

Resisting the Urge to Ignore Weed Resistance

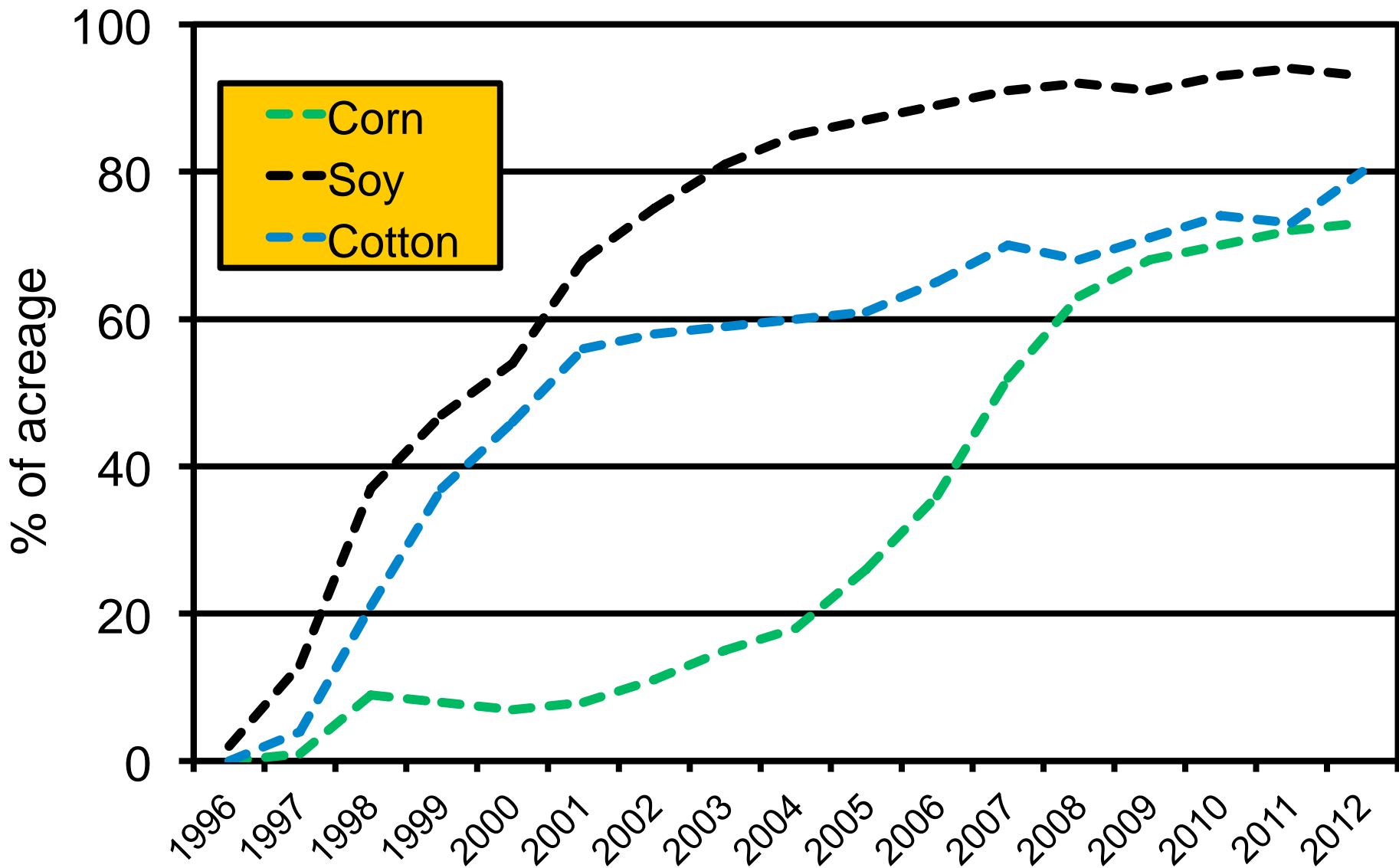


**Kevin Bradley
Associate Professor,
State Extension Weed Scientist
University of Missouri**

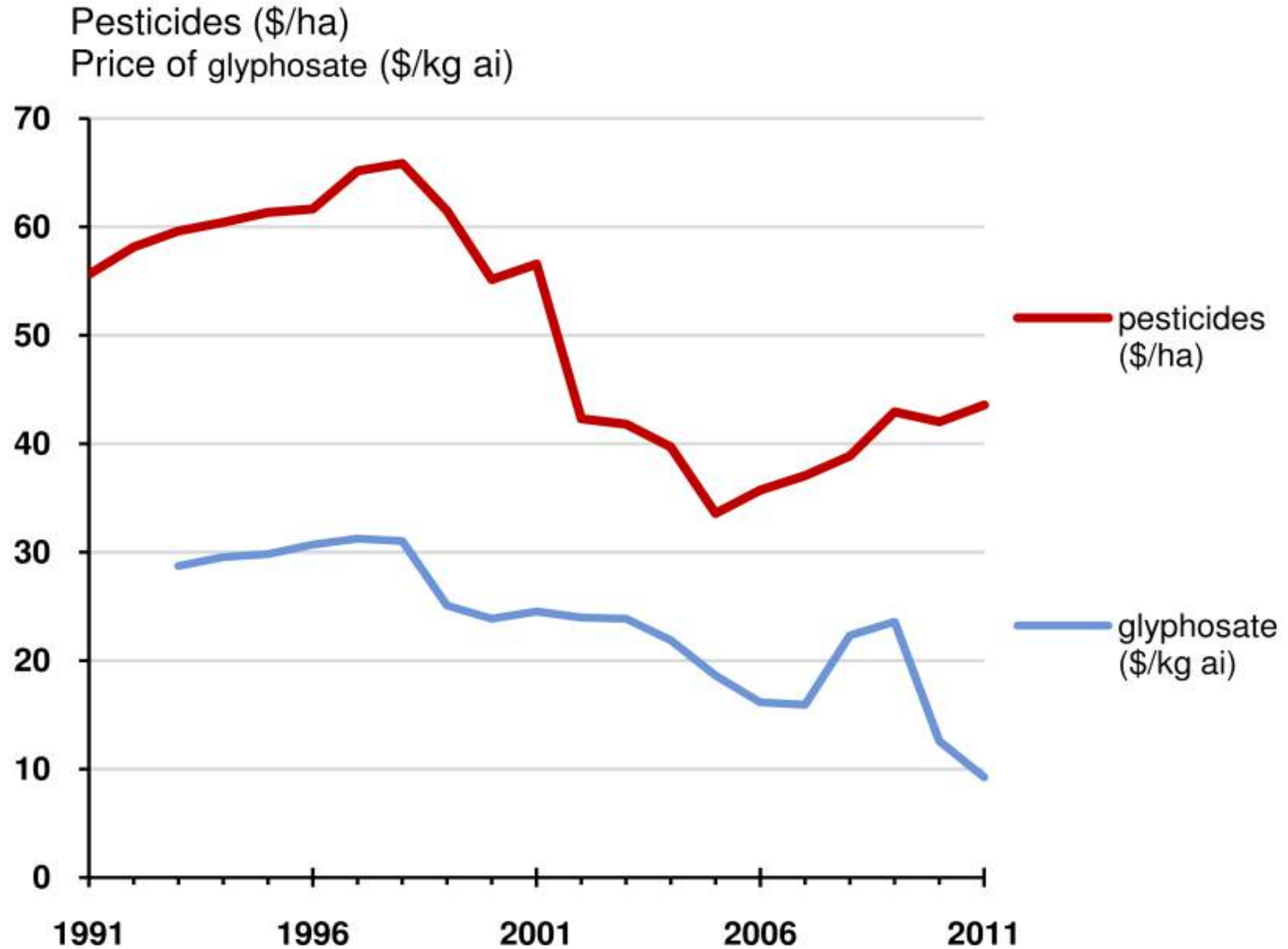
Changing Times in Weed Management...



Adoption of Herbicide-resistant Crops in the U.S.

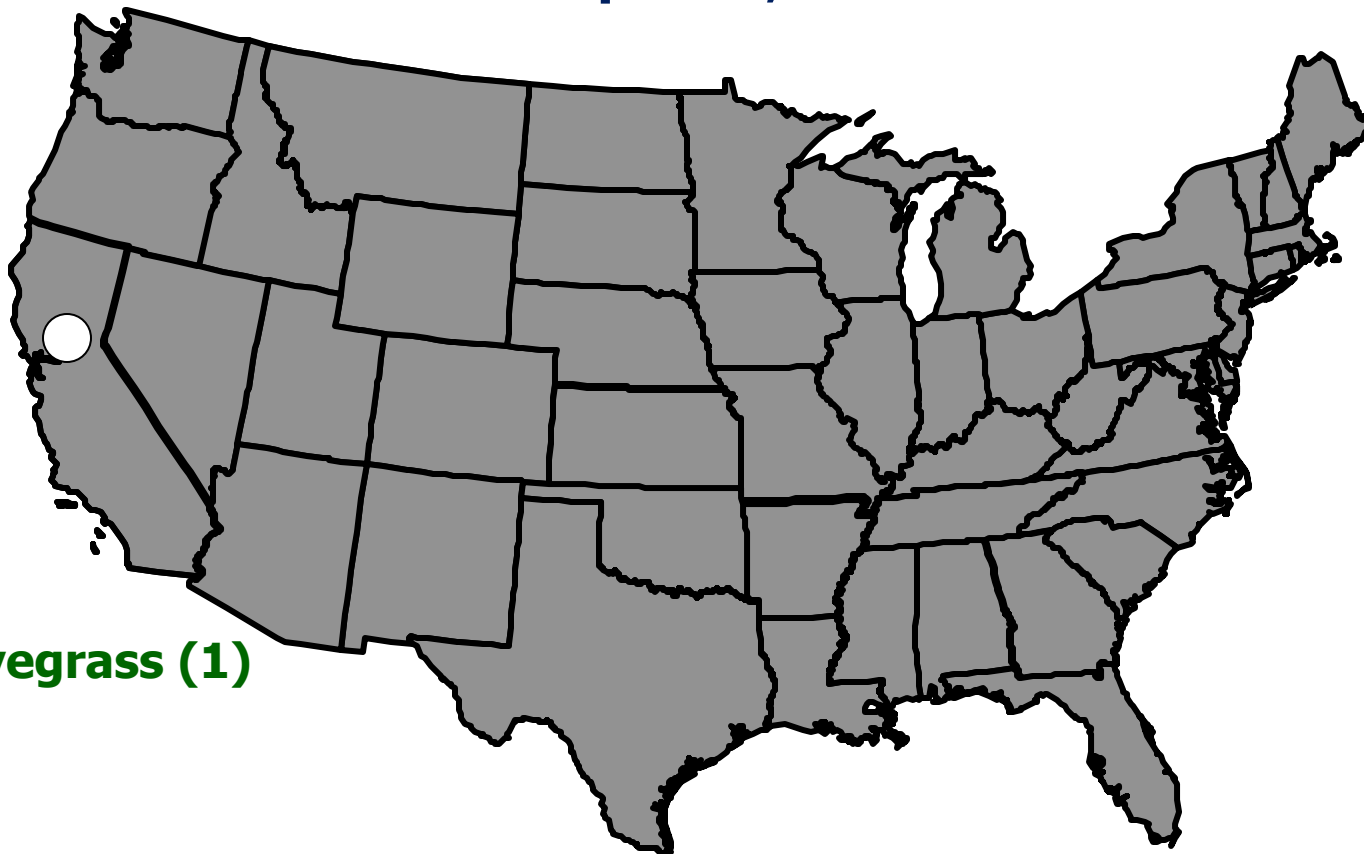


Price of Glyphosate and Costs of all Pesticides used in Soybean Production



Glyphosate-resistant Weed Development in the U.S.

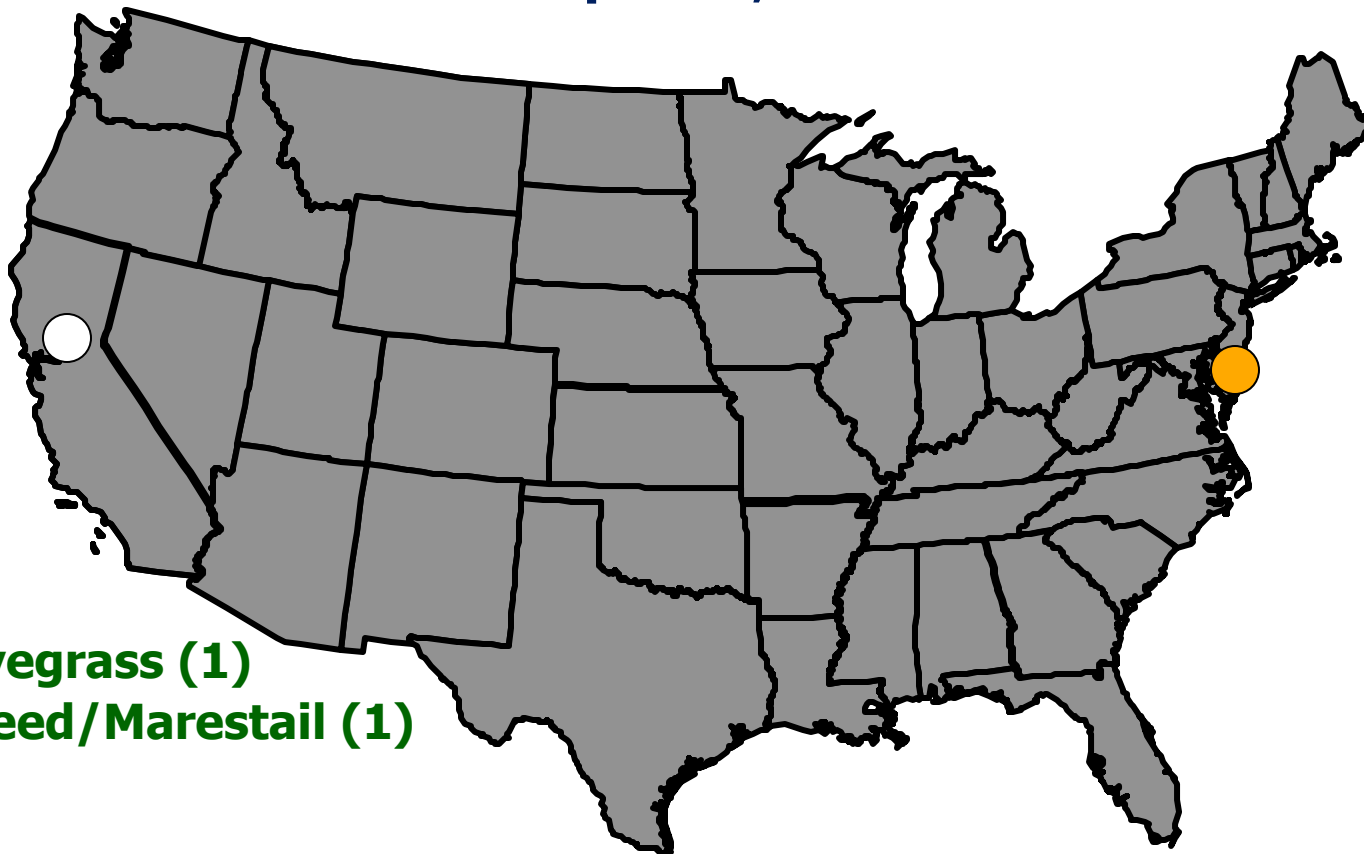
1998: 1 species; 1 state



○ Rigid Ryegrass (1)

Glyphosate-resistant Weed Development in the U.S.

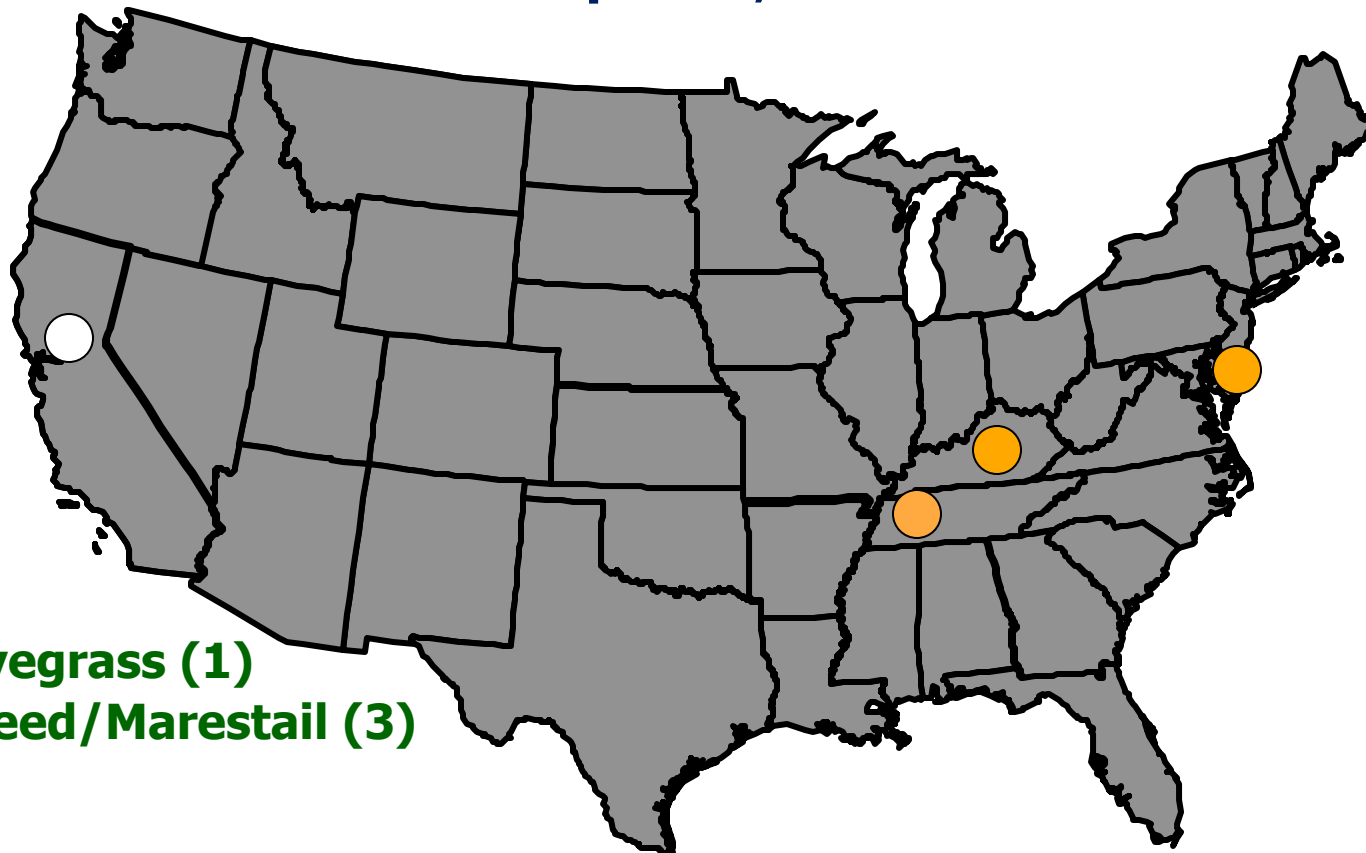
2000: 2 species; 2 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (1)

Glyphosate-resistant Weed Development in the U.S.

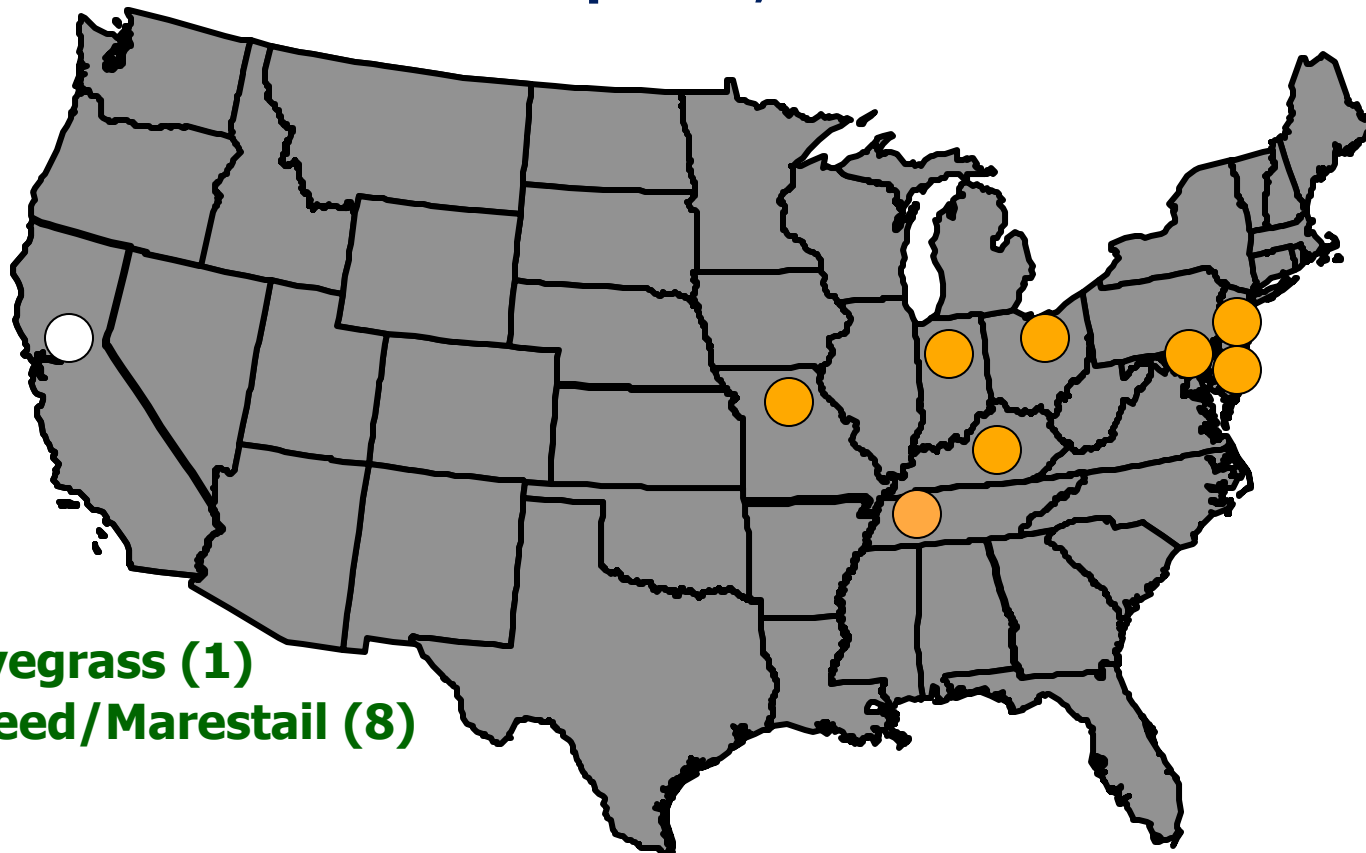
2001: 2 species; 4 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (3)

Glyphosate-resistant Weed Development in the U.S.

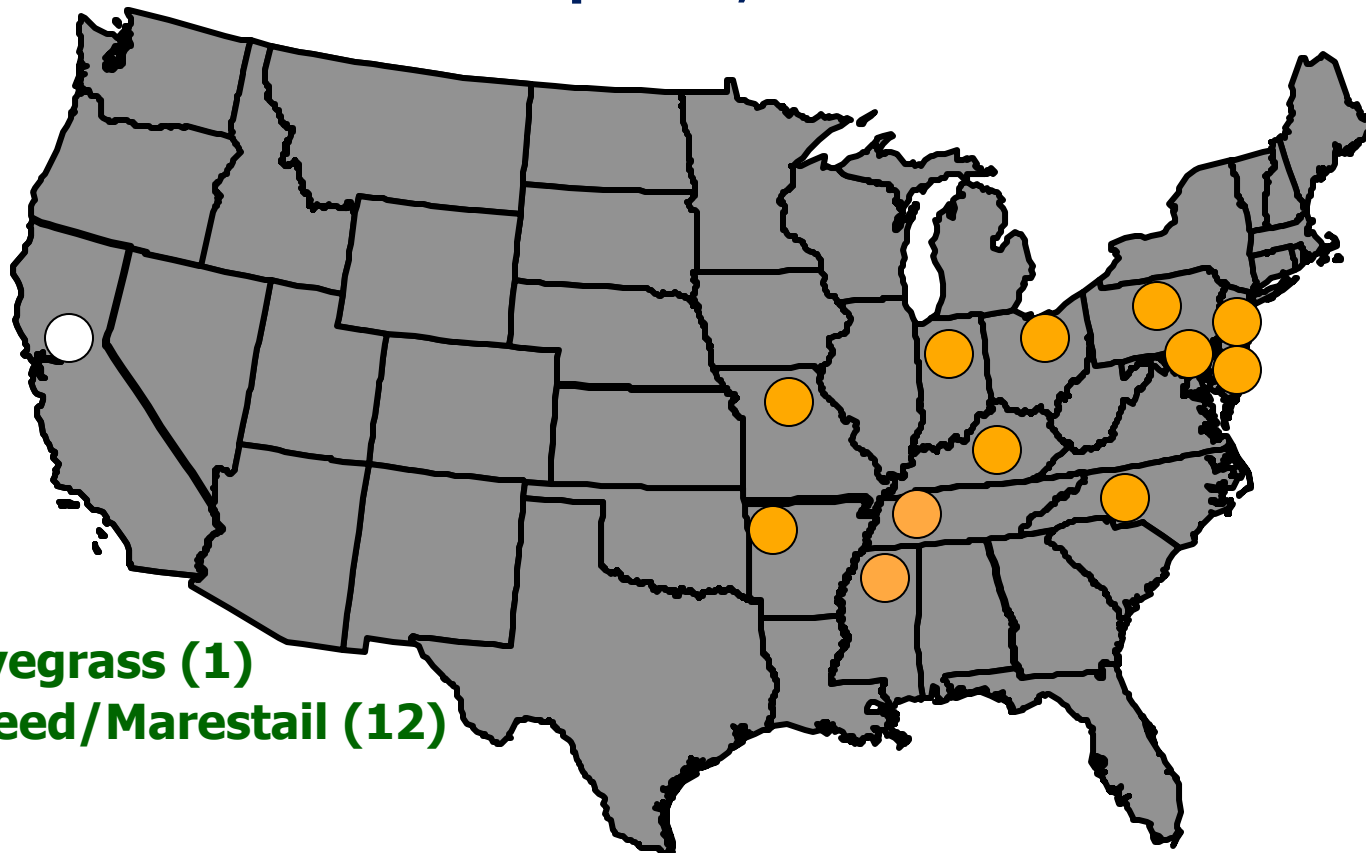
2002: 2 species; 9 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (8)

Glyphosate-resistant Weed Development in the U.S.

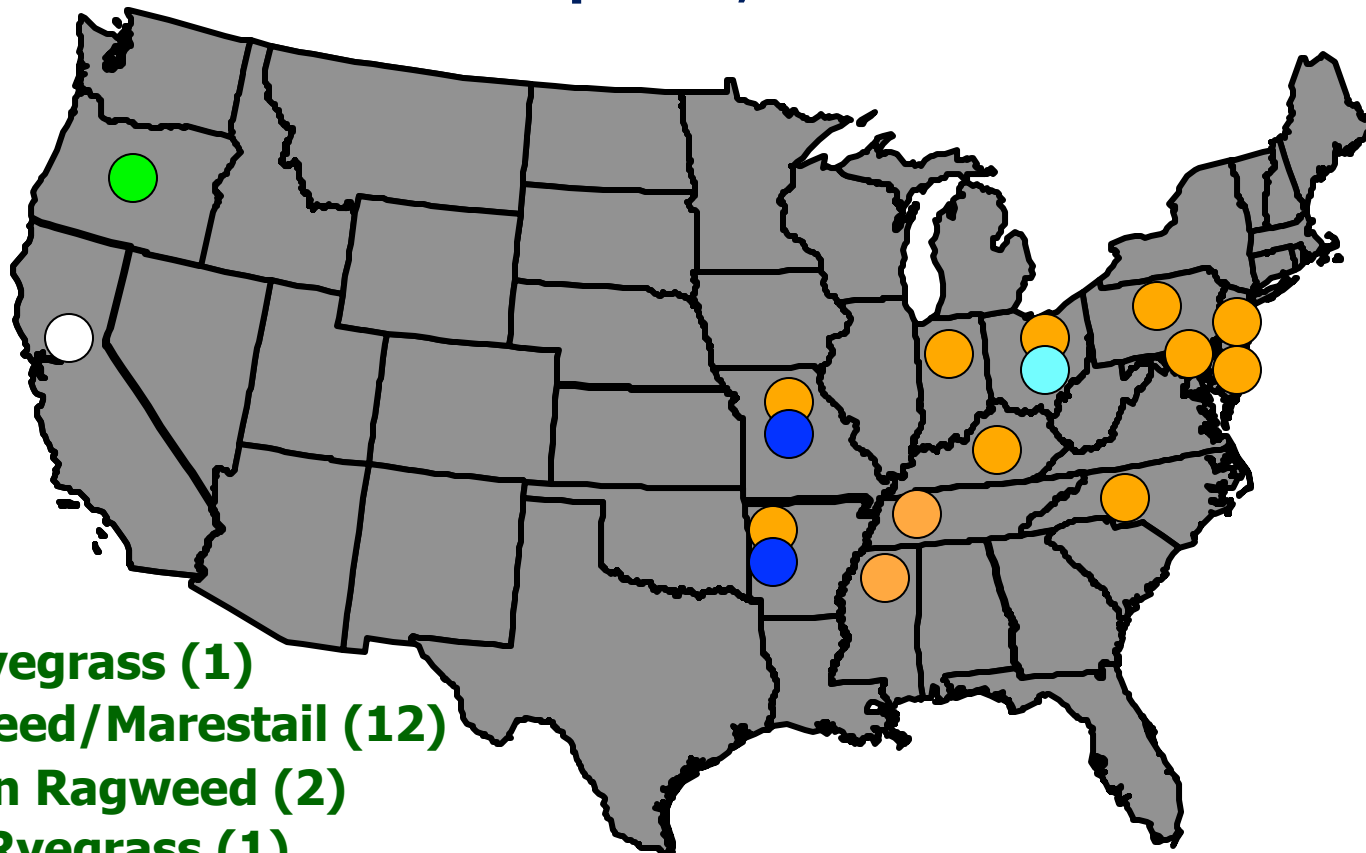
2003: 2 species; 13 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (12)

Glyphosate-resistant Weed Development in the U.S.

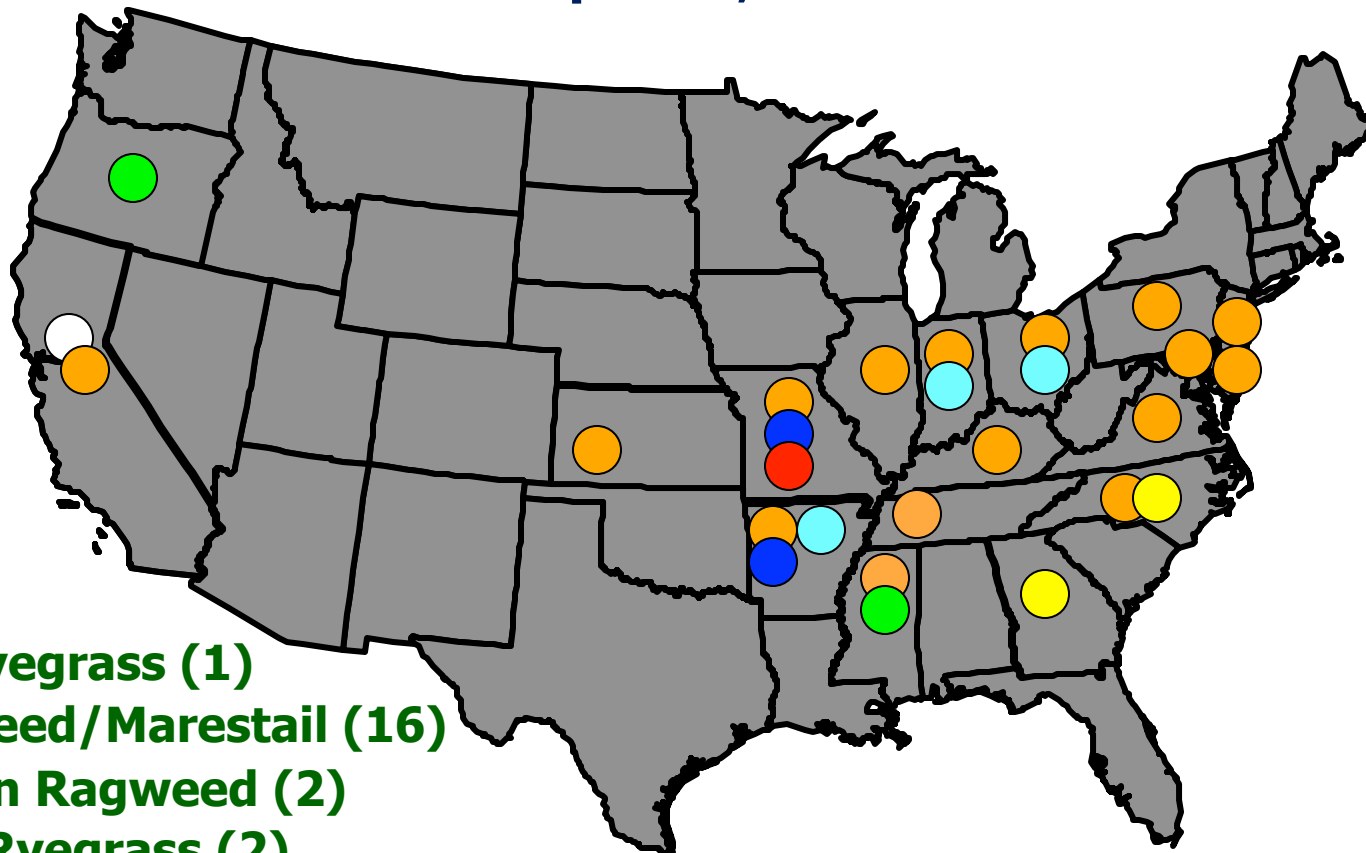
2004: 5 species; 14 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (12)
- Common Ragweed (2)
- Italian Ryegrass (1)
- Giant Ragweed (1)

Glyphosate-resistant Weed Development in the U.S.

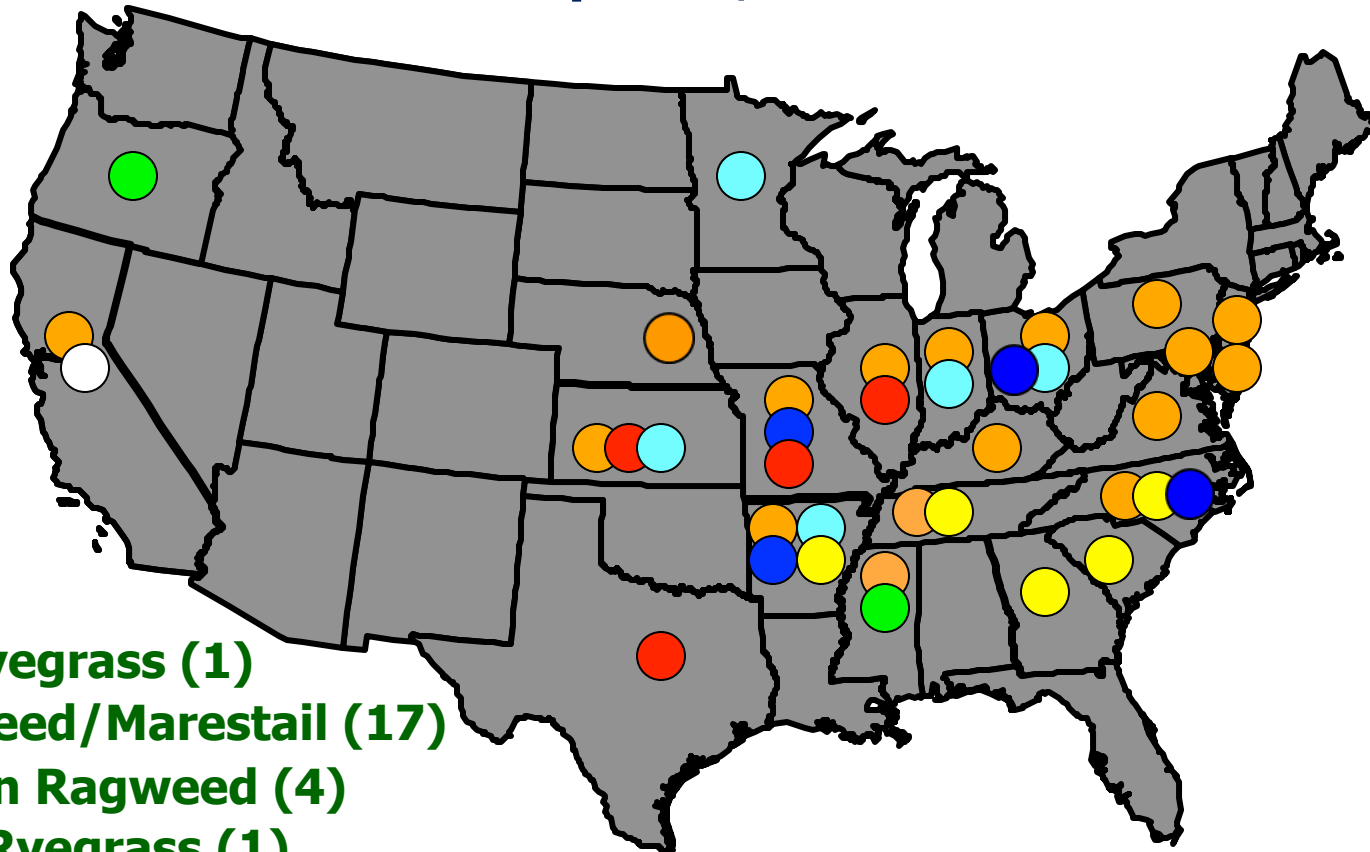
2005: 7 species; 18 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (16)
- Common Ragweed (2)
- Italian Ryegrass (2)
- Giant Ragweed (3)
- Waterhemp (1)
- Palmer Amaranth (2)

Glyphosate-resistant Weed Development in the U.S.

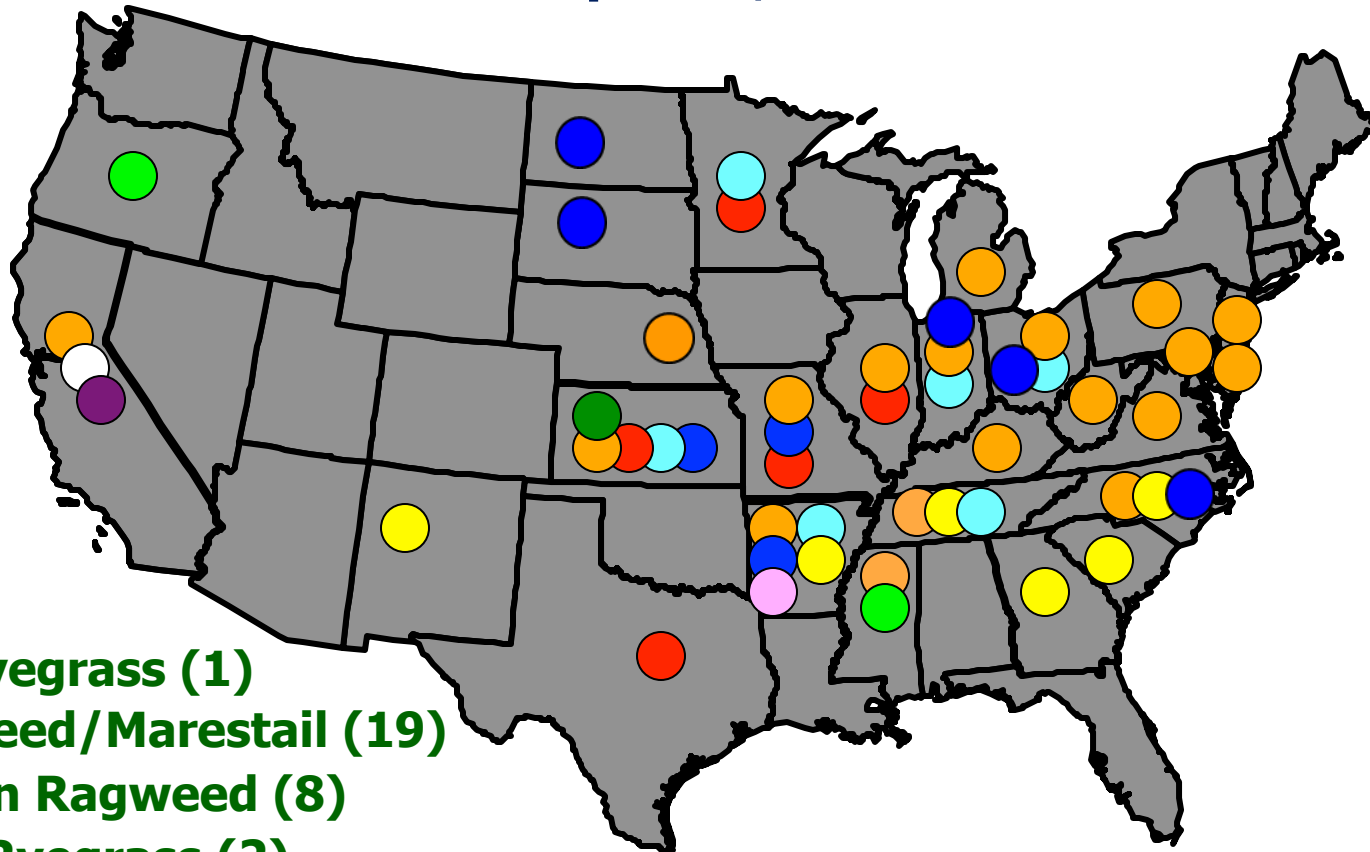
2006: 7 species; 22 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (17)
- Common Ragweed (4)
- Italian Ryegrass (1)
- Giant Ragweed (5)
- Waterhemp (4)
- Palmer Amaranth (5)

Glyphosate-resistant Weed Development in the U.S.

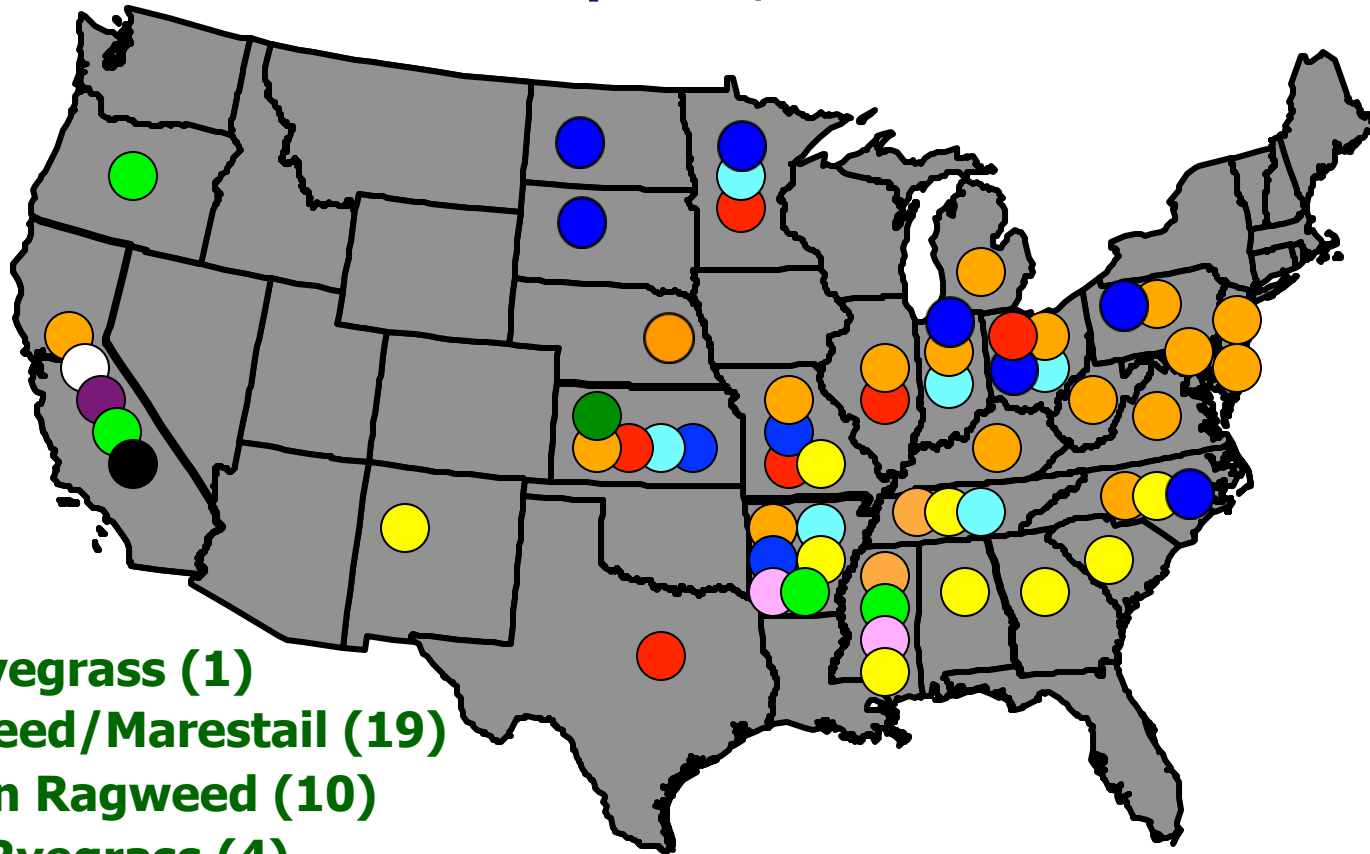
2007: 10 species; 28 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (19)
- Common Ragweed (8)
- Italian Ryegrass (2)
- Giant Ragweed (6)
- Kochia (1)
- Waterhemp (5)
- Palmer Amaranth (6)
- Hairy Fleabane (1)
- Johnsongrass (1)

Glyphosate-resistant Weed Development in the U.S.

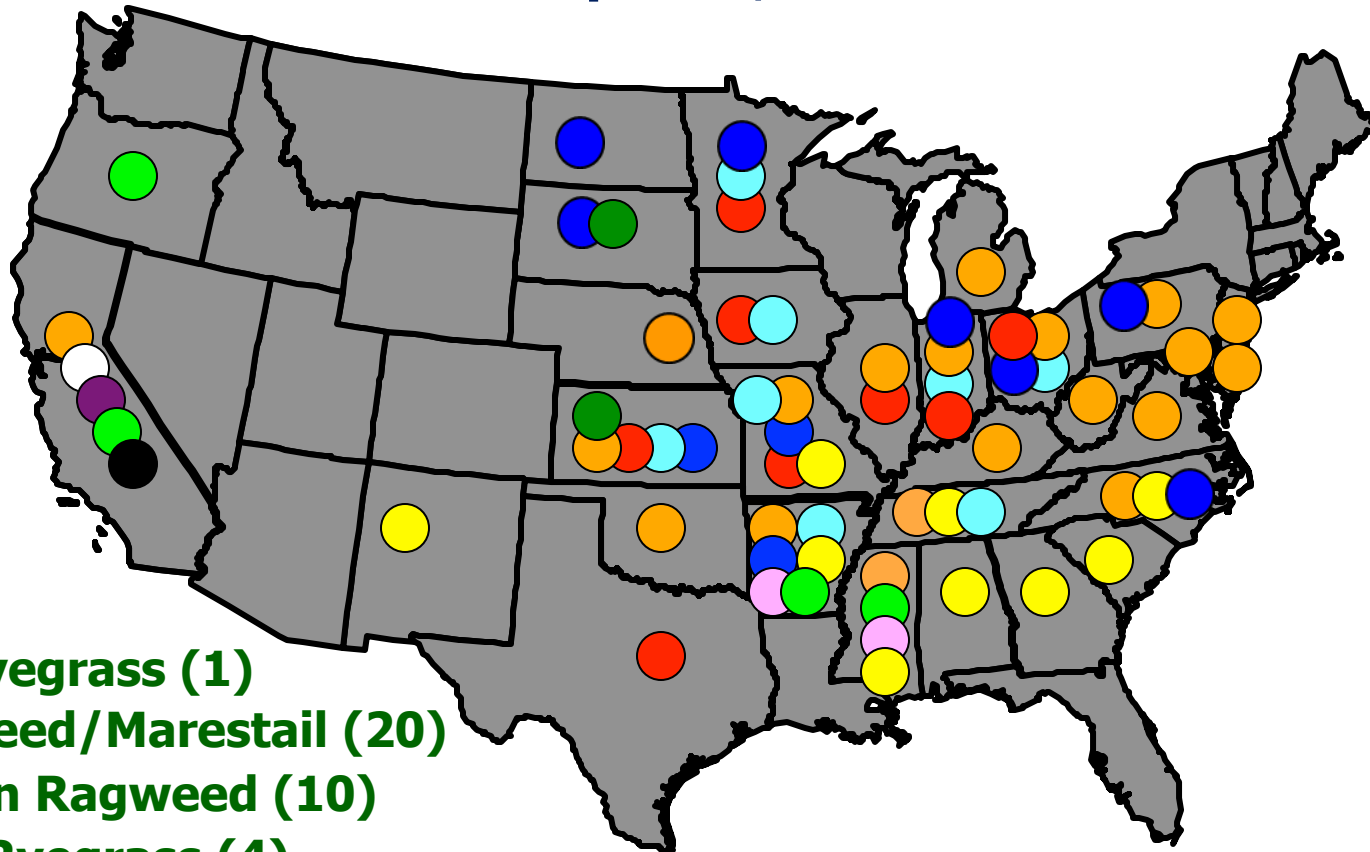
2008: 11 species; 28 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (19)
- Common Ragweed (10)
- Italian Ryegrass (4)
- Giant Ragweed (6)
- Waterhemp (6)
- Palmer Amaranth (9)
- Hairy Fleabane (1)
- Johnsongrass (2)
- Kochia (1)
- Junglerice (1)

Glyphosate-resistant Weed Development in the U.S.

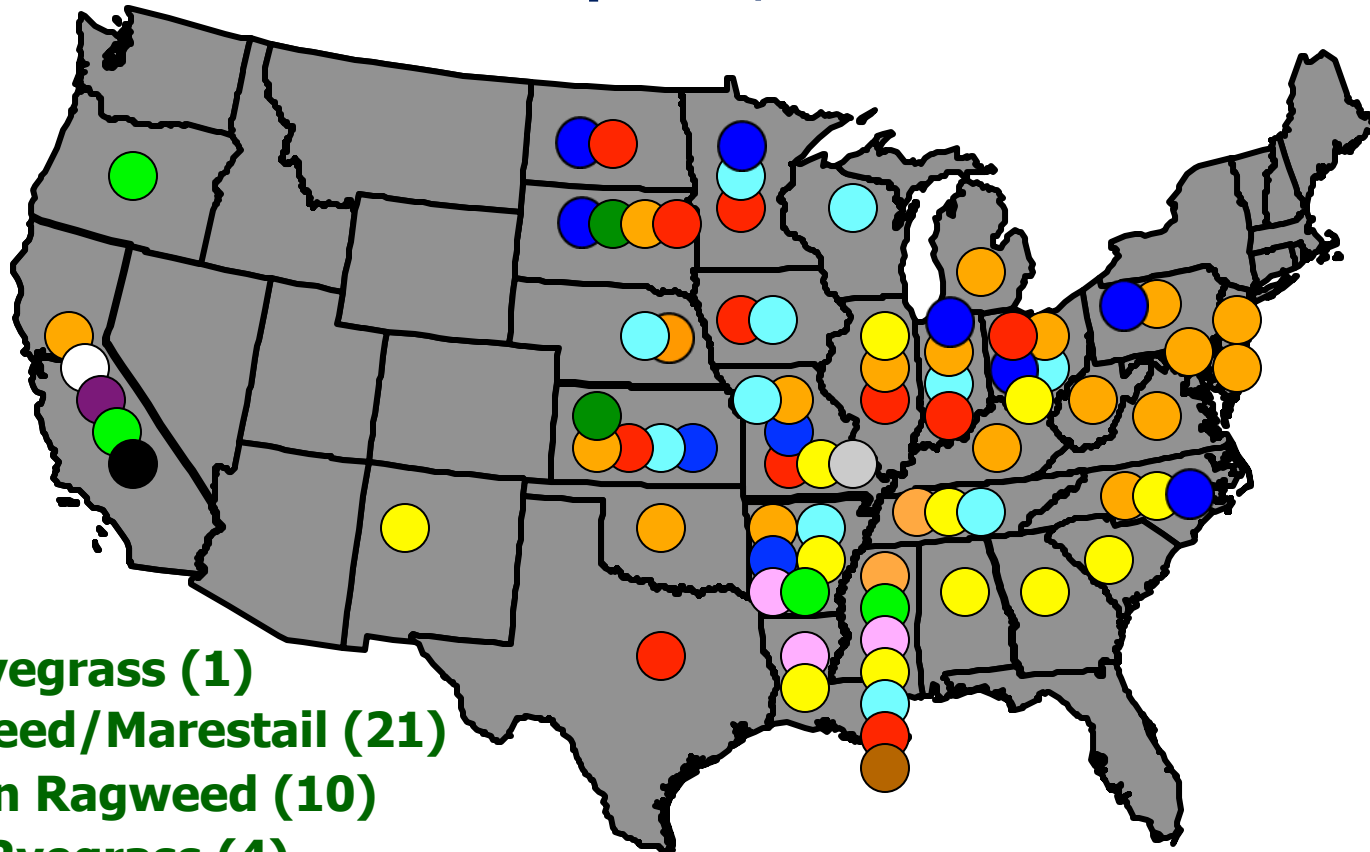
2009: 11 species; 30 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (20)
- Common Ragweed (10)
- Italian Ryegrass (4)
- Giant Ragweed (8)
- Waterhemp (8)
- Palmer Amaranth (9)
- Hairy Fleabane (1)
- Johnsongrass (2)
- Kochia (2)
- Junglerice (1)

Glyphosate-resistant Weed Development in the U.S.

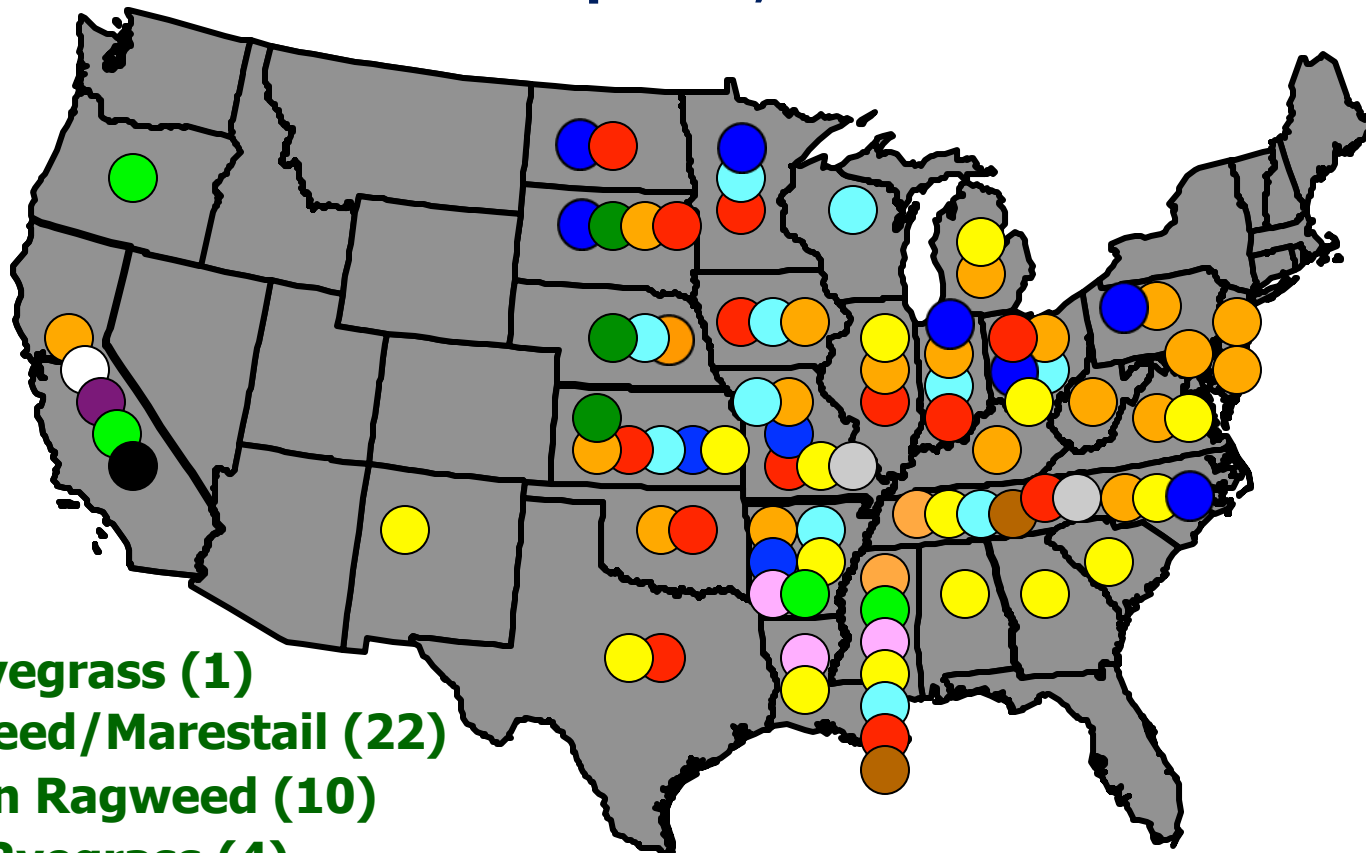
2010: 13 species; 32 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (21)
- Common Ragweed (10)
- Italian Ryegrass (4)
- Giant Ragweed (11)
- Waterhemp (11)
- Palmer Amaranth (12)
- Hairy Fleabane (1)
- Johnsongrass (3)
- Kochia (2)
- Junglerice (1)
- Annual Bluegrass (1)
- Goosegrass (1)

Glyphosate-resistant Weed Development in the U.S.

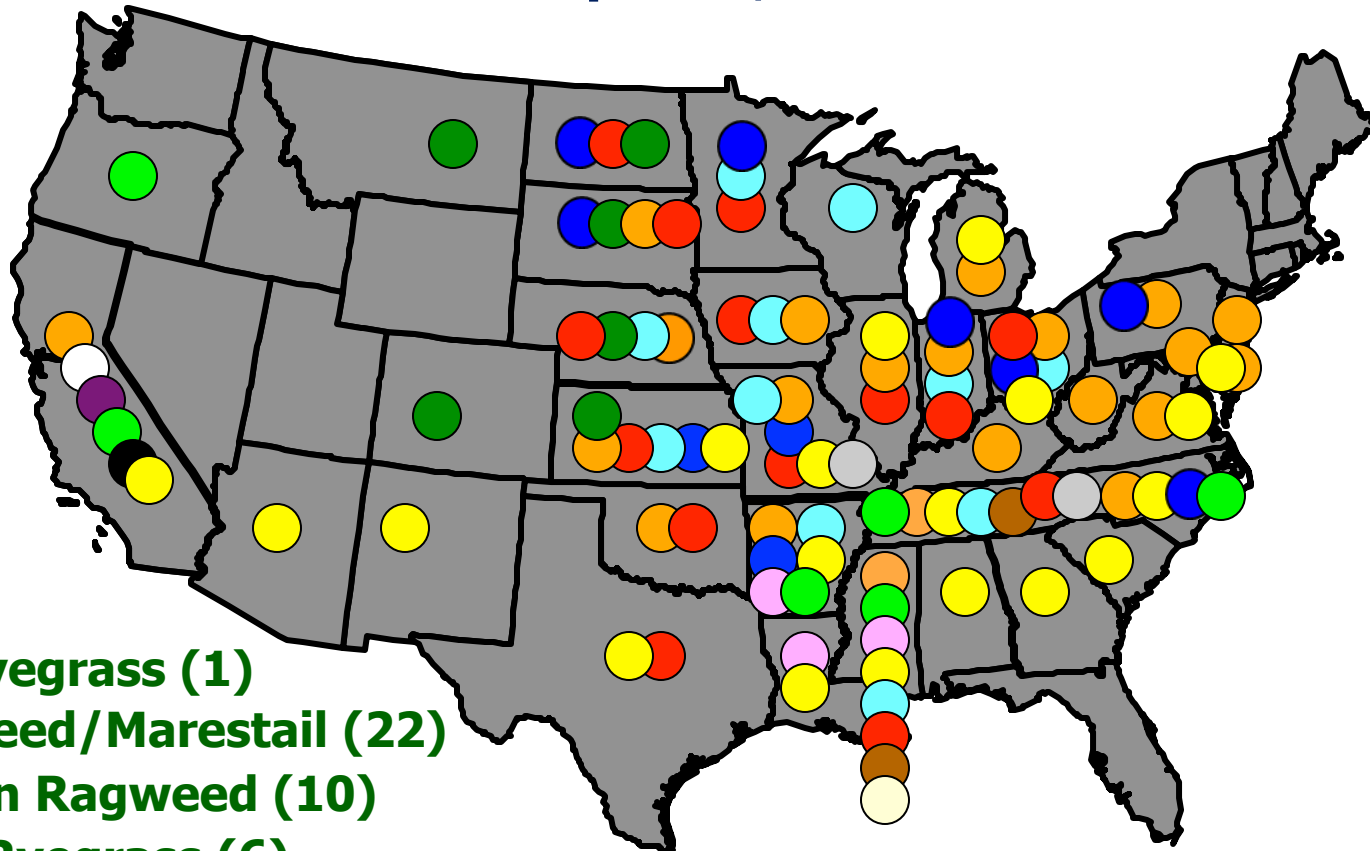
2011: 13 species; 32 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (22)
- Common Ragweed (10)
- Italian Ryegrass (4)
- Giant Ragweed (11)
- Waterhemp (13)
- Palmer Amaranth (16)
- Hairy Fleabane (1)
- Johnsongrass (3)
- Kochia (3)
- Junglerice (1)
- Annual Bluegrass (2)
- Goosegrass (2)

Glyphosate-resistant Weed Development in the U.S.

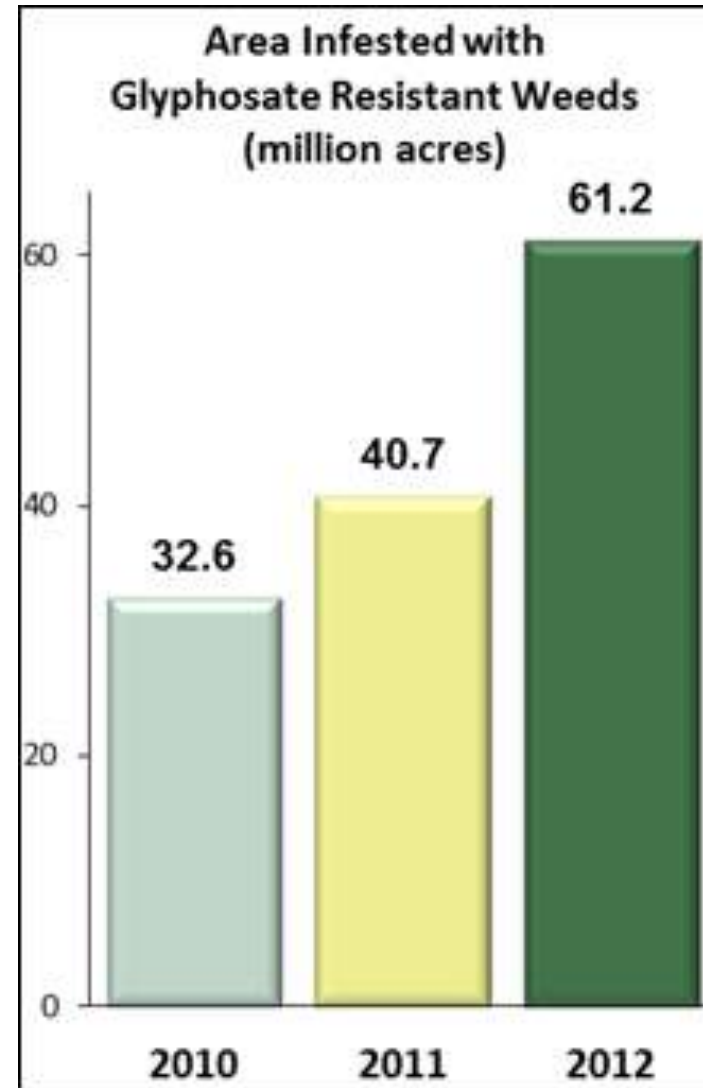
2012: 14 species; 35 states



- Rigid Ryegrass (1)
- Horseweed/Marestail (22)
- Common Ragweed (10)
- Italian Ryegrass (6)
- Giant Ragweed (11)
- Waterhemp (14)
- Palmer Amaranth (18)
- Hairy Fleabane (1)
- Johnsongrass (3)
- Kochia (6)
- Junglerice (1)
- Annual Bluegrass (2)
- Goosegrass (2)
- Spiny Amaranth (1)

And the problem does not appear to be getting better...

- 49% of all U.S. farmers said they have gly-R weeds on their farm in 2012, up from 34% of farmers in 2011
- The acres with gly-R weeds almost doubled in NE, IA, and IN from 2011 to 2012
- 27% of farmers reported having at least 2 gly-R species on their farm



Multiple herbicide resistance is now becoming the bigger issue...

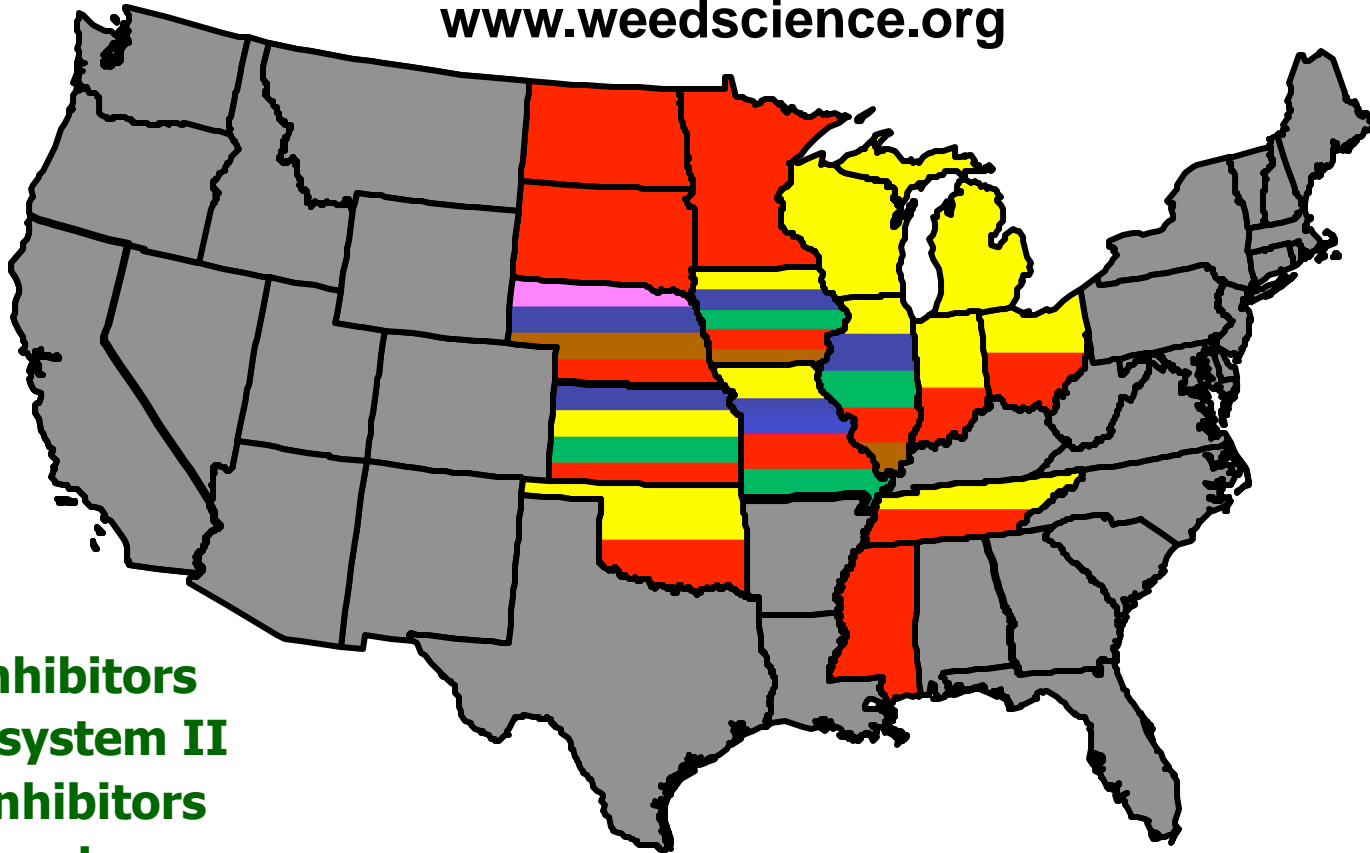
Soybean field south of Moberly, MO treated with 3 applications of glyphosate and 3 applications of a PPO herbicide.





Herbicide Resistance in Waterhemp 2013

www.weedscience.org



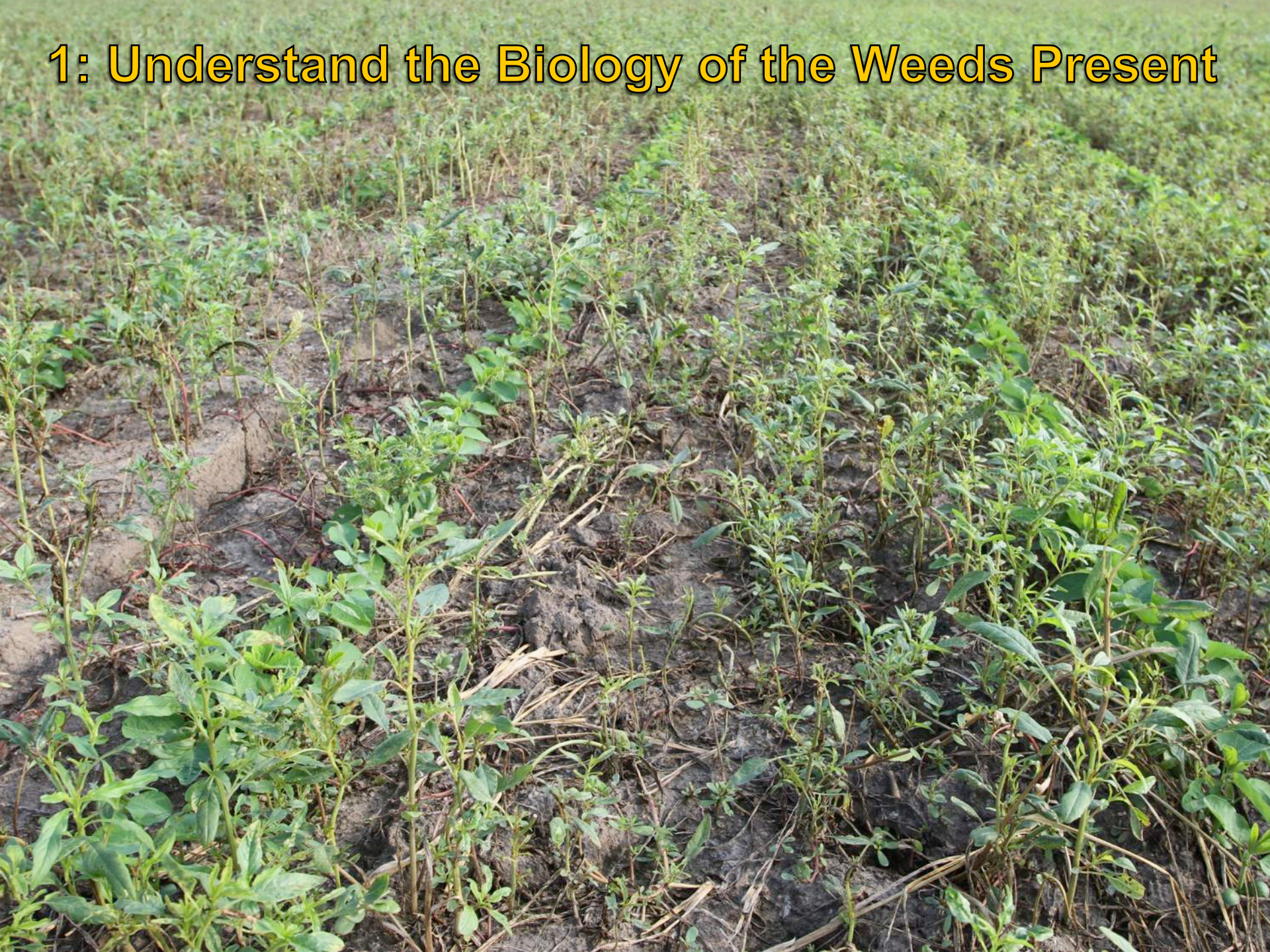
- **ALS-inhibitors**
- **Photosystem II**
- **PPO-inhibitors**
- **Glyphosate**
- **HPPD-inhibitors**
- **Auxins**

We must get out of this rut...



7 Best Management Practices for Herbicide-resistant Weeds

1: Understand the Biology of the Weeds Present



Pigweed Weaknesses?

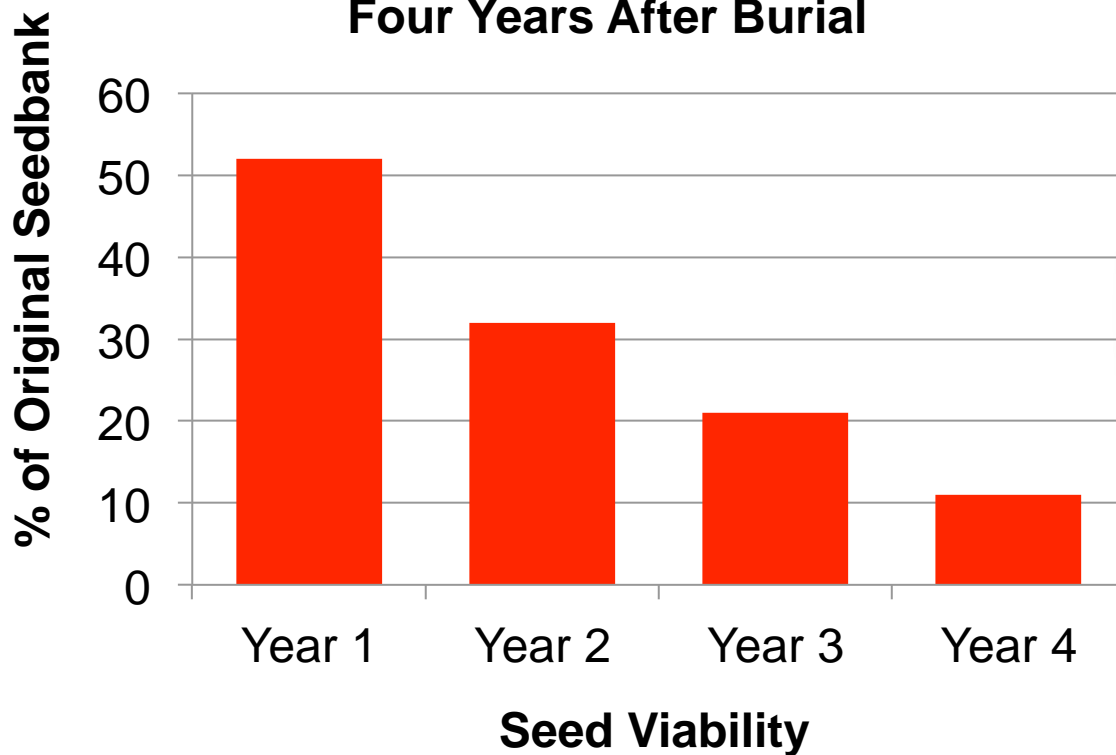


1. Seed are relatively short-lived in the soil (4-5 yrs).

Waterhemp:

#1: Understand the Biology of the Weeds Present

Percentage of the Original Waterhemp Seedbank that Remained Viable for Four Years After Burial

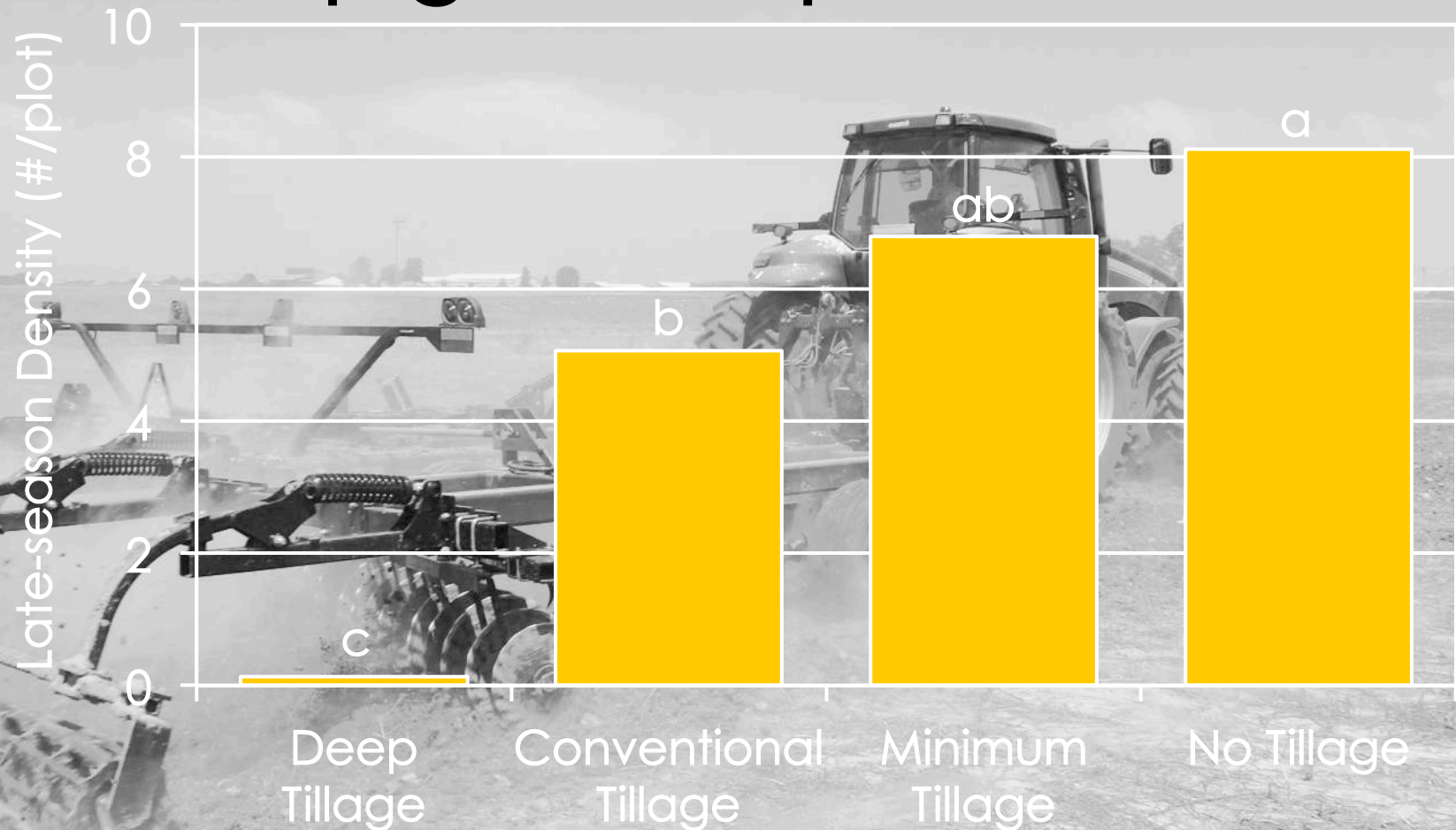


Pigweed Weaknesses?



1. Seed are relatively short-lived in the soil (4-5 yrs).
2. Seed do not emerge from lower soil depths.

What effect does tillage have on the pigweed species?



*Results summarized across herbicide programs, row spacings, and planting populations.

**Means followed by the same letter are not different, $P \leq 0.05$

Giant Ragweed:

#1: Understand the Biology of the Weeds Present



It emerges early and all at once. Take advantage of that weakness!

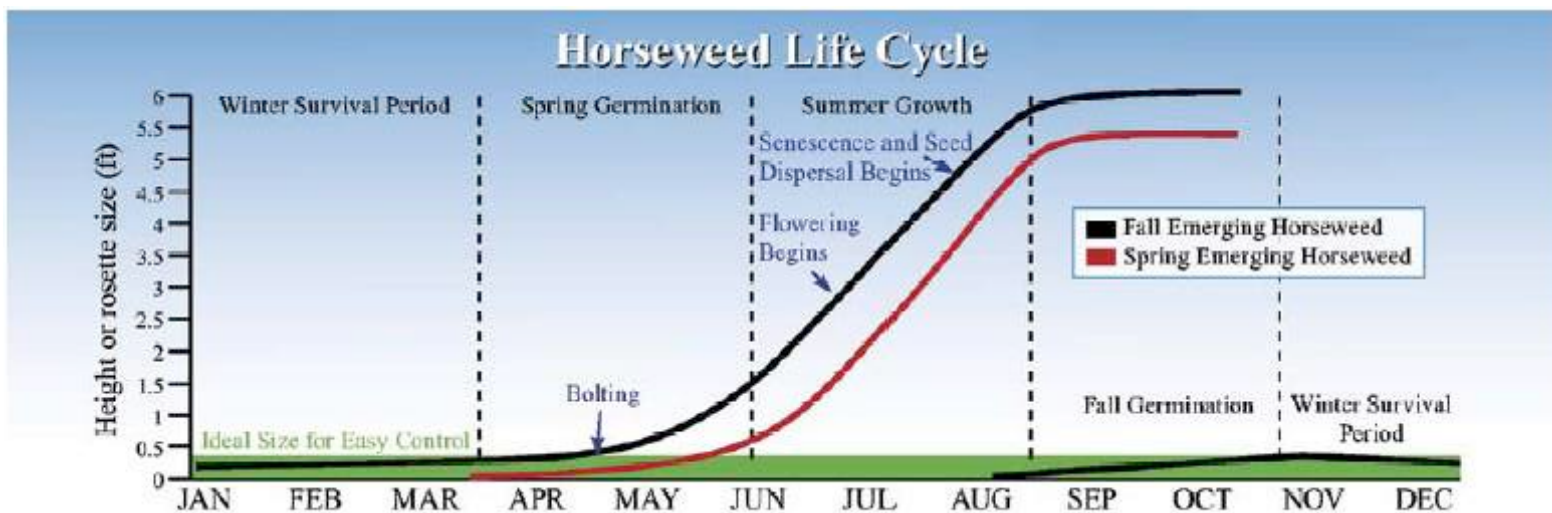
Preplant Management of Glyphosate-Resistant Giant Ragweed in Roundup Ready Soybeans (2011-2012)

<u>Pre-plant Herbicide Treatment</u>	<u>Rate</u>	<u>Gly-R Gt Ragweed Control 6 Weeks After Preplant Application</u>
	-----product/A-----	-----% -----
Roundup PowerMax	22 fl ozs	34
Roundup PowerMax + 2,4-D Ester	22 fl ozs + 1 pt	97
Roundup PowerMax + Sharpen	22 fl ozs + 1 fl oz	89
Roundup PowerMax + Firstrate	22 fl ozs + 0.3 oz	69
Roundup PowerMax + Valor XLT	22 fl ozs + 3 ozs	60
Roundup PowerMax + Authority 1 st	22 fl ozs + 3.2 ozs	73
Roundup PowerMax + Clarity	22 fl ozs + 8 fl ozs	97
Roundup PowerMax + Clarity	22 fl ozs + 16 fl ozs	97
Ignite + Clarity	22 fl ozs + 8 fl ozs	97
Ignite + Clarity	22 fl ozs + 16 fl ozs	97
Gramoxone Inteon + Clarity	3 pts + 8 fl ozs	91
Gramoxone Inteon + Clarity	3 pts + 16 fl ozs	96
	LSD (0.05):	7

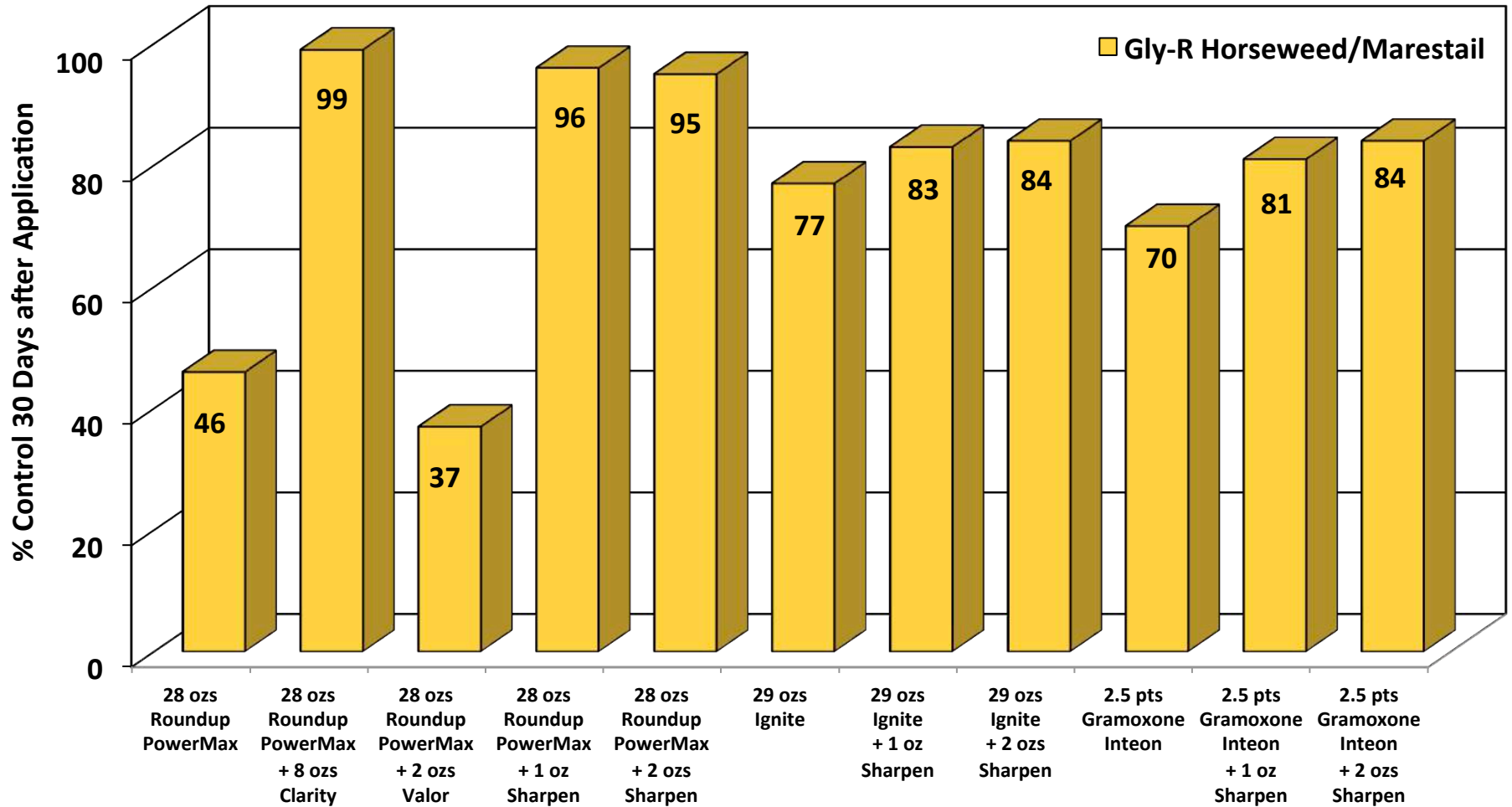
^aAll treatments received a POST (4") application of 22 fl ozs Roundup Pmax + 1.3 pts Flexstar

Horseweed / Mareetail:

#1: Understand the Biology of the Weeds Present



Influence of Pre-plant Herbicide Treatments on Glyphosate-resistant Horseweed Control Across 3 Sites in Tennessee



At this point we have lost...



Examples of Knowing the Enemy and Exploiting it's Weakness:



Source: Dr. Stephen Powles. Professor, University of Western Australia

2. Plant into Weed-free Fields and Keep Fields as Weed-free as Possible



#3: Use a Diversified Approach to Weed Management Focused on Reducing the Soil Seedbank



**All of my recommendations are
focused on keeping this seed...**



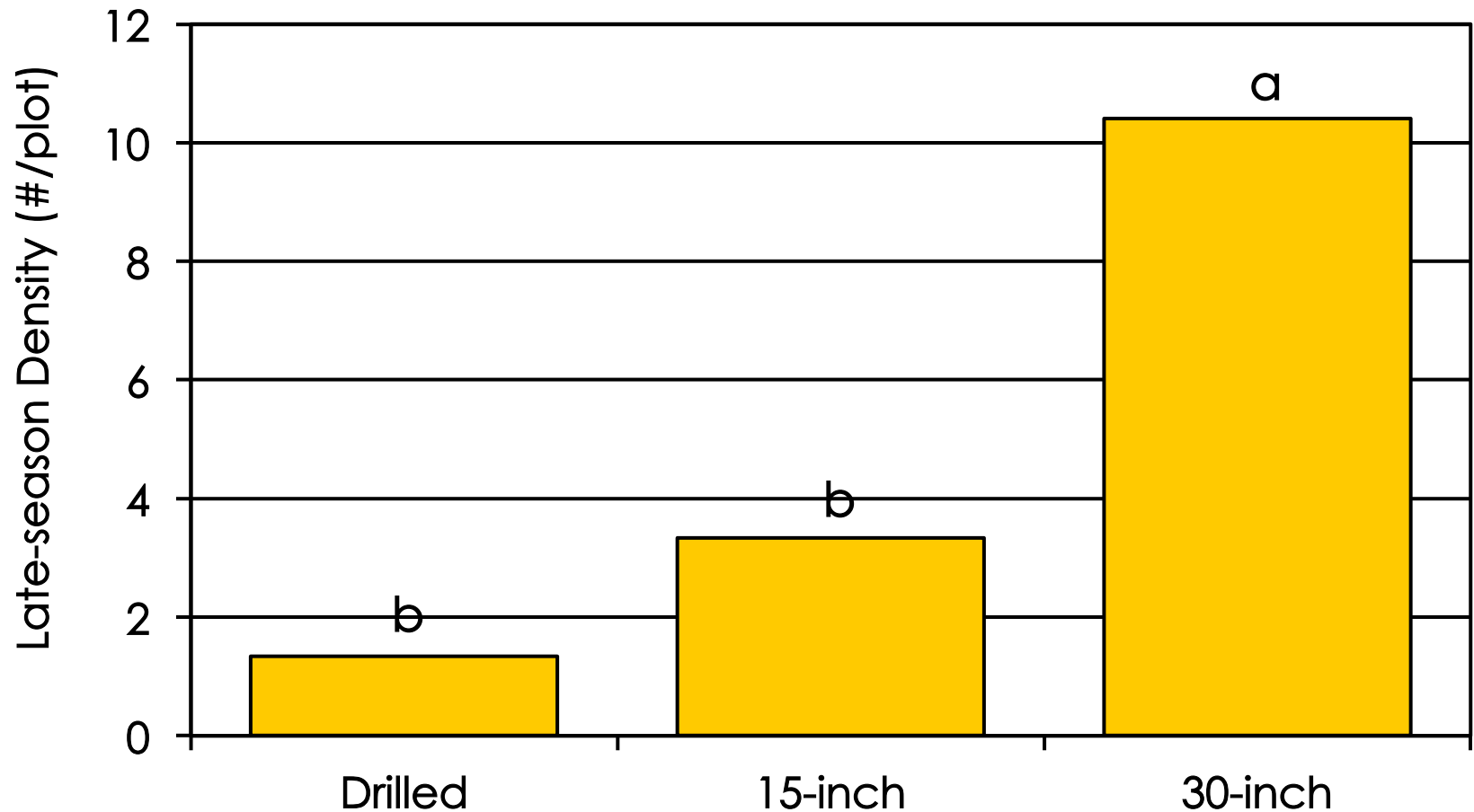


...from being deposited here

#4: Integrate Cultural Management Techniques With Herbicides Wherever and Whenever Possible



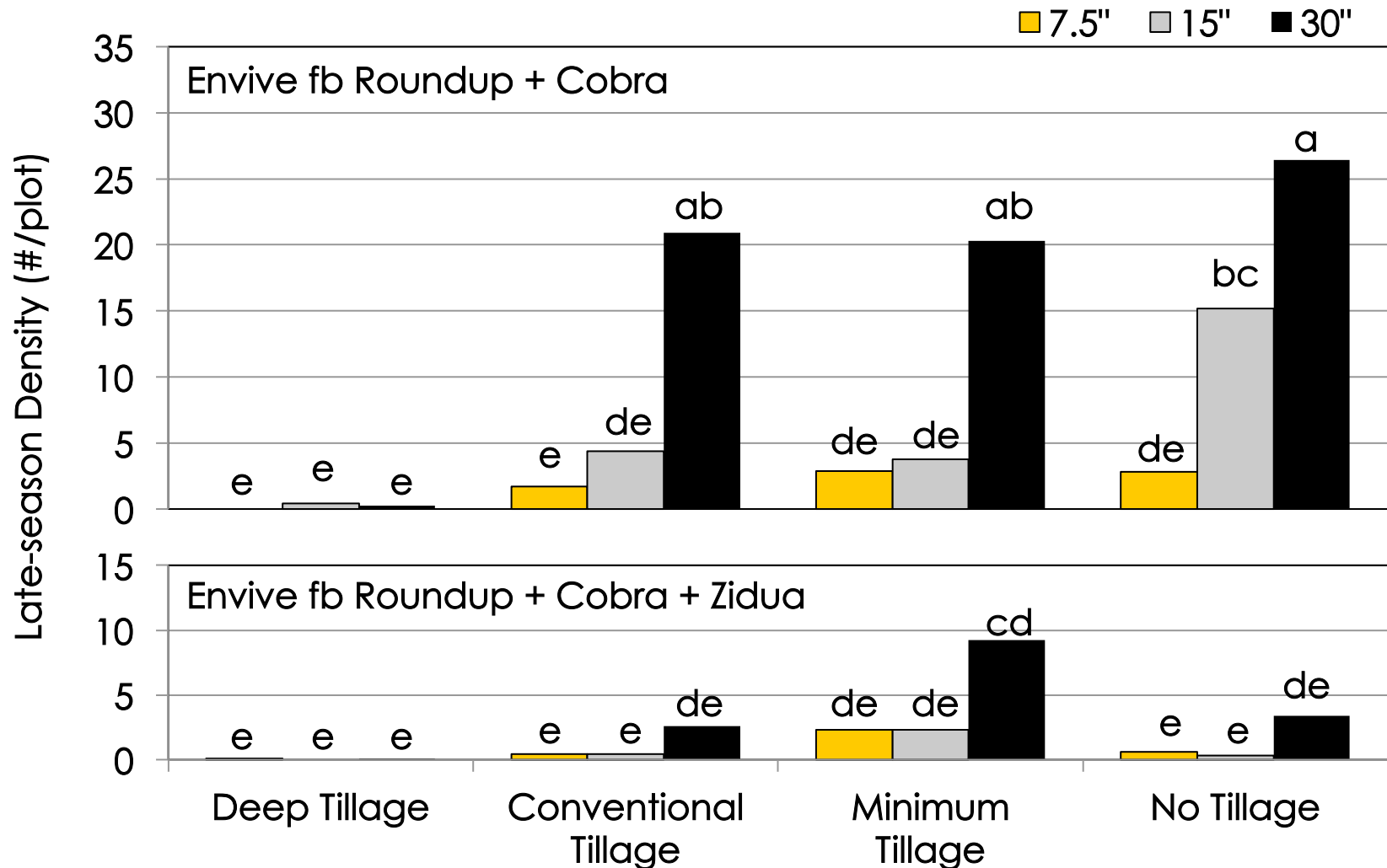
What effect does soybean row spacing have on pigweed control?



*Results summarized across herbicide programs, tillage types, and planting populations.

**Means followed by the same letter are not different, $P \leq 0.05$

Influence of Herbicide Program, Soybean Row Spacing, and Tillage Type on Late-season Palmer Amaranth Density



*Means followed by the same letter are not different, $P \leq 0.05$

Cover crops for weed management...



Influence of Cover Crops on Pigweed Emergence in Georgia

<u>Legume Cover Crop</u>	<u>Early June</u>		<u>Late July</u>	
	- Cereal Rye	+ Cereal Rye	- Cereal Rye	+ Cereal Rye
	---Palmer Pigweed Density (#/m ²)---			
Austrian Winter Pea	4	1	23	15
Vetch	3	0	25	12
Crimson Clover	18	3	25	16
None	46	8	22	14
LSD _{0.05}	----- 18 -----		----- 9 -----	

**#5: Use Multiple
Effective Mechanisms
of Action Against the
Most Troublesome or
Herbicide-resistant
Prone Weeds**



HETEMEEL.COM

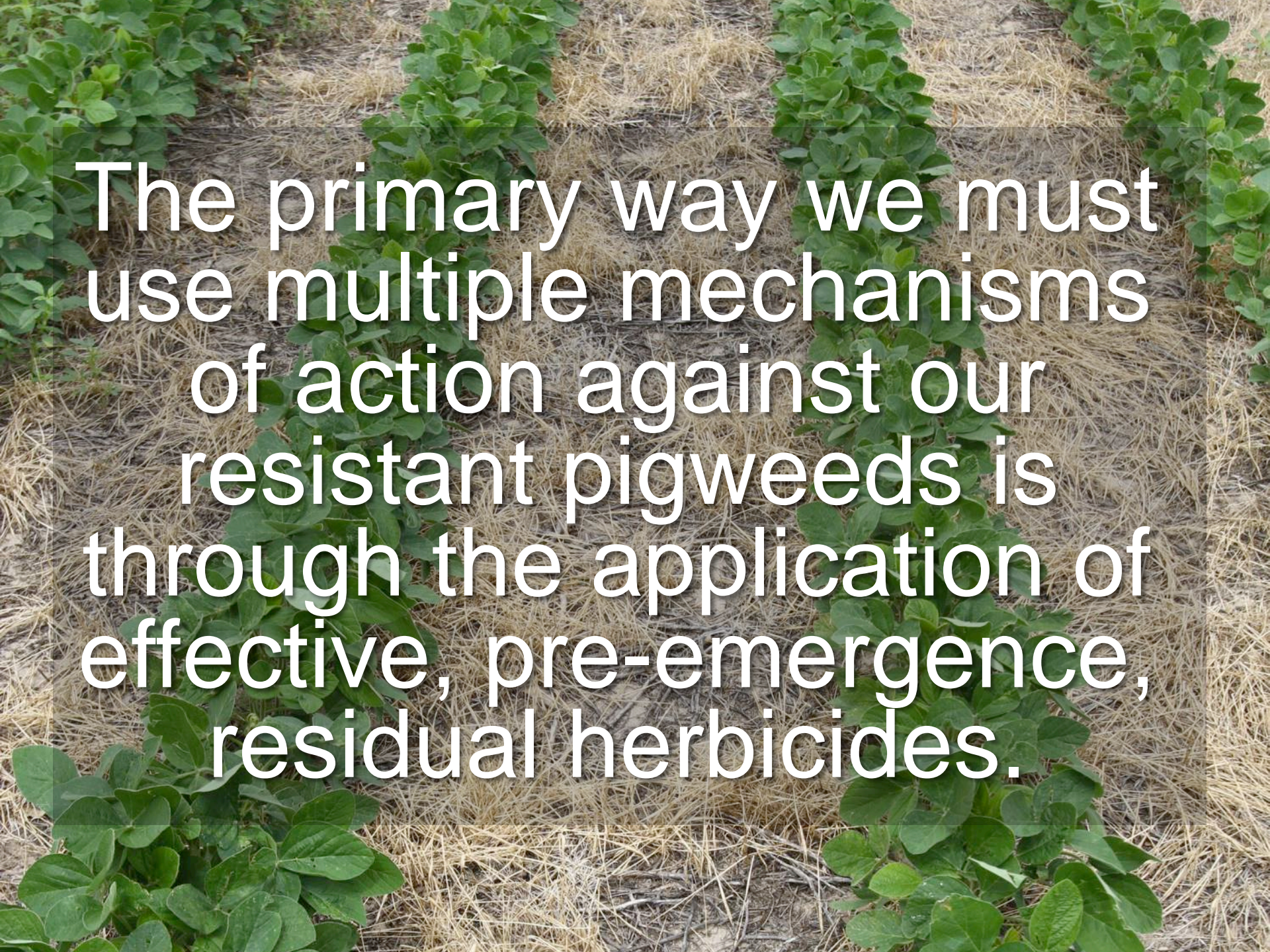


I WANT YOU

**TO LEARN HERBICIDE
CLASSIFICATION!**

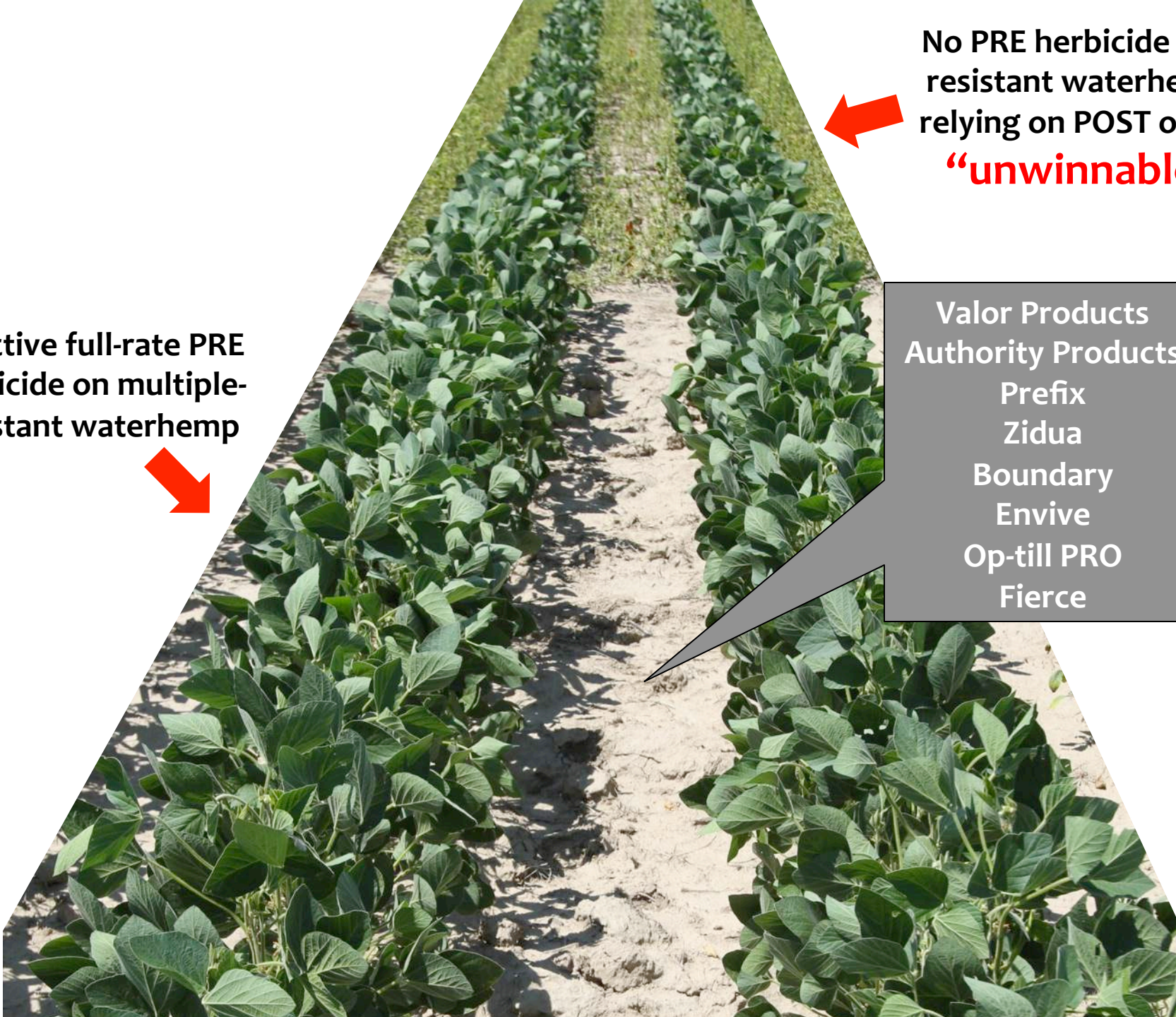


Your success with weed management in 2014 and beyond may depend on **YOUR** ability to understand herbicide classification.



The primary way we must use multiple mechanisms of action against our resistant pigweeds is through the application of effective, pre-emergence, residual herbicides.

effective full-rate PRE
herbicide on multiple-
resistant waterhemp



No PRE herbicide with
resistant waterhemp;
relying on POST only =
“unwinnable”

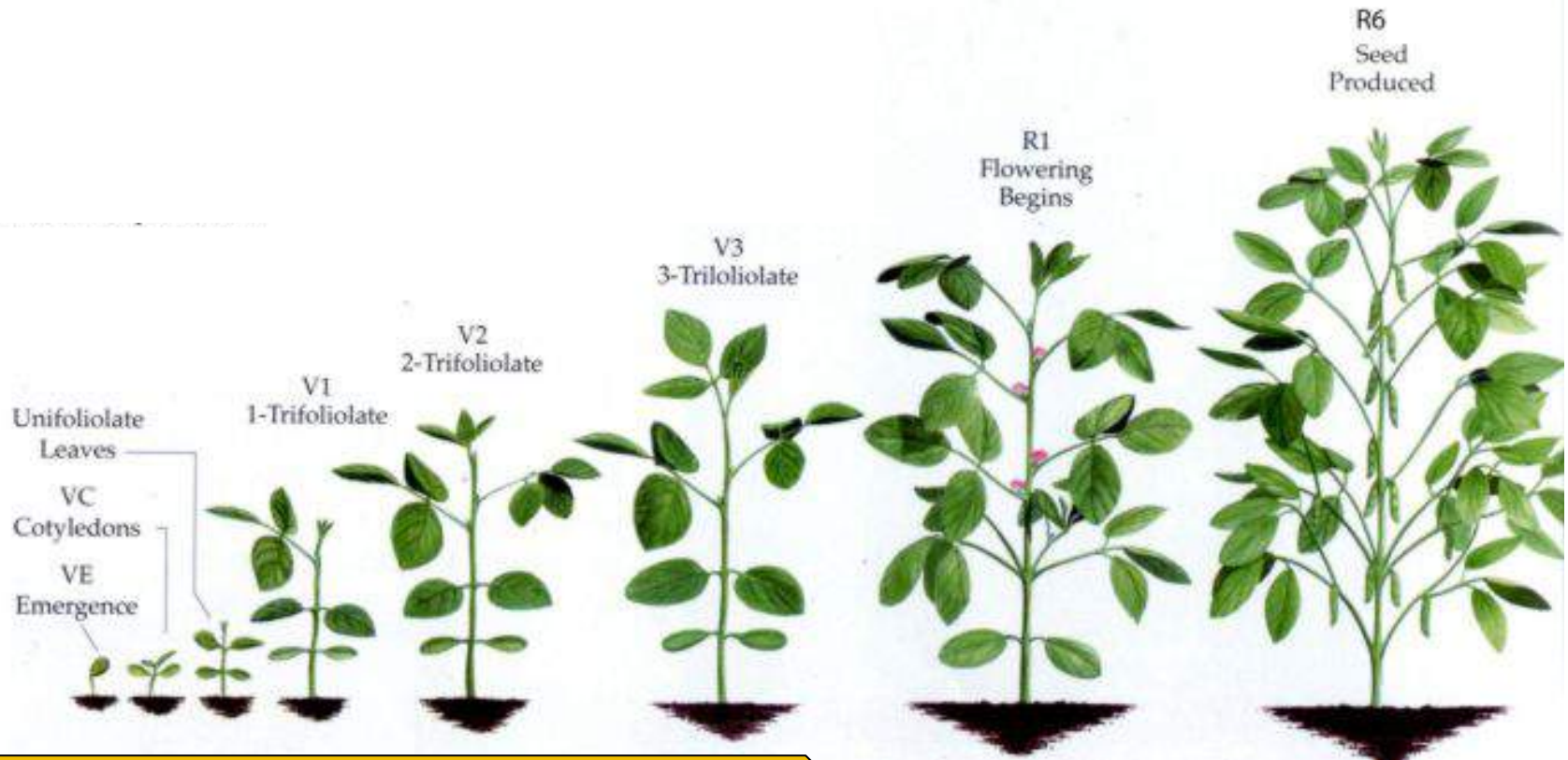


- Valor Products
- Authority Products
- Prefix
- Zidua
- Boundary
- Envive
- Op-till PRO
- Fierce

Additional Thoughts on Pigweed Management:

1. **Use full use rates** and/or combinations of pre-emergence residual herbicides as close to planting as possible.
2. **Overlapping residual** (Anthem, Cinch, Dual II Magnum, Outlook, Prefix, Warrant, Zidua) herbicide programs aren't for all weed species, but they do match the biology of waterhemp and palmer amaranth.
3. Liberty (glufosinate) and the LibertyLink soybean system is still a mechanism of action that works. Only **following a residual herbicide program** and w/ **timely applications**.

“Overlapping residuals” is a program that fits the pattern of pigweed emergence.



Residual, Pre-emergence Herbicide

Contact + Residual Herbicide

**Liberty provides a mechanism of action
that still works, but if we abuse it we will
break it.**

Only with a pre-emergence herbicide
Only with timely POST applications of Liberty



6. Apply the labeled herbicide rate at recommended weed sizes.

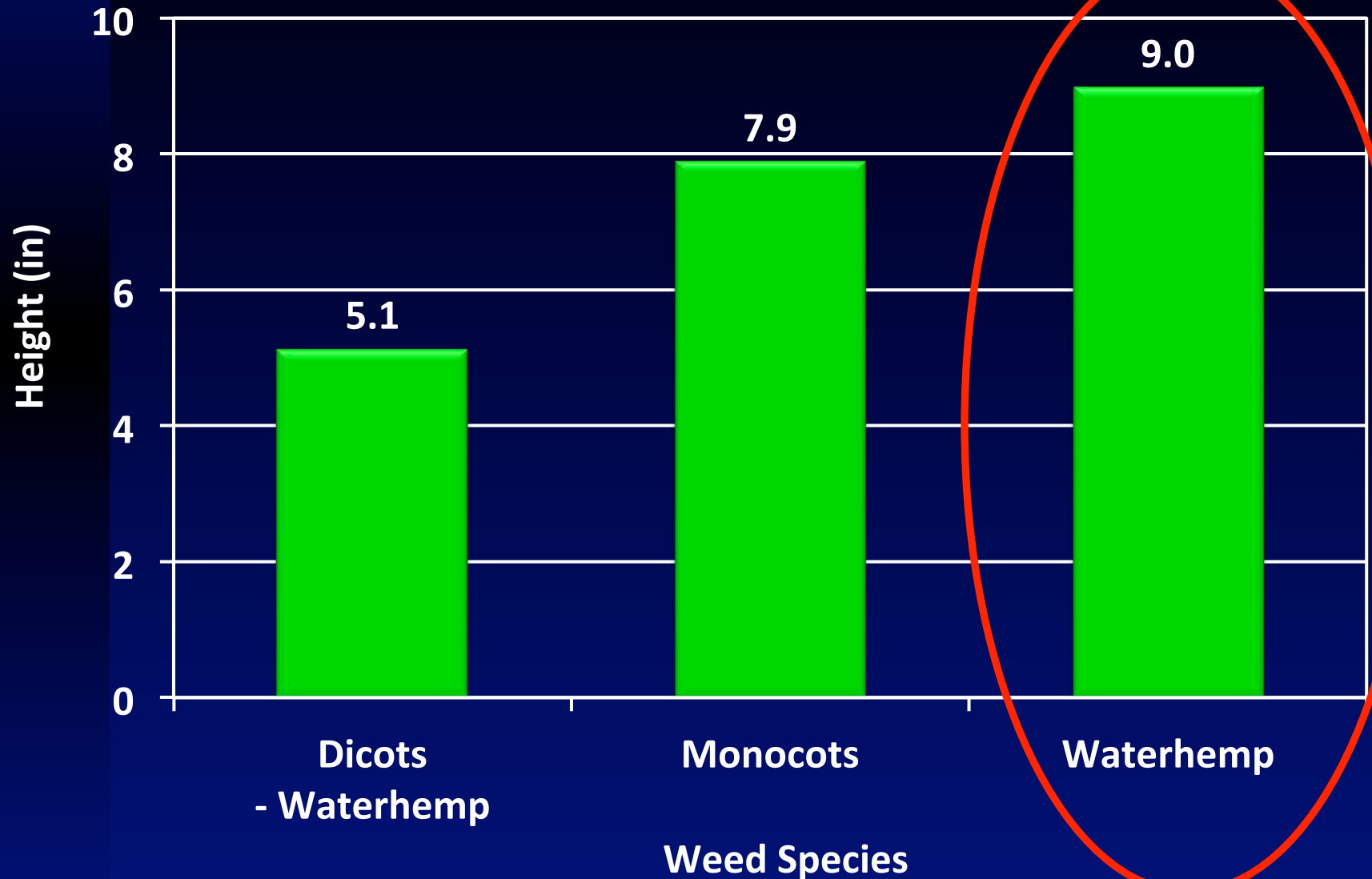


These weeds don't lie...



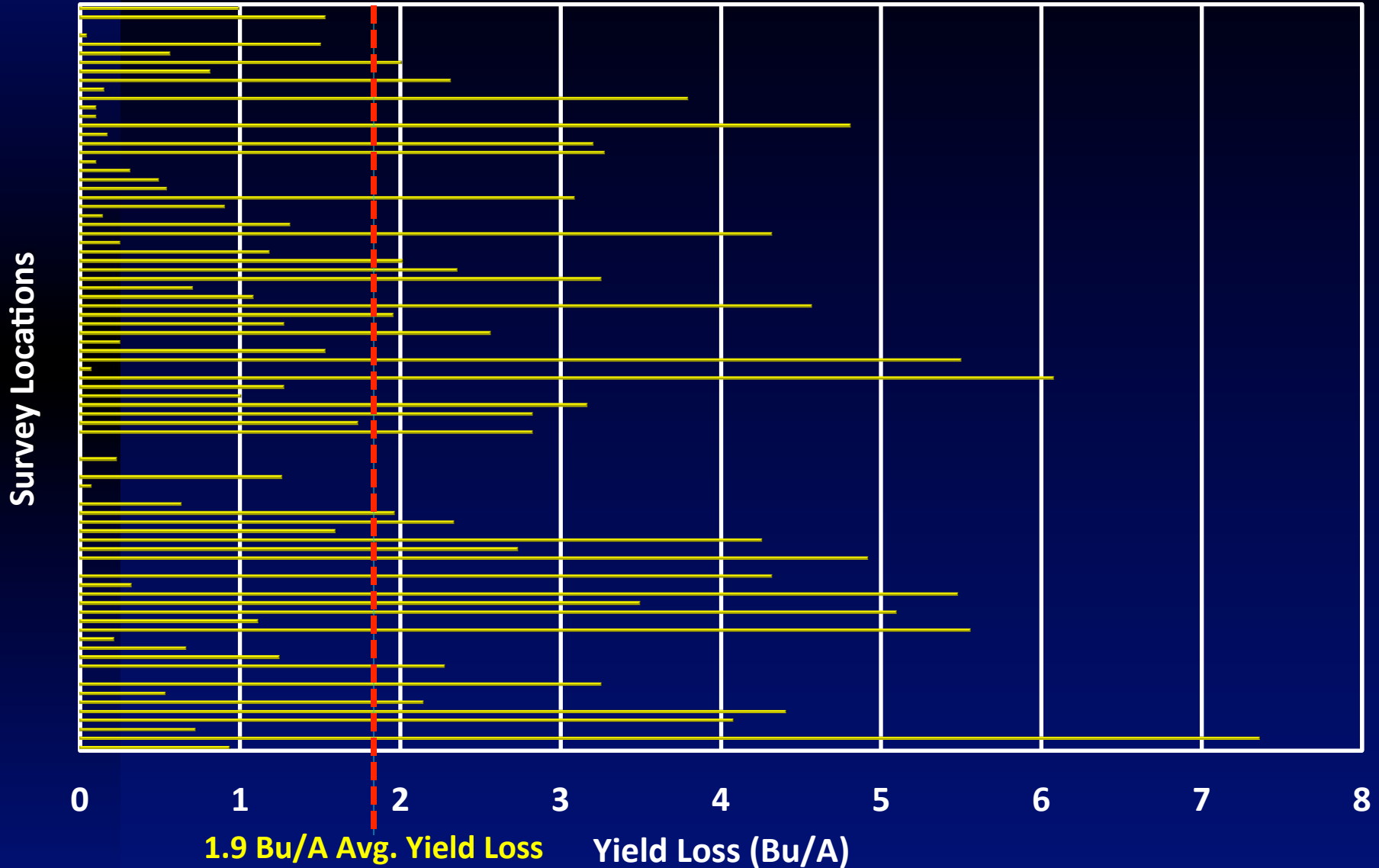
2011-12 Missouri Soybean Weed Survey

Average Weed Height at the Time of the POST Treatment (n=85)



2011-12 Missouri Soybean Weed Survey

Estimated Soybean Yield Loss by 1st POST Herbicide Application (n=85)



7. Prevent Weed Seed Production



Hand Weeding

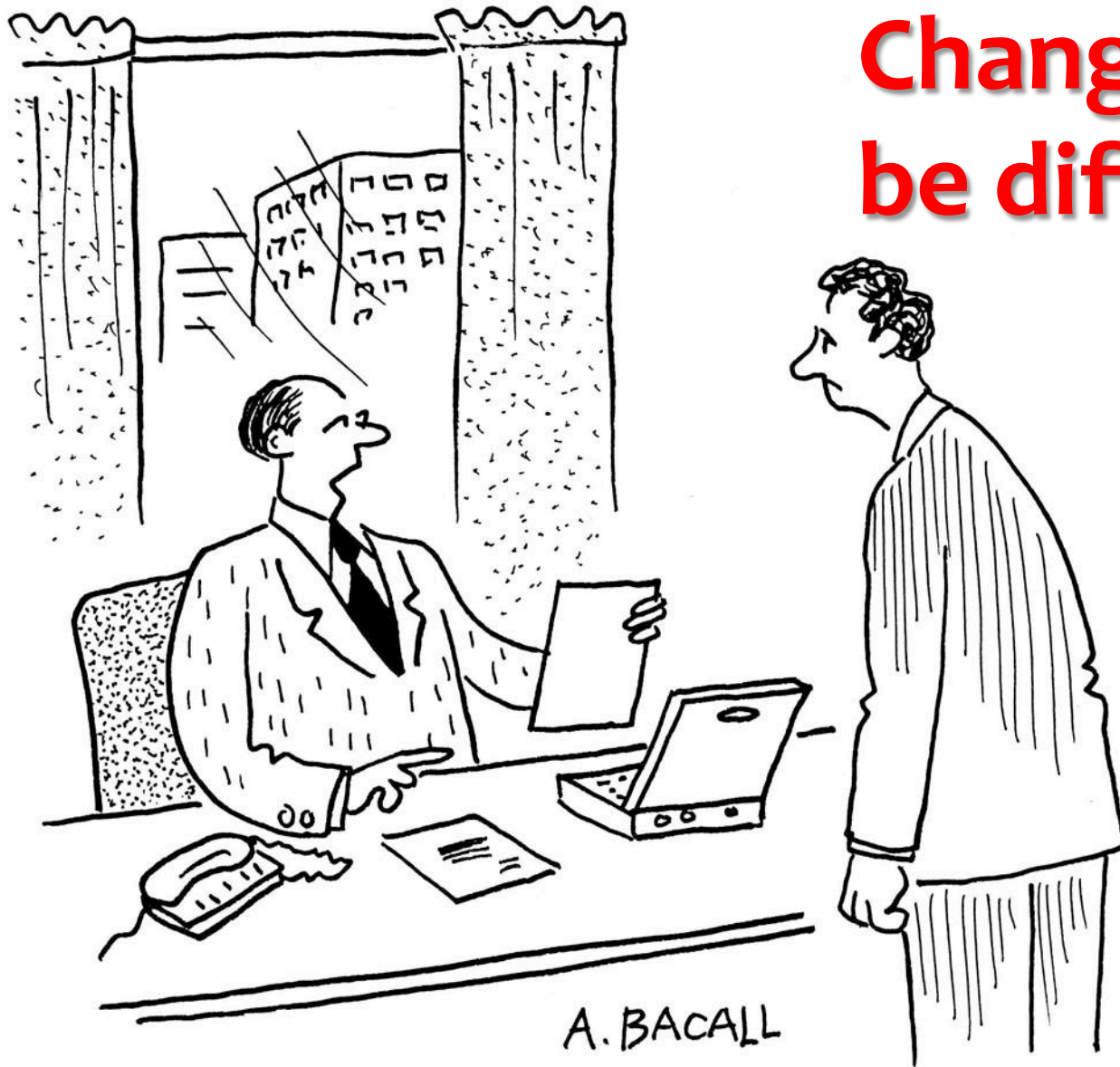




PERSISTENCE

I'm not sure we're persistent enough when it comes to weed seedbank management!

**Change can
be difficult...**



“Your proposal is innovative. Unfortunately, we won’t be able to use it because we’ve never tried something like this before.”

Questions?





WEED SCIENCE

Division of Plant Sciences — CAFNR

 Search

- Home
- Weed ID Guide
- Herbicide Injury
- Publications
- Slideshows
- Videos
- Research Results
- Personnel



Spiny amaranth (*Amaranthus spinosus*) infesting a pasture in northwest Missouri.

Welcome to the University of Missouri's Weed Science homepage. Here you can find information related to our extension, research, and teaching programs or visit some of our web resources like the Missouri Weed Identification or Herbicide Injury Guides. In our "Research Results" section, you can search results from our field research by year, herbicide, weed, or crop. Additionally, you can click on our publication section to see all of the publications and newsletter articles we provide as well as to view and/or listen to some of our power point presentations. We welcome your comments and/or suggestions about this site.

Download our new Weed ID App at the Apple App or Google Play Stores for I-phones, I-pads, and Android devices:



Website:
E-mail:

<http://weedscience.missouri.edu>
bradleyke@missouri.edu

#1 Weed to Watch





Summary / Final Thoughts

Status: Midwest production systems are (or are becoming) dominated by certain “driver weeds” that have a high propensity for resistance evolution.

Cultural practices trends: ↑ narrow row spacings, ↑ cover crops, no apparent shift in tillage practices yet

Primary GR weed mgmt. approach: ↑ PRE herbicides, ↑ POST non-glyphosate herbicides

Grower mindset: Still not where it needs to be! Practices change only when GR weeds occur. Many growers are certain of another “silver bullet”.

