Weed Control Options for Sweet Corn

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Vince Lawson, Superintendent

Muscatine Island Research & Demonstration Farm

Iowa State University

Muscatine Island Research & Demonstration Farm

1935 *75th Anniversary* 2010

Why Is Weed Control Important?

- Weeds compete with crop for water, nutrients & sunlight – reducing crop yield & quality.
- Weeds make disease & insect control more difficult.
- Weeds interfere with harvest.
- Letting weeds reproduce (go to seed) perpetuate these problems in next crop.

New Sweet Corn Herbicide
Zidua 85WDG, BASF Corp.

- Zidua 85WDG (pyroxasulfone) – Group 15 acetamide class herbicide provides residual control of annual grasses and small seeded broadleafs.
- Labeled for corn (field, pop, seed and sweet) and soybean.
- Zidua 85WDG has similar mode of action to Dual, Harness, Outlook, etc. controls germinating seedlings by inhibiting root and shoot growth.
- In its class reported to have improved residual control over several weeds, including Palmer amaranth and pigweeds.

New Sweet Corn Herbicide
Zidua 85WDG, BASF Corp.

- Soil applied - can be used PPI, PRE and EPOST (won't control emerged weeds).
- High specific activity allowing low usage rates: 1.5 – 4.0 oz depending on soil type.
- Can be tank mixed with several herbicides for improved weed control.
- Kumiai owns active ingredient but given marketing rights to three companies:
  - BASF Corp – Zidua (pyroxasulfone)
  - FMC – Anthem (pyroxasulfone + Cadet) for field, sweet & pop corn.
  - Valent – Fierce (pyroxasulfone + Valor) for field corn, soybeans, orchards, vineyards, noncrop areas.

New Sweet Corn Herbicides

- Anthem – premix of Zidua (pyroxasulfone) + Cadet (fluthiacet), from FMC.
- Anthem ATZ – premix of Zidua + Cadet + atrazine, from FMC.
  - Cadet is a contact burn-down herbicide providing little residual control.
  - Pyroxasulfone and atrazine provide soil residual preemergence weed control.
  - 18 month rotation restrictions for some crops.

Group 15 – Acetamide Herbicides

MOA: Disrupts production of very long chain fatty acids inhibiting cell growth and division. Generally affect susceptible seedlings after germination but before emergence.

Active Ingredient	**Product Examples**
Acetochlor	Breakfree, Degree, Harness, Surpass, TopNotch, others
Alachlor	Intrro, Micro-Tech
Metolachlor	Dual II Magnum, others
Dimethenamid	Freedom, Outlook, others
Flufenacet	Define
Pyroxasulfone	Zidua

Group 15 Herbicides Widely Used For Weed Control In Corn

- Generally good crop safety and provide excellent control of grass and several small-seeded broadleaf weeds.
- Applied PPI, PRE, or EPOST.
- Work best when applied to soil surface and shallowly incorporated by rainfall, irrigation or tillage.
- Inhibit root and shoot growth, must be present at weed seed germination or early growth to be effective.
- When used on sweet corn can be tank-mixed with atrazine or Callisto to broaden residual weed control spectrum.

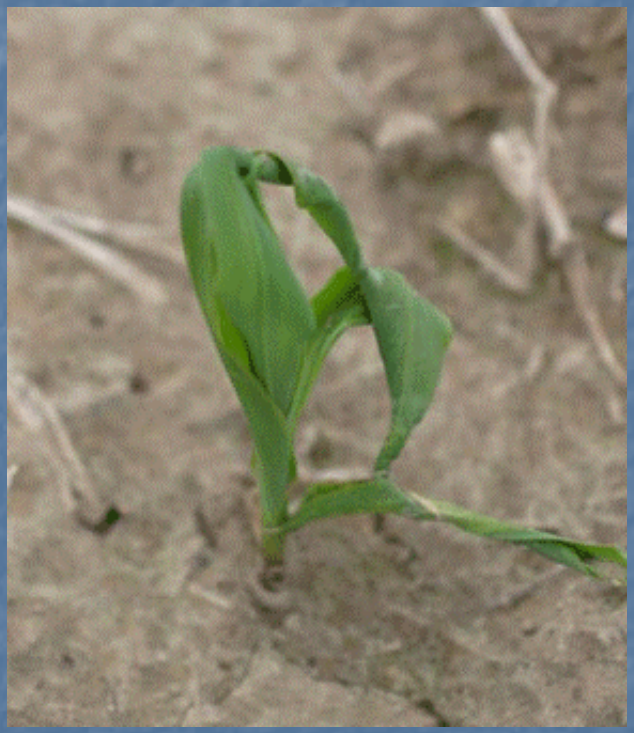


Photo: Define herbicide injury, Kevin Bradley, Unv. of Missouri.

Several Acetochlor Products Are Now Labeled To Use On Sweet Corn.

- **Acetochlor:** Breakfree, Degree, Harness, Surpass, TopNotch.
- **Acetochlor + Atrazine:** Breakfree ATZ, Degree Xtra, Fultime, Harness Xtra, Keystone.
- **See labels for sweet corn usage instructions.**
  - Do not use postemergence.
  - Usage restrictions to prevent ground water contamination.
  - Crop rotational restrictions.

2013 Sweet Corn Herbicide Study

Objective: Evaluate Zidua in a Sweet Corn Weed Management Program

BC0805 sweet corn planted May 10, sand soil, 1.5% OM, pH 6.0, previous crop soybeans. PRE treatments 5/14, EPOST 5/29, POST 6/13.
Wet spring, dry summer but trial irrigated and produced good yield.

2013 Sweet Corn Herbicide Trial
PRE (preemergence) Treatments

Treatment	Timing	Rate/Acre
Dual II Magnum	PRE	1.3 pt
Dual II Magnum + Atrazine 4L	PRE	1.3 pt + 2.0 pt
Zidua 1X	PRE	1.5 oz
Zidua 2X	PRE	3.0 oz
Zidua 3X	PRE	4.5 oz
Zidua 1X + Atrazine	PRE	1.5 oz + 2.0 pt
Zidua 2X + Atrazine	PRE	3.0 oz + 2.0 pt
Zidua 3X + Atrazine	PRE	4.5 oz + 2.0 pt
Zidua + Atrazine + Callisto	PRE	1.5 oz + 1.0 pt + 6.0 oz

2013 Sweet Corn Herbicide Trial
Herbicide Treatments Had Little Effect On Yield

Treatment	Dozen/A	CWT/A	Avg Ear Wt (lb)
Control – no herbicide	1783	161.9	0.55
Dual II Magnum 1.33 pt PRE	1767	168.7	0.60
Zidua 1.5 oz PRE	1791	173.3	0.60
Zidua 3.0 oz PRE	1863	178.3	0.58
Zidua 4.5 oz PRE	1694	155.9	0.55
LSD 5%	*n.s.*	*n.s.*	*0.04*

Sweet Corn Herbicide Trial – PRE Treatments
% Weed Control on July 3

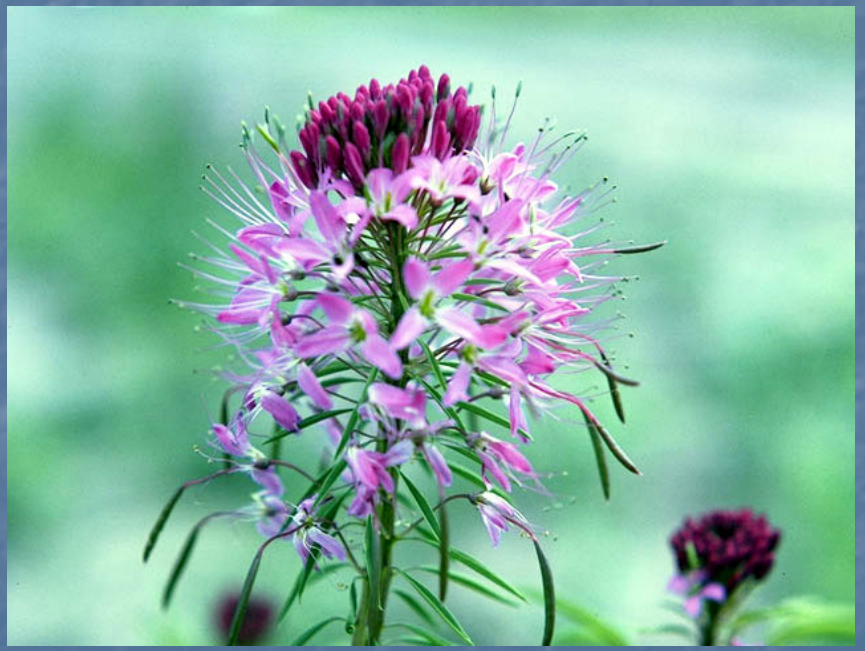
PRE Treatment	Crab grass	Morning glory	Lambs quarter	Carpet weed	Rocky Mtn Bee
Zidua 1.5 oz	61	42	68	81	52
Zidua 3.0 oz	79	59	76	78	56
Zidua 4.5 oz	81	81	96	92	92
Dual II Mag 1.3 pt	77	71	40	17	3

PRE treatments applied May 14, 4.2" rainfall after application.
Sweet corn planted May 10, coarse sand soil, 1.5% O.M.

Rocky Mountain Beeplant

Cleome serrulata

Annual plant, trifoliate leaves, long capsule fruit.



Sweet Corn Herbicide Trial – PRE Treatments
% Weed Control on July 3

PRE Treatment	Crab grass	Morning glory	Lambs quarter	Carpet weed	Rocky Mtn Bee
Zidua 1.5 oz	61	42	68	81	52
Zidua 1.5 oz Atrazine 2.0 pt	62	83	96	100	76
Dual II Mag 1.3 pt	77	71	40	17	3
Dual II Mag 1.3 pt Atrazine 2.0 pt	68	77	75	67	61

PRE treatments applied May 14, 4.2" rainfall after application.
Sweet corn planted May 10, coarse sand soil, 1.5% O.M.

Sweet Corn Herbicide Trial

Photos July 13, 2013

Dual II Magnum 1.3 pt PRE

Dual II Mag. (1.3 pt) + Atrazine (2.0 pt) PRE

Sweet Corn Herbicide Study, 2005

Providence sweet corn planted 5/4. PRE treatments applied 5/4: Dual II Magnum 1.33 pt, Aatrex 4L 2.0 pt, Callisto 6.0 oz

Treatment	Dozen Ears/A	Ear Length	Ear Wt lb
Dual II Mag	831	8.1	.41
Dual + Aatrex	1585	8.5	.51
Dual + Callisto	1991	8.5	.55
Dual + Aatrex + Callisto	1914	8.7	.53
Applying Dual II Magnum with Aatrex and/or Callisto PRE improved weed control and marketable yield.			

2005 Sweet Corn Herbicide Trial
Photos June 10

Dual II Magnum 1.3 pt PRE

Dual II Mag. (1.3 pt) + Atrazine (2.0 pt) PRE

2005 Sweet Corn Herbicide Trial
Photo June 10

Duall II Magnum (1.33 pt) + Callisto (6.0 oz) PRE
Callisto provided best control of velvetleaf.

2013 Sweet Corn Herbicide Trial
EPOST & POST Treatments*

Treatment	Timing	Rate/Acre
Zidua 1X + Atrazine	EPOST	1.5 oz + 2.0 pt
Zidua 2X + Atrazine	EPOST	3.0 oz + 2.0 pt
Zidua Atrazine + Callisto	PRE POST	1.5 oz 1.0 pt + 3.0 oz
Zidua Atrazine + Armezon	PRE POST	1.5 oz 1.0 pt + 0.75 oz
Zidua + Atrazine Armezon + Atrazine	PRE POST	1.5 oz + 1.0 pt 0.75 oz + 1.0 pt

**POST treatments did not hurt yield or ear size.*
EPOST applied May 29 @ V3; POST applied June 13 @ V5.

New Sweet Corn Herbicide **Armezon**, BASF Corp.

- Active ingredient is topramezone (same as Impact from AMVAC).
- Systemic postemergence control or suppression of emerged broadleaf and grass weeds in corn (field, sweet, pop).
- Low usage rates of 0.5 – 1.0 fl oz/A.
- Recommended to apply with adjuvant such as MSO or AMS.
- Do not apply within 45 days of harvest or after V8 growth stage.
- Tank mix with atrazine improves weed control.
- Crop rotation restrictions – 18 months for cucurbits, tomatoes & most vegetables; 9 months for dry bean, snap bean, potato, and some other crops.

Group 27 – HPPD Inhibitors

MOA: Disrupts plant pigment biosynthesis and photosynthesis. Treated plants develop bleaching symptoms in new leaves which progresses to necrosis and plant death. Used in corn for POST control of key broadleaf and certain grass weeds. Soil residual activity in some compounds (mesotrione).

Active Ingredient	**Product Examples***
Mesotrione	Callisto
Tembotrione	Laudis
Topramezone	Impact, Armezon

*Also available as premixes with other compounds.

POST Treatments
% Weed Control on July 3

Treatment	Crab grass	Morning glory	Lambs quarter	Carpet weed	Rocky Mtn Bee
Zidua 1.5 oz + Atz 2.0 pt + Callisto 6.0 oz PRE	69	65	100	98	95
Zidua 1.5 oz PRE Atz 1.0 pt + Callisto 3.0 oz POST	**87**	**97**	98	100	100
Zidua 1.5 oz PRE Atz 1.0 pt + Armezon 0.75 oz POST	**86**	**83**	99	100	96
Zidua 1.5 oz + Atz 1.0 pt PRE Atz 1.0 pt + Armezon 0.75 oz POST	**83**	**88**	97	100	96

PRE treatments applied May 14, 4.2" rainfall after application.
POST treatments applied June 13.

Sweet Corn Herbicide Trial

Photos July 13, 2013

Zidua 1.5 oz PRE
Atrazine 1.0 pt + Callisto 3.0 oz
POST

Zidua 1.5 oz PRE
Atrazine 1.0 pt + Armezon 0.75 oz
POST

Sweet Corn Herbicide Trial – PRE vs. EPOST
% Weed Control on July 3

Treatment	Crab grass	Morning glory	Lambs quarter	Carpet weed	Rocky Mtn Bee
Zidua 1.5 oz + Atz 2.0 pt PRE	62	83	96	100	76
Zidua 3.0 oz + Atz 2.0 pt PRE	66	74	94	100	98
Zidua 1.5 oz + Atz 2.0 pt EPOST	*56*	***96***	*100*	*100*	*98*
Zidua 3.0 oz + Atz 2.0 pt EPOST	***86***	***94***	*100*	*100*	*97*

PRE treatments applied May 14, 4.2" rainfall after application.
EPOST treatments applied May 29 at V3 growth stage.
No significant yield differences between PRE and EPOST treatments.

2013 Zidua Herbicide Evaluation Conclusions

- Zidua performed well and looks to be a good alternative to other Group 15 herbicides (Dual, Harness, Outlook, etc.).
- Zidua showed good crop safety when used with BC 0805 and Temptation sweet corn except at above label rates (4.5 oz/A).
- Broadleaf weed control was improved when used with other herbicides (Armezon, Atrazine, Callisto in this study).
- Herbicide treatments that included POST applications provided best weed control this year.

Weed Control Plan Using Zidua Herbicide On Conventional Hybrid

- Plan to follow RR soybean crop which should reduce weed populations of crab grass, morningglory, lambsquarter, etc.
- Crop following sweet corn will be snap beans.
- Irrigated coarse sand soil type will determine herbicide rates.
- Plan to chisel plow and disk before planting to kill emerged weeds and prepare uniform seed bed for sweet corn planting.

Weed Control Plan Using Zidua Herbicide On Conventional Hybrid

- Planned herbicide applications.
  - PRE - Zidua (2.0 oz) + Atrazine 4L (1.0 pt) *(can't use Callisto because of crop rotation restrictions for snap bean).* Apply to clean tilled ground after planting and before crop emergence.
  - POST – Armezon (0.75 oz) + Atrazine 4L (1.0 pt). Apply when corn V5 growth stage (10" to 12" tall).

Weed Control Plan Using Zidua Herbicide On Conventional Hybrid

- After sweet corn harvest in August field will be tilled to kill weeds and a rye cover crop planted early September.
- Cover crops improve soil tilth, control erosion and hold nutrients.
- Cover crops like rye, sorghum sudan, and buckwheat suppress weeds by competition, shading or allelopathy.

Winter rye planted after sweet corn.

What Else Is New?
Herbicide Tolerant Sweet Corn!

- 2012 Monsanto/Seminis releases Performance Series Sweet Corn having above and below ground insect protection (Bt) and herbicide resistance (glyphosate).

Advantages of Herbicide Tolerant Crops

- Excellent weed control resulting in higher yields and quality.
- More flexibility in herbicide application timing.
- Glyphosate has low toxicity and won't remain active in soil.
- Makes no-till or low-till systems possible benefitting the soil.
- Bt sweet corn reduces pesticide use.

What Are The Concerns?

- Currently, limited cultivar selection in sweet corn.
- Seed expensive, must sign and implement stewardship agreement.
- Not allowed in organic crop production.
- Consumer acceptance of genetically modified organisms (GMO) not universal.
- EPA, FDA, and USDA tasked with weighing benefits and risks.
  - Environmental consequences
  - Human effects
  - Pest resistance

Seminis Performance Series

- Five genetically enhanced cultivars:
  - Obsession II - 80 day bicolor sh2
  - Passion II – 81 day yellow sh2
  - Temptation II – 72 day bicolor se
  - SV9010SA – 79 day bicolor sh2
  - SV9014SB – 76 day bi-color synergistic
- Stacked genetic traits.
  - Herbicide tolerance to glyphosate (Roundup).
  - Three insecticidal proteins:
    - Cry1A.105 - lepidoptera contol
    - Cry2Ab - lepidoptera control
    - Cry3Bb1 - rootworm control

Roundup PowerMax & WeatherMax Herbicide (Monsanto) Supplemental Label for Sweet Corn

- Roundup PowerMax or WeatherMax can be applied to sweet corn preplant burndown, crop preemergence and POST.
- POST application rates 16-22 fl oz/A, do not exceed 44 fl oz/A per application.
- Drop nozzles recommended if corn taller than 24", avoid spraying if corn at reproductive stage.
- Do not apply within 30 days of harvest.
- POST applications can be tankmixed with atrazine, Aim EC, Impact, or Option for improved weed control.
- *Apply Roundup herbicide POST only to "Roundup Ready" sweet corn varieties (Seminis Performance Series).*

What Else Is New?
Herbicide Tolerant Sweet Corn!

- 2014 all Attribute and Attribute II sweet corn varieties from Syngenta can now be treated with Liberty 280 SL herbicide.

Attribute®
Insect protection

LIBERTY LINK®

Bayer CropScience Liberty 280 SL Herbicide Supplemental Label for Sweet Corn

- Liberty 280 SL applied from sweet corn emergence until 24” tall or V7.
- Apply at 20 fl oz/A with ammonium sulfate (AMS).
- Two applications can be made per season.
- Do not apply within 50 days of harvest.
- Can be tankmixed with atrazine, Callisto, Laudis or Permit for improved weed control.
- *Apply Liberty 280 herbicide only to “Liberty-Link” herbicide tolerant hybrids (Syngenta “Attribute” and “Attribute II” hybrids).*

Syngenta Seeds: Attribute II

- Attribute II hybrids available in 2014: Protector a yellow sh2
- Stacked Bt genes provide two insecticidal proteins: Vip3A & Cry1Ab.
- Vip3A (vegetative insecticidal protein) is functionally and structurally different from Cry1Ab protein and provides new mode of action.
- Bt proteins expressed in almost all corn kernels resulting in improved worm control over single gene Bt hybrid.
- Improved control of corn earworms, fall armyworms, black cutworms, western bean cutworm, european and southwestern corn borers and others.
- Herbicide tolerance to Liberty (glufosinate).

Glufosinate (Liberty) and Glyphosate (Roundup) – What's the Difference?

- Both are broad spectrum nonselective POST herbicides used on herbicide tolerant plants. Active ingredients sound similar but have different modes of action!
  - **Glufosinate:** Group 10 glutamine synthesis inhibitor, acts as a contact burn down herbicide. Works best with good coverage of weeds under 6" tall and conditions are warm and sunny.
  - **Glyphosate:** Group 9 EPSP Synthase inhibitor, translocated within plant and blocks biosynthesis of amino acids and plant metabolites. Can be more effective on large plants and grasses than glufosinate.

Roundup – A Victim of Its Own Success?

- Monsanto introduced “Roundup” (glyphosate) in the 1970s.
- Glyphosate is a broad spectrum, nonselective, systemic herbicide used to kill broadleaf and grass weeds.
- Needs to make contact with weed foliage as it provides no residual control.
- With the introduction of glyphosate resistant crops it has become most widely used herbicide in the world.
- Besides agriculture it is also used in large quantities on industrial and government property and by home owners.
- *Unfortunately, overuse is leading to the development of glyphosate resistant weed populations.*

Integrated Weed Management Recommended To Slow Development Of Herbicide Resistant Weeds

- Plan – weed control is continual and ongoing; develop compatible but different control strategies for all crops in rotation.
- Crop Rotation – different crops and cultural methods disrupt weed growth cycles and help prevent buildup of problem weeds.
- Cultural Practices – use recommended practices that promote healthy vigorous crops that out-compete weeds.
- Mechanical Tillage – effective tillage practices kill weeds nonselectively and will slow the development of resistant weeds.
- Herbicides – use multiple modes of action to avoid development of herbicide resistant weed populations.

Weed Control Example Using Attribute BC 0805 (Liberty Link) Sweet Corn

- Planning: First Step in a Weed Mangement Program!
  - Scout fields to identify problem weeds and develop effective control strategies for them.
  - PROBLEM: hard to control pigweed/waterhemp with resistance to atrazine (Group 5), glyphosate (Group 9) and ???

Palmer amaranth

Weed Management Components: *Good Cultural Practices*

- Good cultural practices encourage healthy crop plants that out-compete weeds.
  - Soil pH 6.0 to 6.8.
  - Proper fertility.
  - Irrigation management.
  - Pest control.
  - Uniform plant stand.

www.btny.purdue.edu/Pubs/ID/ID-56

Weed Control Example Using Attribute BC 0805 (Liberty Link) Sweet Corn In Field With Herbicide Resistant Pigweed

- Till ground to kill weeds and prepare seedbed before planting.
- Apply residual herbicide PRE for grass and broadleaf control.
  - Zidua 85WDG (Group 15) and Callisto (Group 27) – use full label rate for soil type.
  - If small weeds have emerged after tillage Gramoxone (Group 22) can be added.

Weed Control Example Using Attribute BC 0805 (Liberty Link) Sweet Corn

- POST herbicide application use Liberty 280SL (Group 10) on weed escapes.
  - Can apply over the top up to corn V7 or 24” tall.
  - 20 fl oz/A with AMS, may apply twice per season.
  - Can be tank mixed with atrazine (Group 5) or Sandea (halosulfuron, Group 2) to provide better weed control and residual. (Since Callisto was used at planting we can’t use it again POST).

Weed Control Example Using Attribute BC 0805 (Liberty Link) Sweet Corn

- After sweet corn harvest destroy late season weeds before they reproduce and contribute to next year's weed problems.
- Plant cover crop such as winter rye or sorghum sudan grass to maintain soil quality and inhibit weed growth.

Integrated Weed Management Practices Used In This Example

- Planning – a crop rotation with good cultural and weed control practices was planned out in advance.
- Crop Rotation – soybean/sweet corn/potato and cover crop allows variety of cultural methods and herbicides to be used.
- Cultural Practices – good fertility, pest control, and irrigation management promote healthy crop.
- Mechanical Tillage – both sweet corn and potato crops will require tillage before planting and after crop removal.
- Herbicides – multiple modes of action.
  - Soybeans: Prowl (3) and Roundup (9)
  - Sweet corn: Zidua (15), Callisto (27), Atrazine (5), Liberty (10)
  - Potato: Dual II Magnum (15), Lorox (7) Poast (1)

Where To Find Weed Control Information:

- **Midwest Vegetable Production Guide for Commercial Growers.** This bulletin includes recommended weed control practices and products, herbicide effectiveness table, crop rotations restrictions, PHI's, and more. Internet: www.btny.purdue.edu/Pubs/ID/ID-56/.
- Pesticide labels: http://www.cdms.net/LabelsMsds/LMDefault.aspx?ms=1,2,3,4 (or Google "CDMS labels").
- University Agricultural Extension Service & Crop Specialists.
- Herbicide company websites.

Good Luck in 2014!

Vince Lawson, Superintendent

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