



# Annual Cropping Systems Weed Management Update



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Wisconsin Crop  
Weed Science  
UNIVERSITY OF WISCONSIN-MADISON

**\*\*NEW WEBSITE**

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HOME RESEARCH RESOURCES BLOG: OUT OF CONTROL

## Home

### Herbicide Resistance Management *for Wisconsin Farms*



The mission of this program is to evaluate weed management practices to help Wisconsin growers sustainably control weeds and maximize the production of corn, soybean, small grains, and sweet corn crops. Through integration of applied field research and extension activities, we strive to deliver

#### WISCONSIN CROP MANAGER

- Online Webinar Training Sessions Starting in December
- UW-Extension/Madison Plant Disease Diagnostic Clinic (PDDC) Update
- Vegetable Crop Update 10/24/13
- UW-Extension/Madison Plant Disease Diagnostic Clinic (PDDC) Update
- Accepting Nominations for the 2014 WI CCA of the Year Award

<http://wcws.cals.wisc.edu/>





## Topics for today

- 1) New herbicide updates for 2013
- 2) Pyroxasulfone
- 3) Update on Herbicide Resistance Concerns

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**vmdavis@wisc.edu (608) 262-1392**





# New Herbicide Updates

- Corn
  - Instigate: DuPont; rimsulfuron + mesotrione
    - Rate: 5.25 to 6.0 oz/a
    - 14 day EPP to V2 corn
  - Anthem: FMC; Cadet + Zidua
    - Rate: 7 to 13 fl oz/a
    - 45 days EPP to V4 corn



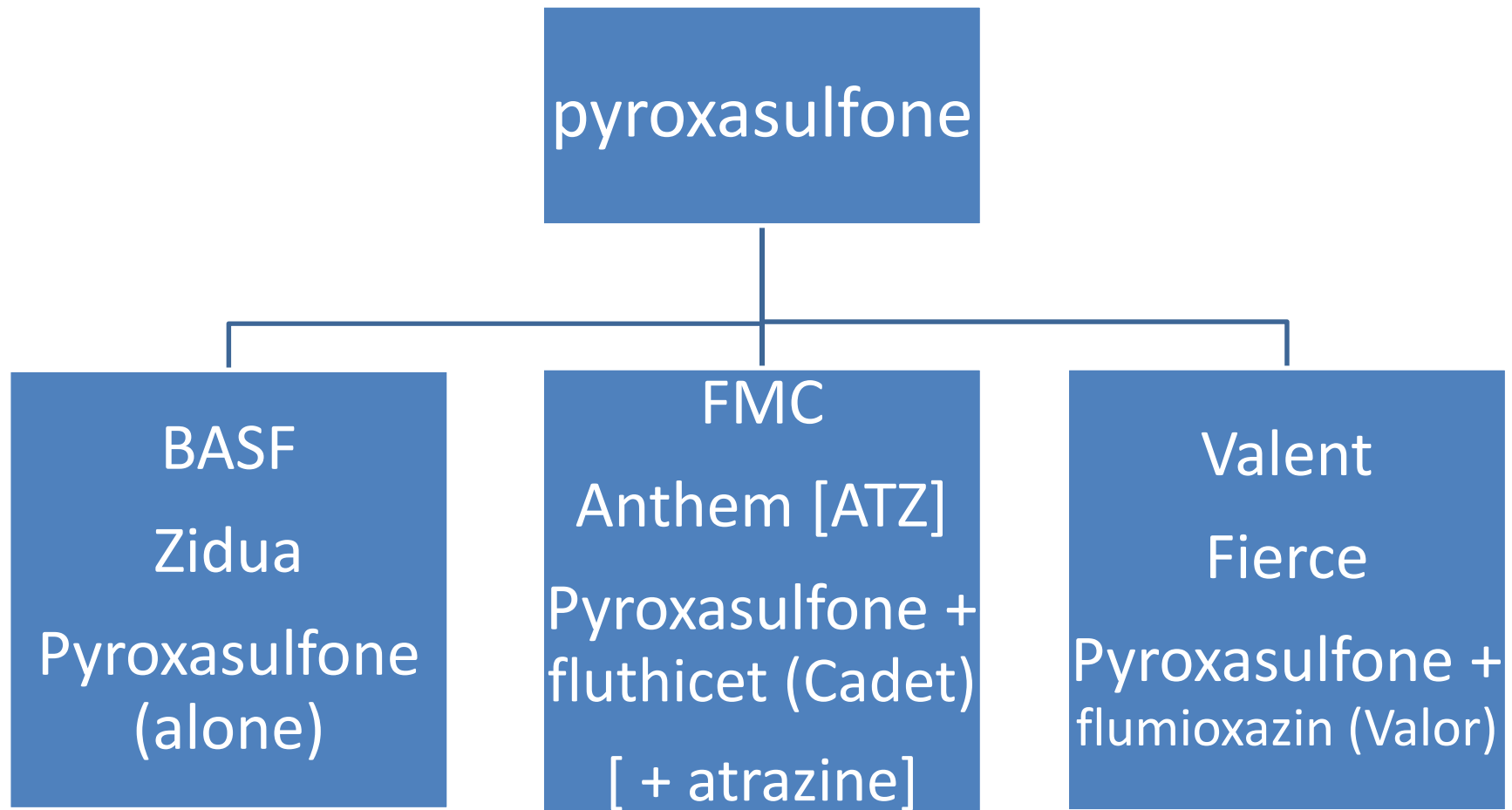


# New Herbicide Updates

- Soybean
  - Marvel: FMC; Cadet + Fomesafen
    - Rate: 5.0 to 7.25 fl oz/a
    - Not labeled North of I94 (check geography restrictions)
- Pyroxasulfone products labeled on soybean



# Pyroxasulfone (KIH-485)





# Zidua

## *BASF*

- Pyroxasulfone - alone
  - MOA: seedling shoot inhibitor
- Preemergence in corn and soybeans
- Low use rates, soil type dependent
- Residual control of both grasses and broadleaves, especially smaller seeded broadleaves including pigweeds
- **Now registered in corn and soybean**



# Dow Product Formulation Changes

NXT Product Formulations, Active Ingredient Loading and Delivery, and Rate Ranges						
Product	Formulation	<u>Lbs ai/gallon</u>		<u>Lbs ai/application unit</u>		Rate* Range
		Acetochlor	Atrazine	Acetochlor	Atrazine	
Surpass NXT	7.0 EC	7.00	--	0.875/pt	--	1.25 - 3.4 pts/A
FulTime NXT	4.04 SE	2.70	1.34	0.675/qt	0.335/qt	2.9 - 4.4 qts/A
Keystone NXT	5.6 SE	3.10	2.50	0.775/qt	0.625/qt	1.4 - 3.0 qts/A
Keystone LA NXT	6.0 SE	4.30	1.70	1.075/qt	0.425/qt	1.8 - 2.7 qts/A

\*Determined by soil texture and organic matter content, tillage, and weed density; consult product labels for specific rate recommendations.



# Herbicide resistance update

To die.....  
or not to die?

**June 11, 2012; 14 D after 32 Fl oz Roundup Weathermax**





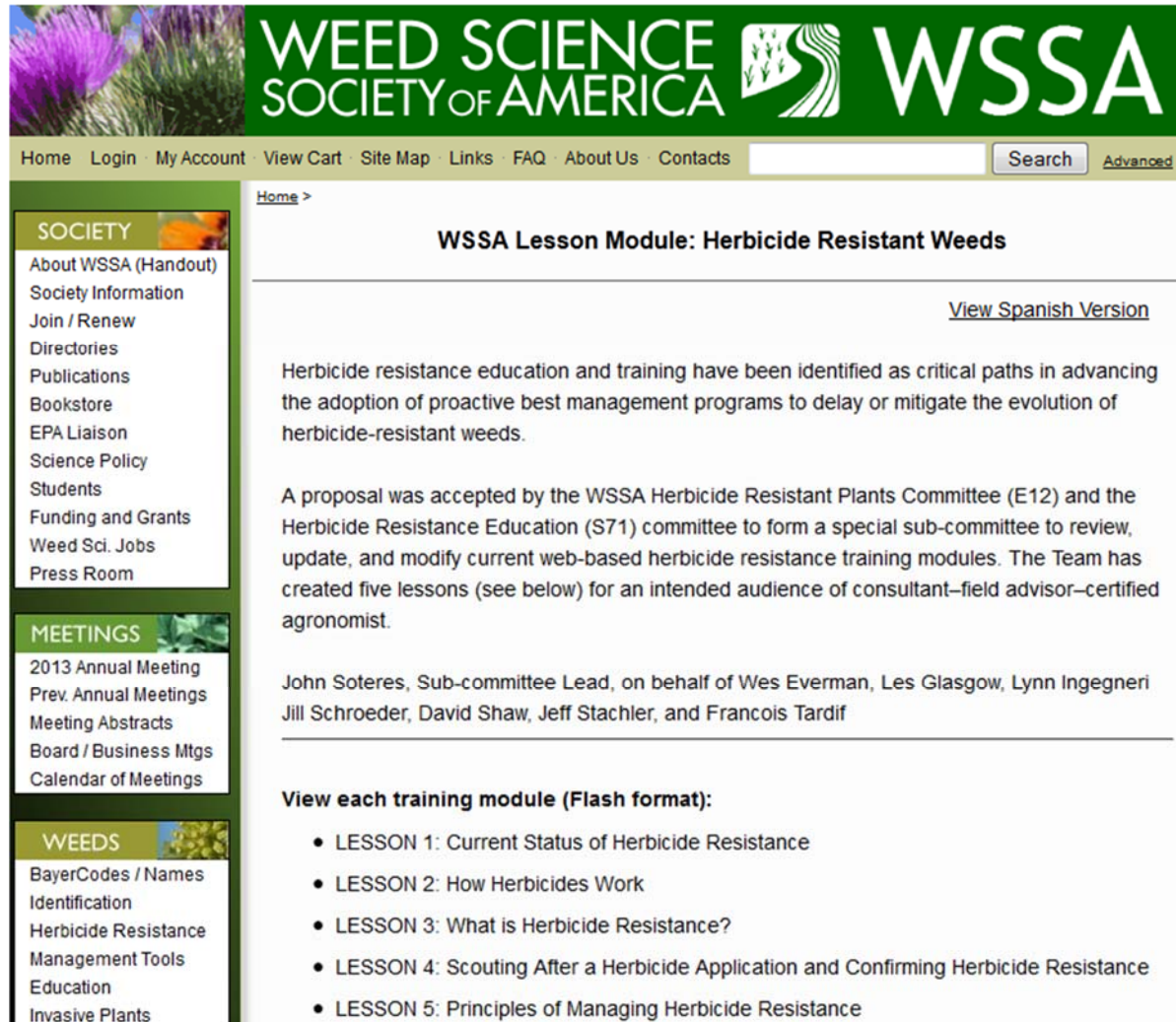
# Most concerning weeds for herbicide resistance in WI

- Giant Ragweed
  - CONFIRMED resistant to glyphosate
  - CONFIRMED resistant to cloransulam-methyl (FirstRate®)
- Horseweed
  - CONFIRMED resistant to glyphosate
- Amaranthus sps. (Palmer amaranth, Powell amaranth, redroot & smooth pigweed, and waterhemp)
  - None confirmed resistant, but movement continues north (evidence in MI, IL, and IN)
- 2012 and 2013 Late-season weed survey



# WSSA Herbicide Resistant weed modules:

<http://www.wssa.net/LessonModules/herbicide-resistant-weeds/index.htm>



The screenshot shows the WSSA (Weed Science Society of America) website. The header features the WSSA logo and navigation links. The main content area is titled "WSSA Lesson Module: Herbicide Resistant Weeds" and includes a link to the "View Spanish Version". The text discusses the importance of herbicide resistance education and training, and mentions a proposal accepted by the WSSA Herbicide Resistant Plants Committee (E12) and the Herbicide Resistance Education (S71) committee. It also lists the sub-committee members: John Soteres, Wes Everman, Les Glasgow, Lynn Ingegneri, Jill Schroeder, David Shaw, Jeff Stachler, and Francois Tardif. A section titled "View each training module (Flash format):" lists five lessons: LESSON 1: Current Status of Herbicide Resistance, LESSON 2: How Herbicides Work, LESSON 3: What is Herbicide Resistance?, LESSON 4: Scouting After a Herbicide Application and Confirming Herbicide Resistance, and LESSON 5: Principles of Managing Herbicide Resistance. A sidebar on the left contains links for SOCIETY, MEETINGS, and WEEDS.

**WEED SCIENCE SOCIETY OF AMERICA WSSA**

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## WSSA Lesson Module: Herbicide Resistant Weeds

[View Spanish Version](#)

Herbicide resistance education and training have been identified as critical paths in advancing the adoption of proactive best management programs to delay or mitigate the evolution of herbicide-resistant weeds.

A proposal was accepted by the WSSA Herbicide Resistant Plants Committee (E12) and the Herbicide Resistance Education (S71) committee to form a special sub-committee to review, update, and modify current web-based herbicide resistance training modules. The Team has created five lessons (see below) for an intended audience of consultant–field advisor–certified agronomist.

John Soteres, Sub-committee Lead, on behalf of Wes Everman, Les Glasgow, Lynn Ingegneri, Jill Schroeder, David Shaw, Jeff Stachler, and Francois Tardif

**View each training module (Flash format):**

- LESSON 1: Current Status of Herbicide Resistance
- LESSON 2: How Herbicides Work
- LESSON 3: What is Herbicide Resistance?
- LESSON 4: Scouting After a Herbicide Application and Confirming Herbicide Resistance
- LESSON 5: Principles of Managing Herbicide Resistance

**SOCIETY**

- About WSSA (Handout)
- Society Information
- Join / Renew
- Directories
- Publications
- Bookstore
- EPA Liaison
- Science Policy
- Students
- Funding and Grants
- Weed Sci. Jobs
- Press Room

**MEETINGS**

- 2013 Annual Meeting
- Prev. Annual Meetings
- Meeting Abstracts
- Board / Business Mtgs
- Calendar of Meetings

**WEEDS**

- BayerCodes / Names
- Identification
- Herbicide Resistance
- Management Tools
- Education
- Invasive Plants





# Palmer amaranth

(*Amaranthus  
palmeri*) is in  
Wisconsin Crop  
Production Fields

Wisconsin Crop  
Manager article  
10/13/11







# Most concerning weeds for herbicide resistance in WI

- Giant Ragweed
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  - CONFIRMED resistant to cloransulam-methyl (FirstRate®)
- Amaranthus sps. (Palmer Amaranth and Waterhemp)
  - None confirmed resistant, but movement continues north (evidence in MI and IN)
- 2012 (and 2013) Late-season weed survey



## News

Connect with experts  
around the country:

## Palmer amaranth found in more Michigan fields: Now is a good time to scout

**Now is the ideal time to scout for Palmer amaranth, a glyphosate-resistant pigweed that's recently been identified in more Michigan counties.**

Posted on **July 27, 2012** by **Christy Sprague**, Michigan State University Extension, Department of Plant, Soil and Microbial Sciences



Over the past few weeks I have received calls reporting that Palmer amaranth has been identified in more areas of Michigan. Counties where Palmer amaranth has now been confirmed include St. Joseph, Kalamazoo, Shiawassee, Clinton and Barry counties. The first report of this weed was in a southwest Michigan soybean field in St. Joseph County in 2009. In 2010 and 2011, it seemed to remain in a localized area in St. Joseph, Clinton and Barry counties. In 2011 a small patch of Palmer amaranth was also found on a field's edge in Shiawassee County. Through greenhouse testing we were able to confirm that the Palmer amaranth populations found in southwest Michigan and Shiawassee County had high levels of resistance to both glyphosate (Roundup) and ALS-inhibiting herbicides.

While we have not yet been able to confirm resistance to these herbicides in the recently reported populations in Clinton and Barry counties, the fact that Palmer amaranth in these fields were not controlled by glyphosate suggest that these populations are also glyphosate-resistant and are also probably ALS-resistant.

### How is glyphosate-resistant Palmer amaranth getting into Michigan?

Since Palmer amaranth is not native to Michigan, we have speculated that the glyphosate-resistant Palmer amaranth populations found in Michigan have been established by seed brought in from another source. What is this source? While we may never know the direct source, when examining the field histories

# Now in 8 counties

[http://msue.anr.msu.edu/news/palmer\\_amaranth\\_found\\_in\\_more\\_michigan\\_fields\\_now\\_is\\_a\\_good\\_time\\_to\\_scout](http://msue.anr.msu.edu/news/palmer_amaranth_found_in_more_michigan_fields_now_is_a_good_time_to_scout)



October 30, 2012

## Aggressive Palmer amaranth weed found in northern Indiana

WEST LAFAYETTE, Ind. - Populations of the fast-spreading Palmer amaranth weed have been confirmed in five counties in northwestern Indiana, a Purdue Extension weed specialist says.

At least 50 corn and soybean fields of Jasper, Newton, Pulaski, LaPorte and Cass counties have verified infestations.

Palmer amaranth is a green, flowering plant that has caused widespread damage in cotton production in southern states. Most populations are glyphosate resistant, and the weed thrives in fields with an increasing number of weeds per day and each having greater than 10 feet.

Travis Legleiter, Purdue weed science program specialist, said the rapid growth and general hardness of the weed makes it a problem in corn and soybean fields.

"Palmer amaranth's competitiveness is what makes it a concern for us," he said. "We know from our counterparts in the South how devastating this weed can be to crops. And now we know Palmer amaranth can be competitive in northern geographies, too."

Farmers might be familiar with other amaranth species such as Redroot, smooth pigweed or waterhemp. In fact, the confirmed cases were misidentified as waterhemp before farmers noticed that their applications of traditional herbicides such as glyphosate weren't controlling the problem.

Legleiter said farmers across Indiana should be aware of the Palmer species and know it differs from other species.

"Palmer amaranth does have distinguishing characteristics. The first thing is the length of the petiole. In southern states the petiole and stem will be significantly longer. Especially on older plants. If you take the petiole and leaf blade and fold them over, the petiole is longer on Palmer

## Follow Us



## Research News

Organic status will make Purdue research more competitive

Purdue gets \$6 million to develop robotic pruning for grapes, apples

Warmer climates don't necessarily mean more fertile soils, study says

You can avoid being scammed in donating to Hurricane Sandy victims

Prof. Election season makes it hard to like some Facebook friends

[More Research News](#)

<http://www.purdue.edu/newsroom/releases/2012/Q4/aggressive-palmer-amaranth-weed-found-in-northern-indiana.html>





# Palmer Amaranth in Northwestern Indiana

*Stories you know are real, because I can't make this up ☺*

## 2012

- Soybean grower accepts 'free' dairy manure in early spring
- Planted soybean May 15<sup>th</sup>
- 21 day later, sprayed Extreme at 3 pts. + 16 oz of Roundup
- 21 days later Second Application 32 oz Roundup
- July 9<sup>th</sup>, (3<sup>rd</sup> POST application) 12 oz Cobra + 12 Oz Crop Oil + 2 oz Surfactant

August 8<sup>th</sup>, 2012 photos:

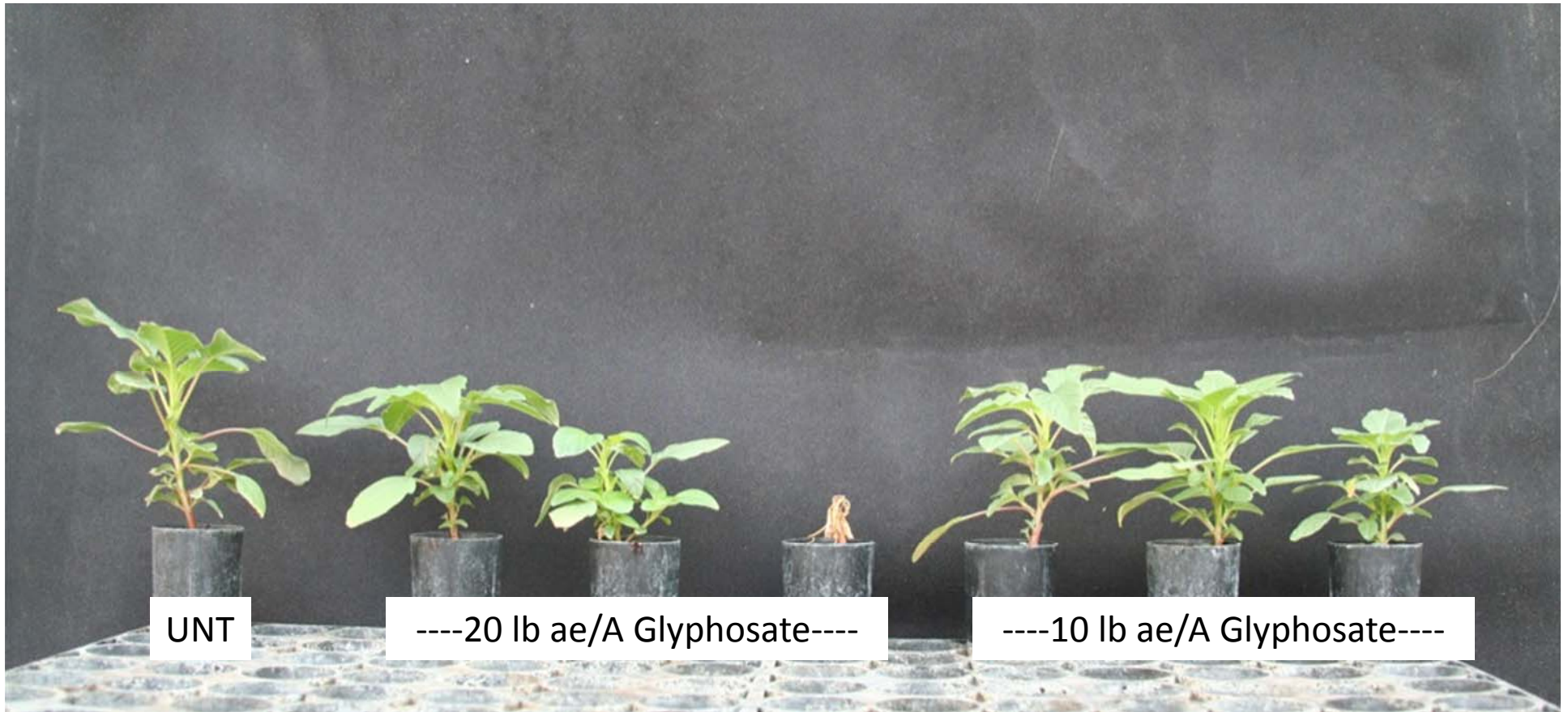




August 8<sup>th</sup>, 2012



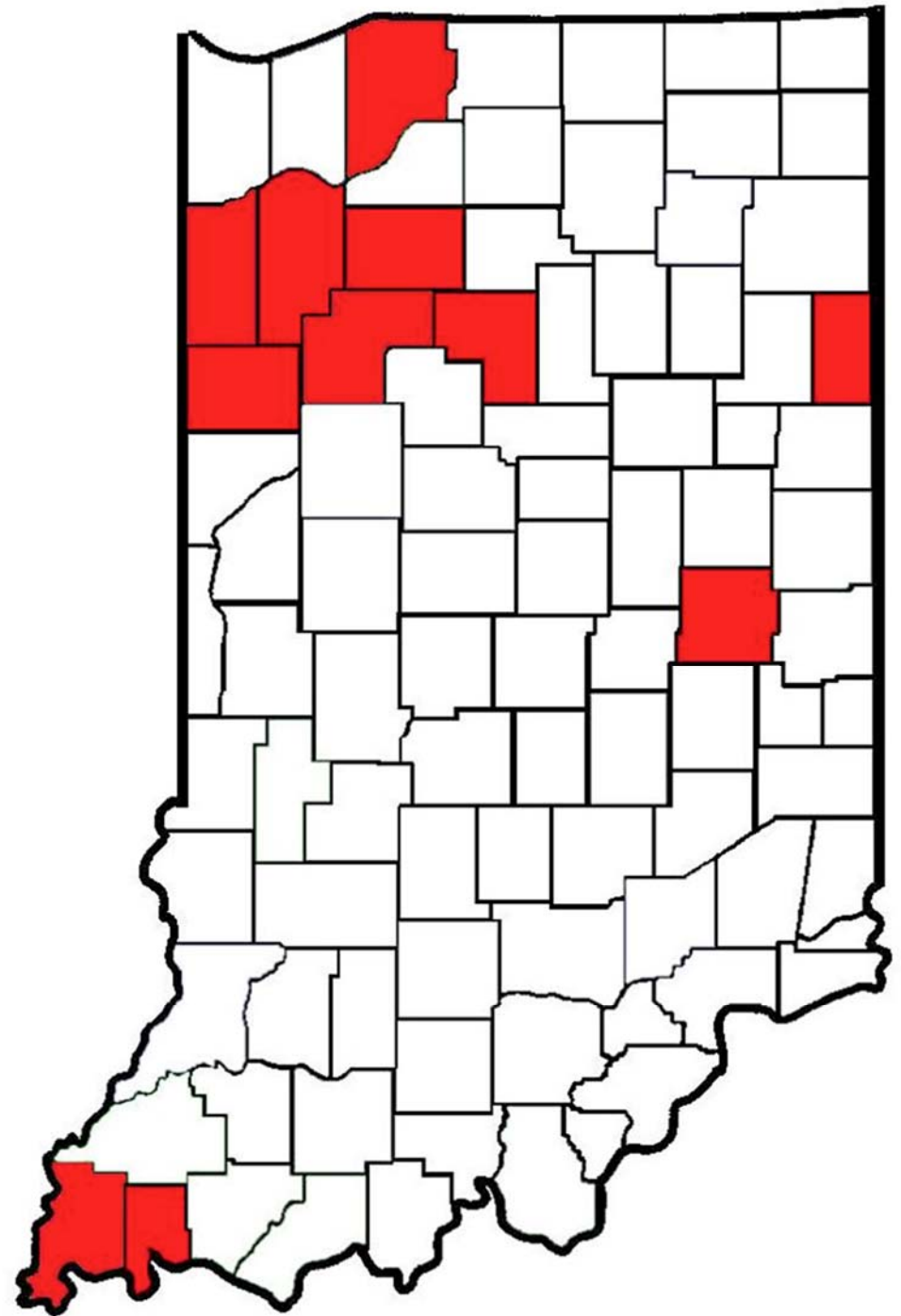
# Response of an Indiana population of Palmer Amaranth (45) to Glyphosate



(courtesy of Bill Johnson, Purdue University)

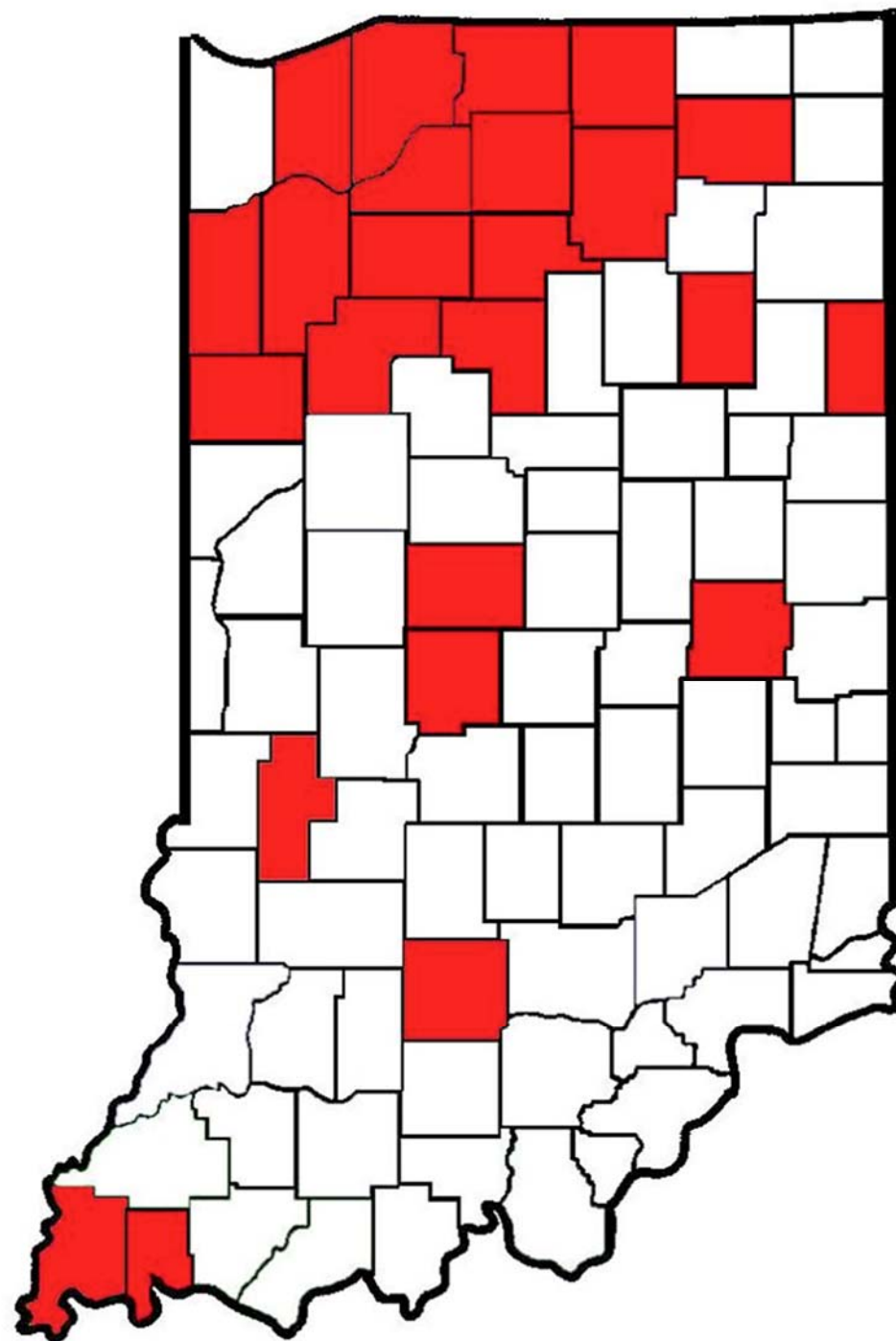


# Confirmed locations of Palmer Amaranth - May 2013



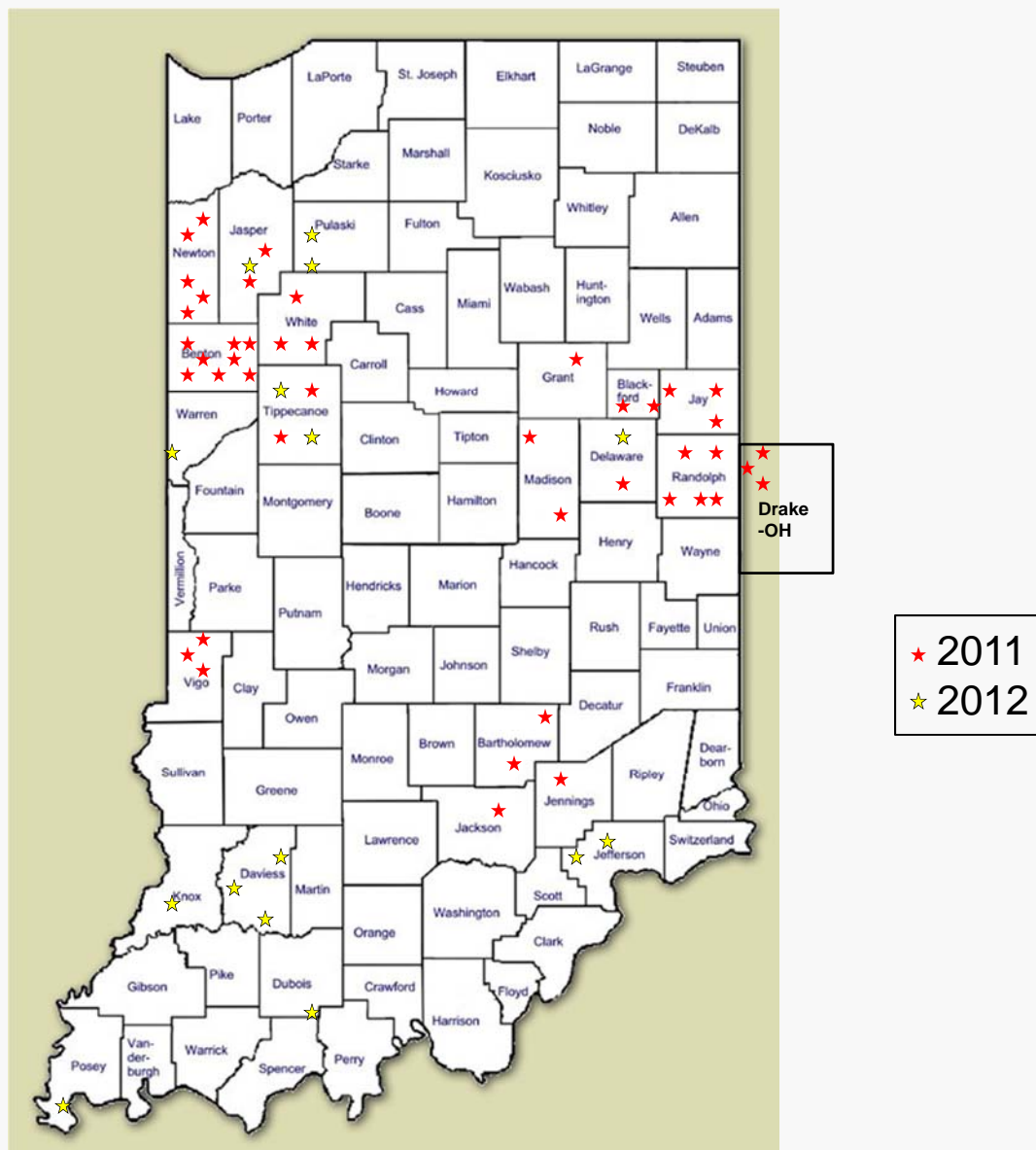


# Confirmed locations of Palmer Amaranth – September 2013





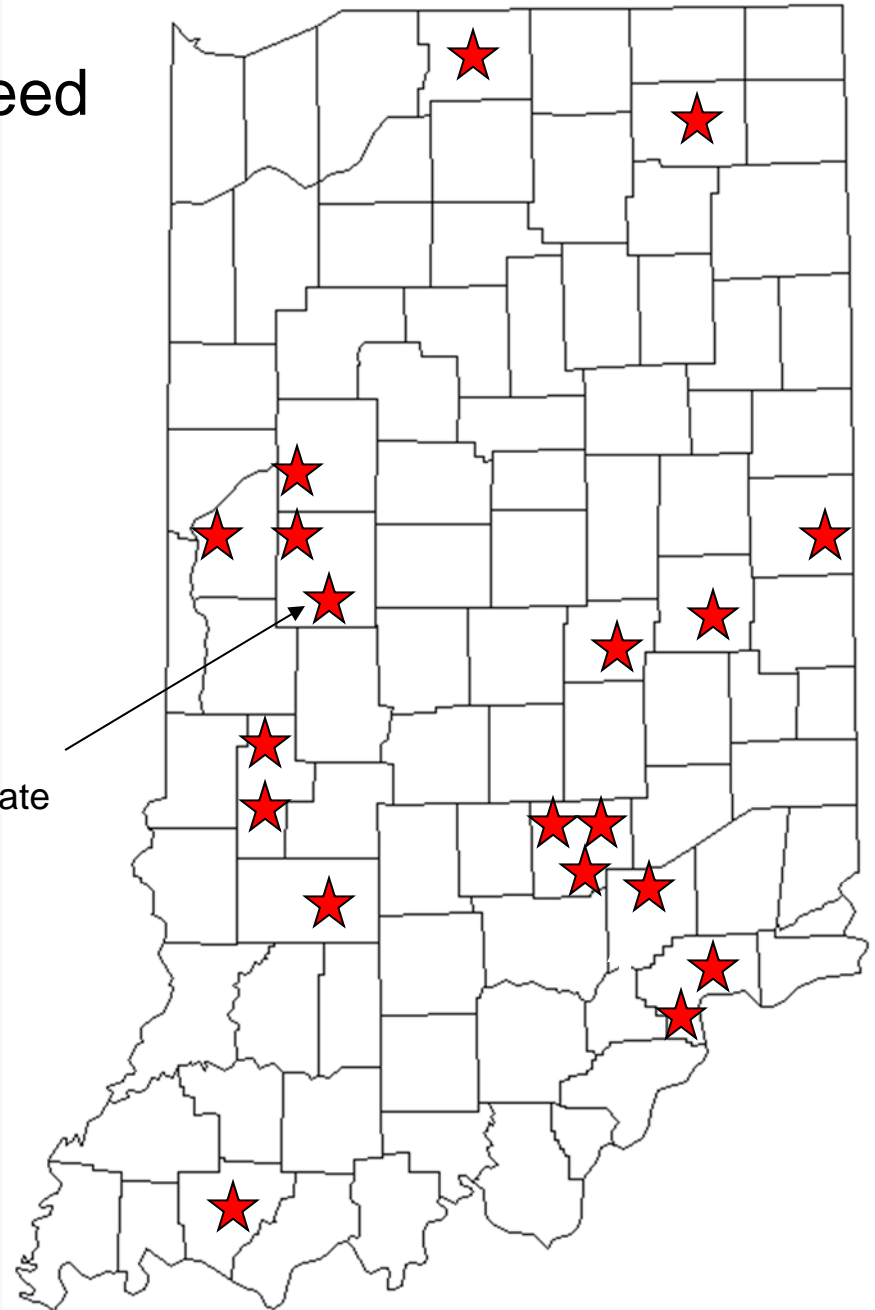
# Glyphosate Resistant Waterhemp September 18, 2013





# Indiana Counties with Glyphosate Resistant or Tolerant Giant Ragweed Populations (January 2008)

This Montgomery county field has glyphosate-resistant marehail, glyphosate-resistant giant ragweed, and glyphosate “tolerant” common lambsquarter!

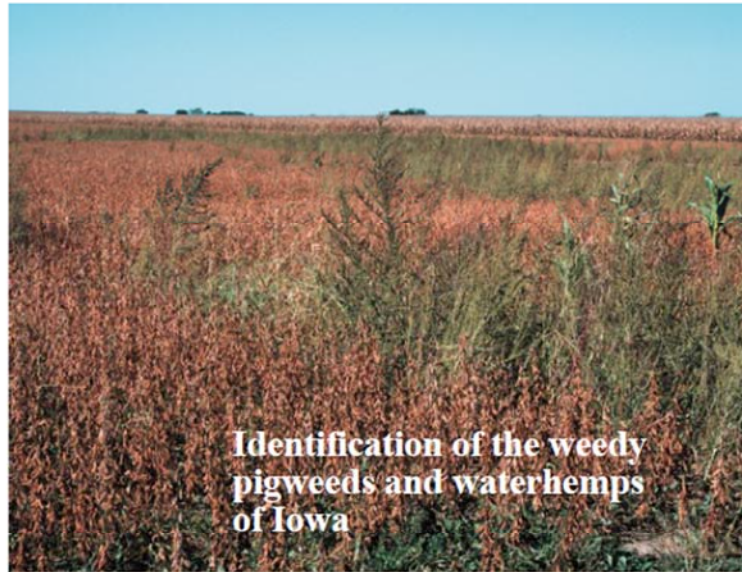






# Be on the lookout for Amaranths in WI

## Iowa State University Extension Publication



### Identification of the weedy pigweeds and waterhemp of Iowa

Sponsored by the Iowa Soybean Promotion Board

Donald B. Pratt  
M.S. Botany, Iowa State University

Micheal D. K. Owen  
Professor of Weed Science, Iowa State University

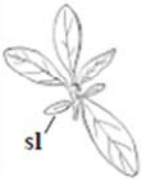
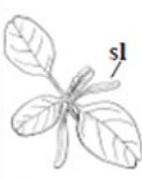

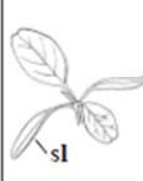









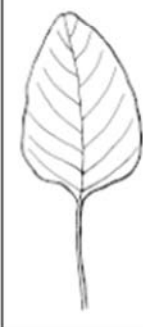
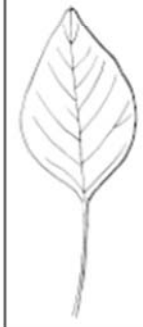
Lynn G. Clark  
Associate Professor of Botany, Iowa State University

Anna Gardner  
Illustrator

<http://ipcm.wisc.edu/blog/2011/11/palmer-amaranth-is-in-wisconsin-crop-production-fields/>



## Pigweed and waterhemp identification table

	Common Waterhemp	Redroot Pigweed	Smooth Pigweed	Powell Amaranth	Palmer Amaranth
Seedling shape					
Stem hairs					
Leaf shapes					
Separate male and female plants	Yes	No	No	No	Yes
Seedhead shape	smooth, long, slender	prickly, short, stout	slightly prickly, long, slender	prickly, very long, thick	very prickly, very long, thick



# Be on the lookout for Amaranths in WI

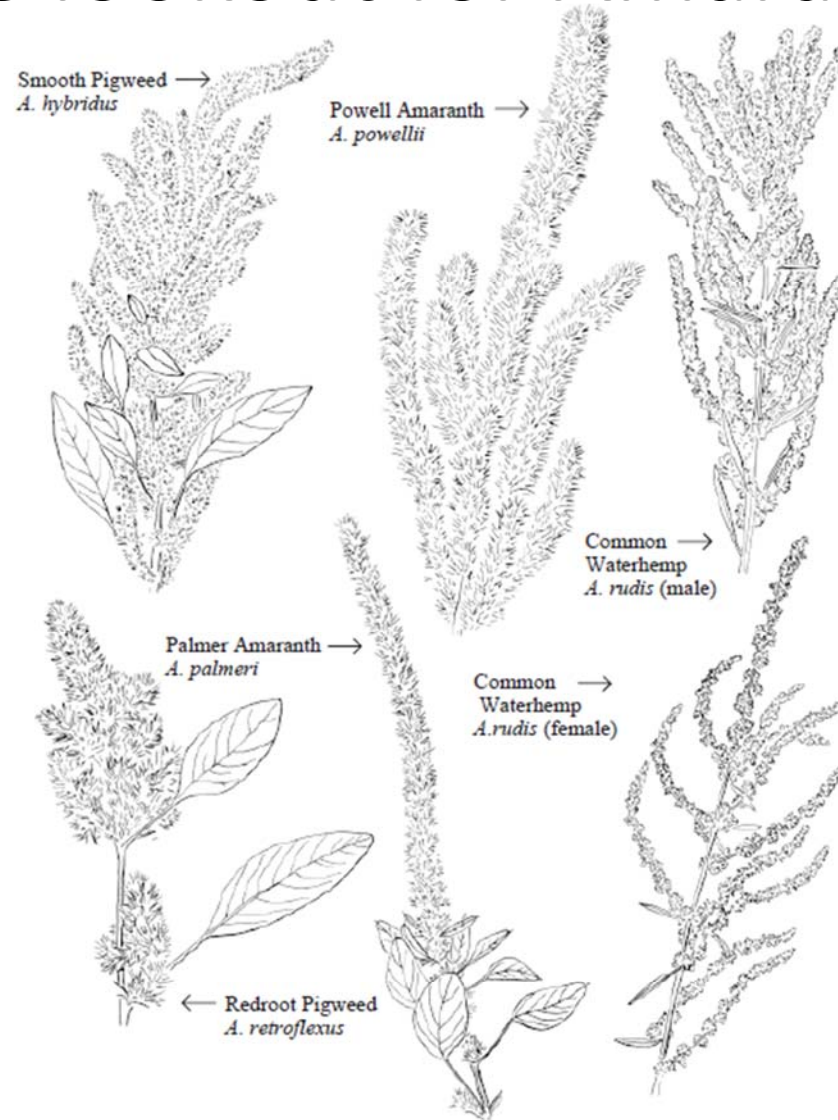


Figure 1. Seedhead shapes with male common waterhemp for comparison.



# Be on the lookout for Amaranths in WI

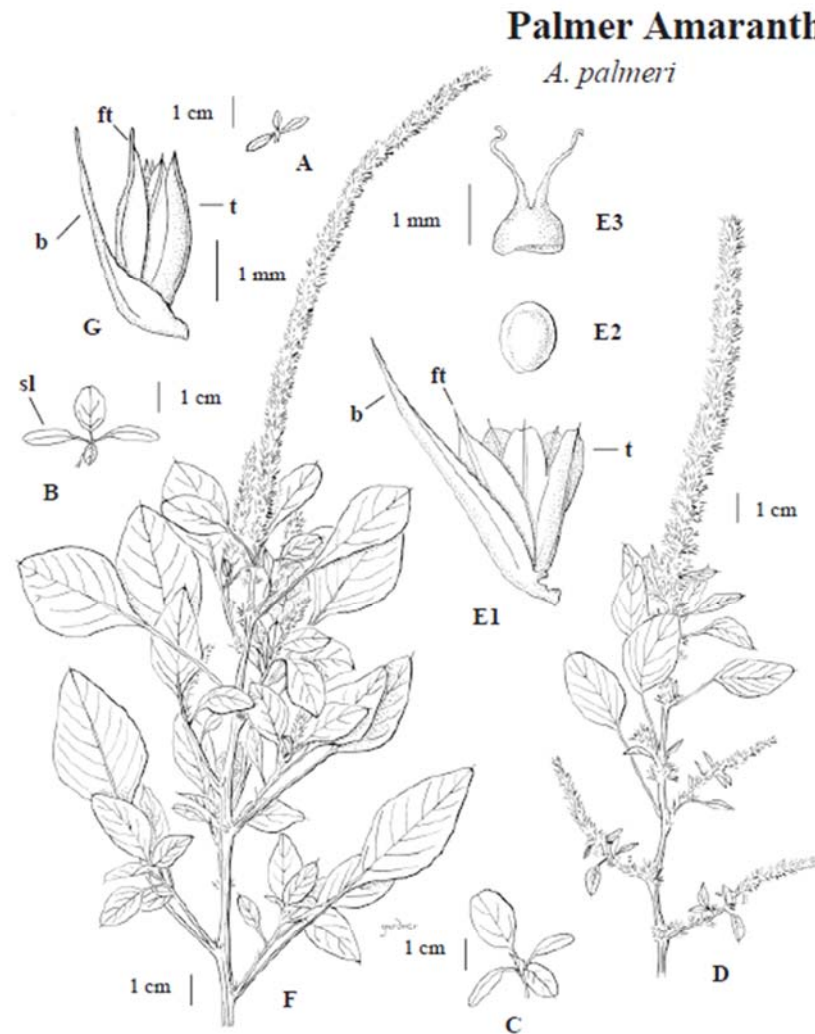


Figure 6. A-C. Seedlings: A. Seed leaf stage. B. Single-leaf stage (sl—seed leaf). C. Two-leaf stage. D. Seedhead (female plant). E. Female flower, exploded view: E1. Flower and bract; E2. Seed; E3. Seed cap. F. Flowering male plant. G. Male flower. (b—bract; ft—first tepal; t—tepals)





# Most concerning weeds for herbicide resistance in WI

- Giant Ragweed
  - CONFIRMED resistant to glyphosate
  - CONFIRMED resistant to cloransulam-methyl (FirstRate®)
- Amaranthus sps. (Palmer Amaranth and Waterhemp)
  - None confirmed resistant, but movement continues north (evidence in MI and IN)
- 2012 (and 2013) Late-season weed survey





## Late-Season Weed Escapes in Wisconsin Corn and Soybean

Vince M. Davis; Cropping Systems

Ross Recker; Weeds

The potential impact of late-season weed escapes in corn and soybean fields is a growing concern for growers. Management tactics, including

discing and

herbicide

management to delay the onset

of weeds that may be most vulnerable to

attention and pro-active resistance

management. To help with this, the

Madison Field Crops Weed Science Extension program is asking

growers to participate in a research study investigating the weed species diversity in

corn and soybean fields due to reduced atrazine use and subsequent

increased use of glyphosate. The purpose of this research is to identify areas in the state

Thanks for  
Funding  
from the

<http://www.zoomerang.com/Survey/WEB22FSESTMEKJ>





# OBJECTIVE OF LATE SEASON WEED ESCAPE SURVEY

- **Identify areas of Wisconsin for potential shifts to weeds that:**
  - are more difficult to control with glyphosate
  - where glyphosate resistant weeds may first appear
- **Direct attention to these areas**
- **Pro-active resistant management tactics can be implemented before wide-scale control failures occur**
- **Conduct glyphosate-resistant screening in the greenhouse**





# MATERIALS AND METHODS

- **On-line survey distributed to Wisconsin producers in June**
  - Generated sample locations
  - Gained crop history, herbicide use, tillage, and problematic weeds for sample locations
  - Lets take a quick look



# Field Survey for Late Season Weed Escapes

**Please enter information for just one field in your operation per survey.**

*You can fill out as many surveys (entering as many fields from your operation) as you would like by filling out additional surveys.*

**What is the name of the field you are going to enter information for in this survey?**

**Approximate field size (acres):**

**County:**

**What crop is currently growing in this field?**

**When was the last year atrazine was applied to this field?**

**What herbicides were applied to the field this year?**

Burndown and  
Preemergence:

Postemergence:

**What are the 5 most problematic weeds  
to control in this field?**

1.

2.

3.

4.

5.



*Compared to 10 years ago, how often do you now rely on atrazine in this field?* MORE, LESS, or ABOUT THE SAME

*Compared to 10 years ago, how often do you now rely on glyphosate in this field?* MORE, LESS, or ABOUT THE SAME

*Are you concerned about glyphosate-resistant weeds in this field?* VERY, A LITTLE, or NOT CONCERNED

*Which type of tillage system is typically used in this field?*

- Full ( < 15% residue at planting)
- Minimum (15% to 30% residue at planting)
- No-till ( > 30% residue at planting)

*How many total acres do you farm?*

*What percentage of your farm acres are usually planted to corn?*

*If you would allow UW Extension to survey this field for late-season weed escapes,  
please give the following information:*

Contact/Participant Name

Contact Phone Number

Contact Email





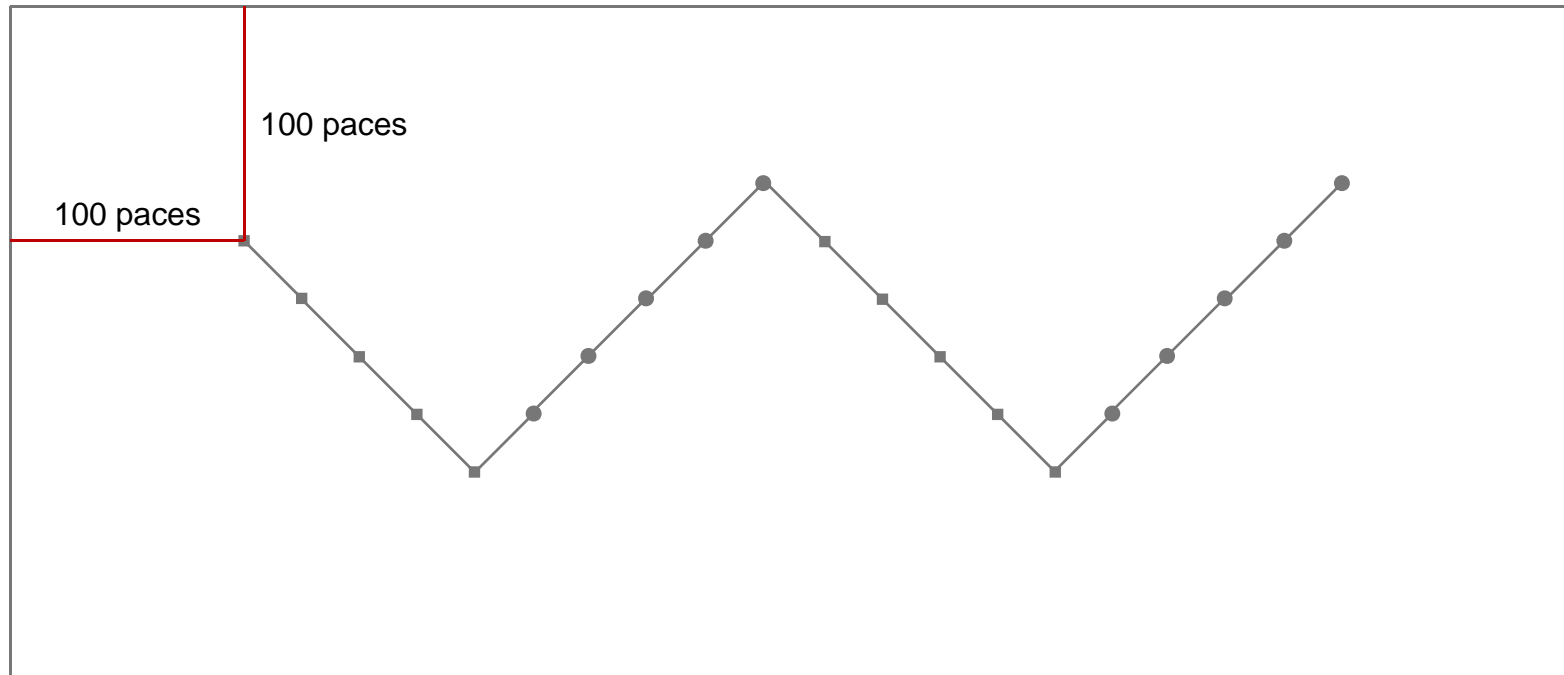
# MATERIALS AND METHODS

- **On-line survey distributed to Wisconsin producers in June**
  - Generated sample locations
  - Gained crop history, herbicide use, tillage, and problematic weeds for sample locations
  - Lets take a quick look
- **In-field survey in corn and soybean fields during late-July through early-September followed the online survey**



# MATERIALS AND METHODS

- **In-Field Survey Sampling Procedure**



- 20 quadrants ( $\text{m}^{-2}$ ), spaced approximately 20 m apart
- Counted number of each weed species in each quadrant





# MATERIALS AND METHODS

- **Frequency data were calculated for each weed species**

$$\text{Frequency} = \frac{\text{number of fields where species occurred}}{\text{number of fields sampled}} \times 100$$

- **Data can be grouped separately by**
  - Region (based on National Agricultural Statistics Service reporting districts)
  - Crop, tillage, atrazine use history
    - not focusing on these categories today



# REGIONS

**NC**

**C**

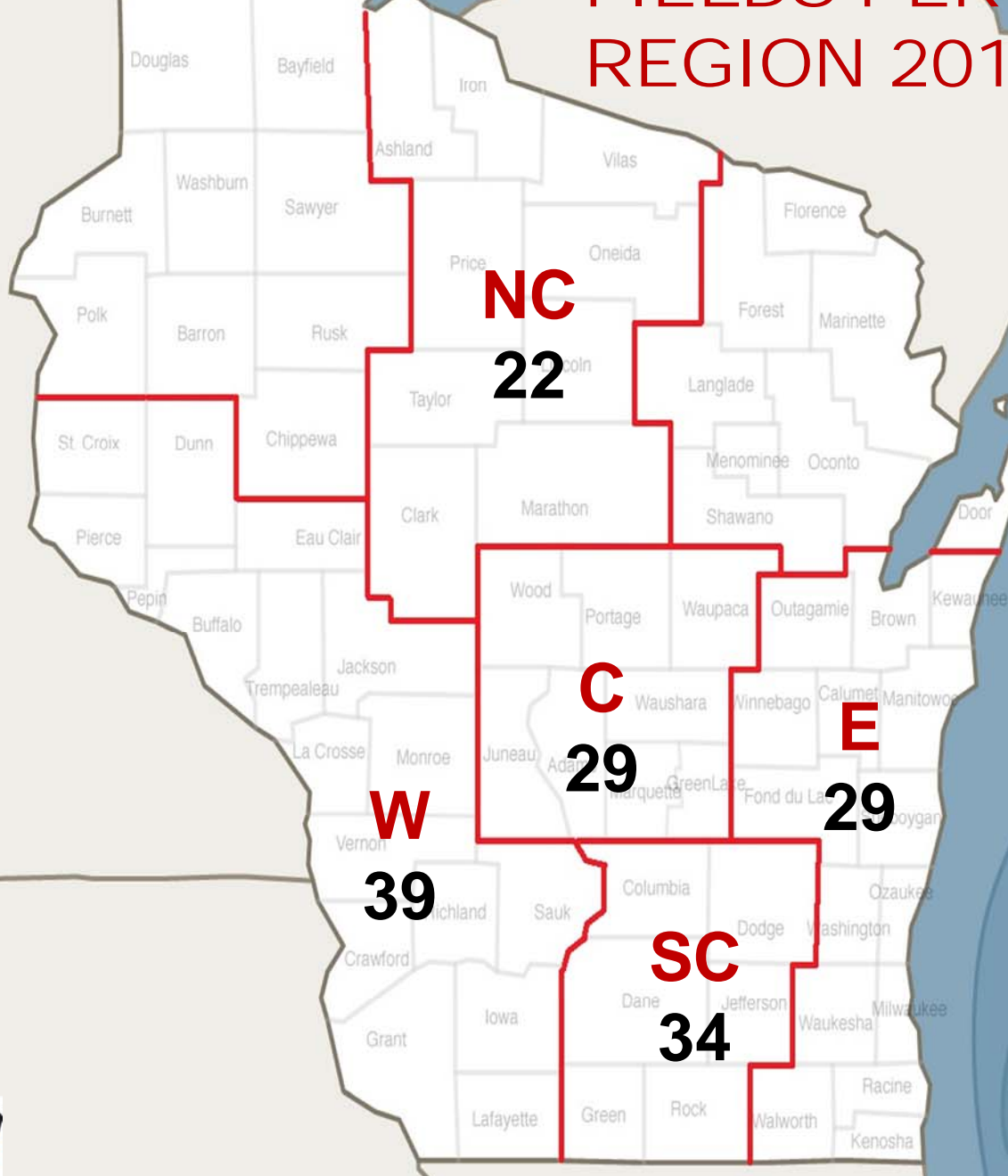
**W**

**E**

**SC**



# FIELDS PER REGION 2012





# FIELDS PER REGION 2013

**NC**  
**20**

**C**  
**22**

**W**  
**58**

**E**  
**23**

**SC**  
**67**



# FIELDS PER REGION TOTAL

**NC**  
**42**

**C**  
**51**

**E**  
**52**

**W**  
**97**

**SC**  
**101**





# 2012 IN-FIELD SURVEY

- **153 fields sampled (Number of fields surveyed by crop and region shown below)**

	-----Crop-----		-----Region-----				
	Corn	Soybean	NC	W	C	E	SC
Fields Surveyed	90	63	22	39	29	29	34

- **64 different weed species documented**
  - 43 broadleaf species
  - 21 grass species or plants resembling grass species
- **Top 5 most frequent weeds and percent frequency**
  - 1) Common lambsquarters (58.3%)
  - 2) Dandelion (57.6%)
  - 3) Velvetleaf (32.5%)
  - 4) Giant foxtail (24.5%)
  - 5) Yellow foxtail (22.5%)





# 2013 IN-FIELD SURVEY

- **190 fields sampled (Number of fields surveyed by crop and region shown below)**

	-----Crop-----		-----Region-----				
	Corn	Soybean	NC	W	C	E	SC
Fields Surveyed	110	80	20	58	22	23	67

- **82 different weed species documented**
  - 61 broadleaf species
  - 21 grass species or plants resembling grass species
- **Top 5 most frequent weeds per field and percent frequency**
  - 1) Dandelion (62.6%)
  - 2) Common lambsquarters (54.7%)
  - 3) Velvetleaf (34.7%)
  - 4) Fall panicum (22.1%)
  - 5) Volunteer corn (22.1%)





# 2012 & 2013 IN-FIELD SURVEY

- **190 fields sampled (Number of fields surveyed by crop and region shown below)**

	-----Crop-----		-----Region-----				
	Corn	Soybean	NC	W	C	E	SC
Fields Surveyed	110	80	42	97	51	52	101

- **92 different weed species documented**
  - 67 broadleaf species
  - 25 grass species or plants resembling grass species
- **Top 5 most frequent weeds and percent frequency**
  - 1) Dandelion (59.8%)
  - 2) Common lambsquarters (56.0%)
  - 3) Velvetleaf (32.8%)
  - 4) Fall panicum (21.6%)
  - 5) Yellow foxtail (21.3%)



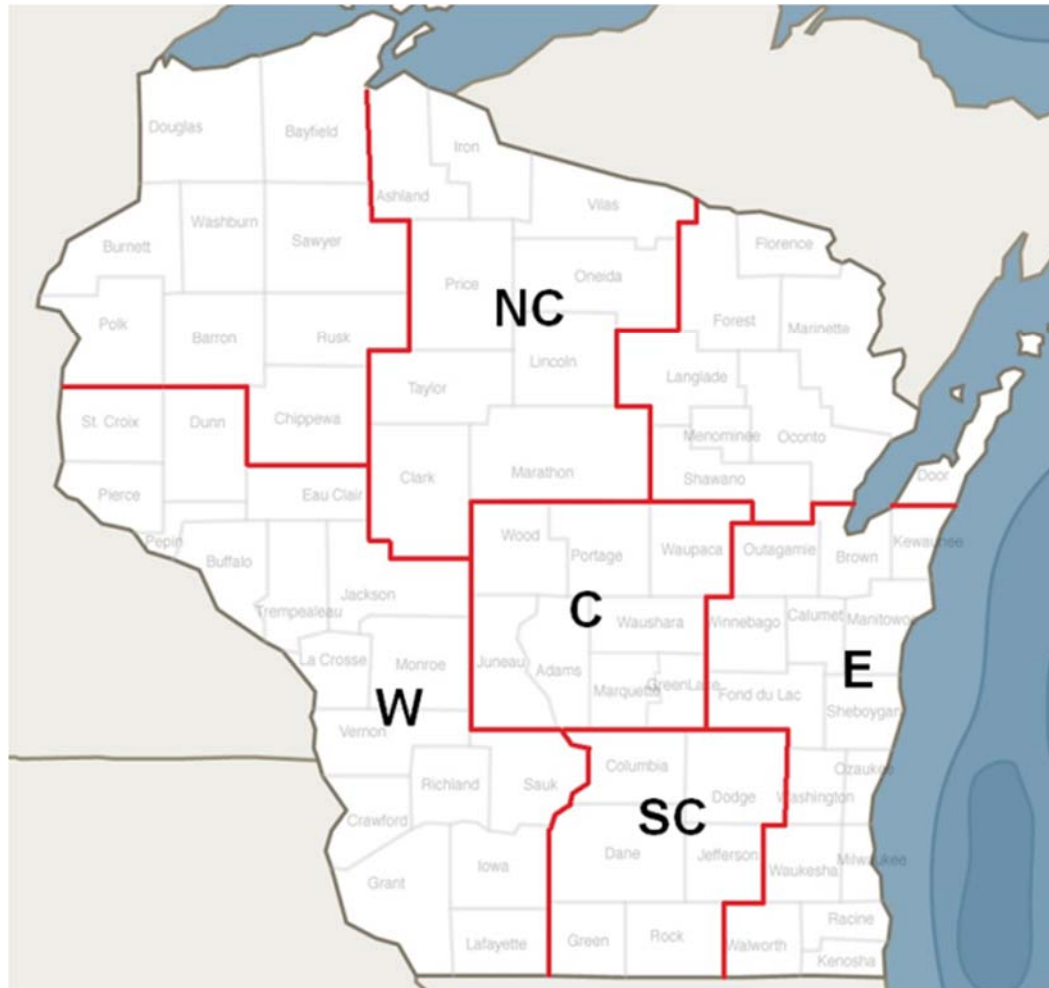


# WEEDS COLLECTED WITH SUSPICION OF GLYPHOSATE RESISTANCE

-----Number of Populations Collected-----			
Weed Species	2012	2013	Total
Giant ragweed	5	10	15
Waterhemp	5	9	14
Common lambsquarters	5	1	6
Velvetleaf	4	1	5
Powell amaranth	3	-	3
Common ragweed	2	1	3
Redroot pigweed	2	-	2
Horseweed	1	1	2
Smooth pigweed	1	-	1
Ladysthumb	1	-	1



# WHERE IS THE GIANT RAGWEED AND WATERHEMP?





# GIANT RAGWEED





# GIANT RAGWEED





# WATERHEMP





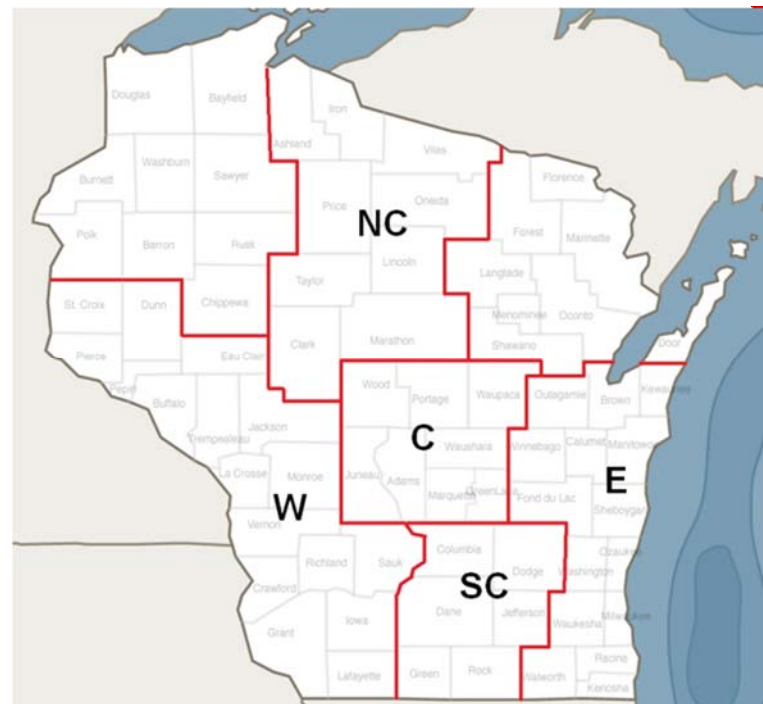
# Common Waterhemp (*Amaranthus rudis*)

- Resistant to 6 herbicide Mode-of-Actions!





# WHERE IS THE GIANT RAGWEED AND WATERHEMP?



Common Name	State	Region					Chi-square test <sup>1</sup>
		NC	W	C	E	SC	
		----- % -----					P-value <sup>2</sup>
Giant ragweed	12.5	0.0	<b>21.7</b>	3.9	1.9	<b>18.8</b>	<.0001****
Waterhemp	8.8	2.4	8.3	0	9.6	15.8	0.0092***

<sup>1</sup> P-Value Significance: 0 to 0.001 = '\*\*\*\*'; 0.001 to 0.01 = '\*\*\*'; 0.01 to 0.05 = '\*\*'; 0.05 to 0.1 = '\*'

<sup>2</sup> A significant p-value indicates a correlation between weed species frequency and crop type.





# GIANT RAGWEED MANAGEMENT

**One-pass programs –WILL NOT WORK**

**Start with clean field, Use a residual herbicide**

**In soybean**

1. Use a PRE PPO + cloransulam (Authority First/Sonic; Gangster)
2. Use a PRE PPO + imazethapyr (Authority assist, Optill) or PRE PPO + PSII (Authority MTZ or Lorox) or PRE PPO + seedling shoot inhibitor (Prefix)

**Follow all pre programs with TIMELY postemergence applications!**





# GIANT RAGWEED MANAGEMENT

## In corn

Use a PRE triazine + acetanilide + HPPD

Followed by: Glyphosate + .....

HPPD and/or triazine and/or ALS and/or growth regulator (Callisto Xtra, Halex, Laudis, Capreno, Status, Northstar, Yukon)

**Spray postemergence applications TIMELY!**



# HORSEWEED





**Glyphosate-resistant horseweed  
Jefferson County, WI**

**Glyphosate-susceptible horseweed  
Grant County, WI**



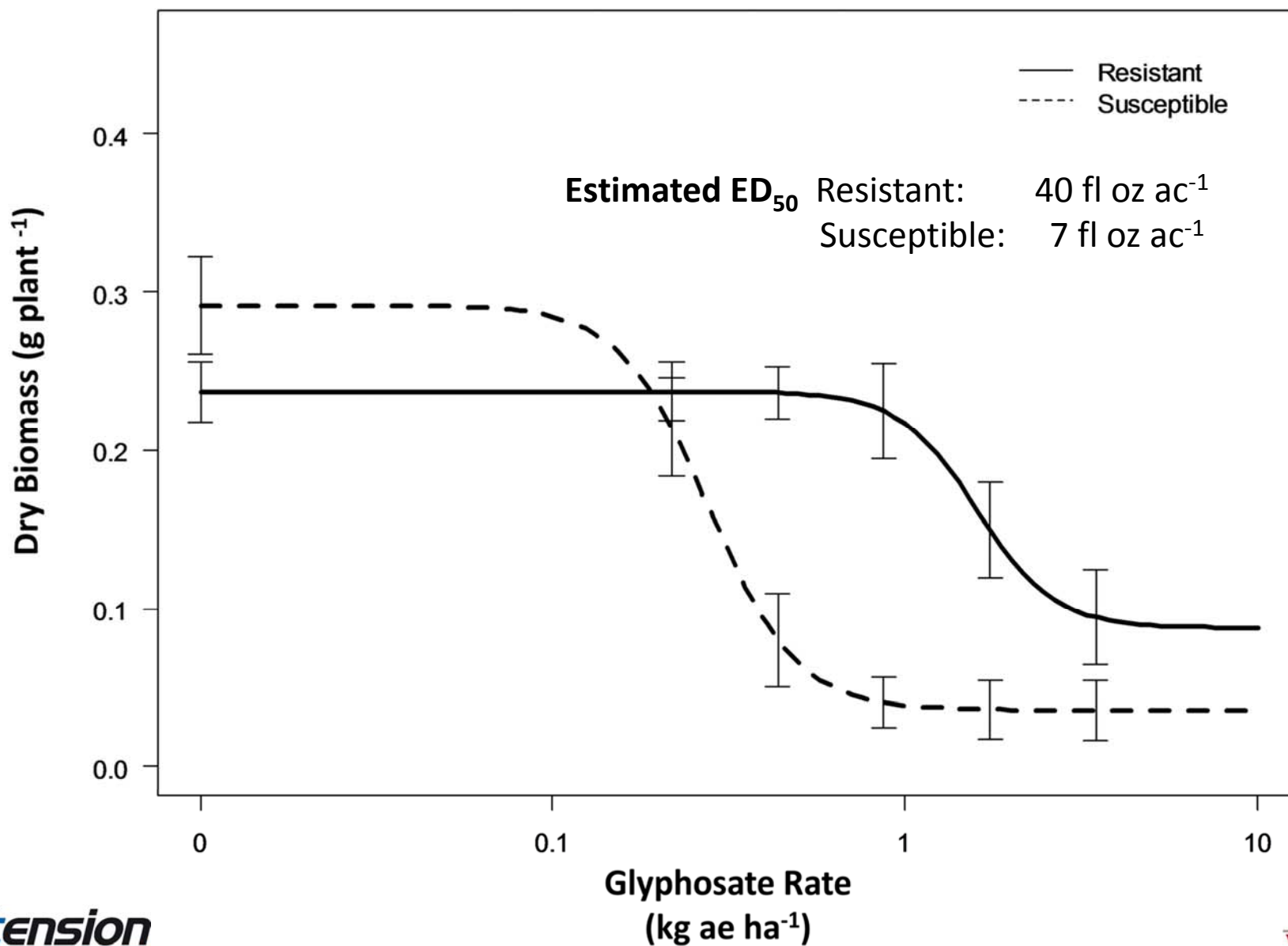
**4x    2x    1x    0.5x    0.25x    0x    0x    0.25x    0.5x    1x    2x    4x**

**Glyphosate rate for each column of plants**

**(1x = 0.87 kg ae ha<sup>-1</sup>)**



## Response to Glyphosate from Two Wisconsin Horseweed (*Conyza canadensis*) Populations Collected in 2012







# Horseweed Management

---

- Horseweed (*Conyza canadensis*) is typically a winter annual weed.
- Mostly a problem in no-till production
- Very small seeded with low seedbank survival
- Start with a clean field
  - Spring tillage works well
  - In No-till, time burndown applications prior to 4" vertical growth
  - Include 2,4-D with glyphosate but observe preplant interval
  - Use effective residual herbicides to provide season long control





# Resistance, In conclusion

---

- Herbicide Resistance is a major problem in many surrounding states, and it continues to be a major concern in WI
- We must consider all Integrated Weed Management options in our crops, especially if you notice certain weeds are becoming more difficult to control





# Resistance, In conclusion

---

- Know your target weed problems
- Plan to rotate herbicide Mode of Actions
- Start with clean fields
- Use residual herbicides
- Consider in-crop tillage

The WI advantage:

- For annual weeds populations that become extremely challenging to control, consider rotating to a perennial forage crop alfalfa



# Value of Residual Herbicide in Reduced Soybean Stands



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<http://www.plantmanagementnetwork.org/edcenter/seminars/soybean/residualherbicide/>


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### Value of Residual Herbicide in Reduced Soybean Stands

April 2013



By Vince M. Davis, Ph.D.  
Assistant Professor  
University of Wisconsin-Madison  
Phone: 608-262-1392  
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<b>Executive Summary</b> (5 min 18 sec)	<b>Full Presentation</b> (36 min 01 sec)
for PC and Android	for PC and Android
for Apple devices	for Apple devices

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**Summary:** This presentation will help consultants, growers, and other practitioners in the North Central U.S. evaluate the importance of residual herbicide use in soybean systems to maximize profit and proactively manage for herbicide resistance. Herbicide-resistant weeds are a serious threat across the Nation. It is important to maximize the benefits of cultural weed control by using the best agronomic management practices. However, the cost of soybean seed is dramatically increasing and this presentation discusses the interaction and relative importance of residual herbicide verses extra soybean plants in the canopy.

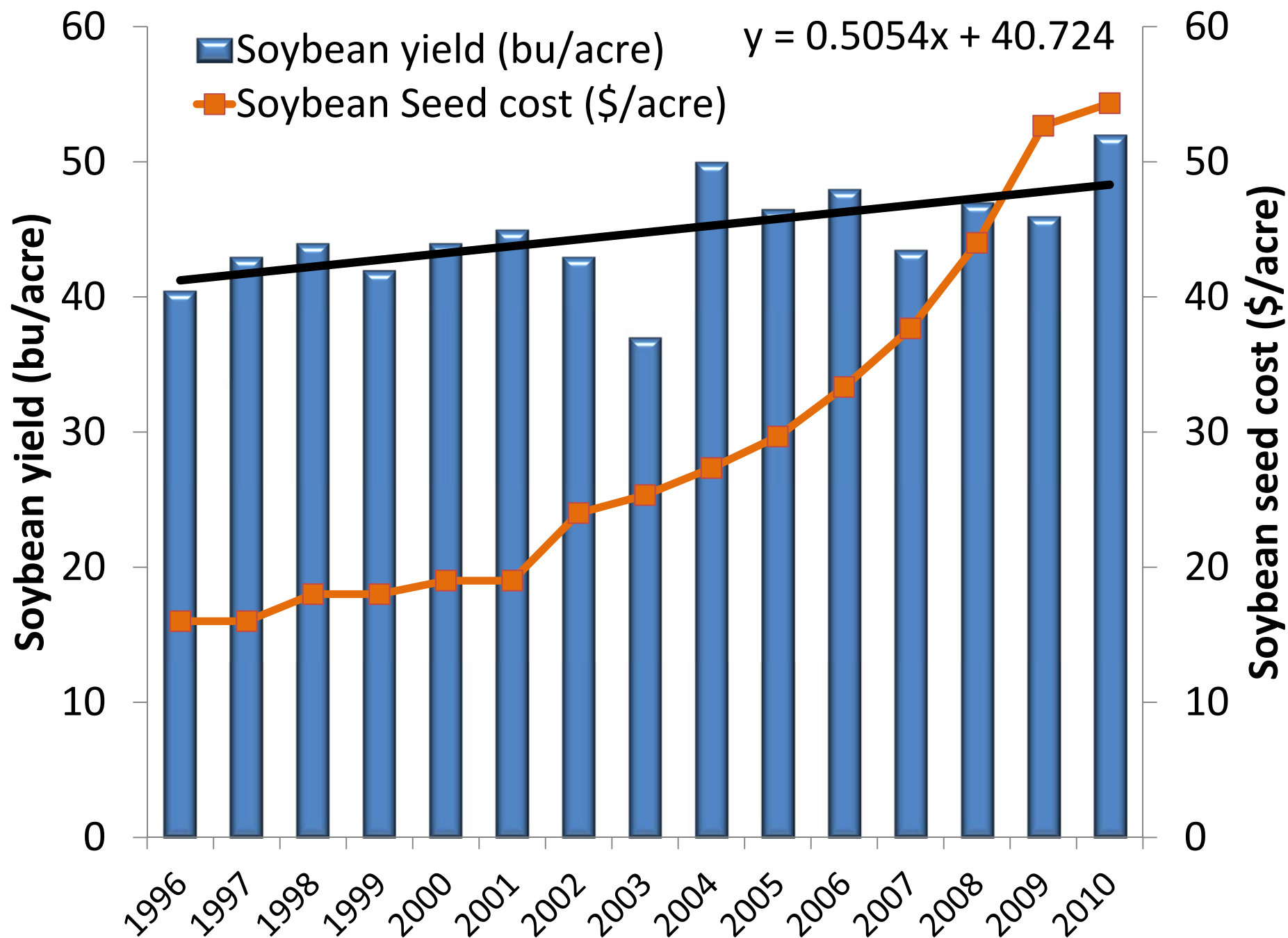


# Background

- Soybean seed costs have dramatically increased since the mid 1990's
- Soybean growers in the Midwest are reducing seeding rates; current recommendations are to establish a stand of 100,000 plants per acre
- Glyphosate-Resistant weeds are a major concern for the sustainability of soybean production
- Rotating herbicide mode-of-actions, mainly through preemergence residual products, is often the first recommendation to avoid herbicide resistance
- Crop canopy closure aids in weed suppression, earlier canopy development is better





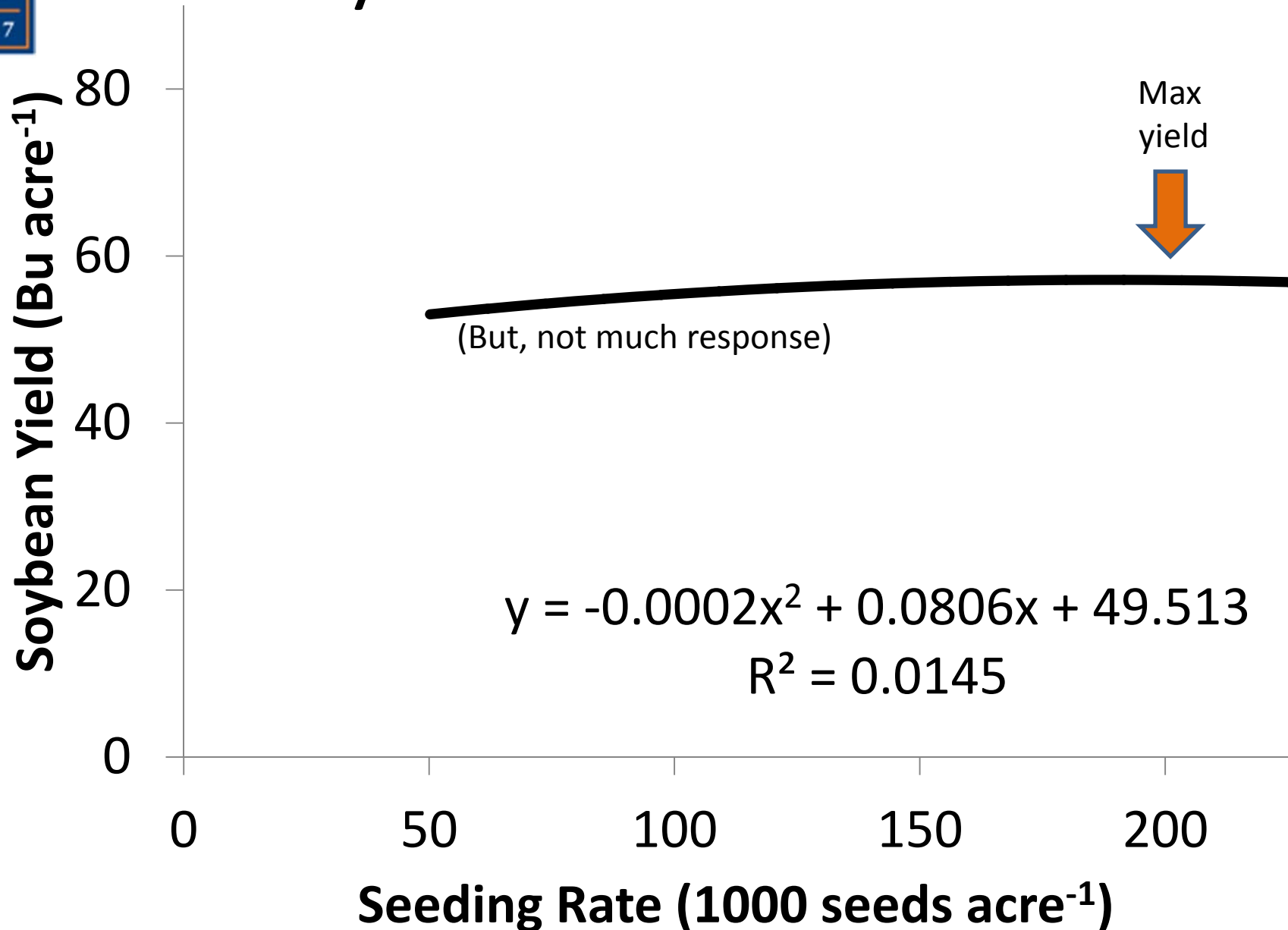


Soybean yield data: <http://www.nass.usda.gov/> Seed Cost data: <http://www.farmdoc.illinois.edu/>





# 50 site years of data from Illinois







# What is the value of residual herbicides in low seeding rate soybean systems?

Current M.S. graduate project, Mr. Ryan DeWerff

## ○ Site Description

- 2012 Data only
- Field Preparation
  - Fall - chisel plowed
  - Spring – field cultivated
- Planted on **May 21**
  - **15" rows**
- Predominant Weeds
  - giant foxtail
  - Redroot pigweed
  - common lambsquarters
  - common ragweed

## ○ Experimental Design

- 2 x 2 x 5 factorial in RCB
  - **[2] With or without PRE residual**
  - [2] POST herbicide programs applied at V4
    - glyphosate
    - conventional
  - [5] Soybean seeding rates
    - high
    - moderate
    - high blend
    - moderate blend
    - low



# Seeding Rate by Residual herbicide use

Herbicide Treatments		Seeding Rate Structure	
		Seeds / acre	
PRE residual	S-metolachlor+	High	190,000 GR <sup>a</sup>
	fomesafen	Moderate	120,000 GR <sup>a</sup>
Conventional program	imazamox fb	High blend	120,000 GR <sup>a</sup>
	fluazifop <sup>b</sup>		70,000 C <sup>b</sup>
Glyphosate program	glyphosate+	Moderate blend	95,000 GR <sup>a</sup>
	imazamox		35,000 C <sup>b</sup>
		Low	60,000 GR <sup>a</sup>

<sup>a</sup>glyphosate-resistant seed

<sup>b</sup>conventional seed



# Canopy at 4 **WAP** (weeks after planting)

With PRE herbicide (top)



seeds/  
acre **60,000**



**120,000**



**190,000**



Without PRE herbicide (bottom)



# Canopy at 4 WAP (weeks after planting)

With PRE herbicide (top)



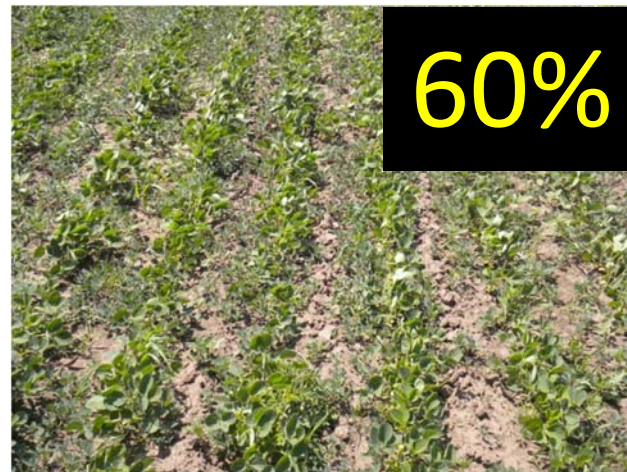
seeds/  
acre 60,000



120,000



190,000



Without PRE herbicide (bottom)



# Canopy at 8 WAP; 3 week after POST

With PRE herbicide (top)



seeds/  
acre **60,000**



**120,000**



**190,000**



Without PRE herbicide (bottom)



# Canopy at 8 WAP; 3 week after POST

With PRE herbicide (top)



seeds/  
acre 60,000



120,000



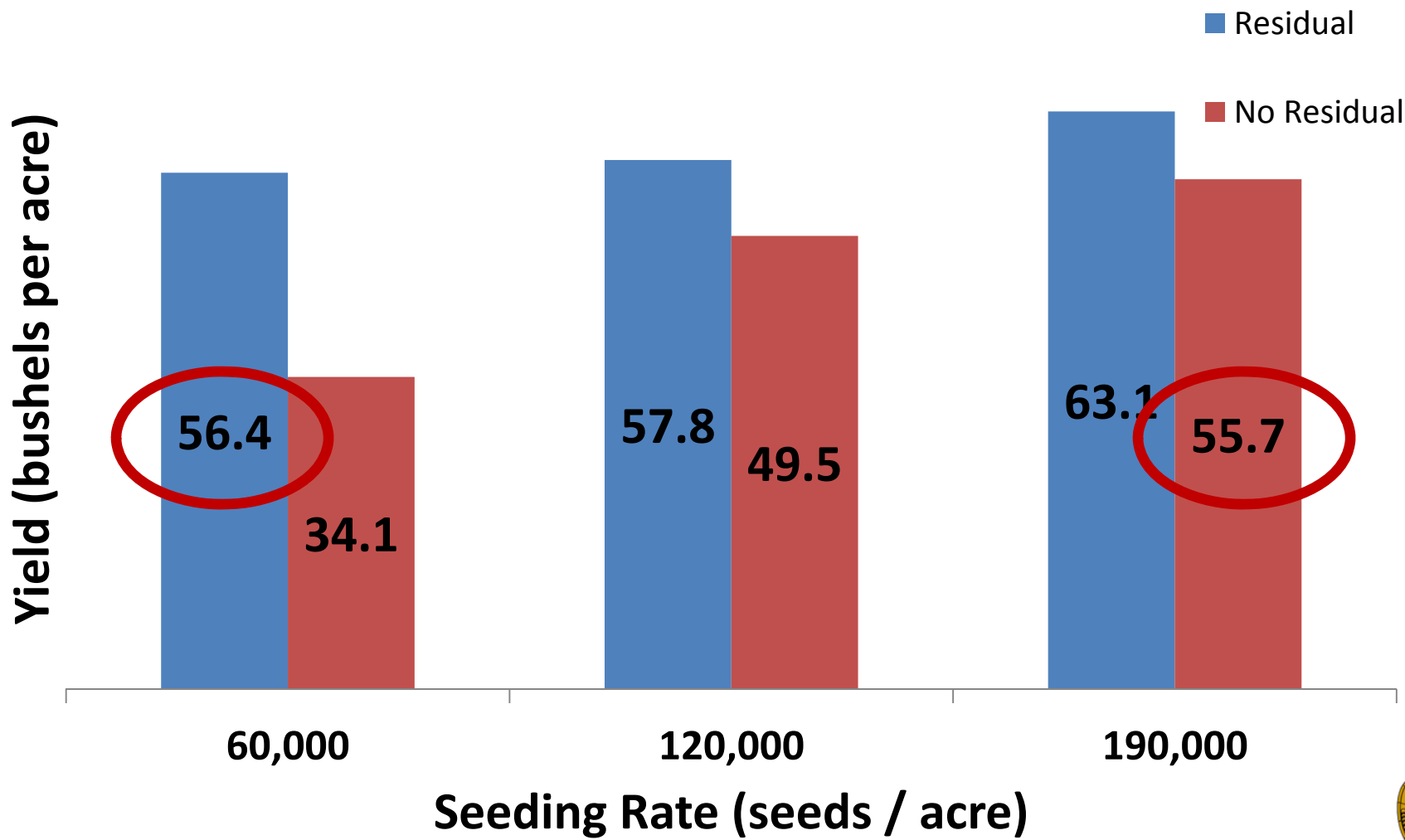
190,000



Without PRE herbicide (bottom)



# Yield for Seeding Rate by Residual herbicide use (POST Gly + Conv pooled)





# In Conclusion

- Continue to target an establishment soybean population of 100,000 plants per acre, but monitor State Soybean Extension Specialist recommendations and monitor the Economics that may drive that target even lower
- Scout fields and create records of the most problematic weed species on a field-by-field basis to plan for appropriate herbicide programs with using multiple Modes of Action for the weeds of most concern
- Start with a weed-free field and use a residual herbicide to limit early-season weed competition, This will:
  - Maximize canopy development
  - Limit the number of weeds exposed to POST herbicides
  - Limit the size of weeds that are exposed to POST herbicides
- Routinely scout in-crop and make timely POST applications





## WEED OUT RESISTANCE

- Know Your Weeds
- Know Weed Growth
- Know Weed Seed Characteristics
- Know Herbicide Resistance

## IN THE FIELD

- Crop Rotation
- Multiple Herbicide Modes of Action
- Mechanical Practices
- Know Herbicide Tolerant Traits

## SPRAY ATTENTION

- Herbicide Mode of Action and Properties
- Drift Management
- Know Environmental Conditions
- Know Your Neighbors

## THE BOTTOM LINE

- Risk Management
- Cost-Benefit of Practices
- Know the Cost of Poor Weed Control





# Change in Herbicide Diversity Over Time

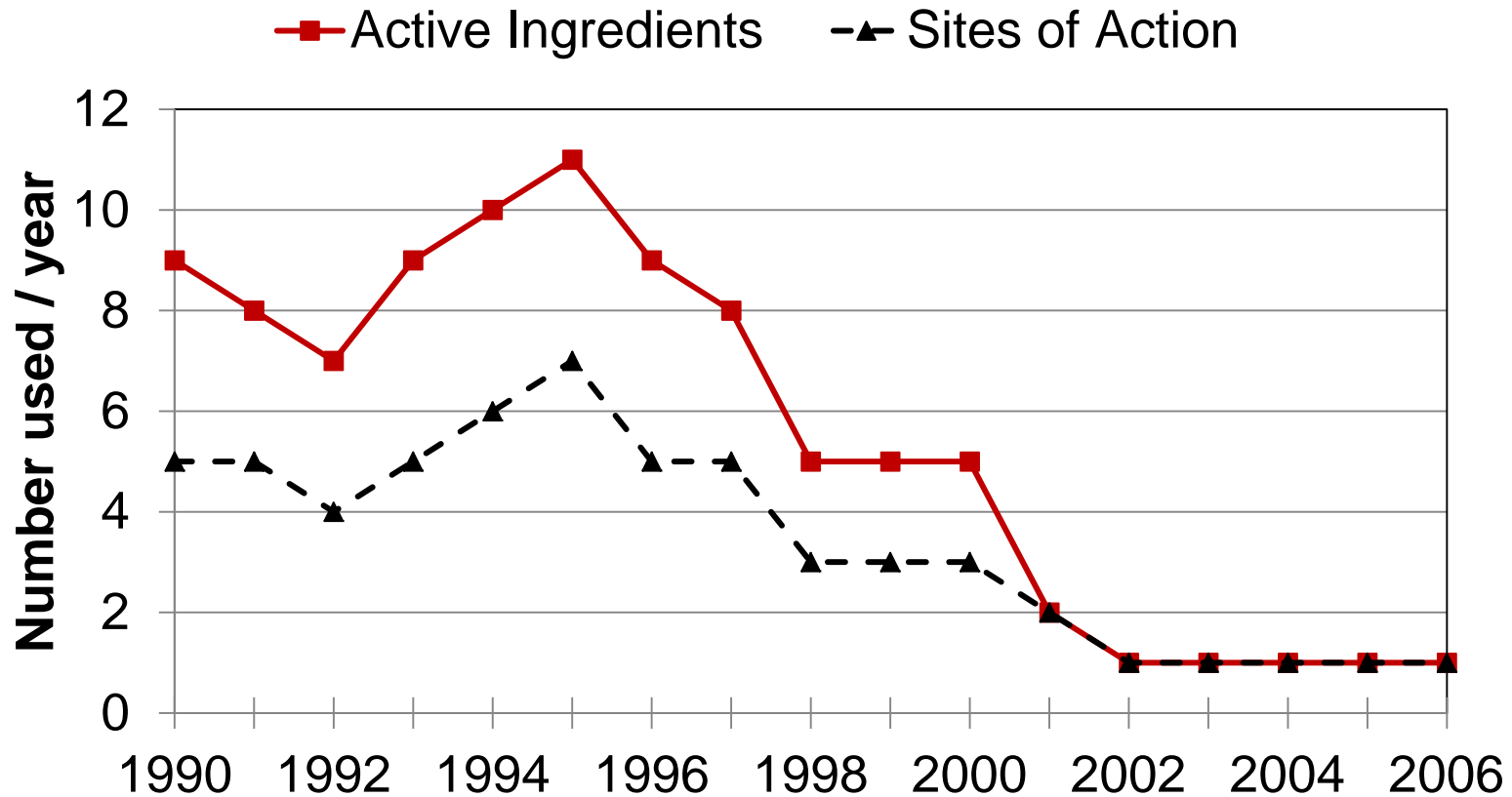


Figure 1. Number of different herbicide active ingredients and herbicide sites of action used on at least 10% of U.S. soybean hectares from 1990 to 2006. Data adapted from USDA-NASS (2008)



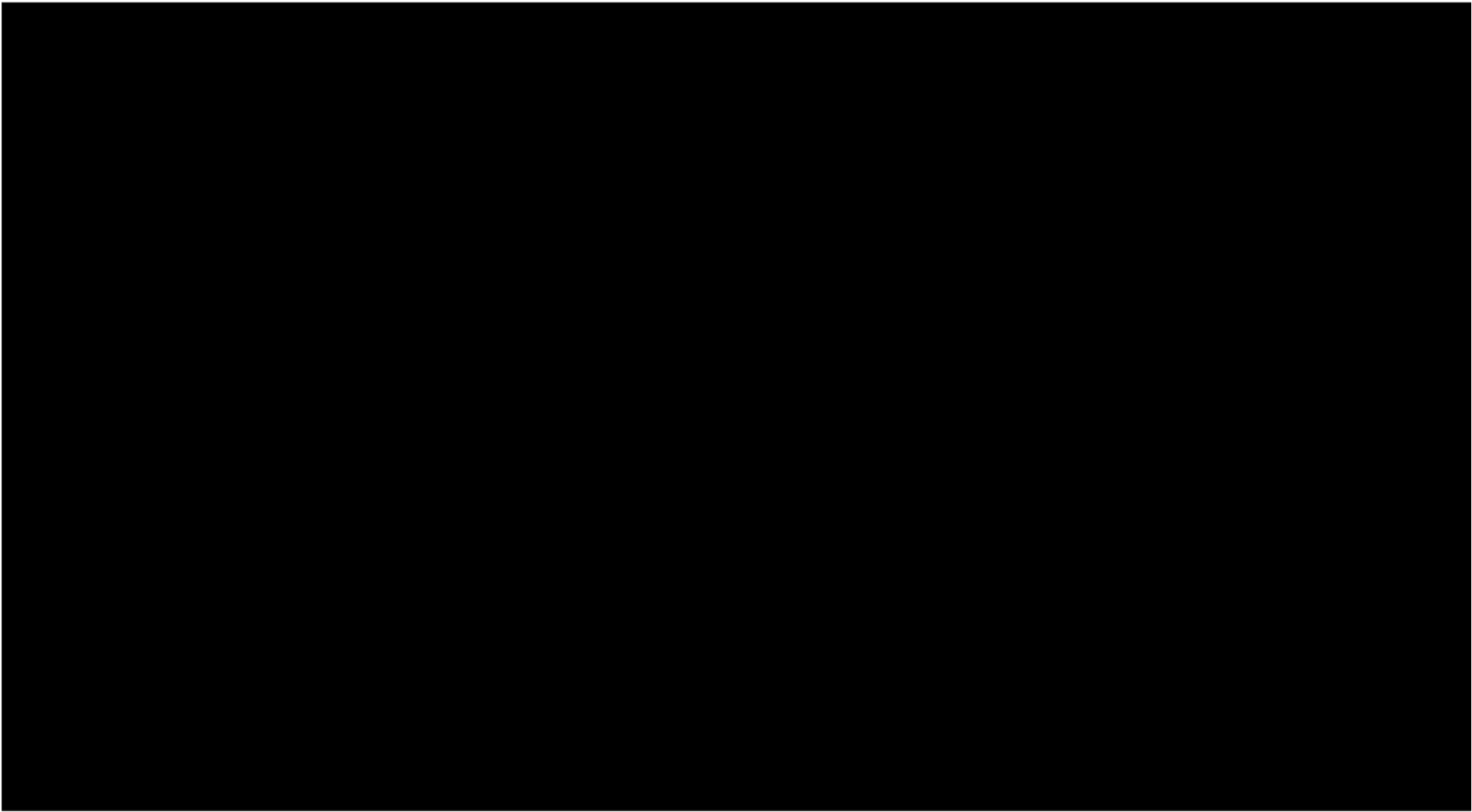
# Herbicide Resistant Weed Management Training videos

1. Highlights from this year's Agronomy Field Day- Use of Residual Herbicides at Low Soybean Seeding Rates (Project will be completed in Winter 2014)
2. Herbicide Resistant Weed Management Training Module (Project will be completed in Winter 2014)











# National Threat of Glyphosate-Resistant Pigweeds:

UW efforts to research and extend relevant information in Wisconsin



**WISCONSIN**  
UNIVERSITY OF WISCONSIN-MADISON

*Dr. Vince Davis, Dr. Elizabeth Bosak, Tommy Butts, Daniel Smith*



# Project Summary

- National study conducted at 9 separate universities
- Sponsored by the United Soybean Board
- Aims to provide information on the biology, seed dynamics, and traditional vs. non-traditional methods for controlling pigweed species in soybean production systems



# Pigweed Seedlings



Images courtesy of  
UW-Madison Weed  
Science Department





# Pigweed Species



**Palmer Amaranth**

Rebekah D. Wallace, University  
of Georgia, Bugwood.org



**Waterhemp**

Bruce Ackley, The Ohio State  
University, Bugwood.org



**Powell Amaranth**

Bruce Ackley, The Ohio State  
University, Bugwood.org



**Redroot Pigweed**

Mary Ellen (Mel) Harte,  
Bugwood.org



# Tillage Effects on Pigweed Emergence

- Small-scale study evaluating pigweed emergence in three tillage systems: no-till, pre-plant tillage, and pre-plant tillage with interrow cultivation (Spring 2013)
- Larger-scale study with 4 tillage regimes (Fall 2013)
  - Fall moldboard plow, Spring field cultivator
  - Fall chisel plow, Spring field cultivator
  - Vertical tillage
  - No-till



# Tillage Effects on Pigweed Emergence





# Pigweed Seed Persistence

- Study will be initiated this fall and continue for the next 3 years
- Two pigweed species at two different soil depths
- Each year, four replicates will be removed and seed germination will be assessed



# Pigweed Seed Retention at Soybean Harvest

**Goal:** To determine the percentage of pigweed seed retained by the plant at soybean maturity to assess the effect on soil seedbank management.

## Materials & Methods:

- 5 fields were sampled and 5 mature pigweed plants were harvested from each field (25 total plants)
- Seed will be threshed, and weighed to determine total seed production per plant
- Germination tests will be conducted to assess the viability of new seeds in the soil seedbank





# Soybean Row Width and Seeding Rate Effect on Pigweed Development

**Goal:** To evaluate the impact of soybean seeding rate and row width on pigweed development and control in a Liberty Link soybean system.

## Materials & Methods:

- Row Width: 15" and 30"
- Seeding Rate: 70,000; 130,000; and 190,000 seeds per acre
- Herbicide Programs: PRE + POST vs. POST
- Weed counts and heights were taken twice during the growing season
- At soybean harvest, pigweed dry biomass and total seed production were measured
- Soybean canopy closure was measured using digital imagery and yield was recorded at harvest





15", 190,000 seeds/acre, PRE+POST



15", 190,000 seeds/acre, POST only



30", 70,000 seeds/acre, PRE+POST



30", 70,000 seeds/acre, POST only



# Managing Pigweeds Utilizing New Herbicide Technologies

**Goal:** To develop strategies for managing pigweed species assuming resistance to various combinations of multiple herbicide modes of action.

## Materials & Methods:

- Weed control ratings were taken to determine the residual control of herbicides such as 2,4-D and dicamba
- Weed counts and heights were recorded 21 d after the early POST and 21 d after the late POST applications to assess the whole herbicide program's effectiveness



# Cover Crops Influence on Pigweed Populations

**Goal:** To establish the value of cover crops for suppressing pigweed populations.

## Materials & Methods:

- Oats, cereal rye, and an untreated control were established this fall
- Stand counts, heights, and biomass were collected to characterize the cover crop
- Next season, emerged pigweed species will be counted to assess cover crop suppression of weed populations





# Effects of Herbicide Carryover on Cover Crop Establishment

**Goal:** To assess the impact of herbicide carryover on cover crop establishment.

## Materials & Methods:

- Herbicide treatments were applied this spring to determine potential for decreased cover crop stands due to carryover
- 3 annual rye varieties, cereal rye, tillage radish, and oats/field peas were seeded this fall and evaluated for stand vigor
- Next spring, the cover crops will be rated based on their weed suppression abilities





# THANK YOU!

**Vince M. Davis**

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## Questions?