Pigweed Resistance: How Much? To What? And Where?

Robert Nichols
Cotton Incorporated
Definition: Weed Resistance

“Inherited ability of a weed population to survive and reproduce after exposure to an herbicide dose (rate) that would control an unselected population”

--- Weed Science Society of America
Determination of Resistance

1. Investigate Report of Field Failure (P = F0)
2. Collect Seed (F1)
3. Plant seed of suspected and known susceptible populations in the greenhouse.
4. Treat with range of herbicide rates.
5. Compare response of suspected and susceptible population. If significantly different, the suspected population is likely resistant.
6. Cross survivors. Seed are F2. Repeat the test. If the F2 generation is also resistant, the trait is clearly heritable.
North Carolina 2006

Untreated

88 oz. Glyphosate (4x) 3 times
Weedy Pigweed Species

- *Amaranthus retroflexus* – Red Root Pigweed
- *A. rudis, tuberculatus* - Waterhemp
- *A. hybridus* – Smooth Pigweed
- *A. plameri* – Palmer amaranth
- Several others

- Bryson & DeFelice. 2009. Weeds of the South. Univ. of GA Press
Waterhemp
(Amaranthus tuberculatus)

A dioecious annual weed, growing 4-6 feet tall, producing many seed
Palmer Amaranth
(Amaranthus palmeri)

A dioecious annual weed, growing 4-8 feet tall, producing up to 500,000 seed per year.
Dioecious Amaranth Species

*Palmer Amaranth*  
*Waterhemp*
Herbicide Mode of Action

“The way an herbicide kills a plant”

**ALS** = Acetolactate Synthase:
Cadre, Pursuit, Staple, Osprey, many others

**EPSPS** = Enolpyruvyl Shikimate Synthase:
Glyphosate

**PPO** = Protoporphyrinogen Oxidase
Valor, Reflex, Flexstar, Cobra, Goal

**Glutamine Synthetase** - Ignite
Acetolactate Synthase (ALS) Resistant *Palmer Amaranth*

* Year of 1st report
Nationwide acres of glyphosate-resistant soybean, cotton, and corn as a percent of all acres of the crops

Acres of Glyphosate-Resistant Crop Cultivars

Million Acres

- **Cotton**
- **Corn**
- **Soybean**

Year:
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
Soybean Acres Exposed to Herbicide Modes of Action
Cotton Acres Exposed to Herbicide Modes of Action

![Graph showing cotton acres exposed to herbicide modes of action from 1990 to 2006. The graph compares the use of Glyphosate, DNA, and Photosystem II Inhibitors.](image_url)
Corn Acres Exposed to Herbicide Modes of Action
Total Acres Exposed to Herbicide Modes of Action for Corn, Soybean, Cotton
Number of Glyphosate-Resistant Species

Count

Years

Glyphosate Resistant Weeds in United States

- Horseweed – 2000 (DE)
- Palmer amaranth – 2004 (GA)
- Giant Ragweed – 2005 (AR)
- Waterhemp – 2005 (MO)
- Ryegrass – 2005 (MS)
- Johnsongrass – 2007 (AR)
Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2004
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Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth
2008
Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth - 2009
Counties with Glyphosate-Resistant Palmer Amaranth

Cumulative Counties

Year

2004 2005 2006 2007 2008 2009
Impacts of Glyphosate-Resistant *Palmer Amaranth*

- Increase complexity and costs of weed management in cotton and soybean
- Compromise conservation tillage in the short-term and possibly the long-term
- May precipitate a cascade of resistance in post emergence broad-leaf herbicides
Glyphosate Resistant
*Palmer Amaranth*

**Economic Threat to Soybeans**

If ALS and glyphosate are compromised, PPO herbicides are the only post emergence option except glufosinate.

**Economic Threat to Cotton**

PPO herbicides are not an over-the-top option. If ALS herbicides and glyphosate are compromised, there are no selective post emergence options except glufosinate.
The Usual Problem:
• Costs of Post-Resistance Management Remain Unknown, until Resistance Develops.
• Therefore, Additional Current Costs are Rejected, and the Risks of Unknown Future Costs are Accepted.

The New Problem:
• We Do Not Have the Next Mode of Action.
• A New Mode of Action, if Discovered Today, Would Probably Not be Registered in the U.S. for 7-10 Years.

• **Barrett et al.** Reducing the Development, Spread, and Adverse Economic and Environmental Impact of Herbicide Resistant Weeds. Grant Proposal to National Institute of Food and Agriculture. (Submitted 8/11/10; rejected 10/27/10.)

• **Shaw et al.** Management of Herbicide Resistant Weeds. Special Report by the Weed Science Society of America to USDA-APHIS. (in preparation)
Palmer Amaranth

• How Much, To What, and Where?
• Long-time resident of the Southwest; now frequently dominant in the Southeast and Mid-South.
• Often Resistant to ALS, especially in North Delta, GA, and Carolinas
• Generally Resistant to glyphosate in NC, SC, GA, AL, TN, AR, MO – north MS, central LA.
Current Situation

- Need New Weed Management Programs.
- Need to Save Conservation Tillage.
- Need to Implement Resistance Management - Manufacturers and Growers.
- Does Resistance Management Include Trait Management?