Waterhemp Management in Soybean

Kevin Bradley
Associate Professor, State Extension Weed Scientist
University of Missouri
Waterhemp
<table>
<thead>
<tr>
<th>Seedling shape</th>
<th>Common Waterhemp</th>
<th>Redroot Pigweed</th>
<th>Smooth Pigweed</th>
<th>Powell Amaranth</th>
<th>Palmer Amaranth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image1" alt="Seedling shape" /></td>
<td><img src="image2" alt="Seedling shape" /></td>
<td><img src="image3" alt="Seedling shape" /></td>
<td><img src="image4" alt="Seedling shape" /></td>
<td><img src="image5" alt="Seedling shape" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stem hairs</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image6" alt="Stem hairs" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Leaf shapes</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7" alt="Leaf shapes" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Separate male and female plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seedhead shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>smooth, long, slender</td>
</tr>
</tbody>
</table>

Source: Identification of the weedy pigweeds and waterhemp of Iowa, Iowa State University.
What makes waterhemp so problematic?
What makes waterhemp so problematic?

- Palmer Amaranth
- Redroot Pigweed
- Smooth Pigweed
- Spiny Amaranth
- Tumble Pigweed
- Waterhemp

# Seed per Plant

Sellers et al. 2003
What makes waterhemp so problematic?

→ → extended germination pattern → → → →

What makes waterhemp so problematic?

- 10 weeks of competition from typical waterhemp densities found in IL soybean fields resulted in a 43% yield loss in soybean (Hager et al. 2002).

- Waggoner and Bradley (2011) reported that waterhemp was found in 87% of the Missouri soybean fields that were surveyed at an average density of 22 plants m\(^{-2}\), and resulted in an average yield loss of 3 Bu/A even after control measures were implemented.
Palmer Amaranth and Waterhemp Growth Through the Growing Season (Mokane, Missouri 2009)

- Palmer Amaranth: 1.1 – 2.5”/day
- Waterhemp: ¾ - 1 ¼”/day

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What makes waterhemp so problematic?

1. Dioecious: male and female flowers on separate plants.

2. Waterhemp pollen can remain viable up to 120 hours after pollen shed.

3. Long distance pollen dispersal can occur to plants as much as ½ mile away.

4. The pollen transfers the resistance trait!

Herbicide Resistance in Waterhemp - 2014

- Group 2, ALS-inhibitors (9)
- Group 5, Photosystem II (5)
- Group 14, PPO-inhibitors (5)
- Group 9, Glyphosate (14)
- Group 27, HPPD-inhibitors (4)
- Group 4, Auxins (1)

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Distribution of Resistance to 3X Use Rates of Selected Herbicides in Missouri Waterhemp (2013)

- 2,4-D (growth reg; group 4)
- atrazine (PSII; group 5)
- chlorimuron (ALS; group 2)
- glyphosate (EPSPs; group 9)
- lactofen (PPO; group 14)
- mesotrione (HPPD; group 27)

Distribution of Waterhemp with Multiple Herbicide Resistances in Missouri (2013)

# of herbicide resistances in a waterhemp population

Top 15 Resistant Weeds According to # of Herbicide Modes of Action

1. Rigid Ryegrass - 11 modes
2. Barnyardgrass - 9 modes
3. Annual Bluegrass - 9 modes
4. Goosegrass - 7 modes
5. Blackgrass - 6 modes
6. Waterhemp - 6 modes
7. Junglerice - 6 modes
8. Italian Ryegrass - 5 modes
9. Palmer Amaranth - 5 modes
10. Common Ragweed - 5 modes
11. Wild Oat - 5 modes
12. Horseweed - 5 modes
13. Redroot Pigweed - 4 modes
14. Downy Brome - 4 modes
15. Common Lambsquarters - 4 modes

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What are the weaknesses we must exploit?
1. Seed are relatively short-lived in the soil (4-5 yrs).
Percentage of the Original Waterhemp Seedbank that Remained Viable for Four Years After Burial

2. Seed do not emerge from low soil depths (≥6” or so).
What effect does tillage have on the pigweed species?
What effect does tillage have on the pigweed species?

*Means followed by the same letter are not different, P≤0.05

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Influence of Tillage Type on the Vertical Distribution of Pigweed Seed in the Soil Profile
(Chamois, MO 2013)

% of Total Pigweed Seed

0-1”
- No-till (Spring Preplant Burndown) 10
- Minimum Till (Spring Vertical Tillage Pass) 12
- Conventional Till (Spring Disk + Field Cultivator) 9
- Deep Till (Fall Moldbrd Plow + Spring fld Cultivat) 2

1-2”
- No-till (Spring Preplant Burndown) 33
- Minimum Till (Spring Vertical Tillage Pass) 22
- Conventional Till (Spring Disk + Field Cultivator) 39
- Deep Till (Fall Moldbrd Plow + Spring fld Cultivat) 16

2-4”
- No-till (Spring Preplant Burndown) 17
- Minimum Till (Spring Vertical Tillage Pass) 18
- Conventional Till (Spring Disk + Field Cultivator) 24
- Deep Till (Fall Moldbrd Plow + Spring fld Cultivat) 25

4-6”
- No-till (Spring Preplant Burndown) 12
- Minimum Till (Spring Vertical Tillage Pass) 27
- Conventional Till (Spring Disk + Field Cultivator) 12
- Deep Till (Fall Moldbrd Plow + Spring fld Cultivat) 25

6-8”
- No-till (Spring Preplant Burndown) 21
- Minimum Till (Spring Vertical Tillage Pass) 18
- Conventional Till (Spring Disk + Field Cultivator) 8
- Deep Till (Fall Moldbrd Plow + Spring fld Cultivat) 27

8-10”
- No-till (Spring Preplant Burndown) 7
- Minimum Till (Spring Vertical Tillage Pass) 3
- Conventional Till (Spring Disk + Field Cultivator) 8
- Deep Till (Fall Moldbrd Plow + Spring fld Cultivat) 5

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Whatever management approach you take, the ultimate objective must be to reduce the soil seedbank.
Integrate Cultural Management Techniques With Herbicides Wherever and Whenever Possible
What effect does soybean row spacing have on pigweed control?

*Results summarized across herbicide programs, tillage types, and planting populations.

**Means followed by the same letter are not different, $P \leq 0.05$
Influence of Soybean Row Spacing and Herbicide Programs on Late-season Waterhemp Density in LL Soybean (2012-13, Moberly Missouri)

*Results summarized across soybean seeding rates.
**Means followed by the same letter are not different, $P \leq 0.05$
What effect does soybean planting population have on pigweed control?

![Bar graph showing late-season density (#/6 m²) for different planting populations.](https://example.com/graph.png)

- 130k: a
- 160k: b
- 190k: b
- 220k: b

*Results summarized across herbicide programs, tillage types, and row spacings.*

**Means followed by the same letter are not different, P ≤ 0.05**

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What kind of weed control can we expect from cover crops?
Influence of Cover Crops vs. Herbicide Treatments on Cumulative Resistant Waterhemp Emergence (Moberly, MO 2013)

- Nontreated Control
- Late Spring Burndown (Roundup+2,4-D)
- Fall Trtmt (Roundup+2,4-D+AthrtyXL)
- Austrian Pea
- Cereal Rye/H. Vetch
- Hairy Vetch
- Crimson Clover
- Tillage Radish
- Oats
- Italian Ryegrass
- Cereal Rye
- Wheat

Cumulative Summer Ann Weed Emergence (#/m²)

© Kevin Bradley, Univ. Missouri
## Influence of Cover Crops on Pigweed Emergence in Georgia

<table>
<thead>
<tr>
<th>Legume Cover Crop</th>
<th>Early June - Cereal</th>
<th>Early June + Cereal Rye</th>
<th>Late July - Cereal</th>
<th>Late July + Cereal Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austrian Winter Pea</td>
<td>4</td>
<td>1</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Vetch</td>
<td>3</td>
<td>0</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>Crimson Clover</td>
<td>18</td>
<td>3</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>None</td>
<td>46</td>
<td>8</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td><strong>LSD0.05</strong></td>
<td><strong>------- 18 -------</strong></td>
<td><strong>------- 9 -------</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Impact of Crop Rotation

In one Missouri survey, the likelihood of finding resistant waterhemp was 44% higher in fields with soybeans grown continuously for 5 years compared to fields that had at least one other crop added to the rotation during the 5-year time period.

What’s the best way to manage the pigweed species?
What’s the best way to manage the pigweed species?

1) To never see them!

2) By using multiple, effective herbicide modes of action.

We achieve 1) and 2) through the application of effective, pre-emergence, residual herbicides.
Your success with weed management in 2015 and beyond may depend on YOUR ability to understand herbicide mode-of-action and classification.
No PRE herbicide with resistant waterhemp; relying on POST only = “unwinnable”

effective full-rate PRE herbicide on multiple-resistant waterhemp
Effective PRE Active Ingredients

Group 14 Herbicides
- flumioxazin
- sulfentrazone

Group 15 Herbicides
- metolachlor
- pyroxasulfone
- dimethenamid
- Acetochlor

Group 5 Herbicides
- Metribuzin

Group 3 Herbicides
- Trifluralin
# Herbicide Classification

Repeated use of herbicides with the same site of action can result in the development of herbicide-resistant weed populations.

## Site of Action

<table>
<thead>
<tr>
<th>Site of Action</th>
<th>Activity</th>
<th>Control</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>POST-EM</td>
<td>Inhibitors</td>
<td>POST-EM</td>
<td>POST-EM</td>
</tr>
<tr>
<td>PRE-EM</td>
<td>Inhibitors</td>
<td>PRE-EM</td>
<td>PRE-EM</td>
</tr>
<tr>
<td>POST-Emergence</td>
<td>Inhibitors</td>
<td>POST-Emergence</td>
<td>POST-Emergence</td>
</tr>
<tr>
<td>PRE-Emergence</td>
<td>Inhibitors</td>
<td>PRE-Emergence</td>
<td>PRE-Emergence</td>
</tr>
<tr>
<td>POST-Planting</td>
<td>Inhibitors</td>
<td>POST-Planting</td>
<td>POST-Planting</td>
</tr>
<tr>
<td>PRE-Planting</td>
<td>Inhibitors</td>
<td>PRE-Planting</td>
<td>PRE-Planting</td>
</tr>
<tr>
<td>POST-Seedbed</td>
<td>Inhibitors</td>
<td>POST-Seedbed</td>
<td>POST-Seedbed</td>
</tr>
<tr>
<td>PRE-Seedbed</td>
<td>Inhibitors</td>
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## Activity

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<td>Inhibitors</td>
<td>PRE-EM</td>
<td>PRE-EM</td>
</tr>
<tr>
<td>Activity 1</td>
<td>POST-Emergence</td>
<td>POST-Emergence</td>
</tr>
<tr>
<td>Activity 2</td>
<td>PRE-Emergence</td>
<td>PRE-Emergence</td>
</tr>
<tr>
<td>Activity 3</td>
<td>POST-Planting</td>
<td>POST-Planting</td>
</tr>
<tr>
<td>Activity 4</td>
<td>PRE-Planting</td>
<td>PRE-Planting</td>
</tr>
<tr>
<td>Activity 5</td>
<td>POST-Seedbed</td>
<td>POST-Seedbed</td>
</tr>
<tr>
<td>Activity 6</td>
<td>PRE-Seedbed</td>
<td>PRE-Seedbed</td>
</tr>
</tbody>
</table>

## Control

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**Additional Thoughts on Waterhemp Management:**

1. **Use full use rates** and/or combinations of pre-emergence residual herbicides as close to planting as possible.

2. **Overlapping residual** herbicide (Anthem, Cinch, Dual II Magnum, Outlook, Prefix, Warrant, Zidua) programs aren’t for all weed species, but they do match waterhemp.

3. Liberty (glufosinate) and the LibertyLink soybean system is still a mechanism of action that works. Only following a residual herbicide program and w/ timely applications.

4. Soon-to-be-released technologies will not “solve” the problem of resistant waterhemp, or change #’s 1-3.
#1. Use full use rates and/or combinations of pre-emergence residual herbicides as close to planting as possible.

But there are still some product labels that talk about reduced rates!!!

**FULL USE RATE (25)**

Rate Table 1:
Fall Application, Early Pre-plant, Preplant Burndown, Pre-plant Incorporated, and Preemergence:
No-Till, Minimum-till, Conventional tillage

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Organic Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5 – 2%</td>
</tr>
<tr>
<td></td>
<td>Ounces Product Per Acre</td>
</tr>
<tr>
<td>Coarse: Loamy Sand, Sandy loam</td>
<td>5.0 – 6.0</td>
</tr>
<tr>
<td>Medium: Loam, Silt Loam, Silt, Sandy clay loam</td>
<td>6.5 – 7.5</td>
</tr>
<tr>
<td>Fine: Silty Clay Loam, Clay Loam, Clay</td>
<td>7.0 – 8.0</td>
</tr>
</tbody>
</table>

**REDUCED RATE FOR GMO SOYBEAN (ROUNDUP READY, LIBERTY LINK etc.) (26)**

Rate Table 2:
Use rates in Table 2 are to be used in conjunction with a planned POST herbicide program; at these reduced rates will provide early season control or suppression to reduce early season weed competition.

Fall application, Early Pre-plant, Early Pre-plant Burndown, Preplant Incorporated, Preemergence:
No-Till, Minimum-till, Conventional Tillage

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<td>Coarse: Loamy Sand, Sandy loam</td>
<td>3.0 – 4.0</td>
</tr>
<tr>
<td>Medium: Loam, Silt Loam, Silt, Sandy clay loam</td>
<td>3.2 – 4.0</td>
</tr>
<tr>
<td>Fine: Silty Clay Loam, Clay Loam, Clay</td>
<td>4.0 – 5.0</td>
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</tbody>
</table>
#2. Overlapping residuals is a program that fits the pattern of waterhemp emergence.
#3. Liberty provides a mechanism of action that still works, but if we abuse it we will break it.

Only with a pre-emergence herbicide
Only with timely POST applications of Liberty
#4. Soon-to-be-released technologies will not “solve” the problem of resistant waterhemp, or change the emphasis that we should place on good weed management practices.