Perspectives of herbicide-resistant weeds in agriculture and the need for greater management diversity

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Introduction

• Weed management tactics, in a general sense, have not changed appreciably in several decades
  – Tactics include cultural, mechanical, herbicidal and biological
  – Specific tactics however have seen many changes reflecting not only technological improvements but also the need to address social and economic considerations
Introduction

• Despite the fact that evolved resistance to herbicides has been a concern for at least four decades, new herbicide resistances have “tipped the cart”

• There are a number of issues/problems in managing herbicide-resistant weeds
  – Grower knowledge
  – Time management
  – Economic concerns
  – Lack of new herbicides
Important glyphosate-resistant weeds found in glyphosate-resistant crops

1. Common waterhemp
2. Horseweed
3. Common ragweed
4. Giant ragweed
5. Palmer pigweed
6. Johnsongrass

1 Multiple herbicide resistances are found in these weeds
The grower perception of herbicide resistance
The reality of herbicide resistance
Hypothetical development of weed population shift

Farmer becomes aware of problem

Adapted from Gunsolus (U of Mn, 1993)
Estimated multiple resistances based on 2011 waterhemp population collections and inclusionary probability from the 2013 collections¹

<table>
<thead>
<tr>
<th>Herbicide resistance(s)²</th>
<th>Number of 2011 populations</th>
<th>Estimated herbicide resistance frequency in Iowa fields (95% Confidence Limit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>2</td>
<td>1.3% to 1.5%</td>
</tr>
<tr>
<td>1 way</td>
<td>9</td>
<td>5.8% to 6.7%</td>
</tr>
<tr>
<td>2 way</td>
<td>26</td>
<td>16.7% to 19.3%</td>
</tr>
<tr>
<td>3 way</td>
<td>33</td>
<td>23.2% to 24.5%</td>
</tr>
<tr>
<td>4 way</td>
<td>19</td>
<td>12.2% to 14.1%</td>
</tr>
<tr>
<td>5 way</td>
<td>10</td>
<td>6.4% to 7.4%</td>
</tr>
<tr>
<td>Total multiple</td>
<td>88</td>
<td>56.7% to 65.3%</td>
</tr>
</tbody>
</table>

¹Project sponsored by the Iowa Soybean Association
²Assessment of Herbicide Groups 2, 5, 9, 14, and 27
Number of farms and average farm size in the US

![Graph showing the number of farms and average farm size in the US from 2007 to 2014. The graph indicates a decrease in the number of farms and an increase in average farm size over this period.](image-url)
Site-specific weed management

Scouting is mandatory to provide the best tactics for individual fields
Mechanical tactics
Weed seedbank management
PAGMan – USDA-ARS & SDSU

Four-row grit applicator has 8 nozzles, one for each side of four rows
Grit application rate is about 500 kg/ha
Air is pressurized at about 500 kPa
Before & after grit application
(note level of in-row control)

Weedy V3

Treated at V1 (June 15) + V3 (June 23)
Cultural tactics

- Increase crop rotation complexity
- Temporal changes in crops
  - summer annuals (corn and soybean) vs. spring grains
- Date of planting
- Row spacing to improve crop competitiveness
- Inclusion of perennial forages
Cover crops and management within the crop systems
Soybean row spacing

30” rows  V2

15” rows  V2
Biological control tactics
Robotics
RNAi technology is an example
The key to herbicide resistance management: Many little hammers

Seedbed prep tillage

Cover crops

Post-plant tillage

Field border management
“Ideal” Integrated Weed Management

**Current**

- Herbicide
- Cultural
- Mechanical

**Future**

- Herbicide
- Cultural
- Mechanical
- Biological
Conclusions

• Diversity means adopting weed management tactics designed to address field-specific problems
• Diversity means that weed management must include long-term planning using many tactics based on field scouting
• Diversity means that individual growers recognize weed escapes and use multiple tactics to achieve control
• Diversity means that action is taken immediately
Call to action

• Use scouting of individual fields to integrate biological, mechanical and cultural tactics to increase weed management diversity
• Develop public and private programs to control weed escapes prior to seed maturity thus improving weed seedbank management and reducing herbicide-resistant weed population densities
• Incentivize innovation in non-chemical weed management practices