

# Integrating Residual Herbicides into Corn and Soybean Weed Management Plans

Jeffrey L. Gunsolus  
gunso001@umn.edu



UNIVERSITY OF MINNESOTA  
**EXTENSION**

**Driven to Discover<sup>SM</sup>**

# Harvest Time Reveals Weed Issues

## Giant Ragweed



# Harvest Time Reveals Weed Issues

## Common Waterhemp



# Harvest Time Reveals Weed Issues

## Common Waterhemp



What can be done to prevent this?



# A Bit of Weed Management History

- Our problem weeds today, are no different than when we left the Pursuit and Accent era of the 1990's
  - Problem weeds were common and giant ragweed, waterhemp and common lambsquarters.
  - However, one difference is an increase in frequency of herbicide-resistance in all but lambsquarters
  - In the 1990's MN farmers readily adopted Postemergence weed control because it decoupled planting date from spray date



# A Bit of Weed Management History

- Our problem weeds today, are no different than when we left the Pursuit and Accent era of the 1990's
  - Problem weeds were common and giant ragweed, waterhemp and common lambsquarters.
  - However, one difference is an increase in frequency of herbicide-resistance in all but lambsquarters

**We need to rethink the total post-emergence approach**



# Which herbicide application timings do you currently use? (from SE/SC MN PPAT Survey)

	2003	2004	2005	2006 All S MN	2007	2008	2009	2010 Soybean	2010 Corn
Postemergence only	53	58	50	53	60	50	50	71	47
Sequential (pre/post)	43	35	37	34	34	30	36	17	37
Pre-plant incorporated	32	31	32	35	31	25	24	9	22
Pre-plant surface	23	20	2	18	21	18	14	5	16
Preemergence only	27	20	18	20	21	14	13	6	14
Burndown	24	19	14	16	16	11	11	14	12
Fall applications for control of next season's summer annual weeds	10	8	6	4	15	5	5	0	3
Fall applications for control of perennial and winter annual weeds	8	5	3	4	2	2	1	0	2

# Development of herbicide resistance

**Herbicide resistance generally derives from a lack of diversification**

**Herbicide resistance usually develops within an individual field or farm, rather than carried in from elsewhere.**

**Field records typically hold the key to understanding why resistance has developed.**

**Note: As resistance becomes more prevalent the likelihood of seed movement by water and combine or pollen increases, rapidly increasing the prevalence of resistant weed biotypes.**





# How do you manage weed resistance?

(Top 2 answers from SE/SC MN PPAT Survey)

- 1. Use mechanical control**
- 2. Rotate herbicide mode of action**
- 3. Not concerned about weed resistance**
- 4. Tank mix with additional herbicides**
- 5. Use Preplant or Preemergence followed by POST program**



# How do you manage weed resistance?

(Top 2 answers from SE/SC MN PPAT Survey)

13% **1.** Use mechanical control

28% **2.** Rotate herbicide mode of action

3% **3.** Not concerned about weed resistance

41% **4.** Tank mix with additional herbicides

16% **5.** Use Preplant or Preemergence followed by POST program



# 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)



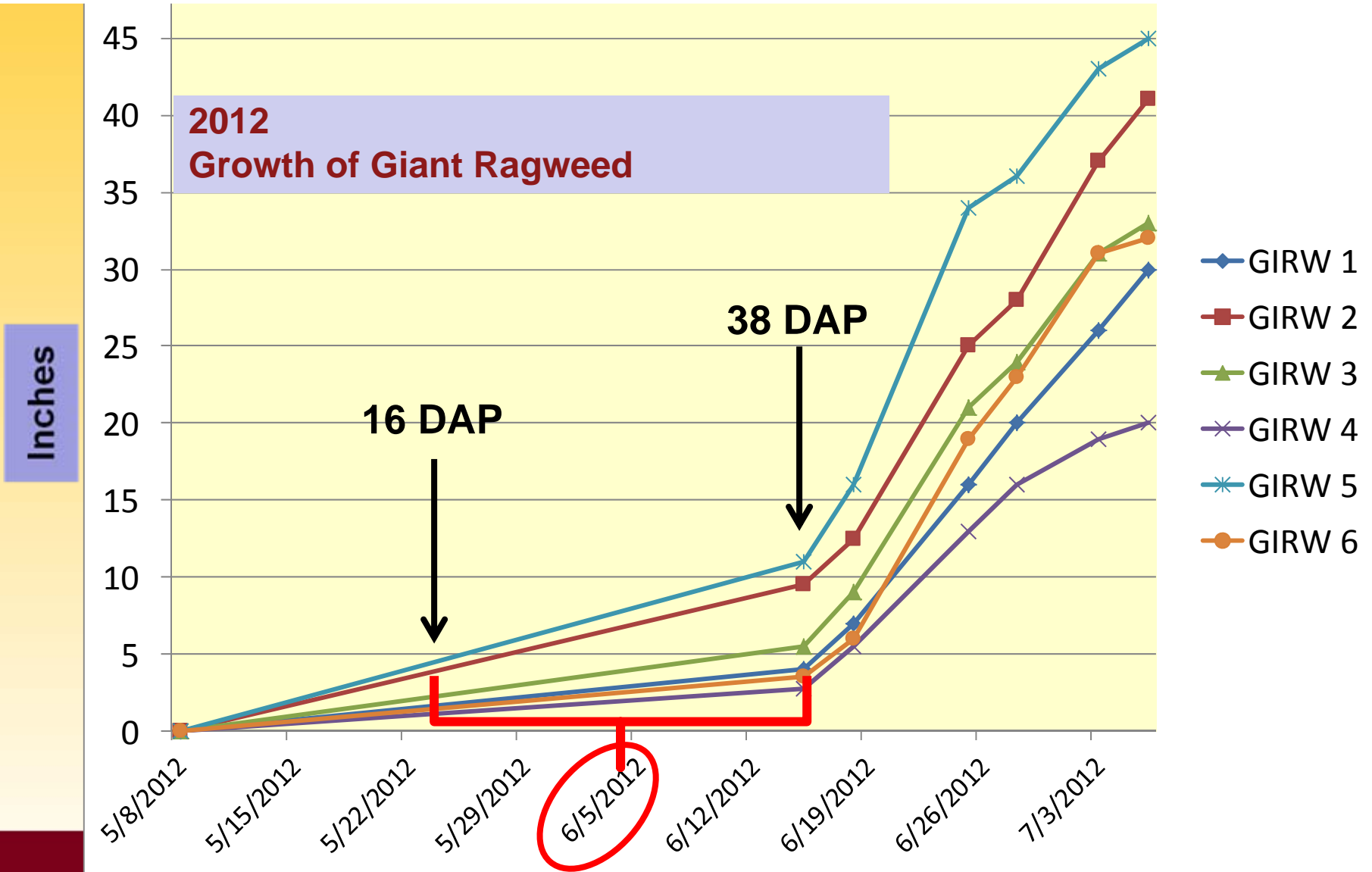
# Advantages PRE Herbicides Bring to Weed Management

<b>Reduces:</b>	<b>Increases:</b>
<b>Weed density</b>	<b>Increases yield potential</b>
<b>Weed species diversity</b>	<b>Herbicide/adjuvant compatibility</b>
<b>Weed size at time of postemergence application</b>	<b>Consistency of weed control</b>
	<b>Nitrogen efficiency in corn</b>
	<b>Early season weed canopy in soybean – Free Weed Control</b>

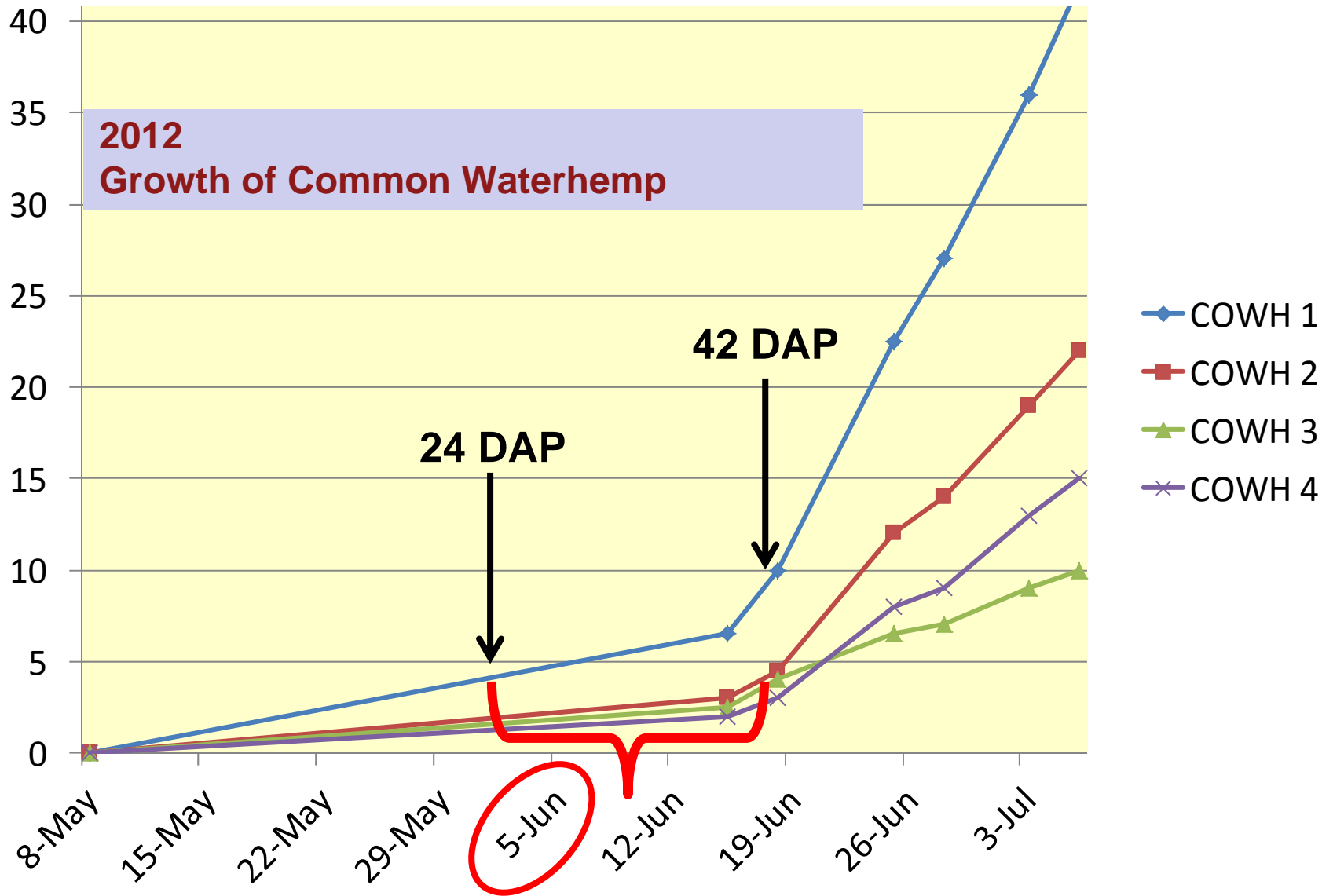
**PRE's provide added value –  
Value that isn't always easy to  
quantify**



# Weed Spectrum, Differing Emergence Rates and Early-Season Weed Growth Influence Control



# Weed Spectrum, Differing Emergence Rates and Early-Season Weed Growth Influence Control



# 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



# 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

In Soybean there aren't many broad-spectrum control options

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		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.

# Several PRE Options in Soybean

## Why the big spread in Girw response to Tier 1 options?


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.

# Where Do I Find SOA Information?

- Herbicide Labels are Starting to Include them

**Specimen Label**

 **Dow AgroSciences**

**SureStart<sup>®</sup>**

**Herbicide**

®Trademark of Dow AgroSciences LLC

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

Group	15	2	4	HERBICIDE
-------	----	---	---	-----------



# 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](http://glyphosateweeds crops.org/Info/MOA_060807.pdf)

**UNIVERSITY OF MINNESOTA**  
Driven to Discover™

MyU | One Stop | Directories | Search U of M

## Applied Weed Science Research

Department of Agronomy & Plant Genetics

**What's Inside**

- Project Leaders
- Research Reports
- Publications
- Herbicides
- Weeds
- Images
- Links
- Contact Us

**Applied Weed Science Home**

**Related Links**

- University of Minnesota Extension
- College of Food, Agricultural and Natural Resource Sciences
- Agronomy and Plant Genetics

©1997-2009 Regents of the University of Minnesota. All rights reserved. Contact U of M | Privacy

## 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)
<b>1</b>	<b>ACCase Inhibitors</b> (acetyl CoA carboxylase)	Aryloxyphenoxy propionate	fenoxaprop fluzafop quizalofop diethodim sethoxydim	component of <i>Fusion Fusilade DX Assure II, Targa Select, Arrow Poast, Poast Plus</i>
<b>2</b>	<b>ALS Inhibitors</b> (acetolactate synthase)	Sulfonylurea	chlormuron foramsulfuron halosulfuron iodosulfuron nicosulfuron	<i>Classic Option Permit Autum 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 chloransulfam	14
Axiom	<i>Define Sencor</i>	flufenacet metribuzin	15
Basis	<i>Resolve Harmony GT</i>	rimsulfuron triflurosulfuron	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>	atrazine bromoxynil	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	2
Canopy EX	<i>Classic</i>	chlormuron	2
Celebrity Plus	<i>Express</i>	triflurosulfuron diflufenzopyr	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



# Several PRE Options in Soybean

In Soybean there aren't many broad-spectrum control options

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.

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



Photo Credit to Bob Hartzler at ISU, Ames, IA

**Crop rotation -  
10 months to Corn**





# Vegetable Friendly Program



- Pre - Boundary + Sharpen (5-14-15)
- Alternate years with glyphosate (9) & glufosinate (10)
- If you don't grow alfalfa
  - Consider Flexstar GT (9 - 14)



# Vegetable Friendly Program



- Pre - Enlite (2-14)
- Alternate years with glyphosate (9) & glufosinate (10)
- If you don't grow alfalfa
  - Consider Flexstar GT (9 - 14)



# 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
<b>Tier 2</b>							
				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
<b>Tier 3</b>							
				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

<b>Tier 2</b>					
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
<b>Tier 3</b>					directed
Dual	15				0-5 inch
Harness/Surpass	15				0-11 inch
Outlook	15				0-12 inch
<b>Corn POST</b>					
<b>Tier 1</b>					
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**



# Vegetable Friendly Program



- Pre - Verdict (14-15)
- SureStart/TripleFlex (2-4-15)
  - No sweet corn the following year
- Alternate years with glyphosate (9) & glufosinate (10)
- Other post-emergence tank mix partners



# 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
2006	Corn	Dual + Simazine	Impact + atrazine
2007	Corn	Dual + Simazine	Impact + atrazine
2008	Corn	Dual + Simazine	Impact fb Callisto
2009	Corn	Dual + Simazine	Impact fb Callisto

Year	Crop	PRE	MOA*	POST	MOA*
2012	Corn Beans				
2013	Corn Beans				
2014	Corn Beans				
2015	Corn Beans				
2016	Corn Beans				

MOA\* = Herbicide Mode of Action

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



**CONFIRMED HPPD  
RESISTANCE**

**TAKE CONTROL with MY PLAN**

Year	Crop	Pre	Post

Year	Crop	PRE	MOA*	POST	MOA*
2012	Corn				

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

2005	Corn	Dual + Simazine	Callisto + atrazine
2006	Corn	Dual + Simazine	Impact + atrazine
2007	Corn	Dual + Simazine	Impact + atrazine
2008	Corn	Dual + Simazine	Impact fb Callisto
2009	Corn	Dual + Simazine	Impact fb Callisto

	Beans				
2014	Corn Beans				
2015	Corn Beans				
2016	Corn Beans				

**MOA\* = Herbicide Mode of Action**

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

**CONFIRMED HPPD  
RESISTANCE**

**TAKE CONTROL with MY PLAN**

Year	Crop	Pre	Post

Year	Crop	PRE	MOA*	POST	MOA*
2012	Corn				

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

2005	Corn	Dual + Simazine	Callisto + atrazine
------	------	--------------------	------------------------

	Beans				
2014	Corn				

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

2008	Corn	Dual + Simazine	Impact fb Callisto
------	------	--------------------	-----------------------

--	--	--	--	--	--

2009	Corn	Dual + Simazine	Impact fb Callisto
------	------	--------------------	-----------------------

2016	Corn				
	Beans				

**MOA\* = Herbicide Mode of Action**

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

# When Planning to Use a PRE Herbicide Consider:

Using full label rates as a good resistance mgmt. BMP

**Table 1: Soil Texture Groupings for SureStart Use Rate Selection.**

Coarse	Medium	Fine
Sand Loamy Sand Sandy Loam	Loam Silt Silt Loam Sandy Clay Loam	Silty Clay Loam Silty Clay Sandy Clay Sandy Clay Loam Clay Loam Clay

**Use Rates for SureStart by Soil Texture and Organic Matter Content**

Soil Texture	Soil Organic Matter Content	
	Less Than 3%	3% or Greater
	Pints/Acre	Pints/Acre
Coarse	1.5 – 2.0	1.5 – 2.0
Medium	1.5 – 2.5	1.75 – 3.0
Fine	2.0 – 3.0	2.0 – 3.0



# When Planning to Use a PRE Herbicide Consider:

## Influence of soil type and pH on Crop Injury

- 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:

### 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.



# When Planning to Use a PRE Herbicide Consider:

The PRE approach requires some planning and isn't as easy as the multiple application, glyphosate approach to weed management but it is still  
**A LOT EASIER THAN.....**





# Hand Weeding



# Reactive Weed Management Strategies

- In addition to proactive practices, even greater diversification will be required
  - Crop Rotation with Chemical Rotation
  - Liberty Link technology
  - Early-season competitive crops in the rotation
  - Cultivation, yes cultivation
  - Target the use of the HRC in the crop w/in your crop rotation where you really need it to be effective
  - Don't rely on HRC technology where effective herbicide alternatives exist



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

<http://www.wssa.net>



## • 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/>

**Home**

News Archives  
Publications  
Yield Loss Calculator  
Tank Mix Calculator

**Member Institutions**

Iowa State University  
Kansas State University  
Michigan State University  
North Dakota State University  
Purdue University  
South Dakota State University  
The Ohio State University  
The Pennsylvania State University  
University of Delaware  
University of Guelph  
University of Illinois  
University of Kentucky  
University of Minnesota  
University of Missouri  
University of Nebraska  
University of Wisconsin

**Sponsors**

BASF  
Bayer  
Dow AgroSciences  
DuPont  
Illinois Soybean Association  
Indiana Soybean Board  
Monsanto  
Syngenta  
USDA-CSREES NCIPM  
Competitive Grants Program  
Valent USA

**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
- Biology and Management of Common Lambsquarters
- Facts About Glyphosate Resistant Weeds
- Understanding Glyphosate To Increase Performance
- 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

**Coming Soon**



# How Do You Win A Game?

- You have a plan
- You develop a strategy
- You keep you opponent guessing
- You keep one step ahead
- You take advantage of weaknesses
- You take note of changes and adjust
- You ***TAKE CONTROL***

***TAKE CONTROL***



UNIVERSITY OF MINNESOTA | EXTENSION  
Driven to Discover<sup>SM</sup>