Pigweed Management
Doug Shoup
Southeast Area Agronomist
Kansas State University

Outline
- Identification/Competitiveness
- Genetic Variability
- Herbicide Resistance
- Manage Resistance

Pigweed Biology

Identification

Redroot pigweed | Palmer amaranth | Common waterhemp
---|---|---
Short Hairs | Long Petiole | No Hairs

Pigweed Competition

- Palmer amaranth
  - Height from 6 to 9 ft tall
  - Up to 2 million seed/plant
  - Soy yield losses up to 56% at 8 plants/3 ft-row

- Common waterhemp
  - Height from 6 to 9 ft tall
  - Up to 2 million seed/plant
  - Soy yield losses up to 56% at 8 plants/3 ft-row

- Redroot pigweed
  - Height from 5 to 8 ft tall
  - Up to 400,000 seed/plant
  - Soy yield losses up to 38% at 8 plants/3 ft-row

Pigweed Biology

Treatment of Weeds at Proper Size

- Rate of Growth when temperatures are in the 80’s and 90’s
  - Especially true with Palmer amaranth
No-till Oklahoma
Preemergence Palmer Amaranth Control in Soybeans
10 DAP

Pigweed Biology

No-till Oklahoma
Preemergence Palmer Amaranth Control in Soybeans
14 DAP

Cobra at 12.5 oz/A applied 20 DAP

Pigweed Biology

No-till Oklahoma
Preemergence Palmer Amaranth Control in Soybeans
20 DAP

Roundup PowerMax at 32 oz/A

Pigweed Biology

No-till Oklahoma
Roundup PowerMax at 32 oz/A

Pigweed Biology
Pigweed Pollination

- Redroot pigweed, smooth pigweed, and prostrate pigweed are monoecious
  - Male and female parts on same plant
- Palmer amaranth and common waterhemp are dioecious plants
  - Male and female parts on separate plants
- Amaranth can cross pollinate between species
  - Potentially transfer resistance genes

Pigweed Pollen Shape

- Pollen shape differences between species
  - Dioecious species generally more apertures

Cultural Practices to Reduce Weed Pressure

- Pollen viability
  - Common waterhemp pollen shown to be viable up to 120h in greenhouse
- Pollen spread
  - Decreased fertilization with greater distances
  - Within 105 ft from pollen source
  - Distances up to a half mile were observed in field studies

Pollination and Multi-Gene Resistance

- Monoecious resistance
- Dioecious resistance

Progeny have a+b genes

Gene a

Gene b

Narrow Row Weed Suppression

- Across 6 site years, narrow row soybean suppressed 60% of *Amaranthus* (Bell, AR ‘15; Schultz, MO ‘15; Steckel, IL ‘04)
- Seed suppression across soybean growth stage and row spacing
No-till Oklahoma

If 60% enter seed bank and 6% emerge = 878,000 plants/ac

If your herbicide program is 95% effective = 1 plant/ft²

1 plant/15 ft of row = 24.4 mil seed/ac

Pigweed Biology

Narrow Row Weed Suppression

• Yield losses can be reduced with narrow rows when under high weed pressure (Steckel, ill. 2004)

Cover crop suppression of weeds

• Cover crops suppress weed emergence
  – Significantly reduced populations and seed production
  – Common waterhemp populations built over time but significantly less in cover crop treatments
  • Can’t rely entirely on CC for weed control

Herbicide Resistance

• Palmer and waterhemp have developed resistance across seven herbicide MOA (Heap 2015)
  – Dinitroaniline (Palmer): Treflan, Prowl
  – Triazine Resistance: Atrazine, Sencor
  – ALS Resistance: numerous Finesse, Pursuit, FirstRate
  – PPO Resistance (Waterhemp): Cobra, Flexstar, Sharpen
  – Glyphosate Resistance: Roundup, Touchdown
  – HPPD Resistance: Callisto, Armazon, Laudis, Balance
  – 2,4-D Resistance (Waterhemp):

Herbicide Resistance Inheritance

• ALS and triazine resistance in pigweeds complete insensitivity to herbicide
  – Triazine also recently found to be metabolic resistance
• Waterhemp resistance to PPO herbicides is by one gene resistance
  – Resistant plants will show symptoms but won’t die
• PPO resistant waterhemp may be common in KS
  – Resistance in KS, IL, MO

PPO Resistant Waterhemp

• Although resistant to PPO herbicides postemergence, plants will be susceptible to PPO herbicides applied preemergence
  – Authority, Valor, Reflex, Sharpen
Glyphosate Resistance

- The mechanism of glyphosate resistance in pigweed is increased expression of the ESPS enzyme.
- Multiple copies of ESPS in individual plants explains varying response to glyphosate within a population.

PPO Resistant Waterhemp

Greenhouse Population

Field Population

Impact/Armezon dose response.

HPPD resistant waterhemp and Palmer amaranth

HPPD resistant Palmer amaranth control with PRE herbicides, Seward (Thompson, Peterson 2013)
Palmer amaranth control averaged over herbicide and rate!

- Control declined over time
- Control ratings were higher in 2014 than 2013 due to much cooler weather during and following 2014 application.

So What’s the Answer?

- Incorporate cultural practices previously mentioned
- Start using a more rigorous preemergence residual herbicide program

Glyphosate Resistant Waterhemp and Palmer Amaranth Control

- Utilize an integrated approach incorporating preemergence residual herbicides with different MOA
- Foundation preemergence herbicides
  - Sorghum: Atrazine Premixes, Lexar/Lumax, Verdict
  - Corn: Atrazine/acetamide premixes, Lexar/Lumax, Balance Flexx, Corvus, Verdict, Accuron
  - Soybeans: Prefix, Authority Elite, Trivence, Boundary, Fierce, Optil Pro, Warrant Ultra

PPO Resistant Waterhemp

WSSA Site of Action Classification

- Number system assigned to different Herbicide Sites of Action
  1. ACCase inhibitors: Assure, Select, Poast, Fusion, etc
  2. ALS inhibitors: Sulfonylureas, Imidazoliones, etc
  4. Auxin receptors: 2,4-D, dicamba, Tordon, etc
  5. Photosystem II inhibitors: atrazine, metribuzin, etc
  9. EPSP inhibitor: glyphosate
  10. Glutamine Synthetase inhibitor: Liberty
  14. PPO inhibitors: Valor, Spartan, Sharpen, Cobra, Cadet, etc
  15. Long Chain Fatty Acid Inhibitors: Dual, Harness, Outlook, Zidua, etc
  27. HPPD inhibitors: Balance, Callisto, Laudis, Armezon, Huskie, etc
1. **Herbicide Site of Action Designation**

2. **Soybean Weed Control Calendar**

- **Foundation preemergence herbicides**
  - (No more than 1 to 2 weeks preplant)
  - Soybeans: Authority, Valor, Fierce, Trivence, Prefix, Dual, Verdict, Zidua, Prowl

3. **Soybean Pre Herbicide Solubility**

- **Preemergence Residual Herbicides Critical for Weed Control in Crops**
  - 3 major processes govern herbicide fate in soil
    - Chemical (adsorption, acid hydrolysis)
    - Physical (leaching, volatility, photo degradation)
    - Microbial degradation
  - Longevity and fate of herbicide is dependent on
    - Clay content, pH, organic matter, soil moisture, microbial population

*Approximate half life of herbicide according to the 2014 Herbicide Handbook

All these factors influence availability and phytotoxicity of residual herbicides
Preemergence weed control (3 WAP) at Manhattan (Peterson and Thompson 2014)

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate</th>
<th>Paam</th>
<th>Vele</th>
<th>Hlng</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fierce</td>
<td>3 oz</td>
<td>100</td>
<td>100</td>
<td>70</td>
</tr>
<tr>
<td>Sonic</td>
<td>3 oz</td>
<td>92</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Sonic</td>
<td>6 oz</td>
<td>96</td>
<td>88</td>
<td>88</td>
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<tr>
<td>Surveil (Valor+FirstRate)</td>
<td>2.4 oz</td>
<td>100</td>
<td>100</td>
<td>78</td>
</tr>
<tr>
<td>Trivence</td>
<td>8 oz</td>
<td>100</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>Prefix</td>
<td>2 pt</td>
<td>98</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Boundary</td>
<td>2 pt</td>
<td>100</td>
<td>80</td>
<td>13</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sorghum Weed Control Calendar

<table>
<thead>
<tr>
<th>Plant Crop</th>
<th>Crop Canopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 10</td>
<td></td>
</tr>
<tr>
<td>Apr 20</td>
<td></td>
</tr>
<tr>
<td>May 20</td>
<td></td>
</tr>
<tr>
<td>Jun 20</td>
<td></td>
</tr>
<tr>
<td>Jul 20</td>
<td></td>
</tr>
</tbody>
</table>

- Fall / Late Winter Burndown
  - Glyphosate + Atrazine + dicamba / 2,4-D
- Foundation preemergence herbicides
  - Chloracetamide + atrazine, Verdict, Lumax EZ
- Postemergence
  - Huskie + atrazine or Clarity + atrazine

Sorghum or Corn Pre Herbicide Solubility

- Water soluble: active with less rainfall
- Less water soluble: active with rain

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>30d</th>
<th>40d</th>
<th>60d</th>
<th>10d</th>
</tr>
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<tbody>
<tr>
<td>Dual</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stinger</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Python</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Callisto</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Zidua (March 30 in wheat) 2 oz 5 0 0
Gramoxone + CDC 3 pt 95 60 45
Prefix + CDC 2 pt 75 70 60
Graxoxone + Prefix + CDC 3 pt + 2 pt 99 95 90
Graxoxone + Trivence + CDC 3 pt + 8 oz 99 99 97
Graxoxone + Anthem + CDC 3 pt + 8 oz 99 95 85
LSD (0.05) 8 4 16

Palmer amaranth control in double crop wheat with preplant treatments (Hay, Peterson, and Shoup, 2015)

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate</th>
<th>7/8</th>
<th>7/24</th>
<th>8/22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zidua (March 30 in wheat)</td>
<td>2 oz</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gramoxone + CDC</td>
<td>3 pt</td>
<td>95</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>Prefix + CDC</td>
<td>2 pt</td>
<td>75</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Graxoxone + Prefix + CDC</td>
<td>3 pt + 2 pt</td>
<td>99</td>
<td>95</td>
<td>90</td>
</tr>
<tr>
<td>Graxoxone + Trivence + CDC</td>
<td>3 pt + 8 oz</td>
<td>99</td>
<td>99</td>
<td>97</td>
</tr>
<tr>
<td>Graxoxone + Anthem + CDC</td>
<td>3 pt + 8 oz</td>
<td>99</td>
<td>95</td>
<td>85</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td></td>
<td>13</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

- Utilize an integrated approach incorporating postemergence and residual herbicides with different MOA
- Postemergence herbicide options
  - Sorghum – Huskie, atrazine, dicamba, 2,4-D
  - Corn – Callisto, Laurus, Capreno, Impact, Armezon, Status, 2,4-D, Glyphosate
  - Soybean – Flexstar, Cobra, Ultra Blazer, Glyphosate
- Burndown options for wheat fallow and DC Soybean?
Gramoxone SL + COC (PP)  
3 pt + 1%  
4WAP MAN

Gramoxone SL + Prefix + COC (PP)  
3 pt + 2 pt + 1%  
4WAP MAN

Gramoxone SL + Boundary + COC (PP)  
3 pt + 2 pt + 1%  
4WAP MAN

Future for Weed Management

- Genetically modified crops
  - Liberty-Link crops (currently available)
  - 2,4-D resistant corn, cotton, and soybean (Dow)
  - Dicamba resistant soybean and cotton (Monsanto)
  - Isoxaflutole-resistant soybeans (Bayer & Syngenta)

Preemergence in Liberty Link soybeans at Manhattan in 2014 (Peterson and Thompson)

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate</th>
<th>Paam</th>
<th>Vele</th>
<th>Ilmg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liberty (P)</td>
<td>36 oz</td>
<td>67</td>
<td>98</td>
<td>93</td>
</tr>
<tr>
<td>Liberty/Liberty (EP/P)</td>
<td>29/29 oz</td>
<td>97</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Valor/Liberty (PRE/P)</td>
<td>3/29 oz</td>
<td>100</td>
<td>100</td>
<td>97</td>
</tr>
<tr>
<td>Fierce/Liberty (PRE/P)</td>
<td>3.5/29 oz</td>
<td>100</td>
<td>100</td>
<td>97</td>
</tr>
<tr>
<td>Authority XL/Liberty (PRE/P)</td>
<td>6/29 oz</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Authority Max/Liberty (PRE/P)</td>
<td>7/29 oz</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Summary

- Amaranthus species are a major challenge for all producers,
  - More of a "watch-out" for no-till producers where tillage isn't used
- Competitiveness of pigweeds can have a negative impact on yield
- Currently there is resistance to 7 different herbicide MOA in amaranth species
- Proper management against resistance is important to keep our technology relevant
Pigweed Management

Doug Shoup
dshoup@ksu.edu
620-212-2399