Institute of Ag Professionals

Proceedings of the

2015 Crop Pest Management Shortcourse &

Minnesota Crop Production Retailers Association Trade Show

www.extension.umn.edu/Ag-Professionals
Do not reproduce or redistribute without the written consent of author(s).
Herbicide Resistant Weeds – Reliance on Herbicide Technologies alone won’t manage the problem

Special Thanks to:
Fritz R. Breitenbach, IPM Specialist
Lisa M. Behnken, Extension Educator
Rochester, MN
Mike Owen & Bob Hartzler
Weed Science
Iowa State University
Herbicide resistance

- Weeds have evolved resistance to 21 of the 25 known herbicide sites of action
  - Consists of 148 different herbicides
- At least 24 species resistant to glyphosate worldwide
- Threatens the continued utility of herbicides for weed control
  - Including herbicide resistant traits (both current and future)

(Heap, 2013)
Herbicide resistance

• This is not a new problem and predates herbicide resistant crops by several decades

• Recently, evolved resistance to glyphosate has become synonymous with herbicide resistance

• It is a much greater and far-reaching problem than glyphosate resistance
Important glyphosate-resistant weeds associated with glyphosate-resistant crops in the USA

Amaranthus tuberculatus
Ambrosia artemisiifolia
Coryza canadensis
Amaranthus palmeri
Ambrosia trifida

... and many biotypes are also resistant to ALS inhibitor and other herbicides!
What Does Herbicide Resistance Look Like?

Injured  Dead  Normal
Another sign of herbicide resistance
Left untended herbicide resistance can sneak up on you!

Don’t delay addressing the problem

Watehemp 2013  
Same Field in 2015
Addressing the problem at this point increases input costs because you must now target the weed seed bank.
Is this a sign of Herbicide Resistance?
Are These Giant Ragweed Going to Die?

These plants needed to be sprayed at 2-3 inches.
Percent of growers at a PPAT location in 2013 & 2014 reporting glyphosate has not been performing as well as when they first used it.

Which weed is becoming the most problematic?

**Waterhemp** ...and it is moving east.

Or Giant Ragweed
...and it is moving west.
But wait, there is worse news: Multiple resistance

<table>
<thead>
<tr>
<th>SOA#’s</th>
<th>SOA#’s</th>
<th>SOA#’s</th>
<th>SOA#’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4,5,9,14,27</td>
<td>2,9</td>
<td>2,5,9,14</td>
<td>2,4,5,9</td>
</tr>
</tbody>
</table>

2 = Pursuit, FirstRate
9 = Glyphosate
14 = Valor, Flexstar, Cobra
ISU Reports waterhemp responses to labeled herbicide rates indicate: 700 fields

**Glyphosate**

- Roundup: 46% Susceptable, 54% Resistant

**Multiple Resistance**

- SOA 2, 5, & 9 (ALS, triazines, EPSPs): Pursuit, Harmony, FirstRate, Atrazine, Metribuzin, Roundup
- Multi-Resistant: 30%
- Other: 70%
Multiple resistant waterhemp in Illinois

10 days after treatment

SOA #5  SOA #14  SOA #2

#5 + #14 + #2
Selection for resistance can also come from PRE herbicides. PPO (SOA#14) - Resistance.

Credit to Aaron Hager, Univ. of Illinois.
Mechanisms of Herbicide Resistance

- **Altered Target Site (e.g. SOA #2)**
  - Conformational change to target protein
  - Prevents herbicide from binding
  - Waterhemp, ragweeds, kochia

- **Amplified expression of an enzyme (e.g. SOA #9)**
  - More proteins than there are herbicide molecules
  - Unaffected proteins continue to function
  - Waterhemp

- **Compartmentalization or sequestration (e.g. SOA #9)**
  - Plants sequester herbicide in vacuoles
  - Prevent herbicide from reaching site of action
  - Giant ragweed

- **Enhanced metabolism (e.g SOA # 4, 27)**
  - Plant is able to rapidly break down herbicide / make it inactive
## Mechanisms of Herbicide Resistance

<table>
<thead>
<tr>
<th>Resistance mechanism</th>
<th>SOA 1</th>
<th>SOA 2</th>
<th>SOA 3</th>
<th>SOA 4</th>
<th>SOA 5</th>
<th>SOA 9</th>
<th>SOA 14</th>
<th>SOA 27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbicide class</td>
<td>ACC’ase</td>
<td>ALS</td>
<td>DNA</td>
<td>PGR</td>
<td>Triazine</td>
<td>Gly</td>
<td>PPO</td>
<td>HPPD</td>
</tr>
<tr>
<td>Target site</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+?</td>
<td>+1</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Metabolism(^2)</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Sequestration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Gene amplification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

- Decreased absorption and/or translocation is also a possible resistance mechanism
- \(^?\) Likely but not conclusively confirmed
- \(^1\) This mutation makes weeds less fit than susceptible wild types
- \(^2\) Can confirm cross-resistance to herbicides from multiple SOA’s (2,4-D & “fops”)
  - Can provide resistance to herbicides that have yet to be discovered
- Crop resistance is metabolism-based for: 2,4-D (Enlist) ; glufosinate (Liberty Link) ; dicamba (Xtend)
- Crop resistance is target site-based for; Roundup Ready corn and soybean
Mechanisms of Herbicide Resistance

• Herbicide resistance is complex
• Herbicides are tremendous selection agents
• Frequency of resistance traits varies among herbicide SOA groups
  – e.g. SOA 2 > SOA 9
• Weeds that out-cross and are genetically diverse are a higher risk
• The numerous mechanisms of resistance indicates the need for using multiple SOA groups and non-herbicide control measures
Mechanisms of Herbicide Resistance

- Altered Target Site (e.g. SOA #2)
  - Conformational change to target protein
  - Prevents herbicide from binding
  - Waterhemp, ragweeds, kochia

- Amplified expression of an enzyme (e.g. SOA #9)
  - More protein than there is herbicide molecules
  - Un-affected proteins continue to function
  - Waterhemp

- Compartmentalization or sequestration (e.g. SOA #9)
  - Plants sequester herbicide in vacuoles
  - Prevent herbicide from reaching site of action
  - Giant ragweed

- Enhanced metabolism (e.g SOA # 27)
  - Plant is able to break down herbicide / make it inactive

Unless the resistant trait reduces a plant's ability to reproduce, the trait does not leave the population.
The Main Drivers of Herbicide Resistance

• 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
  – This calls for weed seed bank management
### Available Sites of Action by Crop

**Sequential Reliance on a single SOA Induces multiple resistance**

<table>
<thead>
<tr>
<th>Site of Action (SOA #)</th>
<th>Corn PRE</th>
<th>Corn POST</th>
<th>Soybean PRE</th>
<th>Soybean POST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>POST</strong></td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>[9]</td>
</tr>
<tr>
<td><strong>Soybean</strong></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>[10]</td>
</tr>
<tr>
<td><strong>POST</strong></td>
<td>[14]</td>
<td>15 (Epost)</td>
<td>[14]</td>
<td></td>
</tr>
<tr>
<td><strong>27</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>14</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>27</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How to Manage Herbicide-Resistant Weeds

- Know how to identify resistance
  - 4 known species (GIRW;CORW;COWH;Kochia)
  - Frequency of resistant plants in the field
  - Response of individual plants

- Admit there is a problem and realize that Herbicide Technology alone cannot adequately address the problem

- Change management strategies quickly to more diverse weed management practices
  - Preemergence herbicides
  - Use other effective POST herbicides
  - Include effective tank-mix partners
  - Consider Liberty Link Crops
  - Integrate Cultural Weed Management Practices
Use PRE’s & at Maximum Rates
Advantages PRE Herbicides Bring to Weed Management

• Reduces weed density
  ➢ Increases yield potential

• Reduces weed species mixtures
  ➢ Improves herbicide and adjuvant compatibility

• Results in a narrower distribution of weed sizes
  ➢ Improves consistency of weed control

• Results in added value
  ➢ Increased nitrogen efficiency in corn
  ➢ Early-season canopy in soybean
Let's see what a PRE can do

<table>
<thead>
<tr>
<th>Weed Code</th>
<th>Rating Date</th>
<th>Rate</th>
<th>Appl</th>
<th>Giant Ragweed</th>
<th>% CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boundary</td>
<td>(5,15)</td>
<td>1.5  pt/a</td>
<td>A / B</td>
<td>20</td>
<td>99</td>
</tr>
<tr>
<td>Boundary</td>
<td>(5,15)</td>
<td>1.5  pt/a</td>
<td>A / D</td>
<td>20</td>
<td>31</td>
</tr>
<tr>
<td>BroadAxe XC</td>
<td>(14,15)</td>
<td>25 oz/a</td>
<td>A / D</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Verdict</td>
<td>5 oz/a</td>
<td>A / C</td>
<td>60</td>
<td>98</td>
<td></td>
</tr>
</tbody>
</table>

A = PRE = 5/13  
B = POST I = 6/5  
C = POST II = 6/8  
D = POST III = 6/10

Common Lambsquarters Control = ~99%  
Common Waterhemp Control = ~99%
Let’s see what a PRE can do

<table>
<thead>
<tr>
<th>Weed Code</th>
<th>Rating Date</th>
<th>Giant Ragweed</th>
<th></th>
<th></th>
<th>INJURY</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>June 5</td>
<td>June 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A = PRE = 5/13</td>
<td>C = POST II = 6/8</td>
<td>E = POST IV = 6/16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trt</th>
<th>Treatment</th>
<th>Rate</th>
<th>Appl</th>
<th>% CONTROL</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fierce (14,15)</td>
<td>3 oz/a</td>
<td>A / E</td>
<td>71</td>
<td>72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sencor (5)</td>
<td>4 oz/a</td>
<td>A / E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verdict (14,15)</td>
<td>5 oz/a</td>
<td>A / E</td>
<td>70</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outlook (15)</td>
<td>10 oz/a</td>
<td>A / E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rowel (14)</td>
<td>3 oz/a</td>
<td>A / C</td>
<td>72</td>
<td>82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zidua (15)</td>
<td>2 oz/a</td>
<td>A / E</td>
<td>73</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verdict (14,15)</td>
<td>5 oz/a</td>
<td>A / E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authority Assist (2,14)</td>
<td>12 oz/a</td>
<td>A / E</td>
<td>75</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enlite 2.8 oz/A (2,14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- chlorimuron</td>
<td>0.33 oz/a</td>
<td>A / E</td>
<td>76</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- thifensulfuron</td>
<td>0.5 oz/a</td>
<td>A / E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- flumioxazin</td>
<td>2 oz/a</td>
<td>A / E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zidua PRO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Optill (2,14)</td>
<td>2 oz/a</td>
<td>A / E</td>
<td>77</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Zidua (15)</td>
<td>2 oz/a</td>
<td>A / E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sonic</td>
<td>4.5 oz/a</td>
<td>A / E</td>
<td>79</td>
<td>81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Common Lambsquarters Control = ~99%
Common Waterhemp Control = ~99%
Let’s see what a PRE can do

Common Lambsquarters Control = ~99%
Common Waterhemp Control = ~99%

<table>
<thead>
<tr>
<th>Weed Code</th>
<th>Rating Date</th>
<th>Trt</th>
<th>Treatment</th>
<th>Rate</th>
<th>Appl</th>
<th>% CONTROL</th>
<th>Giant Ragweed</th>
<th>INJURY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sonic</td>
<td>(2,14)</td>
<td>6</td>
<td>oz/a</td>
<td>A / E</td>
<td>86</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Authority First</td>
<td>(2, 14)</td>
<td>6</td>
<td>oz/a</td>
<td>A / C</td>
<td>86</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fierce</td>
<td>(14,15)</td>
<td>3</td>
<td>oz/a</td>
<td>A / E</td>
<td>86</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FirstRate</td>
<td>(2)</td>
<td>0.3</td>
<td>oz/a</td>
<td>A / E</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Authority First</td>
<td>(2,14)</td>
<td>6.4</td>
<td>oz/a</td>
<td>A / F</td>
<td>86</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surveil</td>
<td>(2,14)</td>
<td>2.8</td>
<td>oz/a</td>
<td>A / F</td>
<td>88</td>
<td>87</td>
</tr>
</tbody>
</table>

A = PRE = 5/13
C = POST II = 6/8
E = POST IV = 6/16
F = POST V = 6/25
WHAT ABOUT WATERHEMP?
OPTILL PRO
OPTILL 2 oz/a + OUTLOOK 10 fl oz/a PREPRE applied: 5/5/15
LIBERTY 280 29 fl oz/a + AMS 8.5 lb/100 gal

June 22, 2015

July 8, 2015

60 Bu/A
OPTILL PRO
OPTILL 2 oz/a + OUTLOOK 10 fl oz/a PREPRE applied: 5/5/15
LIBERTY 280 29 fl oz/a + AMS 8.5 lb/100 gal
MIDPOWE Applied on: 6/23/2015

60 Bu/A  August 27, 2015
BOUNDARY 1.95 pt/a PREPRE applied: 5/5/15
CULTIVATION EAPOWE: 6/24/2015

June 22, 2015

June 29, 2015

57 Bu/A
Consider the impact of an open crop canopy on late-emerging weeds

A closed crop canopy is FREE weed control

Sound agronomics contributes to early canopy closure
VERDICT 5 fl oz/a PREPRE applied: 5/5/15
COBRA 10 fl oz/a + SELECT MAX 15 fl oz/a + COC 1.5 pt/a + AMS 17 lb/100 gal
MIDPOWE : Applied on: 6/16/2015

40 Bu/A
August 27, 2015- Poor lambsquarter control
Consider Layering Herbicides. WHY?
Extend the control season.

• One **strategy** for dealing with glyphosate resistant waterhemp is to **layer** soil residual herbicides.

• Three herbicides were evaluated in this study,
  – 1) **Dual II Magnum** (s-metolachlor) at 1.5 pts/A PRE only
  – or 1.5 pts/A PRE followed by 1.0 pt/A POST
  – 2) **Outlook** (dimethenamid-P) at 18 fl oz/A PRE only
  – or 14 fl oz/A PRE followed by 10 fl oz/A POST
  – 3) **Warrant** (acetochlor) at 1.6 pt/A PRE only
  – or 1.6 pt/A PRE followed by 1.6 pt POST
  – *Rates used were based on soil type and seasonal limits.*

• Selected because of their **known effectiveness** for controlling waterhemp and their **flexibility of application timing**.
Comparison of weed control in soybean with a single preemergence application of Outlook (left) and layered applications of Outlook May 5 and June 8 (right).

Photos taken July 14, 2015.
Comparison of weed control in soybean with a single preemergence application of Outlook (left) and layered applications of Outlook May 5 and June 8 (right).

Photos taken August 27, 2015.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>Appl</th>
<th>5-27-15</th>
<th>6-10-15</th>
<th>6-26-15</th>
<th>7-8-15</th>
<th>9-29-15</th>
<th>BU/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUAL II MAGNUM</td>
<td>1.5 pt/a</td>
<td>A</td>
<td>99 a</td>
<td>96 b</td>
<td>91 b</td>
<td>85 b</td>
<td>81 b</td>
<td>43 cd</td>
</tr>
<tr>
<td>Pursuit</td>
<td>4 fl oz/a</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DUAL II MAGNUM</td>
<td>1.5 pt/a</td>
<td>A</td>
<td>99 a</td>
<td>98 a</td>
<td>96 a</td>
<td>97 a</td>
<td>95 a</td>
<td>49 ab</td>
</tr>
<tr>
<td>Pursuit</td>
<td>4 fl oz/a</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DUAL II MAGNUM</td>
<td>1.0 pt/a</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OUTLOOK</td>
<td>18 fl oz/a</td>
<td>A</td>
<td>99 a</td>
<td>96 b</td>
<td>85 c</td>
<td>73 c</td>
<td>71 c</td>
<td>40 d</td>
</tr>
<tr>
<td>Pursuit</td>
<td>4 fl oz/a</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OUTLOOK</td>
<td>14 fl oz/a</td>
<td>A</td>
<td>99 a</td>
<td>98 a</td>
<td>97 a</td>
<td>97 a</td>
<td>94 a</td>
<td>51 a</td>
</tr>
<tr>
<td>Pursuit</td>
<td>4 fl oz/a</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OUTLOOK</td>
<td>10 fl oz/a</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WARRANT</td>
<td>1.6 qt/a</td>
<td>A</td>
<td>99 a</td>
<td>91 c</td>
<td>82 c</td>
<td>69 c</td>
<td>62 d</td>
<td>32 e</td>
</tr>
<tr>
<td>Pursuit</td>
<td>4 fl oz/a</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WARRANT</td>
<td>1.6 qt/a</td>
<td>A</td>
<td>98 b</td>
<td>95 b</td>
<td>95 a</td>
<td>94 a</td>
<td>90 a</td>
<td>46 bc</td>
</tr>
<tr>
<td>Pursuit</td>
<td>4 fl oz/a</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WARRANT</td>
<td>1.6 qt/a</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A = PRE,  B = POST I (June 8, 2015)
Integrated Weed Management
Game of Percentages

How much to rely on Herbicides??

Life Cycle of Annual Weeds

From Chee-Sanford et al. (2006)
In 2014, I used the following weed management practice(s) on land I farm
(Responses: 416 in 2015)

- No changes: 41%
- Altered crop rotations planned delayed planting/tillage: 23%
- Planted cover crops: 11%
- Rotated HR traits (Liberty): 7%
- Mechanical weed control (ex cultivation): 10%
- Hand pulled weeds/roguing: 12%
- Other: 3%

Could select >1 response
Crop Rotation Study
Jared Goplen
UM Graduate Student, Weed Science
Discovery #1
Giant Ragweed

• Zero Weed Threshold = \(97\%\)
  seed bank depletion in 2 years in any crop rotation.

• How to maintain Zero Weed Threshold?
Discovery #2
Giant Ragweed Emergence

Tillage Before Planting Relatively NO effect on emergence

Percent Emergence

Total Emerged (2013-2014)

7.7%
Discovery #3
Cumulative Percent of Seed Shattered

Soybean Harvest

No difference between fence-line and soybean field

30%
How to maintain Zero Weed Threshold?

1. **Crop Rotation:**
   a) Fewer weed escapes in alfalfa and wheat treatments
      • Less total emergence
      • Competitive
      • Different Sites of Action
      • Harvest schedule

2. **Alter Timing**
   a) Change planting, tillage, and herbicide application schedules to better target giant ragweed.
   b) 95% of giant ragweed emerged by June 9th

3. **Giant Ragweed retains seed well into the fall**
   a) Only ~30% shattered by Oct. 15
   b) Be mindful of seed retention: Mow your Fence-lines
Make a conscious effort to control weeds in your fence rows / waterways.
Which Message(s) will you address in 2016?

- It’s not simple anymore
- You need to map your weeds
- You need to keep fencerows, waterways clean
- You need to prevent weeds from going to seed
- You need to mix up your SOA’s
- You need to use PRE’s & maximum rates
- You need a more robust herbicide plan
- You need to dig out the iron
- New herbicides alone will Not take care of things.
Diversification decisions to consider

- Field map to strategically focus
- Plan – multiple years to address seed bank
- Plan “a” and Plan “b”
  - Plan “a” should always focus on early-season weed control
  - Plan “b” should target weeds <3 inches tall
- Decisions you will need to consider
  - Cost – short- and long-term
  - Time to implement
  - Labor requirements
What is your opinion?

If weeds resistant to multiple herbicides were to be confirmed in your community, which of the following statements would best describe your opinion about your neighbors’ management decisions. *(Please select one answer only)*

A. My neighbors’ herbicide resistance management decisions would have no impact on my ability to manage herbicide resistance on my farm.

B. Even if my neighbors do not manage herbicide resistance, I could still effectively manage it on my own farm.

C. If my neighbors do not manage herbicide resistance, there is no way I could effectively manage it on my own farm.
Rethink our weed management strategies

Crop Rotation
• Goal is to reduce the seed bank

Herbicide Inputs
• Move away from Total Post & One-Pass
  Post with delayed PRE
• Start with a PRE
  Post – target max. of 3-inch weeds

Cultural Control
• Inter-row cultivation
• Seed destruction at harvest
• Mid-season weed management
  Delay planting if targeting early-emerging weeds
• Develop weed maps

Crop Competition
• Via Crop Rotation
• Focus on early-season weed control
  Narrow rows

Weed Management
Would cultural control receive more attention if it were referred to as Precision Agriculture?

New technologies that need to be explored