

Take Control – Putting It All Together

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National Summit on Strategies to Manage Herbicide-Resistant Weeds

<http://nas-sites.org/hr-weeds-summit/>

- Need to move from product-based systems to science-based solutions

Old paradigm (overly simplified)

- Growers as “customers” buying products “off the shelf”
- Simplification of weed management reduces knowledge requirements
- New products will solve problems
- Strategy is to keep new products coming



National Summit on Strategies to Manage Herbicide-Resistant Weeds

<http://nas-sites.org/hr-weeds-summit/>

- Need to move from product-based systems to science-based solutions

Challenges of new paradigm

- Information & knowledge will substitute for chemical compounds
- Grower participation & input will be critical for success
- Growers less likely to participate if they perceive it only leads to regulatory tightening
- Growers need to recognize benefits of a more Integrated Approach




We Have Been Addressing Herbicide Resistance Since the late 1980's

North Central Regional Publication 377

Herbicide Mode of Action and Injury Symptoms

1989




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Herbicide Mode of Action and Crop Injury Symptoms

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Note: This is a Web Sampler. More information and how to order is available [here](#).




A CD-Rom from the University of Minnesota Extension Service for Agricultural professionals & weed science students

Let the Herbicide Mode of Action CD-ROM work for you

Herbicide Resistant Weeds

J. L. Gunsolus

1993



What Does Glyphosate Resistance Look Like?

Photo Credits to Dave Nicolai & Jeff Stachler

Present



Glyphosate Injury Dying? Not Dying

Glyphosate Injury Single Species Patchy Distribution



The Main Drivers of Herbicide Resistance Evolution

- Selection intensity – using the same weed management tactic again and again
 - Need for diversification of weed management tactics
- Allowing weed population size to increase in the seed bank
 - Increases probability of a R-trait
 - Need to prevent pollen and seed production



Impediments to Weed Management

- Durable Weed Management Practices Can Get Sidetracked by One-Year Business Cycles

Prevention vs. Remediation

- “Farmers are loathe to institute complicated preemptive resistance management schemes, especially if they cost more. Still, the best remedial strategy is to look over one’s shoulder and learn from the mistakes of others. When there is resistance somewhere to a pesticide under a similar cropping system, it is time to get scared, and not to say “it hasn’t happened here, therefore it won’t”. When the first resistance appears, and it is not spread throughout the population, further enrichment of resistant individuals in the population can be delayed.”

Jonathan Gressel et al. **1996**.

In Molecular Genetics and Evolution of Pesticide Resistance

ACS Symposium Series; American Chemical Society; Washington, DC

Impediments to Weed Management

- Durable Weed Management Practices Can Get Side-Tracked by Business Plans
 - The 1990's brought us the “dollar today is worth more than a dollar tomorrow” approach to weed management.
 - The early 2000's brought us into an era of uncertainty between herbicide/agricultural business plans and the seed industry business plans
 - The right herbicide on the right weed at the right time works best if one company owns an array of herbicide products.
 - The herbicide resistant trait technology is hampered by the potential confounding of an array of HR traits and the limits to seed storage and distribution....the right path often isn't clear



Impacts of Herbicide Resistance to Weed Management Strategies

- What is at risk?
 - Reducing the durability of developing herbicide resistant crop technologies
 - Enlist (2,4-D + Glyphosate + Glufosinate - SOA# 4,9,10)
 - Xtend (Dicamba + Glyphosate – SOA #4,9)
 - MGI (Mesotrione and Isoxaflutole - SOA #27)
 - Herbicide-based strategies become less effective
 - Overwhelmed by population density
 - Resistance to MULTIPLE SOA's will be THE ISSUE
 - Loss of herbicides critical in minor use crops such as canning peas and sweet corn



Moving Forward

- An observation from this year's North Central Weed Science Society meeting makes it clear that as the Seed/Agrichemical Industry develops new Herbicide Resistant Crop Technologies - All Companies will implement a PRE / POST system
 - ✓ Enlist from Dow AgroSciences (SOA #4)
 - ✓ Xtend from Monsanto (SOA#4)
 - ✓ MGI from Bayer & Syngenta (SOA #27)
- Stacking of Multiple- Herbicide Resistant traits in Crop will continue to increase – but will it get ahead of multiple-resistance in weeds?



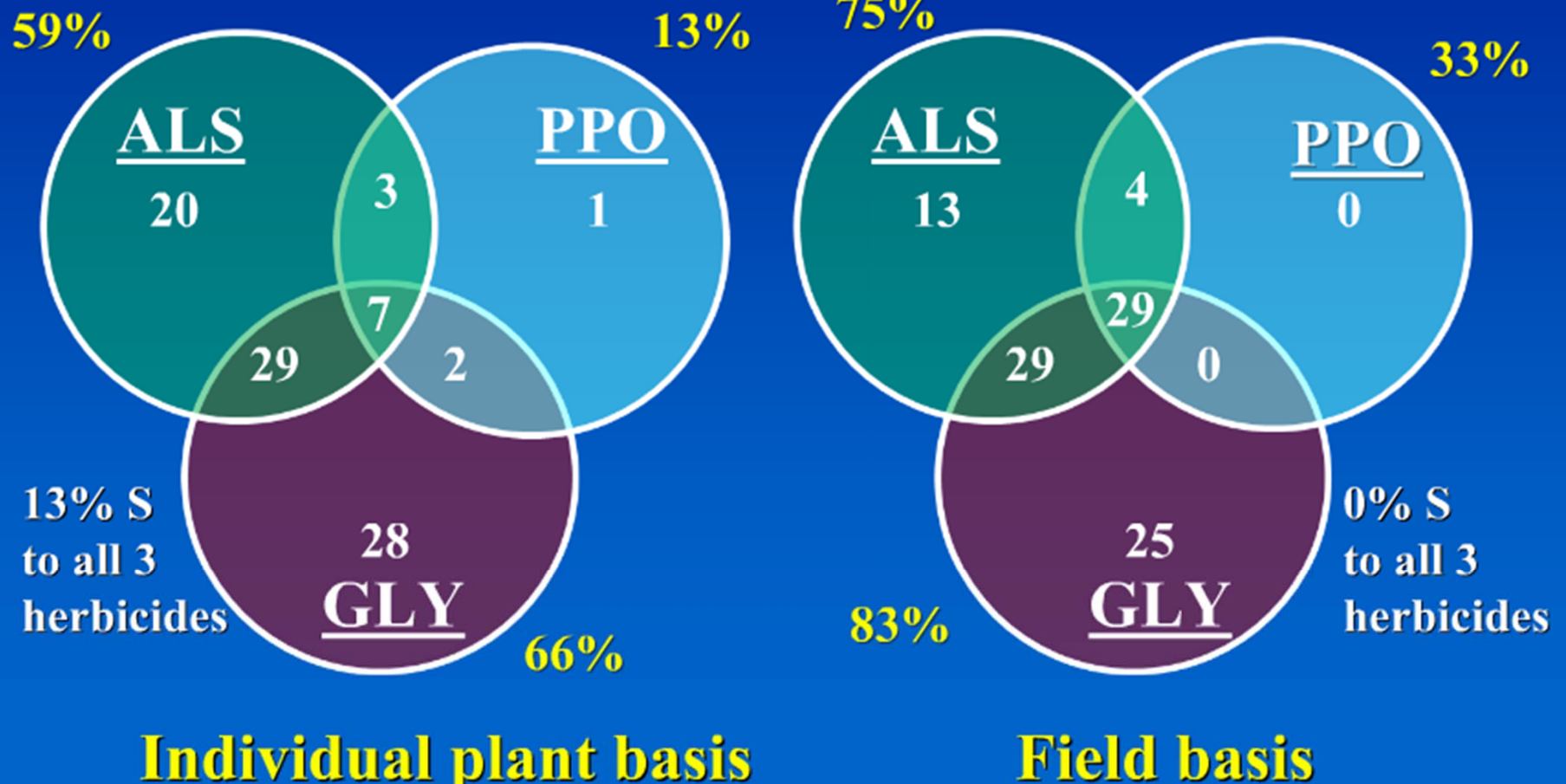
Impacts of Herbicide Resistance to Weed Management Strategies

- ISU Reports waterhemp responses to labeled herbicide rates indicate:
 - 95% of the populations are resistant to SOA #2 - ALS
 - 58% of the populations are resistant to SOA #5 - Atrazine
 - 54% of the populations are resistant to SOA #9 – Glyphosate
 - 28% of the populations are resistant to SOA #27 – HPPD
 - 6% of the populations are resistant to SOA #14 – PPO
- Resistance to multiple SOA's is also not uncommon
 - Consider establishment of RR alfalfa in a field of Giant Ragweed resistant to SOA #9 and #2



2010 Survey Summary

- 122 plants from 24 fields in IL, IA & KY (most suspected of Gly-R waterhemp)



Credit Aaron Hager @ U of Illinois

<http://www.plantmanagementnetwork.org/edcenter/seminars/Corn/Waterhemp/>

Impacts of Herbicide Resistance to Weed Management Strategies

- As the frequency of herbicide resistant traits increase the likelihood of migration increases
 - Palmer Amaranth in MI, IN, WI via cotton seed for dairy and CRP
 - Movement via forage
 - Movement via manure
 - Movement via combine
 - Movement via pollen (yards not miles)
 - Movement via water (runoff and flooding)
 - Movement from ditch banks and field margins



Palmer amaranth

Credit – Christy Sprague Mich. State University

- *Amaranthus palmeri* - “Palmer pigweed”
- Native to the desert Southwest
 - Thrives in hot climatic conditions
 - Tolerant to drought
- One of 10 common pigweed species in the great plains and southeast U.S.
- Not common in the upper Midwest
 - No reports of Palmer amaranth found in U of M herbarium



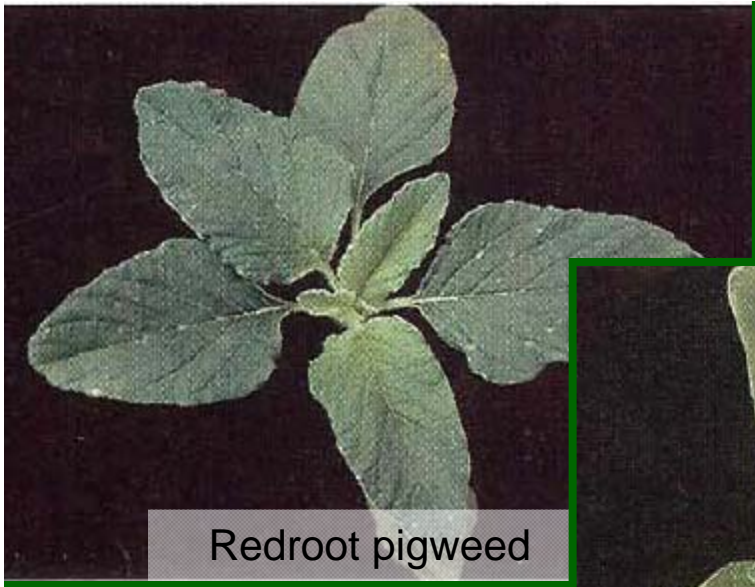
Palmer amaranth plant from above, notice the rosette leaf pattern that is similar to a poinsettia plant



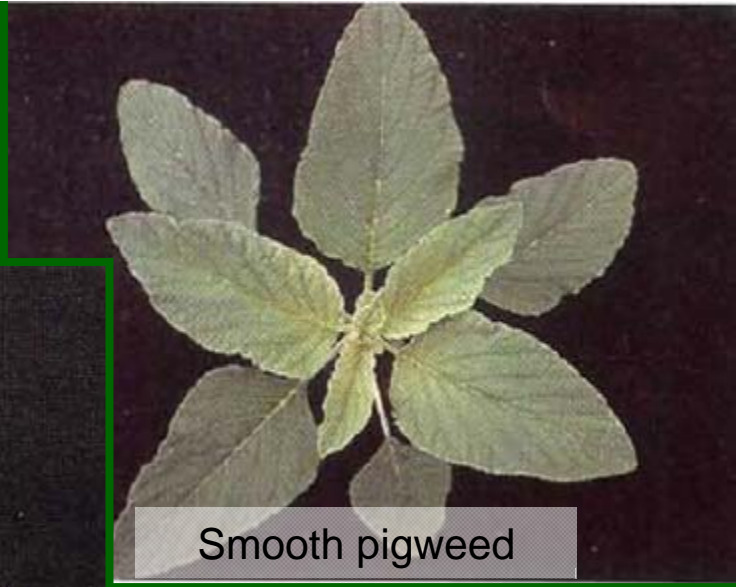
Travis Legleiter, Weed Science Program Specialist & Bill Johnson,
Professor of Weed Science, Purdue University Extension Weed Science



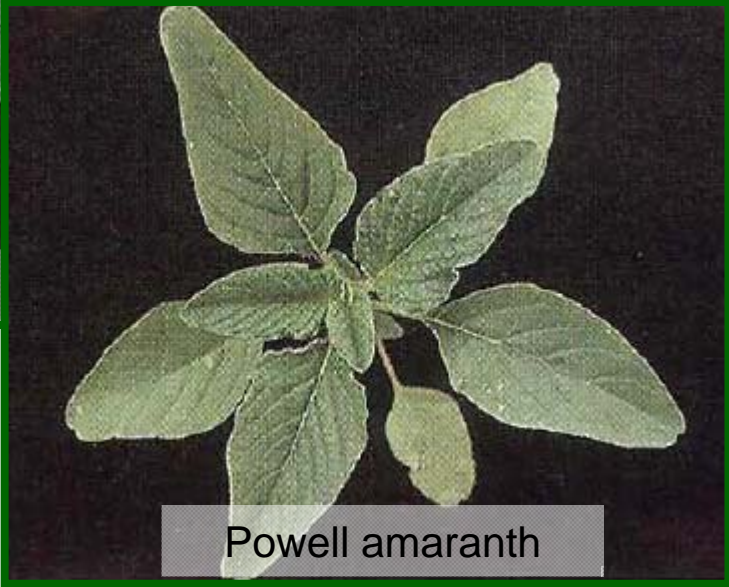
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Redroot pigweed



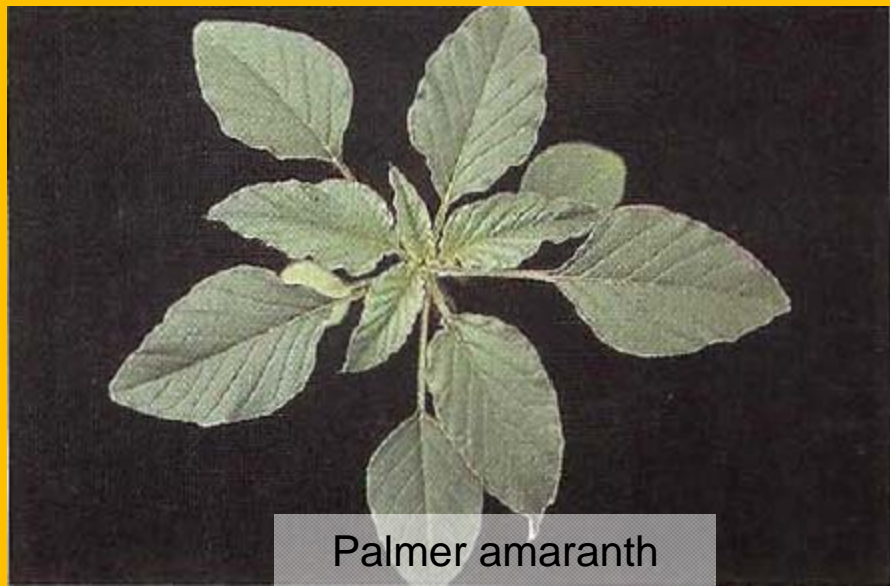
Smooth pigweed



Powell amaranth



Waterhemp

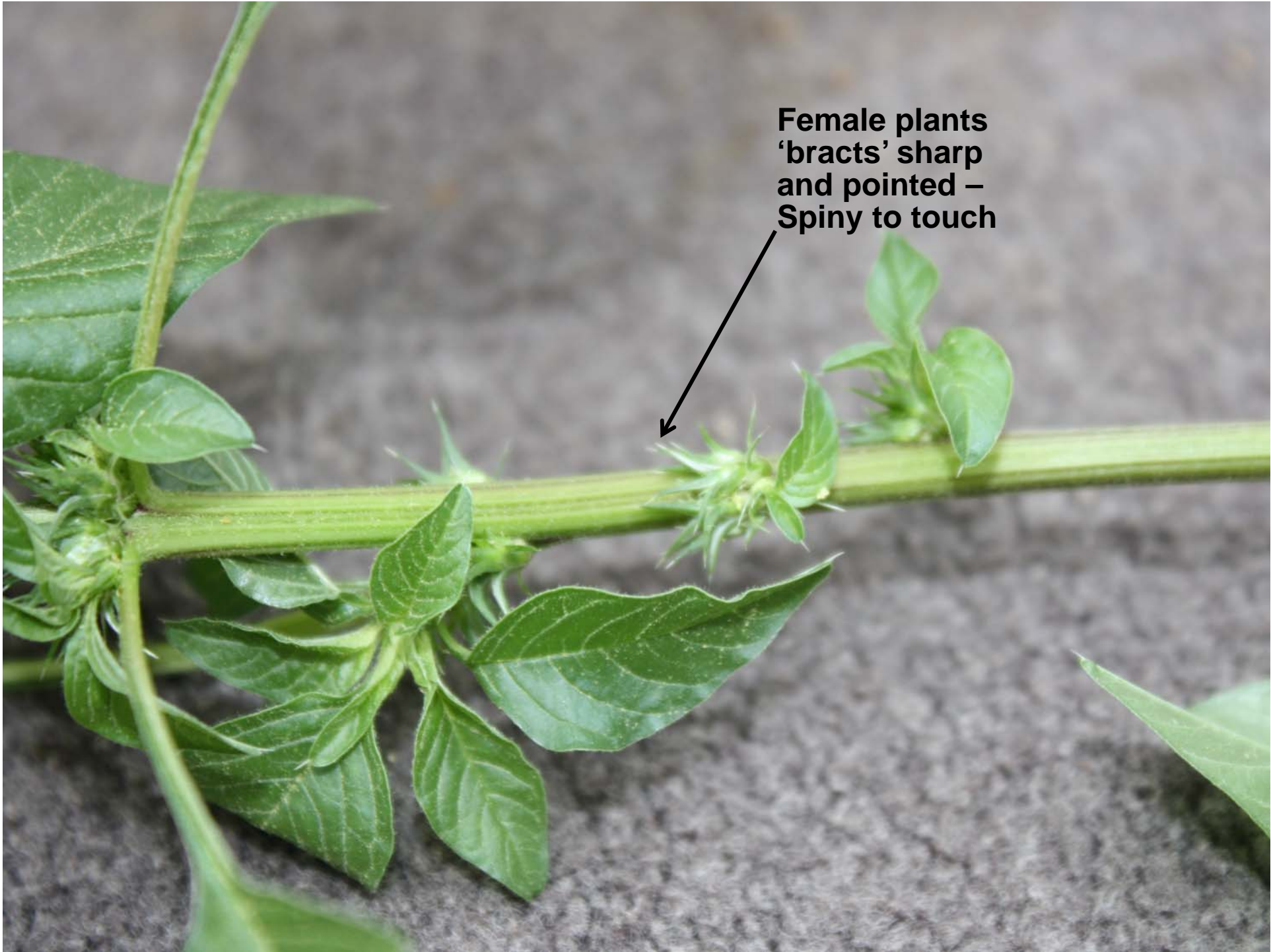


Palmer amaranth

Long leaf petioles



**Female plants
'bracts' sharp
and pointed –
Spiny to touch**





Redroot pigweed



Powell amaranth



Smooth pigweed



Waterhemp



Palmer amaranth

Unbranched inflorescence and prickly to the touch

Pigweed identification: A pictorial guide to the common pigweeds of the great plains
Horak et al. KSU, Extension, 1994

WSSA BMP Adoption Recommendations

<http://www.wssa.net/>


- Implement a Herbicide-SOA labeling system for all herbicide products
- Communicate that the existing herbicide resource is **Exhaustible** and discovery of new, highly effective herbicide SOA's is a rare event. (Note – the trend is to HRC traits)



Where Do I Find SOA Information?

- Herbicide Labels are Starting to Include them

Specimen Label

 **Dow AgroSciences**

SureStart[®]

Herbicide

®Trademark of Dow AgroSciences LLC

For use on herbicide tolerant and conventional field corn, and silage corn

Group	15	2	4	HERBICIDE
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Where Do I Find SOA Information?

- Check out the following web sites

<http://appliedweeds.cfans.umn.edu>

http://glyphosateweeds crops.org/Info/MOA_060807.pdf

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Applied Weed Science Research
Department of Agronomy & Plant Genetics

What's Inside

- Project Leaders
- Research Reports
- Publications
- Herbicides
- Weeds
- Images
- Links
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Introduction

In the states with corn, soybeans, small grains and sugarbeets as major crops, herbicides are applied to more than 97% of crop acreage (NASS, 2001). Although herbicides are applied to increase profitability, incorrect usage can have negative economic and environmental impacts. Emergence of new herbicide-resistant weed species and ground and surface water pollution are concerns that are effecting policies and decisions regarding herbicide use. Ideal weed management that would minimize these undesirable consequences and remain economically sustainable involves a well-rounded approach. Tillage, site-specific herbicide rates, herbicide rotation, and crop rotation are just some of the variables that producers today factor into their weed management. The University of Minnesota has been a trusted source of non-biased, research-based herbicide and weed management information for well over a century. Minnesota producers place value on their relationship with the University of Minnesota Extension Service.

This web site contains research reports, publications, and other information pertaining to weed research conducted at the University of Minnesota. Most information may be downloaded as PDF files. Follow the link below to obtain Acrobat Reader.

Posted 12-16-2011
PRE and POST Herbicide Diversification Options for Glyphosate-Resistant Corn and Soybean (2012)

Posted 12-9-2011
2011 Research Reports for Lambertton Corn and Soybeans

Posted 12-8-2011
2011 Research Reports for Small Grains

Posted 3-9-2011
Focus on Ag Newsletter "Maintaining Roundup's Long-term Effectiveness"

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Corn and Soybean Herbicide Chart

Repeated use of herbicides with the same site of action can result in the development of herbicide-resistant weed populations.

This publication was designed for commercial printing, color shifts may occur on other printers and on-screen.

By Mode of Action (effect on plant growth)

This chart groups herbicides by their modes of action to assist you in selecting herbicides 1) to maintain greater diversity in herbicide use and 2) to rotate among herbicides with different sites of action to delay the development of herbicide resistance.

Site of Action Group*	Site of Action	Chemical Family	Active Ingredient	Product Examples (Trade Name ®)
1 Lipid Synthesis Inhibitors	ACCase Inhibitors (acetyl CoA carboxylase)	Aryloxyphenoxy propionate	fenoxaprop flufazifop	component of <i>Fusion Fusilade DX Assure II, Targa Select, Arrow Poast, Poast Plus</i>
		Cyclohexanedione	clethodim sethoxydim	
2 Amino Acid Synthesis Inhibitors	ALS Inhibitors (acetolactate synthase)	Sulfonylurea	chlorimuron foramsulfuron halosulfuron iodosulfuron nicosulfuron	<i>Classic Option Permit Autumn Accent</i>

By Premix

This chart lists premix herbicides alphabetically by their trade names so you can identify the premix's component herbicides and their respective site of action groups. Refer to the **Mode of Action** chart for more information.

Premix Trade Name ®	Trade Name ®	Component Active Ingredient	Site of Action Group*
Authority First	<i>Spartan FirstRate</i>	sulfentrazone clorasulam	14
Axiom	<i>Define Sencor</i>	flufenacet metribuzin	15
Basis	<i>Resolve Harmony GT</i>	metribuzin thifensulfuron	2
Bicep II Magnum	<i>Dual II Magnum AAtrex</i>	s-metolachlor atrazine	15
Bicep Lite II Magnum	<i>Dual II Magnum AAtrex</i>	s-metolachlor atrazine	15
Boundary	<i>Dual Magnum Sencor</i>	s-metolachlor metribuzin	15
Breakfree ATZ	<i>Breakfree</i>	acetochlor atrazine	15
Breakfree ATZ Lite	<i>Breakfree</i>	acetochlor atrazine	15
Buctril + Atrazine	<i>Buctril</i>	bromoxynil atrazine	6
Bullet	<i>Micro-Tech</i>	alachlor atrazine	15
Camix	<i>Callisto</i>	mesotrione	28
Canopy DF	<i>Dual II Magnum Classic Sencor</i>	s-metolachlor chlormuron metribuzin	15
Canopy EX	<i>Classic</i>	chlormuron	2
Celebrity Plus	<i>Express Clarity Accent</i>	tribenuron diflufenopyr dicamba nicosulfuron	19
Cinch ATZ	<i>Dual II Magnum AAtrex</i>	s-metolachlor atrazine	15
Cinch ATZ Lite	<i>Dual II Magnum AAtrex</i>	s-metolachlor atrazine	15



WSSA BMP Adoption Recommendations

- Demonstrate the benefits and costs of proactive, diversified weed management systems
- Promote full-labeled rates at appropriate weed and crop growth stages
- Reduce the weed seedbank via minimization of weed seed production



Weed Science Field School – Soybean

Key weed species (no ALS or glyphosate resistance):

Common lambsquarters

Common waterhemp

Giant ragweed

Rochester, MN

2012



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Trt. 1

Authority First 3.2 oz/a + Dual II MAG 16 fl oz/a

PRE sprayed on April 24, 2012

Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

June 4, 2012

POST II (V3-V4) sprayed on June 4, 2012

June 18, 2012



June 26, 2012



July 2, 2012



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Trt. 2

Authority First 3.2 oz/a + Dual II MAG 16 fl oz/a

PRE sprayed on April 24, 2012

Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

POST III (V5-R1) sprayed on June 12, 2012

June 11, 2012

June 18, 2012



June 26, 2012



July 2, 2012



Trt. 2

Authority First 3.2 oz/a + Dual II MAG 16 fl oz/a

PRE sprayed on April 24, 2012

Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

POST III (V5-R1) sprayed on June 12, 2012

June 11, 2012

June 18, 2012



Good early-season weed control
increases the time period for effective
postemergence control

June 26, 2012



July 2, 2012



Trt. 3

Warrant 24 fl oz/a

PRE sprayed on April 24, 2012

Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

June 4, 2012

POST II (V3-V4) sprayed on June 4, 2012

June 18, 2012



June 26, 2012



July 2, 2012



Trt. 4

Warrant 24 fl oz/a

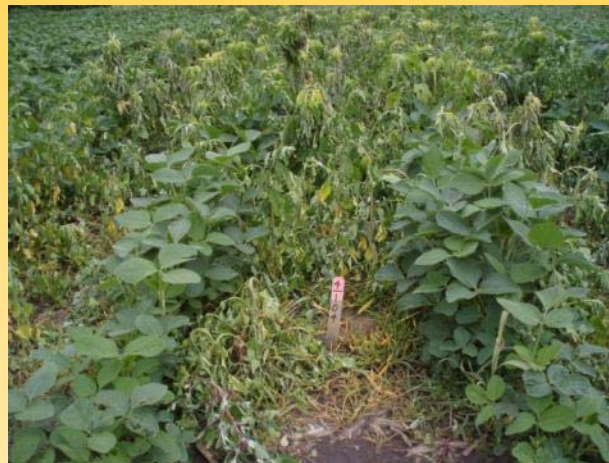
PRE sprayed on April 24, 2012

Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

June 11, 2012

POST III (V5-R1) sprayed on June 12, 2012

June 18, 2012



June 26, 2012



July 2, 2012



Warrant 24 fl oz/a
PRE sprayed on April 24, 2012
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

July 19, 2012



Trt. 3
POST II
(V3-V4)
sprayed
on June
4, 2012

July 27, 2012



July 27, 2012

July 19, 2012



Trt.4
POST III
(V5-R1)
sprayed
on June
12, 2012



Trt. 4

Warrant 24 fl oz/a

PRE sprayed on April 24, 2012

Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

July 19, 2012

POST III (V5-R1) sprayed on June 12, 2012

July 27, 2012



- Poor early-season weed control reduces the time period for effective postemergence control
- Effective postemergence weed control depends on:
 - Weed species diversity, time of weed emergence, density, and difficulty to control



Trt.

Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

Were these beans treated at

V1 on May 18, 2012

June 11, 2012



June 18, 2012



June 26, 2012



July 2, 2012



Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

V1 on May 18, 2012



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Trt.
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal
Were these beans treated at
V3 on June 4, 2012

June 11, 2012



June 18, 2012



June 26, 2012



July 2, 2012



Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal

V3 on June 4, 2012



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Trt.
Roundup PowerMax 22 fl oz/a + AMS 8.5 lb/100gal
Were these beans treated at
V5 on June 12, 2012

June 11, 2012



June 18, 2012



June 26, 2012



July 2, 2012



July 19, 2012

Roundup PowerMax 30 fl oz/a + AMS 8.5 lb/100gal

July 27, 2012



V1



V3



V5



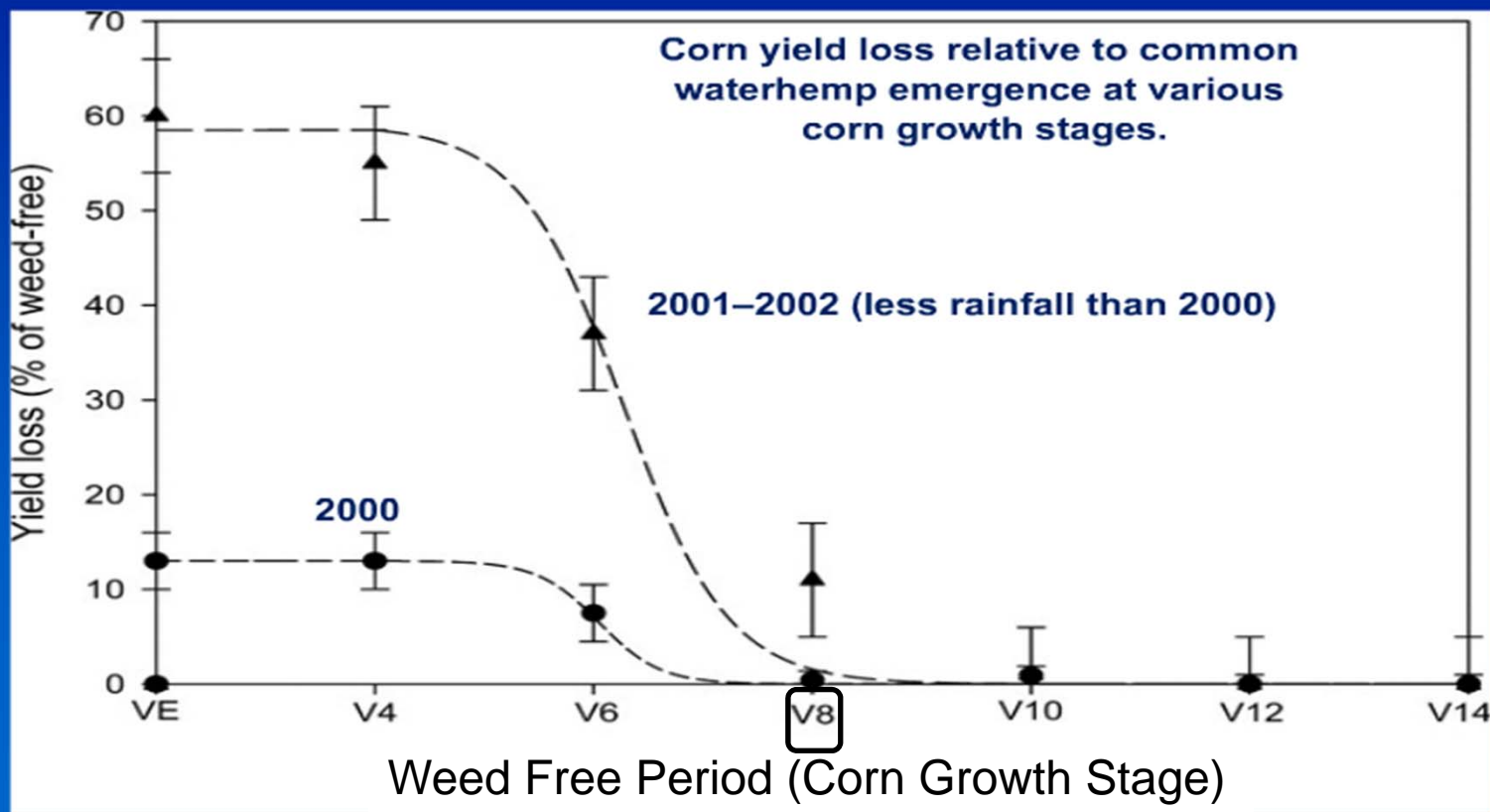
Weed / Crop Competition

Credit Aaron Hager @ U of Illinois

<http://www.plantmanagementnetwork.org/edcenter/seminars/Corn/Waterhemp/>

Common waterhemp (*Amaranthus rudis*) interference in corn

Weed Science 52:359–364



Weed / Crop Competition

Credit Aaron Hager @ U of Illinois

<http://www.plantmanagementnetwork.org/edcenter/seminars/Corn/Waterhemp/>

Common waterhemp (*Amaranthus rudis*) interference in corn Weed Science 52:359–364

Emergence times	Biomass		Seed production		Mortality	
	2000	2001–2002 ^a	2000	2001–2002	2000	2001–2002
	g m ⁻²		seeds plant ⁻¹		%	
VE ^b	430	1,310	3,000	16,000	0	0
V4	220	670	500	13,000	0	0
V6	40	590	90	1,200	90	20
V8	0	290	0	11	90	50
V10	0	1	0	3	100	80
V12	0	4	0	0	100	100
V14	0	0	0	0	100	100
LSD _{0.05}	130	200	500	600	10	10

^a Data are combined over 2001–2002.

^b Indicates common waterhemp emergence times at various corn growth stages.

Weed / Crop Competition

- Seed production potential of common waterhemp emerging at four growth stages of corn and soybean
- Research conducted in Morris, MN in cooperation with SDSU, USDA ARS, and U of MN



Weed / Crop Competition

- Results – vegetative development
 - When emergence occurred during VE – V1 waterhemp biomass was greater when grown in soybean than in corn
 - When emergence occurred at V4 or later waterhemp biomass was very low in either crop
 - In V8-11 corn, minimal waterhemp survival
 - At and after V8 soybean, no waterhemp survived



Weed / Crop Competition

- Results – seed production
 - When emergence occurred during V9-V10 corn waterhemp produced 100-150 seeds per plant
 - When emergence occurred at V8 soybean or later, waterhemp did not produce any seed
 - Therefore, to reduce the weed seed bank you need to emphasize early-season weed control and PRE herbicides can play a big role
 - I recommend targeting your FINAL weed control activities at V8 corn and R1 soybean



Proactive Weed Management Strategies

- **Why Are Farmers Reluctant To Adopt PRE Herbicides?**
 - Concerned about Cost
 - + Competitive market
 - + Incentives often available
 - + In weedy fields we see a favorable return on investment
 - Concerned about Time
 - + Uneven weed emergence and rapid weed growth make timing of POST control challenging
 - Lack of Experience with PRE Herbicides
 - Crop Injury Potential and Crop Rotation Restrictions
 - Not as Easy but it is still A LOT EASIER THAN.....



Hand Weeding



www.extension.umn.edu/AgProfessionals
CPM Short Course: 2011 - Larry Steckel
CPM Short Course: 2012 - Jason Norsworthy



Proactive Weed Management Strategies

- Start with a Preemergence herbicide
 - Provides a great opportunity to reduce selection intensity in herbicide resistant crops
 - Often introduces a different Site of Action
 - Controls weeds as they germinate and when they are most vulnerable
 - **Use the Right Herbicide, for the Right Weeds at the Right Rate and Right Time.**
 - **A good day to PLANT is a good day to apply a PRE herbicide**



Several PRE Options in Soybean

What if waterhemp developed resistance to SOA #14 (PPO's) herbicides?

Tier 1	SOA#		Girw	Colq	Cowh	Sugarbeet
Authority First/Sonic	2	14	P/G	G/E	G/E	30
Gangster	2	14	P/G	G/E	G	30
Optill	2	14	F/G	G/E	G	40
Prefix	15	14	F	G	G/E	18
Tier 2			Girw	Colq	Cowh	
Boundary	5	15	P/F	G	G/E	18
Verdict - 5 oz/A	14	15	P	G	F/G	NCS
Valor	14		N/P	G	G/E	4 to 10

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.

All of the SOA #14 options must be applied by 3 days after planting except:

Prefix can be applied from cracking - V3

Warrant (SOA #15) is also an option

Soybean PRE							Rotation
Tier 1	SOA#			Girw	Colq	Cowh	Sugarbeet
Authority First/Sonic	2	14		P/G	G/E	G/E	30
Gangster	2	14		P/G	G/E	G	30
Optill	2	14		P/F	G/E	G	40
Prefix	15	14		F	G	G	18
Tier 2				Girw	Colq	Cowh	
Boundary	5	15		P/F	G	G/E	18
Verdict	14	15		P	G/E	F/G	NCS
Valor	14			N/P	G	G/E	4 to 10

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.

Follow a PRE herbicide with a timely application of a POST herbicide for extended weed control; Diversification of SOA's will help combat herbicide resistant biotypes

Note Soybean options for broadleaf weed control has a limited number of SOA's

	SOA				Girw	Colq	Cowh	Sugarbeet
Cadet	14				P	F	F	NCS
Cobra	14				G	P	G/E	0
First Rate	2				E	P	P	30
Flexstar GT	14	9			G/E	F-E	E	18
Flexstar	14				G	P/F	G/E	18
Resource	14				P	F	F	1
Liberty (in LL Soybean	10				G	F	G	0

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.

Soybean Carryover Concerns from 2012 to 2013

Carryover of Prefix and Flexstar to Corn

**Crop rotation -
10 months to Corn**



Photo Credit to Bob Hartzler at ISU, Ames, IA



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Several PRE Options in Corn

Corn PRE							Rotation	
Tier 1	SOA #				Girw	Colq	Cowh	Sugarbeet
Lumax	5	15,27			G	G/E	E	18
Surestart/TripleFlex	2	4,15			G	G/E	G	26
Verdict - >10 oz/A	14	15			G	G/E	G/E	NCS
Tier 2					Girw	Colq	Cowh	
Atrazine <0.38#	5				P/F	G/E	F	NCS
Atrazine + Tier 3	15	5 w/higher rate			F/G	G/E	F/G	2CS
Zemax	15	27			F/G	G/E	E	18
Tier 3					Girw	Colq	Cowh	
Dual	15				N	P/F	G	NCS
Harness/Surpass	15				P	F/G	G	NCS
Outlook	15				N	P/F	G	NCS

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.

Early POST Options for PRE Corn Herbicides

Tier 2					
Atrazine <0.38#	5				0-12 inch
Atrazine + Tier 3	15	5 w/higher rate			0-12 inch
Zemax	15	27			0-12 inch
					0-30 inch
Tier 3					directed
Dual	15				0-5 inch
Harness/Surpass	15				0-11 inch
Outlook	15				0-12 inch
Corn POST					
Tier 1					
Callisto Xtra	Ps	HPPD			18
Capreno	ALS	HPPD			18
Halex GT	EPS	Acetanalide	HPP		18

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.

Follow a PRE herbicide with a timely application of a POST herbicide for extended weed control;
 Diversification of SOA's will help combat herbicide resistant biotypes

Note POST weed control offers more opportunities to diversify effective SOA's

Corn POST								
Tier 1	SOA				Girw	Colq	Cowh	Sugarbeet
Callisto	27				G	G/E	E	18
Capreno	2	27			G	G/E	G/E	18/24
Halex GT	9	15, 27			E	E	G/E	18
Hornet	2	4			G/E	P/F	P/F	26
Impact	27				G	G/E	G/E	18
Laudis	27				G	G/E	G/E	10/18*
Status	4				G/E	G/E	G	4
Liberty (in LL Corn)	10				G	F	G	0

Girw = Giant Ragweed; Colq= Lambsquarters; Cowh = Waterhemp.

Corn Carryover Concerns from 2012 to 2013

Carryover of Callisto to Soybean (esp. low pH <6.0 and low OM and CEC soils)



**Crop
rotation
interval –
10 months
to Soybean**



**Photo Credit – Practical Weed Science for the Field Scout – U of MO
Mike Owen – ISU, Ames, IA**



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**CONFIRMED HPPD
RESISTANCE**

TAKE CONTROL with MY PLAN

Year	Crop	Pre	Post
2003	Corn	Dual + Simazine	Callisto + atrazine
2004	Corn	Dual + Simazine	Callisto + atrazine
2005	Corn	Dual + Simazine	Callisto + atrazine

Year	Crop	PRE	MOA*	POST	MOA*
2013	Corn Beans				
2014	Corn Beans				
2016	Corn Beans				

**Use the Right Herbicide, for the Right Weeds
at the Right Rate and Right Time**

		Simazine	atrazine	2016	Corn Beans				
2008	Corn	Dual +	Impact fb						

**Your Goal is Diversification of Effective
Herbicide SOA's on Weed Species Present
Applied in a Timely Manner**

MOA* = Herbicide Mode of Action

<http://appliedweeds.cfans.umn.edu/Pubs.html>

When Planning to Use a PRE Herbicide Consider:

Soil type and pH influence Rate and Crop Injury Potential

- Use of SureStart in soil-applied treatments on soils with less than 1.5% organic matter (O.M.) may result in crop injury. Apply as a soil-treatment to fields which have less than 1.5% O.M. only if the risk of crop injury is acceptable.

Restrictions And Precautions For Soil Application (Not Applicable To Postemergence Use)

- **Corn Planting Depth:** Minimum planting depth should be at least 1 1/2 inches.
- Do not apply to areas where the soil pH is greater than 7.8 as this may result in increased crop injury.



When Planning to Use a PRE Herbicide Consider:

Impact of weather

Adverse Weather Conditions

- Extended cold, wet conditions (soil temperatures below 50°F and excessive rainfall with wet soil conditions), following application of SureStart to herbicide tolerant corn, which persist during germination and/or early crop development may result in crop injury. Injury symptoms, which include yellowing of leaves and/or crop stunting, are usually temporary and affected corn plants usually recover without affecting yield.
- Dry weather following preplant surface or preemergence applications of SureStart may reduce effectiveness. If sufficient activating rainfall or overhead irrigation does not occur within 7 to 10 days of application, rotary hoe, harrow, or shallowly cultivate to incorporate the herbicide lightly into the soil. Use a preplant incorporated application when a period of dry weather is predicted after application.



When Planning to Use a PRE Herbicide Consider:

Interactions with other pesticides:

Soil Insecticide Advisories

When SureStart is used for soil applied weed control in corn:

- Soil applied organophosphate insecticides (except terbufos or phorate, see below) should be applied in a T-band or a band to avoid potential crop injury.
 - Terbufos (Counter insecticide products) or phorate (Thimet insecticide products) should not be used.
 - Soil insecticides from other classes of chemistry may be applied in-furrow, T-banded, or banded.
-
- If any herbicide with ALS (acetolactate synthase) inhibition mode of action such as Pursuit, Canopy, Classic, Scepter, or Squadron herbicide, etc., was applied the previous year, apply SureStart to corn only if the rotational restrictions applicable to corn for the preceding product has been met.



What Weedy Traits Do Problem Weeds Have in Common?

- Outcrossing capability - increases potential to increase the spread of R-traits via pollen and increases genetic diversity
- High seed productivity-especially waterhemp - increases potential for rapid buildup in the seed bank and to spread via flooding, combines, etc.
- The results are highly adaptable weeds
 - Waterhemp biotypes have been documented Resistance to six different Sites of Action including:
 - » ALS, Glyph, PS II's, PPO's, HPPD's and 2,4-D
 - » SOA #'s, 2, 9, 5, 14, 27 and 4, respectively
 - » Some populations contain individuals with multiple-resistance



When a Weed Does More Than Compete With the Crop



Photo Credit to Liz Stahl

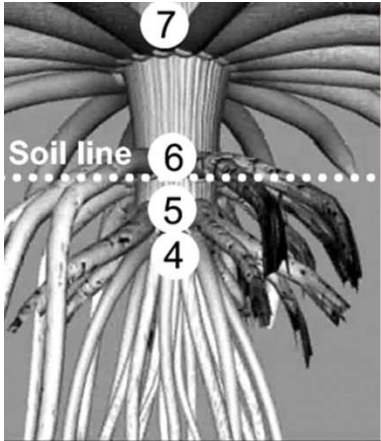
Volunteer Corn Is A Host for Corn Rootworm

- Serves as feeding site for newly emerged rootworm larvae (late May to early June)
- Must control corn before pupation in late-June
- Serves as a feeding/egg laying site for beetles in early- to mid- July
- Negates positive effects of rotating out of corn



Photo Credit to Liz Stahl

Mixtures of Bt toxin expression and root age classes are likely accelerating evolution of Bt-Resistant CRW



Target V4-V5 Volunteer Corn

- Nodal Roots - Dominant Root System by V6
- Target Larvae on Corn before they Pupate
- Removes the Most Competitive Corn
- Often is in Synchrony With First Glyphosate Application

Life Cycle (Western & Northern)

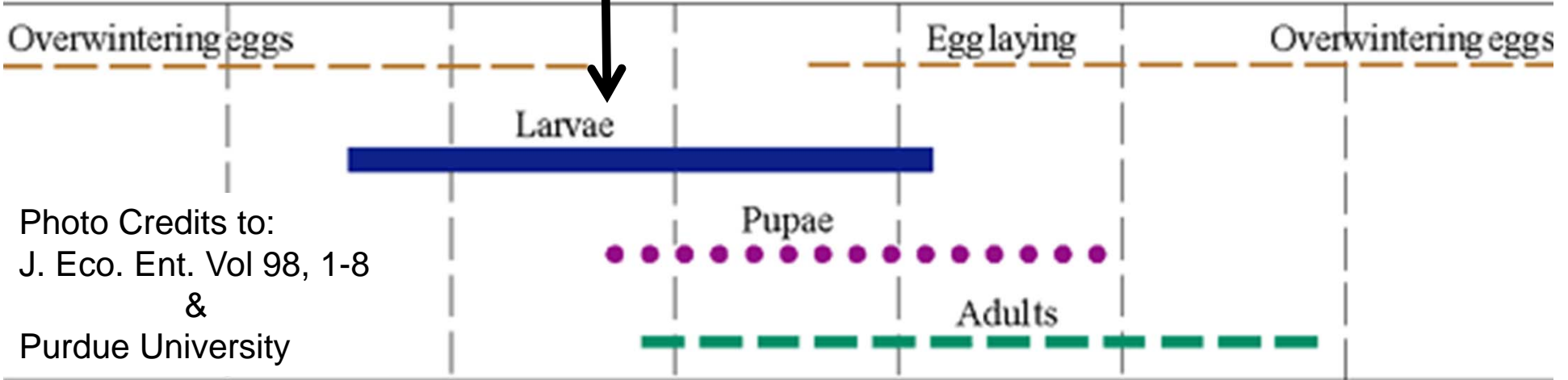


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Time of Attack to Corn



POST Volunteer Corn Options in Soybean

NOTE - Due to stacked LL/RR traits in most corn hybrids, inter-row cultivation is your only option

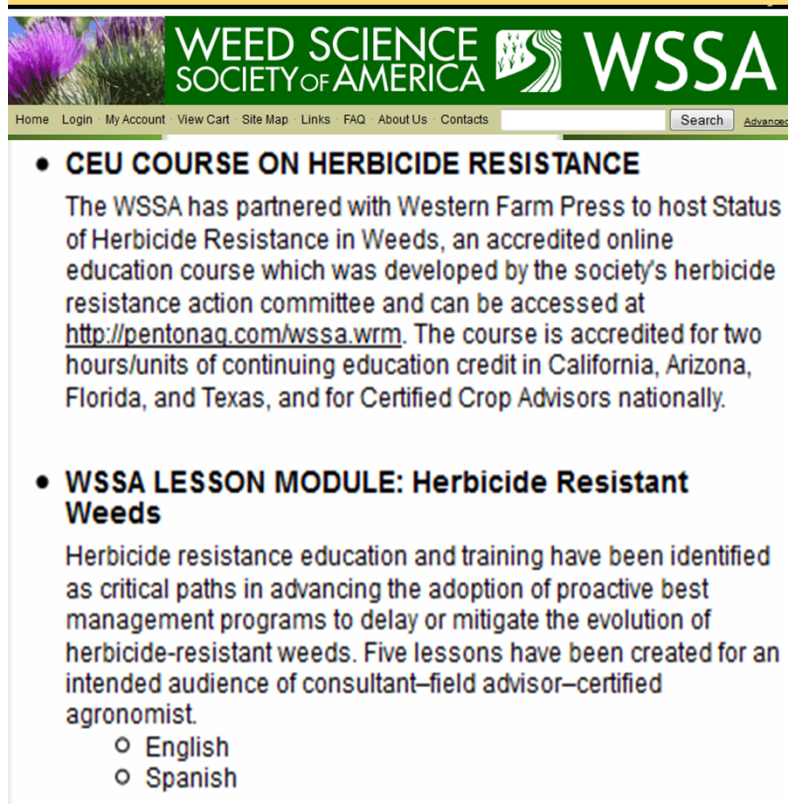
Soybean POST					Rotation
					To
	SOA#			Vol. Corn	Corn
Assure II	1	quizalofop		E	4 mo.
Fusilade DX	1	fluazifop		E	2 mo.
Fusion	1	flu + fenoxaprop		E	2 mo.
Select Max	1	clethodim		E	6 days

**When Tank Mixing w/Gly always add AMS and a HSOC
(e.g. Destiny HC)
To Reduce Antagonism of Glyphosate**



Where Do I Find More Information Regarding Herbicide Resistance Mgmt.?

<http://www.wssa.net>



WEED SCIENCE SOCIETY OF AMERICA WSSA

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- **CEU COURSE ON HERBICIDE RESISTANCE**
The WSSA has partnered with Western Farm Press to host Status of Herbicide Resistance in Weeds, an accredited online education course which was developed by the society's herbicide resistance action committee and can be accessed at <http://pentonag.com/wssa.wrm>. The course is accredited for two hours/units of continuing education credit in California, Arizona, Florida, and Texas, and for Certified Crop Advisors nationally.
- **WSSA LESSON MODULE: Herbicide Resistant Weeds**
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. Five lessons have been created for an intended audience of consultant–field advisor–certified agronomist.
 - English
 - Spanish

<http://glyphosateweeds crops.org/>



The Glyphosate, Weeds, and Crops Web Site

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The content on this web site is produced by the Glyphosate Stewardship Working Group. Members are university weed scientists from major corn and soybean producing states who are actively involved in research and extension efforts in glyphosate-resistant cropping systems.

This site contains the latest information and research from member universities. It also provides links to publications in our Glyphosate, Weeds, and Crops Series, as well as resources in your state and around the country.

NEWS (Updated October 17, 2012)

- Pre-plant Options for the Management of Glyphosate-resistant Giant Ragweed in Soybean
- Management of Glyphosate-Resistant Waterhemp in Soybean
- Glyphosate-resistant Palmer Amaranth in Michigan
- Glyphosate Interactions with Micronutrients and Plant Diseases
- Spread of glyphosate resistance
- Prevalence and Influence of Stalk Boring Insects on Glyphosate Activity on Indiana and Michigan Giant Ragweed
- Glyphosate's Impact on Field Crop Production and Disease Development
- Glyphosate Resistant Waterhemp in Indiana

Benchmark Studies - Glyphosate Resistance Management

- Long-Term Research Study Initiated to Improve the Sustainability of the Roundup Ready® Technology
- Roundup Ready® Crops Have Major Positive Impact on Tillage Practices
- Weed Pressure and Problem Weeds Have Changed with the Adoption of Roundup Ready® Crops
- Herbicide Use Patterns Have Changed with the Wide-spread Adoption of Roundup Ready® Crops
- University Weed Scientists Report on Grower Awareness and Perceptions on Weed Resistance to Glyphosate in Roundup Ready® Crops

The Glyphosate, Weeds, and Crops Series

Available

Biology and Management of giant ragweed
Biology and Management of Giant ragweed
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Facts About Glyphosate Resistant Weeds
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Biology and Management of Horseweed
Biology and Management of Wild Buckwheat
Corn and Soybean Herbicide Mode of Action Chart
Biology and Management of Common Waterhemp

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