

Waterhemp Management

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Cooperative

NDSU

EXTENSION

UNIVERSITY OF MINNESOTA
EXTENSION

Between Herman and Wheaton MN, 2014

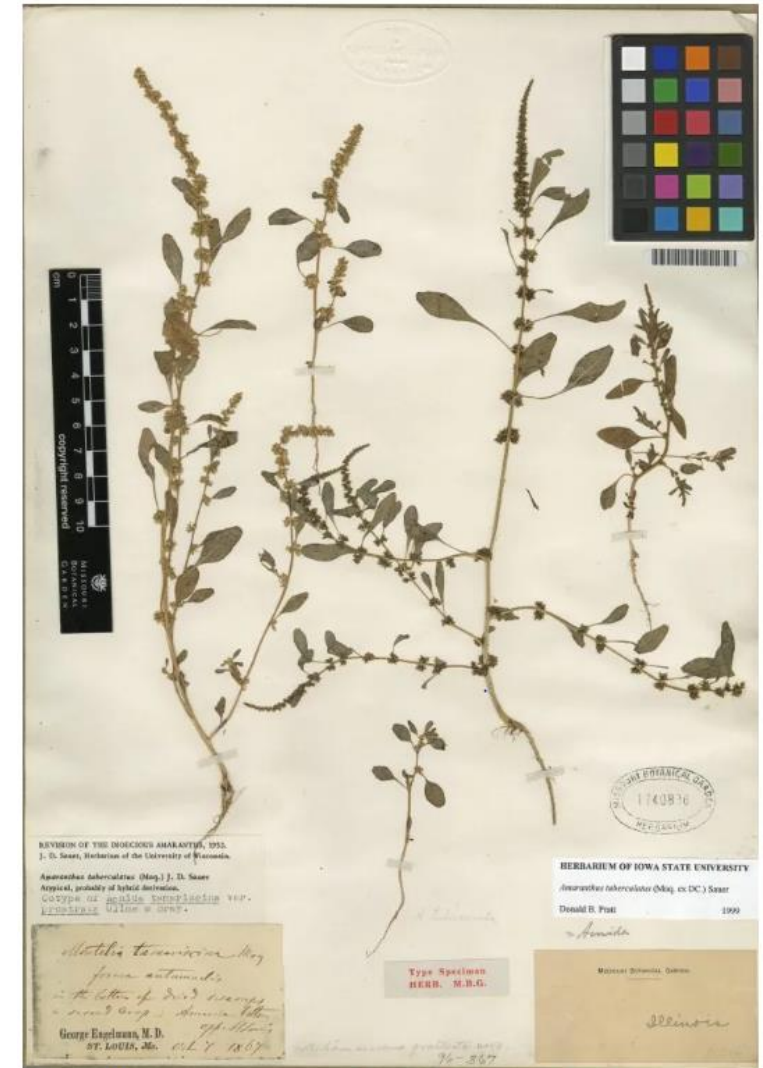
2014 Sugarbeet Field

- Thought it was redroot pigweed
- Water from the creek flooded the north west part of the field
- Creek is connected to the Niemakle Lake / watershed
- Waterfowl production area
- Waterhemp impeded soybean harvest in 2012
- Sugarbeet weed control research in 2013, 2014, and 2015



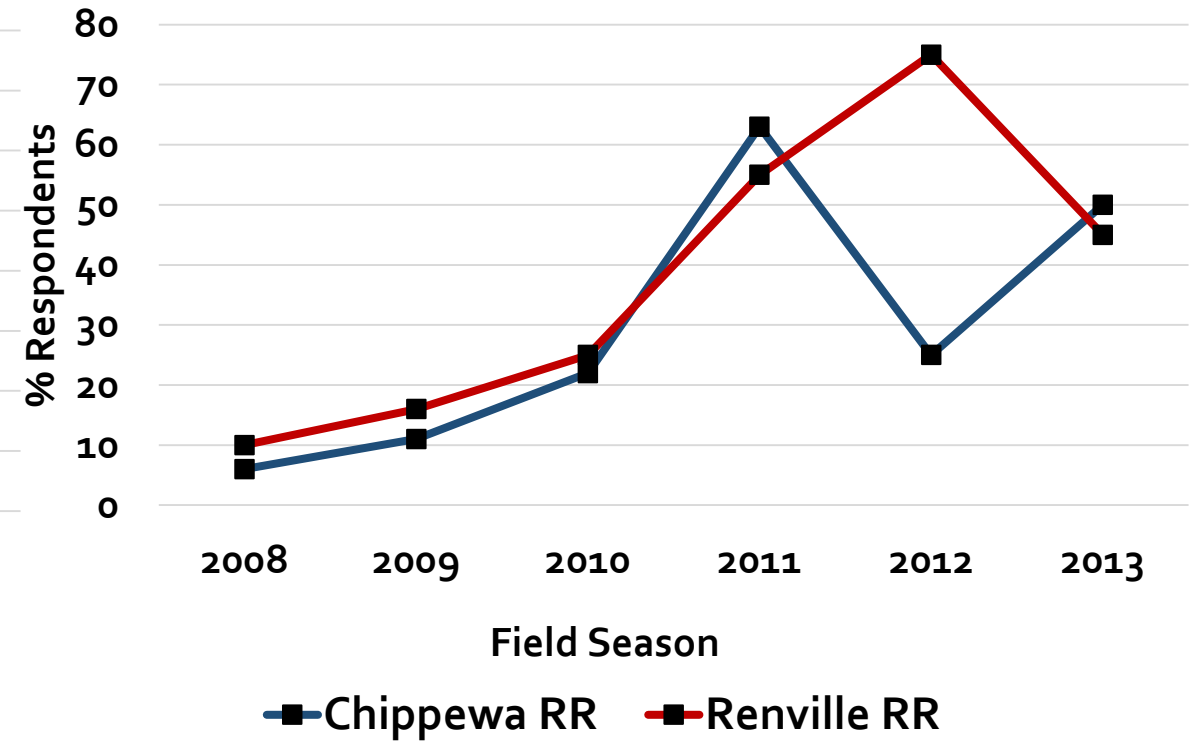
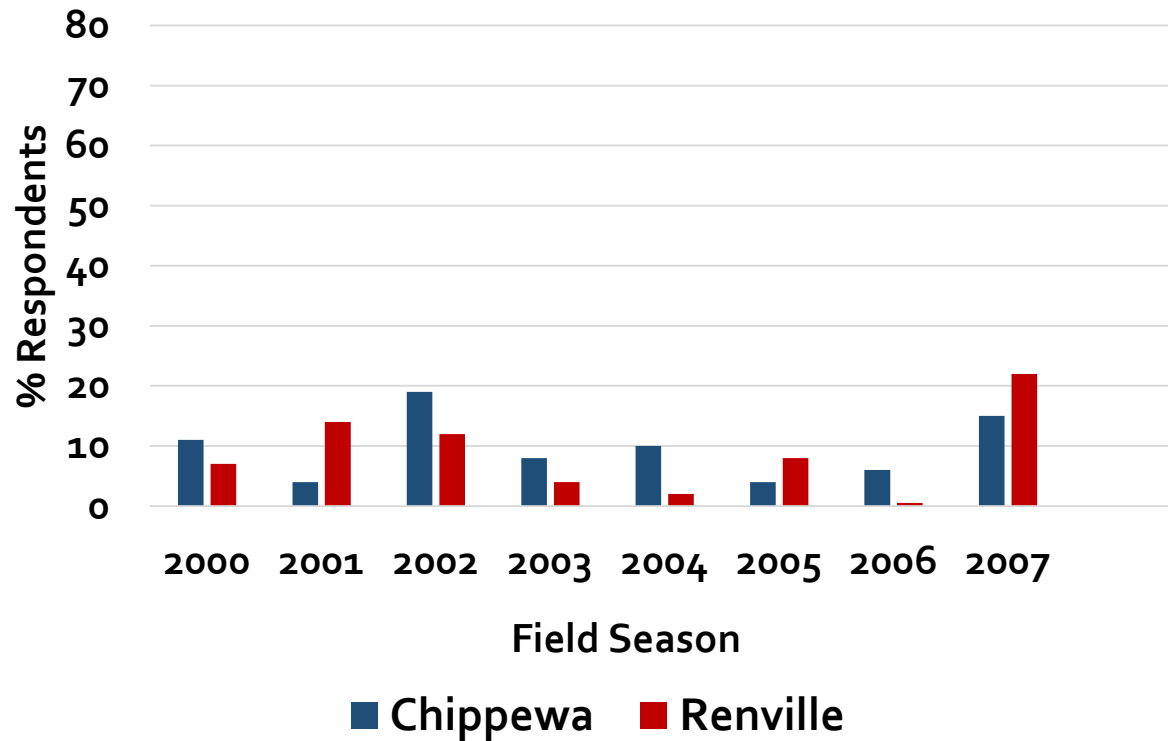
Waterhemp's journey from wetland habitat to agricultural

- Waterhemp is native to North America
- Common along the flood plains of southern and western Illinois (Sauer 1957)
- Compare genetic make-up of plants in fields to those in herbariums and museums
- Mutations in genes related to drought tolerance, rapid growth, and herbicide resistance
- Herbicide-resistant mutations (2 of 7) were discovered in plants from natural habitats
- Others have suggested hybridization with other pigweed species has improved its adaptation to MN soils



A 155-year-old waterhemp herbarium specimen from the Missouri Botanical Garden Herbarium. Credit: Julia Kreiner, University of British Columbia

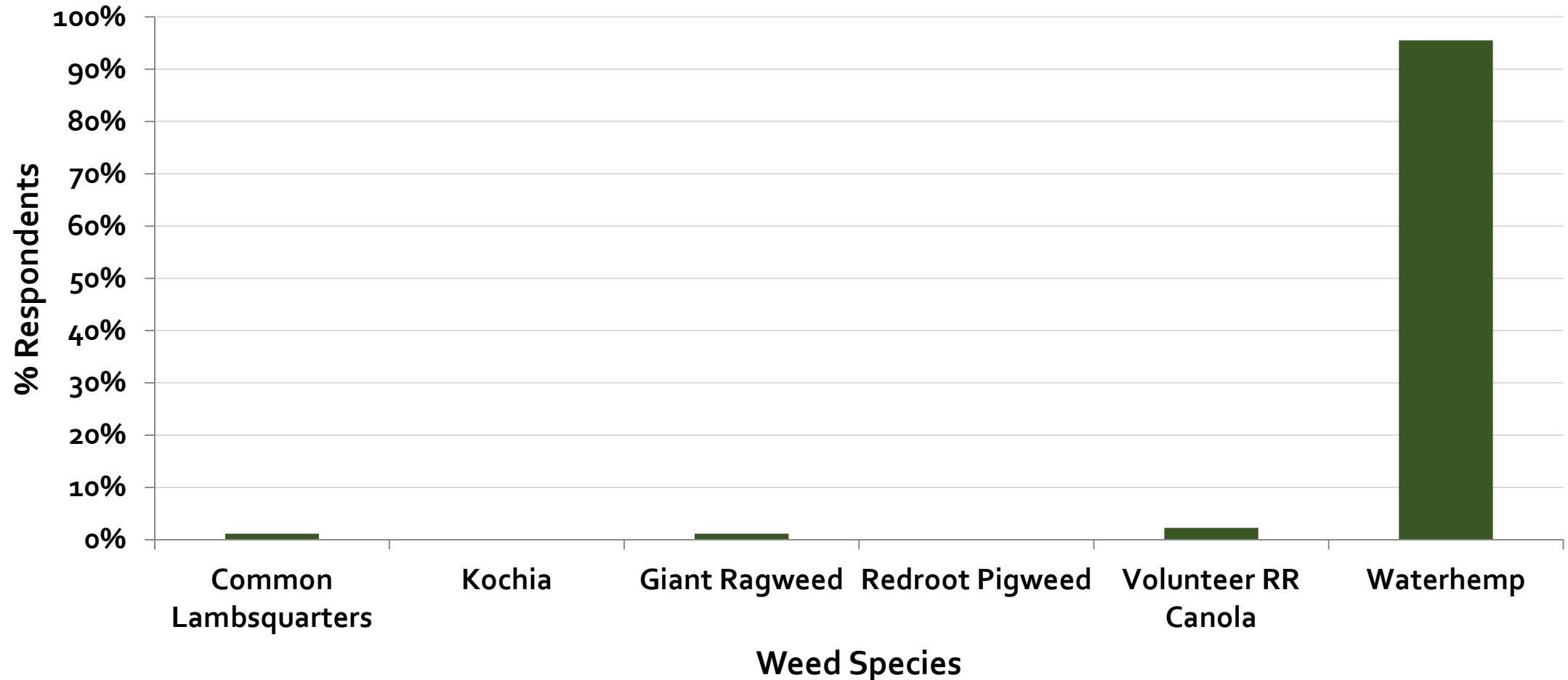
Waterhemp was reported in the growers survey in 2000 and mentioned in the narrative in 2002



Chippewa = Chippewa, Swift and Kandiyohi Counties

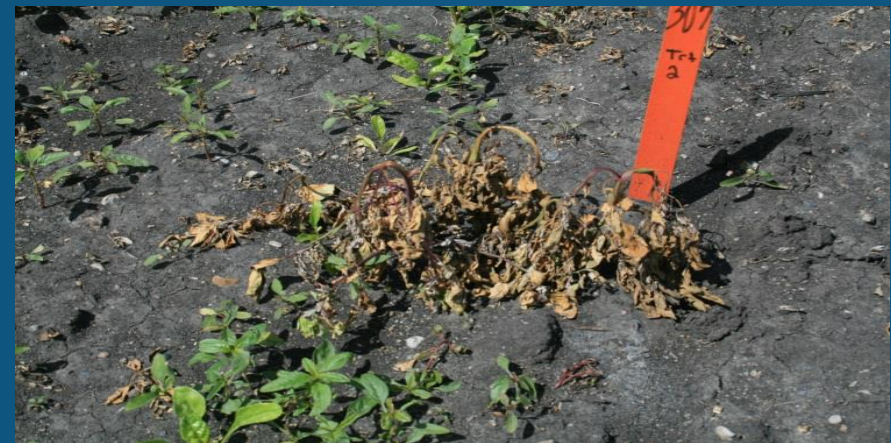
Renville = Renville, Redwood, Faribault, Yellow Medicine, Lac Qui Parle, and Sibley Counties

Waterhemp was the most troublesome weed challenge in sugarbeet in 2019^a



^a2020 Willmar Growers Seminar, Willmar MN, January 22, 2020

Repeat Roundup PM + NIS + AMS applications, Herman MN, 2014



Does PowerMax control waterhemp in Grant and Kandiyohi Counties, MN?

Treatment	Rate	Herman, 2014	Lake Lillian, 2017	Lake Lillian, 2017
	fl oz/A	-----Count/m2-----		
Roundup PowerMax	28	101	192	116
Control	0	432	727	792



Control plot, Jun 6



PowerMax at 1.10 kg/ha

Number of waterhemp per meter square, June 6, 2017, Lake Lillian, MN

YES. 77% control at Herman and 76% control at Lake Lillian

Increasing the rate or repeat applications does not improve control

Repeat Roundup PM + NIS + AMS applications, Herman MN, 2014

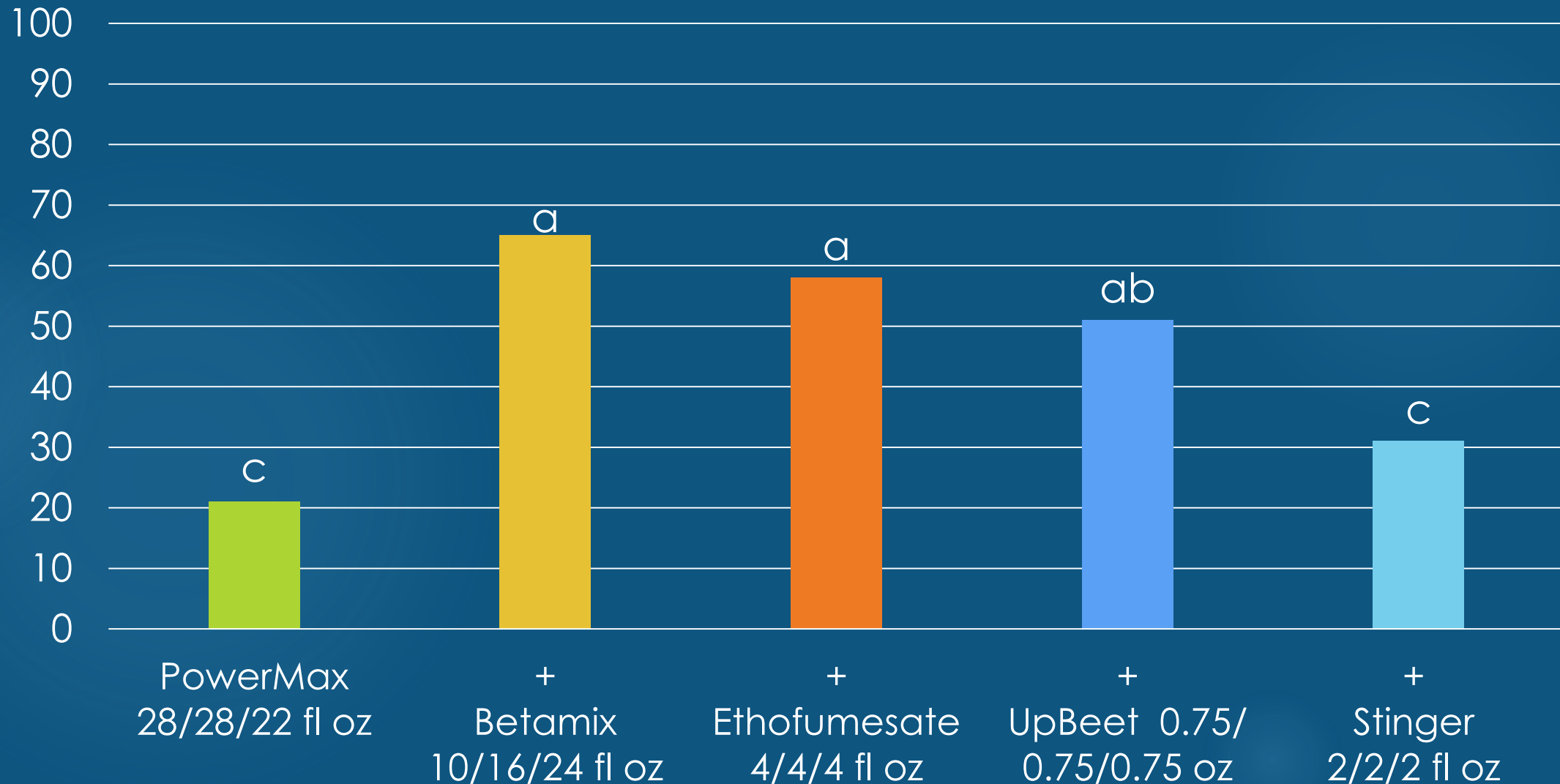


Repeat Roundup PM + NIS + AMS applications, Herman MN, 2014



RESULTS - Postemergence

Waterhemp Control – Aug. 27, 2014

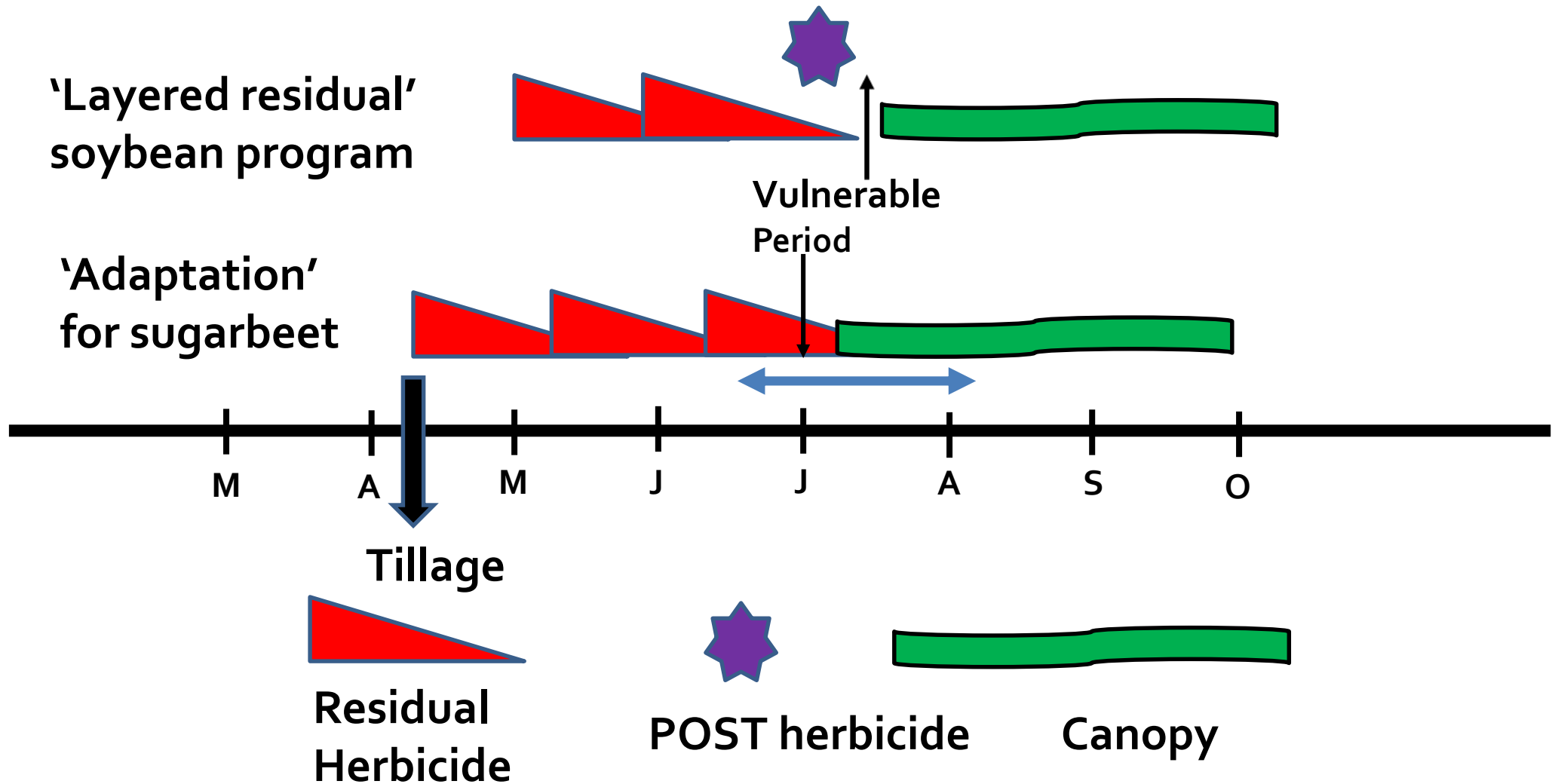


Waterhemp Control Program in Sugarbeet

Planting Date	Recommendation
Sugarbeet plant in April or May	PRE. Dual Magnum at 0.5 to 0.75 pt/A, ethofumesate at 2 to 6 pt/A or Dual Magnum at 0.5 pt/A plus ethofumesate at 2 pt/A
	Split lay-by application (early postemergence / postemergence). Chloroacetamide herbicides applied at 2-lf sugarbeet fb 6- to 8-lf sugarbeet
June	Continue to scout fields for waterhemp. Control escapes with Ultra Blazer (Section 18ee), Liberty with the Redball™ 915 hooded sprayer (24c), or inter-row cultivation
July	Electric Discharge Systems (WeedZapper™)
August / September	Hand remove waterhemp

Layered Residual Herbicides

Objective: Prolong PRE activity until canopy fills

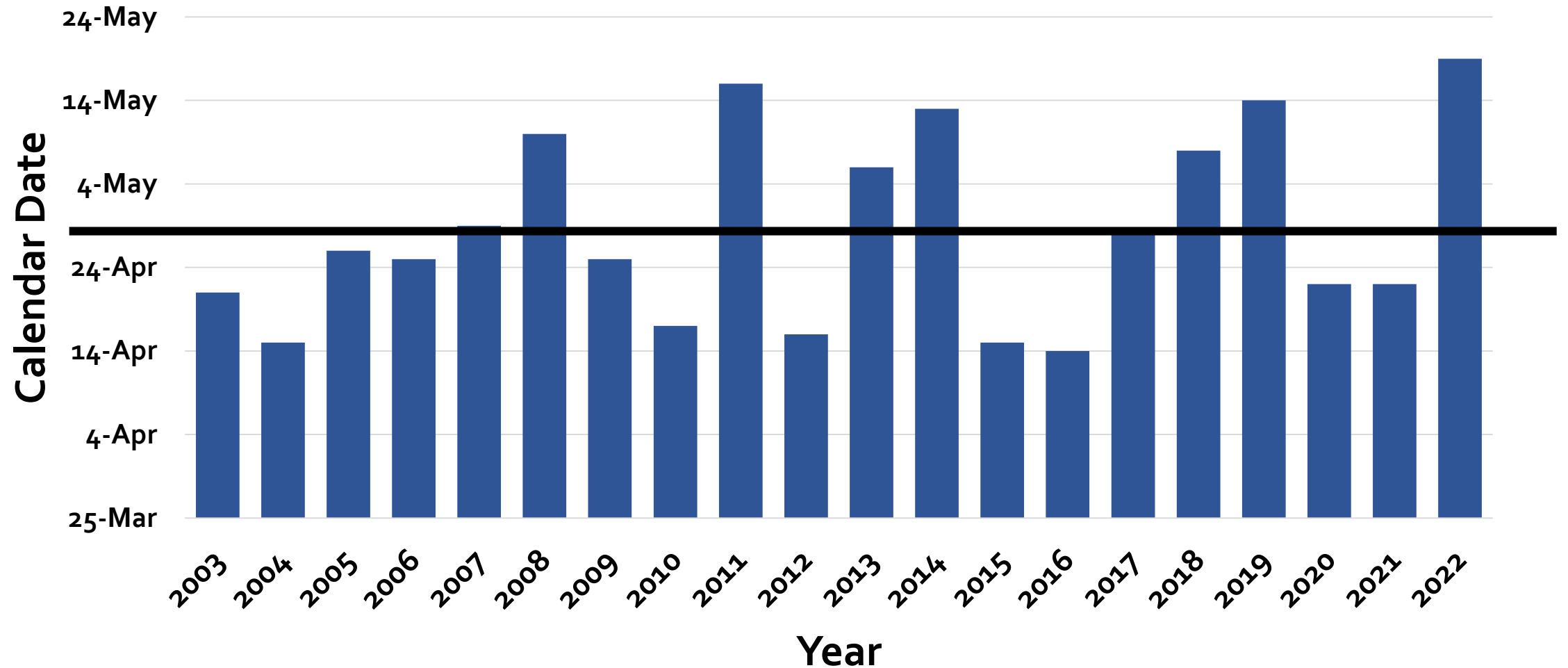


Adapted from a slide created by B Hartzler, ISU

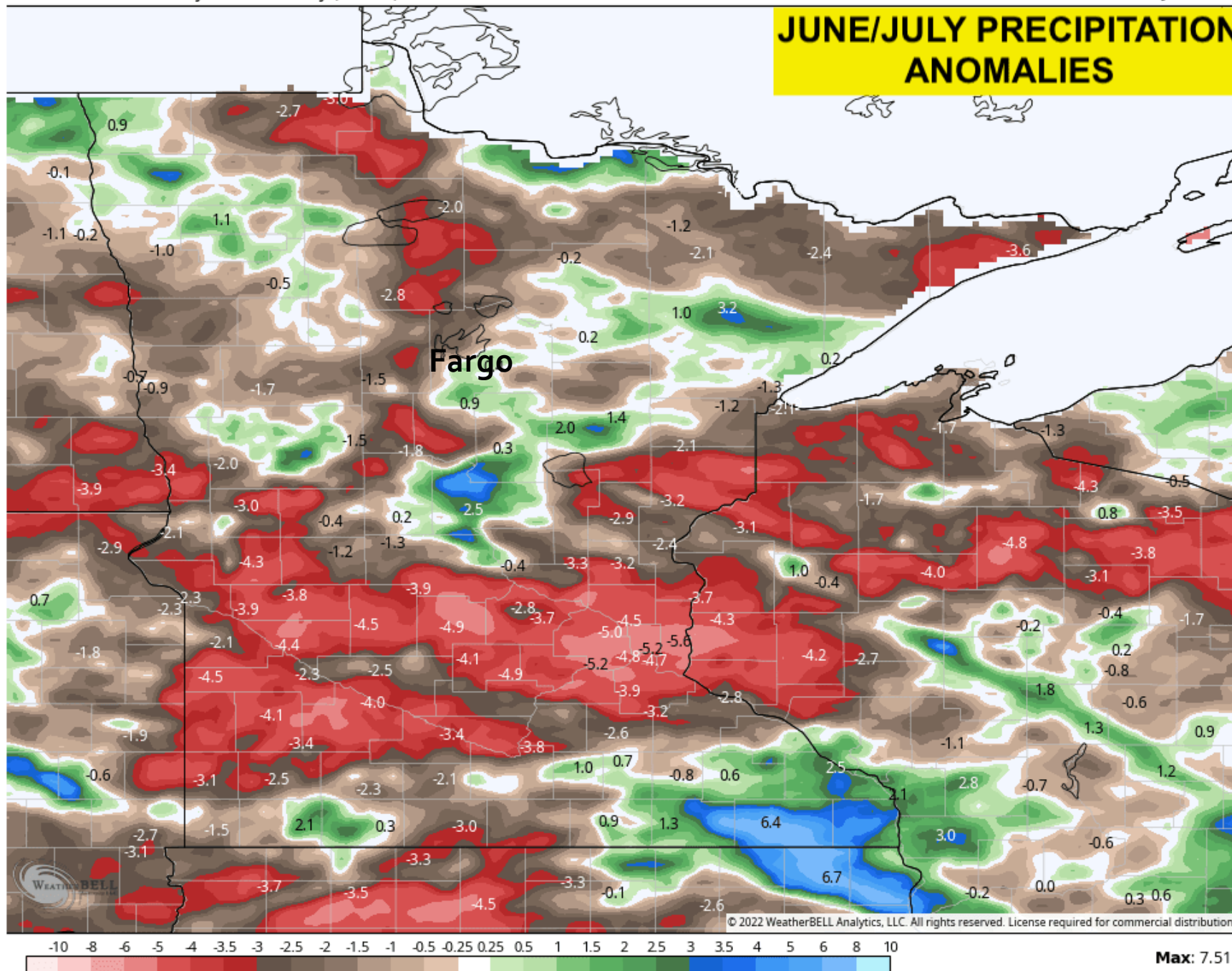




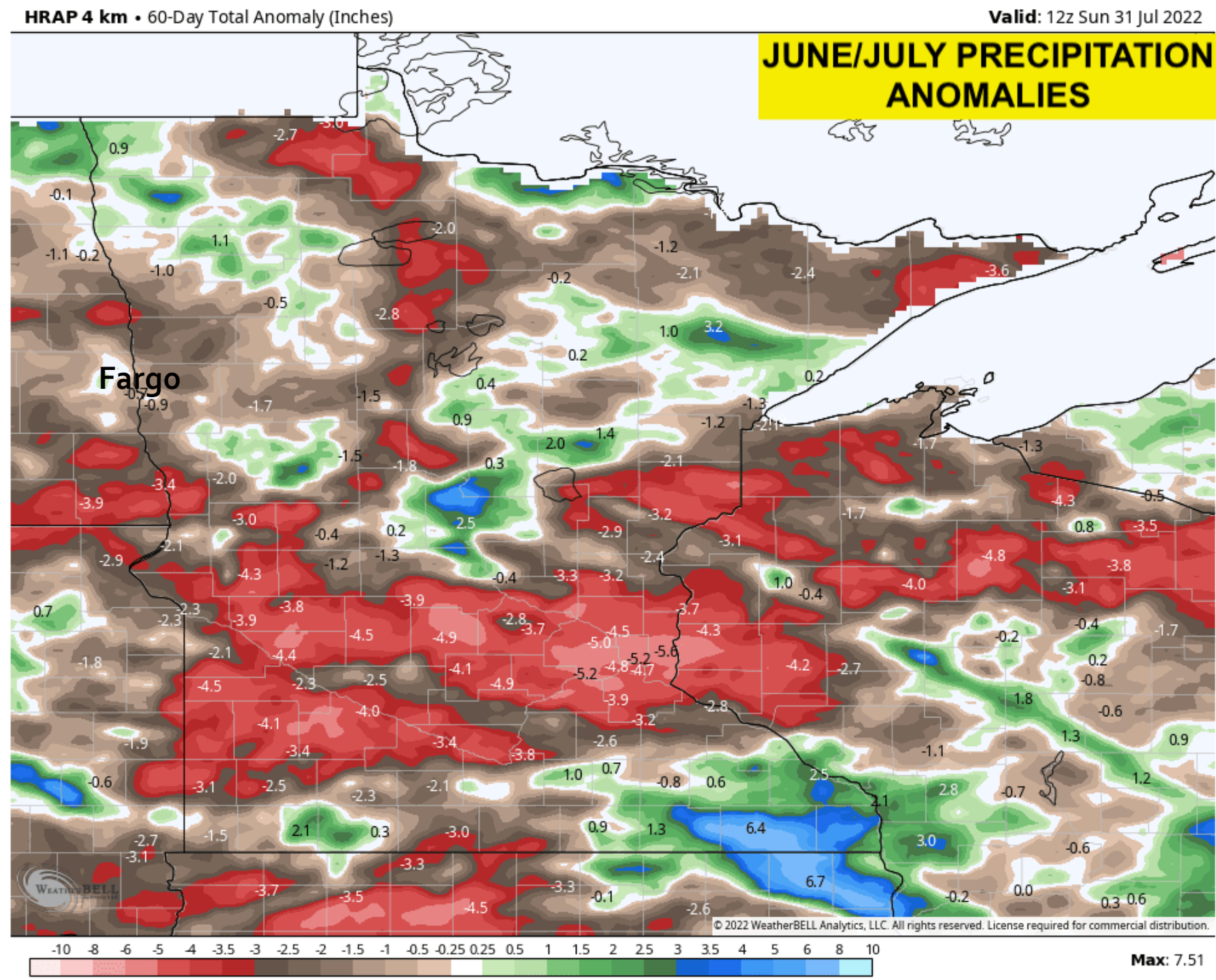
Average sugarbeet plant date, Southern MN Beet Sugar Coop, 2003 to 2022



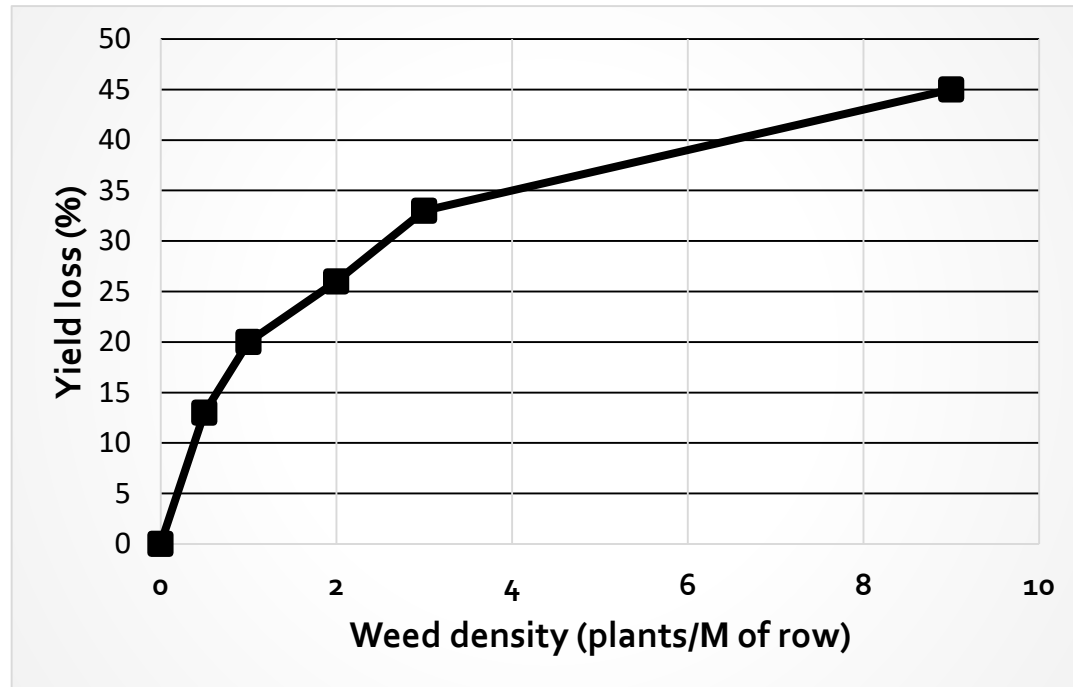
JUNE/JULY PRECIPITATION ANOMALIES



Bring Me the News
Meteorologist Sven
Sundgaard
<https://bringmethenews.com/minnesota-weather/july-2022-in-minnesota-was-hotter-windier-and-drier-than-normal>



Redroot pigweed reduced sugarbeet root yield, Evans and Dexter, 1978



Planting date, environment and weed emergence in sugarbeet (Evans and Dexter, 1978)

Weed	Extractable sucrose per acre		
	Glyndon	Fargo	Crookston
	-----% loss-----		
3 pigweed plants / M row	44	6	1
Plant	May 10	May 4	April 28
Sugarbeet emergence	May 23	May 16	May 11
Pigweed emergence	May 18	May 19	May 18

- Root yield loss even when redroot pigweed were spaced 6.7 feet
- Planting date influences weed interference

Waterhemp control from soil residual herbicides applied PRE, EPOST and POST

Trt	Etho or Etho + DM PRE	Herbicide Treatment
1	No	PM ₃ + etho / PM ₃ + Ultra Blazer
2	No	PM ₃ + etho + Outlook / PM ₃ + etho + Outlook
3	No	PM ₃ + etho + Warrant / PM ₃ + etho + Warrant
4	No	PM ₃ + etho + Outlook / PM ₃ + etho + Warrant
5	Yes	PM ₃ + etho / PM ₃ + Ultra Blazer
6	Yes	PM ₃ + etho + Outlook / PM ₃ + etho + Outlook
7	Yes	PM ₃ + etho + Warrant / PM ₃ + etho + Warrant
8	Yes	PM ₃ + etho + Outlook / PM ₃ + etho + Warrant

Waterhemp control 90, 94, and 59 days after plant, 2022

Trt	Etho or Etho + DM PRE	Herbicide Treatment ^a	Moorhead, MN	Sabin, MN	Blomkest, MN
			%	%	%
1	No	PM ₃ + etho / PM ₃ + Ultra Blazer	63 c	84 c	63 ab
2	No	PM ₃ + etho + Outlook / PM ₃ + etho + Outlook	89 b	97 ab	36 e
3	No	PM ₃ + etho + Warrant / PM ₃ + etho + Warrant	96 ab	98 ab	54 bc
4	No	PM ₃ + etho + Outlook / PM ₃ + etho + Warrant	99 a	98 ab	51 cd
5	Yes	PM ₃ + etho / PM ₃ + Ultra Blazer	98 a	90 bc	71 a
6	Yes	PM ₃ + etho + Outlook / PM ₃ + etho + Outlook	99 a	98 ab	43 de
7	Yes	PM ₃ + etho + Warrant / PM ₃ + etho + Warrant	99 a	99 a	49 cd
8	Yes	PM ₃ + etho + Outlook / PM ₃ + etho + Warrant	99 a	99 a	54 bc
		LSD (0.10)	9	9	9

^aDestiny HC plus Amsol liquid AMS at 1.5 pt/A plus 2.5% v/v accept PM₃ plus Ultra Blazer, Prefer 90 at 0.25% v/v plus Amsol liquid AMS.

POST, Moorhead, Aug 12



POST, Sabin, Sept 15



PRE/POST, Moorhead, Aug 12



PRE/POST, Sabin, Sept 15



POST, rep 2, July 15



PRE/POST, rep 2, July 15



POST, Blomkest, July 25



PRE/POST, Blomkest, July 25



Waterhemp control 90, 94, and 59 days after plant, 2022.

Ethofumesate or Etho + DM PRE	Herbicide Treatment ^a	Moorhead, MN	Sabin, MN	Blomkest, MN
		%	%	%
No	PM ₃ + etho / PM ₃ + Ultra Blazer	63 c	84 c	63 ab
No	PM ₃ + etho + Outlook / PM ₃ + etho + Warrant	99 a	98 ab	51 cd
Yes	PM ₃ + etho / PM ₃ + Ultra Blazer	98 a	90 bc	71 a
Yes	PM ₃ + etho + Outlook / PM ₃ + etho + Warrant	99 a	99 a	54 bc
	LSD (0.10)	9	9	9

Ethofumesate at 6 pt/A PRE, Blomkest, MN,

- Evaluation, 19 DAP, June 15, 2022



Ethofumesate at 6 pt/A PRE, Blomkest, MN,

- No POST soil residual herbicides applied in experiment

Trt 12, rep 2, July 15



Trt 12, rep 3, July 25



Cumulative rainfall (inch) in the first 10 days after residual herbicide application, 2022

	Moorhead, MN	Sabin, MN	Blomkest, MN
	(in)	(in)	(in)
PRE	1.0	0.5	0.9
EPOST	1.7	0.4	0.0
POST	1.8	2.4	0.5
Total	4.5	3.3	1.4

Plant May 24, May 19 and May 27, respectively

Rainfall chronology at Blomkest

PRE May 27, 2022

- 0.79 inch fell on May 30;
 - Midnight to 5:00AM – 0.00
 - 5:00AM to 7:00AM – 0.04
 - 8:00AM to 9:00AM – 0.27
 - 9:00AM to 10:00AM – 0.17
 - 10:00AM to noon – 0.10
 - 1:00PM to 5:00PM – 0.01
 - 6:00PM to 7:00PM – 0.18
 - 7:00PM to 8:00PM – 0.02
 - 8:00PM to midnight – 0.00

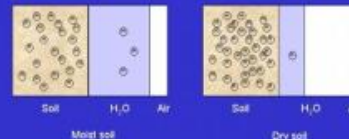
- Hypothesis: rainfall and rainfall intensity influence herbicide activation into soil
- First need to wet the soil surface before water will infiltrate
- 0.5 inch – Dual Magnum
- 0.75 inch – Ethofumesate
- Why more? Solubility and K_{oc}
- DM 'covers' for etho until it rains
- **Are there other options?**

Ethofumesate and Dual Magnum are complimentary

Herbicide	Absorp-tivity	Water Solubility
	^a K _{OC}	(ppm)
Acetochlor	200	233
Outlook	155	1,174
S-metolachlor	200	488
Ethofumesate	340	110
Treflan	7,000	0.3
Dicamba	2	4,500

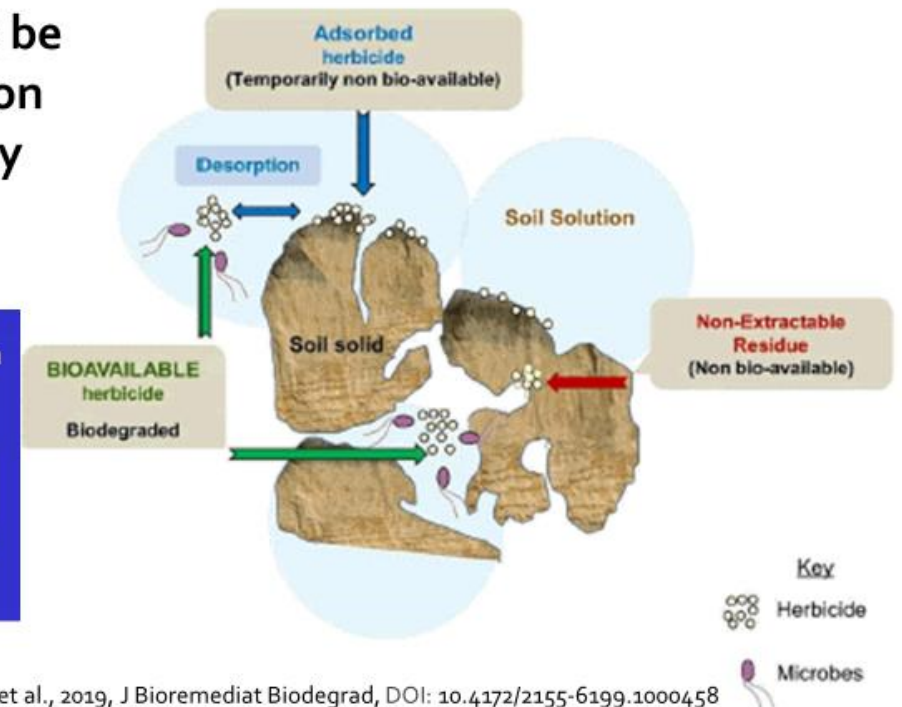
Herbicides must be in the soil solution to be taken up by seeds, roots, or shoots

Figure 2. Soil moisture effect on herbicide availability.



Hartzler, Professor Emeritus, ISU

Kanissery, et al., 2019, J Bioremediat Biodegrad, DOI: 10.4172/2155-6199.1000458



^a The K value represents the ratio of herbicide bound to soil collides versus what is free in the water. Thus, the higher the K value the greater the adsorption to soil colloids.

**Depends on how the manufacturer conducts the experiment. Half-life varies with soil characteristics and environment.

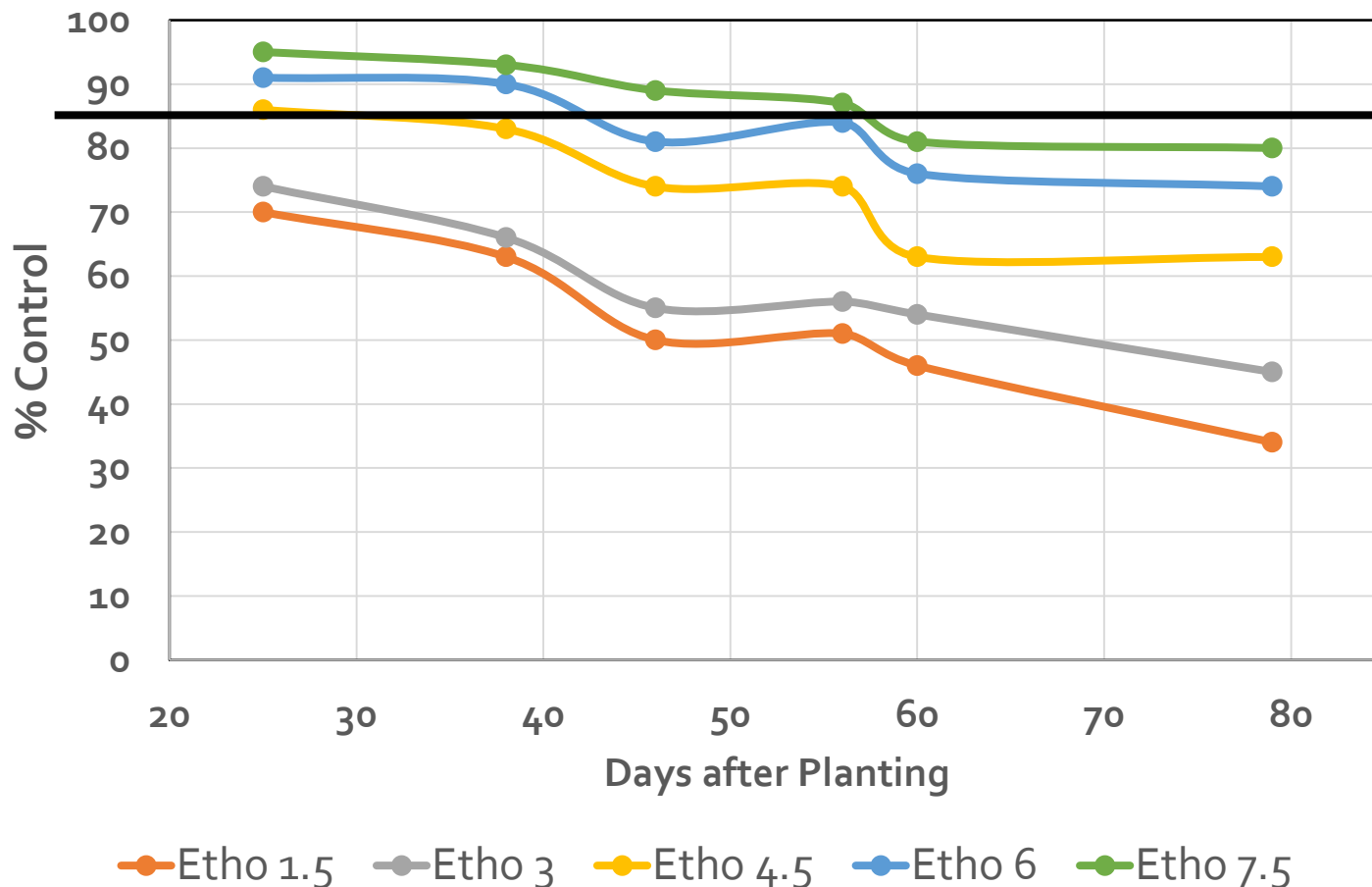
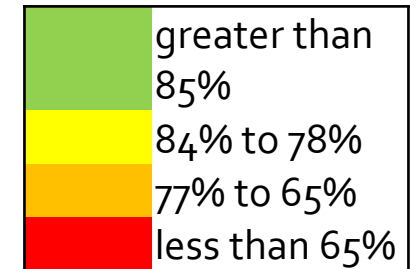
Comparison of PPI and PRE ethofumesate at 3.75 to 4.0 lb/A, 1973-1986

Nortron application	4 of 7 locations	3 of 7 locations
	Rrpw cntl	Rrpw cntl
	%	%
PPI	97	91
PRE	79	93
LSD (0.05)	11	NS

From Dr. Dexter's presentation for PLSC 350, 2012

Waterhemp control in response to ethofumesate PRE, Blomkest MN, 2020

Sublethal rates: full control for less time or less than full control?

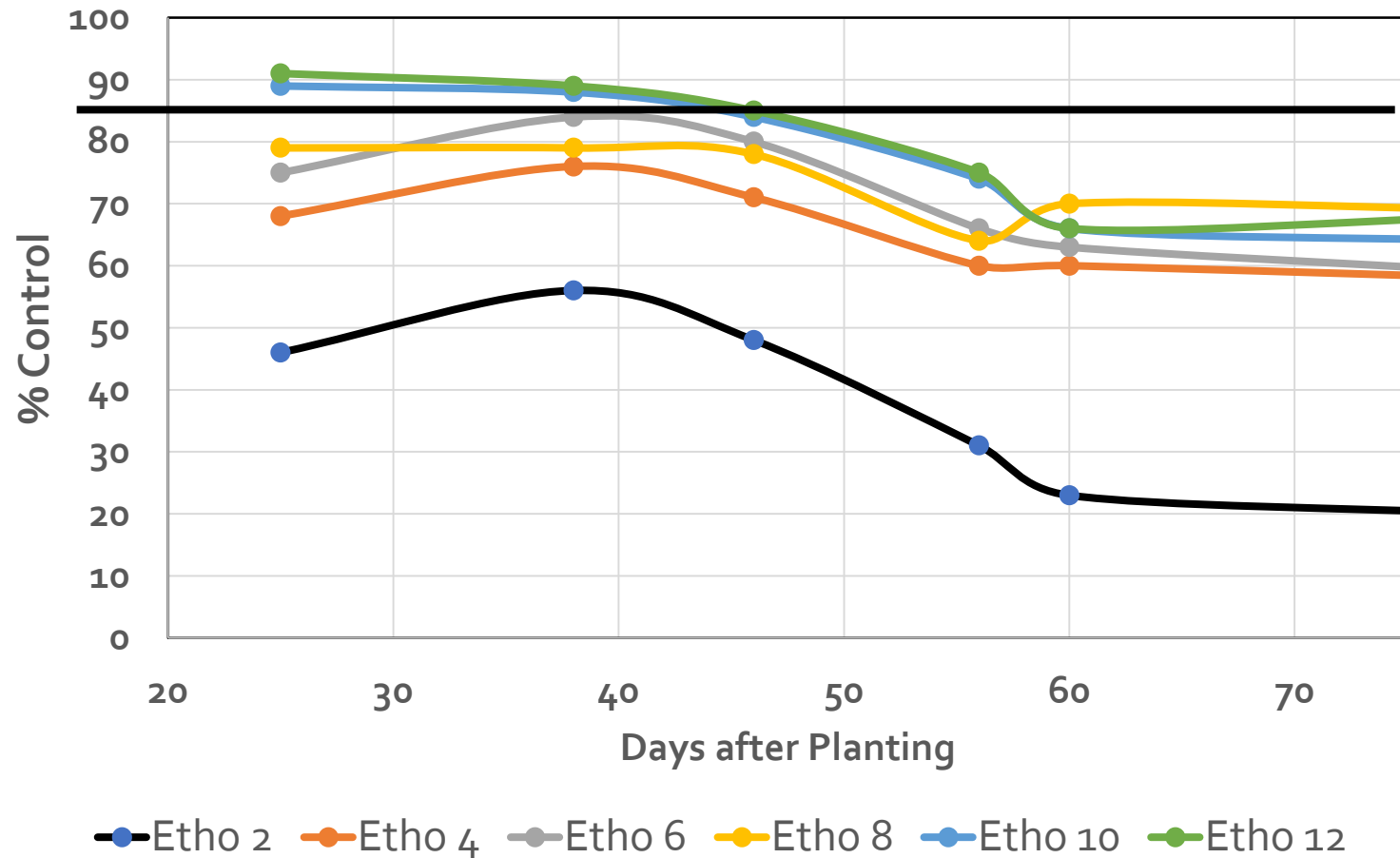
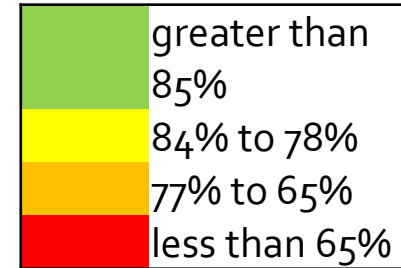


	Days after planting					
	25	38	46	56	60	79
Etho 1.5	70	63	50	51	46	34
Etho 3	74	66	55	56	54	45
Etho 4.5	86	83	74	74	63	63
Etho 6	91	90	81	84	76	74
Etho 7.5	95	93	89	87	81	80

Calendar date	Rainfall (inch)	Total Rainfall (inch)
May 9	0.7	0.7
May 26	1.7	2.4
June 10	0.3	2.7
June 25	1.3	4.0
July 10	3.8	7.8

Waterhemp control in response to ethofumesate PPI, Moorhead MN, 2022

Sublethal rates: full control for less time or less than full control?



Days after planting						
	22	28	38	45	52	72
Etho 2	46	56	48	31	23	20
Etho 4	68	76	71	60	60	58
Etho 6	75	84	80	66	63	59
Etho 8	79	79	78	64	70	69
Etho 10	89	88	84	74	66	64
Etho 12	91	89	85	75	66	68

Calendar date	Rainfall (inch)	Total Rainfall (inch)
June 8	0.9	0.9
June 23	1.7	2.6
July 8	1.9	4.5
July 23	4.5	9.0
Aug 7	1.6	10.6

BMPs for waterhemp control in sugarbeet

1. Plant sugarbeet into fields with documented field history
2. Categorize sugarbeet fields as either low, moderate, or heavy for waterhemp pressure
 - Apply ethofumesate + Dual Magnum / EPOST / POST on low and medium pressure fields
 - Apply ethofumesate at 5 to 7.5 pt/A / EPOST / POST on heavy waterhemp pressure fields and fields with heavy previous crop residue
 - Consider incorporating ethofumesate
3. Use a weed control program in the crop sequences that compliments your program in sugarbeet
4. Crop rotation restrictions to sugarbeet are dependent on environmental conditions **and** the label

The Crop Sequence with Sugarbeet

Corn rotate to Sugarbeet

^a& = premix; + = tank-mix

Products with crop rotation restrictions preventing sugarbeet planting the following year

Premergence	months	Postemergence ^a	months
Verdict (dimethenamid-P & saflufenacil (15&14))	NCS	Acuron GT (meto&meso&bicycle&glyph (15, 27, 27, 9))	18
Anthem Maxx (pyroxasulfone & fluthiacet) (15 & 14)	15	Armezon Pro (topramezone & dimethenamid-P) (27 & 15)	18
Corvus (isoxaflutole, thienencarbazone & safener) (27&2)	17	Halex GT (glyphosate & S-metolachlor & mesiotrione) (9 & 15 & 27)	18
Acuron Flexi (S-metolachlor, mesiotrione, bicyclopyrone & safener) (15 & 27 & 27)	18	Harness Max (acetochlor & mesotrione) (15&27)	18
Balance Flexx (isoxaflutole & safener) (27)	18	Realm Q (rimsulfurone & mesotrione & safener) (2 & 27)	18
Resicore / Resicore XL (acetoachlor, mesotrione & clopyralid) (15 & 27 & 4)	18	Maverick (mesotrione, clopyralid & pyroxasulfone) (27,4,15)	18
Atrazine (5)	2 CS	Sinate (topramezone & glufosinate (27 & 10) + atrazine (need LL Corn))	18
Surestart II (acetochlor, flumetsulam & clopyralid) (15 & 2 & 4)	26		



Soybean rotate to Sugarbeet

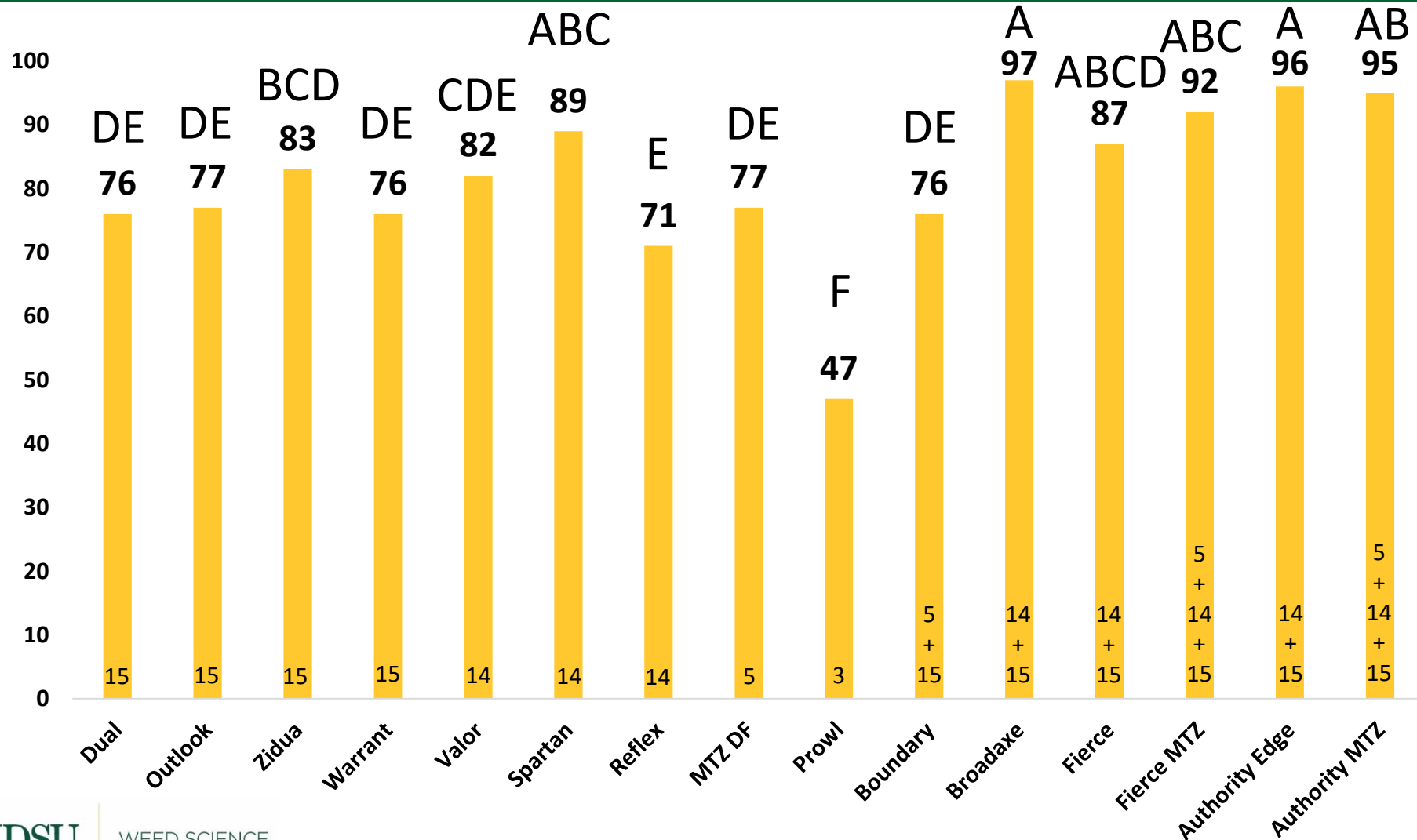
Products with crop rotation restrictions

^a& = premix; + = tank-mix
^bwith soil testing



Preemergence	months	Postemergence ^a	months
XtendiMax / Engenia (dicamba) (need XtendiMax soybean	NCS	Flexstar GT fomesafen & glyphosate) (14 & 9)	18
Fierce *pyroxasulfone & flumioxazin) (15 & 14)	12		
Boundary (S-metolachlor & metribuzin) (15 & 5)	18		
Fierce MTZ (pyroxasulfone & flumioxazin & metribuzin	18		
Authority Edge (sulfentrazone & pyroxasulfone) (14 & 15)	24		
Authority First / Sonic (sulfentrazone & chloransulam) (14 & 2)	30		
Sonic (sulfentrazone & chloransulam (14 & 2)	30 ^b		
Surveil (flumioxazin & chloransulam) (14 & 2)	30 ^b		
Authority MTZ (sulfentrazone & metribuzin) (14, 15 & 5)	36/24 ^b		
BroadAxe XC (S-metolachlor & sulfentrazone) (15& 14)	36		
Zidua Pro (pyroxasulfone, saflufenacil & imazethapyr) (15 & 14 & 2)	40		

Palmer amaranth Control 4 Weeks After Planting



Ultra Blazer

Acifluorfen was applied on over 65,000 acres following Environmental Protection Agency (EPA) approval of a Section 18 emergency exemption in 2021 and 2022

- A single Ultra Blazer application at 16 fl oz/A alone or with NIS on greater than 6-leaf sugarbeet stage.
- Ultra Blazer alone or in mixtures with PowerMax(3) and AMS.
- Target waterhemp up to 4-inch
- Apply Ultra Blazer in afternoon hours on days with maximum day-time air temperatures greater than 85F.
- Application before 6 leaf sugar beet will result in crop injury and potential yield loss.
- 95% of survey respondents (2021) indicated the emergency exemption was beneficial and contributed to overall weed management

2022 (and 2023) Ultra Blazer program objectives

Improve sugarbeet safety; increase waterhemp control

- Revisit repeat applications (Ultra Blazer fb Ultra Blazer at 12 fb 12 fl oz/A)
- Evaluate crop oil concentrate with Ultra Blazer
- Nozzles and spray volume to improve coverage and waterhemp control



PowerMax check, 14 DAT



Ultra Blazer + PowerMax + NIS, 14 DAT



Ultra Blazer + NIS, 14 DAT

Sugarbeet necrosis and growth reduction 14 DAT in response to treatment across locations, 2019 and 2020

Treatment	Rate	Sugarbeet injury	
		2019	2020
	fl oz/A	--% --	--%--
PowerMax + NIS / PowerMax + NIS ^a	28/28	3a	5 a
Ultra Blazer + NIS ^b	16	21 ab	10 a
Ultra Blazer + PowerMax + NIS ^b	16 + 28	39 c	17 abc
Ultra Blazer + Stinger + NIS ^b	16 + 4	16 ab	13 a
Ultra Blazer + PowerMax + Stinger + NIS ^b	16 + 28 + 4	41 c	25 bc
P-Value		0.0120	0.0145

^aPrefer go non-ionic surfactant at 0.25% v/v, CHS Agronomics, Inver Grove Heights, MN.
^bPrefer go non-ionic surfactant at 0.125% v/v, CHS Agronomics, Inver Grove Heights, MN.

Sugarbeet injury in response to treatment, across three greenhouse runs, 2020-2021

		Necrosis	G. Reduction	Fr. Wt. Reduct. ^b
Treatment ^a	Rate	7 DAT	14 DAT	14 DAT
	--fl oz/A--	--%--	--%--	--%--
Ultra Blazer	8	48 bc	55 b	63 ab
Roundup PowerMax (K-salt, loaded)	28	2 d	9 d	(3) c
Touchdown Hi Tech (K-salt, no load)	28	1 d	10 d	(24) d
Cornerstone 5 Plus (IPA-salt, loaded)	28	0 d	9 d	(11) c
Ultra Blazer + PowerMax	8 + 28	67 a	74 a	73 a
Ultra Blazer + Touchdown Hi Tech	8 + 28	43 c	44 c	52 b
Ultra Blazer + Cornerstone 5 Plus	8 + 28	52 b	57 b	61 ab
Control		0 d	8 d	–
P-Value		<0.0001	<0.0001	<0.0001

^aTreatments contained Prefer 90 Non-ionic surfactant at 0.125% v/v.

^bAbbreviations: Fr. Wt. Reduct. = Fresh Weight Reduction as a percent of the control; (), greater than 100%.



Ultra Blazer + NIS



Ultra Blazer + PowerMax3

Hendrum, MN
4 DAT



Ultra Blazer + COC



PowerMax3 / PowerMax3



Ultra Blazer + NIS, 14 DAT

Murdock, MN



Ultra Blazer + NIS, 23 DAT



Ultra Blazer + PowerMax3, 14 DAT



Ultra Blazer + PowerMax3, 23 DAT

Injury and yield in response to treatment, across locations, 2022

Treatment	Rate	Necrosis	Growth Reduction	Root Yield	Sucrose	Recoverable Sucrose
	--fl oz/A--	--%--	--%--	--TPA--	--%--	--lb/A--
Ultra Blazer + NIS ^a	16 + 0.25%	12 b	11 cd	29.8 bc	16.4	8,452 ab
Ultra Blazer + NIS / Ultra Blazer + NIS	12 + 0.125% / 12 + 0.125 %	53 a	18 ab	30.2 ab	16.4	8,643 a
Ultra Blazer + crop oil concentrate ^b	16 + 0.25%	16 b	15 bc	30.5 ab	16.3	8,617 a
PowerMax3 + Ultra Blazer + AMS ^c	25 + 16 + 2.5% v/v	22 b	24 a	28.9 cd	16.3	8,155 b
PowerMax3 + Ultra Blazer+ NIS + AMS	25 + 16 + 0.25% + 2.5% v/v	22 b	22 ab	28.5 d	16.3	8,070 b
PowerMax3 + NIS / PowerMax3 + NIS ^d	25 / 25	0 c	5 d	31.4 a	16.4	8,788 a

^a Prefer 90 non-ionic surfactant

^b Prime Oil, Winfield United, St. Paul, MN.

^c PowerMax3 and Amsol Liquid AMS, Winfield United, St. Paul, MN.

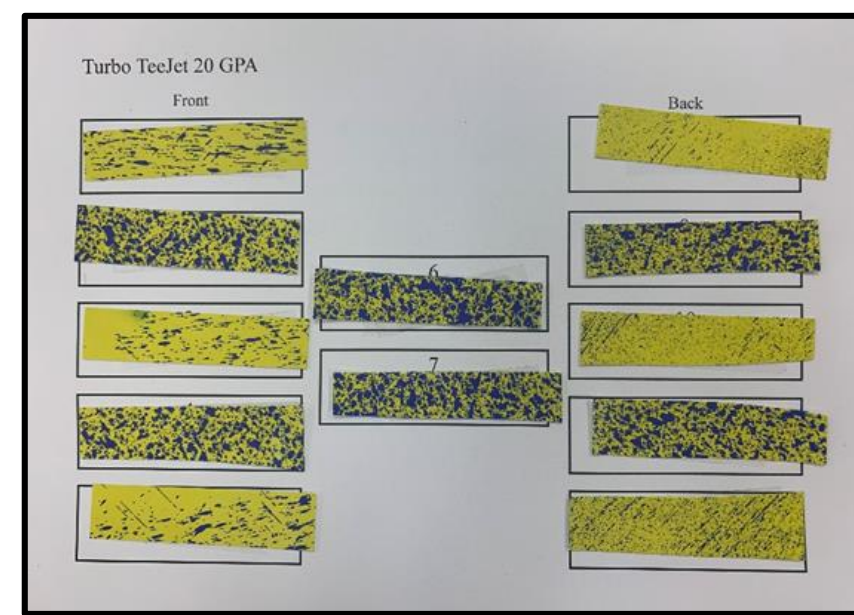
^d Prefer 90 NIS at 0.25%v/v.



Ultra Blazer in 2023

Using our acquired knowledge of spray quality for Cercospora leaf spot control on weed control

- Spray nozzles
- Spray volume



	Necrosis ¹		G Reduction		WH Control ²	
Nozzle	15 gpa	20 gpa	15 gpa	20 gpa	15 gpa	20 gpa
XR TeeJet	33 abc	38 ab	19 a	20 a	60 c	80 a
AIXR	23 c	23 c	8 c	8 c	64 c	68 c
Turbo TeeJet	28 bc	30 bc	15 ab	13 bc	69 bc	78 ab
Turbo TwinJet	26 c	43a	10 bc	19 a	83 a	81 a

¹Necrosis and growth reduction 13 DAT

²Waterhemp control 41 DAT

Moorhead MN, 2022



A few more points

Sugarbeet acres with nurse or cover crops has steadily increased since 2014

Cooperative	Nurse or Cover Crops ¹	
	Sugarbeet acres	% with cover crops
ACS ¹	111,863	27
Minn-Dak ²	69,867	88
SMBSC ³	98,897	82
Total/Weighted	280,627	44

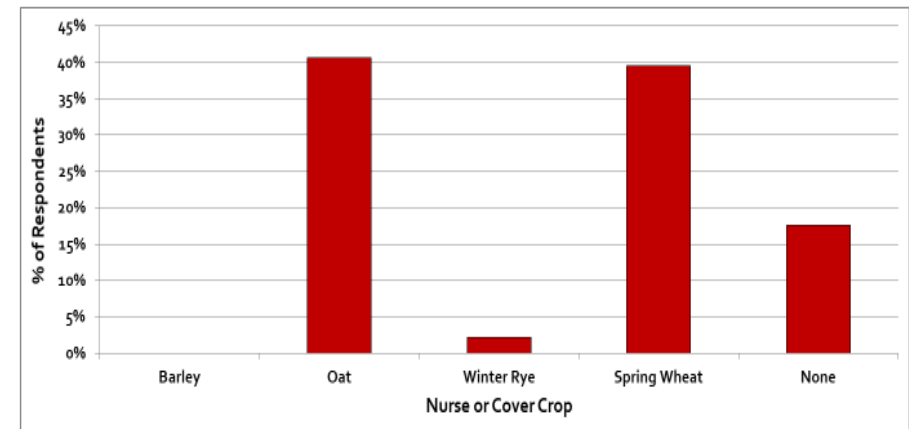
¹2020 sugarbeet acres

²Data from Joe Hastings and Kathy Wang

³Data from Emma Burt

⁴Data from Mark Bloomquist and from Turning Point Survey conducted at 2020 Willmar Grower Seminars

82% of Southern Minnesota Beet Sugar Coop growers seeded a cover or nurse crop with sugarbeet in 2020





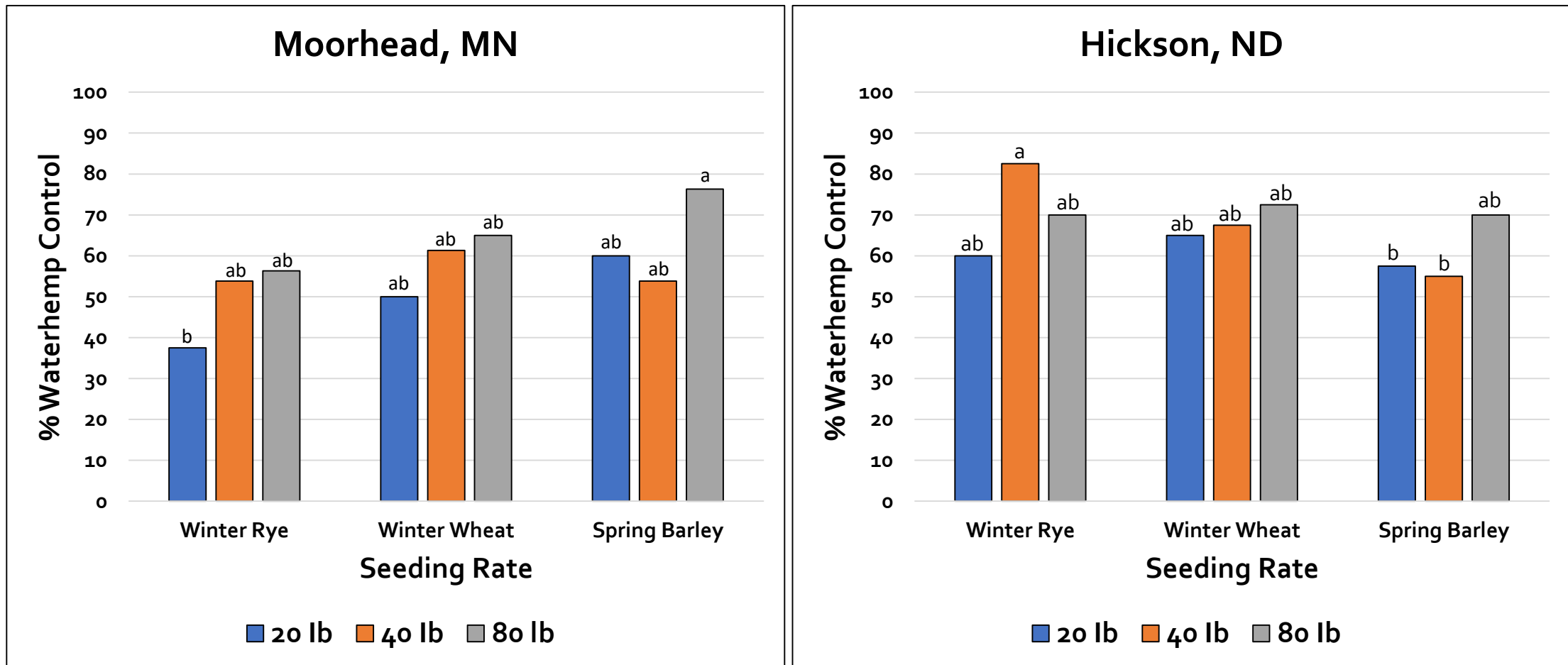
Cover and Nurse Crops for weed suppression

Materials and Methods:

- Factorial Treatment Arrangement
- Factor A = Cereal Grain
Winter Wheat, Winter Rye, Barley, (spring plant)
- Factor B = Seeding Rate (0, 20, 40, 80 lb)
- Sugarbeet plant in April or May

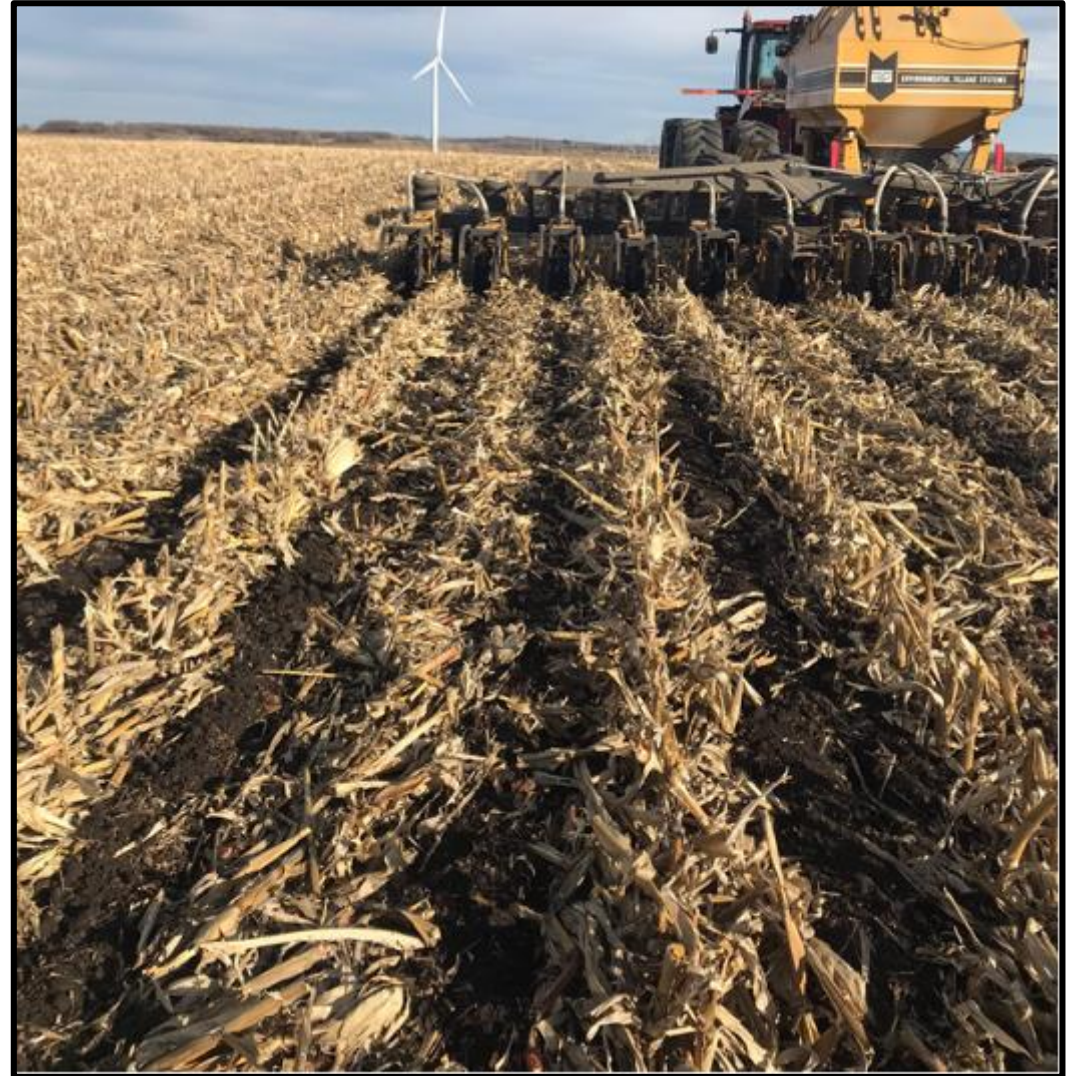
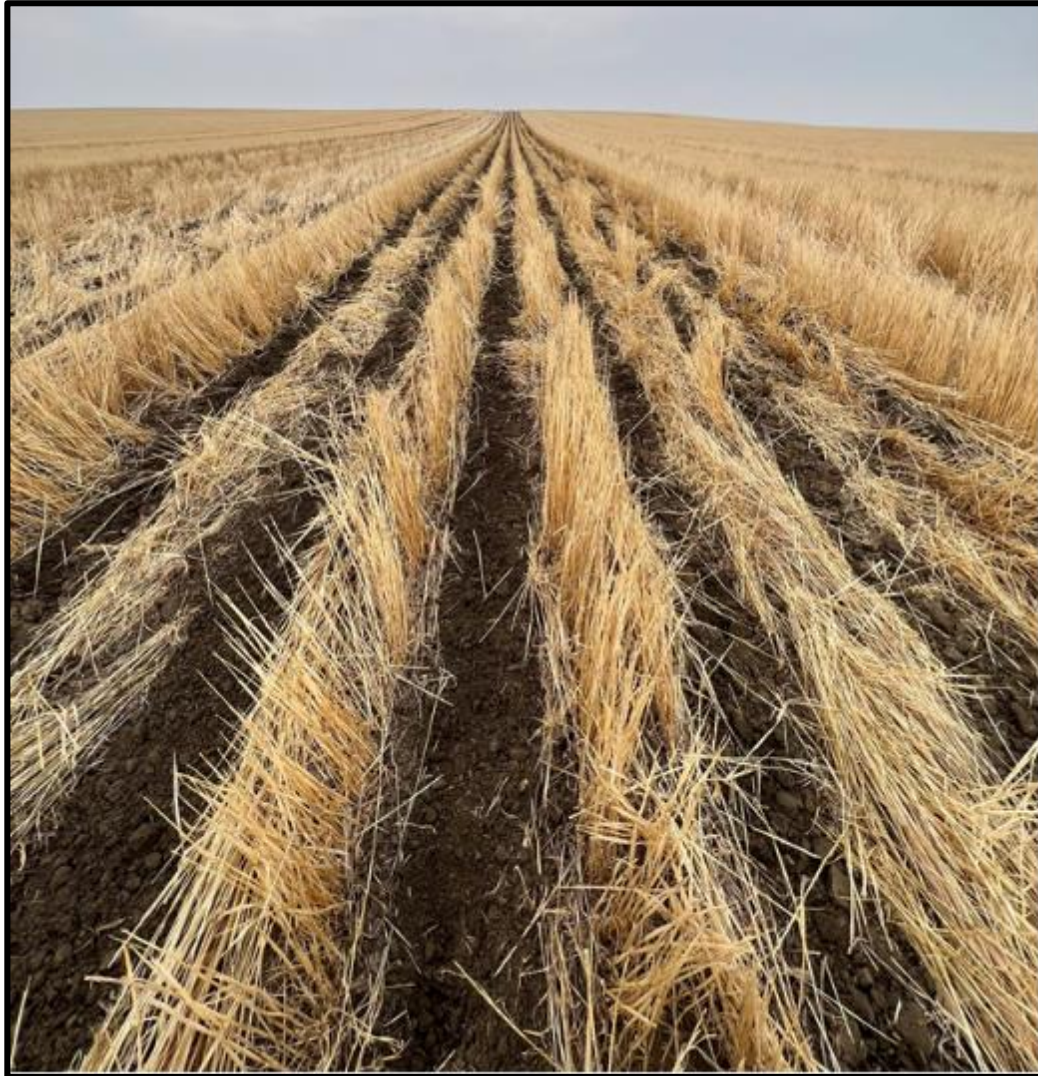
Courtesy of Aaron Hoppe

Visual Percent Waterhemp Control, Moorhead, MN and Hickson, ND, July 2021^a



^acover crops were terminated with PowerMax mixed with ethofumesate and S-metolachlor at 32+6+16 fl oz/A

Some growers are trying strip-tillage



Strip-Tillage may create weed shifts

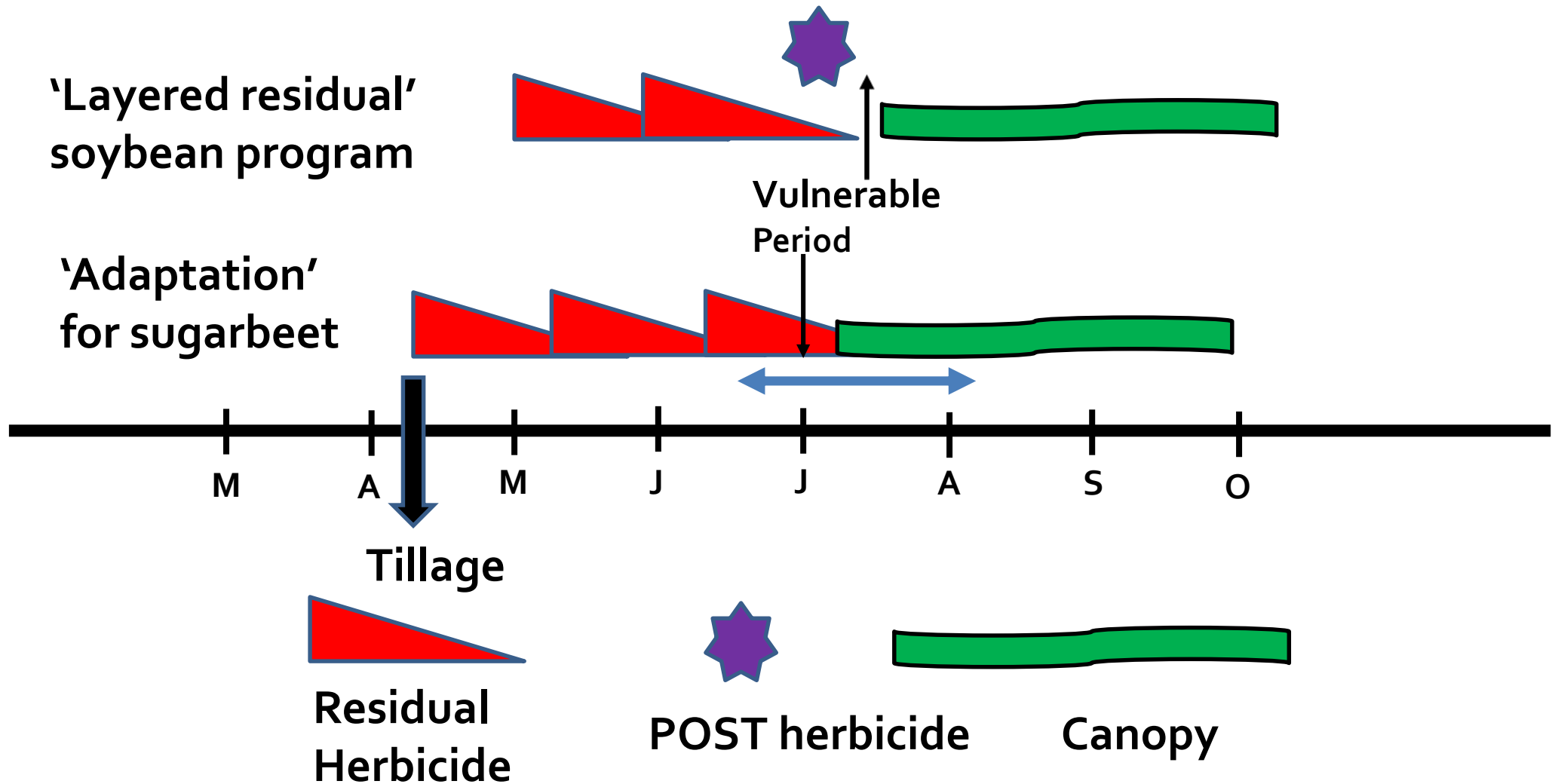
- Strips are made in the fall and freshened in the spring before plant
- We observed winter annual and early emerging summer annual weed escapes in 2022
- Kochia (or other early germinating summer annuals) may get too large before glyphosate application
- Will recommend paraquat after planting and before sugarbeet emergence to control early-emerging weeds

Courtesy of Aaron Hoppe



Layered Residual Herbicides

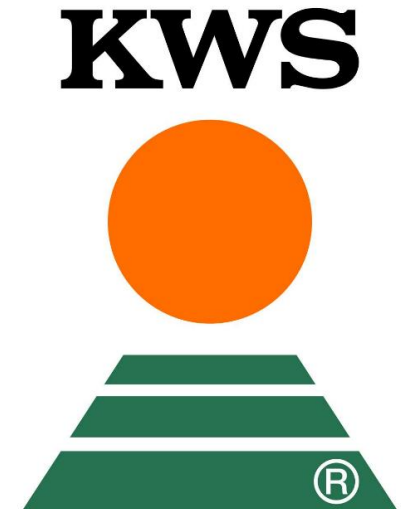
Objective: Prolong PRE activity until canopy fills



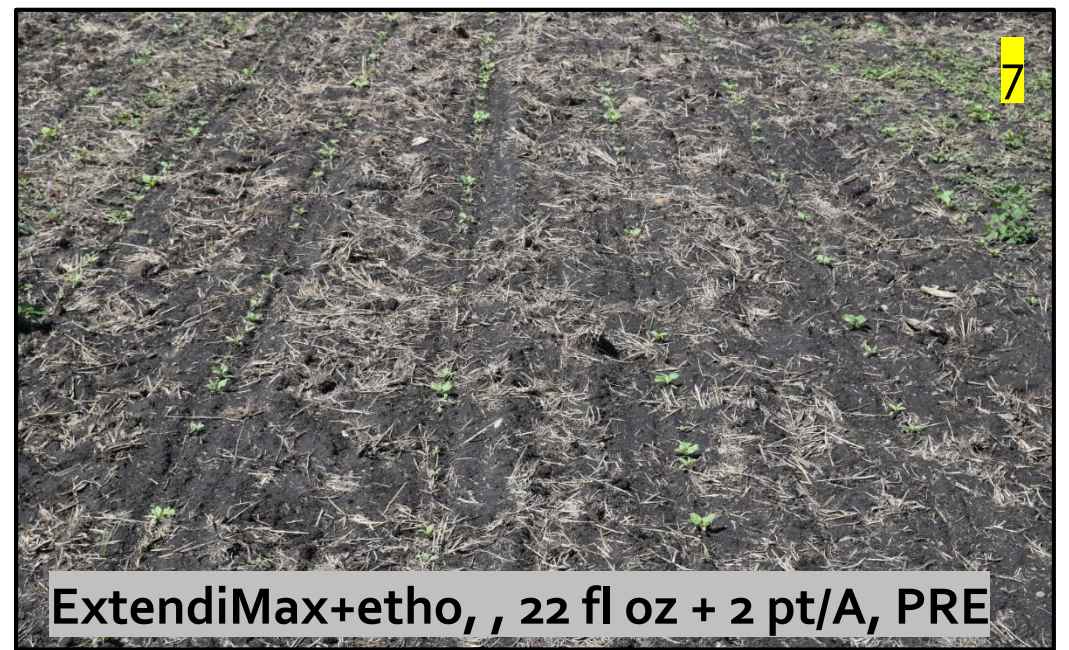
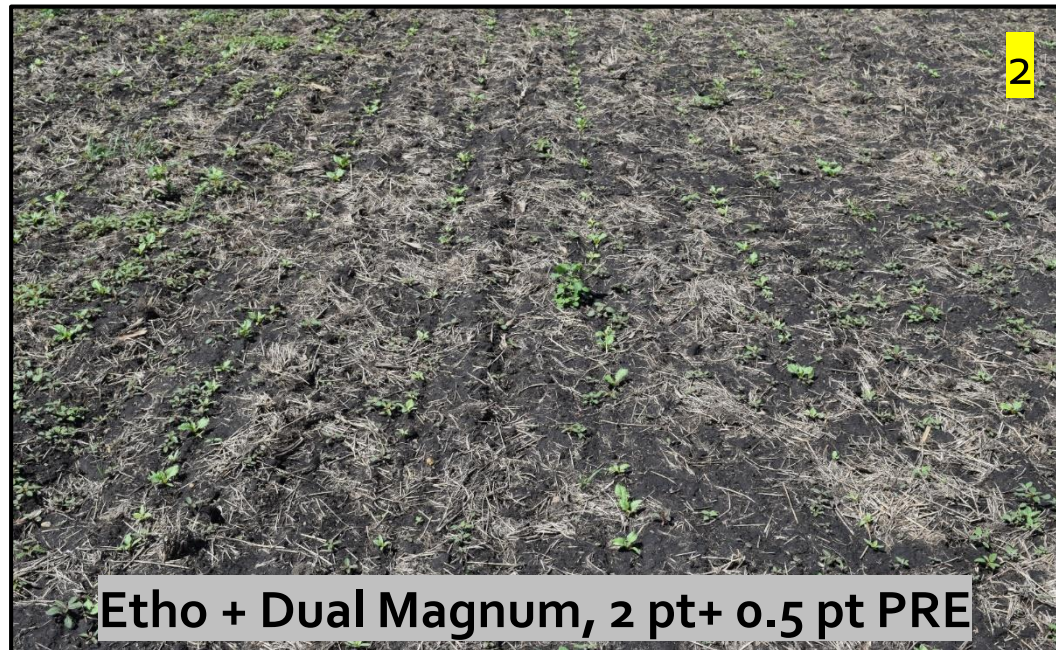
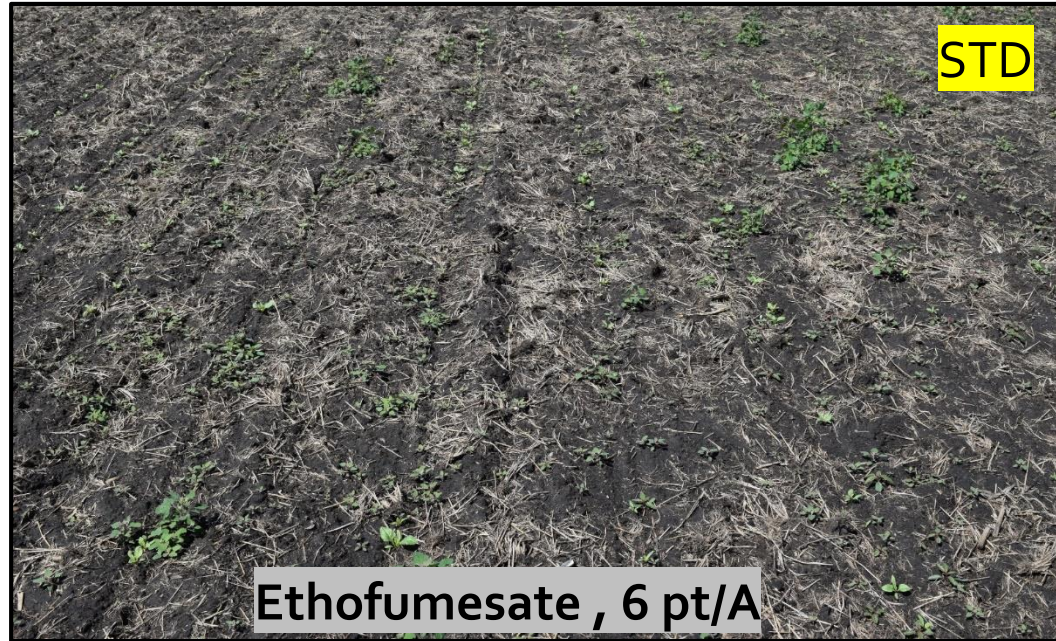
Adapted from a slide created by B Hartzler, ISU

Dicamba and glufosinate compliment sugarbeet herbicides

- Ethofumesate PRE requires significant rainfall to activate
 - Our producers are incorporating etho to improve early season waterhemp control
 - Cover and nurse crops potentially are in conflict with PRE herbicides
 - Dual Magnum PRE may cause injury, especially on low OM peaks
 - Dicamba compliments ethofumesate PRE
- Glufosinate provides consistent waterhemp control
 - A closer
 - Spray weeds less than 3-inch tall
 - Spray when sunny, humid, and two hours after sunrise
 - Stewardship practices so Liberty is relevant in the future



PRE control, Blomkest, MN, 19 DAP





STD

Etho+DM/PM₃+etho+Outlook/PM₃+etho+Warrant



EM / PM₃+etho / Liberty



PM₃+XM / PM₃+Liberty



XM+Etho/PM₃+etho+Outlook / Liberty




Forward Looking Statement - Disclaimer

This presentation may contain forward-looking statements based on current assumptions and forecasts made by Bayer management. Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual future results, financial situation, development or performance of the company and the estimates given here. These factors include those discussed in Bayer's public reports which are available on the Bayer website at <http://www.bayer.com/>. The company assumes no liability whatsoever to update these forward-looking statements or to conform them to future events or developments.

Thank you for your attention and your continued support

Tom Peters

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