Western IPM Kochia Work Group

Basic Research: Integrated Management
Seed bank input, precision management, and decision support tools
Integrated Management (Basic Research)

• Reduce seed bank input
  • Reproduction and flowering
  • Minimize seed production
  • Manipulate flowering, reduce anthesis, reduce pollen production
• Remote sensing applications for IWM/precision management
• Decision-support tool
Table 2. Effect of single and sequential applications of herbicides on glyphosate-resistant giant ragweed plant height, inflorescence injury, and seed production in 2013 and 2014 in field experiments conducted at David City, NE.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate</th>
<th>Plant height</th>
<th>Inflorescence injury</th>
<th>Reduction in seed production plant⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>g ae/ai ha⁻¹</td>
<td>cm</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Nontreated control</td>
<td>-</td>
<td>61 a</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>1,660</td>
<td>29 b</td>
<td>0</td>
<td>22 c</td>
</tr>
<tr>
<td>Glyphosate fb glyphosate</td>
<td>1,660 + 870</td>
<td>22 bc</td>
<td>17 c</td>
<td>46 c</td>
</tr>
<tr>
<td>Glufosinate</td>
<td>740</td>
<td>25 bc</td>
<td>59 b</td>
<td>42 c</td>
</tr>
<tr>
<td>Glufosinate fb glufosinate</td>
<td>740 + 594</td>
<td>28 bc</td>
<td>52 b</td>
<td>78 b</td>
</tr>
<tr>
<td>2,4-D</td>
<td>1,060</td>
<td>24 bc</td>
<td>97 a</td>
<td>98 a</td>
</tr>
<tr>
<td>2,4-D fb 2,4-D</td>
<td>1,060 + 1,060</td>
<td>21 c</td>
<td>99 a</td>
<td>99 a</td>
</tr>
<tr>
<td>Dicamba</td>
<td>280</td>
<td>23 bc</td>
<td>99 a</td>
<td>96 a</td>
</tr>
<tr>
<td>Dicamba fb dicamba</td>
<td>280 + 280</td>
<td>24 bc</td>
<td>99 a</td>
<td>99 a</td>
</tr>
<tr>
<td>P value</td>
<td>0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Integrated Management (Basic Research)

• Precision tillage with automated sensing
  • Green sensor in fallow

• Mapping weeds for removal, late season spraying

• Detection, processing, actuation

• HWSC in dryland summer crops – sorghum, corn
  • Seed retention data at harvest?
Decision-Support Tools for Kochia Management

Muthu Bagavathiannan et al.
A decision support tool to evaluate the effectiveness of Palmer amaranth management strategies in the row crop production systems of the southern United States.

The model operates in three simple steps:

1. Define System  
2. Build Strategy  
3. Compare Output Results
### 1. DEFINE Systems

**Enter operator name:**

**Select the typical duration of crop rotation:**

Specify a name here to customize printouts.

**Select a typical crop rotation (a), enter expected yield (b) and price received (c), and calculate the total specified expenses (d) for each crop in the rotation:**

(Click on the ‘Calculate Costs’ buttons below to determine total specified expenses)

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a. Typical Rotation</strong></td>
<td><strong>b. Expected Yield</strong></td>
<td><strong>c. Expected Price</strong></td>
</tr>
<tr>
<td>Cotton</td>
<td>Corn</td>
<td>Soybean FS</td>
</tr>
<tr>
<td>1200 lbs/acre</td>
<td>210 bu/acre</td>
<td>60 bu/acre</td>
</tr>
<tr>
<td>$0.65/lb</td>
<td>$3.35/bu</td>
<td>$10.00/bu</td>
</tr>
</tbody>
</table>

**Calculate Total Specified Expenses**

- Year 1: $354.08 per acre
- Year 2: $386.61 per acre
- Year 3: $189.27 per acre

**Select up to four crop traits for each crop to create a default rotation** (in the order specified here – blanks are interpreted as conventional):

- **Cotton**
  - Year 1: Glytol/LibertyLink
  - Year 4: LibertyLink
  - Year 7: Glytol/LibertyLink
  - Year 10: Enlist

- **Corn**
  - Year 2: Roundup Ready
  - Year 5: Conventional
  - Year 8: Roundup/LibertyLink

- **Soybean FS**
  - Year 3: Xtend
  - Year 6: Enlist
  - Year 9: Xtend

**Specify prices and rates for Fall options:**

- **Specify Fall Options**

**Enter other expenses associated with herbicide application:**

<table>
<thead>
<tr>
<th>Expense</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor ($/hr)</td>
<td>$13.45</td>
</tr>
<tr>
<td>Fuel ($/gal)</td>
<td>$2.20</td>
</tr>
<tr>
<td>Amortization Rate</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Select weed density:** (plants per 250 square feet)

- High (8-15)

**Enter the extent of pre-existing resistance:**

- Roundup: High
- ALS Chemistry: High
- PPO: High
## 2. BUILD Strategy

Refer to state guidelines and current label information to ensure you are using approved tank mixes and application rates for Xtend or Enlist products.

### Weed Control Costs ($/acre)

<table>
<thead>
<tr>
<th>Year</th>
<th>YR 1</th>
<th>YR 2</th>
<th>YR 3</th>
<th>YR 4</th>
<th>YR 5</th>
<th>YR 6</th>
<th>YR 7</th>
<th>YR 8</th>
<th>YR 9</th>
<th>YR 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>$157.72</td>
<td>$128.82</td>
<td>$139.06</td>
<td>$175.14</td>
<td>$133.82</td>
<td>$132.72</td>
<td>$170.14</td>
<td>$133.82</td>
<td>$128.66</td>
<td>$174.15</td>
</tr>
</tbody>
</table>

### Spring Soilbank (1000/500 sq ft)

<table>
<thead>
<tr>
<th>Year</th>
<th>YR 1</th>
<th>YR 2</th>
<th>YR 3</th>
<th>YR 4</th>
<th>YR 5</th>
<th>YR 6</th>
<th>YR 7</th>
<th>YR 8</th>
<th>YR 9</th>
<th>YR 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>131.5</td>
<td>1.9</td>
<td>34.2</td>
<td>9.6</td>
<td>&lt;0.10</td>
<td>&lt;0.10</td>
<td>&lt;0.10</td>
<td>&lt;0.10</td>
<td>&lt;0.10</td>
<td>&lt;0.10</td>
</tr>
</tbody>
</table>

### Yield (bu or lb/acre)

<table>
<thead>
<tr>
<th>Year</th>
<th>YR 1</th>
<th>YR 2</th>
<th>YR 3</th>
<th>YR 4</th>
<th>YR 5</th>
<th>YR 6</th>
<th>YR 7</th>
<th>YR 8</th>
<th>YR 9</th>
<th>YR 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bu</td>
<td>1,200</td>
<td>209</td>
<td>60</td>
<td>1,200</td>
<td>210</td>
<td>60</td>
<td>1,200</td>
<td>210</td>
<td>60</td>
<td>1,200</td>
</tr>
</tbody>
</table>

### Cash Net Returns ($/acre)

<table>
<thead>
<tr>
<th>Year</th>
<th>YR 1</th>
<th>YR 2</th>
<th>YR 3</th>
<th>YR 4</th>
<th>YR 5</th>
<th>YR 6</th>
<th>YR 7</th>
<th>YR 8</th>
<th>YR 9</th>
<th>YR 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>$193.20</td>
<td>$54.62</td>
<td>$202.67</td>
<td>$175.78</td>
<td>$103.07</td>
<td>$208.01</td>
<td>$180.78</td>
<td>$53.07</td>
<td>$202.67</td>
<td>$161.77</td>
</tr>
</tbody>
</table>

### Crop Rotation

- Cotton
- Soybean FS
- Liberty Link
- Roundup Liberty Link

### Preplant (Cotton ONLY)

- Prosolan
- Prodir

### Preemergence

- Cotoran
- Acuron
- Boundary
- Gramoxone

### Postemergence 1 (Cotton ONLY)

- Liberty
- Liberty
- Liberty
- Liberty

### Postemergence 2 (Cotton ONLY)

- Liberty
- Liberty
- Liberty
- Liberty

### Layby (Cotton ONLY)

- MSMA
- MSMA

### Fertilizer

- Win Burn
- Win Burn
- Win Burn

### WARNING

Inappropriate Tank Mix

### Roundup/Liberty Link
3. COMPARE Output Results

Select Strategies for Comparison:
- Non-Diverse Option
- Current

System Choice:
- Diverse Traits vs. Diverse Traits

- Seedbank (1000s of PA/250 sq ft)
  - Yr 1 to Yr 10

- Yield (percent of default yield)
  - Yr 1 to Yr 10

- Cash Net Returns ($/acre)
  - Non-Diverse Option
  - Current

NPV:
- Non-Diverse Option: $-411
- Current: $1,184
PAM-Summary

• An effective tool for educating herbicide resistance BMPs
• Real-time scenario testing, but does not provide a recommendation
• A real-time feedback generator
• Diversity risk calculator
• Mainly used by crop consultants and distributors
• Most effective in a workshop setting
• Currently in Excel but options for web/mobile application
Effective Site of Action Tool
Effective Site of Action Tool

**Texas A & M**

**Herbicide**

**CORN**

Application Time

- **Burndown**
  - Select Herbicide
  - 2,4-D
  - Paraquat

- **Pre**
- **Post**

Note: Each crop will have a different application time. Each selection will have a subdropdown menu listing herbicide. User will choose Herbicide from list.

**Continue**

**Result - For Corn**

- **By Product Name**
- **By SOA No.**

Filtered by Crop: Corn, Soybean, Cotton

<table>
<thead>
<tr>
<th>Program</th>
<th>Weed 1</th>
<th>Weed 2</th>
<th>Weed 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burndown (dropdown)</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2,4-D</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Paraquat</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPOST</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Enlist Duo (Glyphosate)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enlist Duo (2,4-D)</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Go Back to Menu
SOA Tool - Summary

• An educational tool that guides the selection of herbicides at the dealership
• Indicates herbicides effective on the species
• Takes into account pre-existing resistance
• Warns when the SOA diversity is low
• Real-time evaluation and decision-making
• Mobile/web application
Precision management for kochia

• Detection and differentiation (crops vs other weeds) – machine learning and AI
• Detection of herbicide resistance using sensors
• Field mapping of infestations
• Site-specific herbicide application
Integrated Management (Basic Research)

• Discussion prompt questions:

• What would a practical, useful tool to reduce seed set look like?

• Would a PAM-like decision support tool be useful for kochia?

• What parameters do we need to research to develop a decision support tool for kochia?

• Would green-activated tillage in fallow be useful?
This project was funded in part by the USDA National Institute of Food and Agriculture through the Western Integrated Pest Management Center, grant number 2018-70006-28881
The Syngenta Herbicide Resistance Leaf (HRL) test, a simple method for the rapid detection of herbicide resistance

Abstract
Herbicide resistance is generally verified using seeds collected from field survivors at the end of the growing season in the laborious and time-consuming whole-plant pot test. The Syngenta Herbicide Resistance Leaf (HRL) test, conducted in Petri dishes or other suitable containers, offers an alternative method with resistance manifested by green and healthy mesophyllic leaves and sensitivity by bleaching and necrosis after 2-14 days of exposure to an informative dose rate of herbicide depending on the mode of action. The Syngenta HRL test proved effective for detecting resistance to a number of non-selecting herbicides across a range of broadleaf and grass weed species. Where applicable, it could constitute a very simple and cost-effective methodology for detecting resistance at its very onset by targeting initial plant survivors in the field.

Methodology
The Syngenta HRL test uses a herbicide and water solution to determine resistance. Performance of the test is determined by the phenotypic activity of the leaf and the level of mesophyllic tissue loss or necrosis. The leaves are placed in the solution and observed weekly for changes in the appearance of the leaf over the course of the test. In herbicidal weeds, mesophyllic leaves become chlorotic at the tip and necrotic at the base, as the mesophyllic tissue is lost. This can be observed as a decrease in leaf area and an increase in the number of necrotic leaves. The Syngenta HRL test is designed to differentiate between resistant and sensitive plant varieties and can be used in the early stages of the test to identify the presence of resistant plants.

Preliminary Results

Value of the Syngenta HRL test
The Syngenta HRL test can be used to detect resistance to a variety of herbicides, including systemic and non-systemic chemicals, and to determine the level of resistance. The test can be performed in a laboratory setting and can be adapted to different environments. The Syngenta HRL test is a rapid and sensitive test that can be used to detect resistance at an early stage in the growth of the plant.

Applicability
The Syngenta HRL test is applicable to a wide range of weed species, including broadleaf and grass weeds. It is a simple and cost-effective test that can be used to detect resistance at an early stage in the growth of the plant. The test can be adapted to different environments and can be used to detect resistance to a variety of herbicides, including systemic and non-systemic chemicals.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Site of Action</th>
<th>Concentration</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flumioxazin</td>
<td>PDH</td>
<td>3.1:14</td>
<td>Amaranthus spp.</td>
</tr>
<tr>
<td>Mesotrione</td>
<td>EPSPS</td>
<td>full</td>
<td>Amaranthus spp.</td>
</tr>
<tr>
<td>Atrazine</td>
<td>PDH</td>
<td>2:12</td>
<td>Amaranthus spp.</td>
</tr>
<tr>
<td>Pyrithion</td>
<td>PDH</td>
<td>2:12</td>
<td>Amaranthus spp.</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>EPSPS</td>
<td>full</td>
<td>Amaranthus spp.</td>
</tr>
<tr>
<td>Dicamba</td>
<td>EPSPS</td>
<td>full</td>
<td>Amaranthus spp.</td>
</tr>
</tbody>
</table>