Wirestem muhly control was 99% when Roundup Ultra was applied LPO following PRE application of a 1/2X rate of Bicep Lite II Magnum plus Prowl (Table 4). With Liberty applied LPO following the 1/2X rate of the PRE standard, wirestem muhly control was 90%. When Roundup Ultra or Liberty were applied MPO in tank mixes with the 1/2X rate of the PRE standard, control was about 90%. Due to a moderate infestation of wirestem muhly and above normal rainfall, there were no differences in corn silage yields among these treatments. These control results reinforce the recommendation in the *Cornell Guide for Integrated Field Crop Management* for applying a 1/2X rate of appropriate PRE residual herbicide(s) for annual weed suppression followed by a sequential application of Roundup Ultra application for the wirestem muhly.

Table 4. Wirestem muhly (MUHFR) control ratings and silage corn yields with Roundup Ultra and Liberty herbicides applied following application of a 1/2X rate of a PRE residual herbicide program or as tank mixes with the 1/2X rate of residual herbicides in Cayuga County in 2000.

Herbicides	Rate Amt/A	When Appl.	Control (%) MUHFR	Yield bu/A
Bicep Lite II Mag	6.0 pt	PRE	0	18.9
Prowl	3.6 pt	PRE		
Bicep Lite II Mag	3.0 pt	PRE	99	19.1
Prowl	1.8 pt	PRE		
Roundup Ultra	2.0 pt	LPO		
Bicep Lite II Mag	3.0 pt	MPO	90	20.0
Prowl	1.8 pt	MPO		
Roundup Ultra	2.0 pt	MPO		
Bicep Lite II Mag	3.0 pt	PRE	90	18.2
Prowl	1.8 pt	PRE		
Liberty	28 oz	LPO		
AMS	3.0 lb	LPO		
Bicep Lite II Mag	3.0 pt	MPO	89	18.8
Prowl	1.8 pt	MPO		
Liberty	28 oz	MPO		
AMS	3.0 lb	MPO		
LSD (0.05)			5	2.2