The Impact of Glyphosate-Resistant Horseweed and Pigweed on Cotton Weed Management and Costs

University of Tennessee

L. Steckel, S. Culpepper and K. Smith
## U.S. Upland Cotton Herbicide Usage 1997 to 2003
### USDA NASS 2003 Field Crops Survey

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Area Treated</th>
<th>Total Applied&lt;sup&gt;a&lt;/sup&gt;</th>
<th>%Change&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate</td>
<td>70</td>
<td>12,870</td>
<td>752.9%</td>
<td>Caution. 4 hr restricted entry interval (REI). Relatively non-toxic.</td>
</tr>
<tr>
<td>Trifluralin</td>
<td>39</td>
<td>4,156</td>
<td>-22.2%</td>
<td>Caution. Preplant soil incorporated.</td>
</tr>
<tr>
<td>Diuron</td>
<td>28</td>
<td>1,738</td>
<td>101.1%</td>
<td>Caution. 12 hr REI.</td>
</tr>
<tr>
<td>Pendimethalin</td>
<td>20</td>
<td>1,813</td>
<td>-25.6%</td>
<td>Caution. Preemergence or preplant soil incorporated.</td>
</tr>
<tr>
<td>Pyrithiobac-sodium</td>
<td>12</td>
<td>124</td>
<td>-25.9%</td>
<td>Warning. 24 hr REI.</td>
</tr>
<tr>
<td>Prometryn</td>
<td>11</td>
<td>1,175</td>
<td>-28.1%</td>
<td>Caution. 12 hr REI. Triazine.</td>
</tr>
<tr>
<td>Fluometuron</td>
<td>8</td>
<td>755</td>
<td>-84.1%</td>
<td>Caution. 24 hr REI.</td>
</tr>
<tr>
<td>MSMA/DSMA</td>
<td>7</td>
<td>1,175</td>
<td>-78.6%</td>
<td>Caution. 12 hr REI. Arsenical.</td>
</tr>
<tr>
<td>Cyanazine</td>
<td>&lt;0.5%</td>
<td>52</td>
<td>-97.6%</td>
<td>No longer labeled in cotton. Voluntary cancellation 1999.</td>
</tr>
<tr>
<td>Norflurazon</td>
<td>&lt;0.5%</td>
<td>29</td>
<td>-97.1%</td>
<td>Caution. 12 hr REI.</td>
</tr>
<tr>
<td>Clomazone</td>
<td>&lt;0.5%</td>
<td>16</td>
<td>-96.7%</td>
<td>Caution. 12 hr. REI.</td>
</tr>
<tr>
<td>Bromoxynil</td>
<td>&lt;0.5%</td>
<td>14</td>
<td>-97.3%</td>
<td>Warning. Toxic to wildlife and fish. 96 hr REI.</td>
</tr>
</tbody>
</table>

<sup>a</sup>2003; 1,000 lbs.

<sup>b</sup>Calculated values include adjustments for total U.S. upland cotton acreage. Values normalized to 1997 upland cotton acreage. Bromoxynil value based upon 1999 acreage.
History of Glyphosate-Resistance in Horseweed

- 2000 - DE – VanGessel WSSA
- 2001 - TN Lauderdale & Gibson Co.
- 2002 - KY, OH, IN, MD, & NJ
- 2003 - AR, MS, NC
- 2004 - LA, MO
- 2005 - CA, IL
Spread of GR Horseweed

- 2001 to 2002
- 2003 to 2004
- 2005 to 2006
Horseweed (marestail)  
*Conyza canadensis* (L.) Cronq.  

Syn. *Erigeron canadensis* L.

- Asteraceae (Compositae), Aster family
- Winter annual or biennial
- 6” to 9’ tall (15cm – 3m)
- 50K – 250K seeds/plant
- Taproot w/ fibrous roots – 20” wide to 40” deep
- Adapted to “periodically plant-free, undisturbed soil”

*Holm et al, 1997.*
Horseweed is Very Competitive

Competition to 5th leaf  Horseweed Free

Photo credit: Larry Steckel
Horseweed Competition in Cotton

4.6 horseweed plants/square foot

- Competition to 2 lf
- Competition to 6 lf
- Competition to 10 lf
- Competition to 12 lf
- Competition to 1st Bloom

% Seed Cotton Yield Loss

LSD = 15
Must Start Clean!
2004 Common Horseweed Burndown Program

Photo credit: Larry Steckel
Glyphosate 1qt + Tillage

Photo credit: Larry Steckel
Impact of GL Horseweed on Conservation Tillage
Tennessee 2004
Survey of County Ag Agents

- 18% reduction in conservation tillage in Tennessee.
- Largest cotton acreage counties in TN dropped from 80% conservation tillage to 40%.
Impact of GL Horseweed on Conservation Tillage

North Delta States

- Arkansas best estimate is 15% reduction in conservation tillage due to GR horseweed.
- Similar trends reported in Mississippi and the Bootheel of Missouri
## Horseweed Burndown for Cotton

<table>
<thead>
<tr>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate/Gramoxone + Clarity 8 to 12 ozs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valor 2 ozs or Caparol 32 ozs or Cotoran 32 ozs or Direx 16 ozs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

21 DBP

| Gramoxone Inteon 48 ozs or Ignite 29 ozs + Caparol 32 ozs or Cotoran 32 ozs or Direx 16 ozs |

Newly emerged to rosette (Feb to late-March)

Bolting up to 6” horseweed (Early-April to Cotton Emergence)
Soil Residual Herbicides for GR Horseweed
Cost of GL Horseweed in No-till Cotton

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Early Burndown</strong></td>
<td></td>
</tr>
<tr>
<td>- Roundup OM 22 oz</td>
<td>$4.00</td>
</tr>
<tr>
<td>- Clarity 8 ozs</td>
<td>$5.00</td>
</tr>
<tr>
<td>- Valor 2 ozs</td>
<td>$8.00</td>
</tr>
<tr>
<td>- Caparol 32 ozs</td>
<td>$8.00</td>
</tr>
<tr>
<td><strong>At Planting</strong></td>
<td></td>
</tr>
<tr>
<td>- Gramoxone 40 ozs</td>
<td>$10.00</td>
</tr>
<tr>
<td>- Cotoran 32 ozs</td>
<td>$10.00</td>
</tr>
<tr>
<td><strong>Average Extra Cost</strong></td>
<td>$20.00</td>
</tr>
</tbody>
</table>
What has changed in the past 36 months due to GR horseweed?

✓ More widespread
✓ In-crop emergence
✓ More tank mixes (EPP and Post)
✓ More residual herbicides
✓ More conventional tillage
Summary

- Conservation tillage is an economically advantageous and environmentally beneficial practice.
- GR horseweed has reduced conservation tillage acres.
- GR horseweed can be managed though it is more costly.
History of Glyphosate Resistance in Pigweed

2005-2006

- Palmer pigweed 8 to 12x GA, NC, SC
- Palmer pigweed 2 to 4x AR, TN
- Waterhemp 4x MO
GR Palmer Pigweed in Georgia

Culpepper

WeatherMax 88 oz at 1 inch
WeatherMax 88 oz at 4 inch
WeatherMax 88 oz PDIR
Palmer Amaranth Status in Tennessee
Tennessee biotype regrowth after 22 oz/A Roundup WM
Palmer Amaranth in Tennessee
Glyphosate-Tolerant Palmer Amaranth Management

- **Tennessee**
  - Use Max rate of glyphosate
  - Dual over-the-top with 1\textsuperscript{st} or 2\textsuperscript{nd} glyphosate shot
  - PD - Caparol or Dual
  - Hooded – Valor or Caparol
Cost of GR Horseweed + Palmer in Tennessee Cotton

- **March Burndown**
  - Glyphosate + Clarity + Valor or Caparol or Cotoran
    - Cost: $16.00

- **Post**
  - Glyphosate + Dual
    - Cost: $16.00

- **Post Direct/Hooded**
  - Suprend
    - Cost: $8.00
  - Valor + Glyphosate
    - Cost: $8.00

- **Average Cost**: $47.00
- **Average Cost 2001**: $20.00
- **Difference**: $27.00
Cost of GR Palmer in Georgia Cotton

- **At Planting**
  - Prowl + Reflex $18.00
- **Post**
  - Glyphosate + Dual $14.00
- **Post Direct**
  - Direx + MSMA $8.00
- **Hooded**
  - Gramoxone Inteon $5.00
- **Average Cost** $45.00
## Cost of GR Palmer in Georgia Cotton 1 Field

<table>
<thead>
<tr>
<th>Method</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>At Planting</strong></td>
<td></td>
</tr>
<tr>
<td>- Prowl + Reflex</td>
<td>$15.00</td>
</tr>
<tr>
<td><strong>Post</strong></td>
<td></td>
</tr>
<tr>
<td>- Glyphosate + Dual</td>
<td>$14.00</td>
</tr>
<tr>
<td>- Glyphosate + Staple</td>
<td>$27.00</td>
</tr>
<tr>
<td><strong>Post Direct</strong></td>
<td></td>
</tr>
<tr>
<td>- Direx + MSMA</td>
<td>$8.00</td>
</tr>
<tr>
<td><strong>Hooded</strong></td>
<td></td>
</tr>
<tr>
<td>- Gramoxone</td>
<td>$5.00</td>
</tr>
<tr>
<td><strong>Hand weeding</strong></td>
<td></td>
</tr>
<tr>
<td>- 220 hours</td>
<td>$23.00</td>
</tr>
<tr>
<td><strong>Average Cost</strong></td>
<td>$92.00</td>
</tr>
</tbody>
</table>

Culpepper
Summary

- GR horseweed has reduced no-till cotton acres and has cost producers an extra 15 to 20 dollars/Acre
- GR Palmer pigweed is much more problematic than horseweed due to its more competitive nature
- GR Palmer on average could cost cotton producers an extra >40 dollars/Acre to manage
Implications

- GR horseweed now has to be managed on most cotton acres in the Midsouth.
- GR Palmer pigweed is a much bigger threat to cotton production and every year of delay in its arrival is big savings to producers.
- Resistance management for GR Palmer is necessary.
Brazil Glyphosate Resistant Weeds

a- *Lolium multiflorum* (2003) **Ryegrass**

b- *Conyza bonariensis* (2005) **Fleabane**
   *Conyza canadensis* (2005) **Marestail**

c- *Euphorbia heterophylla* (2005) **Wild poinsettia**

d- *Sorghum halepense* (2006 suspected) **Jgrass**

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at Rio Grande do Sul
Questions