



Weed management in non-GMO soybean: What you need to know



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Common annual weeds in fields



foxtail sp.



c. lambsquarters



pigweed sp.



c. ragweed



velvetleaf



horseweed



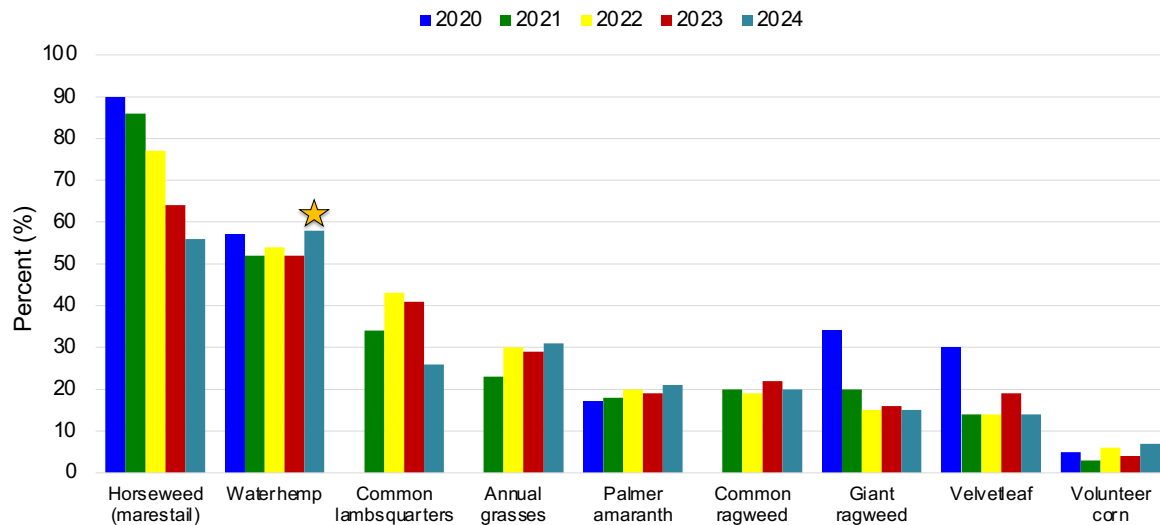
e.b. nightshade



g. ragweed

2

Top weed challenges over time



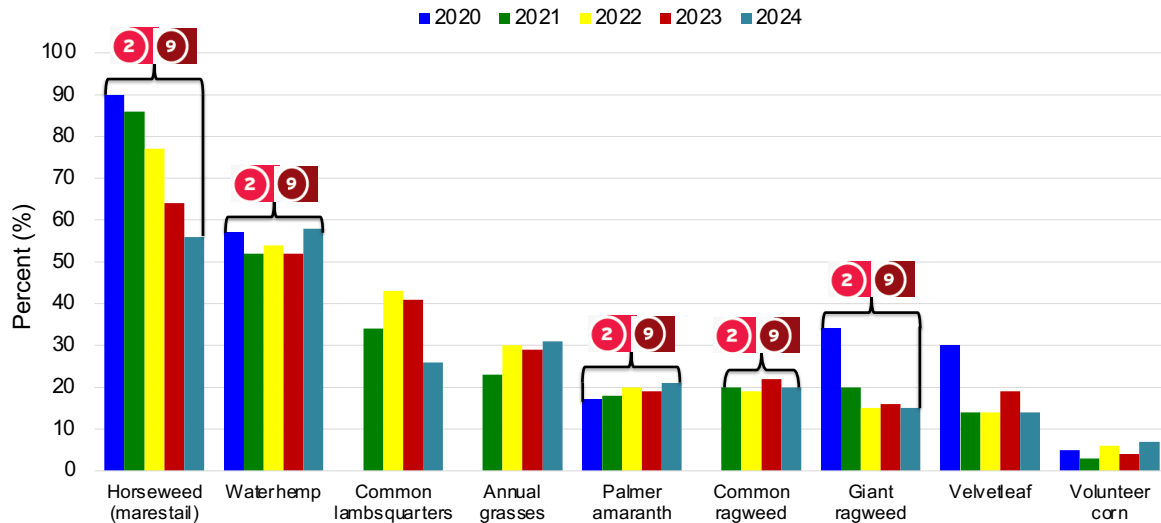
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Strategies for weed control in soybean

1. Herbicide-resistant weeds
2. Start clean
3. Residual activity
4. Timely applications
5. Rotation restrictions

4

Top weed challenges over time



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Herbicide-resistant weeds

Triazine (5)

C. lambsquarters
 C. groundsel
 C. ragweed
 C. purslane
 Powell amaranth
 Purple amaranth
 Redroot pigweed
 Ladysthumb
 Halberdleaf orach
 Lateflowering goosefoot
 Horseweed (marestail)
 Spreading orach
 Velvetleaf
 Late flowering goosefoot
 Eastern black nightshade
 Palmer amaranth

Glyphosate (9)

Horseweed – 2007/2010
 Palmer amaranth - 2010
 Waterhemp – 2011
 C. ragweed – 2014
 G. ragweed – 2016



ALS (2)

C. ragweed
 Waterhemp
 C. lambsquarters
 Smooth pigweed
 Redroot pigweed
 Horseweed
 Kochia
 Giant foxtail
 Powell amaranth
 Palmer amaranth
 Fall panicum

PPO (14)

C. ragweed
 Waterhemp
 Palmer amaranth

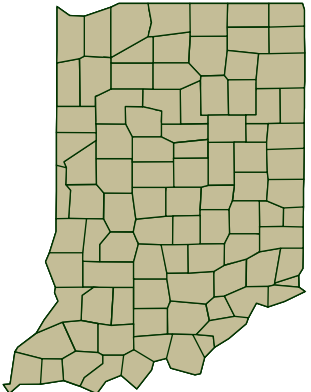
2,4-D (4)

Wild carrot
 Waterhemp

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Herbicide-resistant weeds

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<p>Triazine (5)</p> <p>C. lambsquarters Kochia Redroot pigweed Smooth pigweed Jimsonweed Waterhemp</p>	<p>Glyphosate (9)</p> <p>Horseweed Palmer amaranth Waterhemp G. ragweed C. ragweed</p>	<p>ALS (2)</p> <p>C. ragweed G. ragweed Waterhemp Palmer amaranth Horseweed Kochia Giant foxtail Johnsongrass Shattercane</p>
<p>HPPD (27)</p> <p>Waterhemp</p>		<p>PPO (14)</p> <p>Waterhemp Palmer amaranth</p>
<p>Dicamba (4)</p> <p>Waterhemp</p>		

Source: B.G. Young

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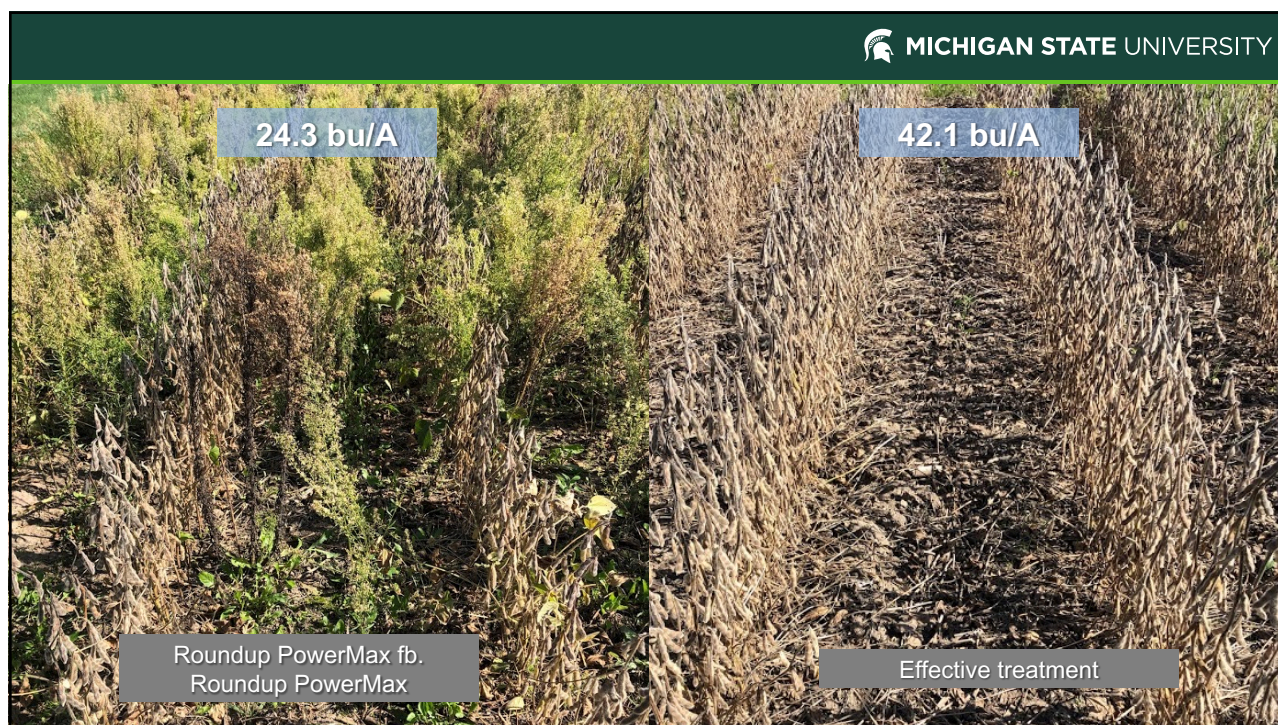
Horseweed

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(2)
(9)



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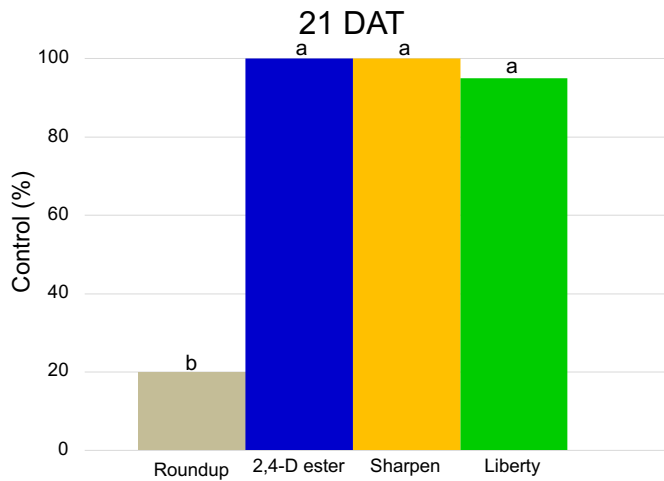


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Burndown options for horseweed control



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Potential spring burndown treatments - *Resistant horseweed*

One effective SOA	Two effective SOA's
1. 2,4-D ester (1 pt)* + glyphosate (4)	Combinations -
2. Sharpen (1 oz) + glyphosate + MSO (14)	1. 2,4-D ester (1 pt)* + Sharpen (1 oz) + glyphosate + MSO (4) (14)
3. Liberty Ultra (24 - 34 fl oz) (10)	2. Sharpen (1 oz) + Liberty + MSO (10) (14)
	3. Liberty + Metribuzin (5) (10)
	4. Gramoxone (3 pt) + Metribuzin (5) (22)

* Apply at least 7 d prior to planting

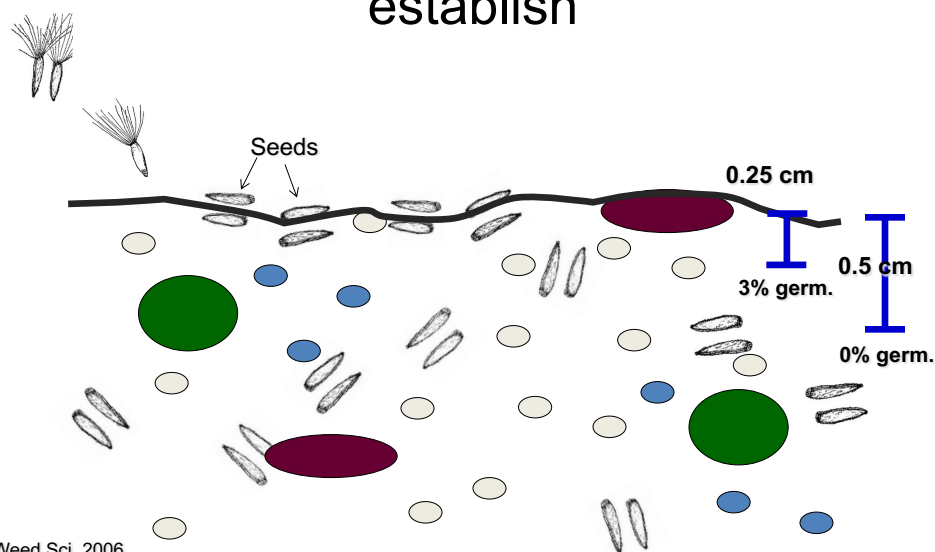
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Conventional tillage



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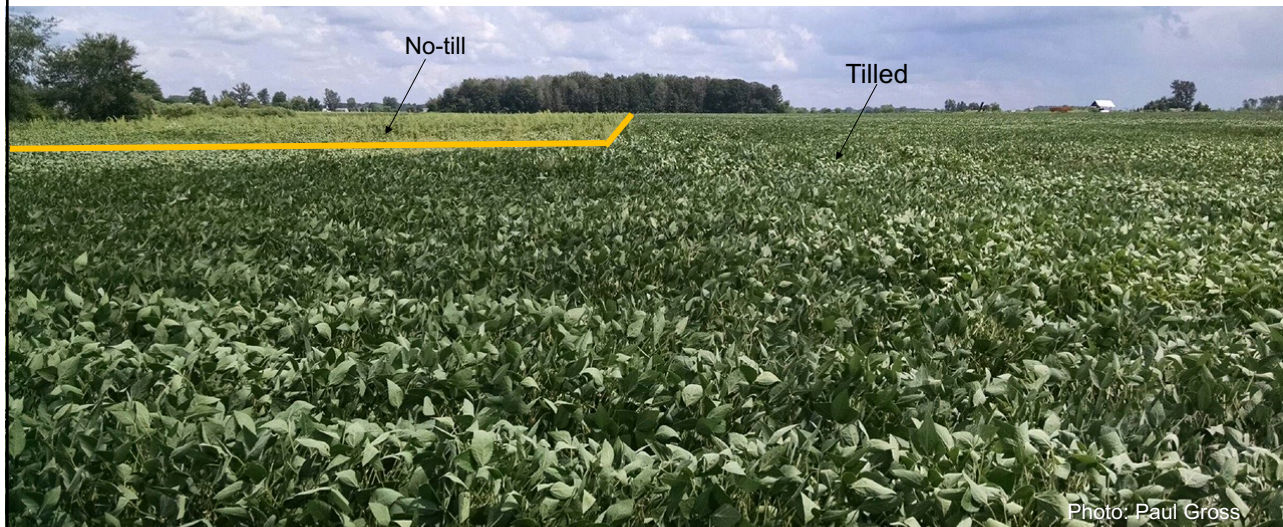
Buried horseweed seeds cannot germinate and establish



Nandula, et al., Weed Sci. 2006

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Tillage can be effective to reduce horseweed populations



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Effective tillage + soil-applied residual herbicides



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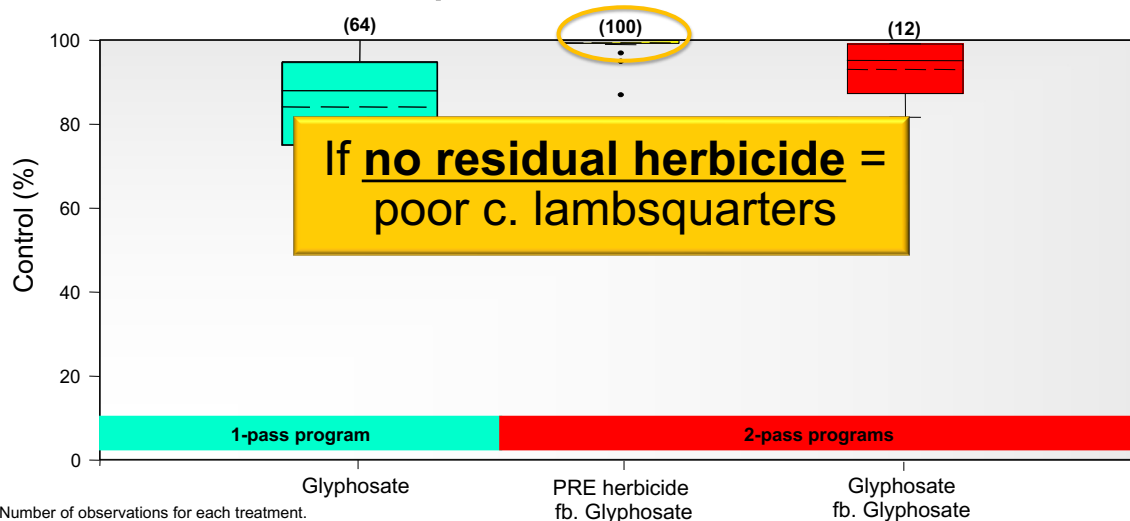
Soil-applied (PRE) herbicides – residual activity

- Soil-applied herbicides are a **foundation** program for hard-to-control and herbicide-resistant weeds
- **Reduce** the number of weeds that are present for the POST herbicide applications
- Soil-applied herbicides should be applied **after tillage** or **in the burndown treatment**



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PRE herbicides improve consistency of common lambsquarters control




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TABLE 2B — Weed Response to Soil-Applied Herbicides in Soybean*																												
Soil-applied	Site of Action	Soybean Tolerance**	Annual Broadleaves													Annual Grasses						Perennials						
			Cocklebur	Horseweed (monostell) ^a	Jimsonweed	Lambsquarters	Nightshade (E. black)	Palmer amaranth ^b	Pigweed	Ragweed (Common)	Ragweed (Giant)	Smartweed	Velvetleaf	Waterhemp ^b	Wild mustard	Barnyardgrass	Crabgrass	Giant foxtail	Green foxtail	Yellow foxtail	Fall panicum	Witchgrass	Sandbur	Bindweed (Field & Hedge)	Canada thistle	Quackgrass	Yellow nutsedge	
Classic	2	2	G	N	F	G	N	N	E	G	P	E	E	N	P	F	F	F	F	F	F	P	P	P	N	N	N	F
Command 3ME	13	1	F	P	F	G	P	P	P	G	P	G	E	P	P	G	E	E	E	G	G	G	F	N	N	N	N	N
Dual Magnum, others	15	1	N	P	N	P	F	G	E	P	N	P	N	G	P	E	E	E	E	E	G	G	P	N	N	N	N	F
FirstRate	2	2	G	N	G	G	P	N	E	E	G	E	G	N	E	F	F	F	F	F	F	P	P	N	N	N	N	P
Lorox/LineX	5	2	P	P	P	G	F	P	G	G	F	G	F	P	G	F	F	F	F	F	F	F	P	N	N	N	N	N
Metribuzin	5	2	F	G	F	G	N	F	E	G	F	E	G	F	E	P	F	F	F	F	F	F	P	N	N	N	N	N
Outlook	15	1	N	N	N	P	G	F	E	P	N	P	N	G	P	E	E	E	E	E	G	G	P	N	N	N	N	F
Prowl/Prowl H ₂ O	3	2	N	P	N	G	P	P	F	P	N	P	F	F	P	G	G	G	G	G	G	G	P	N	N	N	N	N
Pursult	2	1	F	N	F	G	E	N	E	F	F	G	G	N	E	F	F	G	G	G	P	P	P	P	N	N	N	F
Python	2	1	F	N	F	E	G	N	E	F	F	G	G	N	E	P	P	F	P	P	P	P	P	N	N	N	N	N
Sonalan (PPI only)	3	1	N	P	N	G	F	F	G	P	N	P	N	F	P	E	E	E	E	E	E	E	G	N	N	N	N	N
Spartan	14	2	P	F	P	E	E	G	E	F	P	F	F	G	P	N	N	P	P	P	N	N	N	N	N	N	N	G
Trifluralin (PPI only)	3	1	N	P	N	G	F	F	G	P	N	P	N	F	P	E	E	E	E	E	E	E	G	N	N	N	N	N
Valor/Valor EZ	14	2	P	G	F	G	G	G	G	G	F	F	F	G	G	N	N	P	P	P	N	N	N	N	N	N	N	P
Warrant/Enversa	15	1	P	P	N	F	G	G	G	F	N	P	P	G	P	E	E	E	E	E	E	E	F	N	N	N	N	F
Zidua	15	1	P	P	F	F	G	G	E	F	N	F	F	G	F	E	E	E	E	E	E	E	G	N	N	N	N	F


26 different soil-applied premixtures have Good to Excellent control of common lambsquarters

26 different soil-applied premixtures have **Good** to **Excellent** control of common lambsquarters

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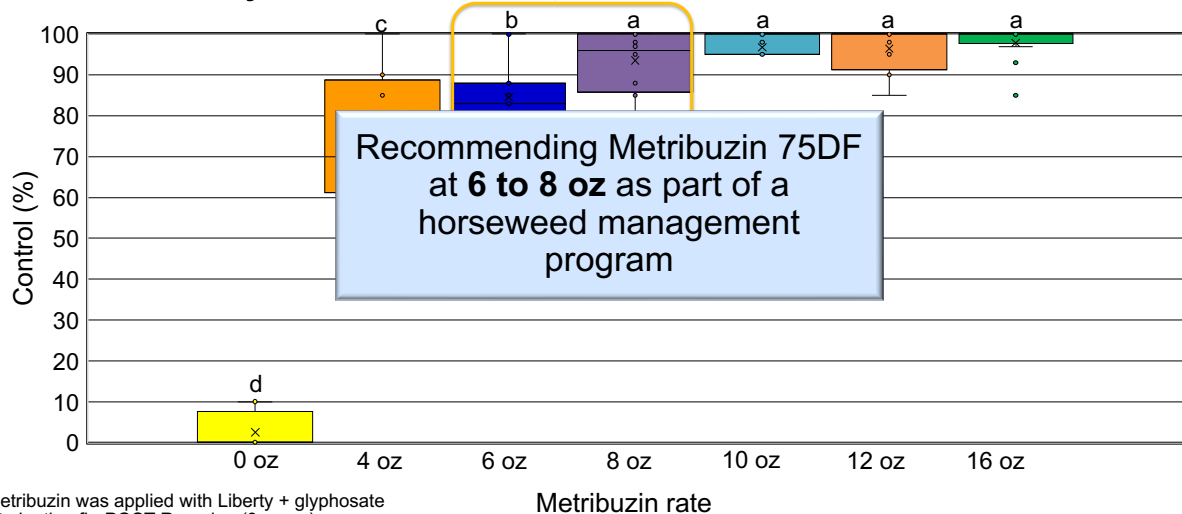
Key PRE herbicides for horseweed control



- Group **5** herbicides:
 - Metribuzin

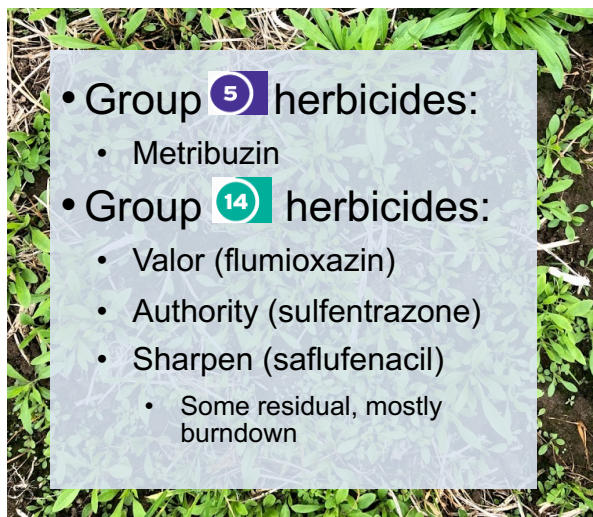
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Horseweed response to metribuzin* rates in no-till soybean – *at soybean harvest*



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Key PRE herbicides for horseweed control



Premixtures:

- Boundary **5** **15**
- Dimetric charged **5** **14**
- Fierce MTZ/Kyber Pro **5** **14** **15**
- Sonic Boom **5** **14**
- Tendovo **2** **5** **15**
- Tripzin ZC **3** **5**
- Trivence **2** **5** **14**
- Zidua PRO **2** **14** **15**

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Waterhemp



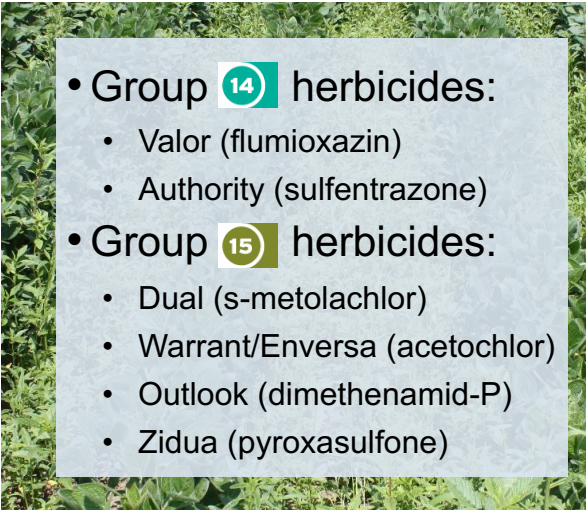
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Effective PREs are important for waterhemp control



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Key PRE herbicides for waterhemp control

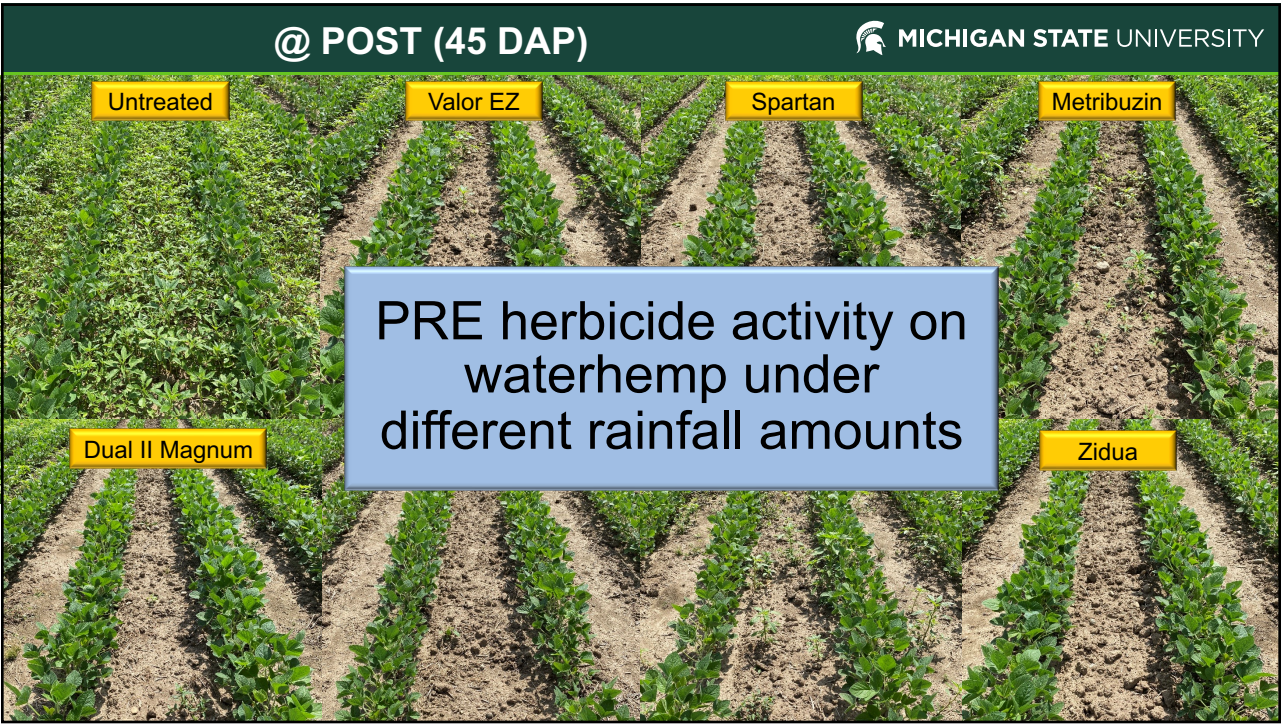


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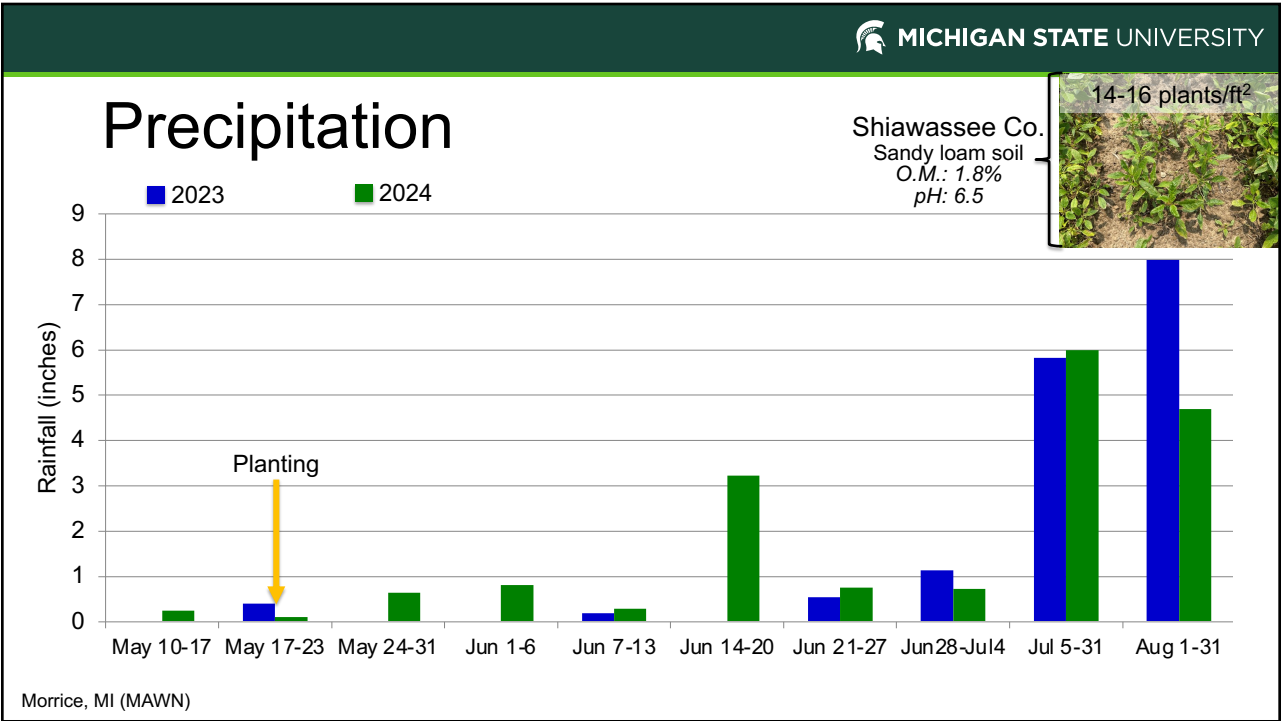
@ POST (45 DAP)



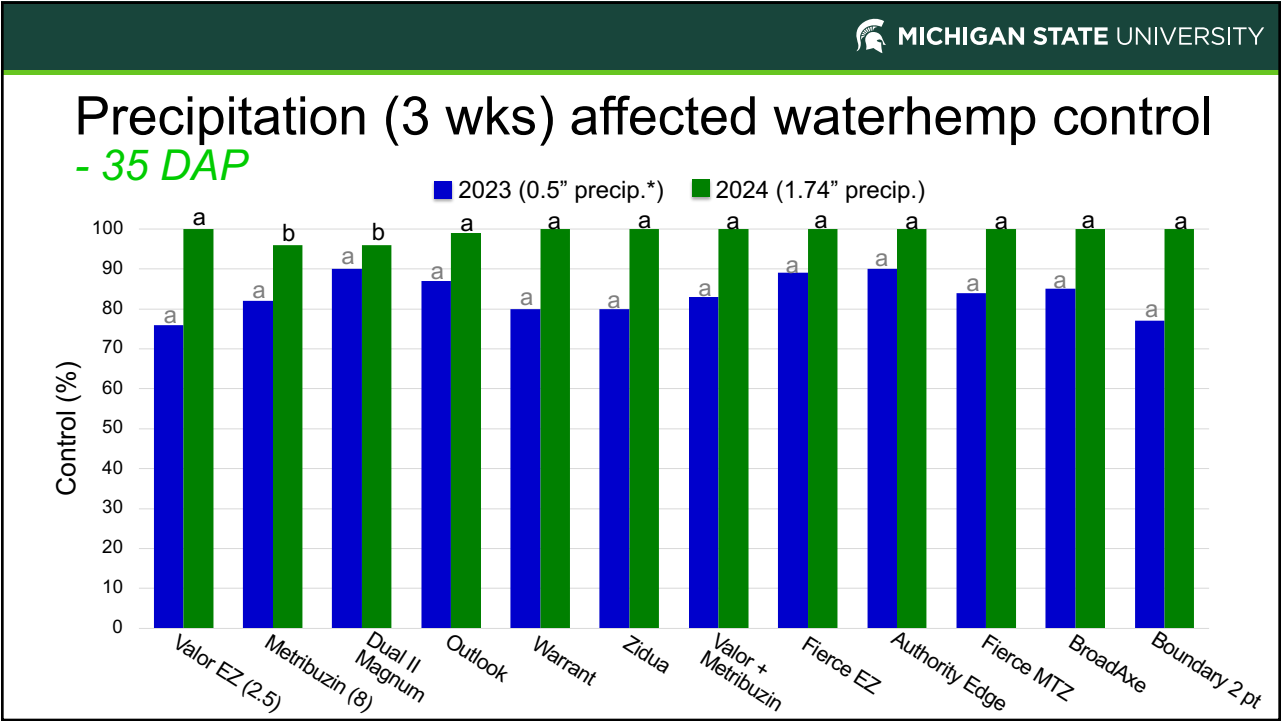
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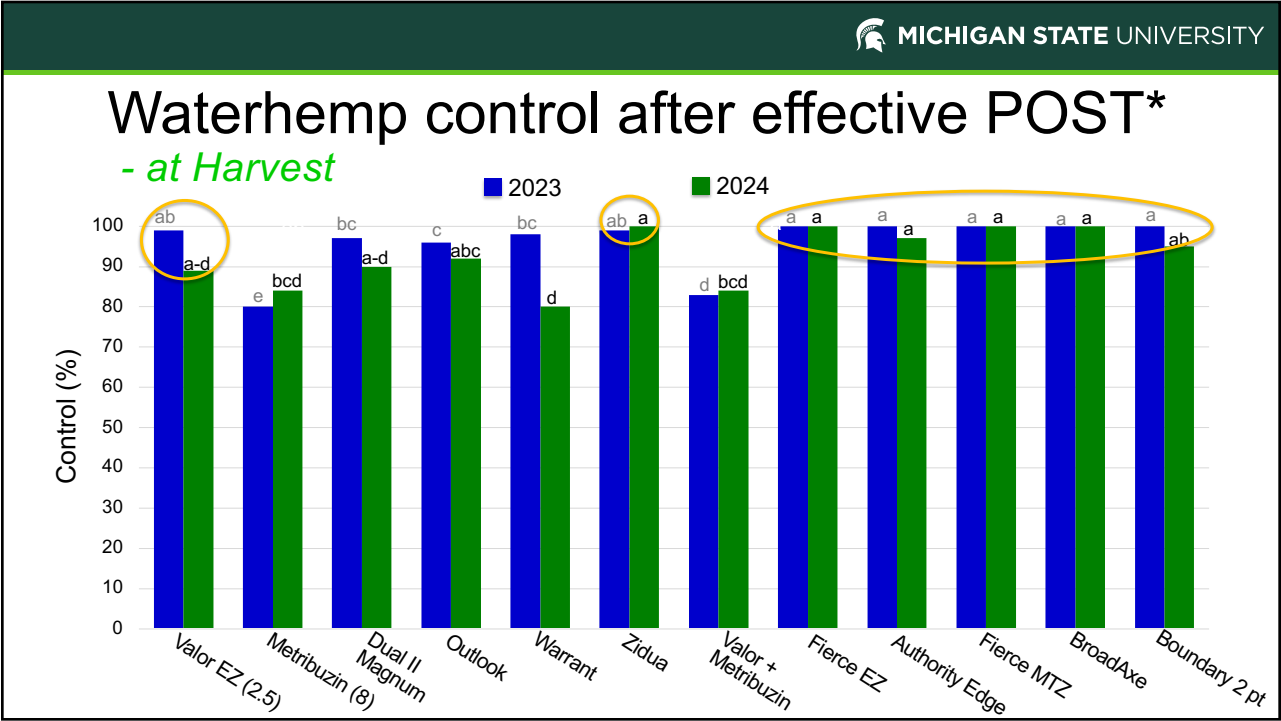
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at Harvest

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Roundup PowerMax 3 (POST)



Effective (PRE) fb.
Effective (POST)



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Key PRE herbicides for waterhemp control

Premixtures:

Group 14 herbicides:

- Valor (flumioxazin)
- Authority (s-metolachlor)

Group 15 herbicides:

- Dual (s-metolachlor)
- Warrant/Enversa (acetochlor)
- Outlook (dimethenamid-P)
- Zidua (pyroxasulfone)

Boundary

Authority Edge/Supreme

Fierce

Fierce MTZ/Kyber Pro

Tendovo

BroadAxe

5 15

5 14

5 14

14 15

14 15

14 15

5 14 15

2 5 15

PREs with multiple effective sites of action are the most effective

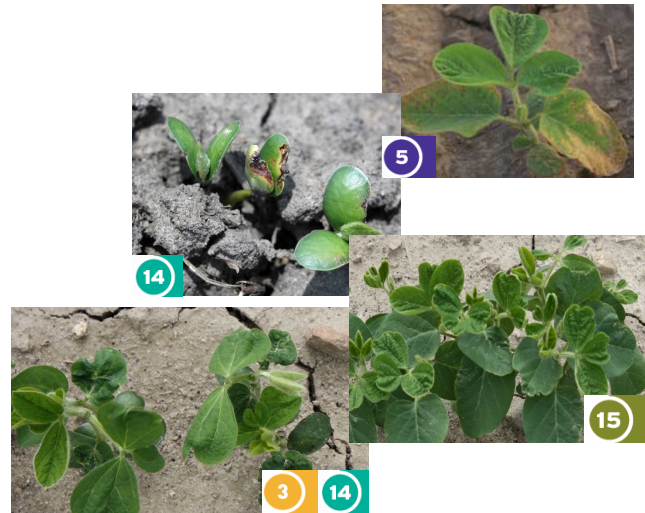
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Soil-applied herbicide precautions

Potential soybean injury

- Herbicide and rate dependent



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Increasing rates of metribuzin + Fierce EZ (6 fl oz)



0 oz/A



8 oz/A



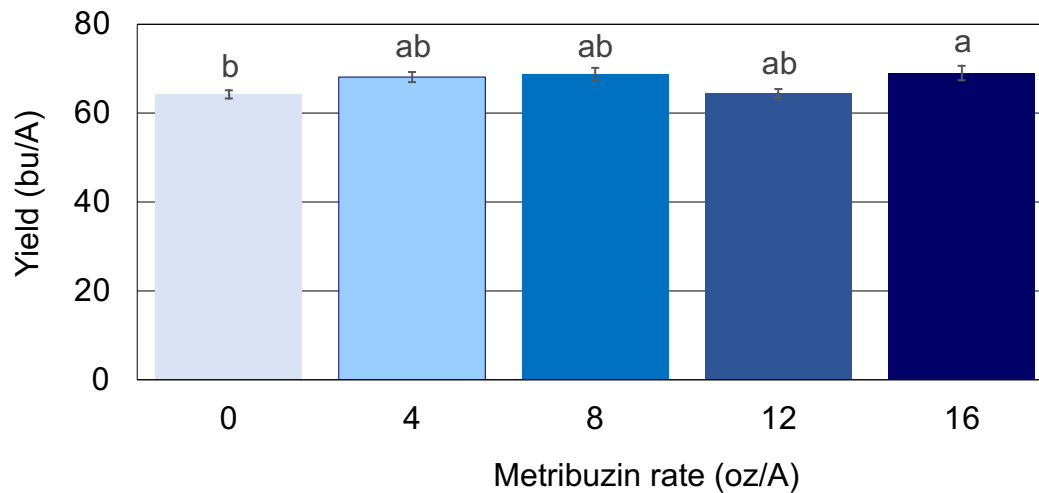
16 oz/A

Metribuzin rate

Clay loam - 2.4% O.M.; pH 7.5.

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Soybean yield with increasing rates of metribuzin + Fierce EZ (6 fl oz)

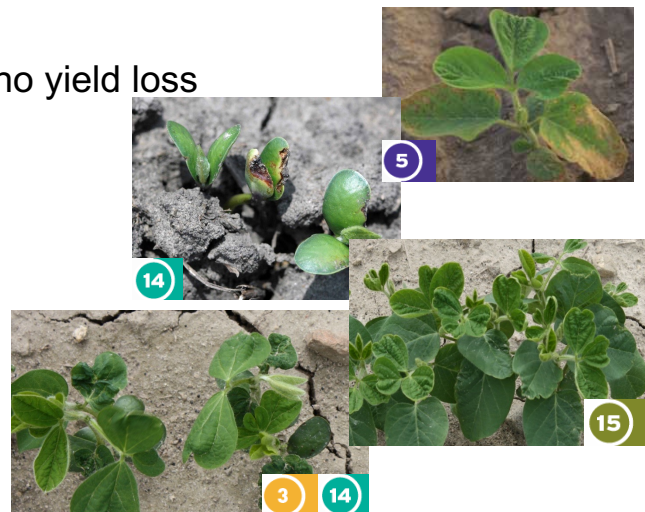


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Soil-applied herbicide precautions

Potential soybean injury

- Herbicide and rate dependent
- Soybean generally recover with no yield loss
- Higher risks:
 - Cool-wet conditions
 - Excessive rainfall
 - High soil pH
 - Sandy soils
 - Low organic matter
- Certain tank-mixtures



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Some soil-applied herbicides cannot be tank-mixed

- Beware of tank-mix interactions
 - *Group 14 herbicides: (some tank-mix restrictions)*
 - *Flumioxazin* products (i.e., Valor, Valor XLT, Envive, Fierce, Fierce XLT, Trivence, Surveil, etc.) - *TM restriction with Sharpen (need 14 d before planting)*
 - *Sulfentrazone* products (i.e., Authority Assist, Edge/First/Supreme/XL, Sonic, etc.) - *TM restriction with Sharpen (need 14 d before planting)*
 - DO NOT tank mix Valor, Envive, Trivence or other flumioxazin products with Group 15 herbicides, such as, metolachlor (*Dual*), dimethenamid (*Outlook*), or acetochlor (*Warrant/Enversa*) products within 14 days of planting, unless soybeans are planted under no-till or minimum till conditions on wheat stubble or no-till field corn stubble.

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PRE application of Valor + Dual Magnum

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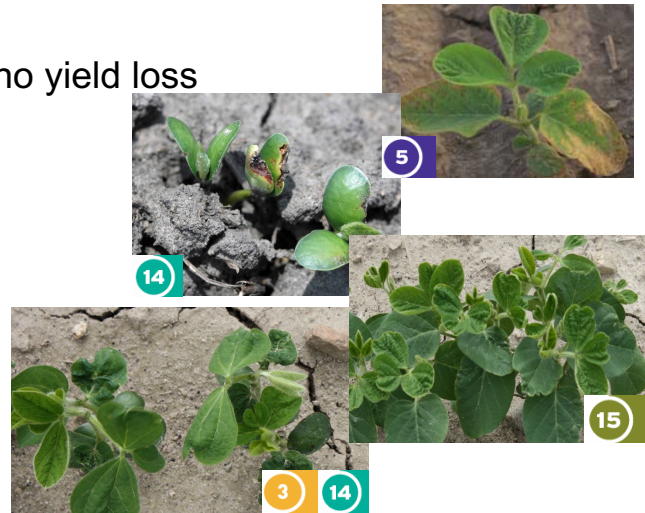


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Soil-applied herbicide precautions

Potential soybean injury

- Herbicide and rate dependent
- Soybean generally recover with no yield loss
- Higher risks:
 - Cool-wet conditions
 - Excessive rainfall
 - High soil pH
 - Sandy soils
 - Low organic matter
- Certain tank-mixtures
- Soybean varietal sensitivity



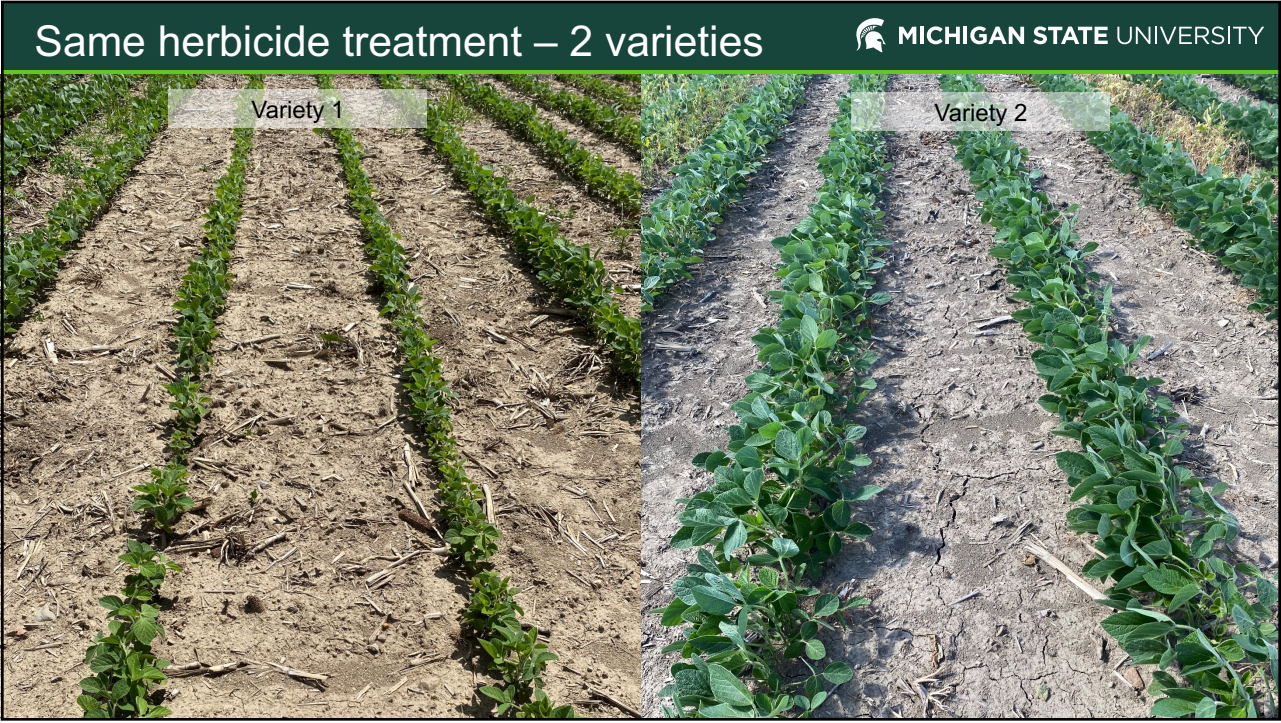
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Consult with seed companies/dealers about potential variety differences in herbicide tolerance

Variety								Relative Maturity	SCN Type	Plant Height	Plant Type	Hilum Color	Approximate Seed Size	Flower	Root
NEW	DF 3144 N E3	1.4	P188788	Med-Tall	Bush	Buff	S	White							
NEW	DF 3165 N E3	1.6	P188788	Med-Tall	Med-Bush	Imp. Black	M	Purple							
	DF 3194 N E3	1.9	Peking	Med-Tall	Med-Bush	Black	S	Purple							
	DF 3211 N E3	2.1	P188788	Medium	Med-Bush	Imp. Black	M	Purple							
NEW	DF 3225 N E3	2.2	P188788	Medium	Med-Bush	Brown	S	White							
NEW	DF 3245 N E3	2.4	P188788	Med-Tall	Med-Bush	Buff	S	White							
	DF 3264 N E3	2.6	Peking	Medium	Bush	Black	S	Purple							
	DF 151 N	1.5	P188788	Medium	Med-Bush	Brown	M	Purple							
	DF 151 N Org	1.5	P188788	Medium	Med-Bush	Brown	M	Purple							
	DF 174 N F	1.7	P188788	Medium	Bush	Clear	L	White/Purple							
	DF 184 N	1.8	P188788	Med-Tall	Bush	Black	M	White							
NEW	DF 184 N Org	1.8	P188788	Med-Tall	Bush	Black	M	White							
	DF 204 N	2.0	P188788	Med-Tall	Med-Bush	Black	S	White							
NEW	DF 205 NF	2.0	P188788	Med-Tall	Med-Bush	Clear	L	Purple/White							
	DF 214 N	2.1	P188788	Medium	Med-Bush	Clear	L	White							
	DF 234 N	2.3	Peking	Med-Tall	Med-Bush	Brown	M	Purple							
	DF 155 F	2.5	None	Tall	Bush	Clear	L	Purple							
	DF 155 F Org	2.5	None	Tall	Bush	Clear	L	Purple							
	DF 260 N	2.6	P188788/437654	Medium	Med-Bush	Buff	M	Purple							
	DF 262 N F	2.6	P188788	Med-Tall	Bush	Clear	L	Purple							
	DF 262 N F Org	2.6	P188788	Med-Tall	Bush	Clear	L	Purple							
	DF 282 N	2.8	P188788	Med-Tall	Medium	Black	M	Purple							

DF 214 N

RELATIVE MATURITY	PLANT HEIGHT	PLANT TYPE
2.1	Medium	Med-Bush

EMERGENCE RATING	2
LODGING	2

- Clear hilum with yield
- Manage for white mold and place on well drained soils
- Strong tolerance to metribuzin chemistry

2025 DF Seed Guide

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POST herbicide applications

- Product selection
- Timing
 - Weed size: 2- to 4-inches
 - Crop size
- Adjuvant selection
- Application parameters
- Watch outs
 - Tank-mixture antagonisms
 - Crop injury



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POST herbicide options



POST grass herbicides 1



- SelectMAX
- Assure II
- Fusilade DX
- Others

ALS-inhibitors

-

ALS-inhibitors

- Harmony
- Synchrony
- Raptor

Photosynthetic-inhibitor 6

- Basagran



PPO-inhibitors 14

- Flexstar
- Cobra
- Ultra Blazer

Photosynthetic-inhibitor 6

- Basagran

2

- Synchrony
- Pursuit

PPO-inhibitors 14

- Resource



Some of these herbicides are also in POST premixtures

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STS Soybean

- Increased tolerance to the sulfonyleurea herbicides
 - Classic (chlorimuron)
 - Harmony (thifensulfuron)
- Synchrony XP – 0.75 oz/A
 - Classic 0.64 oz + Harmony 0.105 oz
 - COC + AMS
- Control of:



DF 234 N



2

RELATIVE MATURITY	PLANT HEIGHT	PLANT TYPE
2.3	Med-Tall	Med-Bush

EMERGENCE RATING	1
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LODGING	1
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- Yielding better than DF 231 N
- Strong emergence and standability
- Tolerant to STS® chemistry

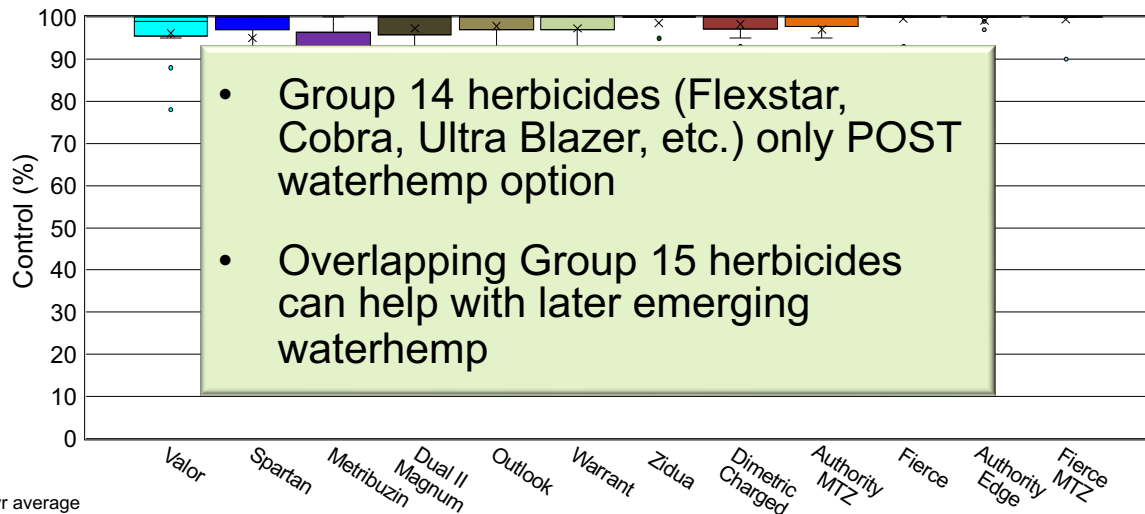
Suppression of:



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Waterhemp control at harvest*

- after an effective POST application



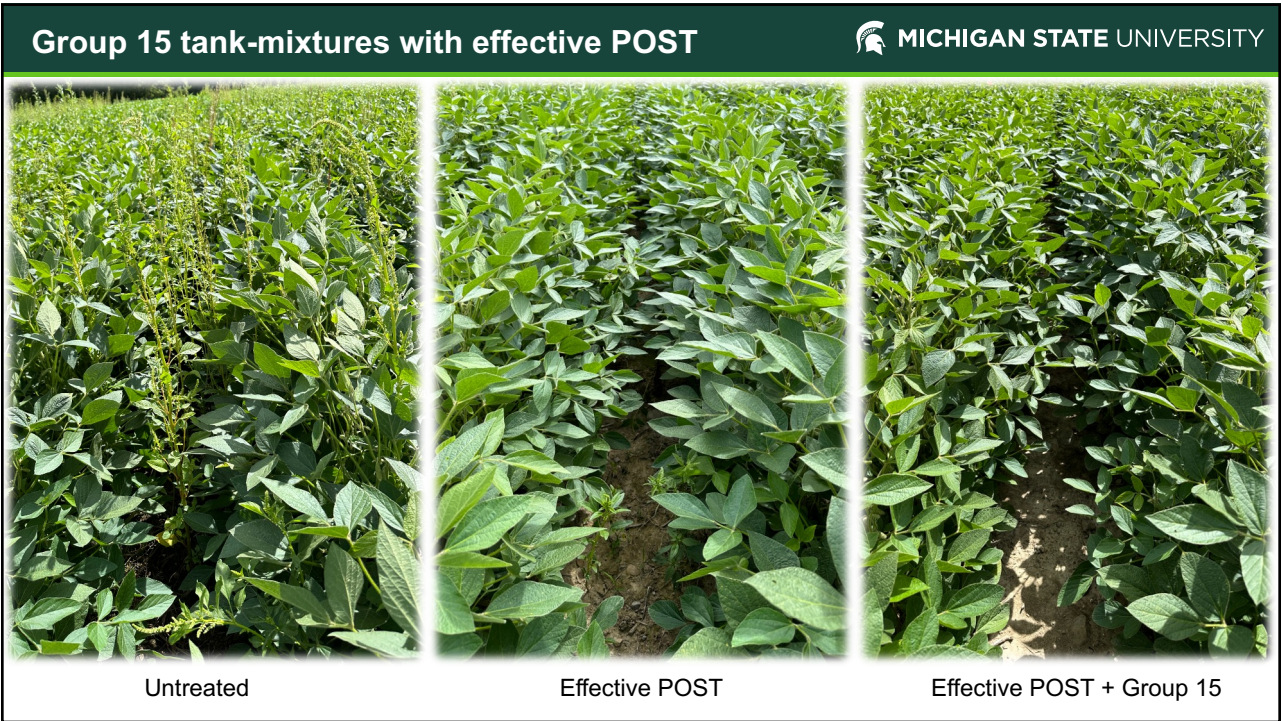
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Options for POST residual control

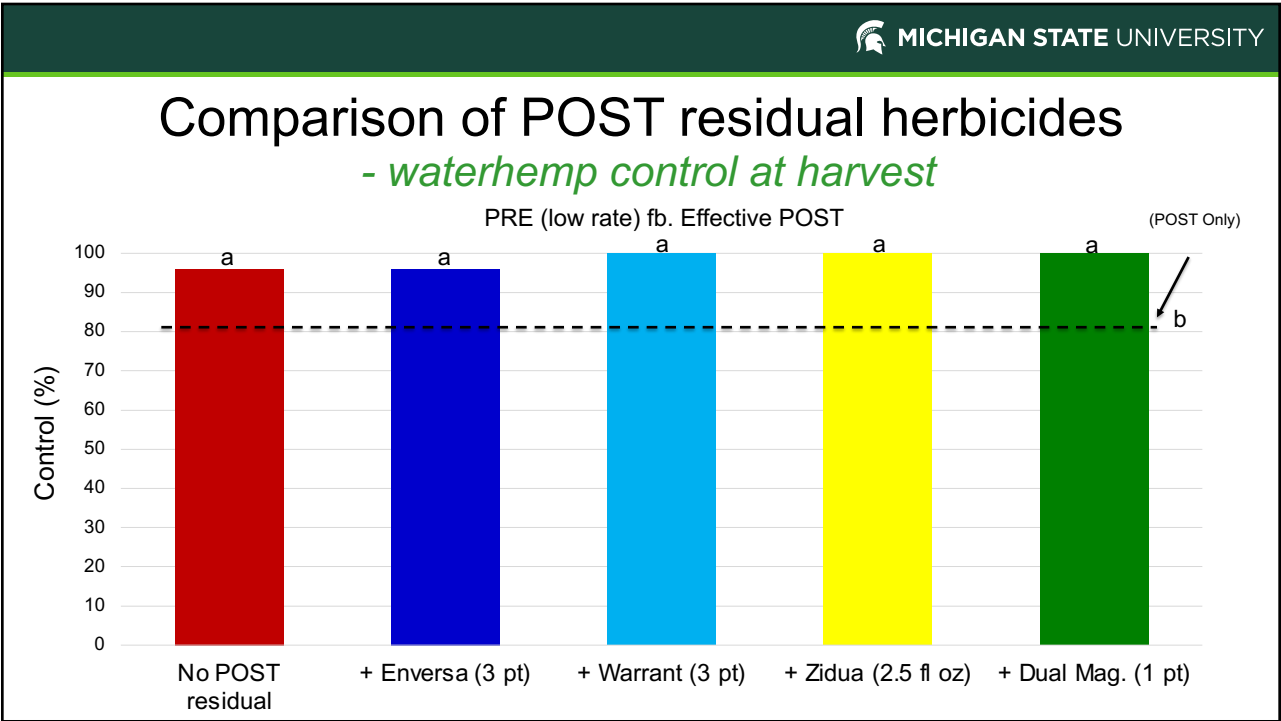
- Group 15 herbicides
 - Dual Magnum
 - Outlook
 - Warrant/Enversa
 - Zidua
- They will not control emerged weeds
- Need to be tank-mixed with an effective POST herbicide
 - Premixes: Prefix, Warrant Ultra



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Thoughts and precautions

Group 15 POST applications

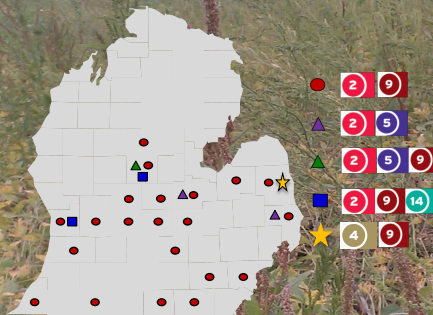
- Can improve late-season waterhemp control
- Not always needed
- Fits well with early planted soybean
- Beware of maximum POST use rates:
 - Dual Magnum = 2 pt; Total = 3.9 pt
 - Outlook = 21 fl oz; Total = 24 fl oz
 - Warrant/Enversa = 3 pt; Total = 8 pt
 - Zidua = 2.5 fl oz; Total = 5.75 fl oz
- Be mindful of rotation restrictions
 - Dual Magnum = wheat 4.5 mo.
 - Outlook, Warrant/Enversa, and Zidua = wheat 4 mo.



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WARNING!!

Multiple-resistant waterhemp
in Michigan*



* Samples submitted to the MSU Diagnostic Clinic

4-way resistance (IL)

■ ALS	2
■ Triazine	5
■ Glyphosate	9
■ PPO	14

7-way resistance (IL)

■ ALS	2
■ 2,4-D (TIR1)	4
■ Triazine	5
■ PPO	14
■ VLC fatty acid inhibitors	15
■ HPPD	27
■ Dicamba	4

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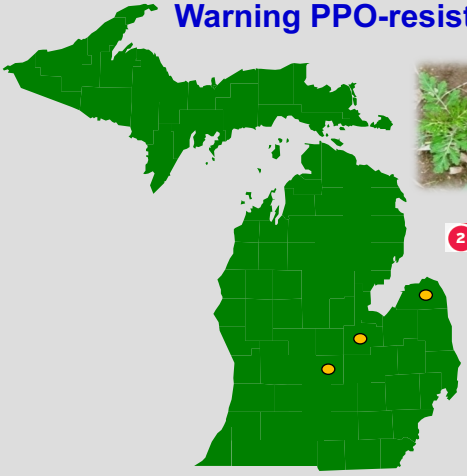

What about PPO-resistance control?

- ALS-resistance
 - Limiting effect
- PRE fb. POST

Common

- PRE:
 - Valor, etc. (flu)
 - Command (c)
 - Metribuzin
- POST:
 - Flexstar, Cobra
 - Prefix, Warrant Ultra

Warning PPO-resistance!!

agweed

weeds)

or Cobra (12.5 fl oz)

4 weeks)


- Cobra (max. seasonal 25 fl oz)

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Grass control can be antagonized with certain grass and broadleaf tank-mixtures

- Example: Group 1 (SelectMax) + Group 14 (Flexstar or Cobra)
- Overcome that antagonism by:
 - Increase the SelectMax rate by 33%
 - Apply 12 fl oz/A instead of 9 fl oz/A
 - Apply the herbicides in separate applications
 - Grass herbicide 1st wait 1 to 3 d prior to the broadleaf herbicide
 - Broadleaf herbicide 1st wait 7 d prior to the grass herbicide



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Keep rotation restrictions in mind

What if you want to plant sugarbeets in two years?



TABLE 12 – Herbicide Crop Rotation Restrictions

p. 150-154

Herbicide	Soil pH Restrictions	in months													
		Soybeans	Field Corn	Seed Corn	Wheat	Oats	Barley	Rye	Alfalfa	Dry Beans	Sugarbeets	Potatoes	Cucumbers	Tomatoes	
Kyro	None	10.5/18*	0	0	4	10.5	10.5	10.5	10.5	18	18	18	18	18	
Laudis*	None	8	0	0	4	4	4	4	10	10/18*	10/18*	10	18	10	
Lexar EZ	None	10	0	0	15	10	10	10	18	18	18	18	18	18	
Liberty/Rely	None	0	0	0	2.5	2.5	2.5	2.5	6	6	0	2.5	6	6	
Lorox/Linex	None	4	4	4	4	4	4	4	4	4	4	4	4	4	
Lumax EZ	None	10	0	0	4.5	10	4.5	4.5	18	18	18	18	18	18	
Marvel	None	0	10	10	4	4	4	4	18	0	18	0	18	4	
Matrix	None	4	0	0	4	9	9	4	4*	10	18*	0	10	0	
Maverick	None	10.5/18*	0	0	4/6*	18	18	18	18	18	18	18	18	18	
MCPA	None	-	-	-	-	-	-	-	-	-	-	-	-	-	
Metribuzin	≥ 7.0	4	4	4	4	4	4	12	4	12	18	4	12	12	
Milestone	None	12*	12*	12*	12*	12*	12*	12*	12*	12*	12*	12*	12*	12*	
Ultra Blazer	None	0	100 d	100 d	40 d	40 d	40 d	40 d	100 d	100 d	100 d	100 d	100 d	100 d	
Upbeet	None	0.5	0.75	0.75	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	
Valor/Valor EZ (2 oz)	None	0	1*	1*	1*	4/8*	3	3	4/8*	3	4/8*	4/8*	4/8*	4/8*	
Valor/Valor EZ (>2-3 oz)	None	0	1*	1*	2*	5/10*	4	4	5/10*	4	5/10*	12	12	12	
Valor XLT*	>6.8	0	10	10	4	12	4	4	12	12	30	30	18	12*	
Varisto	≥6.2	0	8.5	8.5	3	9	9	4	3	0	18*	9	9	9	
Velpar	None	24	12	12	24	24	24	24	24	24	12	12	24	24	
Verdict (5 oz)	None	0/1*	0	0	4	FS	4	4	FS	FS	9	FS	FS	FS	
Verdict (>10 oz)	None	1-4*	0	0	4	FS	4	4	FS	FS	9	FS	FS	FS	

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Evaluation of weed control programs in non-GMO soybean (2010 – 2025)

- Goal: Examine various weed control programs in non-GMO soybean
 - Examine various PREs (17)
 - Scout for weed escapes to determine POST treatments (21 trts)
- Evaluated soybean injury, weed control, yield, and economics
- Yearly results are posted on canr.msu.edu/weeds/

Table 1. Site description.

Crop	Soybean
Variety	ZFS 1326
Soil Texture	loam
Soil pH	6.7
Soil Organic Matter	2.0
Dominant Weeds	ANGR, CHEAL, ALS-R AMBEL
Planting Date	May 14
Application Timings:	
PRE	May 15
EPOS	June 13
POST	June 18
LPOS	June 30
Evaluation Times	21 & 33 d after planting 14 after POST, Prior to harvest

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<https://canr.msu.edu/weeds/> MICHIGAN STATE UNIVERSITY

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MSU Weed Science December 2025

Economics of Weed Control Programs for non-GMO Soybean, 2025
Christy L. Sprague

A field trial sponsored by the Michigan Soybean Promotion Committee (MSPC) was conducted in 2025 at the MSU Plant Pathology Farm in Lansing to compare weed control, soybean injury, soybean yield, and economic returns of potential programs in non-GMO (conventional) soybean. Soil-applied (PRE) herbicide programs were designed to provide control of dominant weed species found in Michigan soybean fields. Seventeen different soil-applied (PRE) herbicide programs were applied immediately after soybean planting and were evaluated –23 and 33 days after planting (DAP). At the 33 DAP evaluation, the PRE herbicide programs were scouted for weed escapes and POST herbicide treatments were selected based on weeds that escaped control. For example, if common ragweed was the escaped weed, herbicides like Flexstar or Cobra, were applied. Herbicide rates were adjusted to weed size. In some cases, some the PREs did not need a POST application at 33 DAP, therefore they were scouted again 45 DAP and POST were then applied and designated late POST (LPOS). Three additional POST only treatments were applied when weeds were 2-inches tall and were designated as an early POST (EPOS) application. All treatments were evaluated one week after the POST application for soybean injury. There was one PRE treatment where a POST herbicide was not applied to show the importance of a PRE followed by POST herbicide program. Site characteristics and herbicide application timings are described in Table 1. Table 2 describes the herbicide programs evaluated. The maximum soybean yield was 51.8 bu/A and yield loss due to weeds was high. The weedy (untreated) yield was 10.3 bu/A, resulting in a yield loss of 41.5 bu/A (80%). Tables 3 & 4 contain the data for soybean injury, weed control, herbicide program costs, soybean yield, and economic returns.

Table 1. Site description.

Crop	Soybean
Variety	ZFS 1326
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Dominant Weeds	ANGR, CHEAL, AMBEL ¹
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Take Home Message

- Be prepared with a comprehensive weed management plan
 - Consider the potential for herbicide-resistant weeds
- Look for alternatives, keeping in mind that there are several sources of information
- Soil-applied (PRE) herbicides will go along way to reduce the pressure on the POST herbicides
- POST herbicides considerations: weed size, tank-mixtures, adjuvants, and overlapping residual herbicides
- Scouting prior to and after POST herbicide application is critical

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Questions

SU is to provide integrated weed management solutions.

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