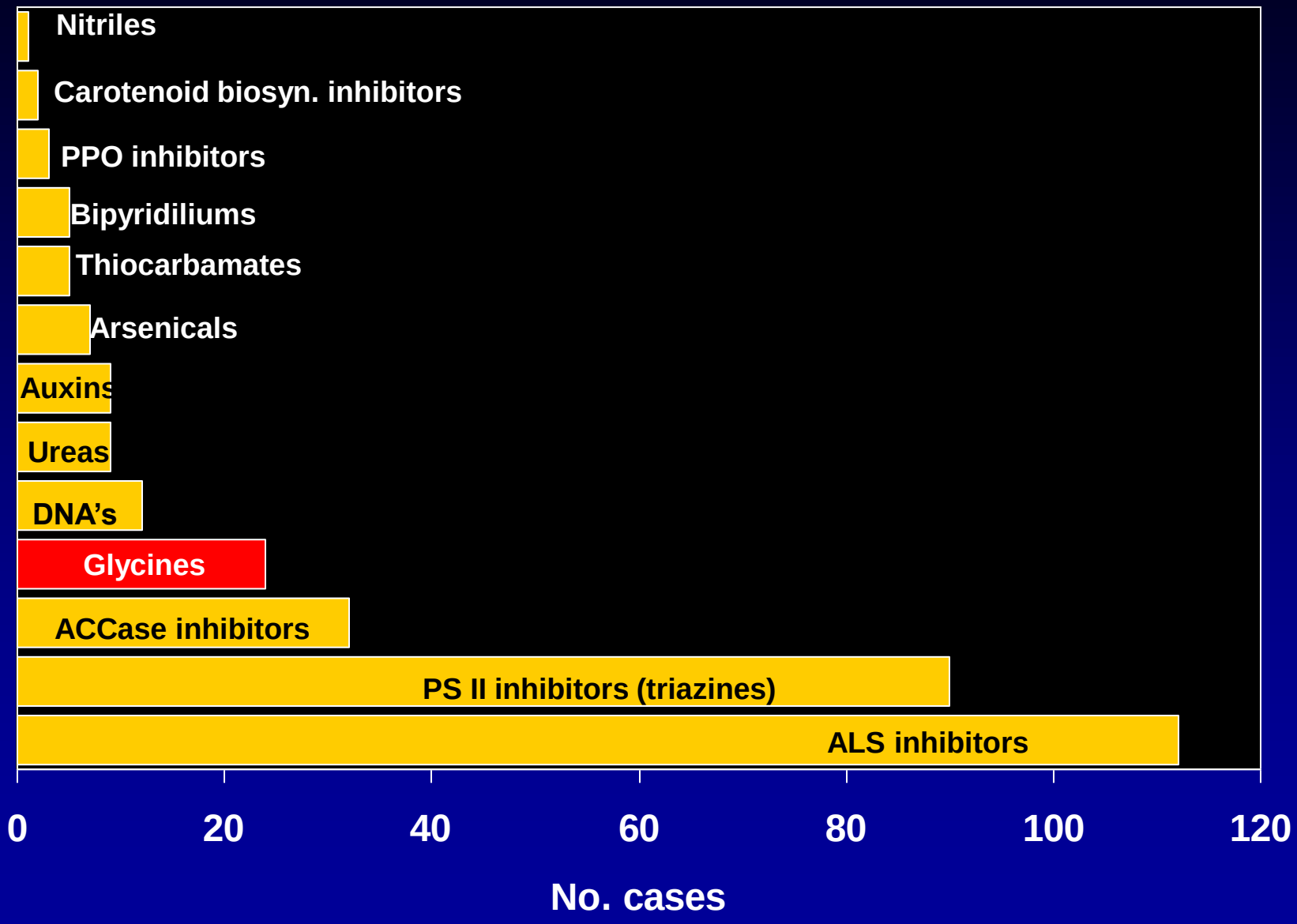
Distribution, Impact, and Management of Glyphosate-Resistant Palmer Amaranth in the Southeast

Herbicide Resistance in US by Mode of Action



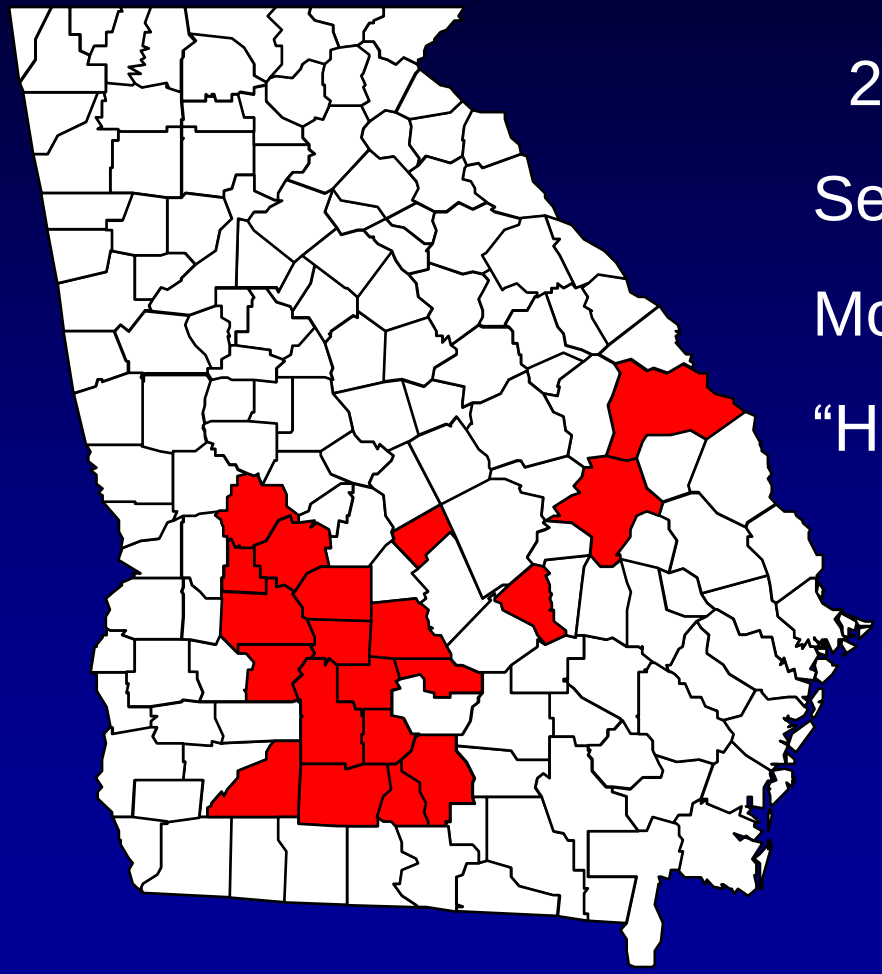
Glyphosate-Resistant Weeds in Southeast

Glyphosate-resistant weeds in U.S.[1]	AL	FL	GA	NC	SC	VA
Common ragweed				X		
Common waterhemp						
Giant ragweed						
Hairy fleabane						
Horseweed				X		
Italian ryegrass						
Johnsongrass						
Rigid ryegrass						
Palmer amaranth			XXX	XXX	XXX	

[1] Weedscience.org

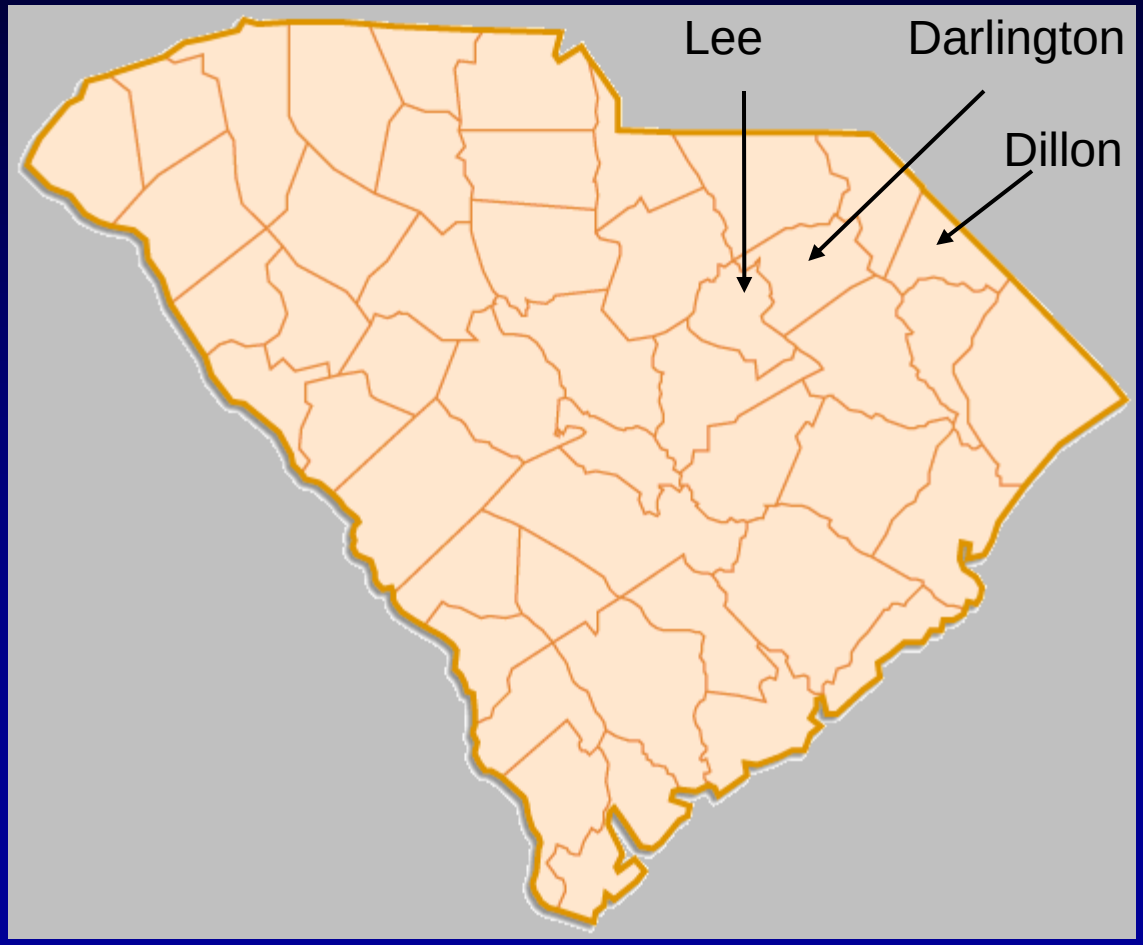

7-6
3pm
7-9
4pm
G

Glyphosate-resistant Palmer amaranth in Georgia, as of end of 2007



20 counties;	300,000 acres
Severe infestation	100,000 acres
Mod. infestation	100,000 acres
“Hot spots”	100,000 acres

Glyphosate-resistant Palmer amaranth
South Carolina, 2006



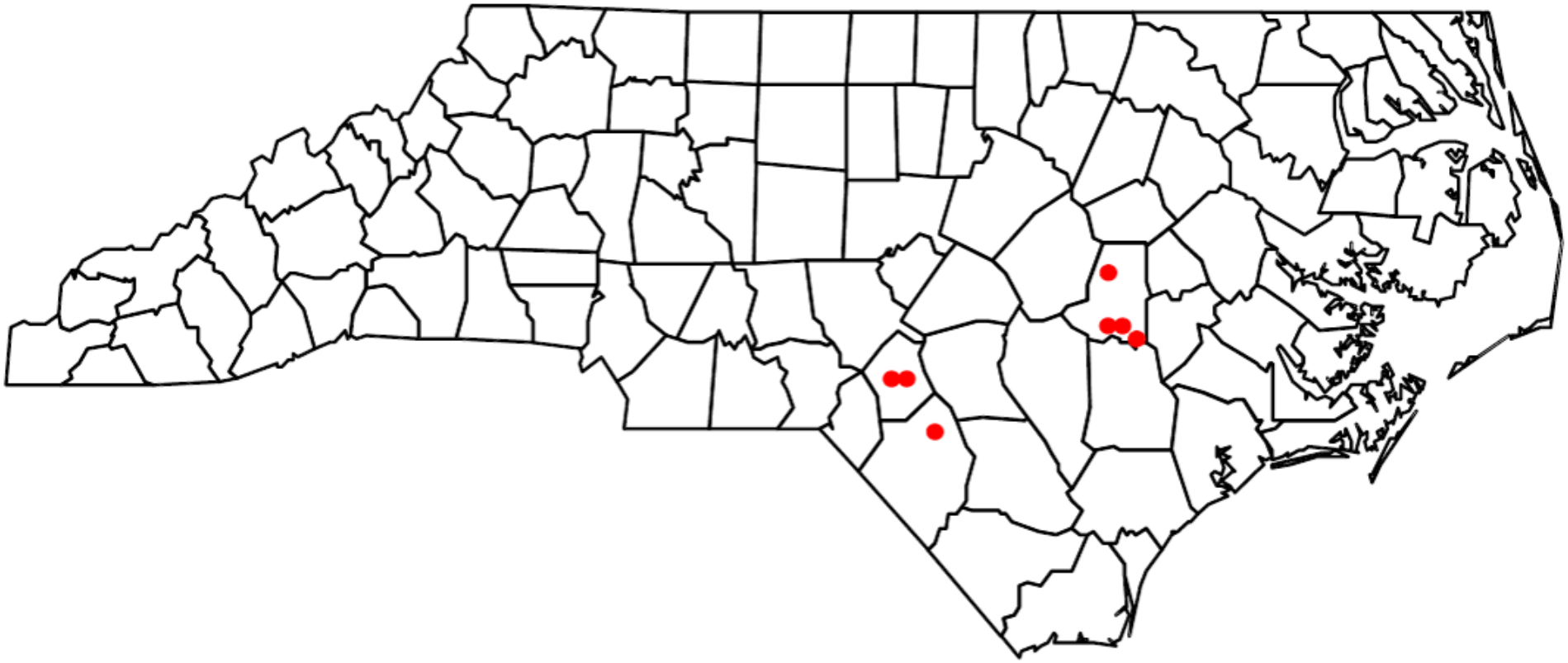
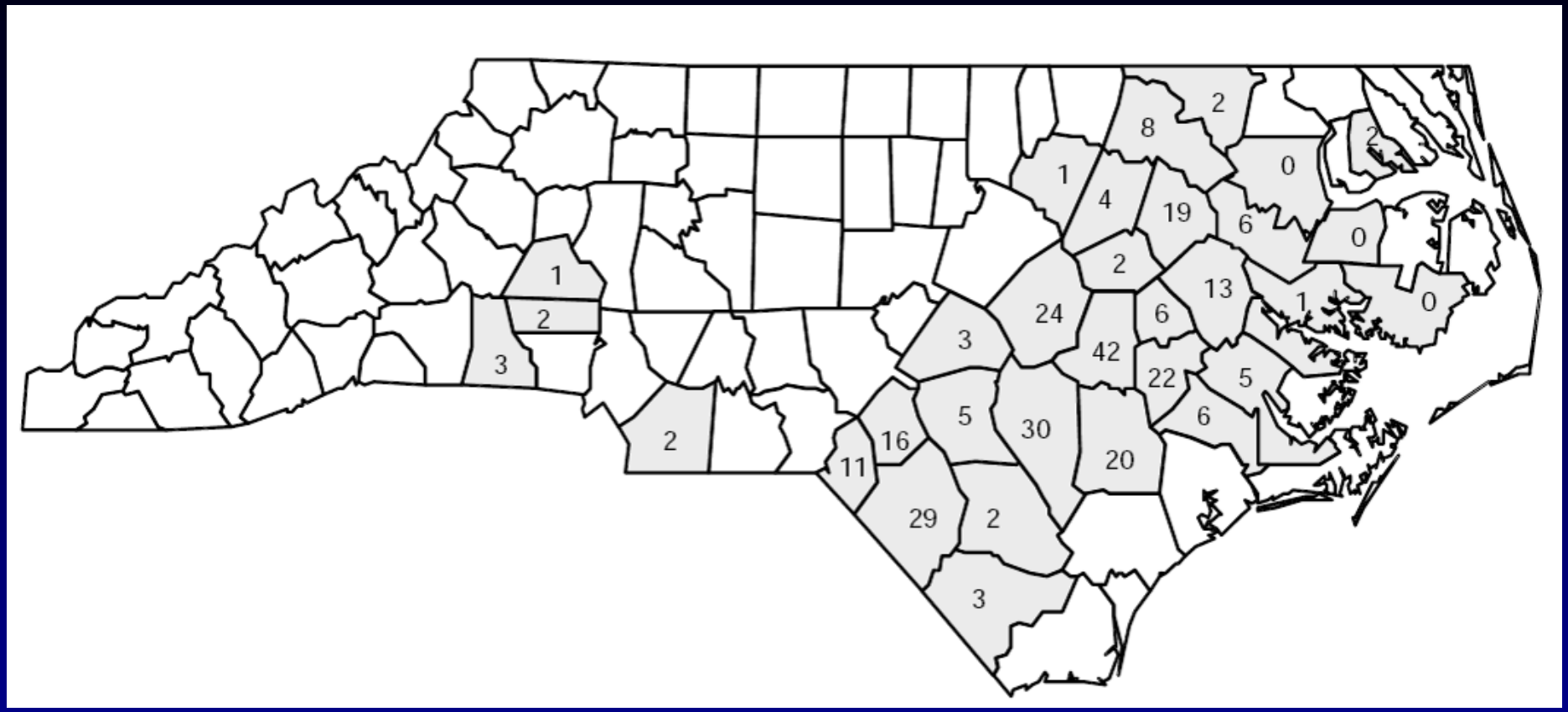
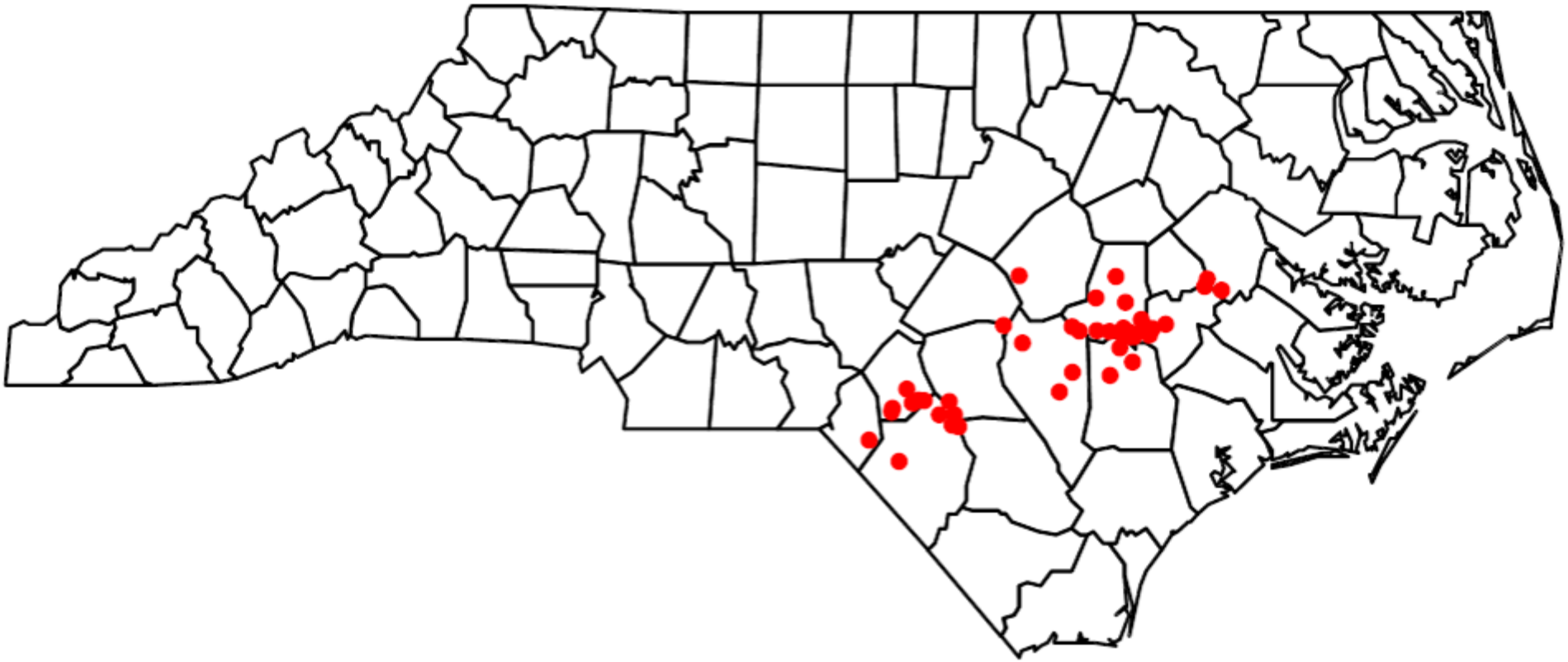


Figure 2. Glyphosate resistance initially suspected in seven fields in Hoke, Robeson, and Wayne counties during 2005 in North Carolina.



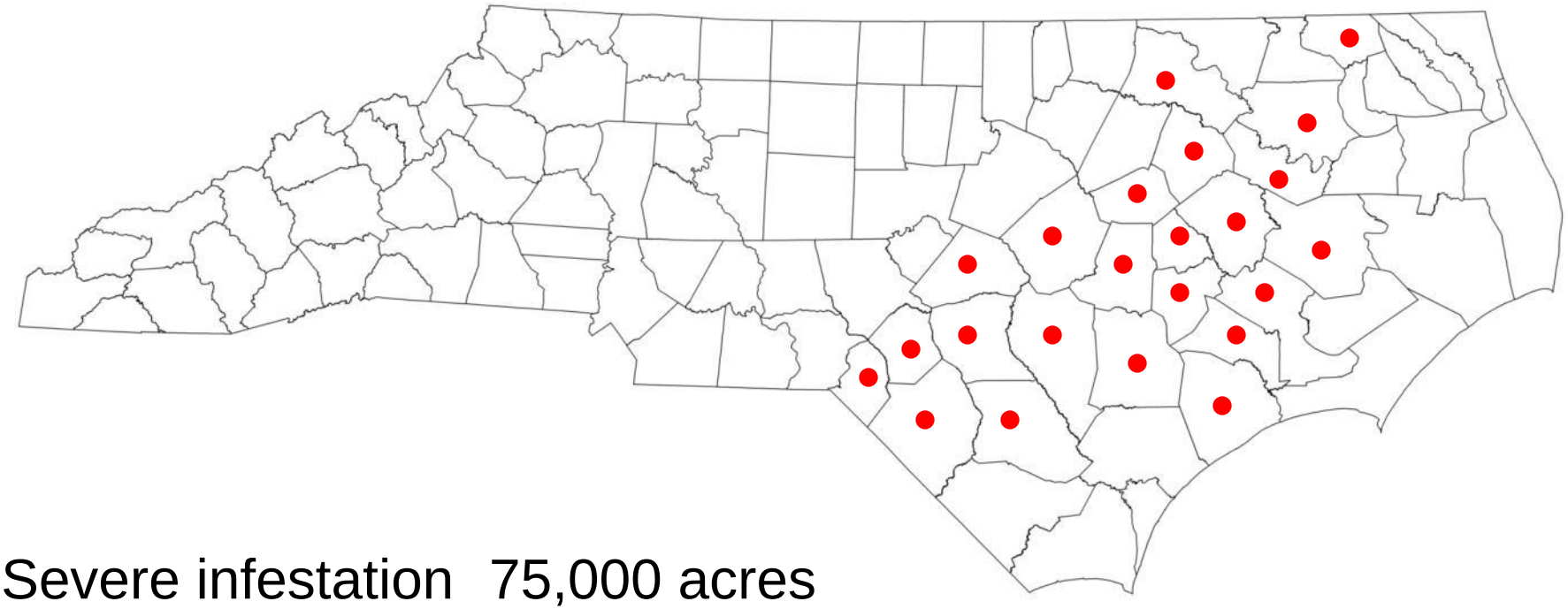
290 fields sampled for screening in fall of 2005.

Number indicates number of fields sampled.



Resistant Palmer amaranth in 49 of 290 fields sampled in fall of 2005

Glyphosate-resistant Palmer amaranth, 2008.
22 counties, up to 200,000 acres



Severe infestation	75,000 acres
Mod. infestation	75,000 acres
“Hot spots”	50,000 acres

Why are we seeing more and more glyphosate-resistant Palmer amaranth?

- Continued spread
  - Seed movement, primarily by equipment.
  - Trait transferred via pollen.
    - Resistance trait carried by pollen.
    - Pollen can move, fertilize females 1000 ft.
    - Implications: if you have susceptible females and your neighbor has resistance, look out!
- Continued selection

Impacts of GR Palmer Amaranth in Southeast

1. Lot of anxiety
2. More cultivation (GA, SC), less no-till (GA); 3-5% acreage
3. Increase in use of residuals, other MOA's
4. More hand-weeding
5. Increased production costs

Herbicide Resistance Management

The focus must be on reducing selection pressure.

Back: Untreated

Front: Roundup only

- Roundup Ready allowed us to be “weed sprayers”
- Resistance will force us to become weed managers
  - Greater complexity
  - Increased costs

In-Crop Glyphosate Resistance Management

1. Do not depend entirely on glyphosate;
   Incorporate other herbicides (other MOA's) into
   RR systems
   i. Residual herbicides preplant or preemergence; residuals have a fit
   ii. Tank mixes postemergence
   iii. Full-use rates
2. Non-chemical control where it fits
3. Watch carefully for escapes; eliminate them before seeding out

Detect Resistance Early

Considerations in Planning Palmer Amaranth Management Systems

- Problem likely to get worse
- No salvage options for cotton; POST options for corn and soybean IF timely
- ALS resistance widespread; can't depend on that chemistry; need to reduce further selection
- PPO inhibitors important now and into foreseeable future; must "protect" that chemistry
- Must focus on reducing seed bank; i.e., consistently good control in all crops in rotation for several years

Multiple glyphosate applications, soybeans, Wayne Co., NC 2005

Herbicide programs for Palmer amaranth in RR cotton

<table>
<tr><th>Glyphosate resistance</th><th>ALS resistance</th><th>Preplant or PRE</th><th>POST</th><th>Layby</th></tr>
<tr><td rowspan="2">No</td><td>No
or
Yes</td><td>Cotoran, Direx, or
Prowl PRE

or</td><td>Light:
Roundup</td><td rowspan="2">MSMA + Direx
MSMA + Layby Pro
MSMA + Suprend**
MSMA + Valor**

or

R’up + Direx
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R’up + Suprend**
R’up + Valor***</td></tr>
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* Note multiple MOA’s, even with an “easy” situation. Note lack of ALS inhibitors.

** Suprend not suggested if ALS-resistant Palmer expected.

*** Try to limit PPO inhibitors (such as Valor and Reflex) to one application per year.

Herbicide programs for Palmer amaranth in RR cotton

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** Suprend not suggested if ALS-resistant Palmer expected.

*** Try to limit PPO inhibitors (such as Valor and Reflex) to one application per year.

Herbicide programs for Palmer amaranth in RR cotton*

Glyphosate resistance	ALS resistance	Preplant or PRE	POST	Layby
Yes	No	Direx + Reflex, Direx + Staple, or Reflex + Staple PRE or	No emerged Palmer: Roundup + Dual Magnum	MSMA + Direx MSMA + Layby Pro MSMA + Suprend MSMA + Valor**
		Valor preplant followed by Direx + Staple or Prowl + Staple	Palmer < 2in.: Roundup + Staple	

* Strong PRE program. Try to limit ALS inhibitors (Staple, Envoke) and PPO inhibitors (Reflex,Valor) to one application per year.

Herbicide programs for Palmer amaranth in RR cotton*

Glyphosate resistance	ALS resistance	Preplant or PRE	POST	Layby
Yes	Yes	Direx + Reflex or Prowl + Reflex PRE or Valor preplant followed by Direx + Prowl	Before Palmer emergence: Roundup + Dual Magnum	MSMA + Direx MSMA + Layby Pro MSMA + Valor

* Try to limit PPO inhibitors (Reflex and Valor) to one application per year.

Glyphosate-resistant Palmer amaranth management in NC cotton

Herbicide program:

- Aggressive preplant/preemergence program.
  - Preemergence critical; cannot “salvage” postemergence.
  - Dual Magnum overtop for additional residual control.
  - Residual herbicide(s) lay-by.

Cultivation:

- Very unpopular; growers don’t want to resort to that. About 70% of cotton strip-till or no-till.

Preplant incorporated herbicides:

- Same situation as cultivation

Roundup. + 2,4-D burndown

Gram. + Reflex PRE

Roundup + Dual first POST

Roundup second POST

Direx + MSMA Layby

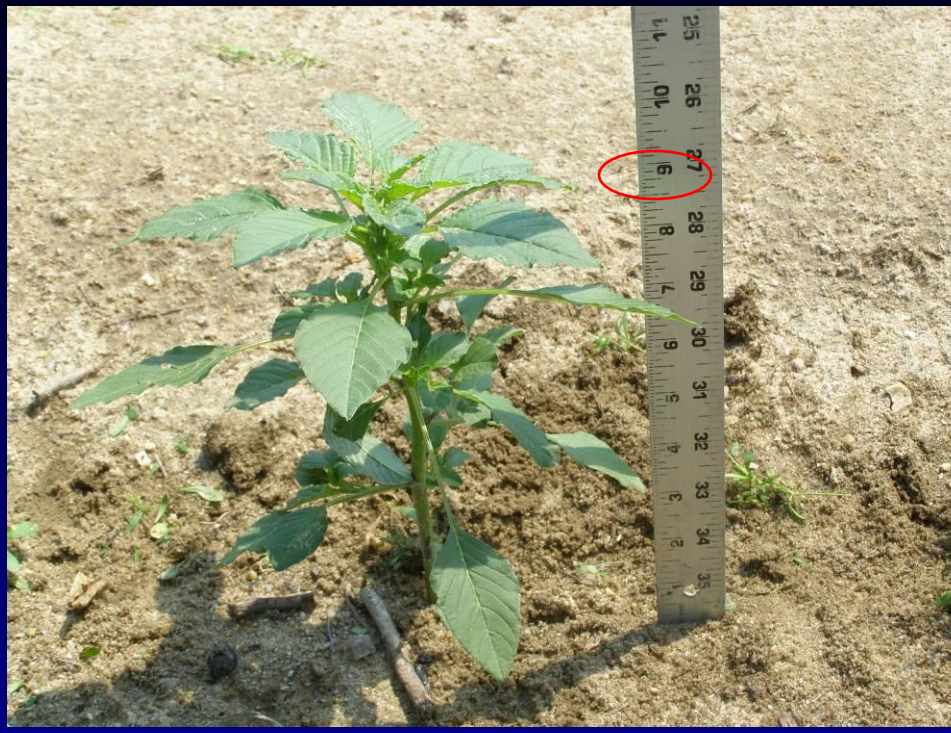
Glyphosate-resistant Palmer amaranth management in NC soybean

Herbicide program:

Aggressive preplant/preemergence program.

POST herbicides/tank mixes as needed.

Max size for POST depends on product;
no label > 8 inches.



Herbicide programs for Palmer amaranth in RR soybean

Soybean variety	Glyphosate resistance	ALS resistance	PRE	POST
RR	No; Lighter infestation	Yes or No	Boundary, Canopy, Dual Magnum, Envive, Intrro, Prefix, Prowl, Reflex, Sencor, or Valor	Roundup
	No: Heavy infestation	Yes or No		Roundup or R'up + Dual Mag. or Sequence or R'up + Flexstar*

* Limit PPO inhibitors (Envive, Prefix, Reflex, Valor) to one application per year.

Herbicide programs for Palmer amaranth in RR soybean*

Soybean variety	Glyphosate resistance	ALS resistance	PRE*	POST*
RR	Yes	No	Boundary; Canopy; Envive; Intrro; Prefix; Reflex; Sencor; or Valor	R'up+ Harmony SG** R'up + Flexstar R'up + Reflex R'up + Blazer
	Yes	Yes	Boundary; Canopy + Dual Mag, Intrro, or Prowl; Envive + Prowl; Valor + Prowl	R'up + Flexstar R'up + Reflex R'up + Blazer

* Limit PPO inhibitors (Envive, Prefix, Reflex, Valor) to one application per year. Products in red are not PPO inhibitors or ALS inhibitors.

** Harmony SG is an ALS inhibitor.

Mount Olive, NC 2008