Herbicide Resistance: These weeds just won't die!

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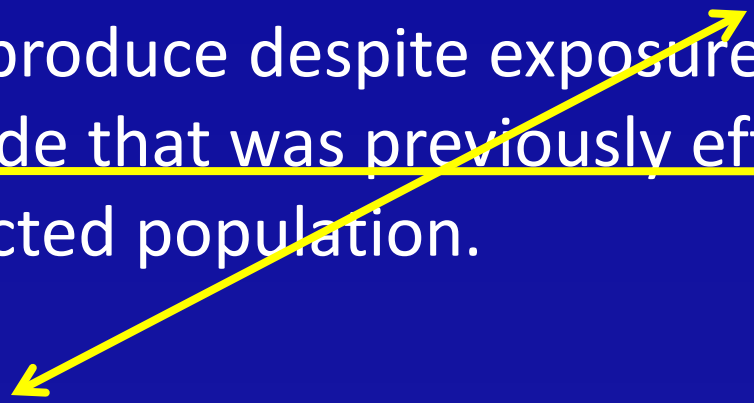
Weed Scientist

LSU AgCenter

What is herbicide resistance?

- Weed Science Society of America definition:
  - The inherited ability of a weed biotype to survive and reproduce despite exposure to a dose of herbicide that was previously effective on an unselected population.



    - Biotype = a subset within a population that has a genetically controlled characteristic not common in the population as a whole.

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What is weed resistance?

Glyphosate-resistant horseweed (mare's-tail) in Arkansas

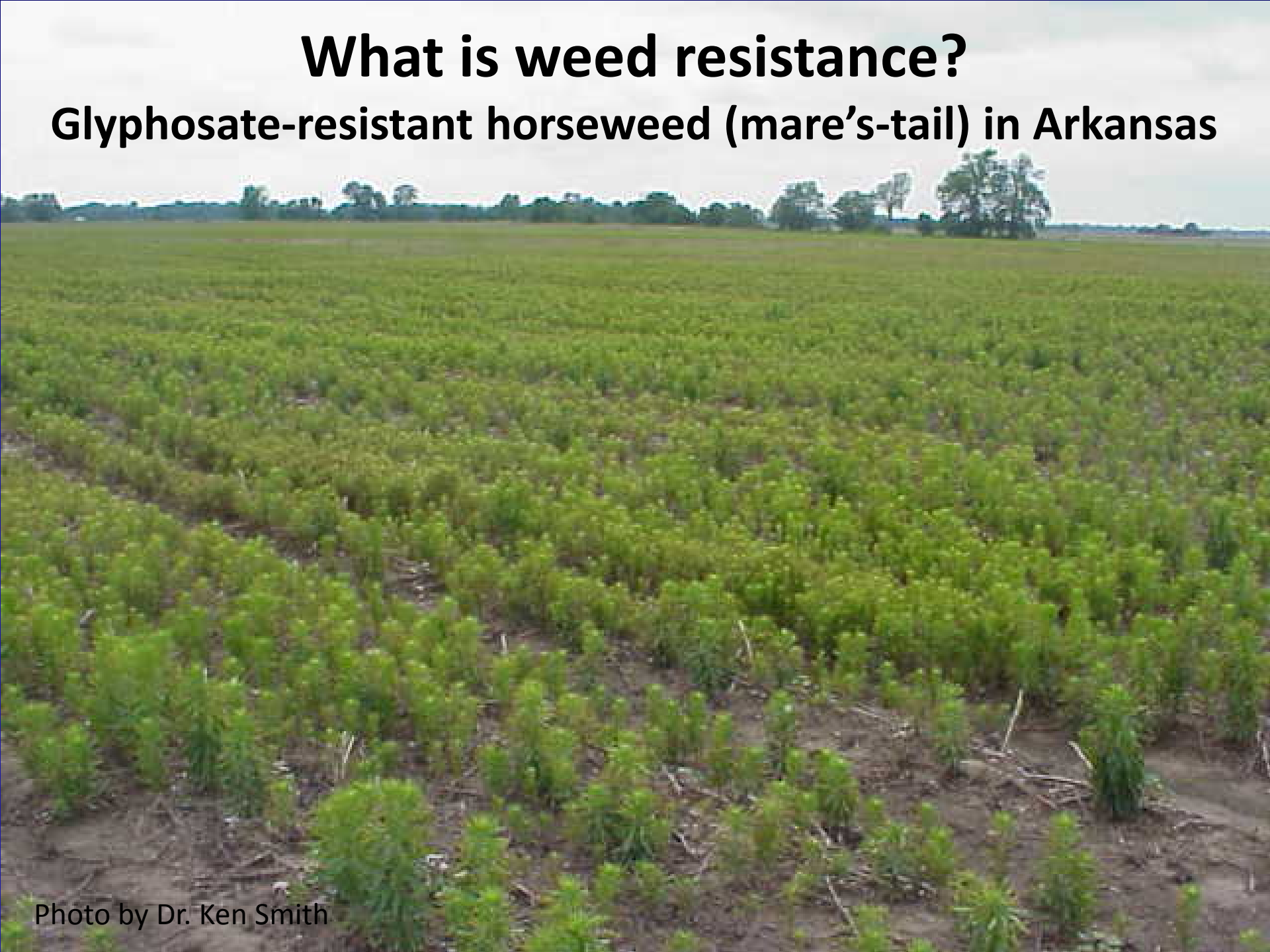


Photo by Dr. Ken Smith

What is weed resistance?

Glyphosate-resistant Palmer amaranth in Georgia

Cotton field following 264 oz/acre of glyphosate

Photo by Dr. Stanley Culpepper

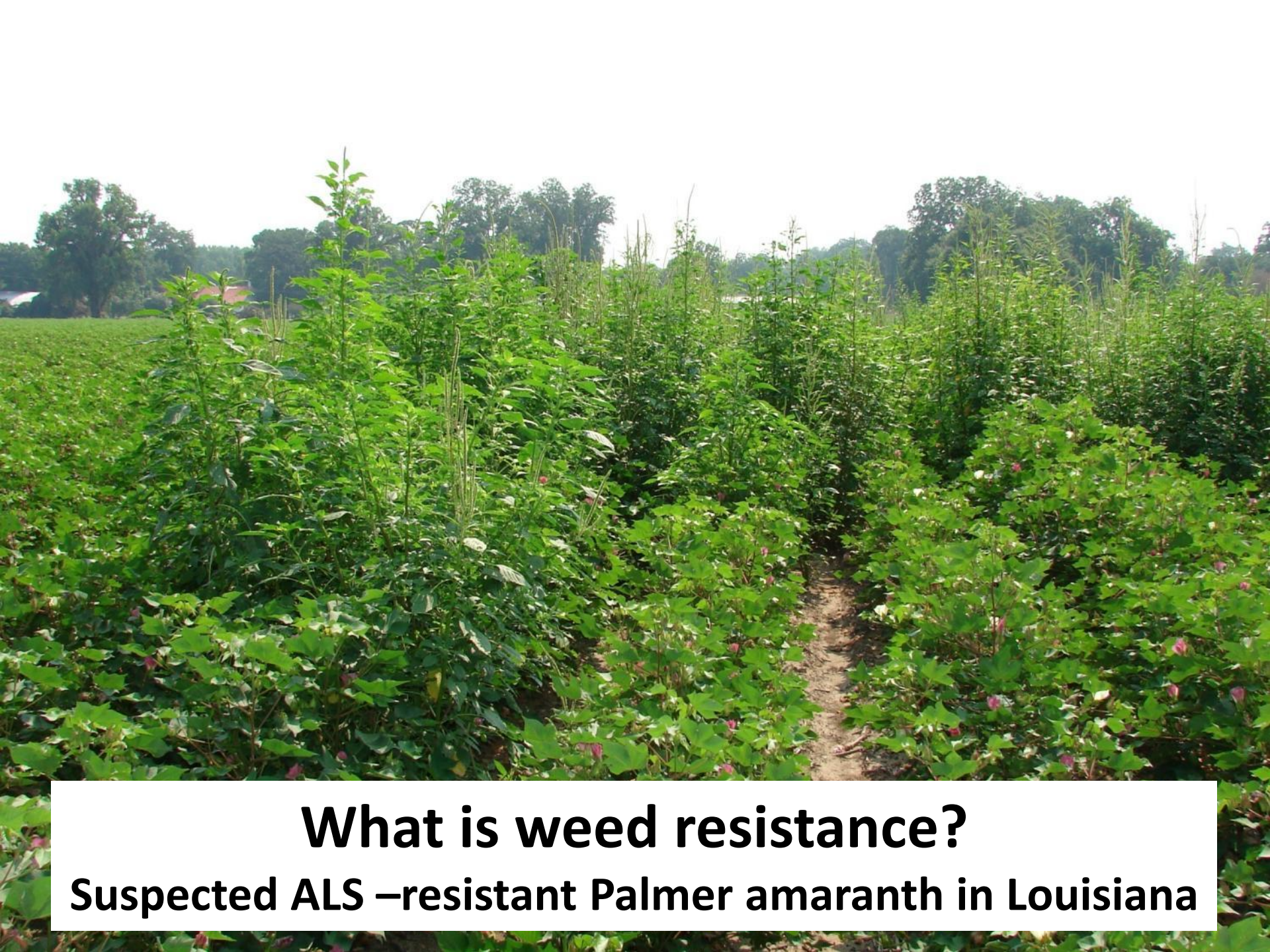
What is weed resistance?

Herbicide-resistant ryegrass in Mississippi

Photo by Dr. Dan Poston

What is weed resistance?

Suspected glyphosate –resistant johnsongrass in Louisiana



What is weed resistance?

Suspected ALS –resistant Palmer amaranth in Louisiana

What is weed resistance?

Suspected glyphosate –resistant Palmer amaranth in Louisiana


COUGAR


2007

When it is not herbicide resistance?

Resistance vs. Tolerance

- Tolera owth when
  - Disa nce betw
    - Ty
    - Morningglory and glyphosate

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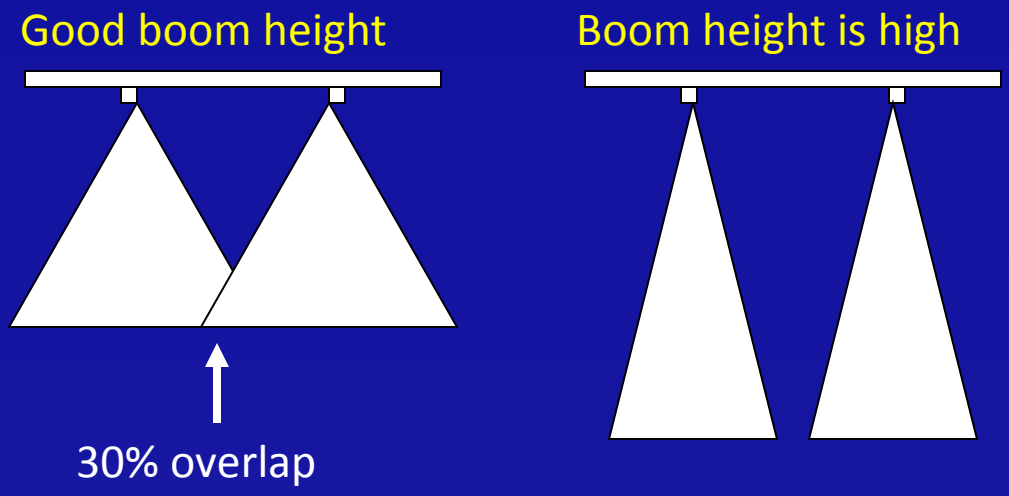
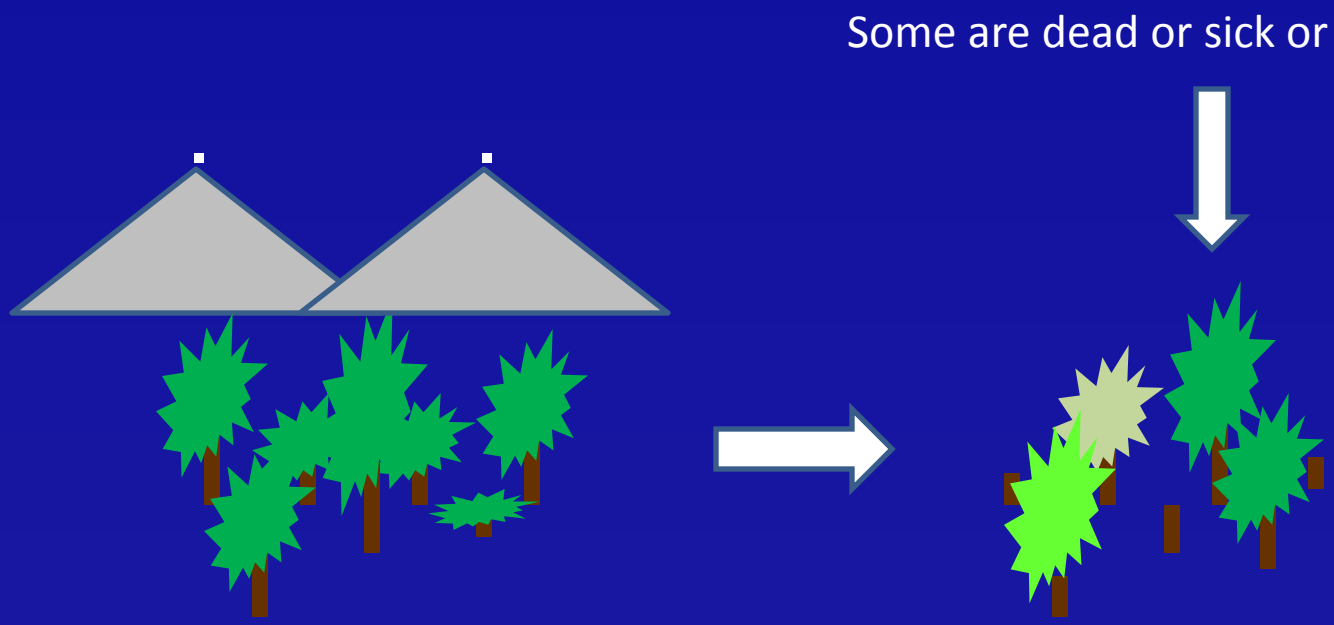
When it is not herbicide resistance?

- Herbicide misapplications due to:
  - Poor spray coverage, spray tip pattern, or clogged tip



When it is not herbicide resistance?

- Herbicide misapplications due to:
  - Applying less than the recommended label rate; or
  - Treating weeds when they are too large can cause problems.



When it is not herbicide resistance?

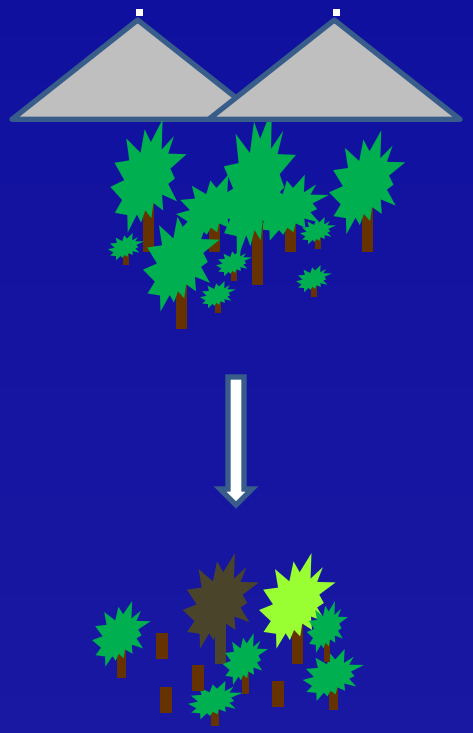
- Adverse environmental conditions;
  - If the temperature is too hot or cold at application.
  - Drought or excessive moisture.
  - Disease, insect, or mechanical damage may cause stress on the weed.

When it is not herbicide resistance?

- Rainfall or irrigation may wash-off postemergence herbicide applications.
  - Postemergence herbicides generally have a rain-fast or rain-free time period on their label.

When it is not herbicide resistance?

- Excessively high weed populations at application.
  - Herbicide spray is intercepted by the larger weeds preventing contact of spray with smaller weeds underneath.



When it is not herbicide resistance?

- New emergence following treatment.

When to suspect resistance!

- The field or area with problem weed(s) has been sprayed repeatedly with the same herbicide or mode of action, **AND**

When to suspect resistance!

- The patch of weeds occurs in the same spot year after year and is spreading.

When to suspect resistance!

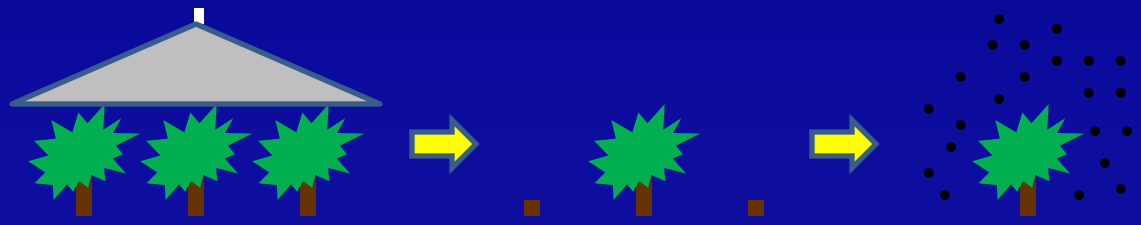
- Other weed species are controlled, but one particular weed species is no longer controlled, **AND**

When to suspect resistance!

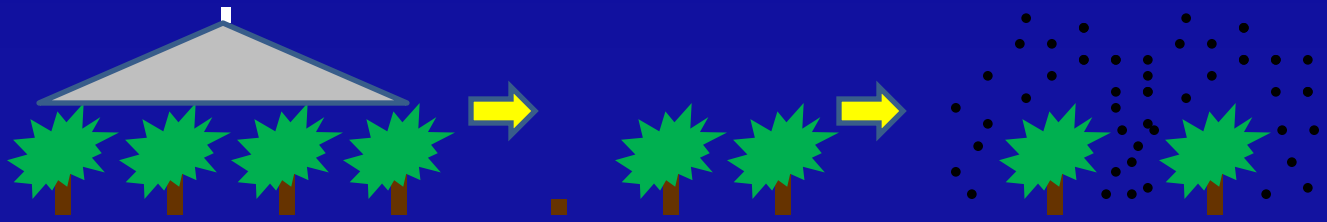
- Surviving plants of the problem weed species may be in a patch where some are dead and/or some show variable injury symptoms, but all are approximately the same age as those that were treated and controlled.

Herbicide Resistance

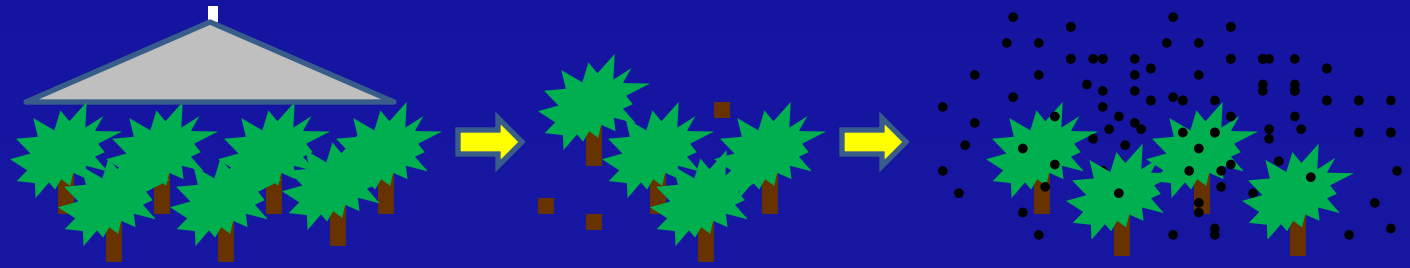
Year 1



Year 2



Year 3



Herbicide Resistance


Photo by Dr. Alan York

Pest Resistance

- Insects first – 1908 – San Jose scale resistant to lime sulfur
  - 2007 - > 500 insects resistance to an insecticide
- 1956 – Idea of herbicide resistance in weeds published by J.L. Harper
  - Not taken seriously

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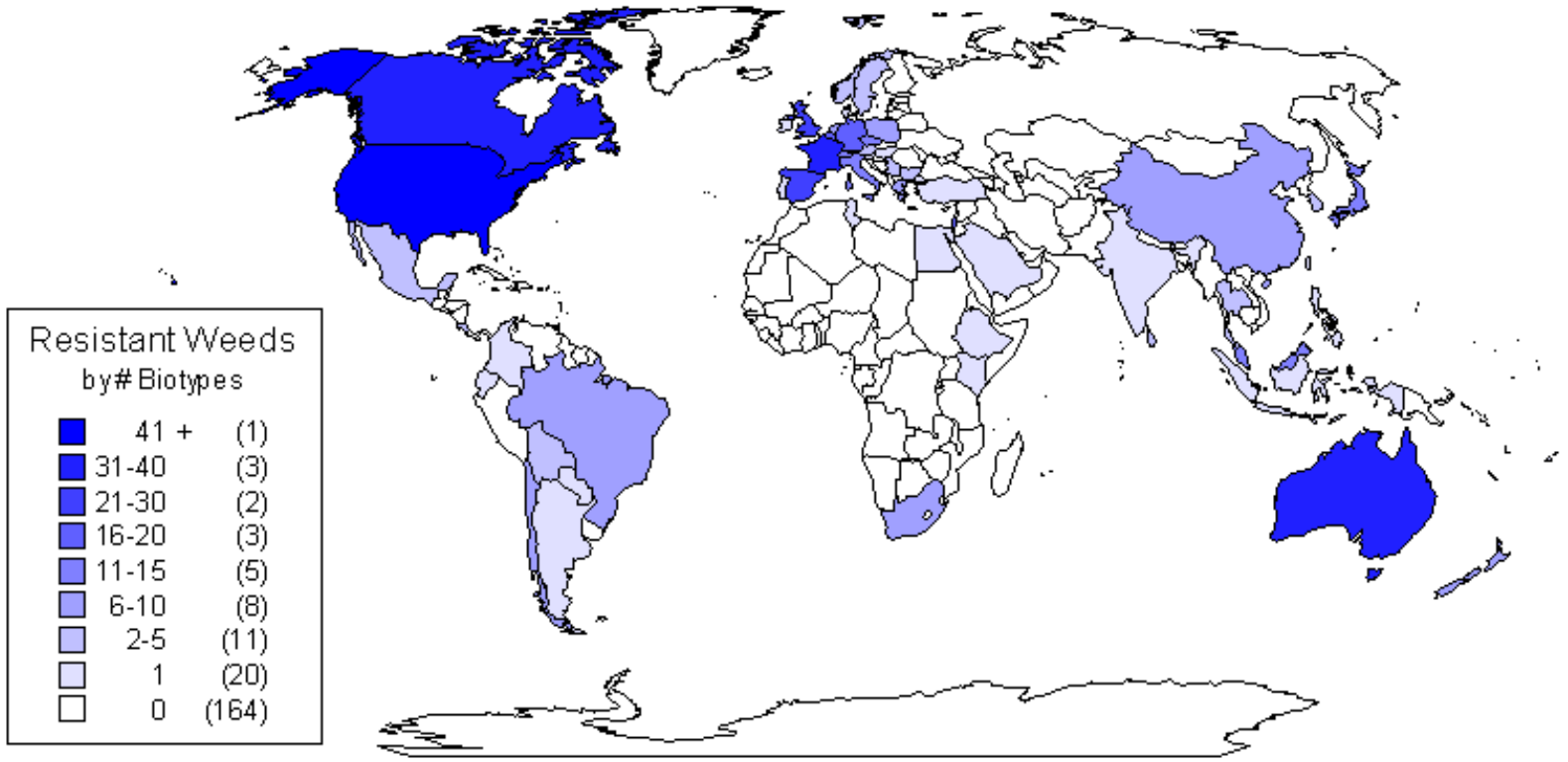
Herbicide Resistance

Distribution of Herbicide Resistant Biotypes



Source: Dr. Ian Heap
www.weedscience.com

Herbicide Resistance

- U.S. – Resistance documented in greater than 40 weed species.
- Louisiana
  - Resistance not a severe problem, YET.
  - Barnyardgrass, common cocklebur, itchgrass, & johnsongrass have been documented
  - 2008 suspected sites investigated by LSU AgCenter
    - ALS-inhibitors and glyphosate
      - Johnsongrass
      - Palmer amaranth
      - waterhemp

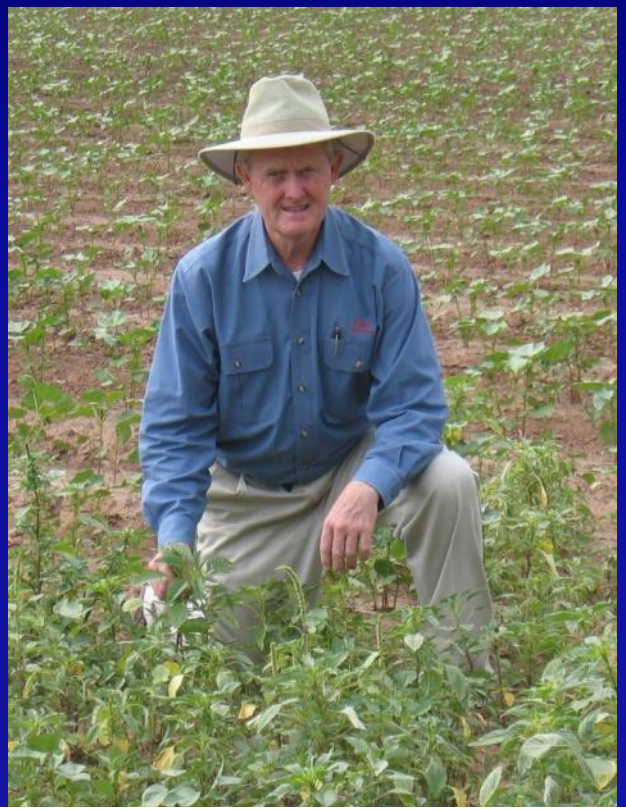





Herbicide Resistance

- Recent popular press articles state:
  - Resistance threatens the ability of crop producers to farm profitably
    - Arkansas, Georgia, Mississippi, North Carolina, Tennessee, and other states.

- Glyphosate gets the headlines, but numerous weed species are resistant to many herbicidal modes of action.



"Glyphosate-resistant Palmer amaranth is the most significant threat to agriculture that I have seen in my 30+ years." Dr. Ken Smith, Extension Weed Scientist, Univ. of Arkansas.

How does a herbicide kill?

- Mode of action
  - The biochemical mechanism by which a herbicide causes growth to cease in target plants.
  - Example: inhibition of ALS (acetolactate synthase), an enzyme involved in synthesis of branched-chain amino acids.
- 16 different herbicidal modes of action

Herbicidal Modes of Action

- ACCase-inhibitors
  - Arrow, Fusliade, Poast, etc.
- ALS-inhibitors
  - Classic, Escort, Outrider, Plateau, etc.
- Photosynthesis-inhibitors
  - Aatrex, Cotoran, Direx, Diuron, Karmex, etc.
- PPO-inhibitors
  - Flexstar, Goal, Ultra Blazer, etc.
- Synthetic auxins
  - 2,4-D, Banvel, Clarity, Paramount, etc.
- EPSP synthase-inhibitor
  - Glyphosate - numerous formulations

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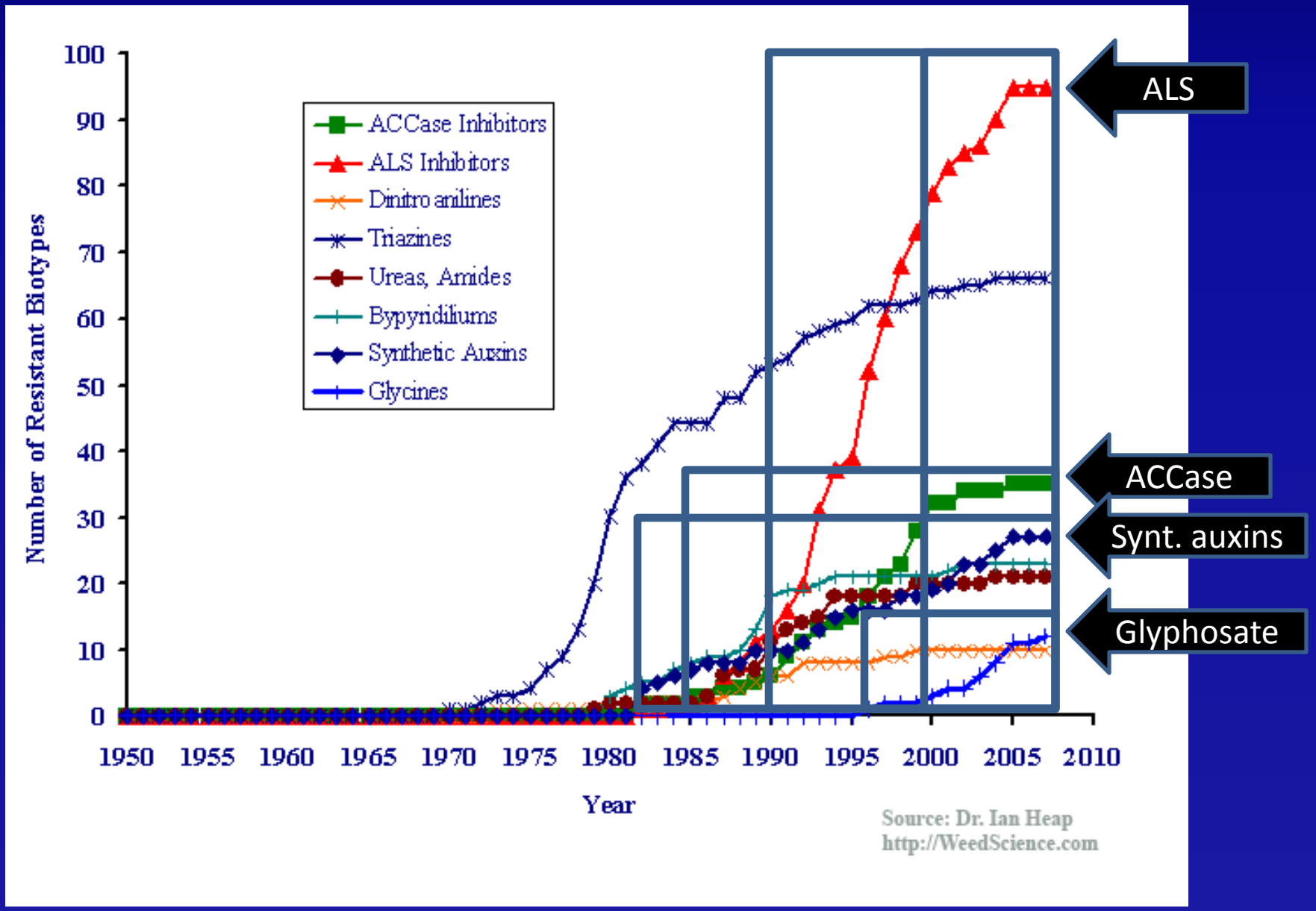
Herbicide Resistance



What kind of resistance is it?

Cross Resistance

or

Multiple Resistance

Cross Resistance

- Biotype is resistant to two or more herbicides having the same mode of action.
- Example: weeds resistant to imidazolinone herbicides (ALS inhibitors) are often resistant to sulfonylurea herbicides (ALS inhibitors).

North Carolina

Hoelon (an ACCase inhibitor)
Hoelon-susceptible biotype

Hoelon (an ACCase inhibitor) on
Hoelon-resistant biotype

Axial (an ACCase inhibitor)
on Hoelon-resistant biotype

Courtesy of Dr. Alan York

Multiple Resistance

- Biotype is resistant to two or more herbicides having different modes of action.
- Example: weeds resistant to both ALS inhibitors and ACC synthase inhibitors.

North Carolina

Hoelon (an ACCase inhibitor) on Hoelon-susceptible biotype

Hoelon (an ACCase inhibitor) on Hoelon-resistant biotype

Osprey (an ALS inhibitor) on Hoelon-resistant biotype

Courtesy of Dr. Alan York


What has caused us to get into this problem?

What causes herbicide resistance?

- Herbicides do not create resistance!
- Herbicides select for resistant individuals already in the population.
- Dependence on one herbicide exuberates the problem.

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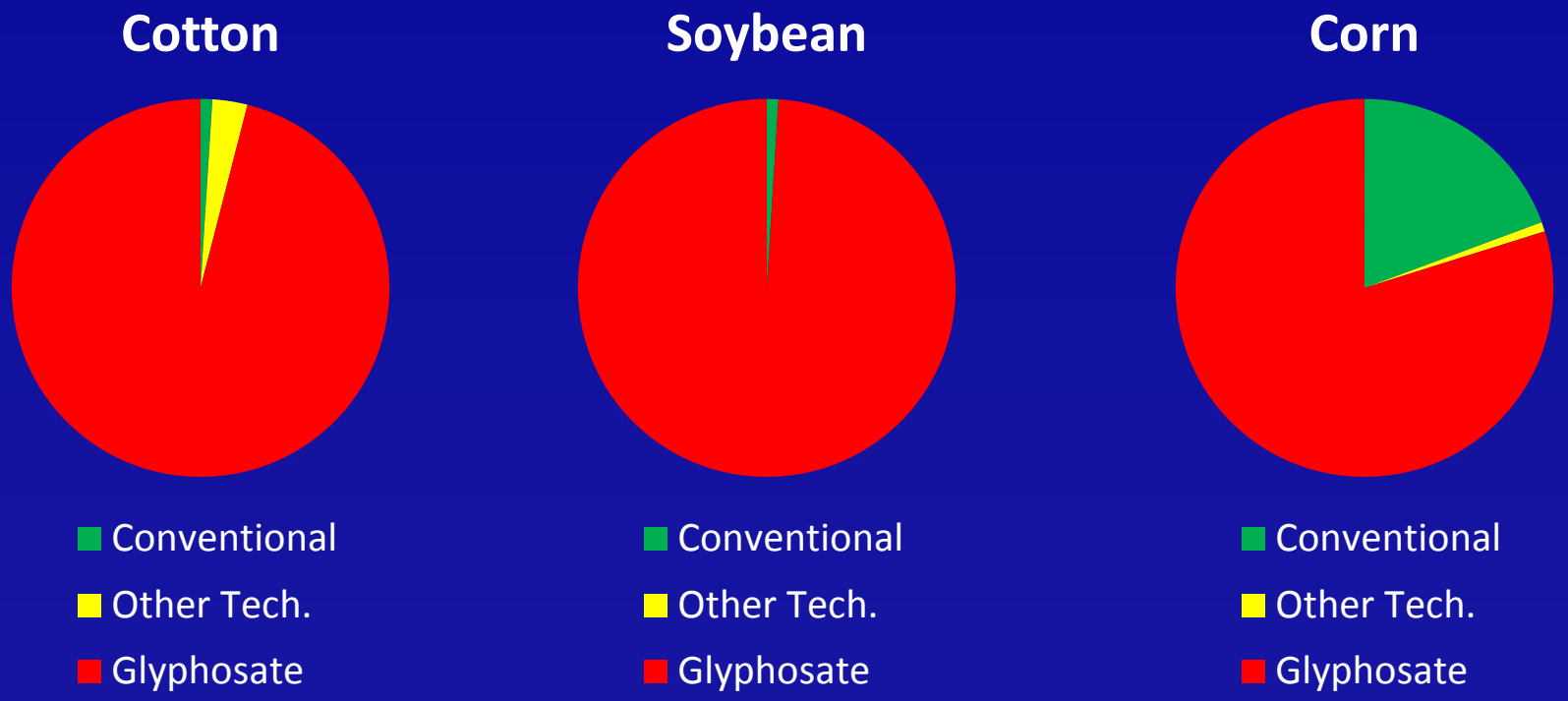
Estimated glyphosate-tolerant crops in 2008



New Herbicide Chemistry

Year	# New Chem.
1946 – 1955	23
1956 – 1965	62
1966 – 1975	74
1976 – 1985	80
1986 – 1995	96
1996 – 2006	<20

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Not the glyphosate's fault!

- Roundup Ready crops are excellent tools
- Glyphosate is an excellent herbicide
  - Controls broadleaf and grass weeds
- Roundup Ready crops helped increase the number of acres in conservation tillage

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Not the glyphosate's fault!

- However,
  - Acreage per producer increased dramatically
  - Speed, speed, speed!
  - Only need glyphosate because it is so good
  - Decreased use of residual herbicides
  - Producers not willing to use tillage or herbicide direct-application equipment

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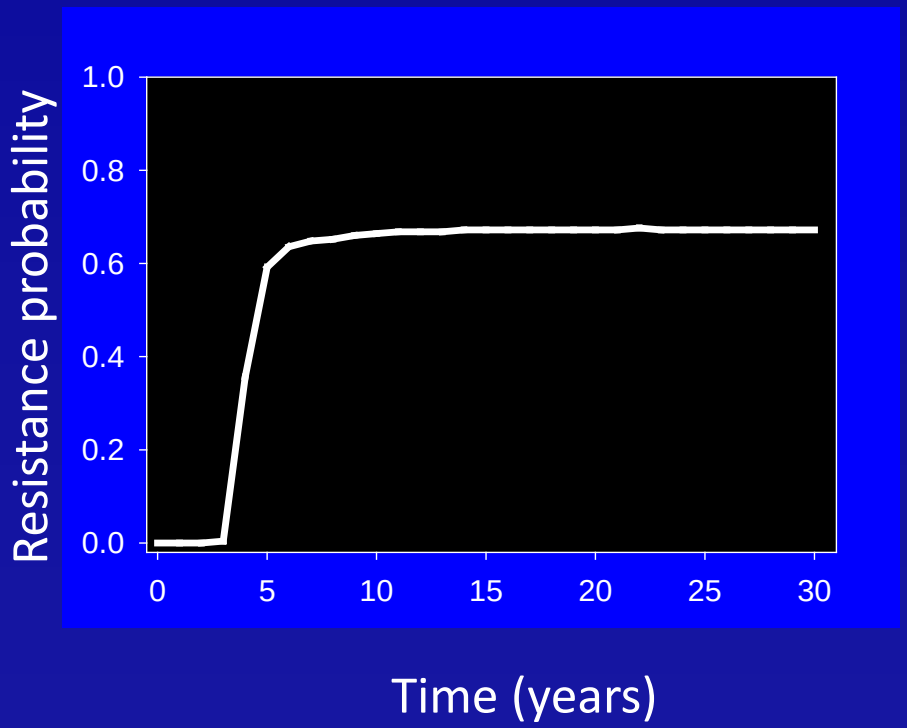
Roundup Ready Cotton

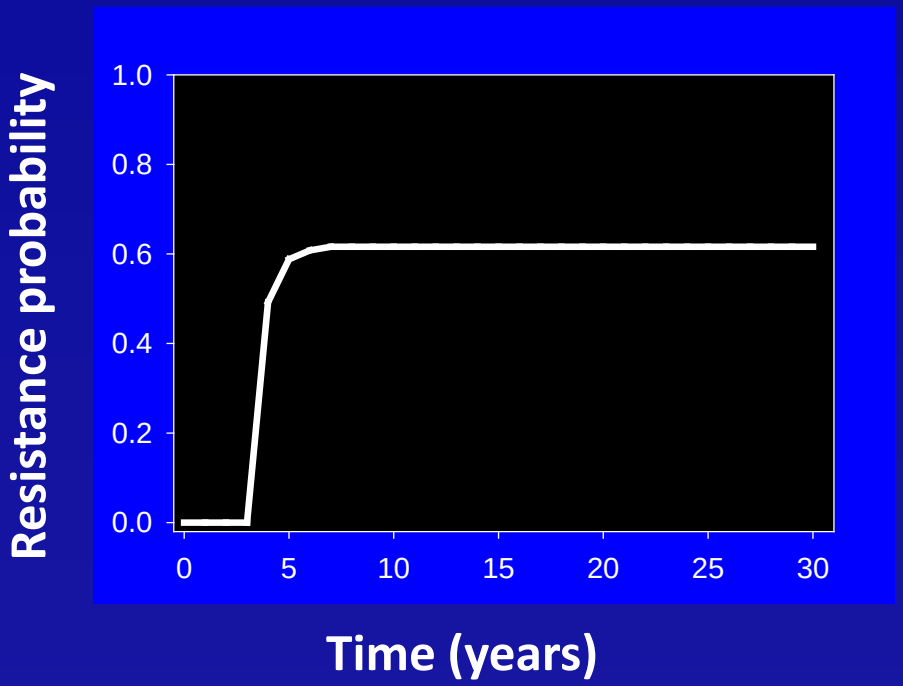


Timing	App. date	Herbicide
Preplant residual	Mar. 30	none
Burndown at planting	May 1	glyphosate
1st POST	May 15	glyphosate
2nd POST	May 30	glyphosate
3rd POST (DIR)	Jun. 15	glyphosate
Layby (DIR)	Jul 1	glyphosate

Herbicide cost/A - $25.35

Provided by Dr. Ken Smith, Univ. of Arkansas

Roundup Ready Cotton



Timing	App. date	Herbicide
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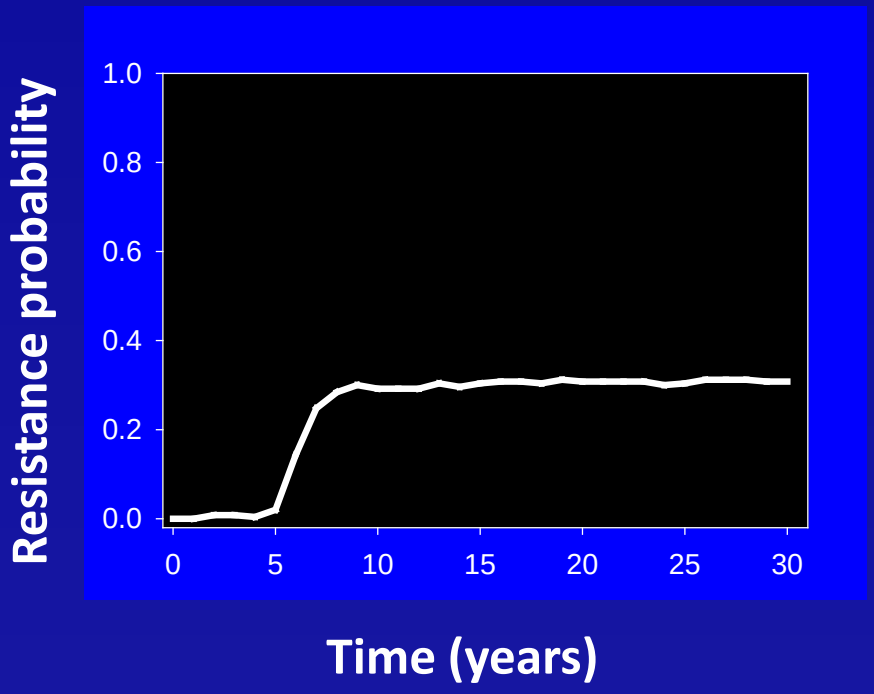
Burndown at planting	May 1	glyphosate
1st POST	May 15	glyphosate
2nd POST	May 30	glyphosate
3rd POST (DIR)	Jun. 15	glyphosate
Layby (DIR)	Jul. 1	glyphosate + Valor®

Provided by Dr. Ken Smith, Univ. of Arkansas

Herbicide cost/A - $33.93

Roundup Ready Cotton



Timing	App. date	Herbicide
Preplant residual	Mar. 30	Reflex®
Burndown at planting	May 1	None
1st POST	May 15	glyphosate
2nd POST	May 30	glyphosate
3rd POST (DIR)	Jun. 15	glyphosate
Layby (DIR)	Jul 1	glyphosate

Herbicide cost/A - $31.46

Provided by Dr. Ken Smith, Univ. of Arkansas

What causes herbicide resistance?

- We caused it!
- Overreliance on a single herbicide or a few herbicides with the same mode of action for weed control
  - Use these herbicides year after year after year!
- Resistance spreads!

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Don’t jump to conclusions!


Stewardship of
Herbicide-Tolerent Technologies
(resistance management)
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Stewardship

1. Reduce reliance on one herbicide
   - Competitive crop, good agronomics, cover crop, cultivation
2. Crop rotation with appropriate herbicide selection
3. Diversity of chemistry
   - Multiple modes of action within a crop
     - At least 2 in corn and soybean, 3 in cotton
     - Residual herbicides
     - Use full labeled rates

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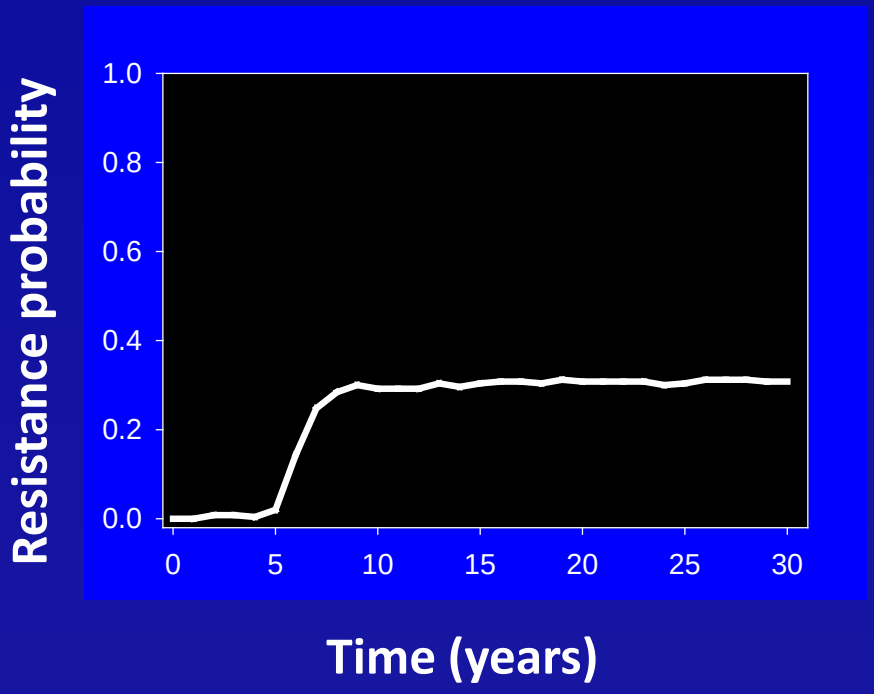
Roundup Ready Cotton



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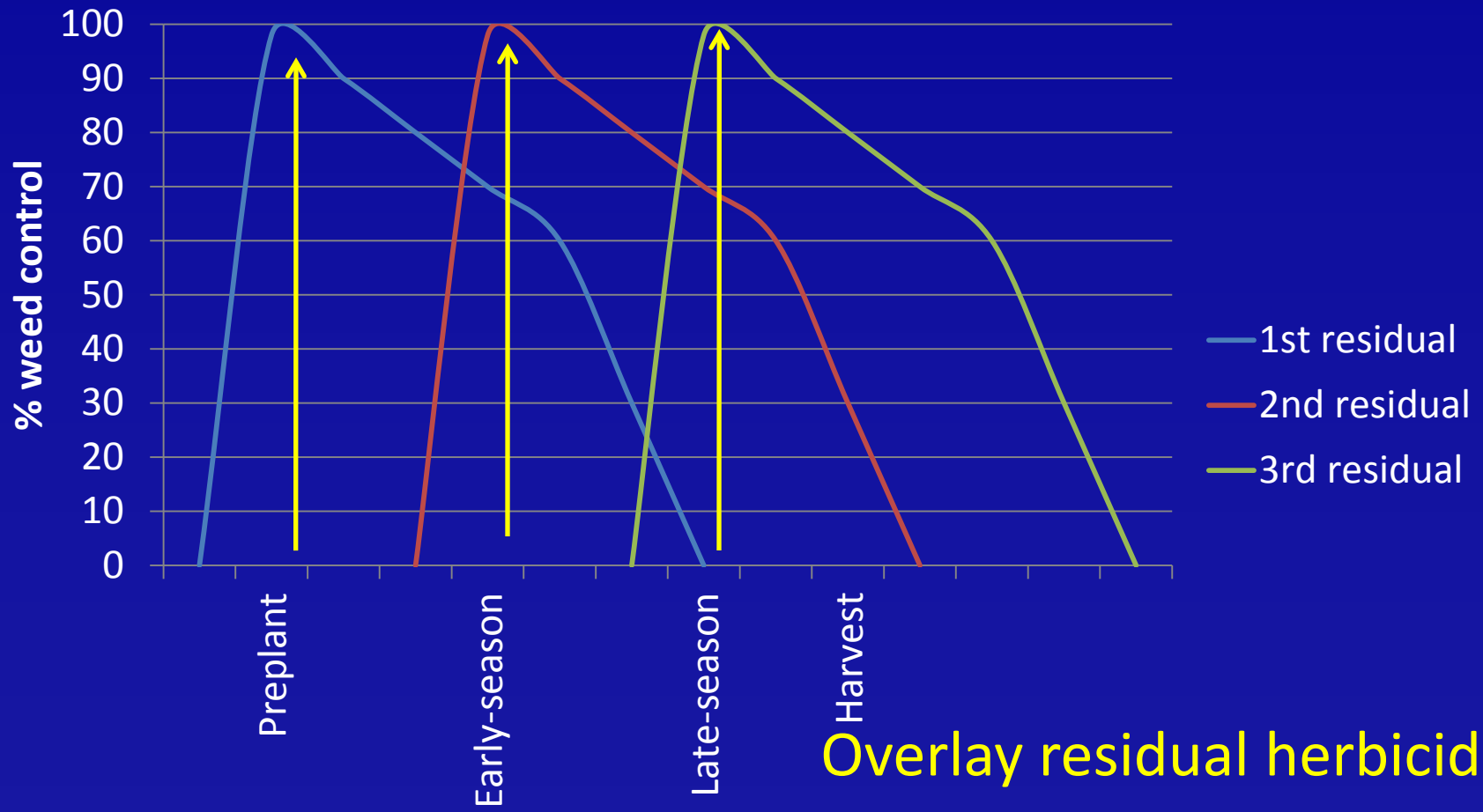
Herbicide cost/A - $31.46

Provided by Dr. Ken Smith, Univ. of Arkansas

Residual herbicides:

Control of resistant weeds



Overlay residual herbicides

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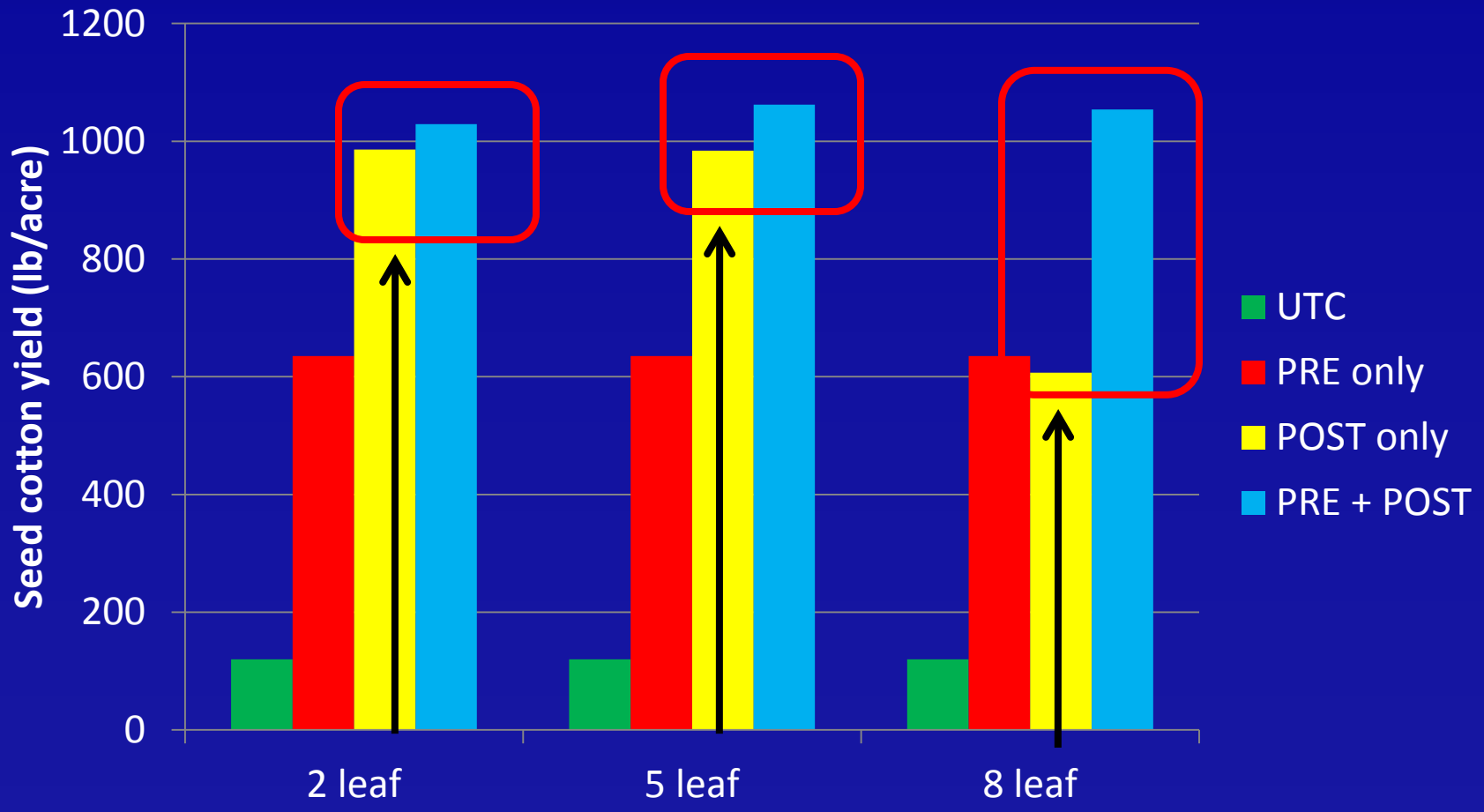
Residual herbicides:

Effect on cotton yield



Stewardship

- Residual PRE or preplant herbicides have a fit; in addition to reducing selection pressure on glyphosate they offer other benefits:
  - Control species missed by glyphosate
- New chemistry (new MOA's) coming very slowly
- Stacked HR traits coming in next 5+ years

Various combinations of:

Glyphosate
Glufosinate
Dicamba
2,4-D
Sulfonylureas
Others

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Herbicide Resistance

- What?
  - Don't assume resistance! Look for reason for failure.
  - Doesn't matter how many herbicide TRADE NAMES you use;
  - If herbicides that are used share the same mode of action (kill the same way);
  - Then the potential to create a resistance problem is very possible.

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Herbicide Resistance

- Stewardship
  - Roundup Ready crops
  - Clearfield rice
  - Future herbicide-tolerant crops

This is not what we want!

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Is this weed resistant?
Want to risk it?

QUESTIONS?