Innovation to Manage Glyphosate-Resistant *Palmer amaranth*

Dave Guthrie and Alan Hopkins
Bayer CropScience

*Palmer amaranth* RoundTable
Little Rock, Arkansas, Dec. 13-14, 2007
<table>
<thead>
<tr>
<th>IGNITE</th>
<th>IGNITE 280</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 oz</td>
<td>22 oz</td>
</tr>
<tr>
<td>40 oz</td>
<td>29 oz</td>
</tr>
<tr>
<td>60 oz</td>
<td>43 oz</td>
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- 1.67 lbs glufosinate-ammonium
- 2.34 lbs glufosinate-ammonium
Best Management Practices

• Know Your Weed Management Options
  – Start Clean
  – Utilize a PPI (yellow herbicide) prior to planting
  – Depending on weed species, pressure, etc., use a Preemergence herbicide behind the planter
  – Plan on a residual material at layby
  – Use Ignite 280 in the LibertyLink trait system
Manage resistance with Ignite

• IGNITE 280 herbicide, in the LibertyLink® trait system, provides fast, non-selective control of more than 100 grasses and broadleaf weeds in cotton.

• The LibertyLink system, with IGNITE 280 herbicide, is the only logical rotational alternative to Roundup Ready cotton where weed resistance is a concern.

• In LibertyLink cotton, IGNITE 280 can be applied as a pre-plant burndown, over-the-top post-emergent, hooded, or post-directed.
Manage resistance with Ignite

- IGNITE 280 can be tankmixed with other contact, systemic and residual herbicides to fit field-by-field needs.
- In a Roundup Ready system, IGNITE 280 can be applied under a hood as part of a program to control glyphosate-resistant weeds.
Managing Glyphosate-Resistant Palmer amaranth

Trials of:
Dr. Stanley Culpepper UGA
2006 & 2007 Macon County, GA

Contributed by
Herb Young & Chris Hopkins
Bayer CropScience 2007
Palmer amaranth Resistance to Glyphosate

Documented in over 20 GA Counties

“Has potential of being the worst problem since the boll weevil.” - Dr. Stanley Culpepper, UGA

Projection to be state-wide in Georgia has been reduced from 10 years to 3 years.

LibertyLink® Cotton and Ignite® 280 have provided control of glyphosate-resistant Palmer amaranth.
**Glyphosate-Resistant Palmer amaranth**

2006 Dr. Stanley Culpepper, UGA Macon County, GA

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**Lbs. Seed cotton/A**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield</th>
<th>Percent Control</th>
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</thead>
<tbody>
<tr>
<td>Roundup 22 oz EP+MP</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RU 22oz + Staple 1.7oz EP + Direx/MSMA PD</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ignite 23 EP + Direx/MSMA PD</td>
<td>1200</td>
<td>100</td>
</tr>
<tr>
<td>Ignite 23 oz EP+MP</td>
<td>1336</td>
<td>90</td>
</tr>
<tr>
<td>Ignite 23 oz EP+MP + Direx/MSMA PD</td>
<td>1345</td>
<td>80</td>
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</table>

**All Treatments: Prowl 2 pt PRE**

EP: Early Post application to 2” Palmer amaranth.
Limited second weed flush due to drought.
Mid-season control evaluation: 6/17/2006
<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate</th>
<th>Timing</th>
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</thead>
<tbody>
<tr>
<td>Prowl H20</td>
<td>2.1 pt</td>
<td>PRE</td>
</tr>
<tr>
<td>Reflex</td>
<td>1 oz</td>
<td>PRE</td>
</tr>
<tr>
<td>WeatherMax</td>
<td>22 oz</td>
<td>POST 1</td>
</tr>
<tr>
<td>WeatherMax</td>
<td>22 oz</td>
<td>POST 2</td>
</tr>
<tr>
<td>Direx</td>
<td>1.0 qt</td>
<td>PD</td>
</tr>
<tr>
<td>MSMA</td>
<td>6.0 lb</td>
<td>PD</td>
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</table>
Laudis Herbicide

Laudis 3.5 SC (Tembotrione + BCS Proprietary Safener)

A new standard in crop safety. No limitation in rotation to key crops:

- Cereal Grains (4 months), Soybean (8 months), Cotton & Sorghum (10 months)

Postemergence application (VE-V8) in corn.

Control of both grass and broadleaf weeds

Novel active ingredient. Allows growers to break the weed-resistance cycle by introducing a unique chemistry mode-of-action to their fields.

Has in-season residual activity.

Can be used in mixtures and programs with other herbicides.

Important: EPA registration of Laudis herbicide was granted Nov. 28, 2007
• GlyTol will offer additional weed control choices for cotton producers seeking a glyphosate weed control system

• H2 stacked cotton (LibertyLink + GlyTol) will provide improved weed control options over current standards while providing a solution for the control of tough to manage or resistant weeds
  • Improves the sustainability of bio-tech weed control

Regulatory

• GlyTol - regulatory approvals are expected in launch year (2009)
  • At launch; US, Canada and possibly Korea and Mexico
  • End of the 2009 season – Japan and Australia and possibly Europe
H2 Cotton – US launch 2010*

- Tolerance to both glufosinate ammonium and glyphosate
- Advantages over RR and LL alone
- More flexibility for weed control

* Anticipated launch subject to regulatory approvals
Herbicide Tolerance US Trials 2007
Twinlink Cotton – US launch 2012*

- Two gene product (Cry1Ab + Cry2Ae)
- Equivalent to BG2

2007 development (field trials and bioassays):

- IRM fit
- Efficacy
- Pest spectrum
- Seasonal patterns of expression
- Trait x variety interactions

* Anticipated launch subject to regulatory approvals
New Technologies

Existing

In the Pipeline

- Liberty Link Technology stacked with proprietary glyphosate herbicide tolerant technology

- Competing proprietary dual $Bt$ insect resistance technology

- Abiotic stress tolerance

Plus exclusive licensing agreement with Senesco to enhance quality & yield
# Mid-South & Southeast Variety Pipeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Early</th>
<th>Mid</th>
<th>Full</th>
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<tbody>
<tr>
<td>2007</td>
<td>ST 4427B2RF</td>
<td>ST 5327B2RF, ST 5283B2RF</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>4 candidates</td>
<td>2 candidates</td>
<td>5 candidates</td>
</tr>
<tr>
<td>2010</td>
<td>6 candidates</td>
<td>5 candidates</td>
<td>2 candidates</td>
</tr>
<tr>
<td>2011</td>
<td>12 candidates</td>
<td>13 candidates</td>
<td>5 candidates</td>
</tr>
</tbody>
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Recent Developments in Trait Technology:

– Agreement with Stine Soybean to Release Liberty Link Varieties.

– Agreement to develop new herbicide tolerant soybeans
  
  • Tolerance to isoxaflutole (Balance Pro) and other “HPPD-inhibitor herbicides”.
  
  • First product will be soybeans with tolerance to glyphosate and “HPPD-inhibitor herbicides” (isoxaflutole).
  
  • Followed by a triple-stack with Bayer’s glufosinate tolerance.
  
  • Bayer has full freedom to operate in the development of other HPPD-inhibitor tolerant crops (including cotton).