

# **Lessons Learned from Dealing with Resistant Waterhemp**





# **A case study with Waterhemp...**

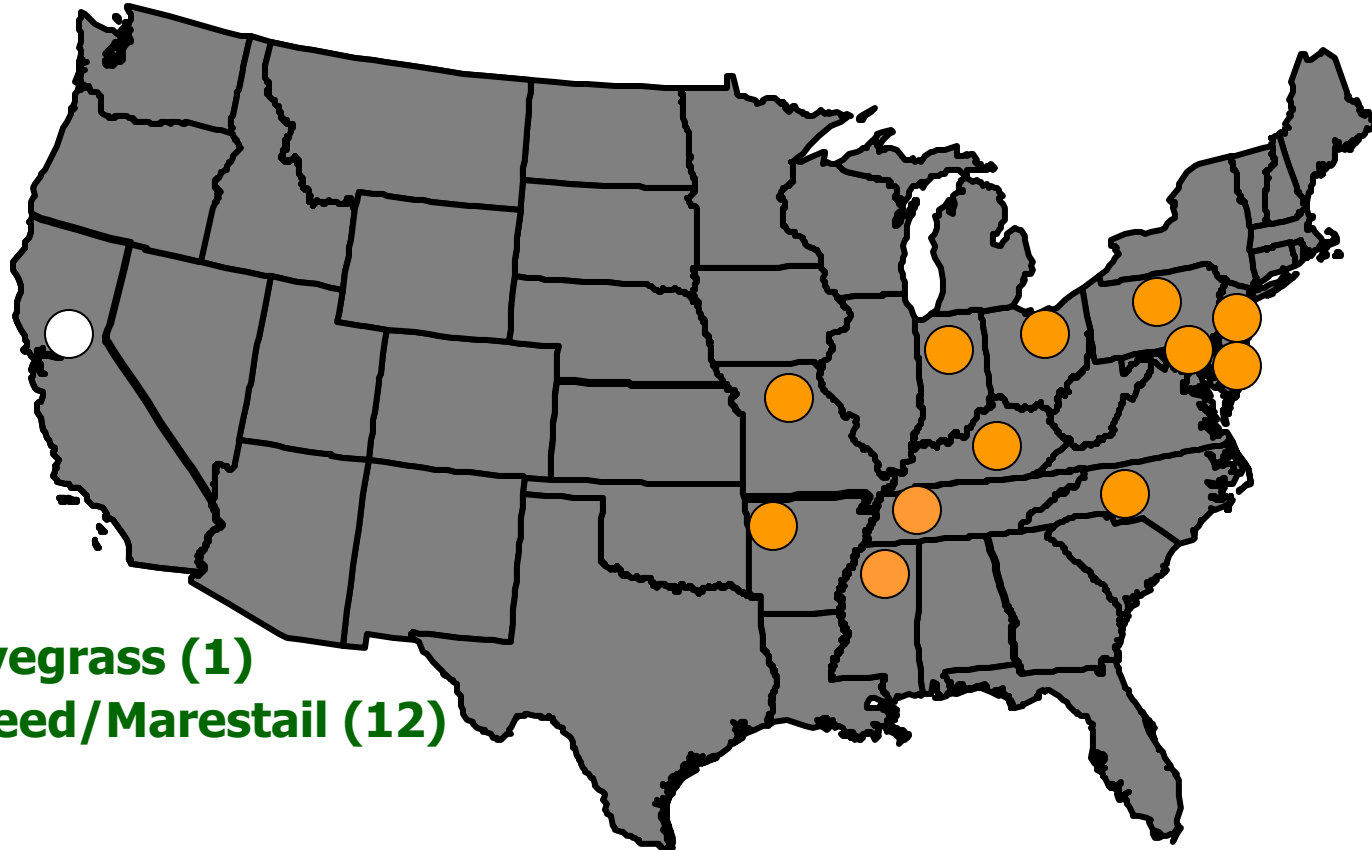
## **Platte County, Missouri Site:**

- called to site in fall 2003; started field trials in 2004
- continuous gly-R soybean since 1996; 1-2 apps gly/year
- 1<sup>st</sup> confirmed case of gly-R waterhemp in the world



# Glyphosate-resistant Weeds in the U.S.

2003: 2 species; 13 states



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

\*Parentheses indicate the number of states in which that resistant weed occurs



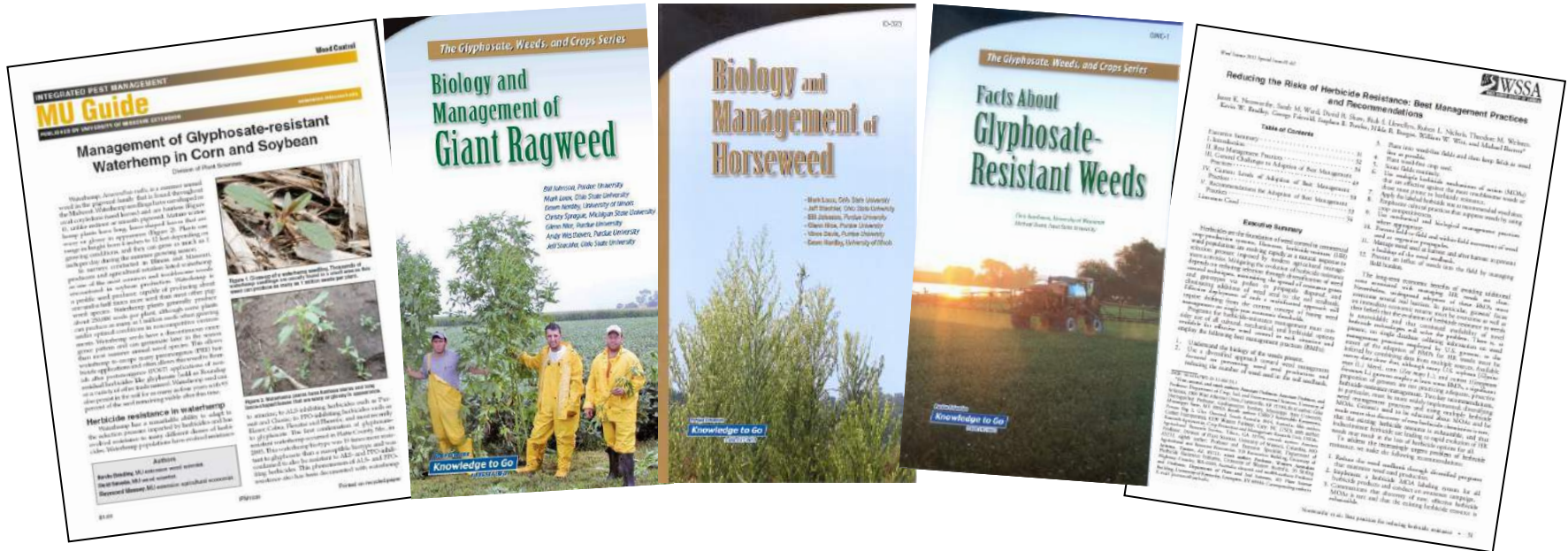
**What has been our  
primary response  
to the problem of  
herbicide  
resistance?**





# Increased educational efforts.

## Publications...



## Training Modules...

## Field Days...

## Videos...

**Herbicide Resistance: Basic Principles**

Herbicide resistance is the result of naturally occurring processes.

Herbicide-resistant individuals or **biotypes**\* are present naturally within the weed population at very low frequencies. These individuals have a herbicide resistance mechanism that allows them to survive the application of a herbicide.

Resistance is heritable. It can be passed from one generation to the next.

WSSA Herbicide Resistance Management Lesson 3 © 2011 WSSA All Rights Reserved



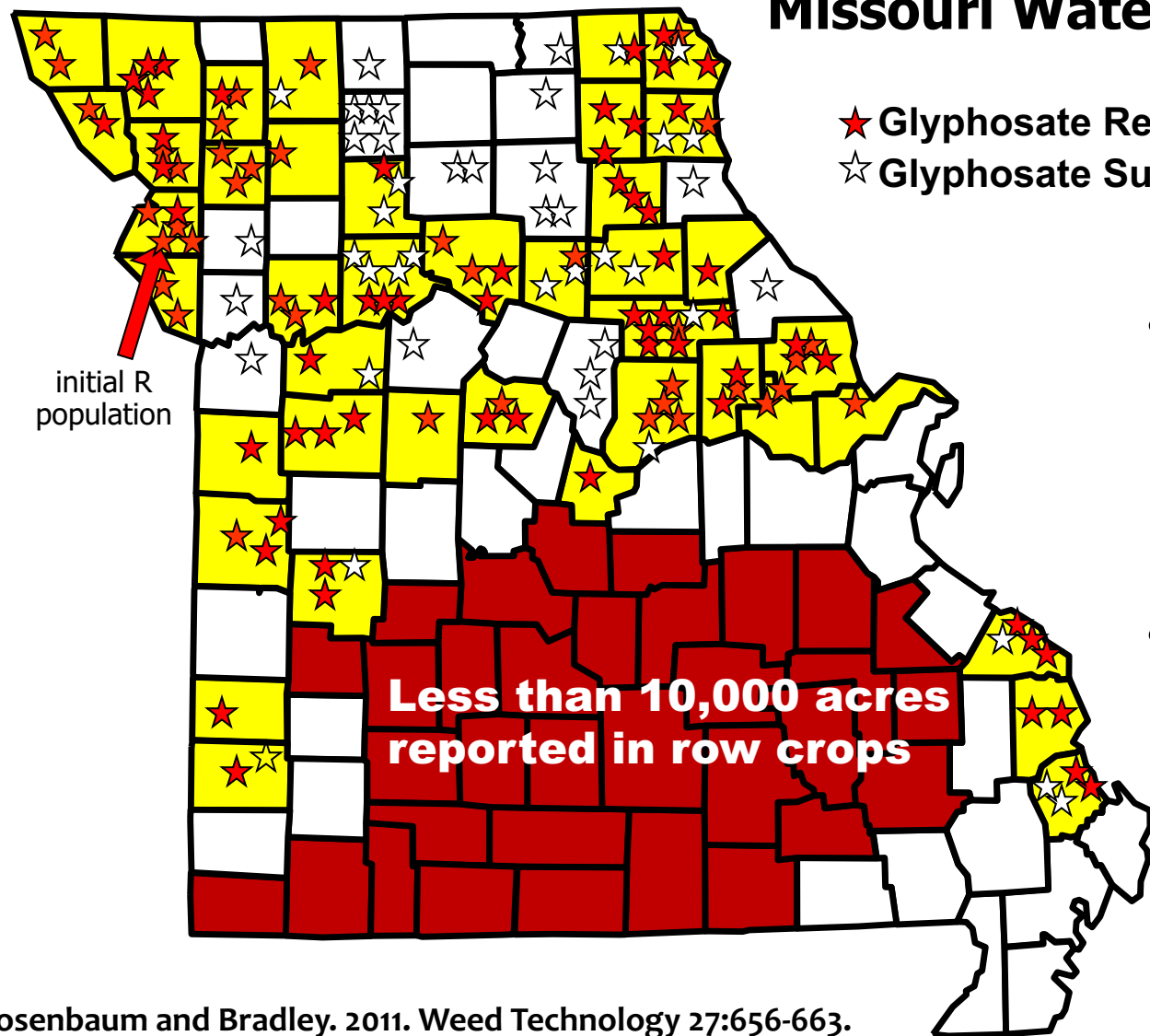
## Herbicide Resistant Weeds in Missouri

Tips on the Identification and Management of Glyphosate-resistant Weeds in Missouri



# And yet...

## Results from a 2008 Survey of Missouri Waterhemp Populations



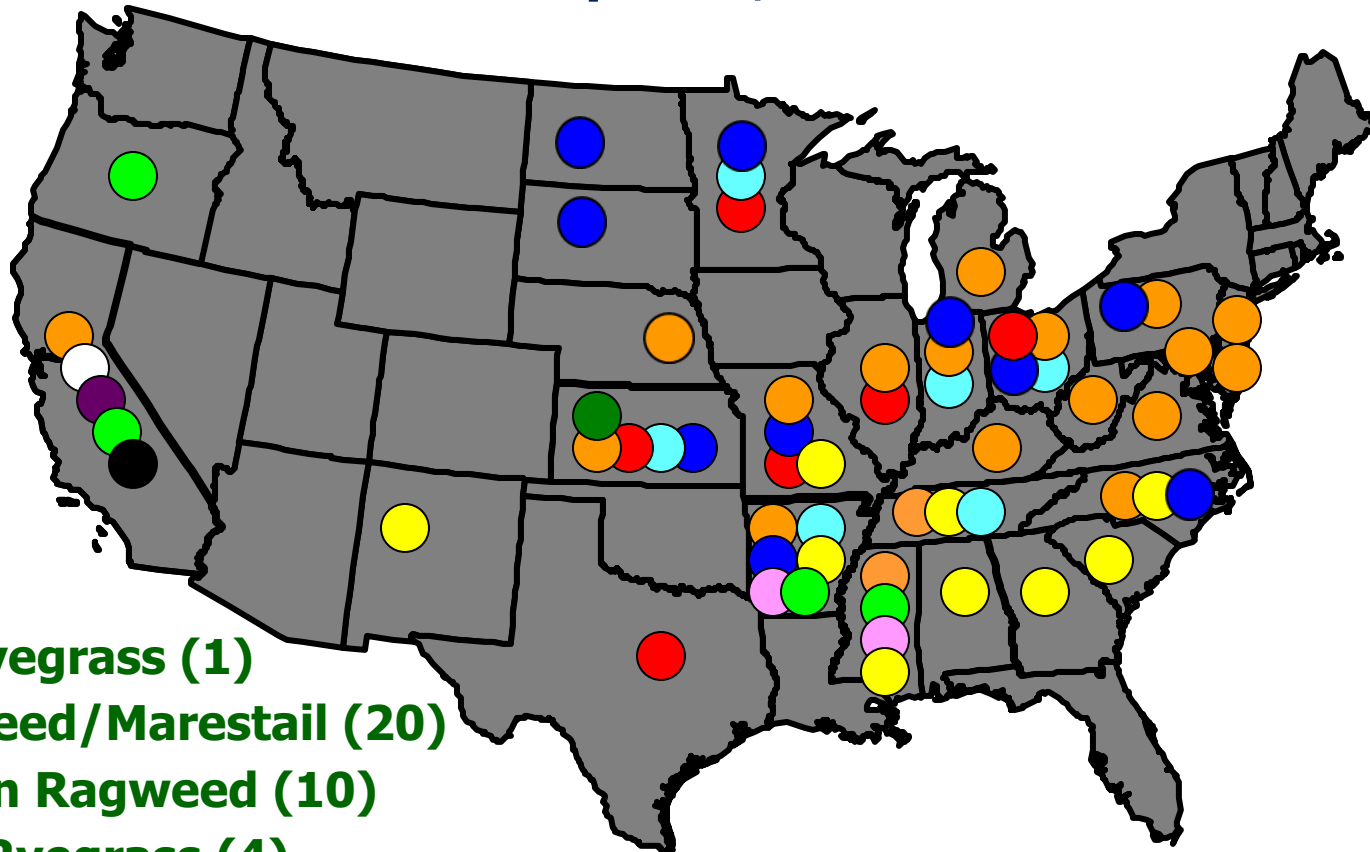
- ★ Glyphosate Resistant (99 populations)
- ☆ Glyphosate Susceptible (45 populations)

- 99/144 (69%) of the waterhemp populations confirmed to be gly-resistant
- 41 counties in Missouri with gly-resistance in waterhemp



# Glyphosate-resistant Weeds in the U.S.

2008: 11 species; 28 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)

\*Parentheses indicate the number of states in which that resistant weed occurs

# I WILL TAKE ACTION AGAINST HERBICIDE-RESISTANT WEEDS.

I will know my weeds. When they grow. When they pollinate.  
And I will stop them before they go to seed.

I will take action in the field and do whatever it takes  
to give my crops the upper hand against weeds.

I will take action with careful herbicide management and use  
multiple herbicide sites of action, because every action counts.


I will take action because it's my bottom line.  
It's not about this year or the next. It's about the long term.

I will take action. This time. For all time.

Now is the time to take action against herbicide-resistant  
weeds. Visit [www.TakeActionOnWeeds.com](http://www.TakeActionOnWeeds.com) to learn how  
you can prevent herbicide-resistant weeds from spreading.



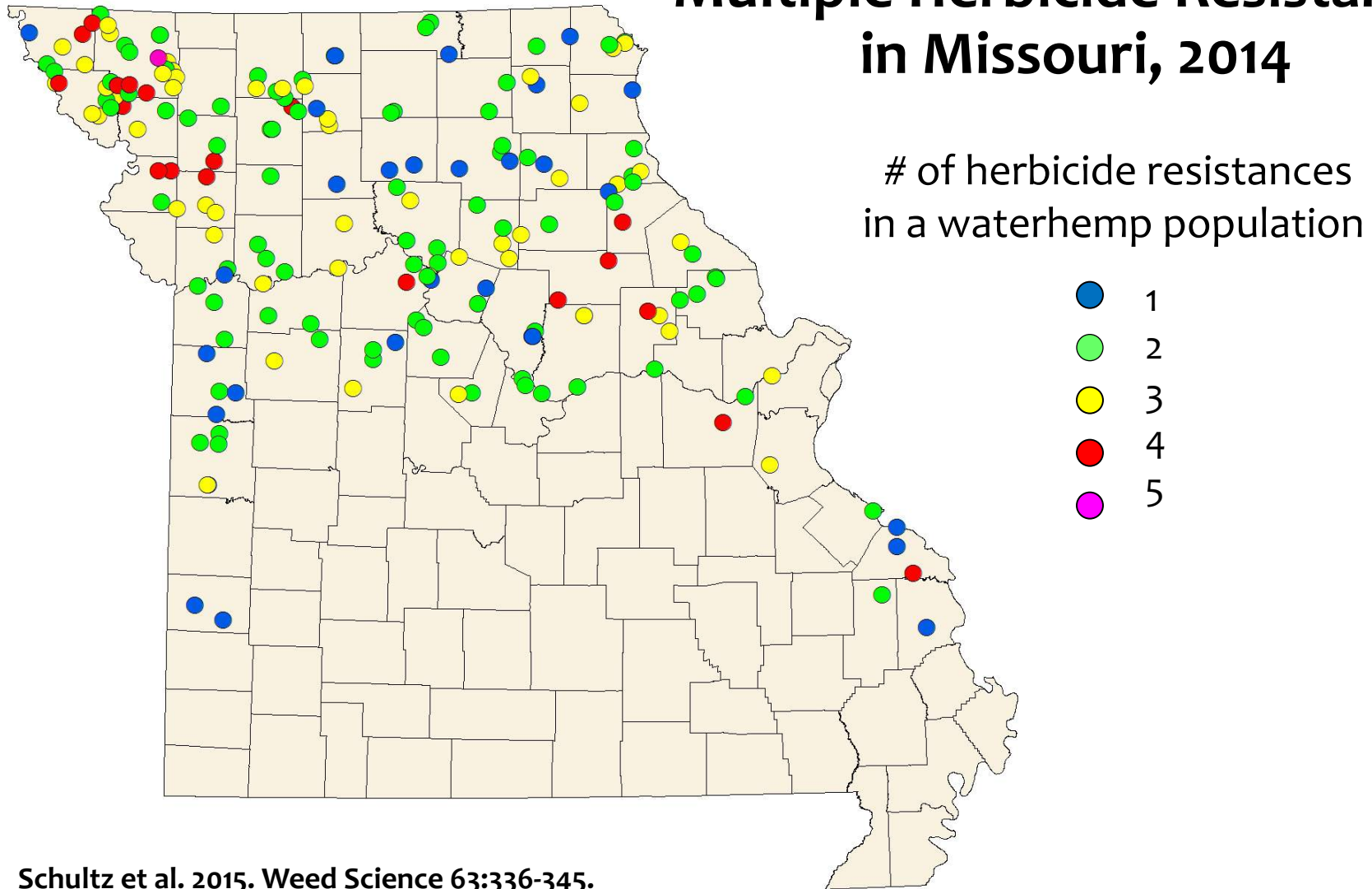
**Take ACTION**  
HERBICIDE-RESISTANCE  
MANAGEMENT

Brought to you by the soy checkoff. 



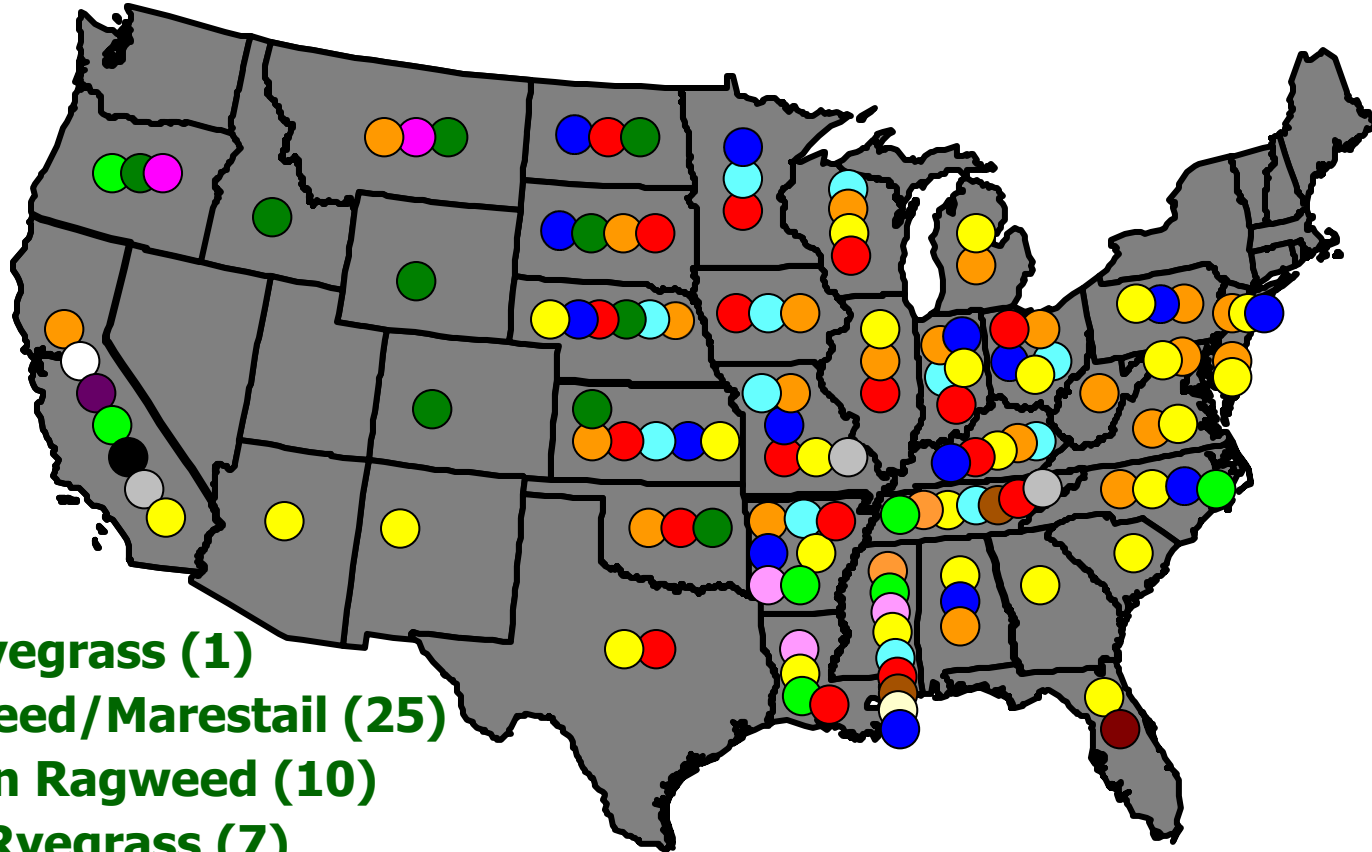
# And yet...

## Distribution of Waterhemp with Multiple Herbicide Resistances in Missouri, 2014



# Glyphosate-resistant Weeds in the U.S.

2016: 16 species; 38 states



○ Rigid Ryegrass (1)

● Horseweed/Marestail (25)

● Common Ragweed (10)

● Italian Ryegrass (7)

● Giant Ragweed (12)

● Waterhemp (18)

● Palmer amaranth (27)

● Hairy Fleabane (1)

● Johnsongrass (3)

● Kochia (10)

● Junglerice (1)

● Annual Bluegrass (3)

● Goosegrass (2)

● Spiny Amaranth (1)

● Russian Thistle (2)

● Ragwd Parthenium (1)

\*Parentheses indicate the number of states in which that resistant weed occurs



# I WILL THINK BEYOND HERBICIDES TO CONTROL WEEDS.

I will take action against herbicide-resistant weeds.  
Every action I can. I will do whatever I can to defend  
this ground. They aren't ordinary fields. They're battlefields.  
And I'm fighting a war on weeds.


I will think beyond herbicides and expand my arsenal.  
I will crowd weeds out and knock them down.  
I will smother them with foliage. I will farm to win.

Mistakes will be made, and weeds will emerge.  
But I will emerge on top. And I will continue  
to take action. Because every action counts.

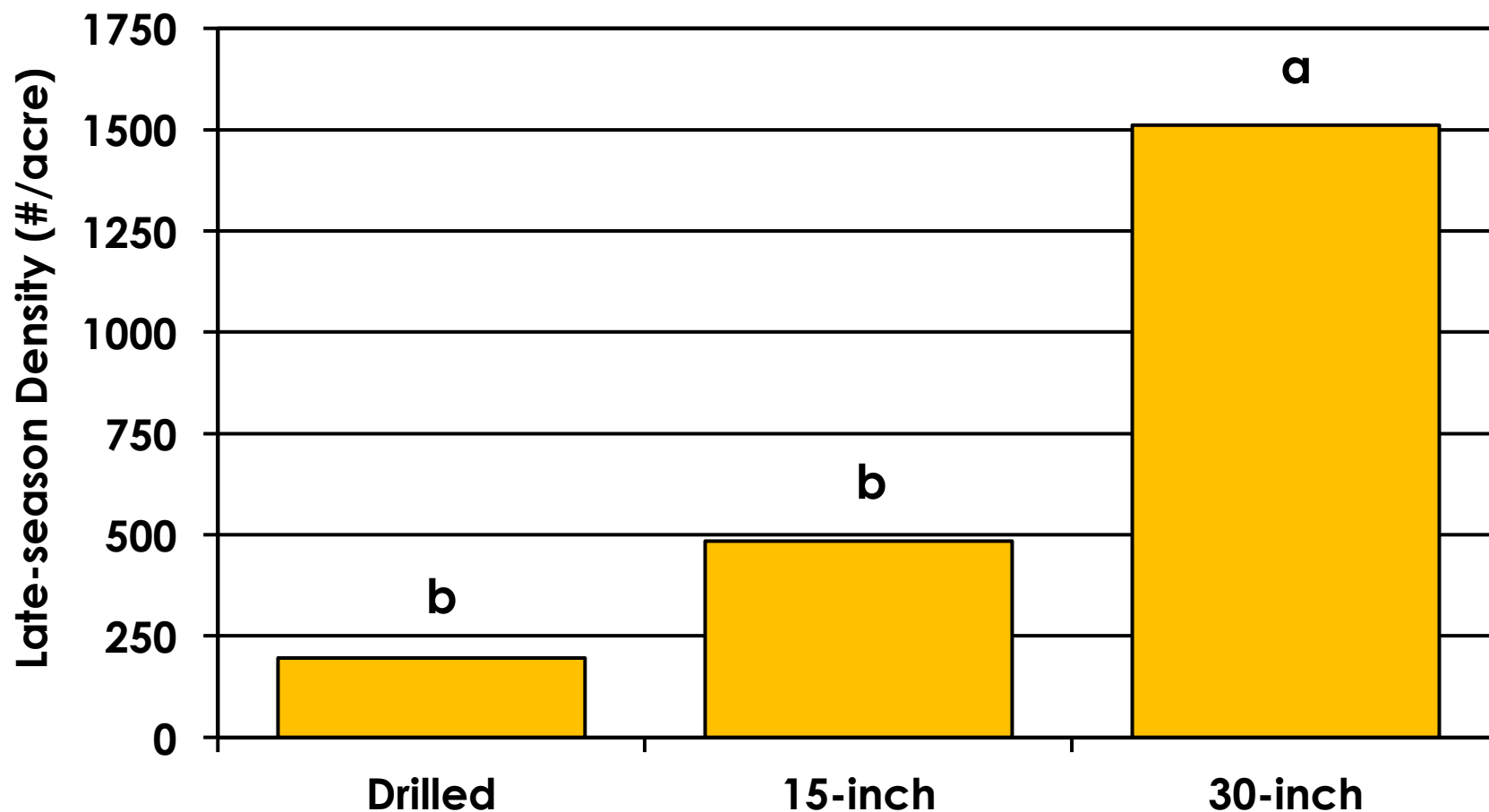
Now is the time to take action against herbicide-resistant  
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diversified weed management strategies.



**Take**  **ACTION**  
HERBICIDE-RESISTANCE  
MANAGEMENT

Brought to you by the soy checkoff. 

# What effect does soybean row spacing have on waterhemp control?



\*End-of-season resistant waterhemp density after an overlapping residual herbicide program.

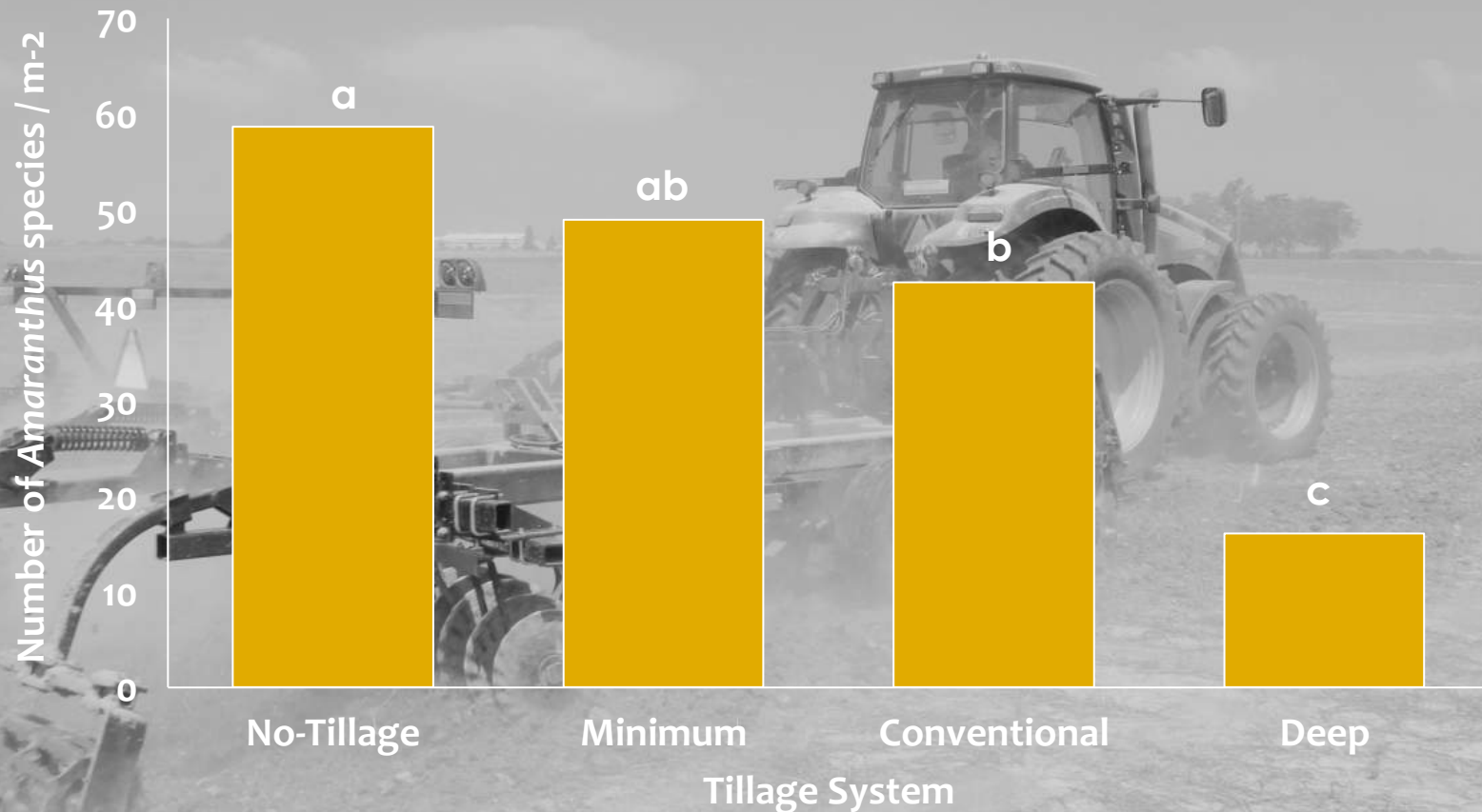
\*\*Means followed by the same letter are not different,  $P \leq 0.05$



# What effect does tillage have on the Pigweed species?



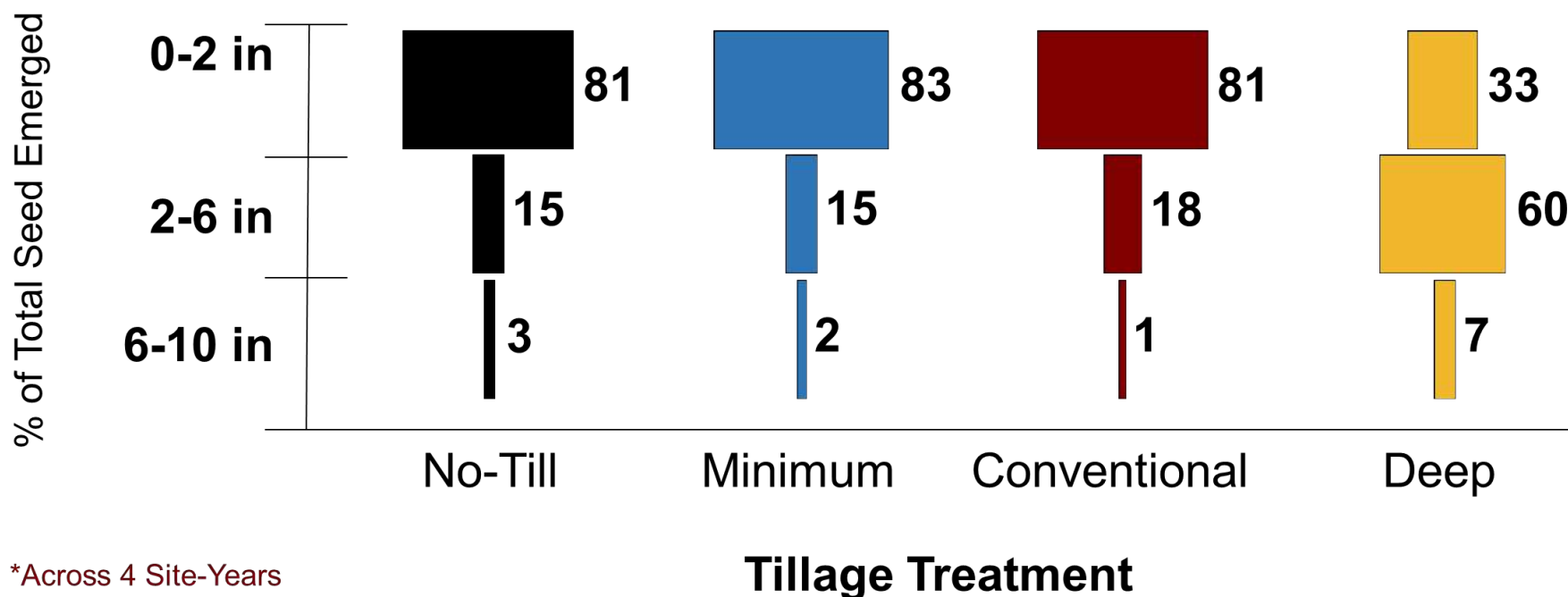
# What effect does tillage have on the Pigweed species?



\*Results summarized across 10 site-years in AR, IL, MO, OH, and TN.

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

# Effects of Different Tillage Types on the Vertical Distribution of Pigweed Seed in the Soil Profile





# What effect does cover crops have on waterhemp management?

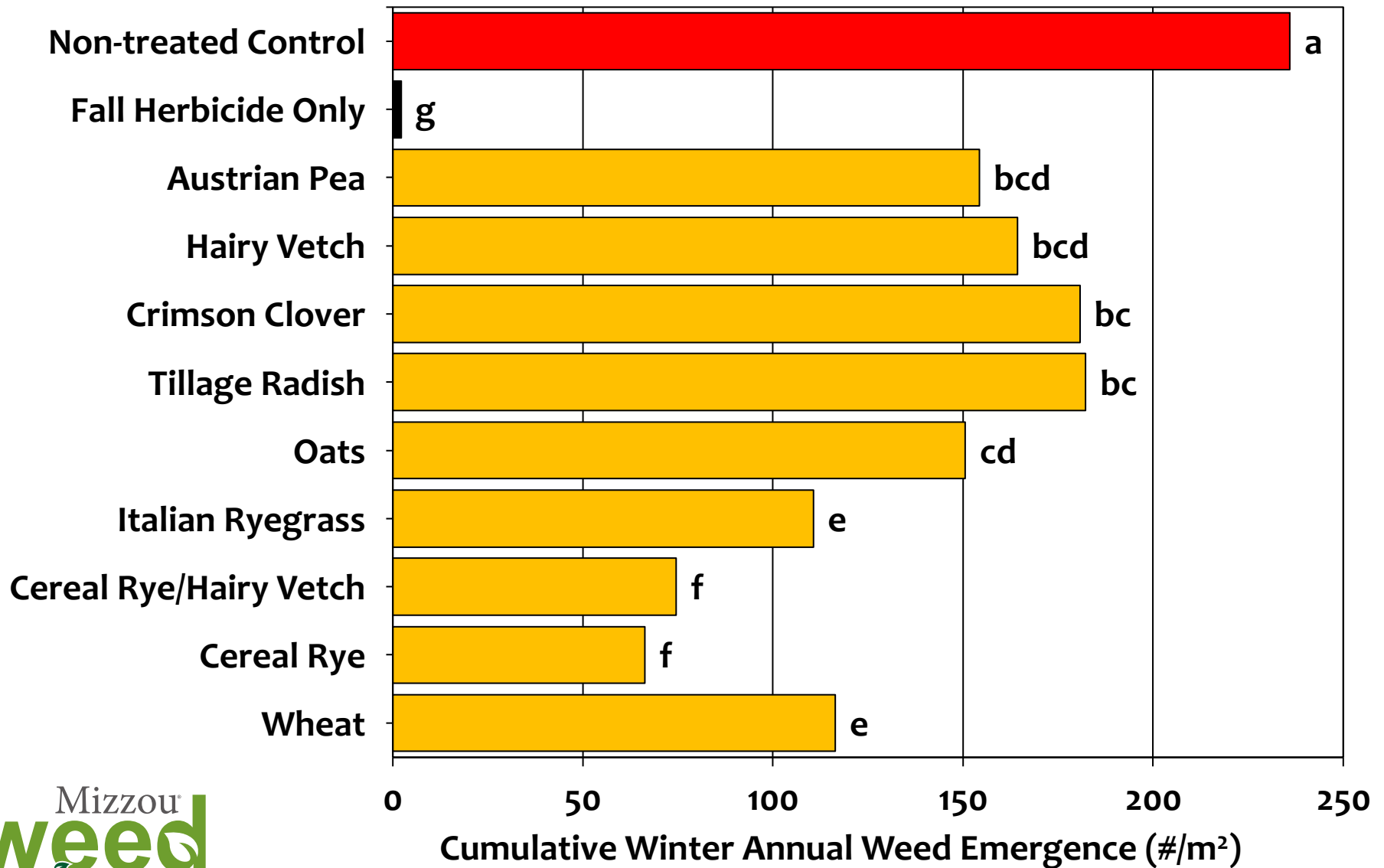


Cornelius, C. and K.W. Bradley, 2016 M.S. Thesis



# Influence of Cover Crops vs. Herbicide Treatments on Cumulative Winter Annual Weed Density

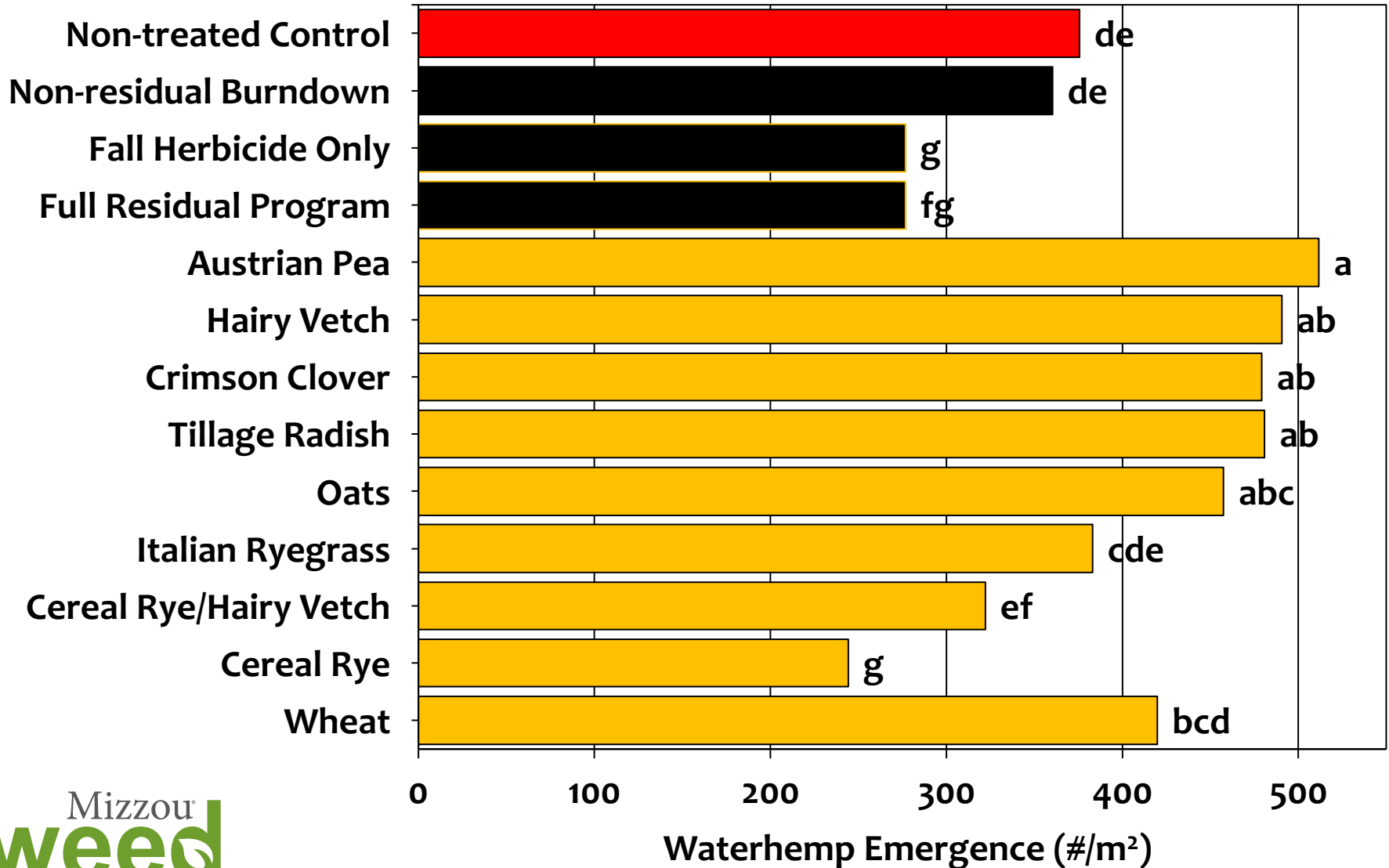
(results summarized across 9 site-years in Missouri)



\*Bars followed by the same letter are not different,  $LSD_{0.05}$

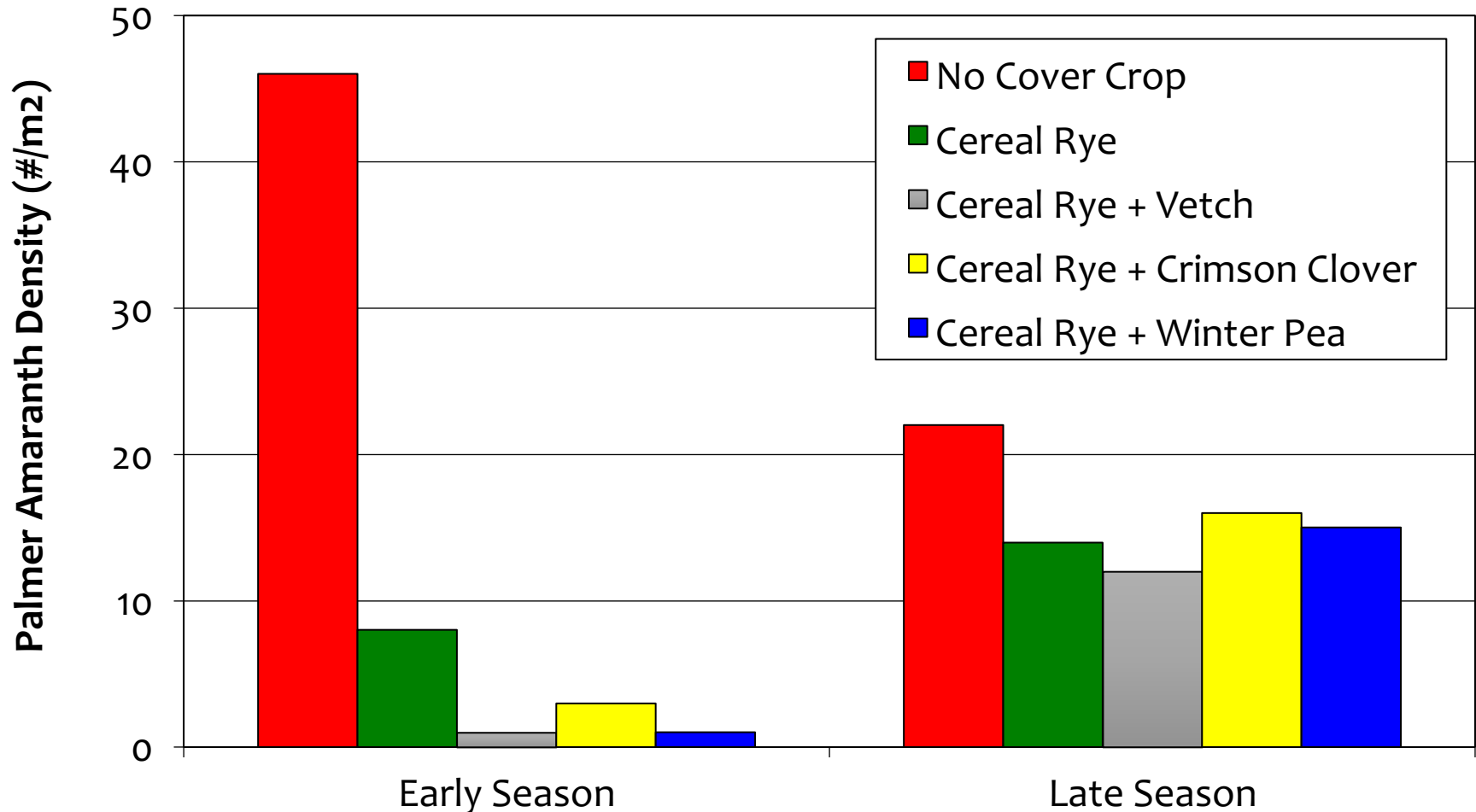
# Influence of Cover Crops vs. Herbicide Treatments on Early Season Waterhemp Emergence

(results summarized across 9 site-years in Missouri)





# Influence of Cover Crops on Palmer Amaranth Emergence in Georgia



**What's the future  
of waterhemp  
management  
look like?**



**A 5-state study revealed that >98% of waterhemp and Palmer amaranth seed are retained on the plant at the time of soybean harvest (Schwartz et al. 2016)**





# Harvest Weed Seed Management:

The next major emphasis area in the fight against resistant weed species.



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



# Harvest Weed Seed Management:

The next major emphasis area in the fight against resistant weed species.

## Investigating Windrow Burning in Missouri





# I WILL USE MULTIPLE HERBICIDE SITES OF ACTION.

I will take action against herbicide-resistant weeds.

I will defend my crops with careful herbicide management.  
And I will use multiple herbicide sites of action because  
every action counts.

I will take action before weeds outgrow control. I will  
apply the right herbicide at the right rate at the right time.

I will take action. This time, for all time.

Now is the time to take action against herbicide-resistant  
weeds. Visit [www.TakeActionOnWeeds.com](http://www.TakeActionOnWeeds.com) to learn how  
you can preserve herbicide technology.



**Take**  
**ACTION**  
HERBICIDE-RESISTANCE  
MANAGEMENT

Brought to you by the soy checkoff.





REPEATED USE OF HERBICIDES WITH THE SAME SITE OF ACTION CAN RESULT IN THE DEVELOPMENT OF HERBICIDE-RESISTANT WEED POPULATIONS.

**MODE OF ACTION**  
Infects on plant growth

This chart groups herbicides by their modes of action to assist you in selecting herbicides (B) to maintain greater diversity in herbicide use and (2) to relate among effective herbicides with different classes of action to delay the development of herbicide resistance.



by PREMISE

The short line grows best in a slightly acidic soil. It is a good source of iron and is also a good source of calcium. It is also a good source of potassium and is a good source of phosphorus. It is also a good source of nitrogen and is a good source of sulfur. It is also a good source of zinc and is a good source of copper. It is also a good source of manganese and is a good source of boron. It is also a good source of iodine and is a good source of selenium. It is also a good source of chromium and is a good source of cobalt. It is also a good source of molybdenum and is a good source of vanadium. It is also a good source of niobium and is a good source of tantalum. It is also a good source of hafnium and is a good source of zirconium. It is also a good source of yttrium and is a good source of lanthanum. It is also a good source of cerium and is a good source of praseodymium. It is also a good source of neodymium and is a good source of promethium. It is also a good source of samarium and is a good source of europium. It is also a good source of gadolinium and is a good source of terbium. It is also a good source of dysprosium and is a good source of holmium. It is also a good source of erbium and is a good source of thulium. It is also a good source of ytterbium and is a good source of lutetium. It is also a good source of hafnium and is a good source of zirconium. It is also a good source of yttrium and is a good source of lanthanum. It is also a good source of cerium and is a good source of praseodymium. It is also a good source of neodymium and is a good source of promethium. It is also a good source of samarium and is a good source of europium. It is also a good source of gadolinium and is a good source of terbium. It is also a good source of dysprosium and is a good source of holmium. It is also a good source of erbium and is a good source of thulium. It is also a good source of ytterbium and is a good source of lutetium.

[illegible][illegible]

**Our Soy Check-off**  
Proteins from Soybeans & Peas

Our success with weed management in the future will be dependent on our ability to really understand the importance of effective herbicide mechanism of action mixing and rotation.

A 3D white figure holding a yellow diamond-shaped sign that reads "WHAT NEXT?". The figure is standing on a white surface, and the sign is tilted slightly to the right. The text "WHAT NEXT?" is written in bold black capital letters on the yellow sign.

# Rotate or Mix Herbicides?

- Analysis of spray records from 105 Illinois fields from 2004 to 2010.
- The occurrence of glyphosate-resistant waterhemp was greatest...
  - where glyphosate was used  $\geq 75\%$  of the time
  - **where herbicide rotation occurred annually!**
- Growers that mixed 3 herbicide modes of action (MOA's) were **51 times less likely to have glyphosate-resistant waterhemp** than growers that mixed 2 MOA's
- **MIXING EFFECTIVE HERBICIDE MOA'S IS THE BEST OPTION!**





# Specific Thoughts on Waterhemp Management in Soybean:





# #1. Use full use rates and/or combinations of pre-emergence residual herbicides as close to planting as possible.

But there are still some product labels that talk about reduced rates!!!

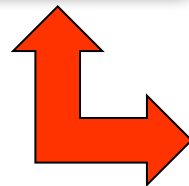
## FULL USE RATE (25)

### Rate Table 1:

Fall Application, Early Pre-plant, Preplant Burndown, Pre-plant Incorporated, and Preemergence:

No-Till, Minimum-till, Conventional tillage

Soil Texture	Organic Matter	
	0.5 – 2%	2 – 4%
	Ounces Product Per Acre	
<b>Coarse:</b> Loamy Sand, Sandy loam	5.0 – 6.0	6.0 – 7.0
<b>Medium:</b> Loam, Silt Loam, Silt, Sandy clay loam	6.5 – 7.5	7.0 – 8.0
<b>Fine:</b> Silty Clay Loam, Clay Loam, Clay	7.0 – 8.0	8.0 – 9.6



## REDUCED RATE FOR GMO SOYBEAN (ROUNDUP READY, LIBERTY LINK etc.) (26)

### Rate Table 2:

Use rates in Table 2 are to be used in conjunction with a planned POST herbicide program; ~~AUTHOR XXXX~~ at these reduced rates will provide early season control or suppression to reduce early season weed competition.

Fall application, Early Pre-plant, Early Pre-plant Burndown, Pre-plant Incorporated, Preemergence:

No-Till, Minimum-till, Conventional Tillage

Soil Texture	Organic Matter	
	0.5 – 2%	2 – 4%
	Ounces Product Per Acre	
<b>Coarse:</b> Loamy Sand, Sandy loam	3.0 – 4.0	3.2 – 4.0
<b>Medium:</b> Loam, Silt Loam, Silt, Sandy clay loam	3.2 – 4.0	3.2 – 4.8
<b>Fine:</b> Silty Clay Loam, Clay Loam, Clay	4.0 – 5.0	4.0 – 5.0

# Effective PRE Active Ingredients



## Group 14 Herbicides

- flumioxazin
- sulfentrazone

## Group 15 Herbicides

- metolachlor
- pyroxasulfone
- dimethenamid
- Acetochlor

## \*Group 3 Herbicides

- Trifluralin
- Pendimethalin

## \*Group 5 Herbicides

- Metribuzin

\*=baggage

## Group 14 Herbicides

(Valor products, Fierce, Envive, etc.)  
(Authority products, Sonic)

## Group 15 Herbicides

(Dual, Prefix, Boundary, etc.)  
(Zidua, Fierce)  
(OpTill, Outlook, etc.)  
(Warrant)

## \*Group 3 Herbicides

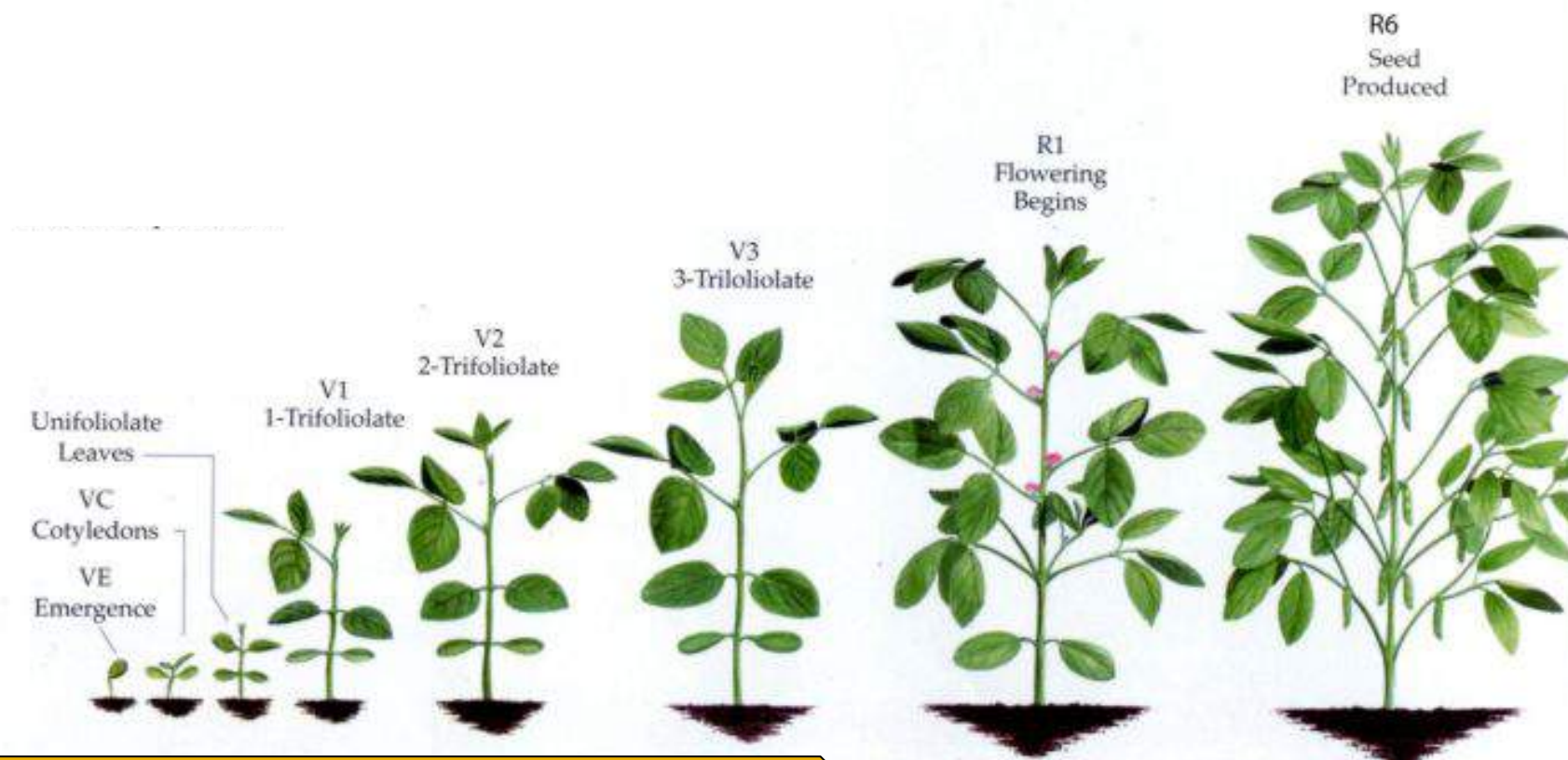
(Treflan)  
(Prowl H2O)

## \*Group 5 Herbicides

(Sencor, Tricor, etc.)



## #2. Overlapping residuals is a program that fits the pattern of waterhemp emergence.



Residual, Pre-emergence Herbicide

Contact + Residual Herbicide

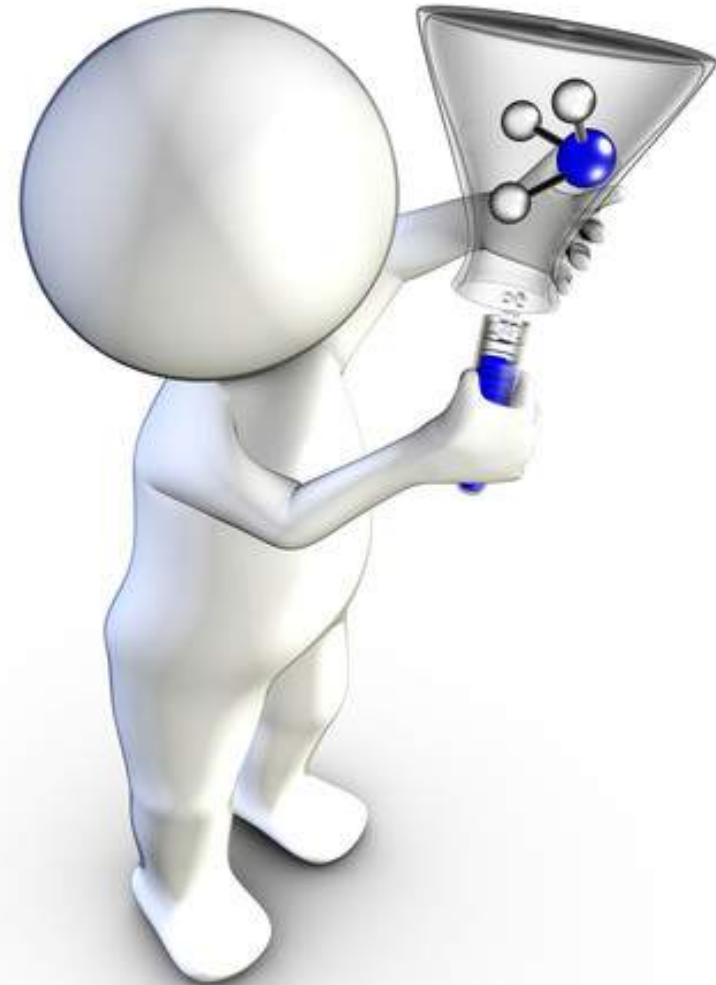


# **#3. Liberty provides a site of action that still works, but if we abuse it we will break it.**

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



**#4. New technologies will not “solve” the problem of resistant waterhemp, or change the emphasis that we should place on good weed management practices.**





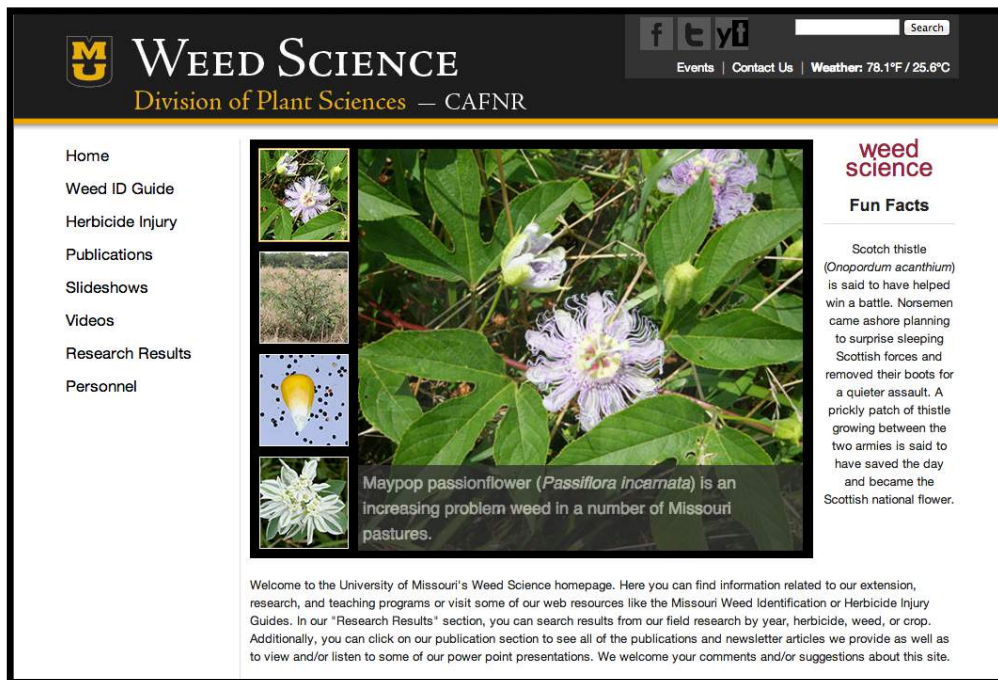




# Mizzou® Weed science

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