

**PENNSYLVANIA VEGETABLE MARKETING AND RESEARCH PROGRAM  
PENNSYLVANIA VEGETABLE GROWERS ASSOCIATION  
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## **New Herbicide Options for Weed Control in Sweet Corn**

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### **Overall summary:**

- Under heavy weed pressure, a full rate of residual herbicide followed by a postemergence application was needed for consistent weed control.
- The newer herbicides (Acuron, Revulin Q, Solstice, Liberty, and Armezon Pro) performed comparable to Lumax, Accent, and Impact in terms of crop safety and yield.
- Across two years, a trend was observed for more sweet corn injury and a negative effect on yield with Zidua and Verdict plus atrazine that needs further research.

### **Introduction:**

Weed control continues to be a problem in sweet corn. However, over the past few years new herbicides have been labeled for use in sweet corn that could provide effective control of problem weed species. Products such as Acuron, Armezon PRO, Anthem, Liberty, Revulin Q, Solstice, Verdict, and Zidua now can be used in sweet corn production. These products have provided effective weed control and exhibited good

crop safety in field corn, however there is limited research experience with them in sweet corn in Pennsylvania and the Mid-Atlantic region. In addition, with herbicide-resistant weeds spreading in the region, it is critical that growers use other effective modes of action to combat these weed problems. Some of these new products may help. While research was conducted on this project in 2016, more than one year is often necessary to provide confidence in its performance.

Newer GMO sweet corn varieties that are resistant to Roundup and Liberty are currently available for use. These varieties can be valuable since glyphosate and Liberty (glufosinate) provide broad-spectrum weed control with no soil residual issues that could interfere with rotational crops. However, due to the increasing number of glyphosate resistant weed species we did not use Roundup Ready sweet corn varieties in this study.

**Objectives:**

1. To examine various new herbicides in sweet corn to determine their effectiveness on weed control.
2. To evaluate these herbicide programs on sweet corn injury and yield impact.

**Procedures:**

Field studies were conducted in 2017 at the University of Delaware Research and Extension Center in Sussex County and Penn State's Russell E. Larson Agricultural Research Farm in Centre County. Studies were conducted were standard small-plot research techniques, arranged in a randomized complete block design with three replications for sites.

The sites were conventionally tilled and soil at UD the soil was a sandy loam with 0.7% organic matter and at PSU was a silt loam with over 2% organic matter. DE site was irrigated. Sweet corn 'BC0805' was planted on May 11 at 24,000 seeds/A at the DE site. At the PA site, 'Remedy' was planted May 22 at 22,000 seeds/A.

Preemergence (PRE) herbicides were applied at planting and postemergence (POST) treatments were applied 4 weeks after planting (4 WAP) on June 8 and June 22 at UD and PSU, respectively. UD treatments were applied in 20 g/A while PSU used 15 g/A.

**Early-season evaluations for PRE applications.**

At 4 WAP, stunting was observed with Verdict+atrazine and Zidua+atrazine at both locations, ranging from 8 to 15% stunting (Table 1). Injury was still observable 5 to 6 WAP, with up to 11% stunting with Zidua at UD and at PSU there was 16 and 20% stunting for Zidua+atrazine and Verdict+atrazine, respectively (Tables 2 and 3).

At UD, Palmer amaranth control was best with Lumax EZ, Acuron, Verdict+atrazine, and Zidua+atrazine (Table 1). Zidua alone and Anthem Maxx provided 85 to 91% control at 4 WAP. Morningglory control ranged from 79 to 89% control with all treatments. Fall

panicum control was at least 95% for all treatments, except Lumax EZ and Verdict+atrazine. Note the low rate of Bicep II Magnum/Cinch ATZ was not rated at DE.

At PSU, common lambsquarters control was excellent ( $\geq 96\%$ ) for all treatments except the low rate of Bicep II Magnum (Table 1). All treatments provide at least 98% control of smooth pigweed, PA smartweed, and giant foxtail. There was no significant differences for velvetleaf, with all treatments providing at least 94% control.

#### **Mid-season evaluations.**

Palmer amaranth control at UD was best with POST applications of a HPPD-herbicide (Group 27) including Armezon, Impact, or Solstice (Table 2). However, treatments of Revulin Q and Accent Q plus Impact also contained a Group 27 herbicide, but control was reduced. In addition, Liberty POST only provided 85% control of Palmer amaranth. This reduced control can be attributed to poor or no early-season control with these treatments, which allowed Palmer amaranth to get too large for complete control.

Morningglory control was less than 88% for all treatments, with applications including Revulin Q, Solstice, and Accent Q plus Impact providing 79 to 88% control. Acuron applied PRE, was providing 86% control at 5 WAP. Armezon Pro and Impact provided 67 and 77% control, respectively.

Fall panicum control was at least 87% for all POST treatments except low rate of Bicep followed by Solstice. Zidua applied PRE provided excellent fall panicum control, with 95% control at 5 WAP.

At PSU, overall weed control was excellent for all species (Table 3). Smooth pigweed control was 99% for all treatments. Verdict+atrazine and Accent Q plus Impact provided at least 87% control of remaining species, but this was statistically lower than other treatments.

#### **Yield.**

Yield at UD was lowest for Verdict+atrazine and Zidua+atrazine (Table 2). Some of the reduced yield was due to weed competition, but Zidua+atrazine and Accent Q plus Impact had compared levels of weed control but yields (lbs./A and number of marketable ears) was significantly different. In terms of marketable ears per acre, the trends do not followed overall weed control. Treatments with only PRE applications had lower number of ears, but Verdict+atrazine and Zidua+atrazine were lower than Lumax EZ or Acuron. Zidua followed by Armezon Pro had lower yield than Anthem Maxx followed by Solstice.

Yield at PSU was quite variable and not differences were detected between treatments (Table 3). The third rep was not yielded due to damage. As a trend, the Verdict+atrazine and Zidua+atrazine had lower yields. However, when Zidua or Anthem Maxx (same active ingredient) was applied without atrazine, yields were higher.

**Summary:**

- Weed control was good to excellent ( $\geq 87\%$ ) for all treatments at Rock Springs, PSU
- Weed control at UD (where Palmer amaranth and fall panicum infestations were heavy) was generally best with Bicep followed by Revulin Q, Bicep followed by Impact+atrazine, Zidua followed by Armezon Pro, and Anthem Maxx followed by Solstice. Treatments with reduced rates of Bicep or no PRE herbicide were generally not as effective for Palmer amaranth control
- Verdict+atrazine and Zidua+atrazine caused sweet corn stunting that persisted for at least 6 weeks after planting.
- Yield loss at UD often corresponded with poor weed control, except Zidua+atrazine and Zidua followed by Armezon Pro where yield loss was observed even though weed control was acceptable.
- In 2016, sweet corn injury from all treatments was minimal at both locations and no significant yield differences at UD. However, there was a trend towards lower yield with Zidua applied PRE.
- Use of Zidua as PRE application for sweet corn needs further investigation. While significant difference in yield occurred only at one site, the consistent trend towards reduced yields with Zidua was observed across years and should be examined more closely.

Table 1. Early-season sweet corn injury and weed control at UD-REC and PSU Rock Springs in 2017. Ratings taken four weeks after planting.

TrtNo.	Herbicide	Rate <sup>a</sup>	Unit	Timing	Delaware						Penn State			
					Injury <sup>x</sup>	Palmer amrnth	Mrng- glory	Fall panicm	Injury	Lambs- quarter	Giant foxtail			
					----- % -----									
2	Lumax EZ	2.7	qt/A	PRE	8 b	100 a	89 a	94 bc	2 c	99 a	99 a			
3	Acuron	2.5	qt/A	PRE	2 cd	96 ab	88 a	95 ab	3 bc	99 a	99 a			
4	Verdict +Atrazine	10/15 1	fl oz/A qt/A	PRE PRE	11.3 a	92 abc	81 bc	89 c	15 a	99 a	99 a			
5	Zidua SC +Atrazine	2/2.5 1	fl oz/A qt/A	PRE PRE	10.7 ab	95 ab	86 ab	97 ab	8 b	99 a	99 a			
6-9	Bicep II Mag.	1	qt/A	PRE	0 d	-- <sup>y</sup>	--	--	1 c	65 b	99 a			
10	Zidua SC	2	fl oz/A	PRE	8.7 ab	85 c	80 bc	99 a	6 bc	96 a	98 a			
11	Anthem Maxx <sup>b</sup>	3	fl oz/A	PRE	4.7 c	91 bc	79 c	95 ab	5 bc	99 a	99 a			
	<i>P<sup>z</sup>&gt;F</i>				0.0001	0.027	0.011	0.027	0.002	0.0001	0.468			

<sup>a</sup>If rates differed between the locations, the UD rates/PSU rates.

<sup>b</sup>Anthem Maxx at 3 fl oz is equivalent to Zidua SC at 1.9 fl oz.

<sup>x</sup>Means within a column followed by the same letter are not significantly different ( $p=0.05$ ) according to Fisher's protected LSD test.

<sup>y</sup>--means ratings not taken.

<sup>z</sup>P values  $\leq 0.05$  indicate significant differences exist among treatments.

Table 2. Sweet\_corn injury one week after POST applications and weed control three weeks after POST applications at UD-REC in 2017.

TrtNo	Herbicide	Rate	Unit	Timing	Injury*	Palmer amrnth	Morn- glory	Fall panicm	Yield lbs	Total ears	# ears market	
					----- % -----			----- per acre -----				
1	Untreated Chk								4,532 d	12,348 a	2,273 e	
2	Lumax EZ	2.7	qt/A	PRE	7.3 ab	89 cd	64 d	69 e	8,585 ab	15,379 a	8,560 c	
3	Acuron	2.5	qt/A	PRE	2.3 bc	85 de	68 cd	78 d	9,926 a	17,854 a	9,621 bc	
4	Verdict + Atrazine	10* 1	fl oz/A qt/A	PRE PRE	2.3 bc	57 g	86 a	63 e	6,168 cd	16,439 a	1,515 e	
5	Zidua SC + Atrazine	2* 1	fl oz/A qt/A	PRE PRE	11.2 a	77 f	50 e	95 ab	7,098 bc	16,666 a	5,530 d	
6	Bicep II Mag. Revolin Q NIS + 30% UAN**	1 3.4*	qt/A oz wt/A	PRE 4 WAP	2.3 bc	93 bc	82 ab	96 a	10,656 a	18,182 a	10,606 abc	
7	Bicep II Mag. Solstice COC	1 3 <sup>a</sup>	qt/A fl oz/A	PRE 4 WAP	2.3 bc	98 ab	82 ab	63 e	9,531 a	17,424 a	8,864 c	
8	Bicep II Mag. Impact Atrazine COC + 30% UAN**	1 0.5* 1	qt/A fl oz/A pt/A	PRE 4 WAP 4 WAP	2.3 bc	97 ab	77 bc	88 bc	9,581 a	15,379 a	11,136 abc	
9	Bicep II Mag. Liberty 280 AMS	1 20	qt/A fl oz/A	PRE 4 WAP	0 c	85 de	77 b	92 abc	10,895 a	17,954 a	12,121 ab	
10	Zidua SC Armezon Pro NIS + 30% UAN**	2 20*	fl oz/A fl oz/A	PRE 4 WAP	9.7 a	98 ab	67 d	96 a	9,269 ab	13,863 a	8,333 cd	

11	Anthem Maxx <sup>b</sup> Solstice COC	3 3 <sup>a</sup>	fl oz/A fl oz/A	PRE 4 WAP	9 a	99 a	88 a	96 ab	10,767 a	17,424 a	11,894 ab
12	Accent Q Impact COC + 30% UAN**	0.5 0.5*	oz wt/A fl oz/A	4 WAP 4 WAP	8 a	82 ef	79 ab	87 c	10,700 a	16,439 a	12,651 a
	<i>P</i> <sup>2</sup> > <i>F</i>				0.003	0.0001	0.0001	0.0001	0.0001	0.191	0.0001

AMS= ammonium sulfate; COC= crop oil concentrate; NIS= nonionic surfactant.

<sup>a</sup>PSU treatments included 0.5 lbs ai of atrazine (1 pt/A).

<sup>b</sup>Anthem Maxx at 3 fl oz is equivalent to Zidua SC at 1.9 fl oz.

\*Rates differ from PSU trials.

\*\*Adjuvants differ from PSU trials.

<sup>x</sup>Means within a column followed by the same letter are not significantly different ( $p=0.05$ ) according to Fisher's protected LSD test.

<sup>z</sup>P values  $\leq 0.05$  indicate significant differences exist among treatments.

Table 3. Sweet\_corn injury and weed control two weeks after POST applications at Rock Springs, PSU in 2017.

TrtNo	Herbicide	Rate	Unit	Timing	Injury <sup>x</sup>	Lambs- quarter	Smooth pigwd	Velvet- leaf	Smart- weed	Giant foxtail	Yield lbs/A
----- % -----											
1	Untreated Chk										11,249 a
2	Lumax EZ	2.7	qt/A	PRE	5 de	99 a	99 a	99 a	99 a	99 a	16,905 a
3	Acuron	2.5	qt/A	PRE	3 e	99 a	99 a	99 a	99 a	98 a	20,554 a
4	Verdict + Atrazine	15* 1	fl oz/A qt/A	PRE PRE	20 a	91 b	95 a	90 b	95 b	96 b	6,827 a
5	Zidua SC + Atrazine	2.5* 1	fl oz/A qt/A	PRE PRE	16 ab	97 a	99 a	99 a	99 a	99 a	12,483 a
6	Bicep II Mag. Revulin Q COC**	1 4*	qt/A oz wt/A	PRE 4 WAP	2 e	98 a	99 a	99 a	99 a	99 a	19,947 a
7	Bicep II Mag. Solstice Atrazine COC	1 3 1 <sup>a</sup>	qt/A fl oz/A pt/A	PRE 4 WAP 4 WAP	5 de	99 a	99 a	99 a	99 a	99 a	18,749 a
8	Bicep II Mag. Impact Atrazine MSO**	1 0.75* 1	qt/A fl oz/A pt/A	PRE 4 WAP 4 WAP	2 e	99 a	99 a	99 a	99 a	99 a	19,041 a
9	Bicep II Mag. Liberty 280 AMS	1 20	qt/A fl oz/A	PRE 4 WAP	1 e	93 b	99 a	98 a	99 a	99 a	17,348 a
10	Zidua SC Armezon Pro MSO**	2 16*	fl oz/A fl oz/A	PRE 4 WAP	10 cd	99 a	99 a	98 a	99 a	99 a	18,950 a



11	Anthem Maxx <sup>b</sup>	3 fl oz/A	PRE	12 bc	99 a	99 a	99 a	99 a	99 a	15,407 a
	Solstice	3 fl oz/A	4 WAP							
	Atrazine	1 <sup>a</sup> pt/A								
	COC									
12	Accent Q	0.5 oz wt/A	4 WAP	1 e	92 b	99 a	92 b	87 c	91 c	18,895 a
	Impact	0.75* fl oz/A	4 WAP							
	MSO**									
	<i>P<sup>2</sup>&gt;F</i>			0.0001	0.0001	0.476	0.009	0.0001	0.0001	0.188

AMS= ammonium sulfate; COC= crop oil concentrate; NIS= nonionic surfactant

<sup>a</sup>PSU treatments included 0.5 lbs ai of atrazine (1 pt/A).

<sup>b</sup>Anthem Maxx at 3 fl oz is equivalent to Zidua SC at 1.9 fl oz.

\*Rates differ from UD trials.

\*\*Adjuvants differ from UD trials.

<sup>x</sup>Means within a column followed by the same letter are not significantly different ( $p=0.05$ ) according to Fisher's protected LSD test.

<sup>z</sup>P values  $\leq 0.05$  indicate significant differences exist among treatments.