2018 Non-GMO Sweet Corn Weed Management

Roger Becker

UNIVERSITY OF MINNESOTA
EXTENSION
Driven to Discover℠

Farm Level Weed Management - Supersedes crop or field level

Manage fields for weeds in all rotations

- **Type of crop, time planted/harvested, fallow or cover for a year, etc.**

When the crop is sweet corn manage, weeds through:

- **Planting date**
- **Variety**
- **Seedbed prep**
  - **tillage, herbicides, cover crops, etc.**

Specific Crop / Field Weed Management

- Post planting:
  - Rotary hoe, tine weeders
  - Cultivate
  - Flaming
  - Grit
- Future?
  - Robotic weeders and sprayers
  - A.I.
  - lethal genes, etc.
- What is not very promising in the future
  - New Herbicides!

Herbicide Resistance Issues

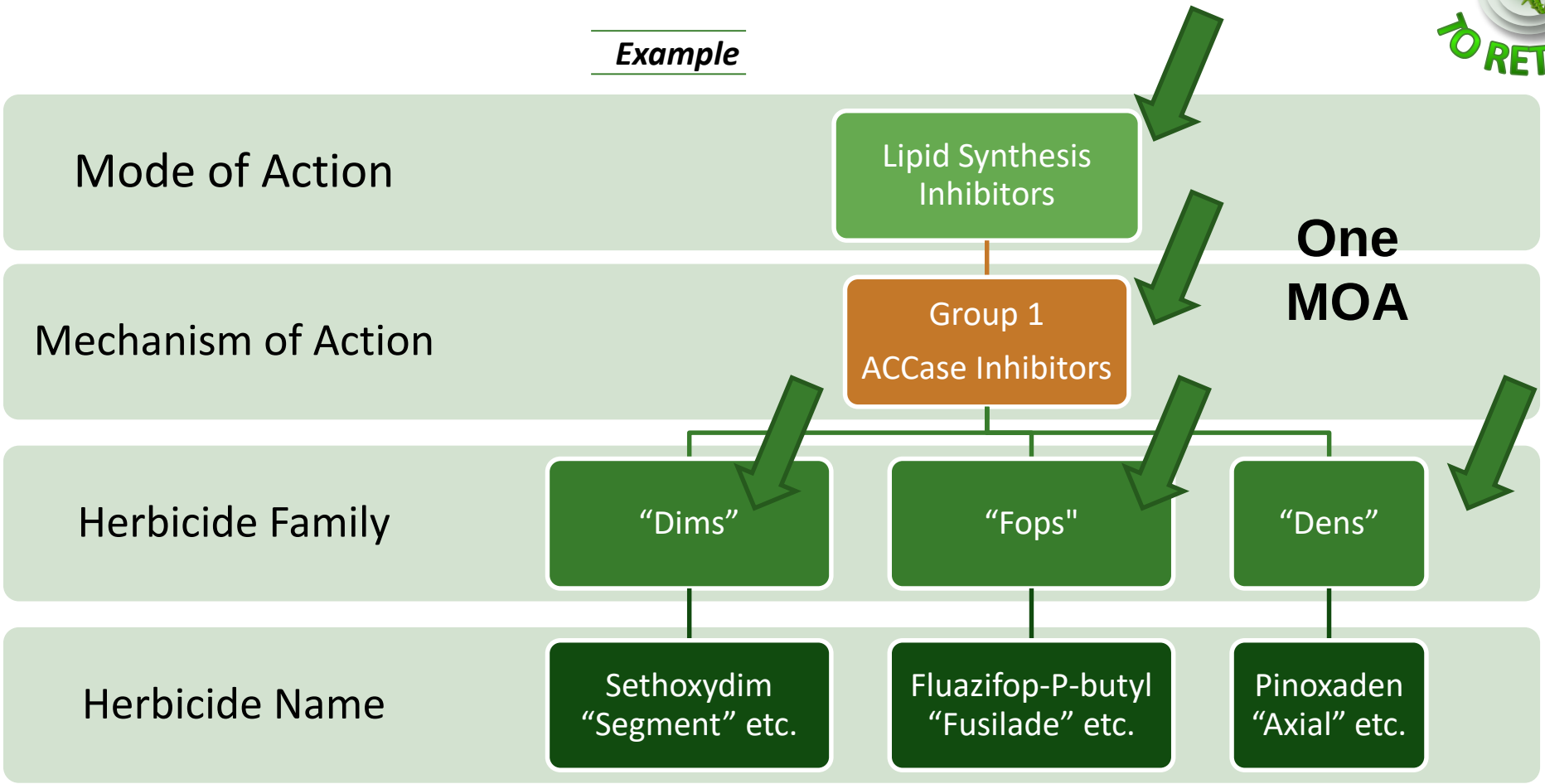
Driving much of the field corn and soybean market new products

- **Influencing product coming online for sweet corn**

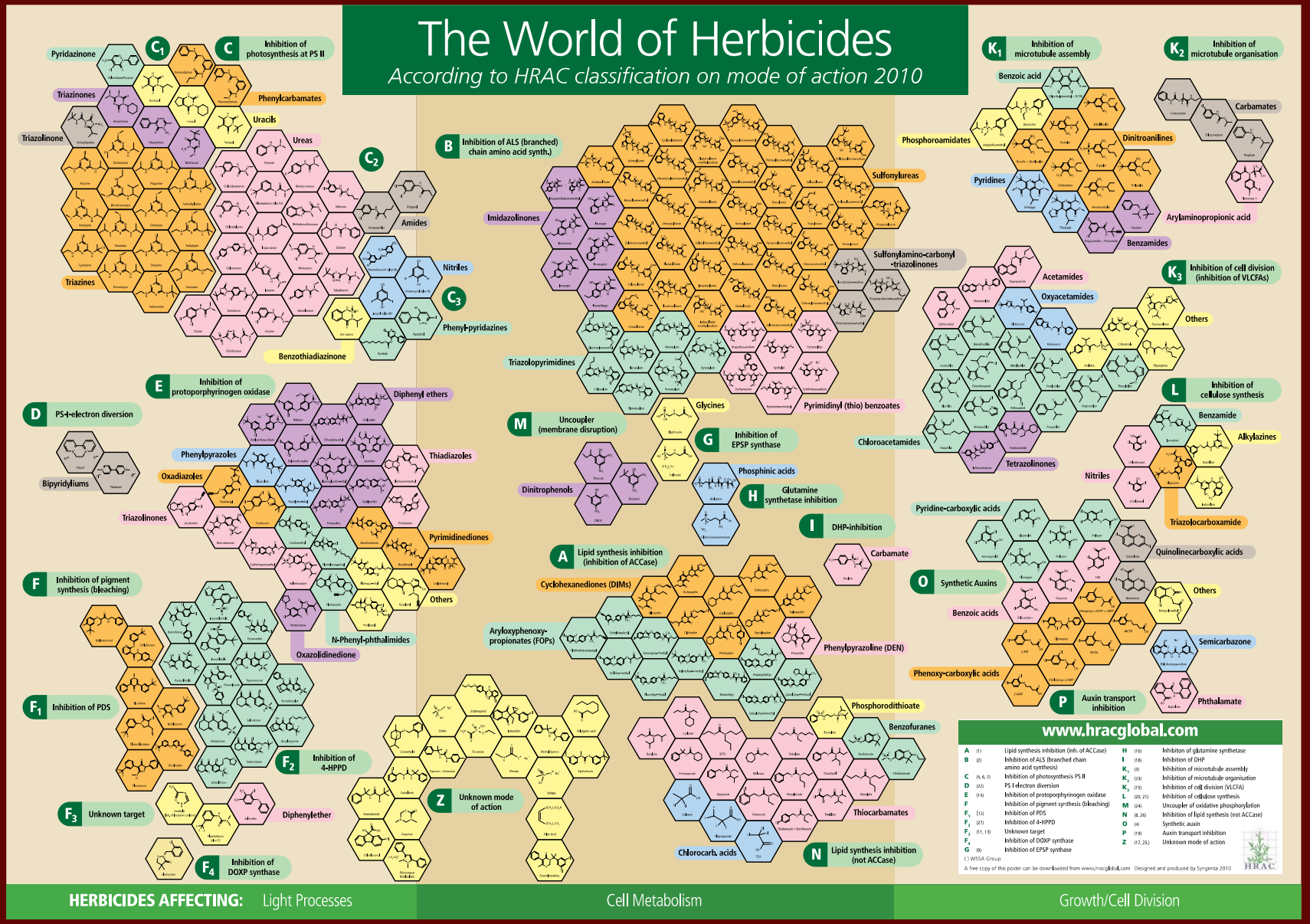
Part of resistance managment is to diversify modes of action (MOA) used

- **Identifies how a herbicide kills a weed**
- **Weed Science Society of America (WSSA) website**
  http://wssa.net

Classification Hierarchy



Herbicide Mode Of Action



http://www.hracglobal.com

University of Minnesota Extension

Sweet Corn Weed Mgt. 2018

http://mwveguide.org

U of M contributions

Roger Becker
Vince Fritz
Bill Hutchison
Angela Orshinsky
Carl Rosen

Soil Applied Single Ingredient

Preemergence options

Annual grasses and some broadleaves:

- **Acetochlor products:** (Harness, Surpass, Breakfree, Topnotch etc. (Do NOT use Warrant on SC) (15)
- **Metolachlor products:** (Dual MAGNUM / II, Brawl / II, Charger Basic / Max, Cinch, EverpreX, Medal, Pennant MAGNUM.(15)
- **Dimethenamid-P products:** (Outlook, Commit, Establish, OpTill PRO, Slider, Sortie, Tower) (15)
- Also: pyroxasulfone (Zidua) (15), Alachlor (Intrro, Micro-Tech) (15), pendimethalin (Prowl H2O) (3), EPTC (8)

Soil Applied Single Ingredient

Preemergence options (cont.)

Annual broadleaves and some grasses:

- Atrazine, simazine (Princep) (5)

Annual broadleaves:

- Mesotrione (Callisto) (27)

Soil Applied Package Mixtures

Preemergence options (cont.)

Most grasses and broadleaves

- Solstice (14, 27)
- Anthem, + Flex and Maxx (14, 15), Anthem ATZ (5, 14, 15)
- Acuron (5, 15, 27, 27), Acuron Flexi (15, 27, 27)
- Zemax (Camix) (15, 27), Lumax EX, Lexar EZ (5, 15, 27)
- Armezon PRO (15, 27)

Most grasses and some broadleaves:

- EPTC + acetochlor (Imperium) (8, 15)
  - (Must Incorporate, RUP product)

Soil Applied Herbicide Options

PRE package mixtures

Most grasses and broadleaves (cont.)

Acetanilide + atrazine pkg. mixtures: (5, 15)

- **Acetochlor** (Breakfree ATZ, Breakfree ATZ Lite, Degree Xtra, FullTime, Harness Xtra, Keytone, etc.)
- **Metolachlor** (Bicep Lite II Magnum, Cinch ATZ, Charger Max ATZ, etc.)
- **Micro-Tech alachlor** (Bullet or Lariat)
- **Dimethenamid-P** (G-Max Lite)

Postemergence Single Ingredient

Annual grasses only

- Accent*, Accent Q* (2)
- Poast, Poast Plus (1)
  - tolerant lines only

*Activity on grasses and some broadleaves

^ Activity on broadleaves and some grasses

Annual broadleaves only

- Aim (14)
- Atrazine^ (5)
- Basagran (6)
- Cadet (14)
- Callisto (27)
- Impact, Amerzon^ (27)
- Laudis^ (27)
- Permit, Sandea (14)
- Shieldex^ (27)
- Starane (4)
- Stinger (4)
- 2,4-D (4)

Postemergence Single Ingredients

Annual grasses only

- Poast on Poast Tolerant lines
  - Non-GMO (trait derived thru breeding selections)

Annual broadleaves and grasses

- Roundup Ready on tolerant lines
- Liberty on on tolerant lines
  - Both stacked with Bt traits in some cases
  - Be absolutely sure DOES have glufosinate or glyphosate trait before spraying

Postemergence Package Mixtures

Most grasses and broadleaves

- Armezon PRO (15, 27)
- Anthem, + Flex, Maxx (14, 27), + ATZ(14, 27, 5)
- Solstice (14, 27)
- Callisto Xtra (5, 27)
- Laddok (atrazine + Basagran) (5, 4)
- Priority (Aim + Permit / Sandea) (14, 2)
- Revulin Q (Accent + Callisto + Safener) (14, 2)

The HPPD Revolution

Mesotrione (Callisto) showing up in a lot of more recent package mixtures

- **Various companies**
- **In part for resistance management for things like waterhemp**
  - **FMC Solstice**
  - **DuPont Revulin Q**
  - **Syngenta Acuron, Acuron Flexi**

HPPD inhibitors

Bleaching: Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)

In order on market introduction:

Isoxaflutole	(Balance)
Mesotrione	(Callisto)
Topramezone	(Impact)
Tembotrione	(Laudis)
Bycylcopyrone	(in Acuron)
Tolpyralate	(Shieldex)

2016 Tested Tolerance of Varieties to New Herbicides

Acuron, Acuron Flexi

Anthem Maxx

Soltsice

Armezon

Verdict

Often x and 2x rates, heavy adjuvant loading, later POST stages, etc.

Acuron, Acuron Flexi

Syngenta (PRE herbicides)

- Acuron 3.34 SC (SYN-A197)
  - metolachlor + mesotrione + bicyclopyrone + atrazine (Grp 15, 27, 27, 5)
- Acuron Flexi (SYN-A205) (Acuron w/o atrazine) (Grp 15, 27, 27)
- Both include benoxacor (safener)
- Bicyclopyrone lower use rate than mesotrione and improves large-seeded broadleaf control
- Grasses, amaranths, lambsquarter, common and giant ragweed

Currently not labeled Early POST on Sweet Corn (is on other corn)

Anthem Products (FMC)

Anthem and Anthem Flex, ATZ, and Maxx

- Anthem, Anthem Maxx
  - pkg. mix pyroxasulfone (Zidua Grp 15) + fluthiacet (Cadet Grp 14)
  - 2.087 + 0.063 vs. 4.174 + 0.126 ai/gal
  - 7-13 vs. 2.5-6.5 fl oz/A PRE
  - 5-12 vs. 2.0 – 6.0 POST up to V4 sweet corn
  - 40 day PHI
- Anthem ATZ
  - adds atrazine (Grp 5) to the pkg. mix
  - PRE 1.75 to 4 pt/A, POST 1.5 to 3 pts/A
  - 45 day PHI

Anthem Products (FMC)

- **Anthem Flex**
  - pkg. mix pyroxasulfone (Zidua Grp 15) + carfentrazone (Aim Grp 14)
  - 2.75 - 7.28 fl oz/A PRE/ Early Preplant (15-45 days)
  - 37 day PHI
  - Early preplant not recom. on irrigated soils or > 40 in precip.

Solstice (FMC)

Solstice 4 FL (F9387) = 4.0 lb ai

- 0.216 fluthiacet-methyl (Cadet Grp 14)
- 3.784 mesotrione (Callisto Grp 27)

POST broadleaf weeds up to V8 corn

- 2.5 to 3.15 fl oz/A (0.078 to 0.098 lb ai/A)
  - 0.25% v/v NIS
    - COC alone on sweet corn improve weed control dry conditions but may increase injury
    - COC 1% v/v + UAN,AMS on field corn
  - Amaranth group, cocklebur, velvetleaf, ragweeds (higher rates), vol. potatoes
  - Temporary leaf speckling or bleaching in some varieties
  - 10 mo. rotation to soybeans, 18 mo. other crops

Armezon PRO

BASF

Topramezone + dimethenamid-p

- **Impact/Armezon (Grp 27) + Outlook (Grp 14)**
- **14 – 20 fl oz/A PRE to 12 inch tall POST**
- **50 day PHI**

Most grasses and broadleaves

Verdict, Armezon Pro

BASF (PRE herbicides)

Processing Varieties Only

Verdict 5.57 EC

Saflufenacil + Dimethenamid-P

- Kixor **(Grp 14)** + Outlook **(Grp 15)**
- **10 fl oz/A PRE**
- **Do not apply on soils < 3% OM**
- **Very, very active or burndown applications**
  - **Severe injury POST to sweet corn**

Most grasses and broadleaves

2016 Sweet Corn Tolerance Screen
Rosemount MN

Syngenta	1	(Acuron Flexi ZC)	2.25 qt/A	(PRE)
Syngenta	2	(Acuron Flexi ZC)	4.5 qt/A	(PRE)
Syngenta	3	(Acuron 3.44 ZC)	3 qt/A	(PRE)
Syngenta	4	(Acuron 3.44 ZC)	6 qt/A	(PRE)
Syngenta	5	(Lumax EZ 3.67 ZC)	3.25 qt/A	(PRE)
Syngenta	6	(Lumax EZ 3.67 ZC)	6.5 qt/A	(PRE)
FMC	7	Anthem Maxx	4 oz/A	(PRE)
FMC	8	Anthem Maxx	6 oz/A	(PRE)
FMC	9	Anthem Maxx	8 oz/A	(PRE)
BASF	10	Verdict	10 oz/A	(PRE)
BASF	11	Armezon PRO + COC + N-PAK AMS	16 oz/A + 1.0% + 2.5% v/v	E POST (1-2
FMC	12	Anthem Maxx + NIS	3 oz/A + 0.25% v/v	E POST
FMC	13	Anthem Maxx + NIS	5 oz/A + 0.25% v/v	E POST
--	14	Outlook + Atrazine 90 DF Std. trt. checks (imbedded	18 oz/A + 0.6 lb/A	PRE
FMC	15	Anthem Maxx + NIS	7 oz/A + 0.25% v/v	E POST
FMC	16	Anthem Maxx + Solstice + atrazine + NIS	2 + 2.5 + 16 oz/A + 0.25% v/v	E POST
FMC	17	Anthem Maxx + Solstice + atrazine + NIS	4 + 5 + 32 oz/A + 0.5% v/v	E POST
FMC	18	(Anthem Maxx) fb Solstice + Atrazine + NIS	(4 oz/A) fb 2.5 + 16 oz/A +0.25%vv	(PRE) E POST
Syngenta	19	Acuron Flexi ZC +Induce + N-PAK AMS	2.25 qt/A + 0.25% + 2.5% v/v	POST (3-4 Inch
Syngenta	20	Acuron Flexi ZC +Induce + N-PAK AMS	4.5 qt/A + 0.5% + 5% v/v	POST
Syngenta	21	Acuron 3.44 ZC + Induce + N-PAK AMS	3 qt/A + 0.25% + 2.5% v/v	POST
Syngenta	22	Acuron 3.44 ZC + Induce + N-PAK AMS	6 qt/A + 0.5% + 5% v/v	POST
Syngenta	23	Lumax EZ 3.67 ZC + Induce + N-PAK AMS	3.25 at/A + 0.25% + 2.5% v/v	POST
Syngenta	24	Lumax EZ 3.67 ZC + Induce + N-PAK AMS	6.5 qt/A + 0.5% + 5% v/v	POST

15 GPA
3 Reps
0 to 2 inch weeds, V1 to V2 / 1 to 3 inch sweet corn for Early Post trts.
3 to 4 inch weeds, V3 to V5 / 4 to 6 inch corn for POST trts.

2016 Sweet Corn Tolerance Screen
Rosemount MN

Variety	Seed Co.
DMFI 21-84	Del Monte
DMFI 21-05	Del Monte
DMFI C448	Del Monte
DMFI C451	Del Monte
C–1679 / XTH1679	IFSI
SC 1263	Seminis
GH 3333	Syngenta
GH 9394	Syngenta
WH 1428P	Syngenta
GSS 3071	Syngenta
SVSK 0391	Seminis
SV 1339 SK	Seminis
C–124	
C–449	
C–1972	
C–624	
SV 1514	Seminis
Owatonna	Harris Moran
Overland	Syngenta
Protégé	Syngenta
GSS 1477	Syngenta
Galaxy	Crites/Snowy River
GH 4927	Syngenta
BC 0805/Remedy	Syngenta 81 DTM Attribut
274 A	IFSI, Ripens Seeds
2171	IFSI
Anthem XR	IFSI, Seminis
XTH20173	IFSI, Ripens Seeds
Latte	Ripens Seeds
Montauk	Ripens Seeds
EX 7143 , EX 08767143	Seminis, Ripens Seeds
Merit (Crop response indic	Seminis
Obsession	Seminis
Devotion	Seminis
Super Surprise	IFSI

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HPPD chlorosis injury post on highly susceptible Merit

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Seed provided by:

- **Teyker, Casper, Thompson, Linge, Paulson, Hallcock, Jorgenson, Deidirck, Jenkins**

THANK YOU!

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Recent herbicides introduced for sweet corn

Roughly in order of most recent first

Shieldex

Shieldex 400 SC (tolpyralate 3.3 lb ai/gal)

Summit Agro USA (Sold by Helena)

- **Group Herbicides (Grp 27 HPPD inhibitor)**
- **POST to < 20 inch or 6 lf collar (V6) sweet corn**
  - **Weeds < 5 inches**
- **1 - 1.35 fl oz/A + SU (MSO / NIS and UAN)**
- **35 day PHI**
- **Many bdlfs. and some grasses**
- **9-12 month replant restriction most crops, 3 mo. for small grains and forage/seed grasses**

Zidua® 0.85 WDG

BASF PRE or PPI

- pyroxasulfone (Zidua Grp 15/K_3)
- 1.0-4 oz/A
- Apply before or after planting before crop emergence, or at spiking up to V4 (4 leaf collars visible)
  - Will not control emerged weeds
- Seed at least 1 inch deep
- Do not exceed
  - 2.75 oz/A per season on coarse soils
  - 5 oz/A per season on other soils
- 37-day PHI

Impact, Armezon (topramezone)

POST in field corn, sweet corn, pop corn

- **1° broadleaf weed control**
- **2° partial grass control**
  - **Synergized by atrazine**

- **Rate: 0.5 to 0.75 oz/A**
  - **Can go to 1 oz, prefer 0.75 to reduce carryover**
  - **If can, TM with 0.5 lb atrazine, control Similar to 1 oz/A**
- **Adjuvant: MSO or COC plus nitrogen additive**
- **PHI 45 days**

Cadet

Cadet (fluthiacet)

- **POST**
  - **0.6-0.9 fl oz/A**
    - **Do not exceed 1.25 fl oz/A per year**
  - **V2 to tasseling**
  - **Velvetleaf and several other broadleaves**
  - **Add COC or NIS**
  - **40-day PHI**

Used alone is for processing ONLY

In Anthem, Anthem Maxx, and Anthem ATZ which are labeled for <u>fresh market</u>

Revulin Q

DuPont Revulin™ Q –

(DPX-UKU48 dry formulation)

- 3.4 to 4 oz/A POST
  - Accent (nicosulfuron Grp 2)
  - Callisto (mesotrione Grp 27)
  - Safener (isoxadifen-ethyl)
- NIS only for sweet corn
- COC, AMS/UAN for field corn

Revulin Q

DuPont Revulin™ Q – 2012

- Do not add AMS/UAN for sweet corn
- Always add 0.25 % NIS
  - COC only if dry (COC ⬆ risk of injury)
    - COC, AMS/UAN for field corn
  - Since can not add AMS or UAN
    - Weeds < 5 in. target
    - Add atrazine if allowed
  - Broadcast up to 12 in. tall or <= 5 lf collars
  - Drop nozzles up to 18 inches

Starane Ultra® 2.8 L

Dow Agrosciences

Starane Ultra® 2.8 L (ae), 1.5 EC phasing out

- Fluroxypyr
- 0.4 fl oz/A PRE
- POST broadcast (up to V4)
  - No additives used alone
  - Use directed spray beyond V4
- Volunteer potato (can apply sequentials)
  - preplant to emerged potato 4-8 in.
  - POST suppression to emerged potato 4-8 in.
- 31-day PHI

Callisto Pkg. Mix

PRE's

Lexar EZ

3 to 3.5 qts

1.74 *S*-metolachlor + 0.224 mesotrione+ 1.74 atrazine lb ai/gal

(Grp 15, 27, 5)

60 day PHI

RUP because contains atrazine

Callisto Pkg. Mix

PRE's

Zemax

3.34 *S*-metolachlor + 0.33 mesotrione lb ai/gal
(Grp 15, 27)

Apply 2.0 qt/A if < 3% OM

2.4 qt/A if >= 3% OM

45 day PHI

(do not apply POST, POST labeled in field corn but can injury sweet corn)

Callisto Pkg. Mix

PRE's (Cont.)

Lumax EZ, 2.7 to 3.25 qts/A (Grp 5, 15, 27)

- 2.49 metolachlor + 0.94 atrazine + 0.249 mesotrione lb ai/gal
- 45 day PHI

POST

Callisto Xtra (Grp 5, 27)

- 20 to 24 fl oz/A
- 45 day PHI
  - 3.2 lb atrazine + 0.5 mesotrione lb ai per gallon

Poast (sethoxydim) on Sweet Corn

Naturally occurring sethoxydim resistance in corn

- **Insensitive ACC-ase inhibitor selected through tissue culture at the U of M**
- **Not transgenic (not GMO)**
- **Grasses only, good option for woolly cupgrass and proso millet POST**

Organic/nontraditional Products

Suppress (Caprylic and capric acids) Westbridge (label includes “Organic”)

Axxe (ammonium nanoate) BioSafe Systems

Ecotec, Brandt Ecotec Plus (rosemary + peppermint oils) Exempt

Scythe (pelargonic acid) Gowan

StorOx, SaniDate, (hydrogen peroxide + peroxyacetic acid) BioSafe Systems

Weed Zap (clove + cinnamon oils) JH Biotech, Inc.

ALL are Nonselective POST products

Compiled from sweet corn search on CDMS (www.cdms.net)

Dicamba on Sweet Corn

Still not labeled, probably will not be.

Vapor drift still likely from neighbors.

Leaf Wrapping From Status
Suregold @ 7 DAT (not all plants affected)

University of Minnesota Extension

UW Extension

Capreno on Sweet Corn No Longer

Bayer Capreno® POST

- **2.88 lbs. tembotrione (Laudis) (Grp 27)**
- **0.57 lb. thiencarbazone-methyl (Corvus) (Grp 2)**

Sweet corn on the old 4-3-09 Label

- **3 fl oz/A**
- **1 qt. of COC per 25 gals + 1.5 qt./A UAN or 1.5 lb./A AMS**
- **After V1and before V6**
- **Do not use with Lorsban®, Counter®, Dyfonate®, Thimet®, or other OPs**
- **18-month rotation restriction for other vegetable crops**

Option on Sweet Corn No Longer

Bayer, in 2006 talks (foramsulfuron) (Grp 2)

ALS-inhibiting herbicide similar to Accent

- Labeled in field and seed corn at 1.5 oz/a
- POST grass control and several broadleaf weeds
- Evaluated for processing and fresh market sweet corn
- Accent intolerant hybrids even morso w/ Option

Sweet Corn Herbicides

Only two products for GMO Traited Sweet Corn You Will Not be Using

- **Roundup** (Grp 9)
- **Liberty** (Grp 10)

Roundup Tolerant Sweet Corn

- Check individual states for labeling
- Currently for use with Monsanto products

Apply anytime emergence through V8 stage or 30 inches (free-standing), which ever comes first

- 11 to 32 fl oz/A
- Recommend drop nozzles if 24 to 30 inches (free-standing) or required if 30 to 48 inches or at reproductive stage
- Reduced rate of residual UM recommendation
- Do not add additional surfactants
- 30-day PHI

Liberty 280 SL on Sweet Corn

Bayer supplemental label thru 2016

NO LONGER LABELED?

- **EPA Reg. No. 264-829 Supplemental label**
  - **Expires 11/05/16, issued 11/21/2013**

Palmer vs. Waterhemp

Palmer

- Native to the desert Southwest
- Most competitive of the Amaranth sp.
- Growth rate as fast as ~2.5”/day

http://www.extension.iastate.edu/CropNewererers/2013/0820hartzlerpope.htm

Waterhemp

- Native to the Midwest
- 2nd most competitive of the Amaranth sp.
- Growth rate as fast as ~1.75”/day

http://southeastfarmpress.com/management/waterhemp-showing-greater-resistance-glyphosate

Palmer vs. Waterhemp

35 days after seeding

Palmer vs. Waterhemp

- **Herbicide resistant**
  - ALS (#2),
  - PSII (#5)
  - glycines (#9)
  - HPPD (#27)
  - DNA (#3)

Herbicide resistant

- ALS (#2)
- PSII (#5)
- glycines (#9)
- HPPD (#27)
- PPO (#14), 2,4-D (#4)

- Both dioecious
- Both produce overwhelming nos. of seed

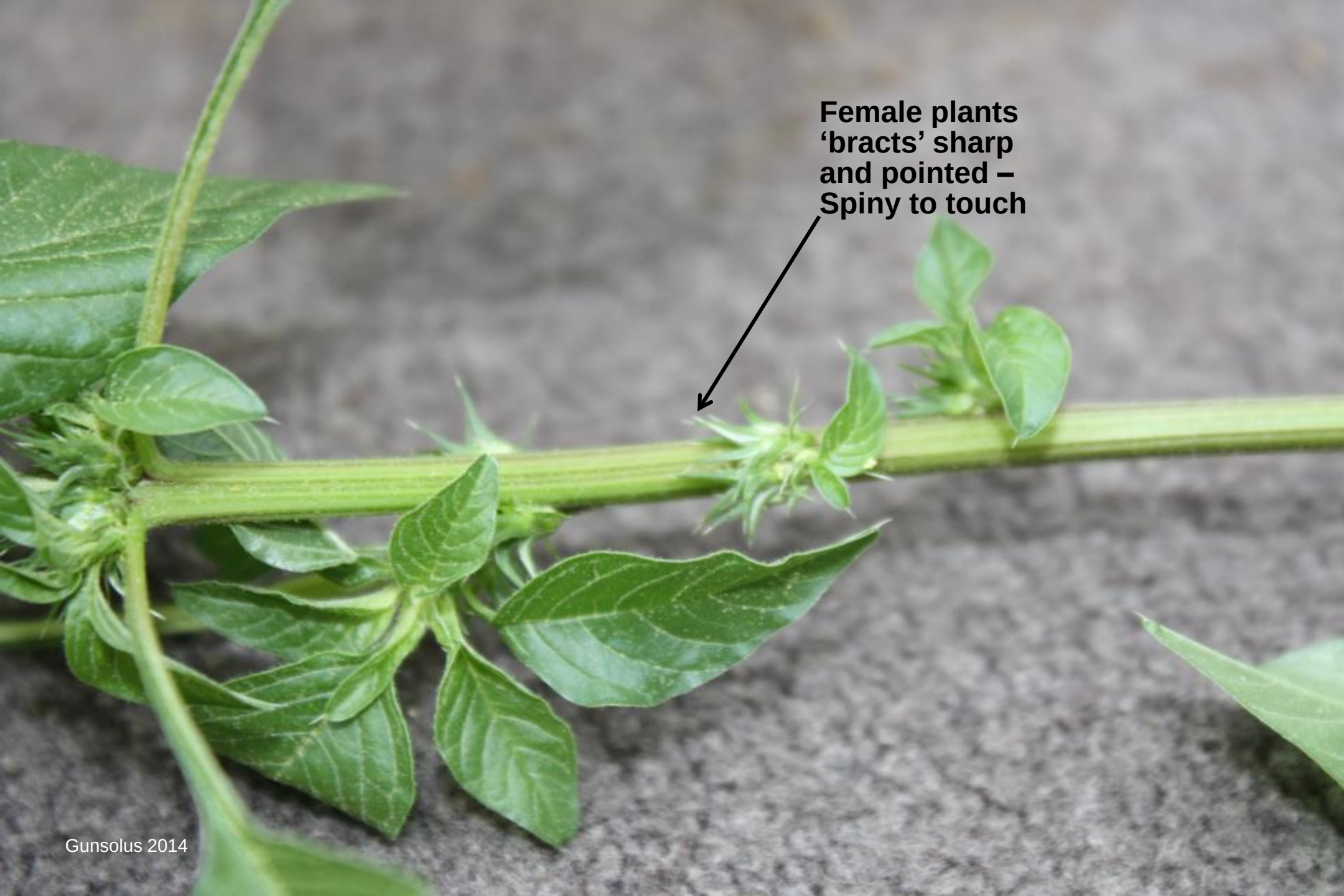
Hand Weeding

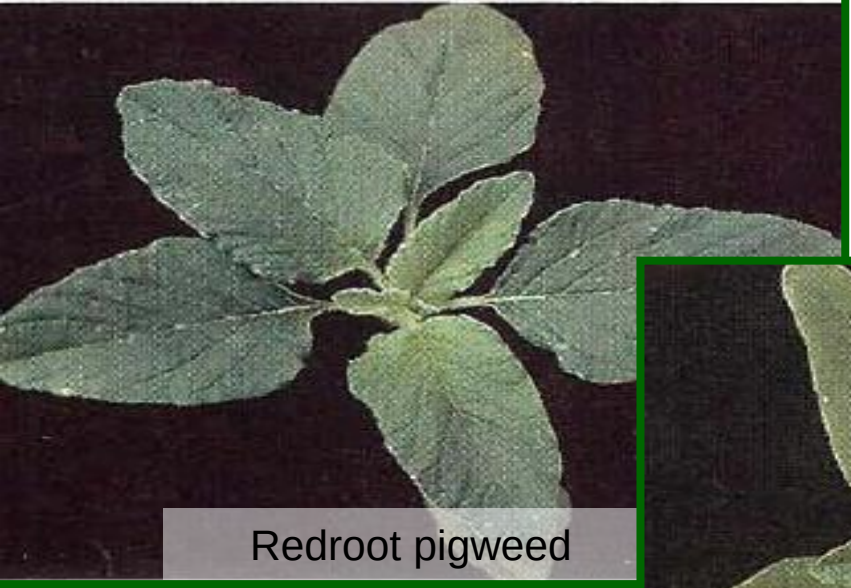
UT Extension

Palmer amaranth plant from above, notice the rosette leaf pattern that is similar to a poinsettia plant

Travis Legleiter, *Weed Science Program Specialist &* **Bill Johnson,**
Professor of Weed Science, Purdue University Extension Weed Science

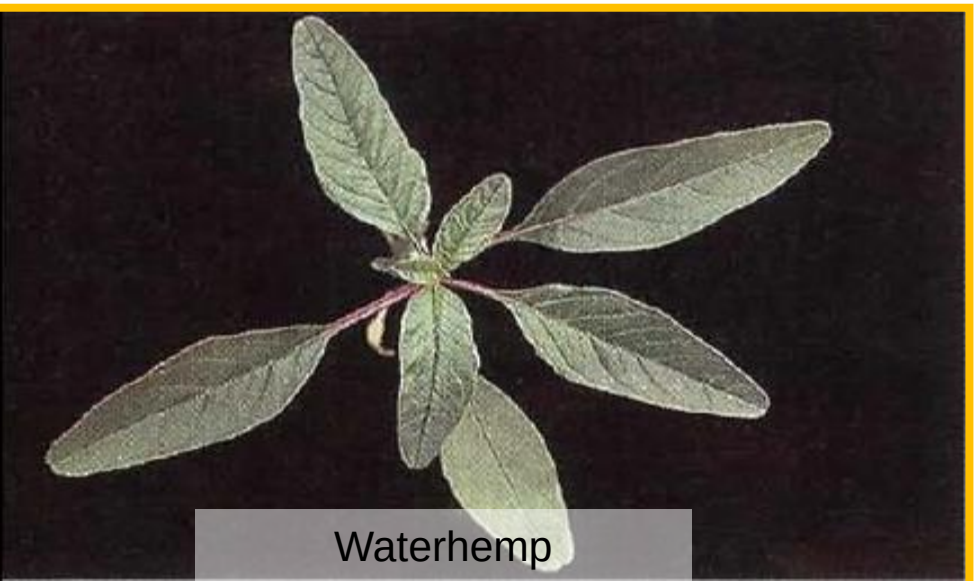
Palmer has long leaf petioles

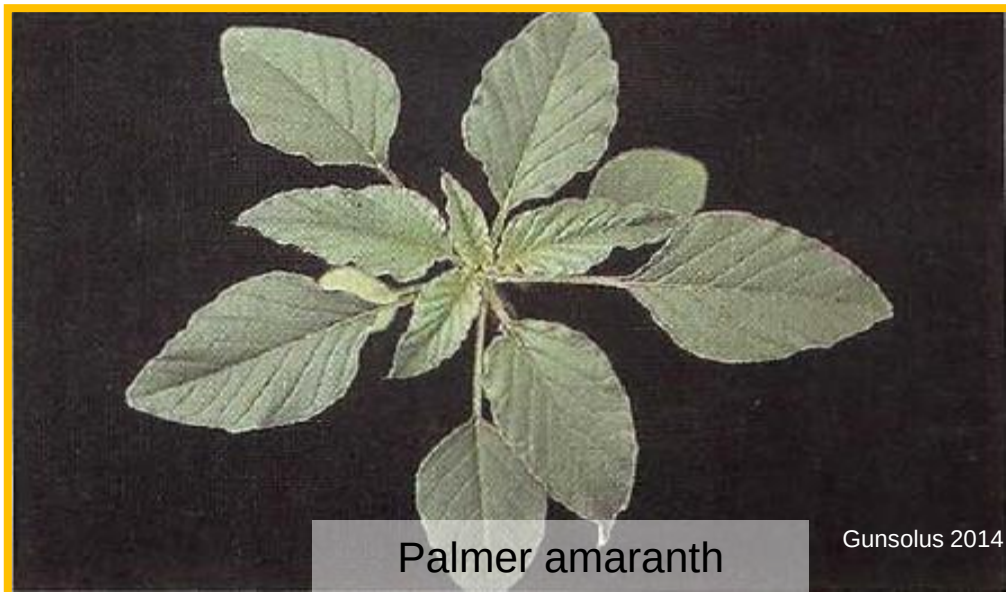

Female plants
‘bracts’ sharp
and pointed –
Spiny to touch
Gunsolus 2014


Redroot pigweed


Powell amaranth


Smooth pigweed


Waterhemp


Palmer amaranth
Gunsolus 2014

Questions?