

Title: *Evaluation of atrazine alternatives for postemergence weed control in sweet corn*

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Introduction: Postemergence applications of HPPD-inhibiting herbicides (Group 27; i.e., Callisto, Impact, Laudis) are commonly used to control broadleaf and some annual grass weeds in sweet corn production. Tank mixing these herbicides with atrazine is commonly recommended because previous research has demonstrated improved weed control efficacy of certain species and a greater weed control spectrum compared to using HPPD-inhibiting herbicides alone. Atrazine remains a key component to sweet corn weed management programs due to its low cost and control efficacy. However, rotational restrictions following atrazine use (up to 24 mo rotation interval) limits its use in diverse rotations, preventing the flexibility in crop rotation management that is often necessary to fulfill processing vegetable contracts. In addition, there is growing concern over increased restrictions on atrazine use due to contamination of water supplies, which has led to increased interest in finding alternatives to atrazine for weed control in corn. Preliminary field crop research conducted in other regions suggest that herbicides with the same mode action as atrazine can also increase the efficacy of HPPD-inhibiting herbicides. These alternative herbicides include Basagran (labeled in sweet corn) and Maestro/Buctril (field corn only). Preliminary research suggests that Starane Ultra (labeled in sweet corn) can also synergize HPPD inhibiting herbicides. Each of these atrazine alternatives have shorter rotation restrictions than atrazine (**Table 1**).

The objective of this study was to compare the weed control efficacy of key postemergence HPPD inhibiting herbicides (Group 27) applied alone or in combination with atrazine, Basagran, Maestro or Starane Ultra to determine if these potential atrazine alternatives can produce similar levels of weed control.

Table 1. Sample of crop rotation intervals for atrazine and potential alternatives.

Herbicide	Rotational Interval to Crop Planting (months)					
	Snap bean	Cabbage	Tomato	Pumpkins	Cucumber	Cereal Rye
Atrazine	24	24	24	24	24	24
Basagran	0	0	0	0	0	0
Maestro	1	1	1	1	1	1
Starane Ultra	4	4	4	4	4	0

Materials & Methods: Field trials were conducted in the 2021 growing season at three locations (Georgetown DE, Rock Springs PA, Geneva NY). Herbicide treatments (**Table 2**) were imposed in a randomized complete block design with three replications. The plots were four rows by 25 feet long and a representative sweet corn variety was used at each location. Standard tillage and seed bed preparation was used followed by an application of a set-up pre-emergence herbicide program (Dual II Mag) across the study site within 2 days of planting. Postemergence herbicide treatments were applied at the V3 crop growth stage. Weed control and crop injury was visually evaluated 2 and 4 weeks after application of postemergence herbicide treatments and just prior to harvest.

Table 2. Herbicide treatments.

Trt No.	HPPD (Group 27)	Product Rate	Tank mix	Product Rate
1	Callisto	3 oz/ac	--	--
2	Callisto	3 oz/ac	Atrazine	1 pt/ac
3	Callisto	3 oz/ac	Basagran	2 pt/ac
4	Callisto	3 oz/ac	Maestro	1.5 pt/ac
5	Callisto	3 oz/ac	Starane Ultra	0.4 pt/ac
6	Impact	0.75 oz/ac	--	--
7	Impact	0.75 oz/ac	Atrazine	1 pt/ac
8	Impact	0.75 oz/ac	Basagran	2 pt/ac
9	Impact	0.75 oz/ac	Maestro	1.5 pt/ac
10	Impact	0.75 oz/ac	Starane Ultra	0.4 pt/ac
11	Untreated	--	Atrazine	1 pt/ac
12	Untreated	--	Untreated	--

Results: Replicated field trials across multiple Mid-Atlantic locations allowed for assessment of herbicide efficacy on different weed species.

At the Delaware location, herbicide treatments did not affect Palmer amaranth control 49 days after application (DAA), with control levels ranging between 85 and 99%. Callisto-based treatments resulted in higher levels of annual morningglory control 49 DAA compared to Impact-based treatments (**Table 3**). Tank-mixing Starane Ultra or Basagran with Callisto resulted in Palmer amaranth and annual morningglory control levels comparable to the Callisto and atrazine tank-mix. Use of Maestro as the tank-mix partner with Callisto resulted in significantly lower annual morningglory control 49 DAA. However, use of Maestro as a tank-mix partner with Impact resulted in significantly greater annual morningglory control compared to Impact alone, with atrazine, or with Basagran. Sweet corn injury was minimal across herbicide treatments.

Table 3. Crop injury and weed control in response to herbicide treatments in 2021 experiment located in Georgetown, DE. Means followed by same letter are not significantly different ($P > 0.05$). DAA = days after application; NS = non-significant.

Treatment	Crop response	Palmer amaranth	Annual morningglory
	35 DAA	49 DAA	49 DAA
	% injury	% control	% control
Callisto	3	85	96 a
Callisto + atrazine	10	99	99 a
Callisto + Basagran	0	94	99 a
Callisto + Maestro	2	93	66 b
Callisto + Starane Ultra	2	91	94 a
Impact	0	81	36 c
Impact + atrazine	3	89	70 b
Impact + Basagran	4	85	36 c
Impact + Maestro	0	99	93 a
Impact + Starane Ultra	3	88	83 ab
atrazine	4	92	96 a
<i>P</i> -value	NS	NS	< 0.001

At the Pennsylvania location, all herbicide combinations resulted in high levels (> 90%) of common lambsquarters and redroot pigweed control 30 DAA (**Table 4**). Though not significantly different, higher levels of weed control were observed in Callisto-based treatments compared to Impact-based treatments both 30 and 60 DAA. Using tank-mix partners with Impact generally increased common lambsquarters control compared to use of Impact alone. Moderate levels of sweet corn injury (7 - 15%) were observed 30 DAA in treatments that used Maestro or Starane Ultra in combination with Callisto or Impact.

Table 4. Crop injury and weed control in response to herbicide treatments in 2021 experiment located in Rock Springs, PA. Means followed by same letter are not significantly different ($P > 0.05$). DAA = days after application; NS = non-significant.

Treatment	Crop response	Common lambsquarters		Redroot pigweed	
	30 DAA	30 DAA	60 DAA	30 DAP	60 DAA
	-- % injury --	--- % control ---		-- % control ---	
Callisto	3	99	99	99	99
Callisto + atrazine	2	99	99	99	99
Callisto + Basagran	5	99	99	99	99
Callisto + Maestro	7	99	99	99	99
Callisto + Starane Ultra	15	99	99	99	99
Impact	3	86	81	97	96
Impact + atrazine	2	99	93	99	99
Impact + Basagran	5	96	91	96	91
Impact + Maestro	10	99	99	99	99
Impact + Starane Ultra	12	99	93	99	99
atrazine	2	90	85	87	83

At the New York location, high levels of weed control (> 90%) were observed across herbicide treatments (**Table 5**). However, significant sweet corn injury (> 30%) was observed 35 DAA when Maestro was used in combination with either HPPD herbicide, as well as the combination of Callisto + Basagran. Field observations suggested that significant rainfall followed by soil water exceeding field capacity close to the time of POST herbicide applications likely contributed to enhanced and prolonged sweet corn injury to these treatments.

Table 5. Crop injury and weed control in response to herbicide treatments in 2021 experiment located in Geneva, NY. Means followed by same letter are not significantly different ($P > 0.05$). DAA = days after application; NS = non-significant.

Treatment	Crop response	Total weed control
	30 DAA % injury	30 DAA % control
Callisto	6	99
Callisto + atrazine	3	99
Callisto + Basagran	35	99
Callisto + Maestro	48	99
Callisto + Starane Ultra	--	--
Impact	5	99
Impact + atrazine	3	99
Impact + Basagran	8	99
Impact + Maestro	31	99
Impact + Starane Ultra	--	--
atrazine	0	99

Summary & Conclusions. Study results suggest that Basagran, Maestro and Starane Ultra can be suitable replacements for atrazine as a tank-mix partner with HPPD herbicides for postemergence control of small seeded broadleaf weeds like pigweeds and lambsquarters. However, variable control levels were observed on annual morningglory, which is a larger seeded species. Additional field trials should be considered to evaluate these treatment combinations on other problematic weed species in the region. Significant crop injury was observed in Basagran and Maestro treatments at one location, though environmental conditions may have exacerbated the magnitude and length of crop injury. Additional field-level evaluations should be considered to develop non-atrazine tank-mix programs for use of HPPD herbicides in sweet corn production systems.