Take Control –
Putting It All Together

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National Summit on Strategies to Manage Herbicide-Resistant Weeds

http://nas-sites.org/hr-weeds-summit/

• Need to move from product-based systems to science-based solutions

Old paradigm (overly simplified)

➢ Growers as “customers” buying products “off the shelf”
➢ Simplification of weed management reduces knowledge requirements
➢ New products will solve problems
➢ Strategy is to keep new products coming
National Summit on Strategies to Manage Herbicide-Resistant Weeds

http://nas-sites.org/hr-weeds-summit/

• Need to move from product-based systems to science-based solutions

Challenges of new paradigm

➢ Information & knowledge will substitute for chemical compounds
➢ Grower participation & input will be critical for success
➢ Growers less likely to participate if they perceive it only leads to regulatory tightening
➢ Growers need to recognize benefits of a more Integrated Approach
We Have Been Addressing Herbicide Resistance Since the late 1980’s
The Main Drivers of Herbicide Resistance Evolution

• Selection intensity – using the same weed management tactic again and again
  – Need for diversification of weed management tactics

• Allowing weed population size to increase in the seed bank
  – Increases probability of a R-trait
  – Need to prevent pollen and seed production
Impediments to Weed Management

• Durable Weed Management Practices Can Get Sidetracked by One-Year Business Cycles

Prevention vs. Remediation

— “Farmers are loathe to institute complicated preemptive resistance management schemes, especially if they cost more. Still, the best remedial strategy is to look over one’s shoulder and learn from the mistakes of others. When there is resistance somewhere to a pesticide under a similar cropping system, it is time to get scared, and not to say “it hasn’t happened here, therefore it won’t”. When the first resistance appears, and it is not spread throughout the population, further enrichment of resistant individuals in the population can be delayed.”

Jonathan Gressel et al. 1996.
In Molecular Genetics and Evolution of Pesticide Resistance
ACS Symposium Series; American Chemical Society; Washington, DC
Impediments to Weed Management

• Durable Weed Management Practices Can Get Side-Track by Business Plans
  – The 1990’s brought us the “dollar today is worth more than a dollar tomorrow” approach to weed management.
  – The early 2000’s brought us into an era of uncertainty between herbicide/agrichemical business plans and the seed industry business plans
  – The right herbicide on the right weed at the right time works best if one company owns an array of herbicide products.
  – The herbicide resistant trait technology is hampered by the potential confounding of an array of HR traits and the limits to seed storage and distribution….the right path often isn’t clear
Impacts of Herbicide Resistance to Weed Management Strategies

• What is at risk?
  – Reducing the durability of developing herbicide resistant crop technologies
    • Enlist (2,4-D + Glyphosate + Glufosinate - SOA# 4,9,10)
    • Xtend (Dicamba + Glyphosate – SOA #4,9)
    • MGI (Mesotrione and Isoxaflutole - SOA #27)
  – Herbicide-based strategies become less effective
    • Overwhelmed by population density
    • Resistance to MULTIPLE SOA’s will be THE ISSUE
  – Loss of herbicides critical in minor use crops such as canning peas and sweet corn
Moving Forward

• An observation from this year’s North Central Weed Science Society meeting makes it clear that as the Seed/Agrichemical Industry develops new Herbicide Resistant Crop Technologies - All Companies will implement a PRE / POST system

  ✓ Enlist from Dow AgroSciences (SOA #4)
  ✓ Xtend from Monsanto (SOA#4)
  ✓ MGI from Bayer & Syngenta (SOA #27)

• Stacking of Multiple- Herbicide Resistant traits in Crop will continue to increase – but will it get ahead of multiple-resistance in weeds?
Impacts of Herbicide Resistance to Weed Management Strategies

- ISU Reports waterhemp responses to labeled herbicide rates indicate:
  - 95% of the populations are resistant to SOA #2 - ALS
  - 58% of the populations are resistant to SOA #5 - Atrazine
  - 54% of the populations are resistant to SOA #9 – Glyphosate
  - 28% of the populations are resistant to SOA #27 – HPPD
  - 6% of the populations are resistant to SOA #14 – PPO

- Resistance to multiple SOA’s is also not uncommon
  - Consider establishment of RR alfalfa in a field of Giant Ragweed resistant to SOA #9 and #2
2010 Survey Summary

- 122 plants from 24 fields in IL, IA & KY (most suspected of Gly-R waterhemp)

**Individual plant basis**

- ALS: 20, 13% S to all 3 herbicides, 28 GLY 66%
- PPO: 1, 0% S to all 3 herbicides
- ALS and PPO: 3, 29

**Field basis**

- ALS: 13, 75%
- PPO: 0, 33%
- ALS and PPO: 4
- ALS and PPO to all 3 herbicides: 29

Credit Aaron Hager @ U of Illinois
http://www.plantmanagementnetwork.org/edcenter/seminars/Corn/Waterhemp/
Impacts of Herbicide Resistance to Weed Management Strategies

- As the frequency of herbicide resistant traits increase the likelihood of migration increases
  - Palmer Amaranth in MI, IN, WI via cotton seed for dairy and CRP
  - Movement via forage
  - Movement via manure
  - Movement via combine
  - Movement via pollen (yards not miles)
  - Movement via water (runoff and flooding)
  - Movement from ditch banks and field margins
Palmer amaranth
Credit – Christy Sprague Mich. State University

• *Amaranthus palmeri* - “Palmer pigweed”
• Native to the desert Southwest
  – Thrives in hot climatic conditions
  – Tolerant to drought
• One of 10 common pigweed species in the great plains and southeast U.S.
• Not common in the upper Midwest
  – No reports of Palmer amaranth found in U of M herbarium
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
Which pigweed is it?

Pigweed identification: A pictorial guide to the common pigweeds of the great plains

Horak et al. KSU, Extension

Redroot pigweed
Smooth pigweed
Powell amaranth
Waterhemp
Palmer amaranth
Long leaf petioles
Female plants 'bracts' sharp and pointed – Spiny to touch
Redroot pigweed

Powell amaranth

Smooth pigweed

Waterhemp

Palmer amaranth

Unbranched inflorescence and prickly to the touch

Pigweed identification: A pictorial guide to the common pigweeds of the great plains
Horak et al. KSU, Extension, 1994
WSSA BMP Adoption Recommendations

http://www.wssa.net/

- Implement a Herbicide-SOA labeling system for all herbicide products

- Communicate that the existing herbicide resource is Exhaustible and discovery of new, highly effective herbicide SOA’s is a rare event. (Note – the trend is to HRC traits)
Where Do I Find SOA Information?

- Herbicide Labels are Starting to Include them
Where Do I Find SOA Information?

- Check out the following web sites

  http://appliedweeds.cfans.umn.edu

  http://glyphosateweeds.crops.org/info/MOA_060807.pdf
WSSA BMP Adoption Recommendations

• Demonstrate the benefits and costs of proactive, diversified weed management systems
• Promote full-labeled rates at appropriate weed and crop growth stages
• Reduce the weed seedbank via minimization of weed seed production
Weed Science Field School – Soybean

Key weed species (no ALS or glyphosate resistance):
  Common lambsquarters
  Common waterhemp
  Giant ragweed

Rochester, MN
2012
Trt. 1

**Authority First** 3.2 oz/a + **Dual II MAG** 16 fl oz/a
PRE sprayed on April 24, 2012

**Roundup PowerMax** 22 fl oz/a + **AMS** 8.5 lb/100gal
POST II (V3-V4) sprayed on June 4, 2012

June 4, 2012       June 18, 2012

June 26, 2012       July 2, 2012
Trt. 2

**Authority First** 3.2 oz/a + **Dual II MAG** 16 fl oz/a  
PRE sprayed on April 24, 2012

**Roundup PowerMax** 22 fl oz/a + **AMS** 8.5 lb/100gal  
POST III (V5-R1) sprayed on June 12, 2012

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June 11, 2012  
June 18, 2012

June 26, 2012  
July 2, 2012
Trt. 2

**Authority First** 3.2 oz/a + **Dual II MAG** 16 fl oz/a
PRE sprayed on April 24, 2012

**Roundup PowerMax** 22 fl oz/a + **AMS** 8.5 lb/100gal
POST III (V5-R1) sprayed on June 12, 2012

June 11, 2012 June 18, 2012

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Good early-season weed control increases the time period for effective postemergence control

June 26, 2012 July 2, 2012
Trt. 3

Warrant 24 fl oz/a
PRE sprayed on April 24, 2012

Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal
POST II (V3-V4) sprayed on June 4, 2012

June 4, 2012  June 18, 2012

June 26, 2012  July 2, 2012
Trt. 4

**Warrant** 24 fl oz/a

PRE sprayed on April 24, 2012

**Roundup PowerMax** 22 fl oz/a + **AMS** 8.5 lb/100gal

POST III (V5-R1) sprayed on June 12, 2012
Warrant 24 fl oz/a
PRE sprayed on April 24, 2012
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

July 19, 2012

Trt. 3
POST II (V3-V4) sprayed on June 4, 2012

July 19, 2012

Trt. 4
POST III (V5-R1) sprayed on June 12, 2012

July 27, 2012

July 27, 2012
Trt. 4
Warrant 24 fl oz/a
PRE sprayed on April 24, 2012
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal
POST III (V5-R1) sprayed on June 12, 2012

July 19, 2012
July 27, 2012

- Poor early-season weed control reduces the time period for effective postemergence control
- Effective postemergence weed control depends on:
  - Weed species diversity, time of weed emergence, density, and difficulty to control
Trt.

**Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal**

Were these beans treated at V1 on May 18, 2012?

June 11, 2012

June 18, 2012

June 26, 2012

July 2, 2012
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

V1 on May 18, 2012
Trt.
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal
Were these beans treated at V3 on June 4, 2012

June 11, 2012

June 18, 2012

June 26, 2012

July 2, 2012
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

V3 on June 4, 2012
Trt.
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal
Were these beans treated at V5 on June 12, 2012

June 11, 2012

June 18, 2012

June 26, 2012

July 2, 2012
Roundup PowerMax 30 fl oz/a + AMS 8.5 lb/100gal

July 19, 2012

V1

V3

V5

July 27, 2012
Common waterhemp (*Amaranthus rudis*) interference in corn

*Weed Science 52:359–364*

Corn yield loss relative to common waterhemp emergence at various corn growth stages.

2001–2002 (less rainfall than 2000)

Weed Free Period (Corn Growth Stage)
Common waterhemp (*Amaranthus rudis*) interference in corn

*Weed Science 52:359–364*

<table>
<thead>
<tr>
<th>Emergence times</th>
<th>Biomass</th>
<th>Seed production</th>
<th>Mortality</th>
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<tbody>
<tr>
<td></td>
<td>g m⁻²</td>
<td>seeds plant⁻¹</td>
<td>%</td>
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<tr>
<td>VE</td>
<td>430</td>
<td>1,310</td>
<td>3,000</td>
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<td>V4</td>
<td>220</td>
<td>670</td>
<td>500</td>
</tr>
<tr>
<td>V6</td>
<td>40</td>
<td>590</td>
<td>90</td>
</tr>
<tr>
<td>V8</td>
<td>0</td>
<td>290</td>
<td>0</td>
</tr>
<tr>
<td>V10</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>V12</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>V14</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>LSDₜ₀.₀₅</td>
<td>130</td>
<td>200</td>
<td>500</td>
</tr>
</tbody>
</table>

*Data are combined over 2001–2002.*

*Indicates common waterhemp emergence times at various corn growth stages.*
Weed / Crop Competition

• Seed production potential of common waterhemp emerging at four growth stages of corn and soybean

• Research conducted in Morris, MN in cooperation with SDSU, USDA ARS, and U of MN
Weed / Crop Competition

- **Results** – vegetative development
  - When emergence occurred during VE – V1, waterhemp biomass was greater when grown in soybean than in corn
  - When emergence occurred at V4 or later, waterhemp biomass was very low in either crop
  - In V8-11 corn, minimal waterhemp survival
  - At and after V8 soybean, no waterhemp survived
Weed / Crop Competition

• Results – seed production
  – When emergence occurred during V9-V10 corn, waterhemp produced 100-150 seeds per plant
  – When emergence occurred at V8 soybean or later, waterhemp did not produce any seed
  – Therefore, to reduce the weed seed bank you need to emphasize early-season weed control and PRE herbicides can play a big role
  – I recommend targeting your FINAL weed control activities at V8 corn and R1 soybean
Proactive Weed Management Strategies

- Why Are Farmers Reluctant To Adopt PRE Herbicides?
  - Concerned about Cost
    + Competitive market
    + Incentives often available
    + In weedy fields we see a favorable return on investment
  - Concerned about Time
    + Uneven weed emergence and rapid weed growth make timing of POST control challenging
  - Lack of Experience with PRE Herbicides
    - Crop Injury Potential and Crop Rotation Restrictions
    - Not as Easy but it is still A LOT EASIER THAN
Hand Weeding

www.extension.umn.edu/AgProfessionals
CPM Short Course: 2011 - Larry Steckel
CPM Short Course: 2012 - Jason Norsworthy
Proactive Weed Management Strategies

• Start with a Preemergence herbicide
  – Provides a great opportunity to reduce selection intensity in herbicide resistant crops
  – Often introduces a different Site of Action
  – Controls weeds as they germinate and when they are most vulnerable
  – Use the Right Herbicide, for the Right Weeds at the Right Rate and Right Time.
  – A good day to PLANT is a good day to apply a PRE herbicide
Several PRE Options in Soybean

What if waterhemp developed resistance to SOA #14 (PPO’s) herbicides?

<table>
<thead>
<tr>
<th>Tier 1</th>
<th>SOA#</th>
<th>Girw</th>
<th>Colq</th>
<th>Cowh</th>
<th>Sugarbeet</th>
</tr>
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<tbody>
<tr>
<td>Authority First/Sonic</td>
<td>2 14</td>
<td>P/G</td>
<td>G/E</td>
<td>G/E</td>
<td>30</td>
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<tr>
<td>Gangster</td>
<td>2 14</td>
<td>P/G</td>
<td>G/E</td>
<td>G</td>
<td>30</td>
</tr>
<tr>
<td>Optill</td>
<td>2 14</td>
<td>F/G</td>
<td>G/E</td>
<td>G</td>
<td>40</td>
</tr>
<tr>
<td>Prefix</td>
<td>15 14</td>
<td>F</td>
<td>G</td>
<td>G/E</td>
<td>18</td>
</tr>
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<table>
<thead>
<tr>
<th>Tier 2</th>
<th>Girw</th>
<th>Colq</th>
<th>Cowh</th>
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</thead>
<tbody>
<tr>
<td>Boundary</td>
<td>P/F</td>
<td>G</td>
<td>G/E</td>
</tr>
<tr>
<td>Verdict - 5 oz/A</td>
<td>P</td>
<td>G</td>
<td>F/G</td>
</tr>
<tr>
<td>Valor</td>
<td>N/P</td>
<td>G</td>
<td>G/E</td>
</tr>
</tbody>
</table>

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.
All of the SOA #14 options must be applied by 3 days after planting except:

Prefix can be applied from cracking - V3

Warrant (SOA #15) is also an option

<table>
<thead>
<tr>
<th>Soybean PRE</th>
<th>SOA#</th>
<th>Girw</th>
<th>Colq</th>
<th>Cowh</th>
<th>Sugarbeet</th>
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<tbody>
<tr>
<td><strong>Tier 1</strong></td>
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<tr>
<td>Authority First/Sonic</td>
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<td>P/G</td>
<td>G/E</td>
<td>G/E</td>
<td>30</td>
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<tr>
<td>Gangster</td>
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<td>P/G</td>
<td>G/E</td>
<td>G</td>
<td>30</td>
</tr>
<tr>
<td>Optill</td>
<td>2 14</td>
<td>P/F</td>
<td>G/E</td>
<td>G</td>
<td>40</td>
</tr>
<tr>
<td>Prefix</td>
<td>15 14</td>
<td>F</td>
<td>G</td>
<td>G</td>
<td>18</td>
</tr>
<tr>
<td><strong>Tier 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boundary</td>
<td>5 15</td>
<td>P/F</td>
<td>G</td>
<td>G/E</td>
<td>18</td>
</tr>
<tr>
<td>Verdict</td>
<td>14 15</td>
<td>P</td>
<td>G/E</td>
<td>F/G</td>
<td>NCS</td>
</tr>
<tr>
<td>Valor</td>
<td>14</td>
<td>N/P</td>
<td>G</td>
<td>G/E</td>
<td>4 to 10</td>
</tr>
</tbody>
</table>

Girw = Giant Ragweed; Colq = Lambsquarters; Cowh = Waterhemp.
Follow a PRE herbicide with a timely application of a POST herbicide for extended weed control; Diversification of SOA’s will help combat herbicide resistant biotypes

Note Soybean options for broadleaf weed control has a limited number of SOA’s

<table>
<thead>
<tr>
<th></th>
<th>SOA</th>
<th>Girw</th>
<th>Colq</th>
<th>Cowh</th>
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<tr>
<td>Cadet</td>
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<td>P</td>
<td>F</td>
<td>F</td>
<td>NCS</td>
</tr>
<tr>
<td>Cobra</td>
<td>14</td>
<td>G</td>
<td>P</td>
<td>G/E</td>
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<tr>
<td>First Rate</td>
<td>2</td>
<td>E</td>
<td>P</td>
<td>P</td>
<td>30</td>
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<tr>
<td>Flexstar GT</td>
<td>14 9</td>
<td>G/E</td>
<td>F-E</td>
<td>E</td>
<td>18</td>
</tr>
<tr>
<td>Flexstar</td>
<td>14</td>
<td>G</td>
<td>P/F</td>
<td>G/E</td>
<td>18</td>
</tr>
<tr>
<td>Resource</td>
<td>14</td>
<td>P</td>
<td>F</td>
<td>F</td>
<td>1</td>
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<tr>
<td>Liberty (in LL Soybean)</td>
<td>10</td>
<td>G</td>
<td>F</td>
<td>G</td>
<td>0</td>
</tr>
</tbody>
</table>

Girw = Giant Ragweed; Colq = Lambsquarters; Cowh = Waterhemp.
Soybean Carryover Concerns from 2012 to 2013

Carryover of Prefix and Flexstar to Corn

Crop rotation - 10 months to Corn

Photo Credit to Bob Hartzler at ISU, Ames, IA
Several PRE Options in Corn

<table>
<thead>
<tr>
<th>Corn PRE</th>
<th>Rotation</th>
<th>Sugarbeet</th>
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<tbody>
<tr>
<td><strong>Tier 1</strong></td>
<td>SOA #</td>
<td>Girw</td>
</tr>
<tr>
<td>Lumax</td>
<td>5 15,27</td>
<td>G</td>
</tr>
<tr>
<td>Surestart/TripleFlex</td>
<td>2 4,15</td>
<td>G</td>
</tr>
<tr>
<td>Verdict - &gt;10 oz/A</td>
<td>14 15</td>
<td>G</td>
</tr>
</tbody>
</table>

| **Tier 2**        | Girw      | Colq      | Cowh |
| Atrazine <0.38#   | 5         | P/F       | G/E  | F    | NCS         |
| Atrazine + Tier 3 | 15 5 w/higher rate | F/G | G/E  | F/G  | 2CS         |
| Zemax             | 15 27     | F/G       | G/E  | E    | 18          |

| **Tier 3**        | Girw      | Colq      | Cowh |
| Dual              | 15        | N         | P/F  | G    | NCS         |
| Harness/Surpass   | 15        | P         | F/G  | G    | NCS         |
| Outlook           | 15        | N         | P/F  | G    | NCS         |

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.
## Early POST Options for PRE Corn Herbicides

<table>
<thead>
<tr>
<th>Tier 2</th>
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<tbody>
<tr>
<td>Atrazine &lt;0.38#</td>
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<td>0-12 inch</td>
<td></td>
</tr>
<tr>
<td>Atrazine + Tier 3</td>
<td>15 5 w/higher rate</td>
<td>0-12 inch</td>
<td></td>
</tr>
<tr>
<td>Zemax</td>
<td>15 27</td>
<td>0-12 inch</td>
<td>0-30 inch</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier 3</th>
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<tbody>
<tr>
<td>Dual</td>
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<td>0-5 inch</td>
<td></td>
</tr>
<tr>
<td>Harness/Surpass</td>
<td>15</td>
<td>0-11 inch</td>
<td></td>
</tr>
<tr>
<td>Outlook</td>
<td>15</td>
<td>0-12 inch</td>
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<table>
<thead>
<tr>
<th>Corn POST Tier 1</th>
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<th></th>
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<tbody>
<tr>
<td>Callisto Xtra</td>
<td>Ps HPPD</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Capreno</td>
<td>ALS HPPD</td>
<td>18</td>
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<tr>
<td>Halex GT</td>
<td>EPS Acetanalide HPP</td>
<td>18</td>
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</tbody>
</table>

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.
Follow a PRE herbicide with a timely application of a POST herbicide for extended weed control; Diversification of SOA’s will help combat herbicide resistant biotypes

Note POST weed control offers more opportunities to diversify effective SOA’s

<table>
<thead>
<tr>
<th>Corn POST Tier 1 SOA</th>
<th>Girw</th>
<th>Colq</th>
<th>Cowh</th>
<th>Sugarbeet</th>
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<tbody>
<tr>
<td>Callisto 27</td>
<td>G</td>
<td>G/E</td>
<td>E</td>
<td>18</td>
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<td>Capreno 2 27</td>
<td>G</td>
<td>G/E</td>
<td>G/E</td>
<td>18/24</td>
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<td>Halex GT 9 15, 27</td>
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<td>E</td>
<td>G/E</td>
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<td>Hornet 2 4</td>
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<td>P/F</td>
<td>P/F</td>
<td>26</td>
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<tr>
<td>Impact 27</td>
<td>G</td>
<td>G/E</td>
<td>G/E</td>
<td>18</td>
</tr>
<tr>
<td>Laudis 27</td>
<td>G</td>
<td>G/E</td>
<td>G/E</td>
<td>10/18*</td>
</tr>
<tr>
<td>Status 4</td>
<td>G/E</td>
<td>G/E</td>
<td>G</td>
<td>4</td>
</tr>
<tr>
<td>Liberty (in LL Corn)</td>
<td>G</td>
<td>F</td>
<td>G</td>
<td>0</td>
</tr>
</tbody>
</table>

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.
Corn Carryover Concerns from 2012 to 2013

Carryover of Callisto to Soybean (esp. low pH <6.0 and low OM and CEC soils)

Crop rotation interval – 10 months to Soybean

Photo Credit – Practical Weed Science for the Field Scout – U of MO
Mike Owen – ISU, Ames, IA
<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Corn</td>
<td>Dual + Simazine</td>
<td>Callisto + atrazine</td>
</tr>
<tr>
<td>2004</td>
<td>Corn</td>
<td>Dual + Simazine</td>
<td>Callisto + atrazine</td>
</tr>
<tr>
<td>2005</td>
<td>Corn</td>
<td>Dual + Simazine</td>
<td>Callisto + atrazine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
<th>PRE</th>
<th>MOA*</th>
<th>POST</th>
<th>MOA*</th>
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</thead>
<tbody>
<tr>
<td>2013</td>
<td>Corn</td>
<td>Beans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>Corn</td>
<td>Beans</td>
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<tr>
<td>2016</td>
<td>Corn</td>
<td>Beans</td>
<td></td>
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</tbody>
</table>

**Use the Right Herbicide, for the Right Weeds at the Right Rate and Right Time**

**Your Goal is Diversification of Effective Herbicide SOA’s on Weed Species Present Applied in a Timely Manner**

**MOA* = Herbicide Mode of Action**

http://appliedweeds.cfans.umn.edu/Pubs.html
When Planning to Use a PRE Herbicide

Consider:

Soil type and pH influence Rate and Crop Injury Potential

- Use of SureStart in soil-applied treatments on soils with less than 1.5% organic matter (O.M.) may result in crop injury. Apply as a soil-treatment to fields which have less than 1.5% O.M. only if the risk of crop injury is acceptable.

Restrictions And Precautions For Soil Application
(Not Applicable To Postemergence Use)

- Corn Planting Depth: Minimum planting depth should be at least 1 1/2 inches.
- Do not apply to areas where the soil pH is greater than 7.8 as this may result in increased crop injury.
When Planning to Use a PRE Herbicide
Consider:

Impact of weather

Adverse Weather Conditions
- Extended cold, wet conditions (soil temperatures below 50°F and excessive rainfall with wet soil conditions), following application of SureStart to herbicide tolerant corn, which persist during germination and/or early crop development may result in crop injury. Injury symptoms, which include yellowing of leaves and/or crop stunting, are usually temporary and affected corn plants usually recover without affecting yield.
- Dry weather following preplant surface or preemergence applications of SureStart may reduce effectiveness. If sufficient activating rainfall or overhead irrigation does not occur within 7 to 10 days of application, rotary hoe, harrow, or shallowly cultivate to incorporate the herbicide lightly into the soil. Use a preplant incorporated application when a period of dry weather is predicted after application.
When Planning to Use a PRE Herbicide
Consider:

Interactions with other pesticides:

Soil Insecticide Advisories
When SureStart is used for soil applied weed control in corn:

• Soil applied organophosphate insecticides (except terbufos or phorate, see below) should be applied in a T-band or a band to avoid potential crop injury.
• Terbufos (Counter insecticide products) or phorate (Thimet insecticide products) should not be used.
• Soil insecticides from other classes of chemistry may be applied in-furrow, T-banded, or banded.

• If any herbicide with ALS (acetolactate synthase) inhibition mode of action such as Pursuit, Canopy, Classic, Scepter, or Squadron herbicide, etc., was applied the previous year, apply SureStart to corn only if the rotational restrictions applicable to corn for the preceding product has been met.
What Weedy Traits Do Problem Weeds Have in Common?

• Outcrossing capability - increases potential to increase the spread of R-traits via pollen and increases genetic diversity

• High seed productivity-especially waterhemp - increases potential for rapid buildup in the seed bank and to spread via flooding, combines, etc.

• The results are highly adaptable weeds
  – Waterhemp biotypes have been documented Resistance to six different Sites of Action including:
    » ALS, Glyph, PS II’s, PPO’s, HPPD’s and 2,4-D
    » SOA #’s, 2, 9, 5, 14, 27 and 4, respectively
    » Some populations contain individuals with multiple-resistance
When a Weed Does More Than Compete With the Crop

Photo Credit to Liz Stahl
Volunteer Corn Is A Host for Corn Rootworm

- Serves as feeding site for newly emerged rootworm larvae (late May to early June)
- Must control corn before pupation in late-June
- Serves as a feeding/egg laying site for beetles in early- to mid- July
- Negates positive effects of rotating out of corn

Mixtures of Bt toxin expression and root age classes are likely accelerating evolution of Bt-Resistant CRW
Target V4-V5 Volunteer Corn

- Nodal Roots - Dominant Root System by V6
- Target Larvae on Corn before they Pupate
- Removes the Most Competitive Corn
- Often is in Synchrony With First Glyphosate Application

Photo Credits to:
J. Eco. Ent. Vol 98, 1-8 & Purdue University
POST Volunteer Corn Options in Soybean

NOTE - Due to stacked LL/RR traits in most corn hybrids, inter-row cultivation is your only option

<table>
<thead>
<tr>
<th>Soybean POST</th>
<th>SOA#</th>
<th>Vol. Corn</th>
<th>Rotation To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assure II</td>
<td>1</td>
<td>quizalofop</td>
<td>E 4 mo.</td>
</tr>
<tr>
<td>Fusilade DX</td>
<td>1</td>
<td>fluazifop</td>
<td>E 2 mo.</td>
</tr>
<tr>
<td>Fusion</td>
<td>1</td>
<td>flu + fenoxaprop</td>
<td>E 2 mo.</td>
</tr>
<tr>
<td>Select Max</td>
<td>1</td>
<td>clethodim</td>
<td>E 6 days</td>
</tr>
</tbody>
</table>

When Tank Mixing w/Gly always add AMS and a HSOC (e.g. Destiny HC)
To Reduce Antagonism of Glyphosate
Where Do I Find More Information Regarding Herbicide Resistance Mgmt.?

http://www.wssa.net

http://glyphosateweedscrops.org/