Getting Rid of Weeds using Multiple Control Tactics

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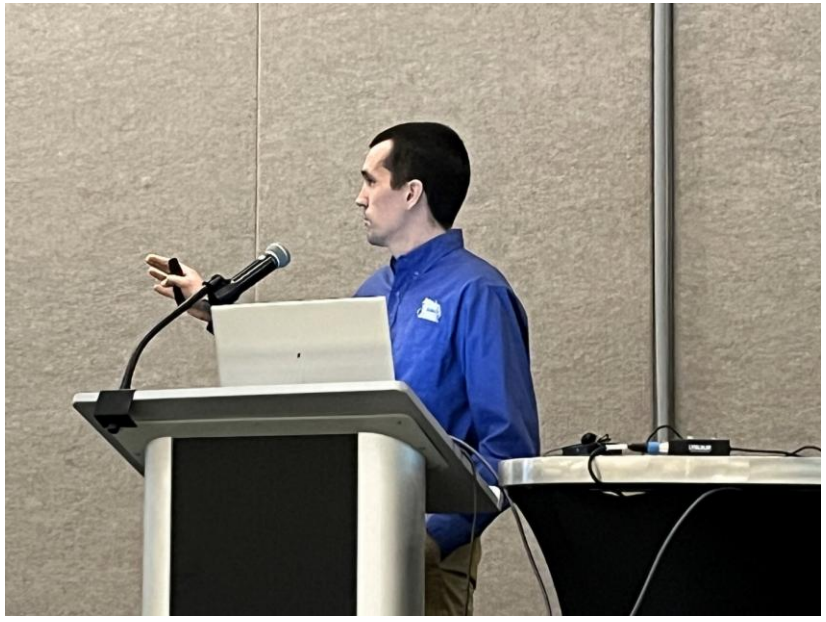
North Dakota State University and

University of Minnesota and

Southern Minnesota Beet Sugar Cooperative

Thank you to our collaborators

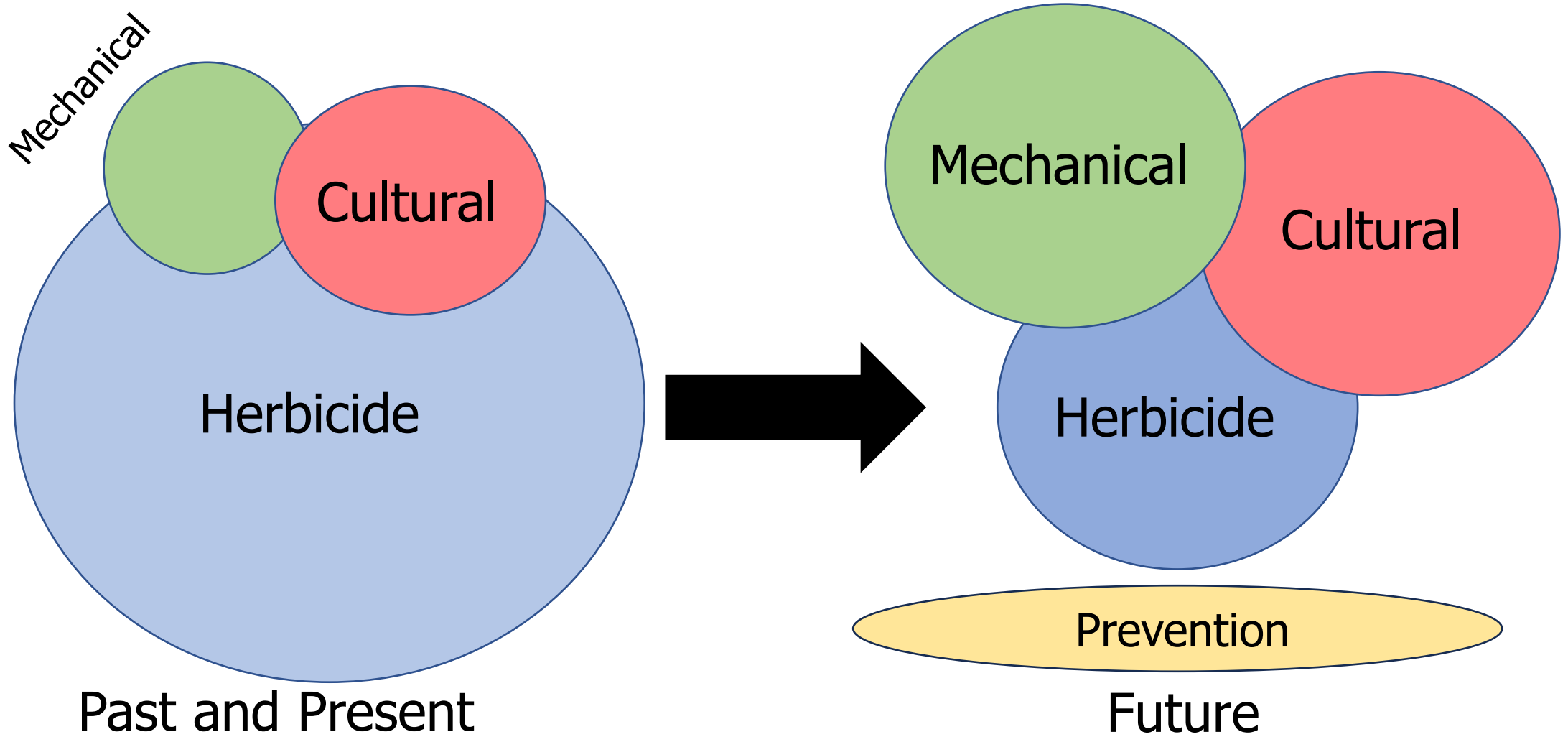
- Sugarbeet Research and Education Board; Brian Ryberg and Lane Schwitters
- David Mettler and SMBSC research team, Mark Bloomquist, Cody Groen, Lynsey Lies, Gary Lindahl, Bob Johnson, Richard Ness
- Our grower cooperators
  - Southern Minnesota Beet Sugar Coop
  - Tom Bakker
  - Petersen Farms
  - Youngkrantz Brothers



How are we going to control weeds in the short term?

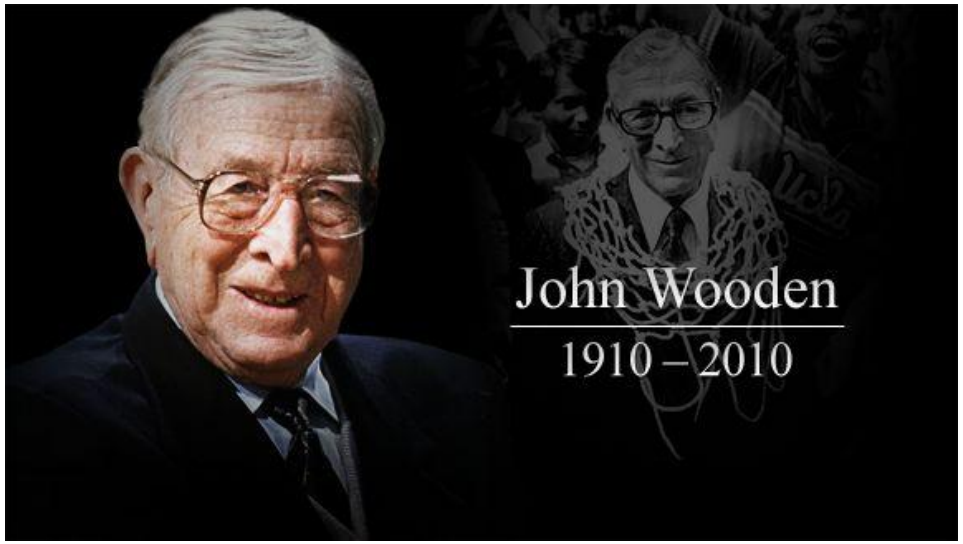
- Focus groups at Renville, Wahpeton and Moorhead in November and December 2025
- Growers, ag-retailers, crop consultants and cooperative agriculturalists
- 2 hour brainstorming session with action items for followup

Integrated Weed Management



Slide adapted from Bob Hartzler, Iowa State University

"It's the details. Little things make big things happen"



It's the little weed management details. Little things potentially make weed-free crop fields a possibility

Outline:
Use the winter season to get back into the classroom

- Study waterhemp biology
- Waterhemp control in sugarbeet; across the crop sequence
- Spray nozzles
- Be aware of environmental conditions effects on POST herbicides
- Harvest weed seed control
- Electricity
- Herbicide resistance


May 11, 2020, Glyndon, MN


May 14, 2020, McLeod County MN


May 2, 2020, Mapleton, ND


May 13, 2020, Renville County MN


May 4, 2020, Lake Lillian, MN


May 11, 2020, Foxhome, MN

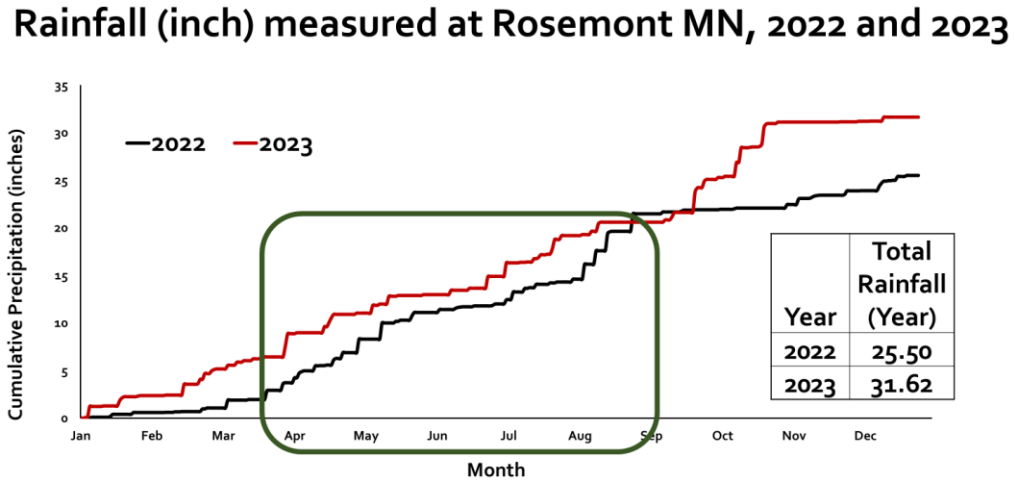

May 14, 2020, Renville County MN

Rainfall (inch) measured at Rosemont MN, 2022 and 2023

- Waterhemp emergence in a soybean field in Rosemount, MN (*Yu et al.*

Year	First observed seedling	50% emergence	90% emergence	Total Waterhemp[a]
2022	24-May	27-May	5-July	130
2023	15-May	28-June	27-July	227

[a]Cummulative waterhemp emergence in 1 square meter



Rainfall pattern may explain the differences in emergence pattern

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2022	24-May	27-May	5-July	130
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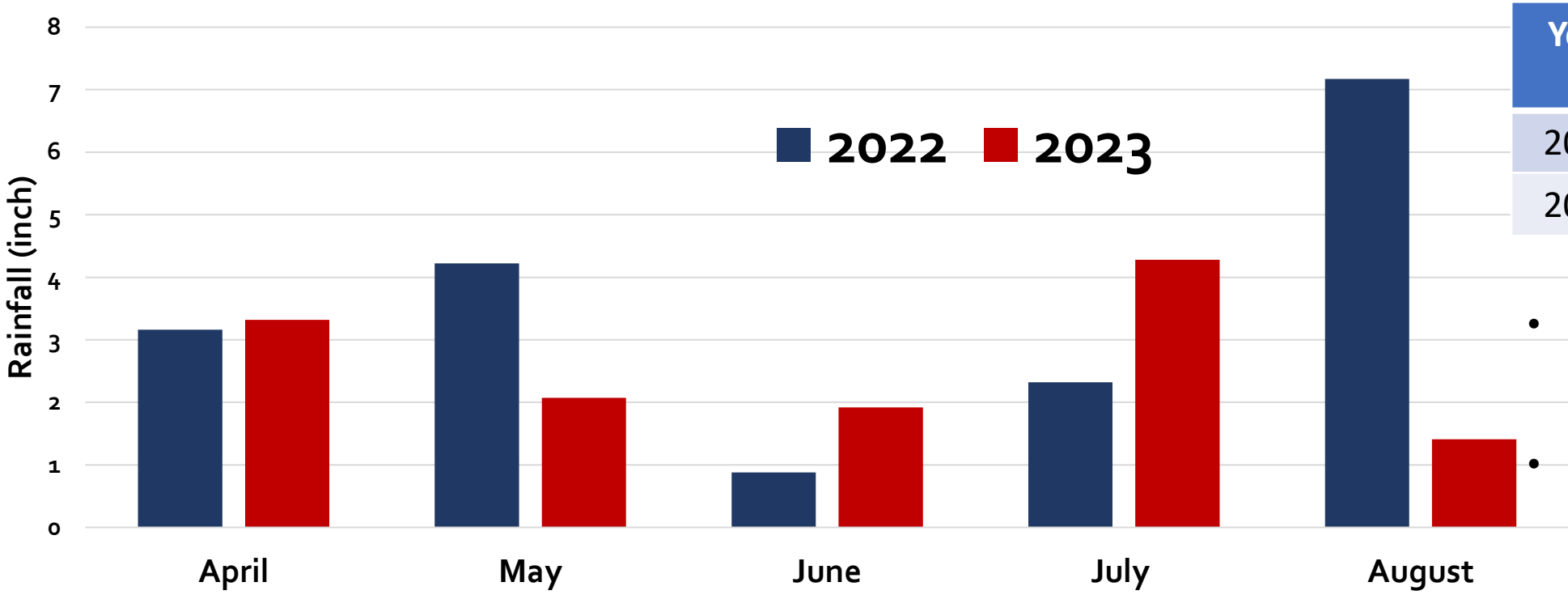
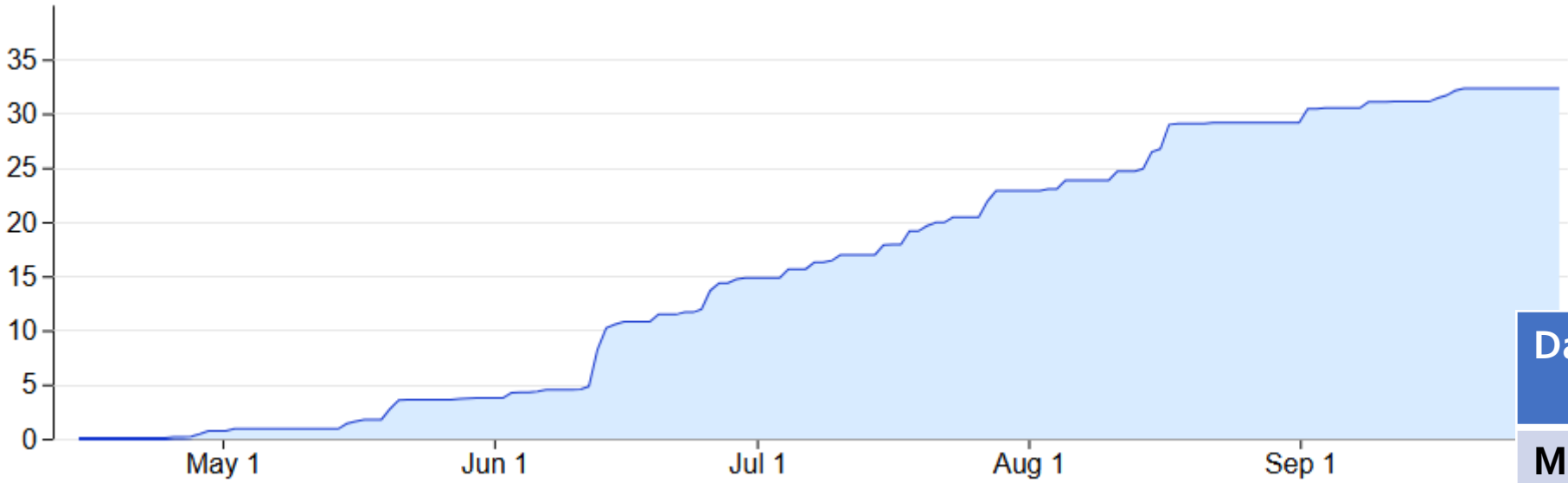
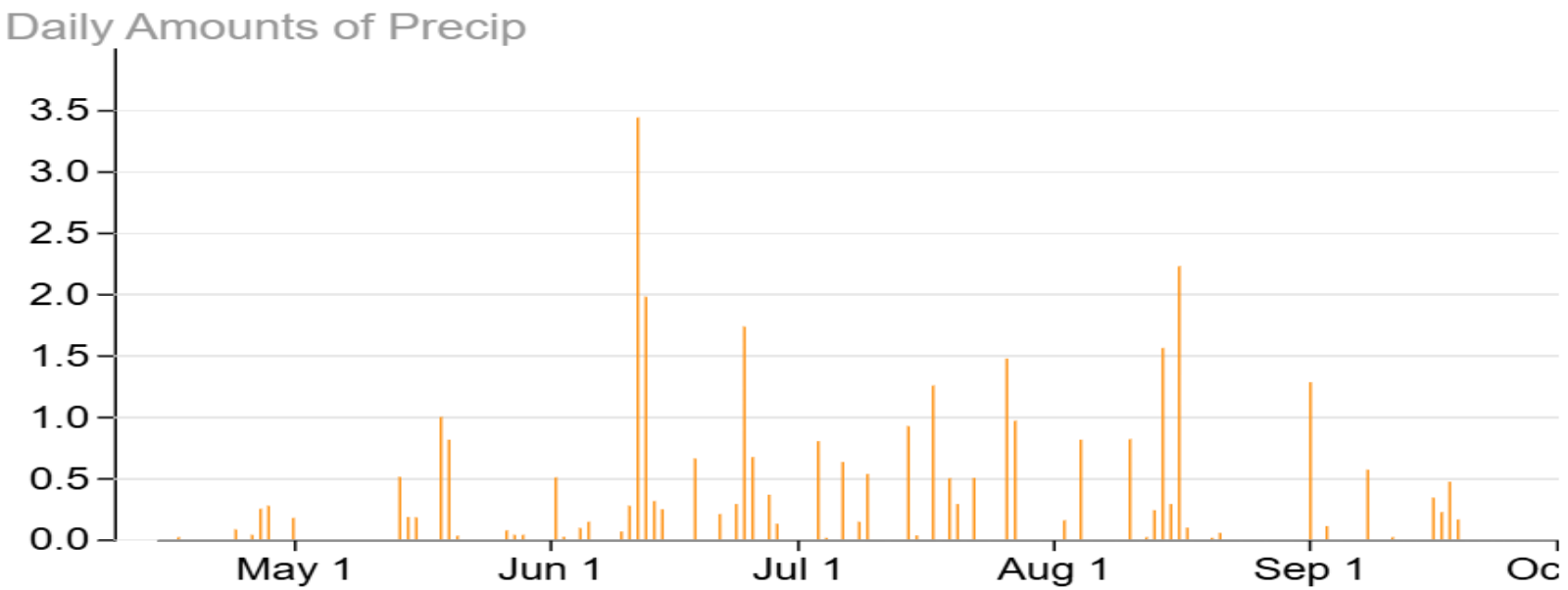


Year	Cummulative Rainfall
2022	17.8
2023	13.0

- No significant events in June and July in 2022
- Rain events Jun 27, Jul 5 and Jul 26 in 2023

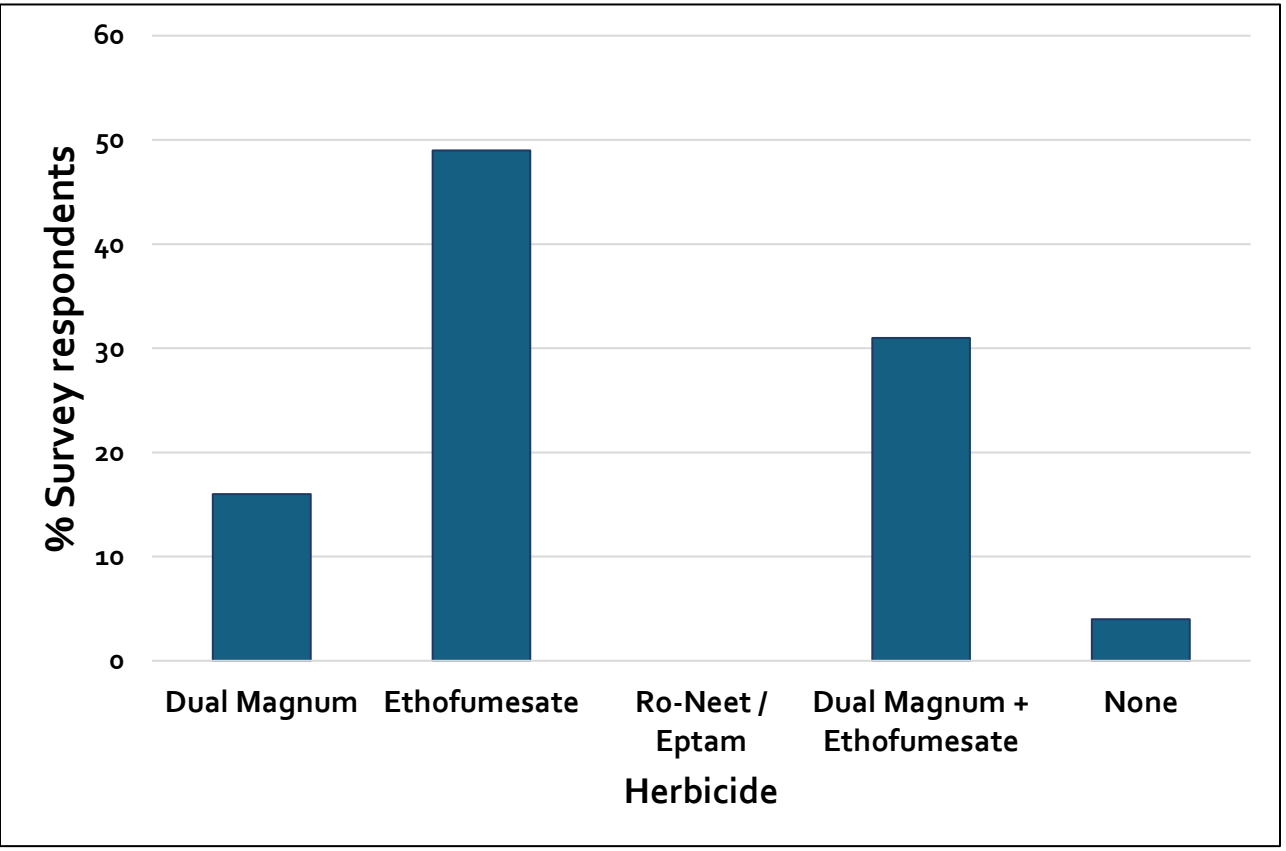


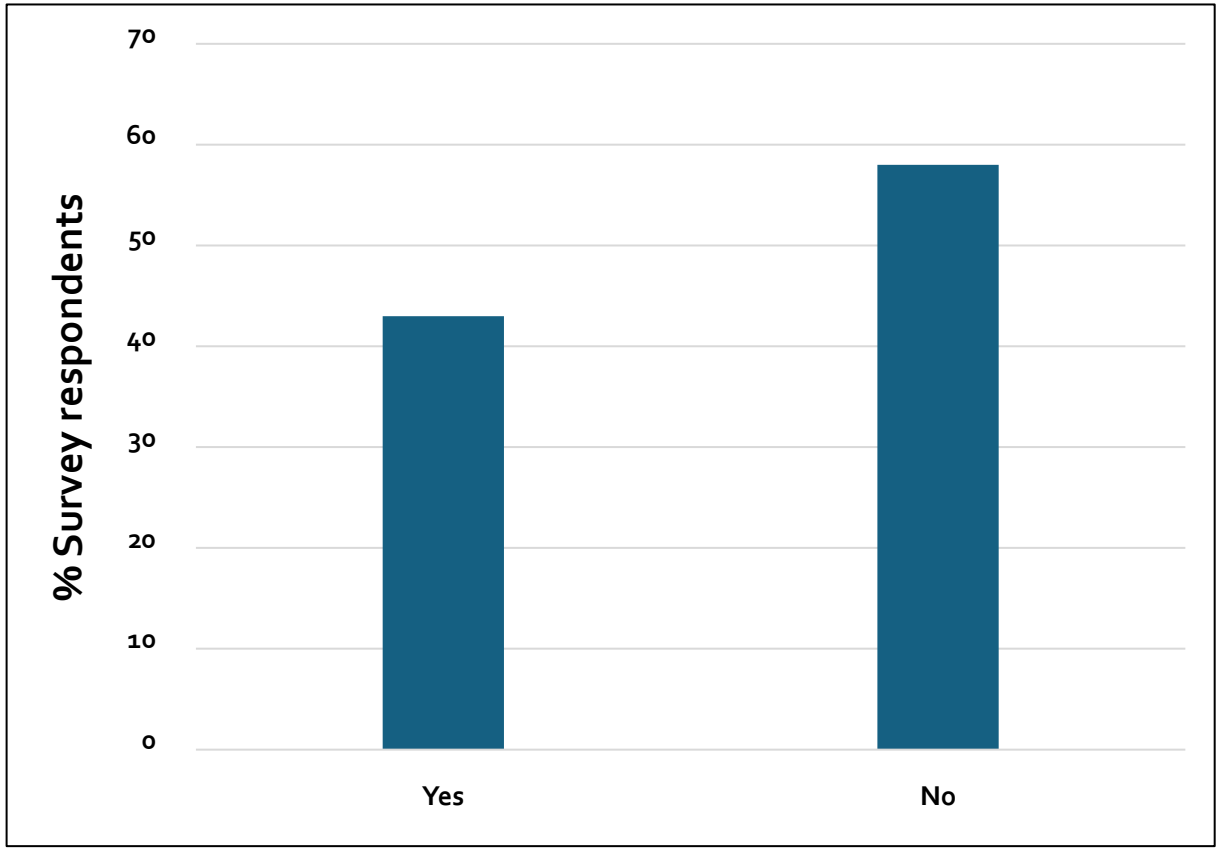
Clara City



Date	Rainfall (inch)
May 19	1.0
June 12	3.4
June 13	2.0
June 25	1.7
July 15	0.9
July 18	1.3
July 27	1.5
July 28	1.0
Aug 15	1.6
Aug 17	2.2
Sept 2	1.3

Which soil-applied herbicide did you use at planting? Was ethofumesate activated with tillage?[a]





[a]Turning Point Survey, 2025 Sugarbeet Growers Seminars

Ethofumesate in 2025
Group 15

Ethofumesate brands for sugarbeet production

- Nortron, Bayer CropScience
- Ethotron, UPL NA Inc.
- Ethofumesate 4SC, Farm Business Network
- Maxtron 4SC (3.78 lb/G), ALBAUGH, LLC
- ~~Nektron SC~~, ~~Atticus~~, ~~LLC~~

UPL

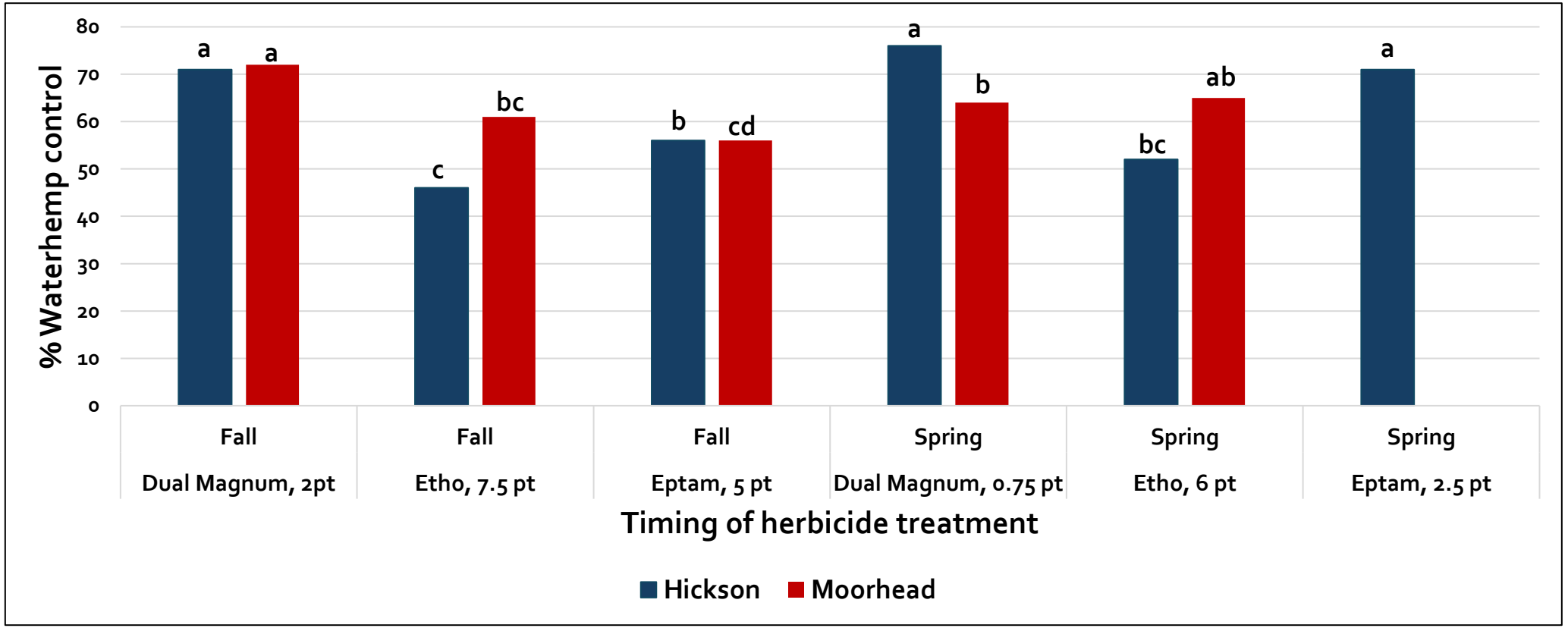
Ethofumesate 101

- Group 15, Benzofurans sub-family
- Inhibits the biosynthesis of VLCFAs
  - act by inhibiting the growth of meristems
  - retard cell division
  - limits development of leaf cuticles
- Absorbed by the emerging shoots (grass) coleoptile and broadleaf (hypocotyl) and roots with translocation to the foliage.
- Sensitive plants either fail to emerge or remain in an arrested state of growth after emergence
- Degradation is dependent on the properties of soil

Ethofumesate 101, continued

- Question. Why is ethofumesate performance inconsistent on waterhemp?
  - As compared to Outlook, ethofumesate has a high KOC value meaning it has a high affinity for binding to soil colloids
  - Ethofumesate is less water soluble than Outlook
- Question. Does rainfall overcome these characteristics?
  - We have increased the use rate
  - We have incorporated ethofumesate
  - Pushing water volume to 20 gpa probably will improve consistency, especially in residue
  - We have attempted fall application to increase the odds of activation
- Question. Does ethofumesate bind to wheat or corn stalk residue?
  - The literature states residue can intercept spray
  - I can't find any information stating etho binds to corn stalks

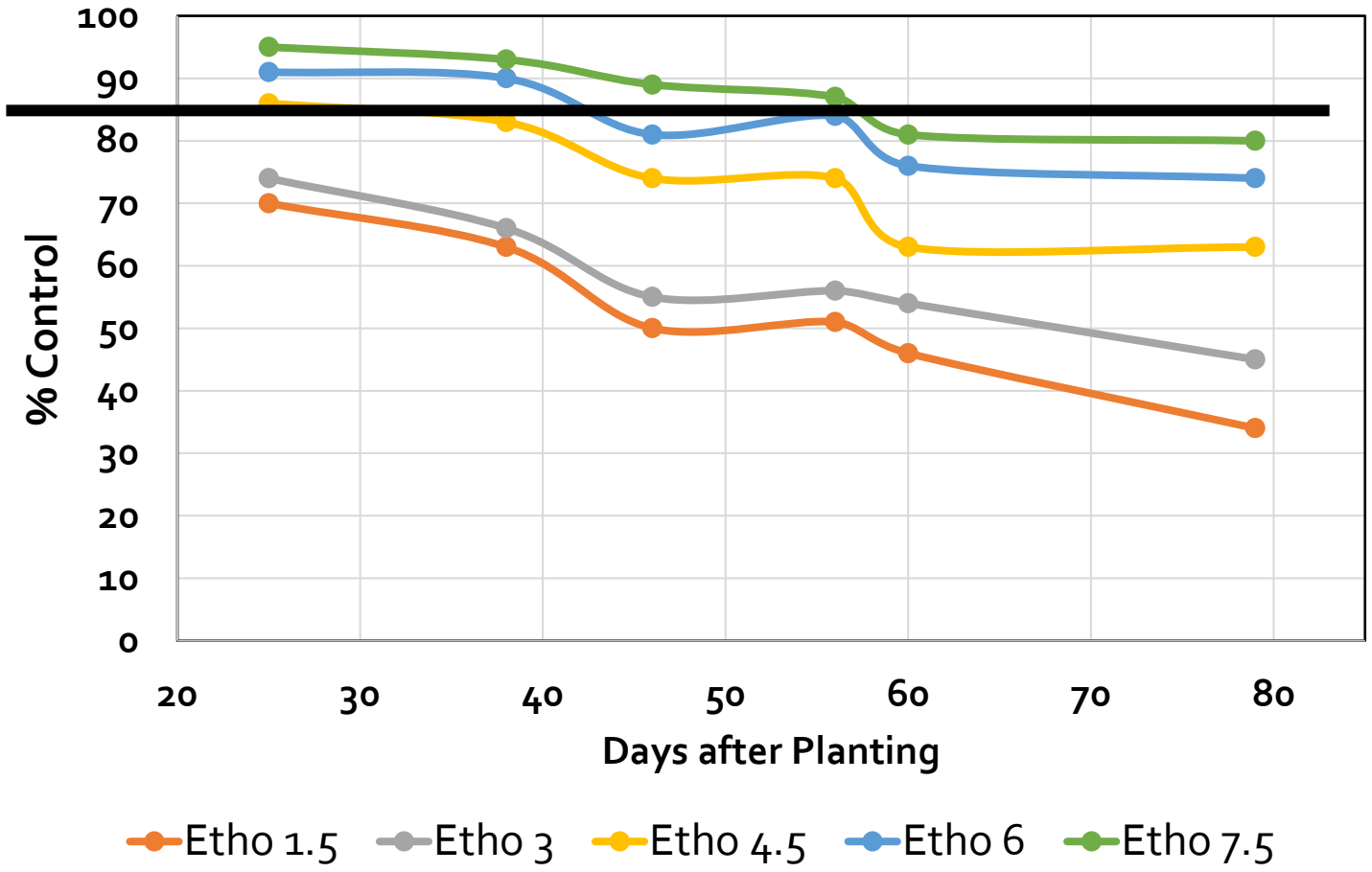
Waterhemp control in response to fall or spring applied treatment, 71 and 73 DAP, Hickson and Moorhead, 2025.[ab]



[a]Treatments sharing the same letter are the same at the 0.10 level.

[b]All treatments contained 2-times Roundup PowerMax3 mixed with ethofumesate at the 2- and 6-lf stage.

Waterhemp control in response to ethofumesate PRE, Lake Lillian, MN, 2020



	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

	greater than 85%
	84% to 78%
	77% to 65%
	less than 65%

What should we use for waterhemp control in 2026?

- Ethofumesate, 4.5 to 6 pt/A
- Dual Magnum at 8 to 12 fl oz/A
- Dual Magnum at 16 lf oz/A after May 1
- Etho + Dual Magnum at 3 pt + 12 fl oz/A

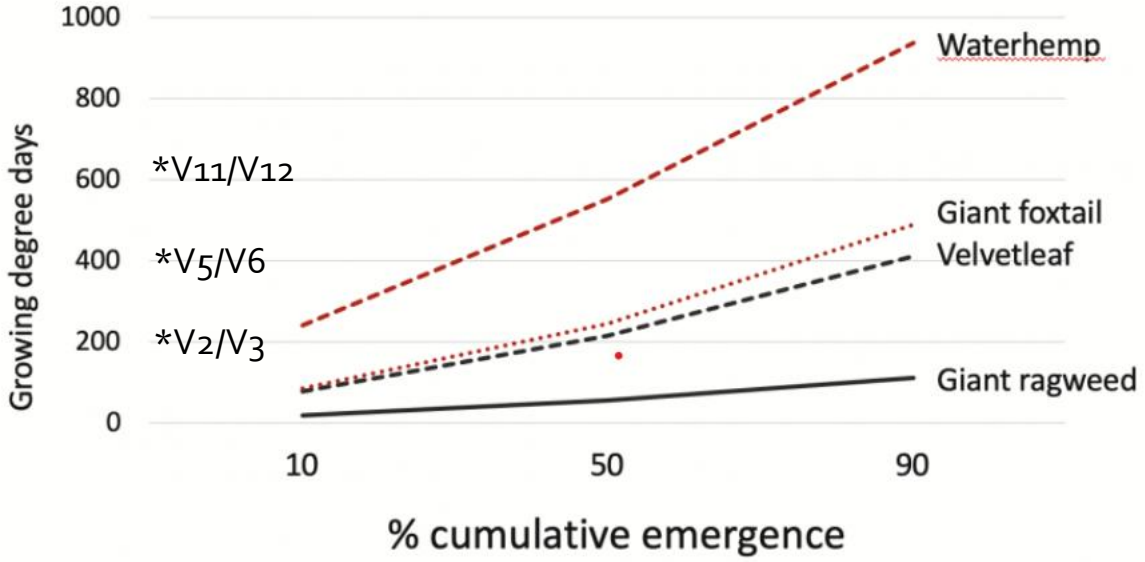


Figure 1. Relationship between growing degree days and emergence of four weeds. Werle, Sandell, Buhler, Hartzler and Lindquist. 2014. Weed Sci. 62:267-279.

The layered residual is strongly contributing to season-long waterhemp control

I think it is time to revisit our layby approach

*According to Holen and Dexter

Peters is proposing

Herbicide	Current Rate	Suggestion for 2026	Maximum use rate	Application timing
	fl oz/A	fl oz/A	fl oz or pt/A	Sgbt stage
Outlook / Outlook	12/12	16	24	12-lf
S-meto / S-meto	16 / 16	20	2.6[a]	60d PHI
Acetochlor/ acetochlor [b]	40 to 48 / 40 to 48	48 to 64	8	8-lf

[a]POST maximum use rate. Dual Magnum applied in the fall or PRE is incremental
[b] Warrant or Enversa

I also am considering Zidua (not labled in sugarbeet) and Treflan layby in sugarbeet

What about etho POST with Roundup PowerMax3? You have 12 fl oz/A to use POST. Use it.

Waterhemp control from postemergence herbicides, across locations and years

Herbicides[1]	Herman 2014	Moorhead 2015	Herman 2015	Lake Lillian 2015	Average
	----------% visual control[2]----------				
glyphosate	36	66	20	61	46
glyphosate + ethofumesate	58	81	40	66	61
glyphosate + Betamix	65	86	40	68	65
gly + etho + Betamix	69	88	73	78	78

[1]Roundup alone with Prefer 90 NIS at 0.25% v/v and N-Pak AMS at 2.5% v/v. Roundup tank-mixes with Destiny HC at 1.5 pt/A and N-Pak AMS at 2.5% v/v.
[2]Visual percent waterhemp control at preharvest evaluation

Waterhemp control results from Truvera™ sugarbeet experiments across years

Truvera®
Truly versatile weed control.

1. XtendiMax mixed with ethofumesate. XtendiMax offers instant soil residual in a dry spring.
2. XtendiMax early POST. ExtendiMax control waterhemp escapes at the 2-lf stage (early lay-by application).
3. A soil residual herbicide POST remains important.
4. The soil residual herbicide should be applied at the 2- to 4-lf stage vs. the 6- to 8-lf stage.
5. Glufosinate mixed with glyphosate at the 6- to 8-lf stage controls waterhemp escapes.


Untreated Control


Etho + XtendiMax/Warrant+RUP+ etho/RUP+etho+gluf


Our waterhemp control standard
Etho+ Dual Magnum/RUP+etho+ Outlook/RUP+etho+Warrant


Etho+XtendiMax/Etho+XtendiMax/RUP+etho+gluf

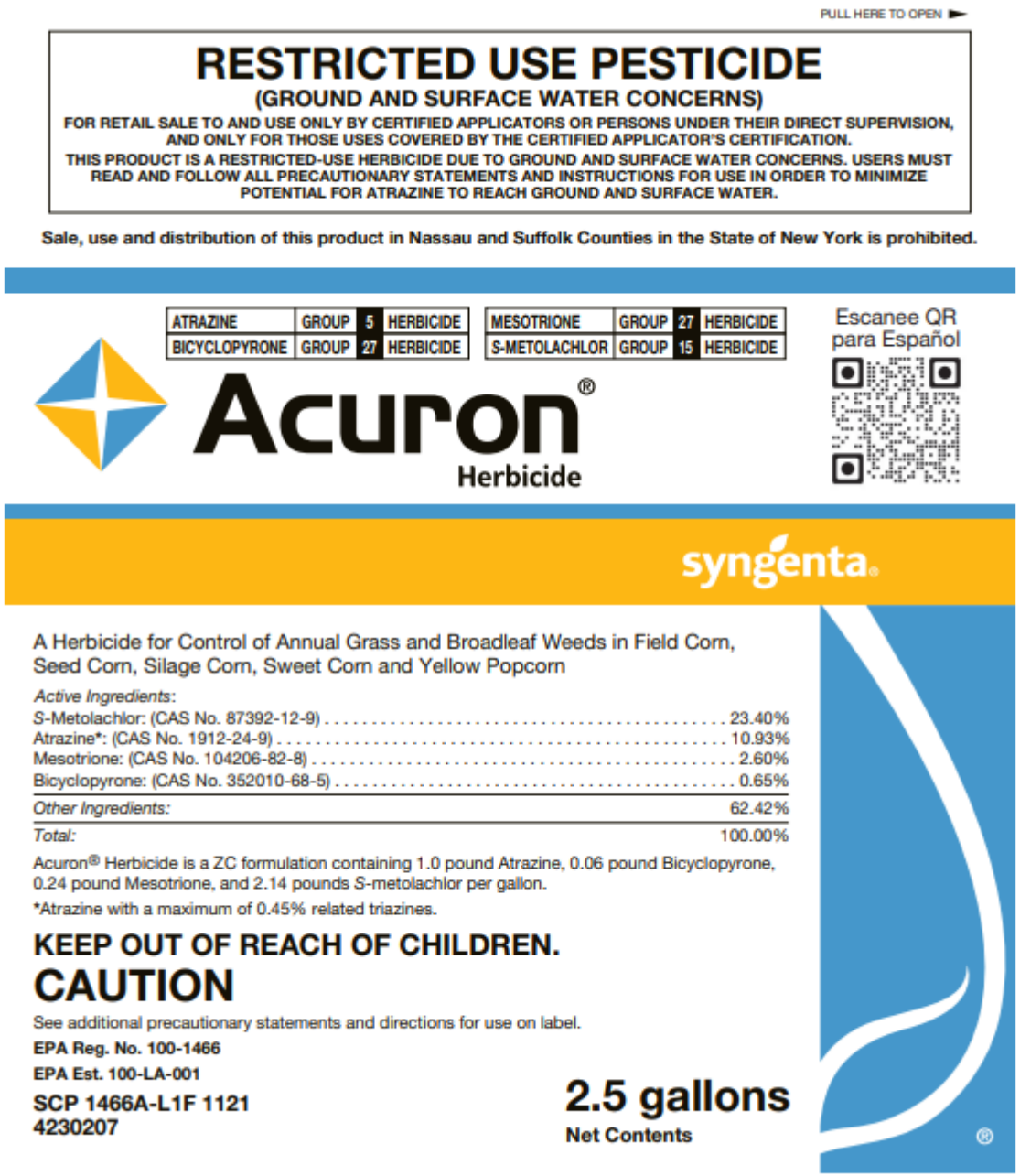
For waterhemp control: need 3-4 effective active ingredients in a program. POST when weeds are less than 3-inch. PRE mandatory for time management constraints and overall effectiveness.

	Wheat	Sugarbeet	Corn	Soybean
PRE	14	15	15 27	3 4 5 14 15
POST/PRE	15	15	15	15
POST	27 6 4		4 5 27	4 10

- Lots of 15s
- Not much for waterhemp control in sugarbeet
- Lots of options in soybean; I'm not saying waterhemp control in soybean is easy

Get back to herbicide basics GROW, https://growiwm.org

- What are the most important weeds on your farm?
- Are they herbicide resistant? Which herbicides?
- What herbicides are in the PREMIX?
- What site-of-action group?
- Are the herbicides effective (95% control) against the weeds in your field.
- What is the labeled rate for control? Is the labeled rate the same as the PREMIX rate?
- https://www.cdms.net/
- Use the 2026 North Dakota Weed Control Guide to determine rates, % control, rotation restriction for crops in your sequence.



- PPI, PRE, or EPOST
- Rate changes with OM
- Controls numerous important MN and ND weeds including waterhemp
- Flexible
- Reliable
- 18 MONTH ROTATION RESTRICTION TO SUGARBEET

Case-study, Acuron Herbicide

PREMIX	Active Ingredient	Trade Name	SOA	Effective waterhemp?
Acuron	bicyclopyrone	Optogen	27	✓
	mesotrione	Callisto	27	✓
	atrazine	Aatrex	5	✓
	S-metolachlor	Dual II Magnum	15	✓

What is the use rate for my Amenia, ND Farm?

4% organic matter, 3 qt per acre

Always include Group 5 herbicide with a Group 27 herbicide due to synergy.

What is the herbicide rate in each component in the PREMIX?
Is the herbicide rate effective for waterhemp control?

Active Ingredient	Trade Name	Rate (lb ai/A in Acuron at 3 qt/A	Rate for effective control	Effective Herbicide	Comment
bicyclopyrone	Optogen	0.045	0.045	✓	partial control
mesotrione	Callisto	0.188	0.188-0.240	✓	control
atrazine	Aatrex	0.75	2	✓	partial control
S-metolachlor	Dual II Magnum	1.59	1.53	✓	control

TripleFlex II Herbicide

- PPI, PRE, or EPOST
- Rate changes with OM
- Controls numerous important MN and ND weeds including waterhemp
- One effective waterhemp control herbicide
- 26 MONTH ROTATIONAL RESTRICTION TO SUGARBEET

PREMIX	Active Ingredient	Trade Name	SOA	Effective waterhemp?
TripleFlex	acetochlor	Harness	15	✓
	flumetsulam	Python	2	
	clopyralid	Stinger HL	4	

The "Nozzle Compromise": Select the nozzle producing the correct droplet size for the spray job

Sprayers 101 https://sprayers101.com
Tom Wolfe and Jason Deveau

- Herbicide or fungicide?
- Are you applying a contact or translocating herbicide?
- Spray coverage?
- Are you trying to reduce spray drift?
- Does brand or style matter?
- What do the labels say?

Nozzle Droplet Size Classification

Color Codes for Droplet Size

Category	Symbol	Color Code	Approx. VMD Range (microns)
Extremely Fine	XF	Purple	<60
Very Fine	VF	Red	60-145
Fine	F	Orange	145-225
Medium	M	Yellow	226-325
Coarse	C	Blue	326-400
Very Coarse	VC	Green	401-500
Extremely Coarse	XC	White	501-650
Ultra Coarse	UC	Black	>650

Size Comparison:

Diameter of Common Items (approximate) in Microns

- 2,000 μm #2 pencil "lead"
- 850 μm paper clip
- 420 μm staple
- 300 μm toothbrush bristle
- 150 μm sewing thread
- 100 μm human hair

Based on ASABE 572.1 Standards and referenced in nozzle charts, American Society of Agricultural and Biological Engineers

- I am searching for a medium to course droplet size
- I need good coverage to hit multiple growing points and intend to spray 20 gpa
- I intend to spray at 10 mph
- Nozzle orifice size determined from the table
- Check the label

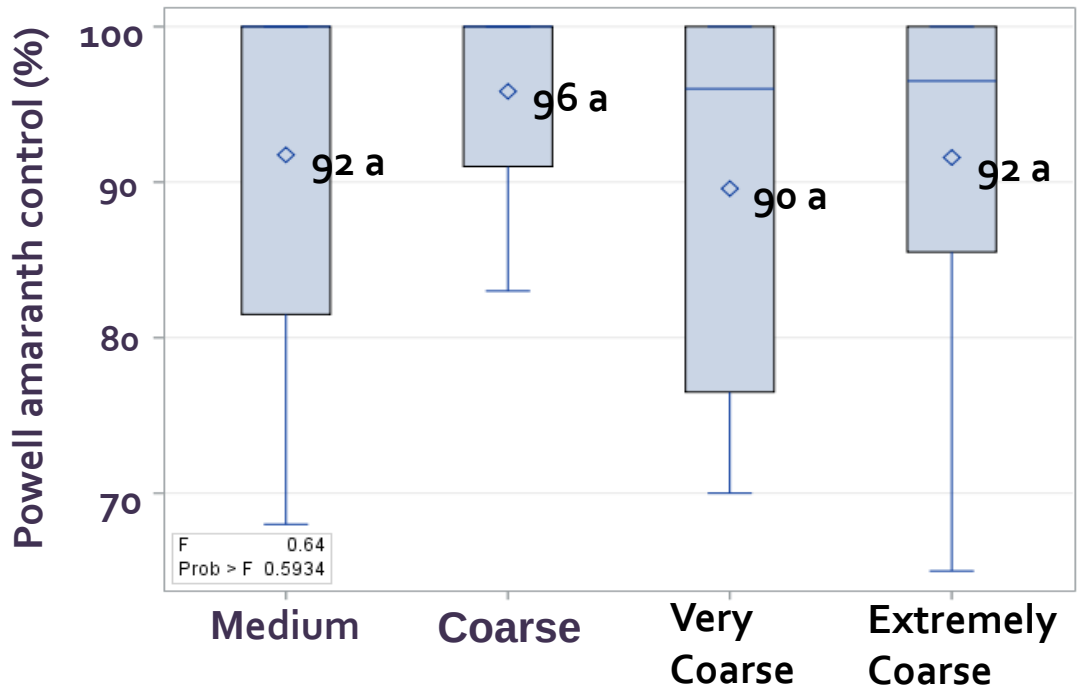
TIP PART NO. (STRAINER MESH SIZE)	PSI	DROP SIZE	CAPACITY ONE TIP IN GPM	CAPACITY ONE TIP IN OZ/MIN	APPLICATION RATE FOR 20" SPRAY TIP SPACING											
					GALLONS PER ACRE (GPA)								TURF APPLICATION GALLONS PER 1000 SQ. FT.			
					4 MPH	5 MPH	6 MPH	8 MPH	10 MPH	12 MPH	15 MPH	20 MPH	2 MPH	3 MPH	4 MPH	5 MPH
TT11001 (100)	15	VC	0.061	7.8	4.5	3.6	3.0	2.3	1.8	1.5	1.2	0.91	0.21	0.14	0.10	0.08
	20	C	0.071	9.1	5.3	4.2	3.5	2.6	2.1	1.8	1.4	1.1	0.24	0.16	0.12	0.10
	30	M	0.087	11	6.5	5.2	4.3	3.2	2.6	2.2	1.7	1.3	0.30	0.20	0.15	0.12
	40	M	0.10	13	7.4	5.9	5.0	3.7	3.0	2.5	2.0	1.5	0.34	0.23	0.17	0.14
	50	M	0.11	14	8.2	6.5	5.4	4.1	3.3	2.7	2.2	1.6	0.37	0.25	0.19	0.15
	60	M	0.12	15	8.9	7.1	5.9	4.5	3.6	3.0	2.4	1.8	0.41	0.27	0.20	0.16
	75	F	0.14	18	10.4	8.3	6.9	5.2	4.2	3.5	2.8	2.1	0.48	0.32	0.24	0.19
	90	F	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2	0.51	0.34	0.26	0.20
TT110015 (100)	15	VC	0.092	12	6.8	5.5	4.6	3.4	2.7	2.3	1.8	1.4	0.31	0.21	0.16	0.13
	20	VC	0.11	14	8.2	6.5	5.4	4.1	3.3	2.7	2.2	1.6	0.37	0.25	0.19	0.15
	30	C	0.13	17	9.7	7.7	6.4	4.8	3.9	3.2	2.6	1.9	0.44	0.29	0.22	0.18
	40	M	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2	0.51	0.34	0.26	0.20
	50	M	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5	0.58	0.39	0.29	0.23
	60	M	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	75	M	0.21	27	15.6	12.5	10.4	7.8	6.2	5.2	4.2	3.1	0.71	0.48	0.36	0.29
	90	F	0.23	29	17.1	13.7	11.4	8.5	6.8	5.7	4.6	3.4	0.78	0.52	0.39	0.31
TT11002 (50)	15	VC	0.12	15	8.9	7.1	5.9	4.5	3.6	3.0	2.4	1.8	0.41	0.27	0.20	0.16
	20	VC	0.14	18	10.4	8.3	6.9	5.2	4.2	3.5	2.8	2.1	0.48	0.32	0.24	0.19
	30	C	0.17	22	12.6	10.1	8.4	6.3	5.0	4.2	3.4	2.5	0.58	0.39	0.29	0.23
	40	M	0.20	26	14.9	11.9	9.9	7.4	5.9	5.0	4.0	3.0	0.68	0.45	0.34	0.27
	50	M	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4	4.4	3.3	0.75	0.50	0.37	0.30
	60	M	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9	4.8	3.6	0.82	0.54	0.41	0.33
	75	M	0.27	35	20	16.0	13.4	10.0	8.0	6.7	5.3	4.0	0.92	0.61	0.46	0.37
	90	F	0.30	38	22	17.8	14.9	11.1	8.9	7.4	5.9	4.5	1.0	0.68	0.51	0.41
TT110025 (50)	15	VC	0.15	19	11.1	8.9	7.4	5.6	4.5	3.7	3.0	2.2	0.51	0.34	0.26	0.20
	20	VC	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	30	C	0.22	28	16.3	13.1	10.9	8.2	6.5	5.4	4.4	3.3	0.75	0.50	0.37	0.30
	40	M	0.25	32	18.6	14.9	12.4	9.3	7.4	6.2	5.0	3.7	0.85	0.57	0.43	0.34
	50	M	0.28	36	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2	0.95	0.63	0.48	0.38
	60	M	0.31	40	23	18.4	15.3	11.5	9.2	7.7	6.1	4.6	1.1	0.70	0.53	0.42
	75	M	0.34	44	25	20	16.8	12.6	10.1	8.4	6.7	5.0	1.2	0.77	0.58	0.46
	90	F	0.38	49	28	23	18.8	14.1	11.3	9.4	7.5	5.6	1.3	0.86	0.65	0.52
TT11003 (50)	15	XC	0.18	23	13.4	10.7	8.9	6.7	5.3	4.5	3.6	2.7	0.61	0.41	0.31	0.24
	20	VC	0.21	27	15.6	12.5	10.4	7.8	6.2	5.2	4.2	3.1	0.71	0.48	0.36	0.29
	30	C	0.26	33	19.3	15.4	12.9	9.7	7.7	6.4	5.1	3.9	0.88	0.59	0.44	0.35
	40	M	0.30	38	22	17.8	14.9	11.1	8.9	7.4	5.9	4.5	1.0	0.68	0.51	0.41
	50	M	0.34	44	25	20	16.8	12.6	10.1	8.4	6.7	5.0	1.2	0.77	0.58	0.46
	60	M	0.37	47	27	22	18.3	13.7	11.0	9.2	7.3	5.5	1.3	0.84	0.63	0.50
	75	M	0.41	52	30	24	20	15.2	12.2	10.1	8.1	6.1	1.4	0.93	0.70	0.56
	90	F	0.45	58	33	27	22	16.7	13.4	11.1	8.9	6.7	1.5	1.0	0.77	0.61
TT11004 (50)	15	XC	0.24	31	17.8	14.3	11.9	8.9	7.1	5.9	4.8	3.6	0.82	0.54	0.41	0.33
	20	VC	0.28	36	21	16.6	13.9	10.4	8.3	6.9	5.5	4.2	0.95	0.63	0.48	0.38
	30	C	0.35	45	26	21	17.3	13.0	10.4	8.7	6.9	5.2	1.2	0.79	0.60	0.48
	40	M	0.40	51	30	24	19.8	14.9	11.9	9.9	7.9	5.9	1.4	0.91	0.68	0.54
	50	M	0.45	58	33	27	22	16.7	13.4	11.1	8.9	6.7	1.5	1.0	0.77	0.61
	60	M	0.49	63	36	29	24	18.2	14.6	12.1	9.7	7.3	1.7	1.1	0.83	0.67
	75	M	0.55	70	41	33	27	20	16.3	13.6	10.9	8.2	1.9	1.2	0.94	0.75
	90	F	0.60	77	45	36	30	22	17.8	14.9	11.9	8.9	2.0	1.4	1.0	0.82
TT11005 (50)	15	XC	0.31	40	23	18.4	15.3	11.5	9.2	7.7	6.1	4.6	1.1	0.70	0.53	0.42
	20	VC	0.35	45	26	21	17.3	13.0	10.4	8.7	6.9	5.2	1.2	0.79	0.60	0.48
	30	C	0.43	55	32	26	21	16.0	12.8	10.6	8.5	6.4	1.5	0.97	0.73	0.58
	40	M	0.50	64	37	30	25	18.6	14.9	12.4	9.9	7.4	1.7	1.1	0.85	0.68
	50	M	0.56	72	42	33	28	21	16.6	13.9	11.1	8.3	1.9	1.3	0.95	0.76
	60	M	0.61	78	45	36	30	23	18.1	15.1	12.1	9.1	2.1	1.4	1.0	0.83
	75	M	0.68	87	50	40	34	25	20	16.8	13.5	10.1	2.3	1.5	1.2	0.92
	90	F	0.75	96	56	45	37	28	22	18.6	14.9	11.1	2.6	1.7	1.3	1.0
TT11006 (50)	15	XC	0.37	47	27	22	18.3	13.7	11.0	9.2	7.3	5.5	1.3	0.84	0.63	0.50
	20	VC	0.42	54	31	25	21	15.6	12.5	10.4	8.3	6.2	1.4	0.95	0.71	0.57
	30	C	0.52	67	39	31	26	19.3	15.4	12.9	10.3	7.7	1.8	1.2	0.88	0.71
	40	M	0.60	77	45	36	30	22	17.8	14.9	11.9	8.9	2.0	1.4	1.0	0.82
	50	M	0.67	86	50	40	33	25	19.9	16.6	13.3	9.9	2.3	1.5	1.1	0.91
	60	M	0.73	93	54	43	36	27	22	18.1	14.5	10.8	2.5	1.7	1.2	0.99
	75	M	0.82	105	61	49	41	30	24	20	16.2	12.2	2.8	1.9	1.4	1.1
	90	F	0.90	115	67	53	45	33	27	22	17.8	13.4	3.1	2.0	1.5	1.2
	15	XC	0.49	63	36	29	24	18.2	14.6	12.1	9.7	7.3	1.7	1.1	0.83	0.67
	20	VC	0.57	73	42	34	28	21	16.9	14.1	11.3	8.5	1.9	1.3	0.97	0.78

Droplet size and nozzle manufacturer

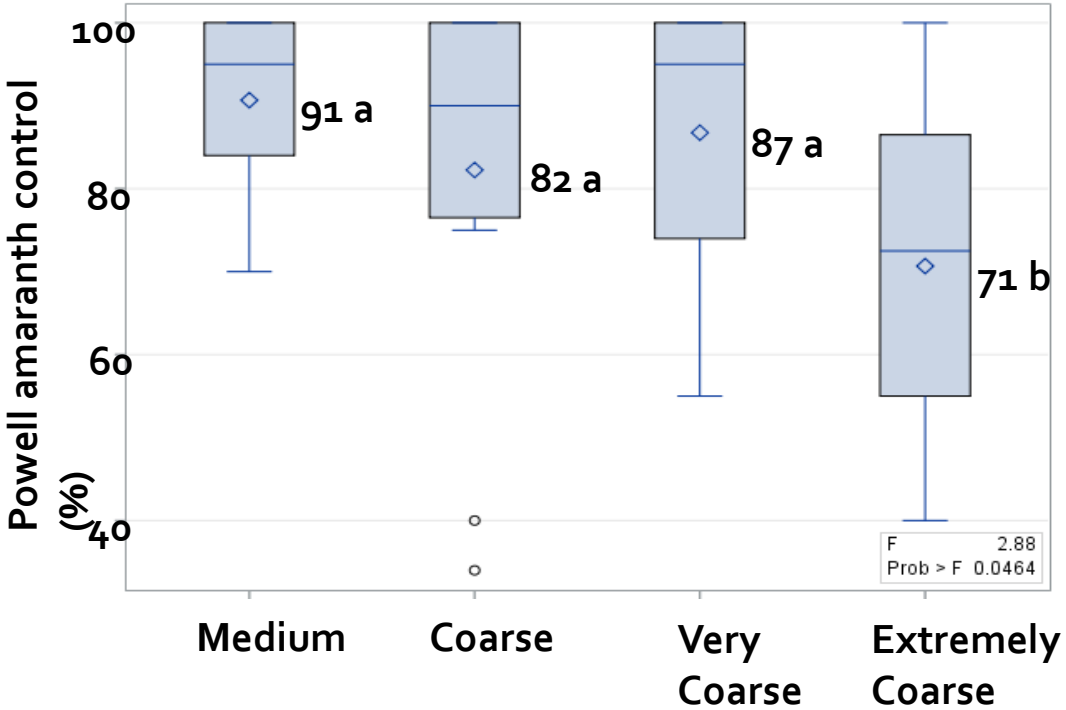
	Powell amaranth Control (%)	
Herbicide(s)[a]	Nozzle Brand A	Nozzle Brand B
Liberty Ultra (29 fl oz/A)	**88 b**	**72 b**
Liberty Ultra + Enlist One (32 fl oz/A)	**97 a**	**88 a**

[a]MSO (2 pt/A), AMS (3 lbs/A), Anti-Foam (2 oz/100 gal), 10 mph

Brand A (all 60 psi)



Brand B (30 to 60 psi)



Sprayer travel speed

Sprayer travel speeds make a difference on taller and more dense weed populations

Liberty Ultra (29 fl oz/A) plus AMS (3 lb/A)

20 GPA

Tall = 10 to 18 inch
Short = < 5 inch

	Visual Control (%)	
Sprayer travel speed (mph)	Tall Powell Amaranth	Short Powell Amaranth
6	69 AB	88 AB
8	74 A	78 B
10	63 AB	65 C
12	57 B	63 C

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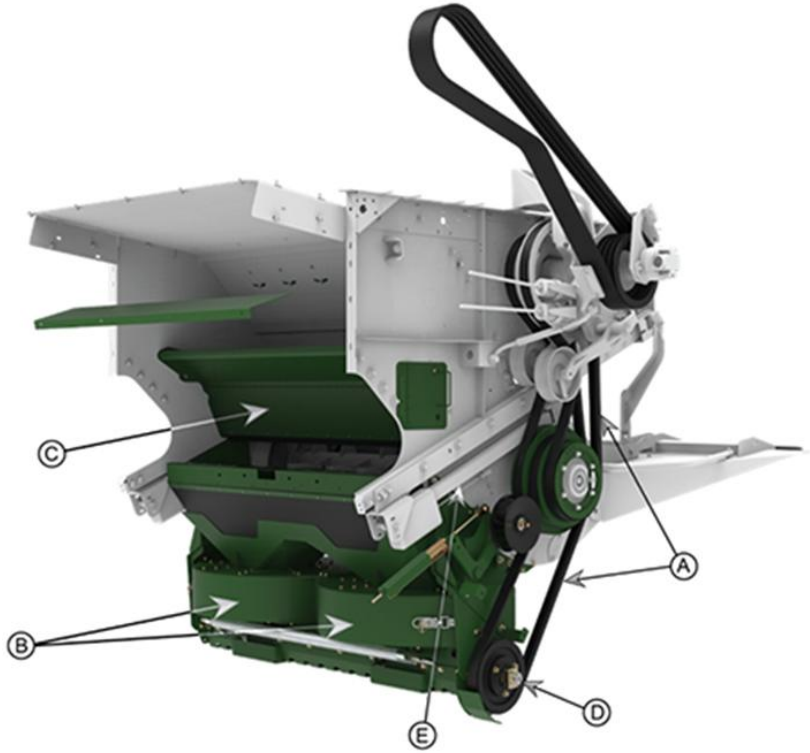
POWER YOUR HARVEST WITH THE REDEKOP X9 SCU

JOHN DEERE

- Weed seed kill rates were 99% at 28% chaff moisture
- Higher chaff flow rates reduced seed kill rates
- 'green waterhemp'

Top 5 Seed-Retaining Broadleaf Weeds

1. Smooth pigweed
2. Palmer amaranth
3. Hemp sesbania
4. Waterhemp
5. Jimsonweed



Tony Kramer

Product Manager - Planting and Harvest Technology
RDO Equipment Co.
Cell - 701.680.7531


NDSU
Image Credit: Mike Oslie,
NDSU Carrington REC

Volunteer Barley

With HWSC

Without

Combine performance data across experiments including Minnesota

What Have We Learned?

- Impact mills can reduce weed seed returned to the soil seedbank
- Effectiveness depends on seed retention at harvest – waterhemp is a good candidate
- Impact mills are a long-term, cumulative management tool
- There are logistical and economic tradeoffs
  - cost of impact mill is approximately $75,000
  - increased fuel usage and reduce engine capacity depending on the crop harvested
  - potentially slowdown speed of harvest

Mills combined with herbicides and other techniques provide an integrated weed management strategy

What is Stinger HL injury?

- Stinger HL causes epinasty and upward cupping of sugarbeet leaves.
- No reported yield loss from Stinger HL
- Very minimal plant response from cotyledon through 4 lf stage
- Injury can increase from 4- to 8-lf stage. I attribute this to humidity, air temperature and sugarbeet stage.

Stinger HL yield experiment conducted across multiple locations

Objectives

1. Evaluate 2-times Stinger HL at 1.8, 2.4 and 3.2 fl oz/A mixed with Roundup PowerMax3
2. Evaluate 2-times Stinger HL at 2.4 fl oz/A mixed with Select Max and Roundup PowerMax3
3. Evaluate 2-times Stinger HL at 2.4 fl oz/A mixed with *S*-metolachlor, Roundup PowerMax3, and etho
4. Evaluate sugarbeet tolerance from herbicide mixtures with soilborne fungicides and insecticides

Stinger HL yield experiment conducted across multiple locations

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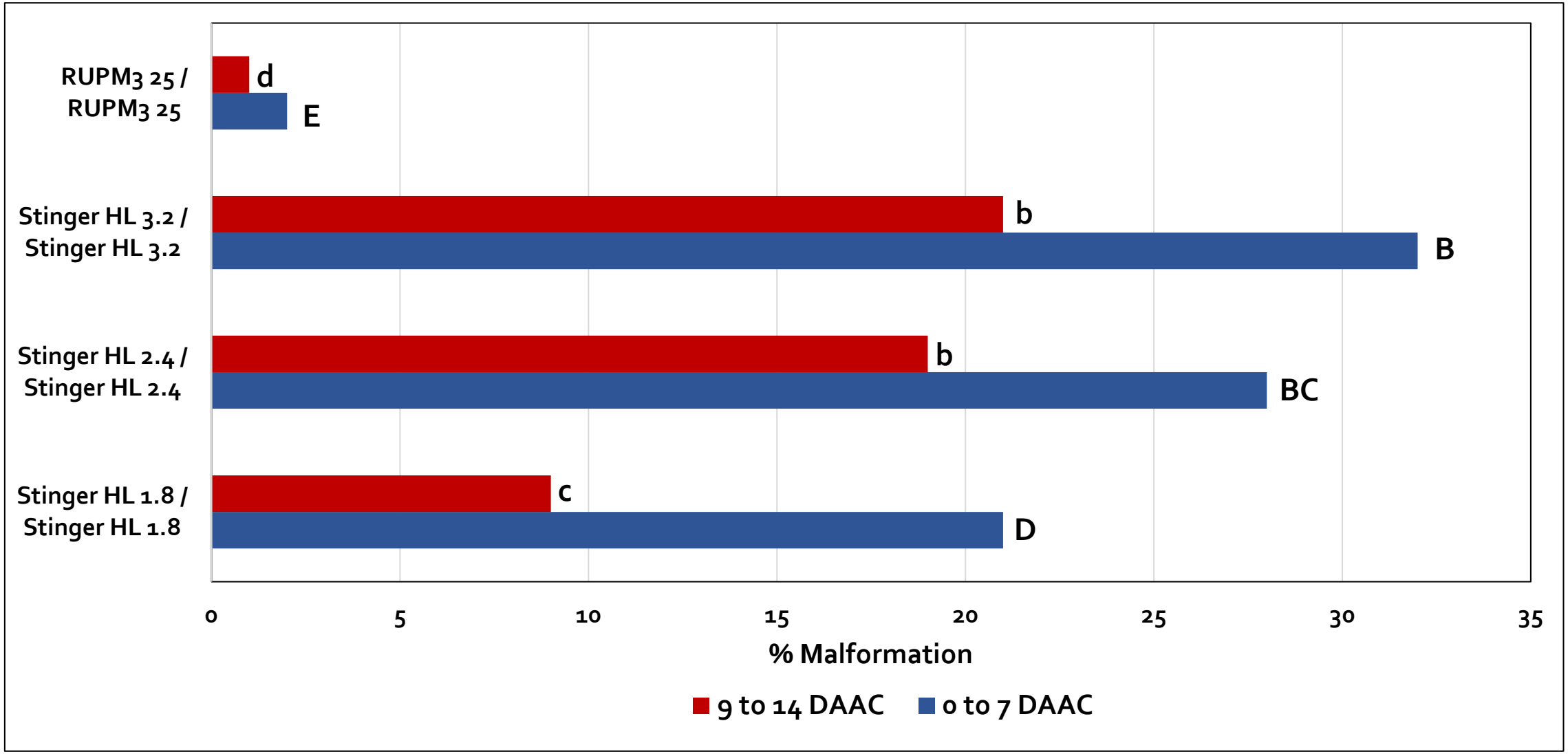
4. Evaluate sugarbeet tolerance from herbicide mixtures with soilborne fungicides and insecticides

Sugarbeet malformation[ab], across locations, 2025



[a] Stinger HL mixed with Roundup PowerMax3; applied at V2 and V6.

[b] Visible percent sugarbeet malformation following 2-time Stinger HL application

June 11, 2025
Prinsburg, MN

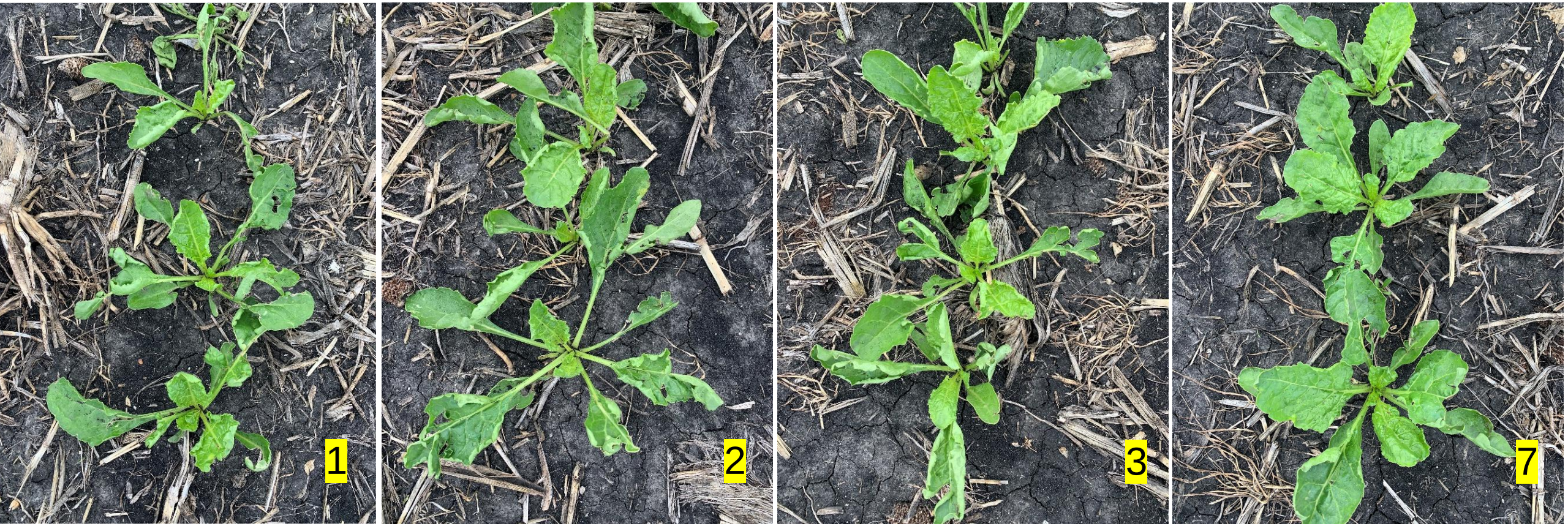
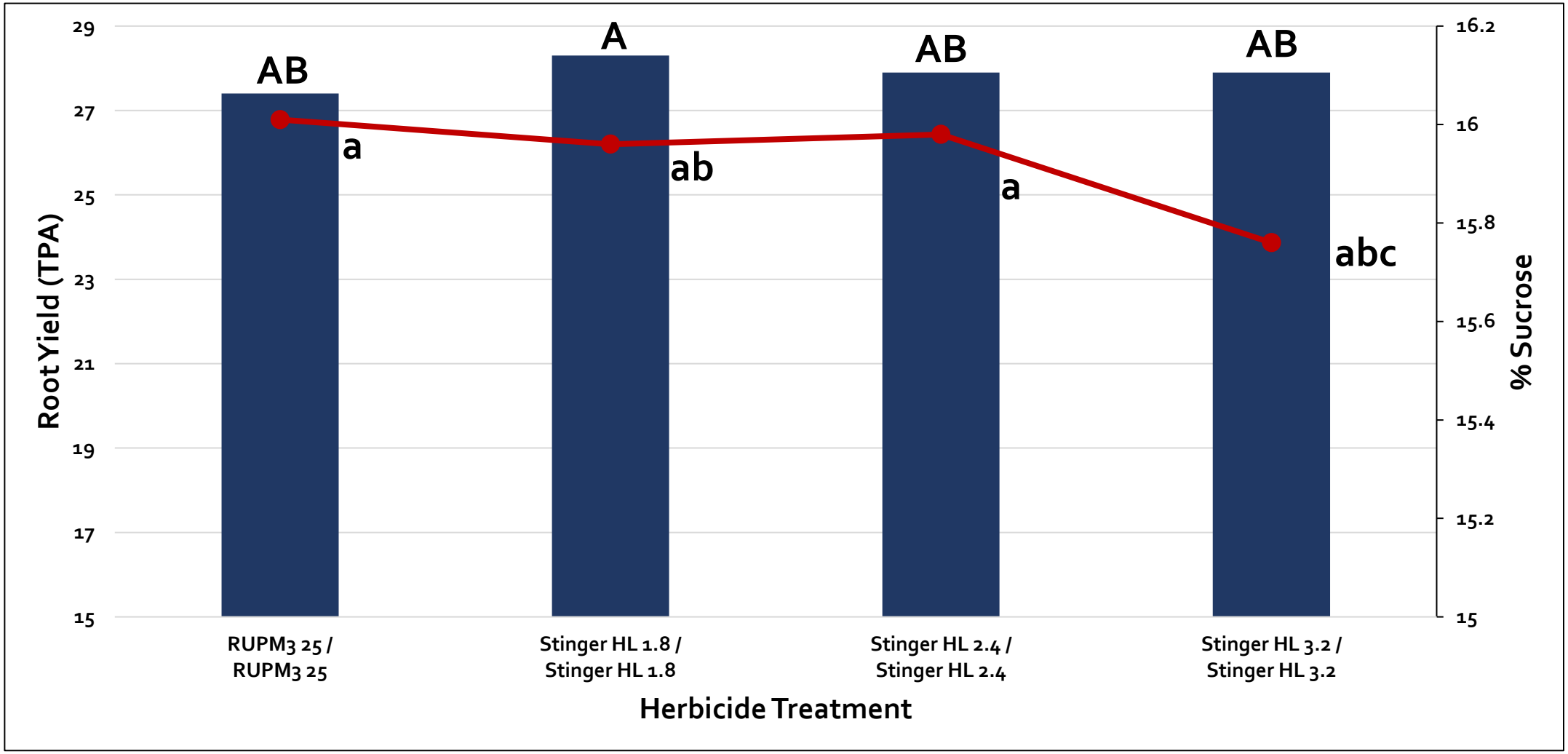


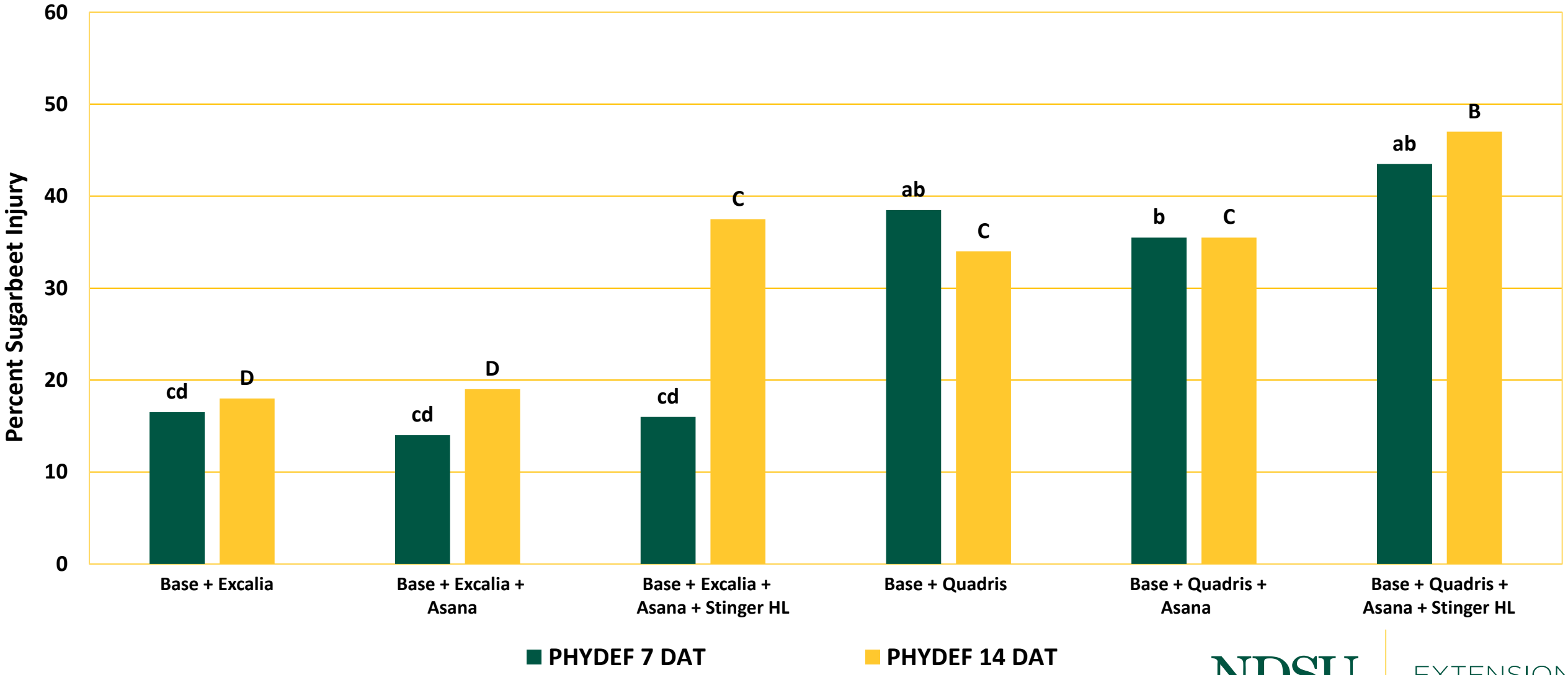
Photo Credits:
David Mettler

Stinger HL[a] did not reduce sugarbeet root yield or percent sucrose, across locs, 2025.[a]



[a]Stinger HL mixed with Roundup PowerMax3 and etho

Sugarbeet malformation (PHYDEF) from soilborne complex mixtures, combined across environments.[ab]



[a]means within a main effect not sharing any letter are significantly different by the Fisher's Protected LSD at the 5% level of significance

[b]Base= Roundup PowerMax3, etho and Outlook at 30, 12 and 18 fl oz/A

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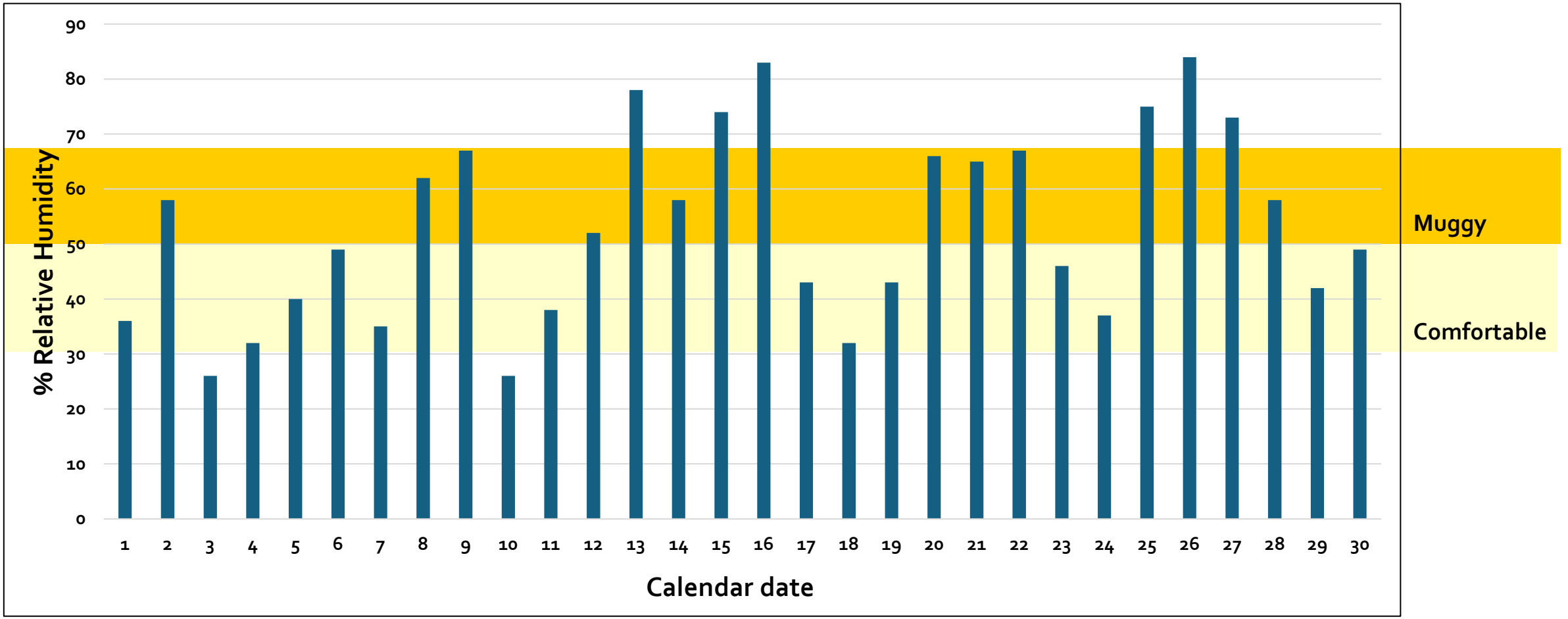
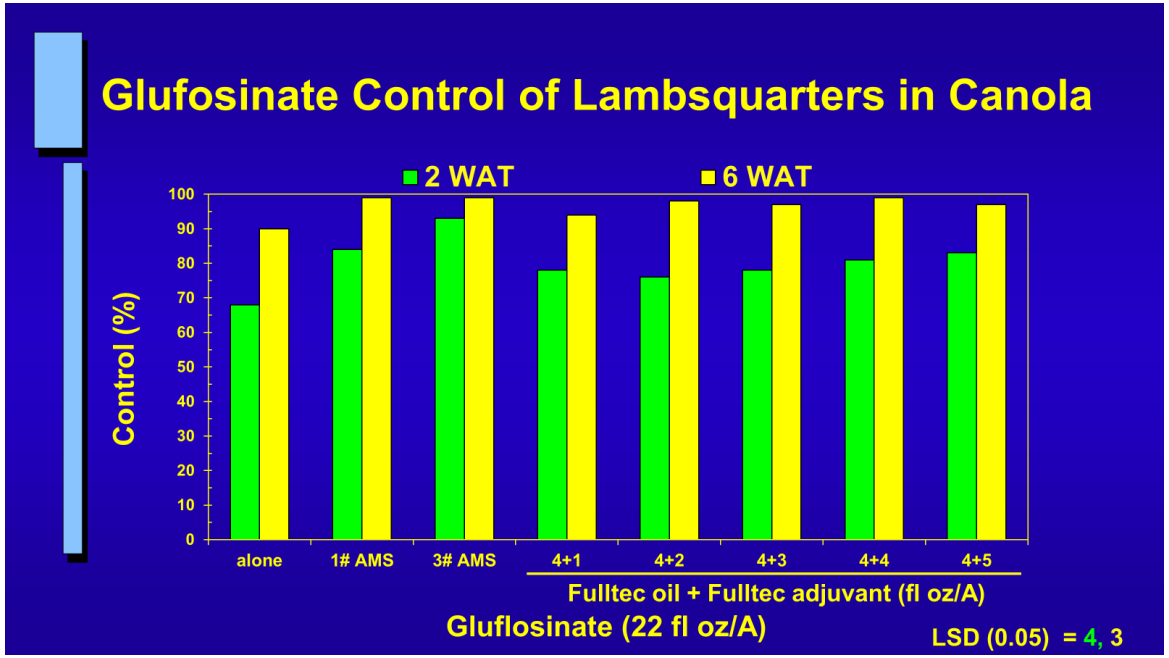
Relative humidity June 2025, 12:00 noon to 6:00PM, Hillsboro, ND



Question: Would anyone delay making a Liberty Ultra application because of low humidity?

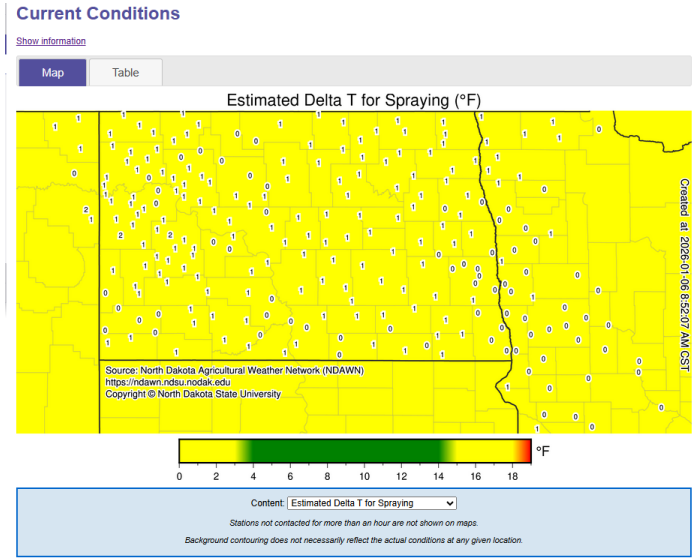
- Remember, Peters' says that waterhemp can grow 2-inch per day in June
- Probably not, but knowledge of how environmental conditions impact herbicides is important
- The appropriate herbicide rate, spray quality (droplet size, uniformity of droplets, coverage), and adjuvant system will improve outcomes in challenging environments

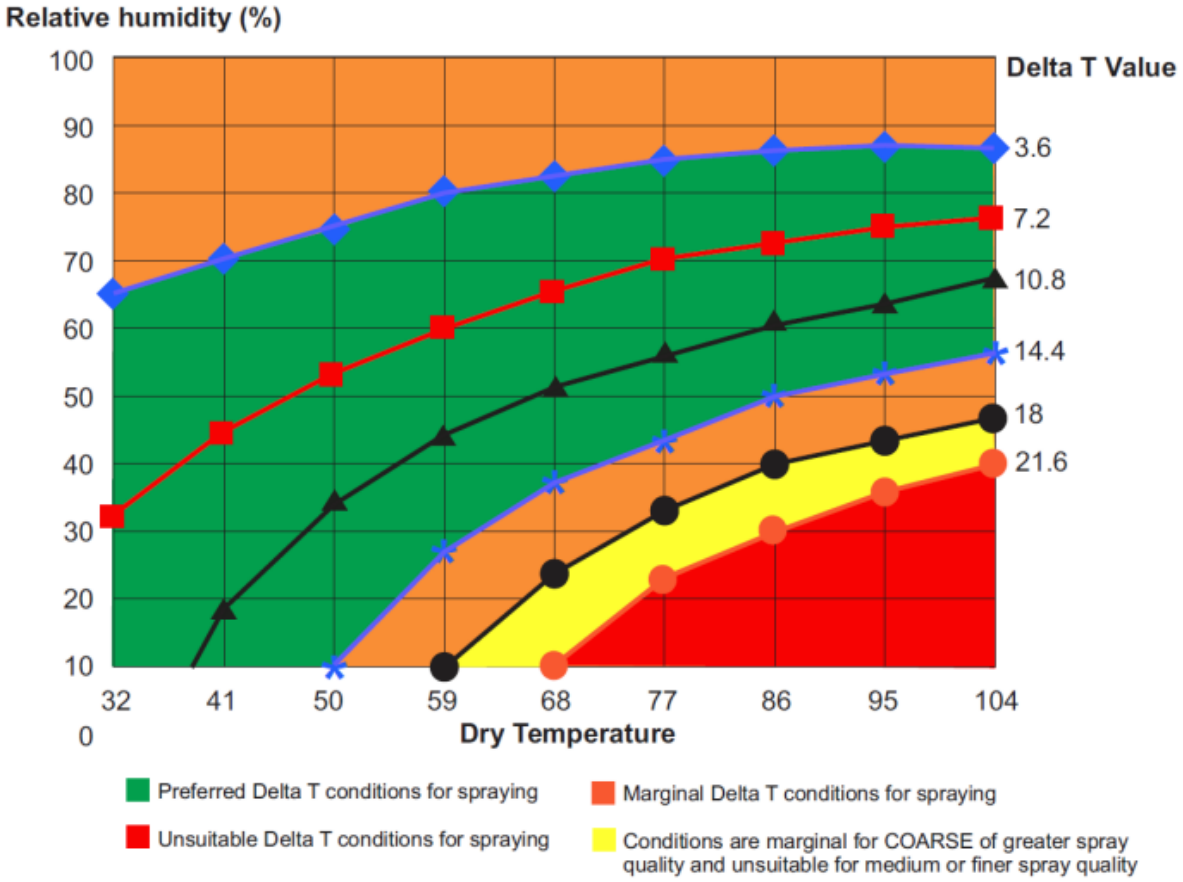


Liberty Ultra prefers humidity conditions

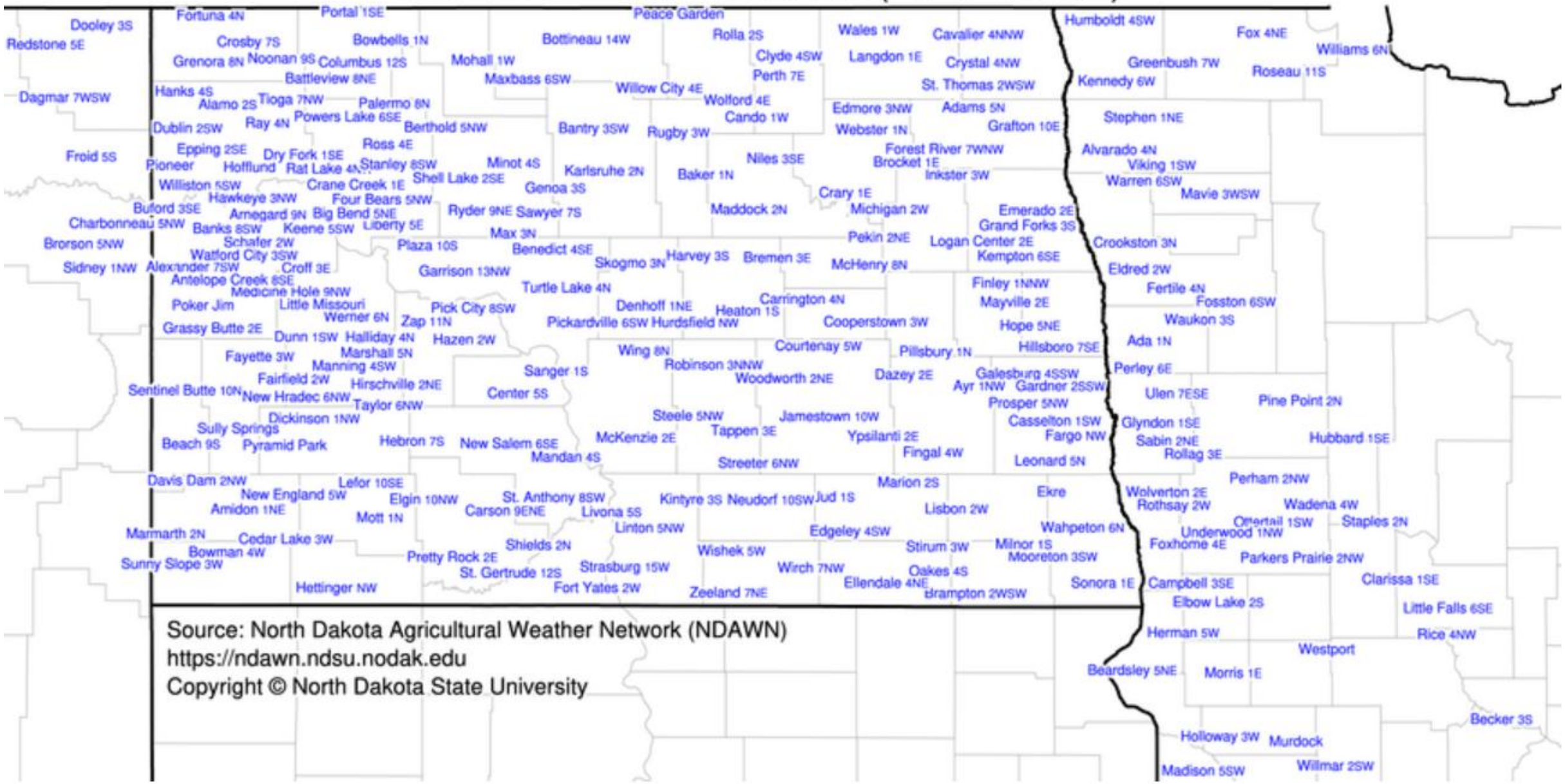
Delta T chart

- Impact of humidity and temperature on droplet evaporation
- Low humidity creates droplets that rapidly evaporate



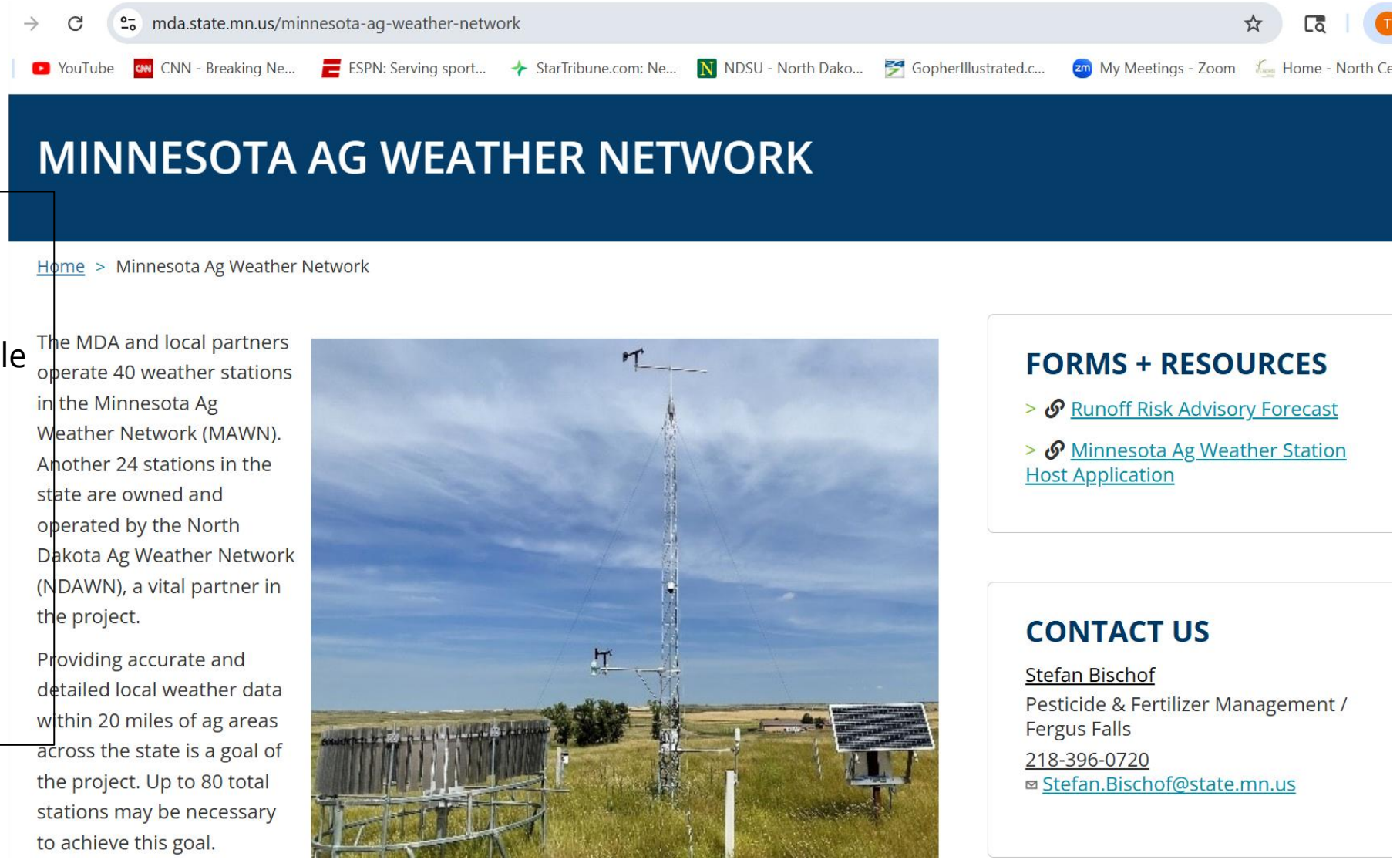


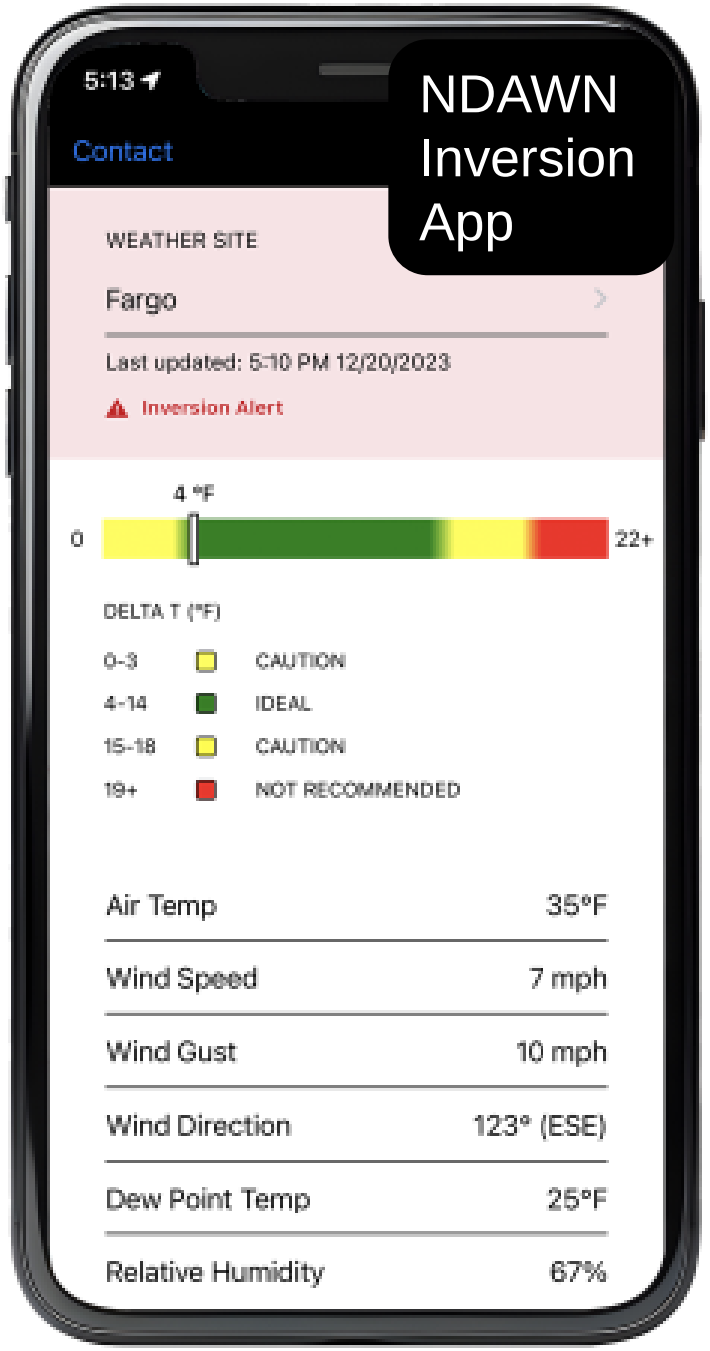
NDAWN Station Locations (2026–01–02)



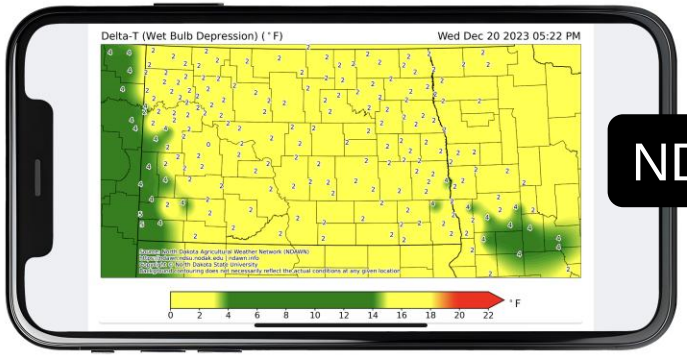
NDAWN in Minnesota is called MAWN, Minnesota Ag Weather Network

- MAWN is similar to ND
- Minnesota station data is available at: ndawn.ndsu.nodak.edu
- In MN, 64 stations operated by MAWN AND NDAWN
- MAWN has the same algorithms and download capability





The warmer and sunnier the better (65F+), but watch Delta T.



NDSU | EXTENSION ND Delta T Home Next 6 Days Past 7 Days Archive About

ATTENTION. The 2025 growing season has concluded and daily updates of this site have been disabled. This is a static website view as of October 31, 2025.

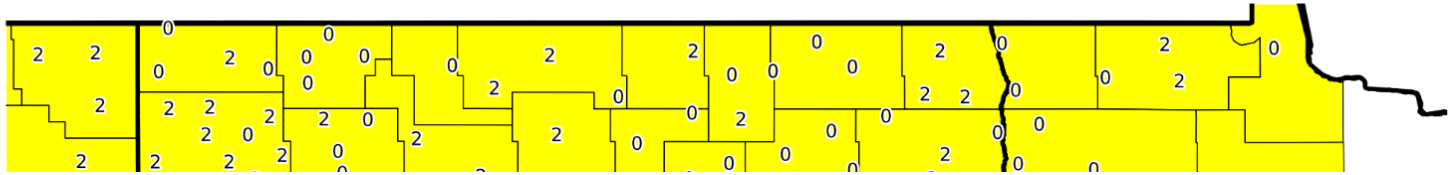
Managed by Rob Proulx, NDSU Extension Technology Specialist

Check the NDAWN Inversion App

Delta T is just one weather variable to consider before spraying. Check the NDAWN Inversion app for the latest temperature, wind conditions, Delta T, and inversion alert for your location.

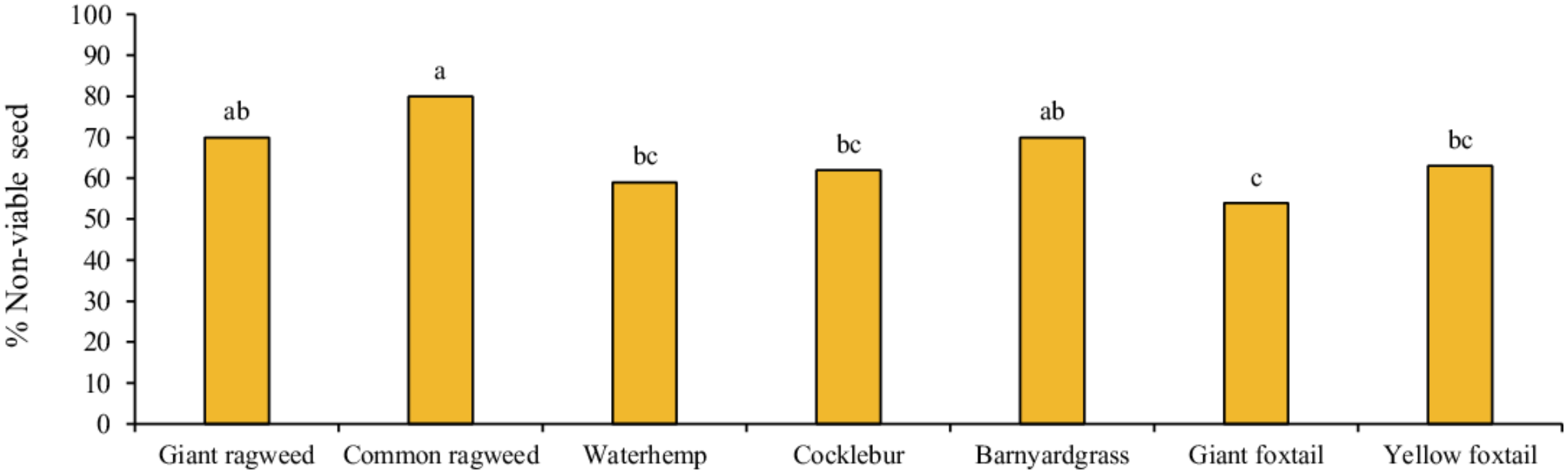
Current Conditions

Delta-T (Wet Bulb Depression) (°F) Jan 27 2026 12:01 AM



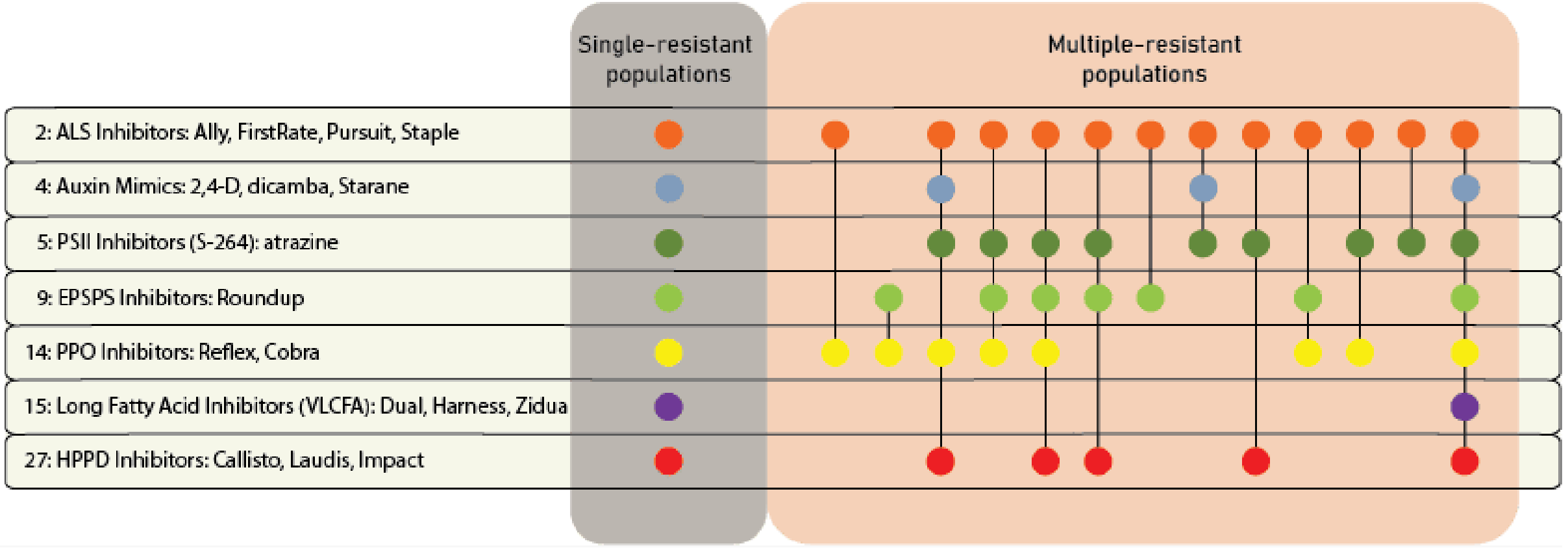
Scratch pad new in 2025

Electrocution reduces the number of viable seed that are returned to the soil seedbank



Schreier et al. 2022
Univ. of Missouri

Herbicide resistance in waterhemp…will it ever end?



Chloroacetamides in 2024
Group 15

Dimethenamid

- Outlook, BASF

Acetochlor (encapsulated)

- Warrant, Bayer CropScience
- Enversa, Corteva agriscience
- Arrest CS, Sharda USA LLC

***S*-metolachlor**

- Dual Magnum, Syngenta Crop Protection, LLC
- EverpreX, Corteva agriscience
- Medal, Syngenta Crop Protection, LLC
- Brawl, TENKOZ, Inc.
- Moccasin, UPL NA Inc.
- Charger Basic, WinField United

Waterhemp response to soil-residual herbicides in Illinois (Hausman et al. 2013)

Active Ingredient	Brand	Rate	Control 60 DAT	Density 60 DAT
		pt/a	%	(plants /unit area
Acetochlor	Harness	1.7	82 ab	49 defg
Acetochlor	Harness	3.4	88 a	4 g
S-Metolachlor	Dual Magnum	1.6	7 d	215 abc
Untreated Control			-	363 a

[a]Means with the same letter are not significantly different at the 0.05 level

The next series of slides curiosity of Dr. Aaron Hager, Univ of Illinois

Dose response curves from the greenhouse

- Different rates across a spectrum, low to high
- Determine rate to reduce 50% of the plant biomass
- Calculate a ratio; resistant to susceptible
- Compare across chloroacetamide products

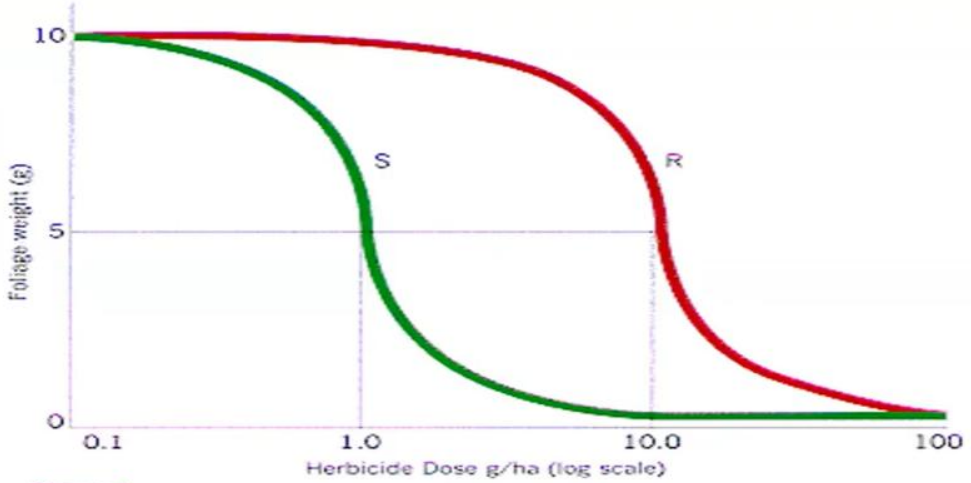


Figure 1.
Dose response curves for a Susceptible (S) and a Resistant (R) population

ED_{50} (susceptible) = 1.0 ED_{50} (resistant) = 10.0

$$\text{Resistance Index} = \frac{ED_{50}\ (\text{resistant})}{ED_{50}\ (\text{susceptible})} = \frac{10}{1} = 10$$

Resistance ratios for two Illinois waterhemp populations resistant to Group 15 herbicides. LD_{50} values represent the rates required to reduce waterhemp emergence/survival by 50 percent.

Herbicide	Resistant populations (CHR-M6 and MCR-NH40)	Sensitive populations (ACR and WUS)	R/S ratio
	……..LD_{50} (g ai ha^{-1})……..		
S-metolachlor	1808–3360	53–101	18–64
dimethenamid	729–1463	26–35	21–56
pyroxasulfone	65–153	9–10	7–17
acetochlor	178–226	13–40	5–18

Results 21 DAT: Dual II Magnum

CHR-M6

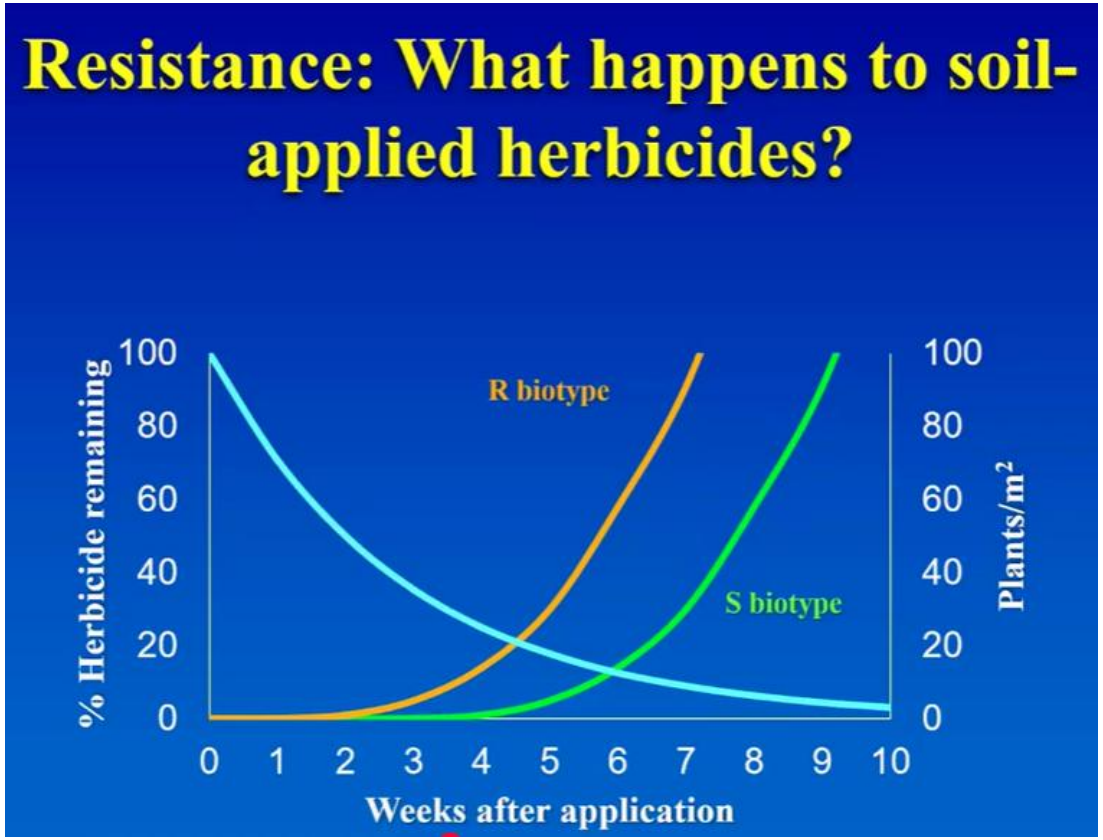
MCR-NH40

WUS

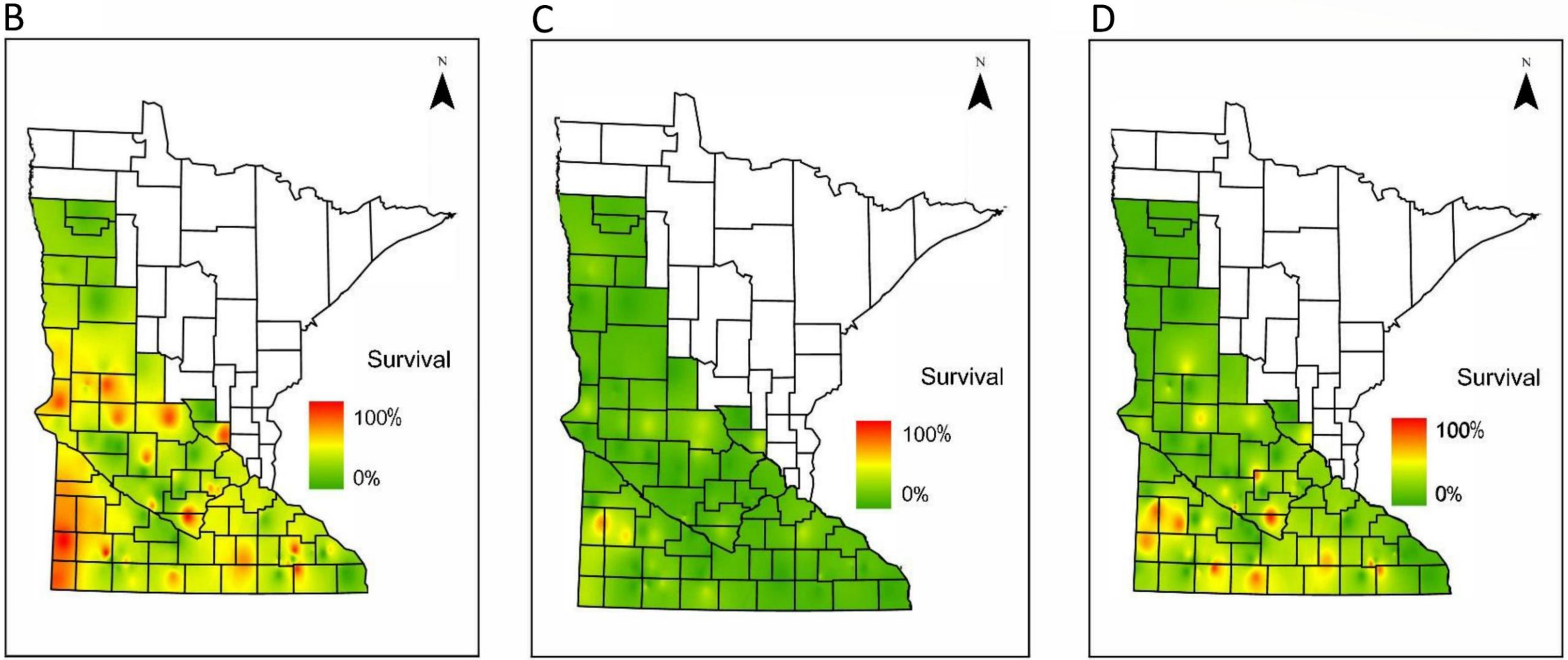
ACR

Resistance implications

- Resistance to foliar herbicides is black and white
  - Rate
  - Size
  - Optimize application conditions
- More difficult with soil applied products
  - Length of residual control is less with resistant populations
  - Soil applied herbicides are dependent on environmental conditions
- Herbicide dissipates over time



Distribution of herbicide resistant populations: SOA 5 (B), SOA 4 (C), SOA 14 (D), Singh et al., 2024



How does resistant mapping impact waterhemp control at SMBSC?

- Scout your fields. Be on the look-out for ‘observations’ that don’t make sense
- Take advantage of genetic testing opportunities for seed from escape plants
- Tank-mixes of effective herbicides; use effective herbicides in the crop sequence
- Compliment mechanical and cultural control strategies with your used of herbicides

Thank you for your continued support

Tom Peters

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