

Meeting the Challenge of Glyphosate-Resistant Palmer Amaranth in Conservation Tillage

Robert Nichols, Cotton Incorporated

K. Balkcom, USDA-ARS

S. Culpepper, University of Georgia

M. Marshall, Clemson University

D. Monks, Auburn University

M. Patterson, Auburn University

A. Price, USDA-ARS

L. Steckel, University of Tennessee

The Current Situation

“Weed resistance could have a significant impact on conservation tillage, which farmers have widely adapted not only as a cost-cutting measure but as a means to limit soil erosion and reduce chemical use. It could cause us to rethink our entire agronomic process.”

Delta Farm Press – Jan. 28, 2010

Uncontrolled Palmer Amaranth in Conservation Tillage Cotton



Weed Management

- Practical weed management consists of mechanical and chemical means.
- When herbicides are effective, the need for tillage and cultivation declines.
- When effective herbicides are not available, the need for tillage increases.

Palmer Amaranth



Relative Growth Rates of Amanranths

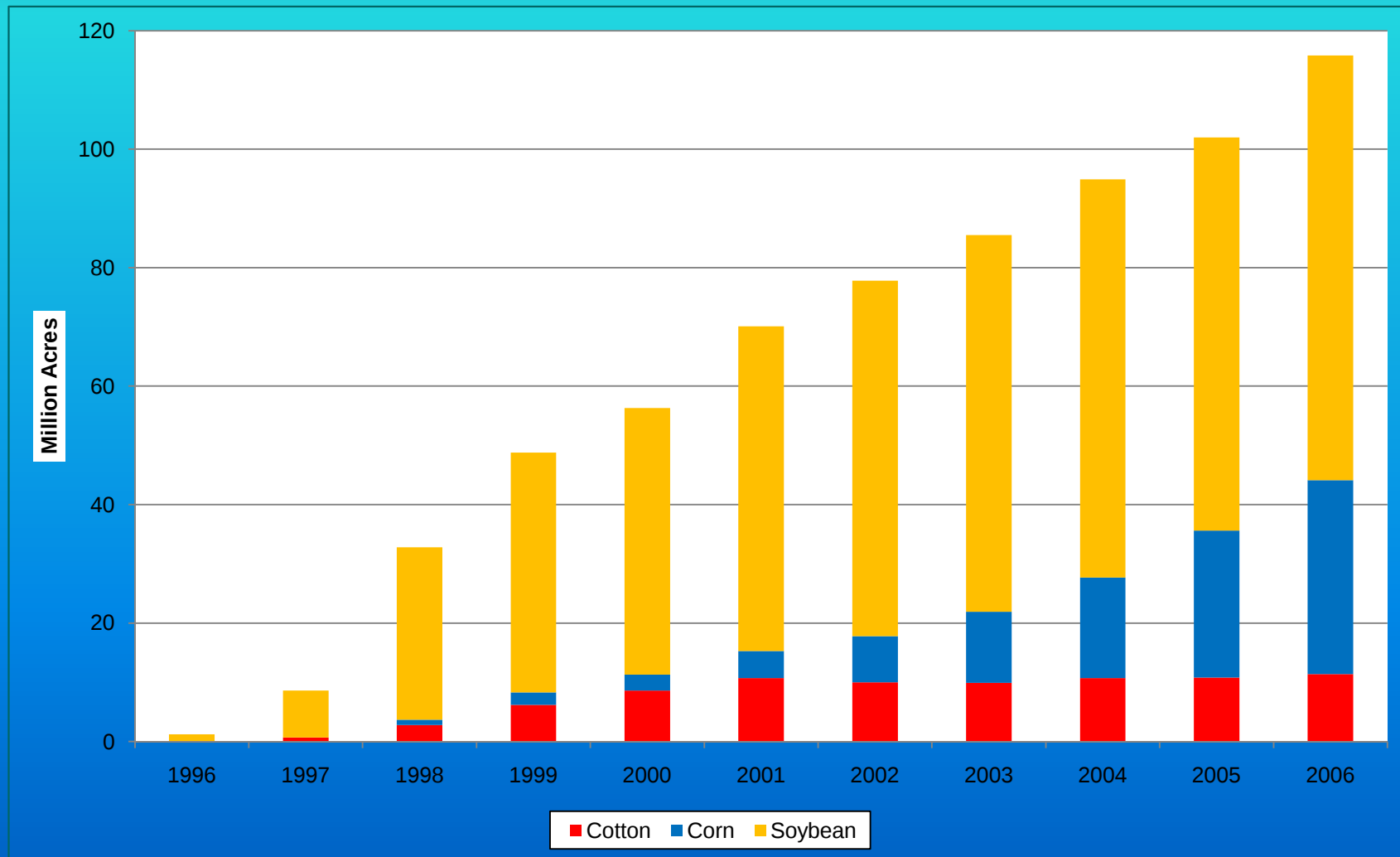
<u>Week's Growth</u>	2	4	6
	----- inches -----		
Palmer amaranth	4	10	38
Red Root Pigweed	3	7	24
Common Waterhemp	2	4	16
Smooth Pigweed	2	6	12
Spiny Pigweed	1	6	10
Tumble Pigweed	1	2	9

Sellers et al. 2003 Weed Science 51:329-333.

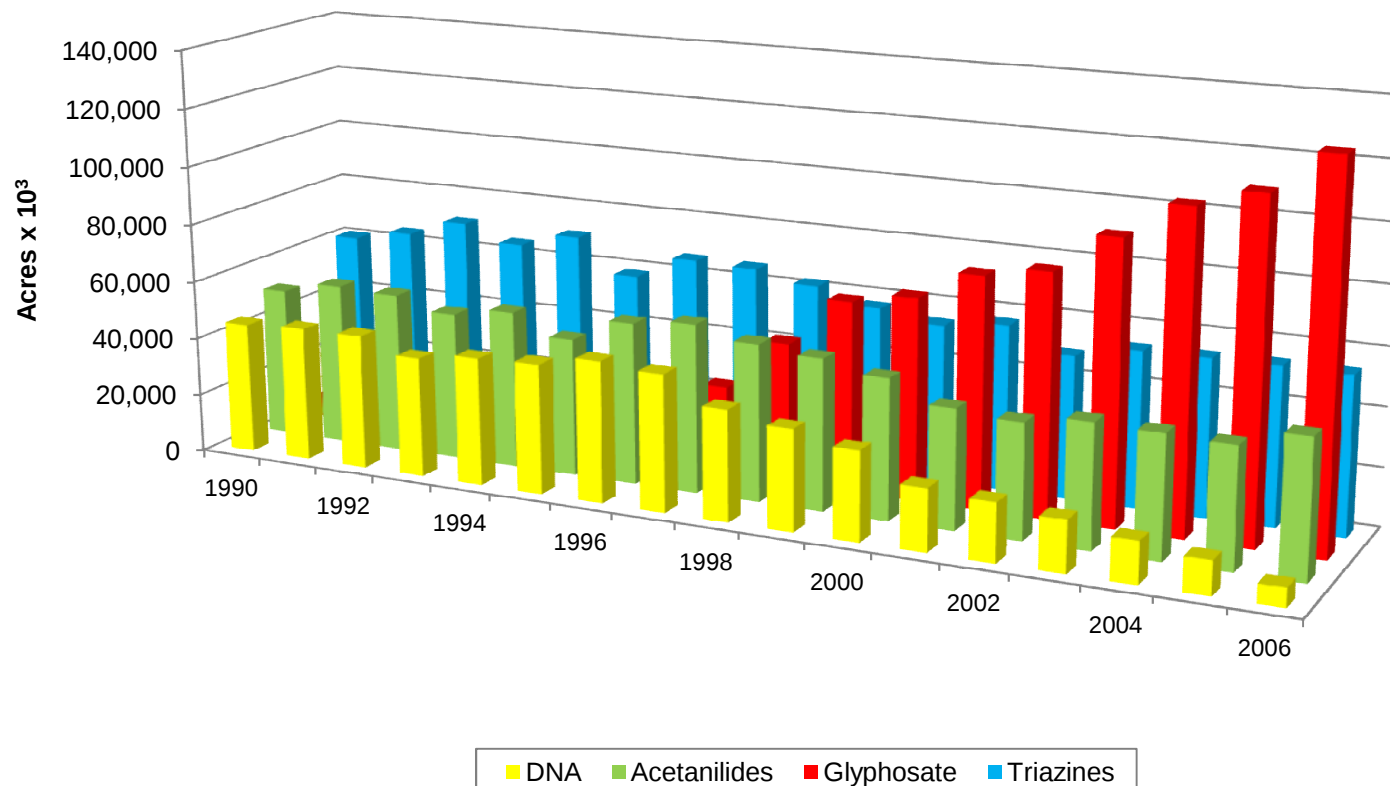
Rooting Depth of Palmer Amaranth



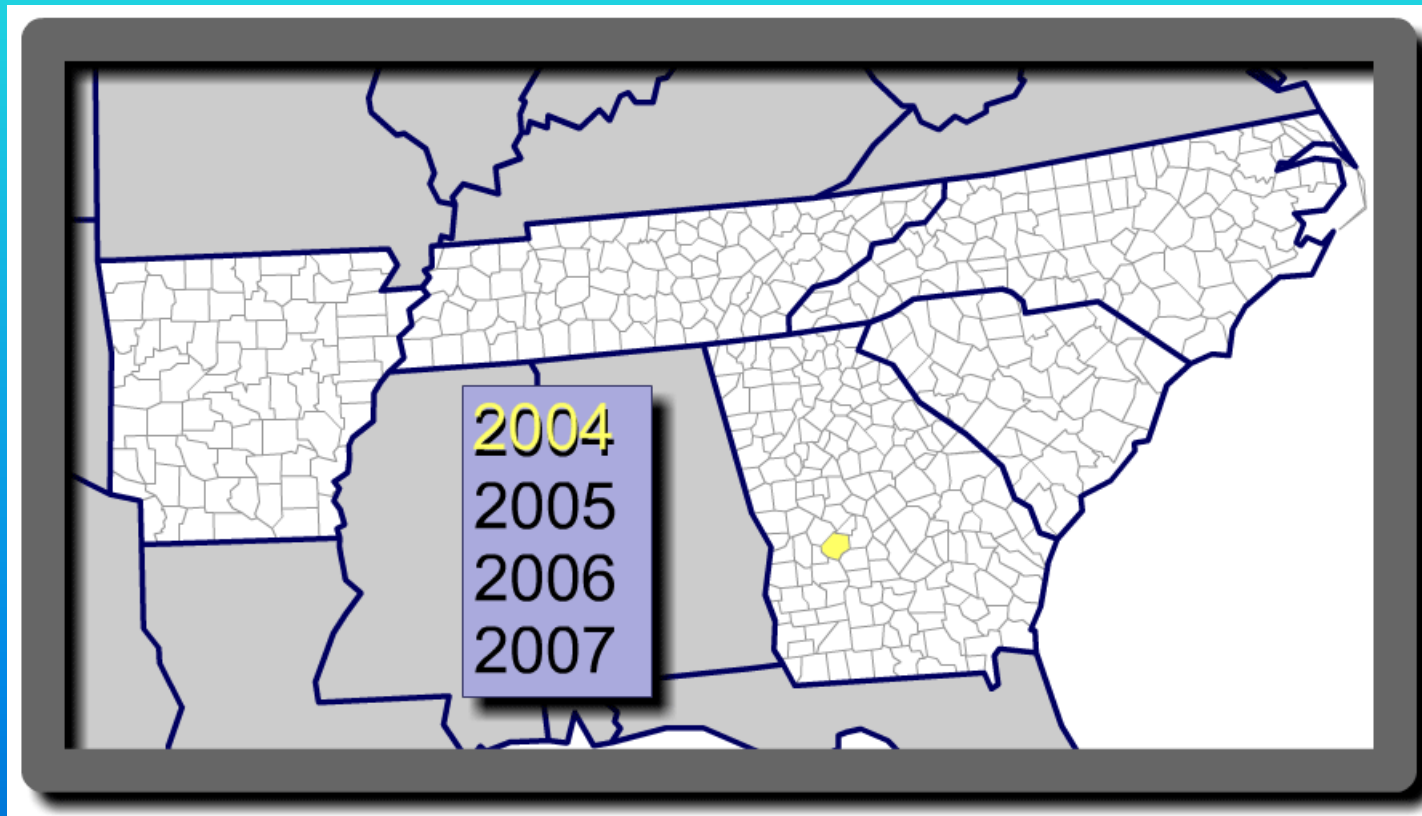
Glyphosate-Resistant Crop Acres



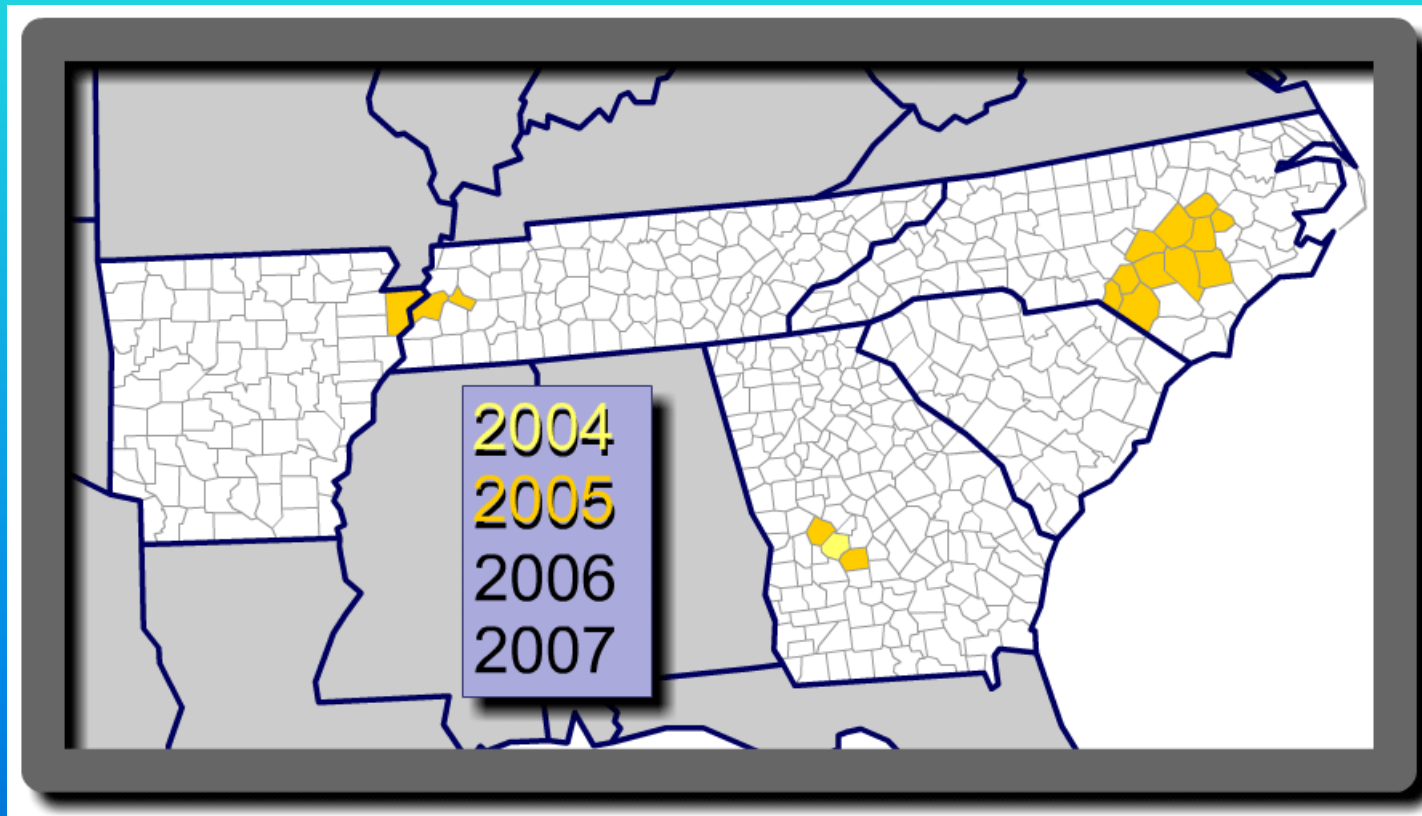
Total Acres Exposed to Herbicide Modes of Action for Corn, Soybean, Cotton



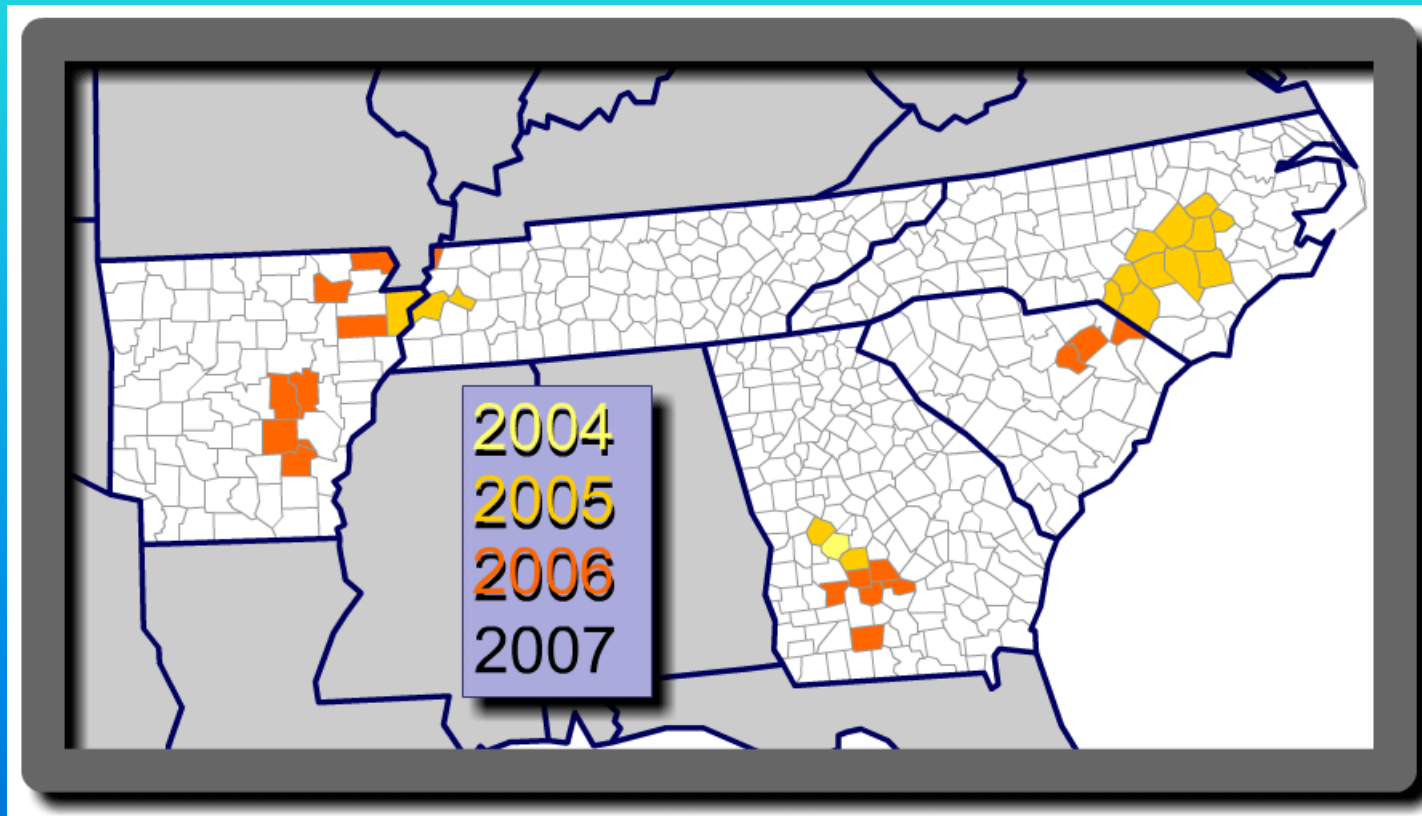
Initial Discovery of Glyphosate-Resistant Palmer Amaranth



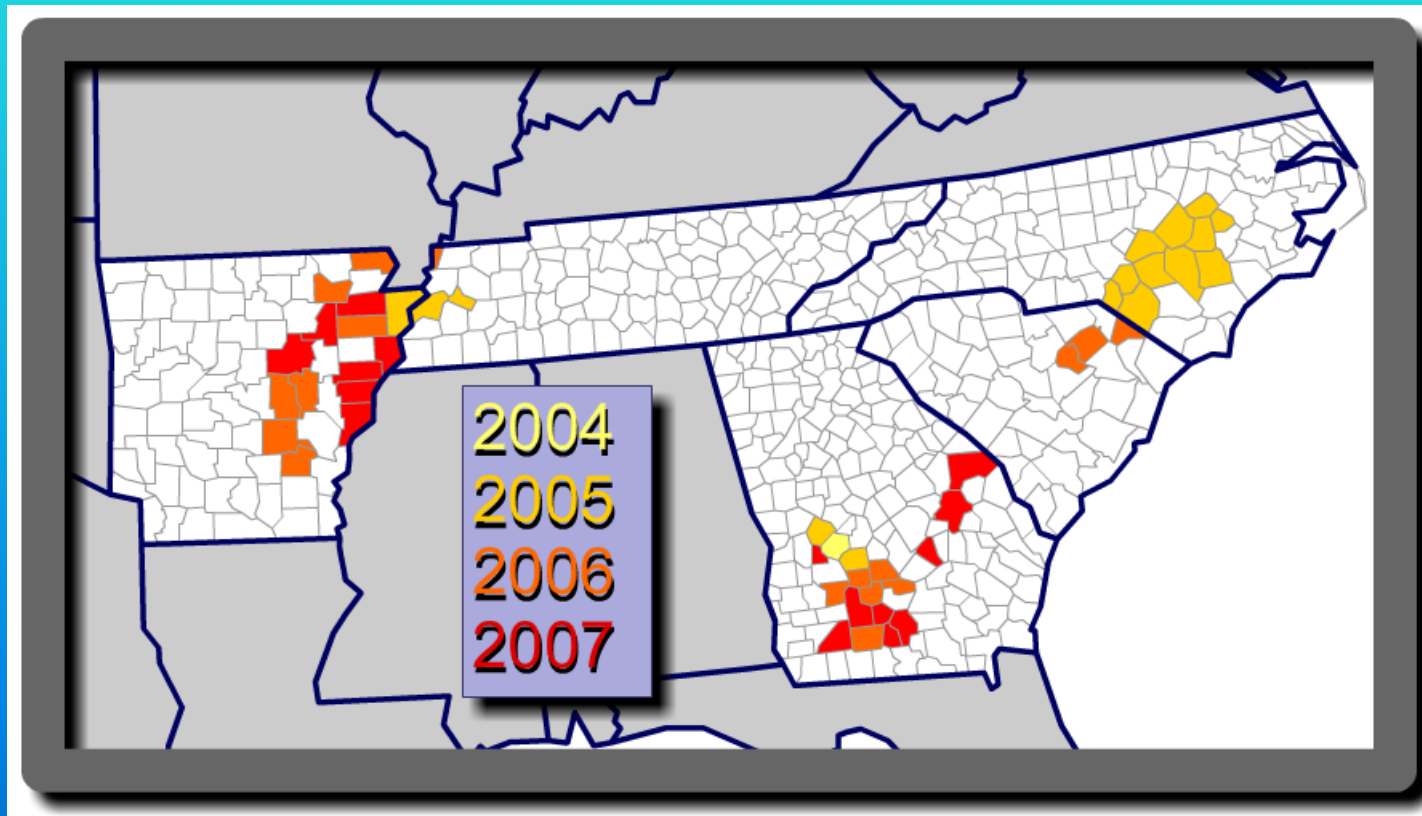
Glyphosate-Resistant Palmer Amaranth Found in Three Centers



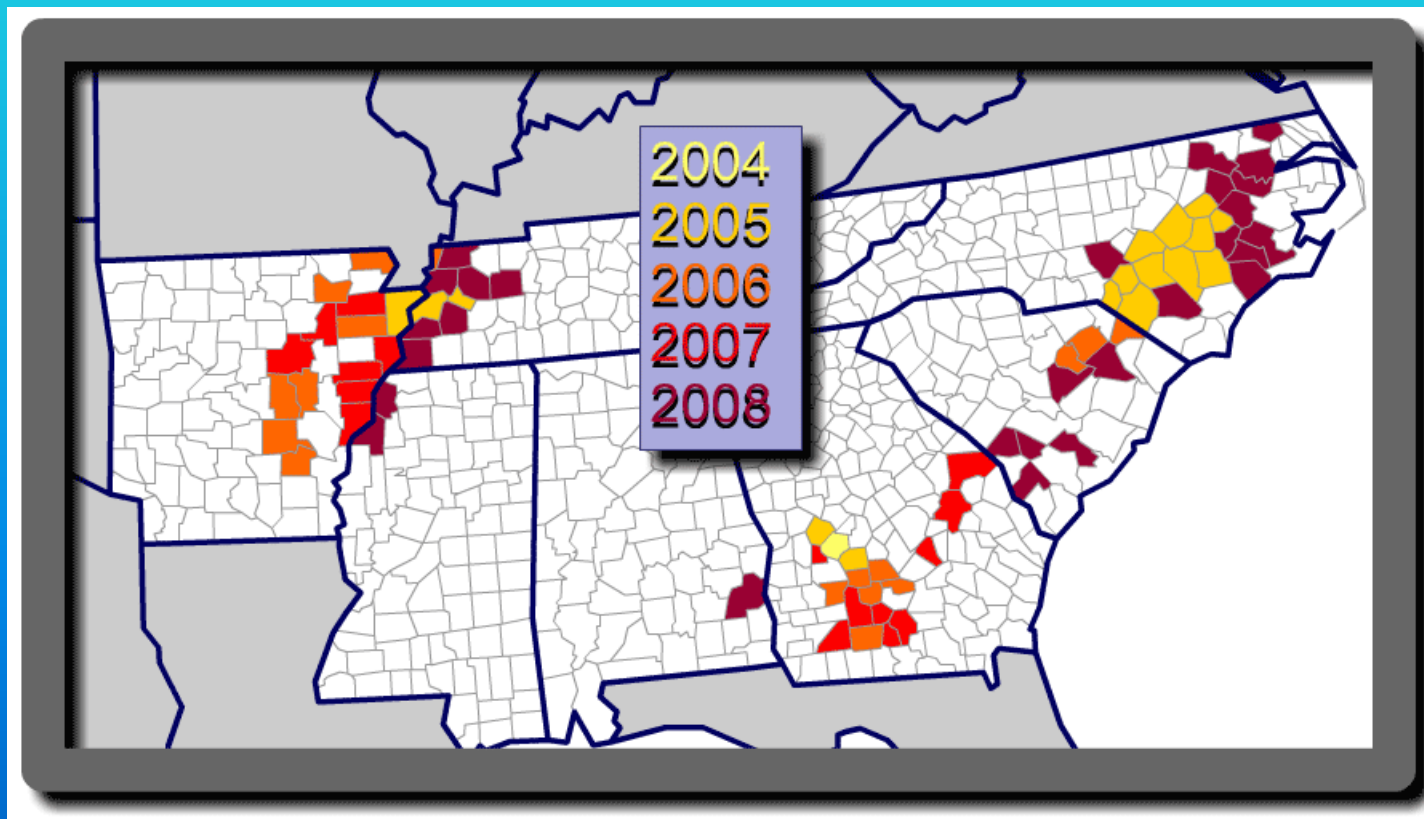
Glyphosate-Resistant Palmer Amaranth Monitoring Documents Spread



Glyphosate-Resistant Palmer Amaranth Continues to Spread



Glyphosate-Resistant Palmer Amaranth Dominates Southeastern Coastal Plain and North Delta



Impacts of Glyphosate-Resistant Palmer Amaranth

- **Increase Complexity and Costs of Weed Management in Cotton and Soybean**
- **Pose a Challenge to Conservation Tillage**
- **Increase Risk of a Resistance Cascade of Post Emergence Broad-Leaf Herbicides**

Herbicide Programs for Cotton - Georgia

**No Glyphosate-Resistant
*Amaranthus palmeri***

Technology Fee - \$ 42.18/acre

Pendimethalin - \$ 4.48/acre

Glyphosate (2x) - \$ 9.60/acre

Total = \$ 56.26/acre

**Glyphosate-Resistant
*Amaranthus palmeri***

Technology Fee - \$ 42.18/acre

Fomesafen + Pendimethalin -
\$ 18.62/acre

Metolachor + Glyphosate -
\$ 18.02/acre

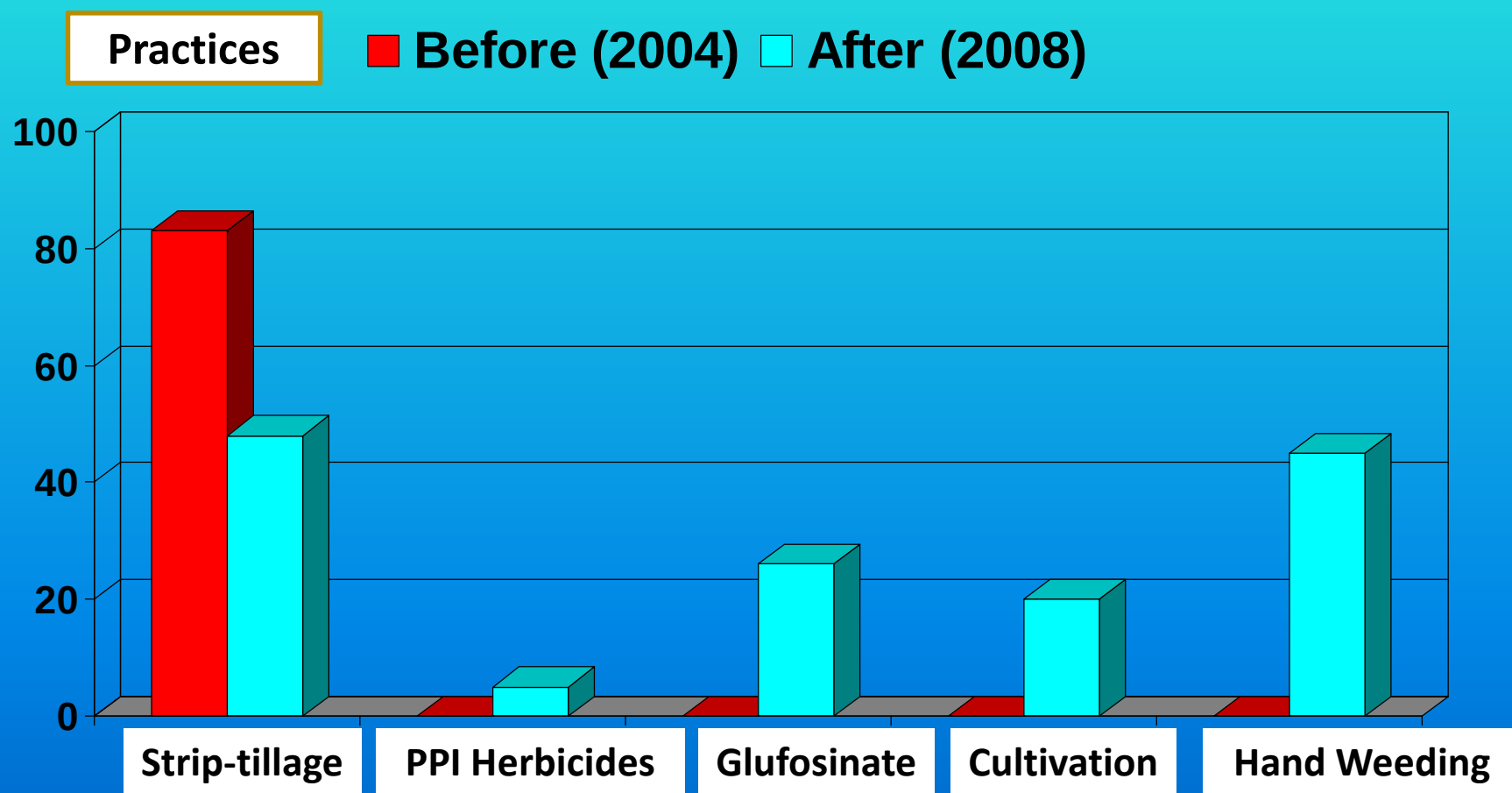
Diuron + MSMA - \$ 3.46/acre

Total = \$ 82.28/acre

Impact on Conservation Tillage Acres



Impact of Glyphosate-Resistant Palmer Amaranth in Central Georgia



Cotton Weed Management Systems

- Conventional
 - Full tillage, pre-plant incorporated and early and late post-directed herbicides; 2-3 cultivations
- Glyphosate-Resistant Cultivars
 - Conservation tillage, pre-plant burn down, two post emergence glyphosate applications, lay by
- Glyphosate-Resistant Weeds
 - Tillage (?); Cover Crops (?)
 - Pre-emergence residuals, glyphosate + residual early post, lay by, cultivations (?)

Experimental Design

Culpepper et al. 2009

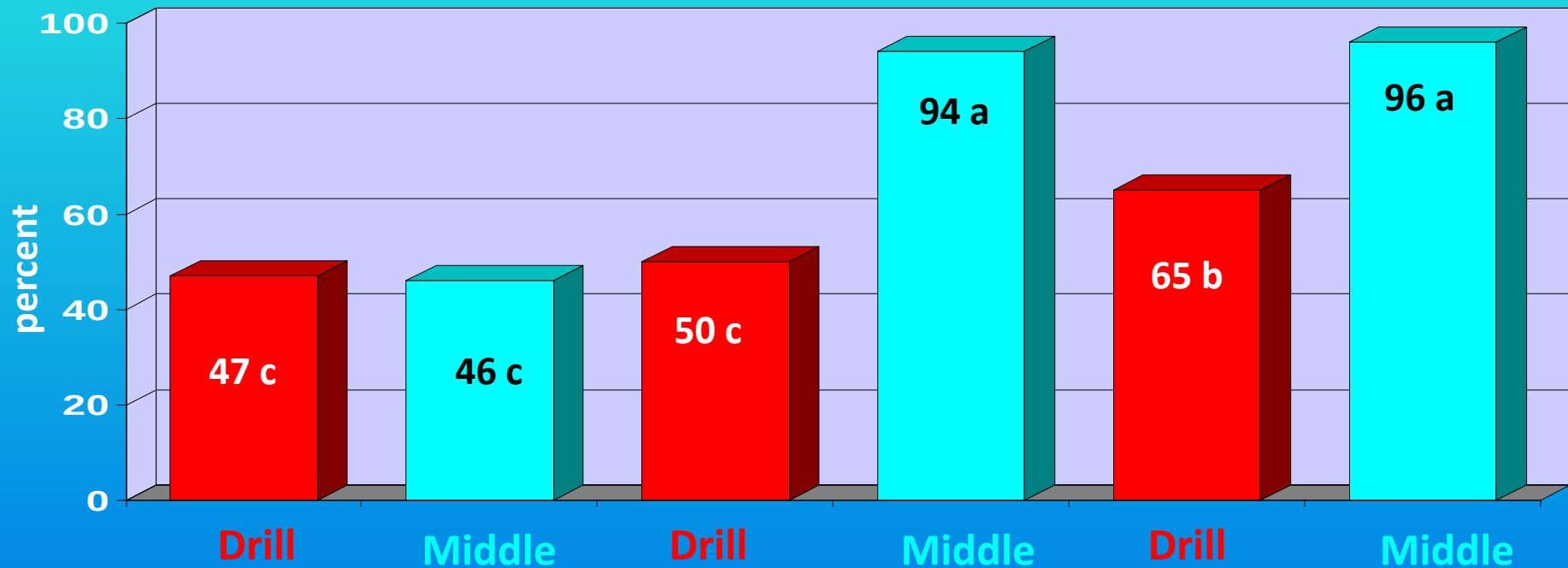
Factorial:

2 deep tillage options

2 cover crop options

4 herbicide systems

Reduction in Palmer Amaranth Emergence



— Deep turn —

— Rye cover —

— Deep turn —

+ Rye cover

Non-treated: 620 plant/m² in row.

No herbicides applied.

Palmer Amaranth Response to Deep Tillage

No deep tillage
No cover crop



Deep tillage
No cover crop



Staple + Reflex + Direx PRE
Roundup Weather Max + Parrlay POST
Direx + MSMA Lay by

Palmer Amaranth Response to Cover Crops

No deep tillage
No cover crop



No deep tillage
Rye cover crop



Staple + Reflex + Direx PRE
Roundup Weather Max + Parrlay POST
Direx + MSMA Lay by

Palmer Amaranth Response to Deep Tillage and Cover Crops

No deep tillage

No cover crop

Deep tillage

Rye cover crop



Staple + Reflex + Direx PRE
Roundup Weather Max + Parrlay POST
Direx + MSMA Layby

Palmer Amaranth Response to Herbicide Systems

No deep tillage
No cover crop



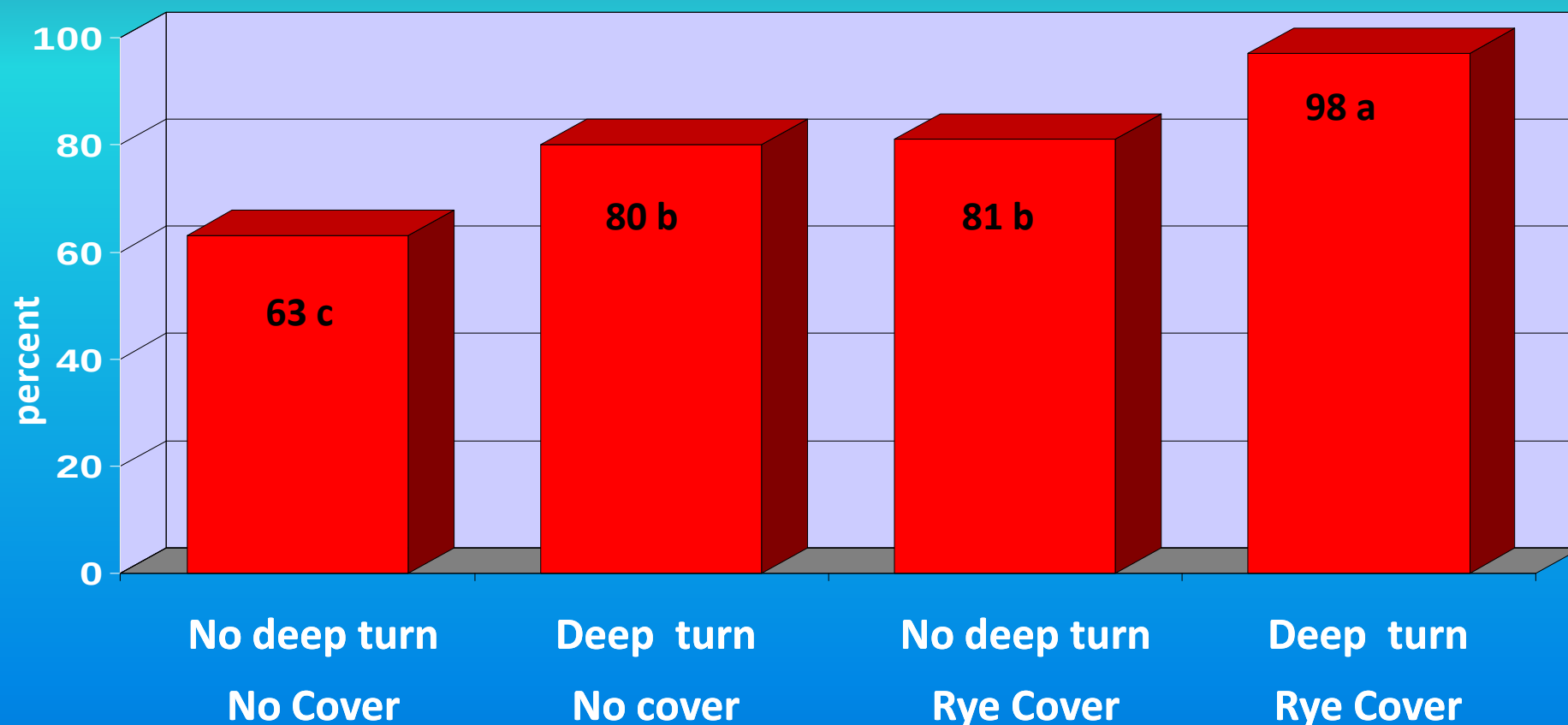
Staple + Reflex + Direx PRE
Roundup Weather Max + Parrlay POST
Direx + MSMA Layby

No deep tillage
No Cover crop



Staple + Reflex + Direx PRE
Ignite + Parrlay POST
Direx + MSMA Layby

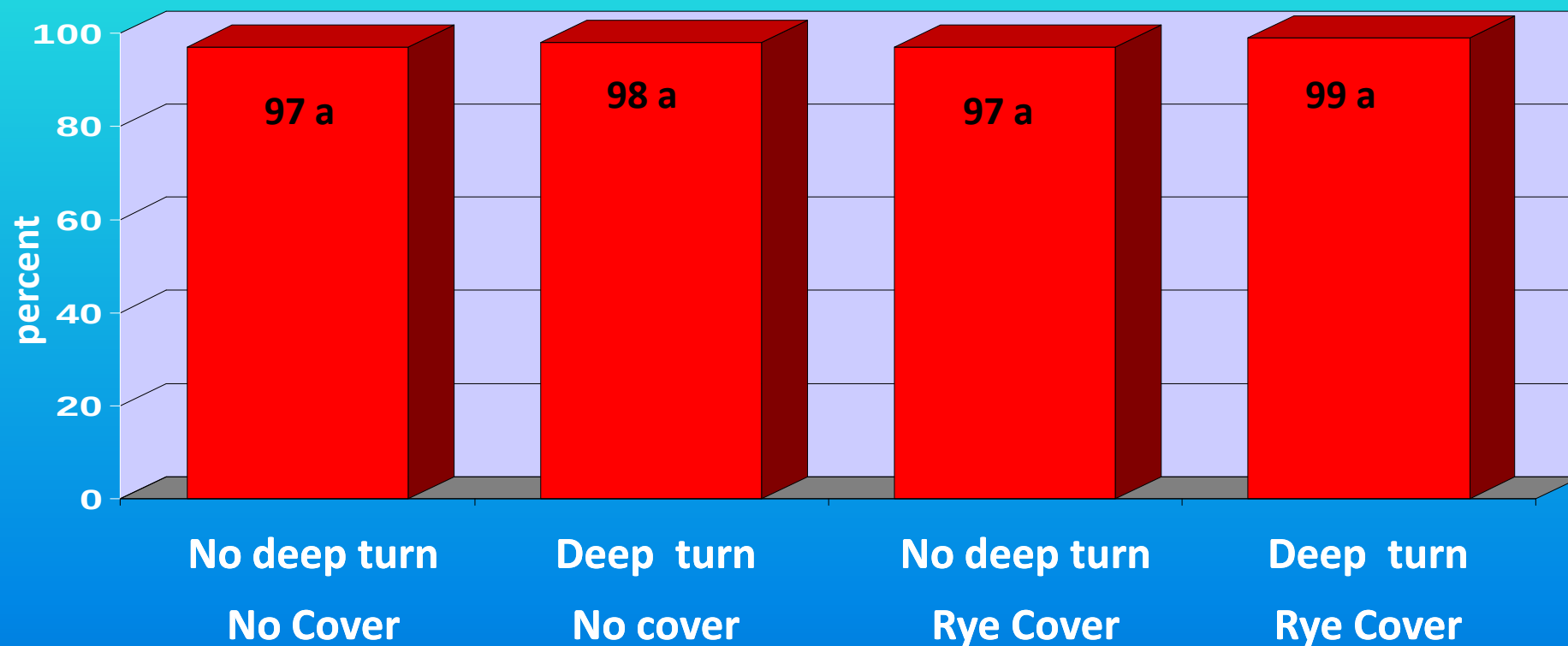
Glyphosate-Resistant Palmer Amaranth Control Glyphosate Systems



Rye 7 foot when killed, rolled, planted. Deep turn 12 inch in previous fall.

Herbicides: Direx + Reflex + Staple PRE; Roundup + Parrlay POST, Direx + MSMA at layby.

Glyphosate-Resistant Palmer Amaranth Control Glufosinate Systems



Rye 7 foot when killed, rolled, planted. Deep turn 12 inch in previous fall.

Herbicides: Direx + Reflex + Staple PRE; Ignite + Parrlay POST, Direx + MSMA at layby.



Potential Weakness of High Residue Systems Weed Control Down the Drill



Conservation Innovation Grant

- Cooperative Project of Auburn Univ., Clemson Univ., Univ. of Georgia, Univ. of Tennessee, and Cotton Incorporated.
- 2009, 2010, extension 2011.
- Two sites each in AL, GA, SC, and TN
- Three weed management programs:
 - Grower Standard
 - Fall Inversion followed by High Residue Management
 - High Residue Management

Herbicide Modes of Action

“The way an herbicide kills a plant”

Examples:

ALS – Acetolactate Synthase

Cadre, Pursuit, Staple, Osprey, many others

Glycine – Glyphosate

PPO – Protoporphyrinogen Oxidase

Valor, Reflex, Flexstar, Cobra, Goal

Glyphosate Resistant Palmer Amaranth

Economic Threat to Cotton and Soybean

Since protoporphyrinogen oxidase (PPO) herbicides are not an over-the-top option, if acetolactate synthase (ALS) herbicides and glyphosate are compromised, there will be no selective post emergence options for cotton.

If ALS and glyphosate are compromised, then PPO herbicides are the only selective post emergence option for soybean.

Glyphosate-Resistant Palmer Amaranth

- **Threatens Sustainability of Post Emergence Herbicides in U.S. Agriculture.**
- **If Protoporphyrinogen Oxidase (PPO) herbicides are heavily used pre-emergence in cotton, and are the only post emergence option in soybean, what is their future?**
- **Need for a General Resistance Management Plan for Herbicide Modes of Action in Broadleaf Agronomic Crops.**