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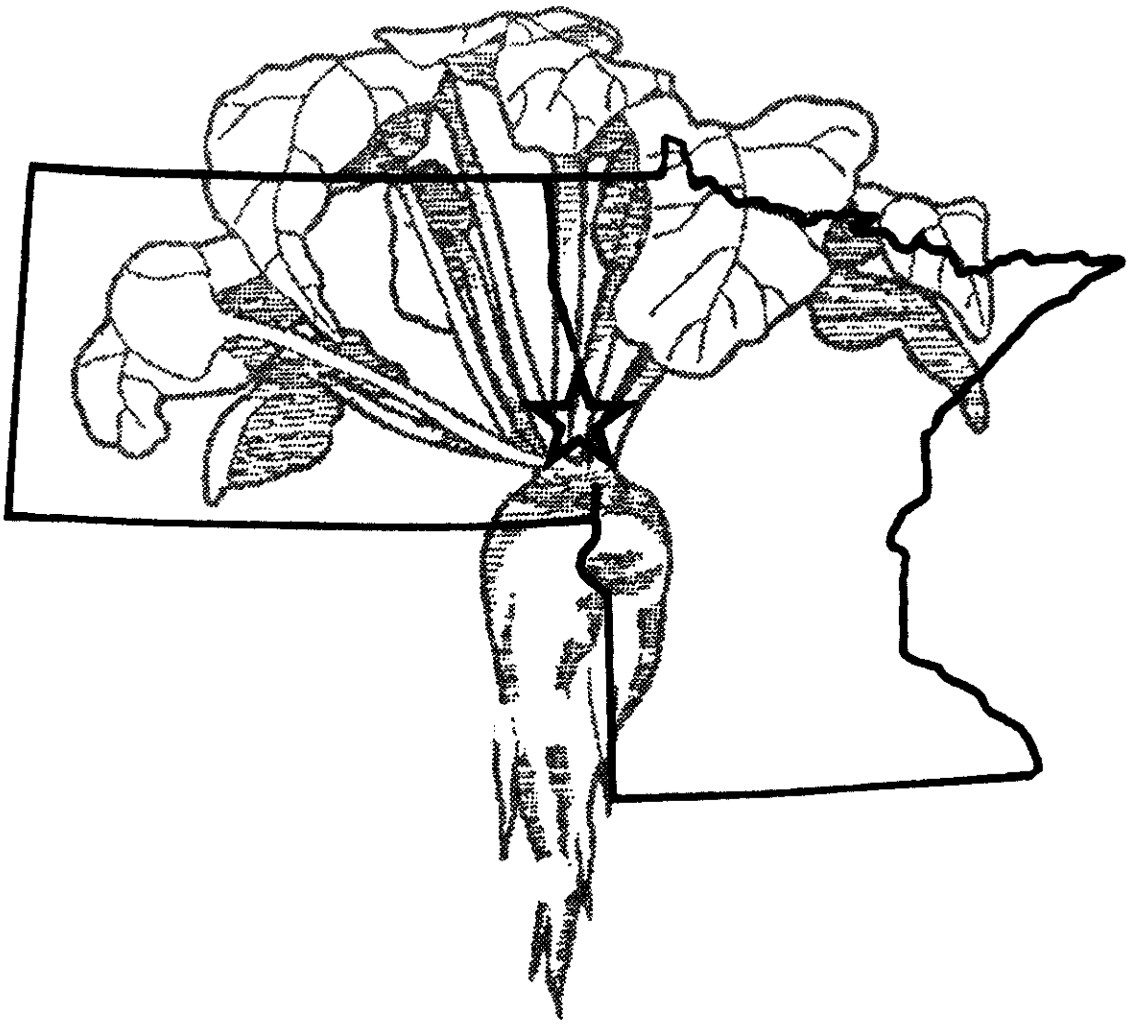

2024
Sugarbeet Research and Extension Reports

A portion of the contents of this booklet report on one year of work. Since results may vary from year to year, conclusions drawn from one year of work may not hold true in another year. The contents of this booklet are not for publication or reprint without permission of the individual author

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CONTENTS

WEED CONTROL

SUGARBEET PHYSIOLOGY STORAGE

ENTOMOLOGY

SOIL MANAGEMENT PRACTICES

SUGARBEET VARIETY TRIALS

WEED CONTROL

TURNING POINT SURVEY OF WEED CONTROL AND PRODUCTION PRACTICES IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2024

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The annual weed control and production practices live polling questionnaire was conducted using Turning Point Technology at the 2025 winter Sugarbeet Grower Seminars. Responses are based on production practices from the 2024 growing season. The survey focuses on responses from growers in attendance at the Fargo, Grafton, Grand Forks, Wahpeton, ND, and Willmar, MN, grower seminars. Respondents from seminars indicated the county in which the majority of their sugarbeet were produced (Tables 1,2,3,4,5). Survey results represent approximately 199,179 acres reported by 233 respondents (Table 6) compared with 210,364 acres represented in the 2024 survey. The average sugarbeet acreage per respondent was calculated from Table 6 at 855 acres, which was the same as in 2024. Before the 2025 Sugarbeet Grower Seminars, respondent age had yet to be evaluated, moreover, it may be useful to monitor the average age of producers over time. The Millennial Generation (1981-2000) represented 43% of respondents surveyed and Generation X (1965-1980) represented 36% (data not shown). Fifteen percent of the growers surveyed were from the Boomer Generation (1946-1964) while 3% represented the Traditionalist Generation (1922-1945) and 4% represented Generation Z (2001-2020).

Survey participants were asked a series of questions regarding their production practices used in sugarbeet in 2024. Growers were asked about their tillage practices for sugarbeet in 2024 (Table 7). Ninety-six percent of all respondents indicated conventional tillage as their primary with 3% practicing strip tillage and 1% using no tillage.

Across locations, 52% of respondents indicated wheat was the crop preceding sugarbeet (Table 8), 34% indicated corn (field or sweet), 5% indicated soybean and 2% indicated dry bean. Preceding crop varied by location with 100% of Fargo and Grand Forks growers indicating wheat preceded sugarbeet and 72% of Willmar growers indicated corn as their preceding crop. Seventy-one percent of growers who participated in the winter meetings used a nurse or cover crop in the 2024 growing season (Table 9) which was 4% less compared with the previous survey in 2024. Cover crop species varied widely by location with spring barley being used by 40% and 39% of growers at the Grand Forks and Wahpeton meeting, respectively, and oat being used by 40% of growers at the Willmar meeting.

Fifty-two percent of survey respondents indicated weeds as their most serious production problem in sugarbeet, for the fourth year in a row (Table 10) in the 2024 growing season, as compared with 54% of survey participants in the 2023 growing season. In the 2024 growing season, Cercospora leaf spot (CLS) was the most serious problem overall for 16% of respondents. Emergence and stand was named as the most serious overall by 10% of respondents across locations; however, emergence was the most serious problem for 20% of growers in Grand Forks.

Waterhemp was named as the most serious weed problem in sugarbeet for the fifth year in a row by 78% of respondents in the 2025 survey (Table 11) as compared with 76% in the 2024 survey and 73% in the 2023 survey. Twelve percent of respondents indicated kochia, 5% said common ragweed, and 2% of respondents indicated common lambsquarters was their most serious weed problem in the 2024 growing season. The increased presence of glyphosate-resistant waterhemp and kochia, along with a wet and cool growing environment from May to June in 2024 prolonged the emergence of both waterhemp and kochia, which are likely the reasons for these weeds being named as the worst weeds.

Troublesome weeds varied by location with 98%, 79%, and 67% of Willmar, Wahpeton, and Grand Forks respondents, respectively, indicating waterhemp as their most problematic weed. Waterhemp replaces kochia as the worst weed for respondents of the Grafton meeting (Drayton Factory District) with 51% of responses in the 2025 survey. Thirty-seven percent of Grafton growers reported kochia as the most serious weed problem, which was 21% less than in the 2024 survey. The recent registration and accepted use of kochia control herbicide, phenmedipham (Spin-Aid), and widely available tallow amine adjuvant for improving glyphosate-resistant kochia control has likely created a shift in weed control problems for Grafton growers who have historically reported kochia as their most serious weed problem in sugarbeet. Further, Extension has taken a very proactive stance with kochia, starting with burndown before sugarbeet emergence and use of ethofumesate preplant or preemergence in fields where kochia is problematic.

Preplant incorporated (PPI) or preemergence (PRE) herbicides were applied by 89% of survey respondents in the 2025 survey (Table 12) as compared with 82% in the 2024 survey. We have observed greater implementation of soil residual herbicides in the northern production area as compared with previous years. Sixty-nine percent of Grafton survey participants applied a PPI or PRE herbicide in the 2025 survey as compared with 40% in the 2024 survey. Conversely, 98% of Wahpeton survey participants applied a PPI or PRE herbicide in sugarbeet in the 2024 growing season, similar to 99% in the 2023 growing season. Once again, a likely reason for this variation is the more common presence of glyphosate-resistant waterhemp in the southern sugarbeet growing areas of the Red River Valley which continues to move north with each growing season, and increasing presence of glyphosate-resistant kochia in the northern sugarbeet growing areas, reflected in sugarbeet growers' weed control practices with the increased use of ethofumesate in Grafton (Table 12). The most commonly used soil-applied herbicide was ethofumesate with 35% of all responses (Table 12). The second most commonly used soil-applied herbicide was either Dual Magnum (using 24c local needs label) alone or a combination of Dual Magnum plus ethofumesate at 25% and 27%, respectively, across locations.

In 2022 and 2023 growing seasons, growers' in the Red River Valley experienced delayed planting dates and minimal precipitation proceeding sugarbeet planting. This influenced growers' to "opt in" to mechanical incorporation of ethofumesate rather than depend on timely rainfall for incorporating ethofumesate PRE. We surveyed the growers on incorporation method of ethofumesate applied PPI or PRE in the 2024 growing season. Of the growers who applied ethofumesate across locations, 37% elected to apply as a PRE, while 36% elected to apply PPI and 27% elected to not apply ethofumesate PRE (Table 13). Thirteen percent of growers used a field cultivator for ethofumesate PRE and 7% reported using a multi-weeder for ethofumesate incorporation.

Sixty-seven percent of growers' indicated excellent to good weed control from soil-applied herbicide, regardless of herbicide used and method of activation (calculated from Table 14).

The application of soil-residual herbicides applied 'lay-by' to the 2024 sugarbeet crop was reported by 96% of respondents (Table 15). *S*-metolachlor and Outlook were the most commonly applied lay-by herbicides with 44% and 39%, respectively, of responses. The majority of growers responding at the Willmar meeting indicated using Outlook (69% of responses), while *S*-metolachlor was more commonly applied by growers of the Fargo (78% of responses), Grafton (65% of responses) and Grand Forks (77% of responses) meetings.

Lay-by applications are postemergence (POST) to sugarbeet and PRE to small seeded broadleaf weeds and occur from cotyledon to 6- or 8-leaf sugarbeet. Soil residual chloroacetamide herbicides [site of action (SOA) 15] are the primary method for controlling amaranthus species in sugarbeet. Despite responsible weed management in sugarbeet, waterhemp escapes still occur. Sugarbeet are rescued from waterhemp escapes using inter-row cultivation, contact herbicide Ultra Blazer [active ingredient acifluorfen (SOA 14)], hand-weeding, electric weeder, or left in the field. Forty-four percent of respondents, across locations, indicated hand-weeding as their rescue treatment for waterhemp escapes (Table 16). Seventeen and 15% of Willmar growers reported inter-row cultivation and electric weeding as their second and third most frequent rescue treatments. In contrast, thirty-eight percent of Wahpeton growers left waterhemp escapes in the field and have a greater reliance (19% of respondents) on Ultra Blazer for waterhemp escapes than 10% of growers in Fargo and Grand Forks.

Growers were asked about other weed control methods (rescue) later in sugarbeet development. Sixty-six percent of growers utilized hand-weeding on the 2024 sugarbeet crop (Table 17). Thirty-seven percent of respondents stated less than ten percent of their acres were hand-weeded, 13% was 10-50 percent hand-weeded, and 9% had 100 or more acres hand-weeded during the 2024 season.

Thirty-five percent of participants reported row-crop cultivation (Table 18). However, most respondents (16%) indicated less than ten percent of their acres were cultivated. Conversely, 4% reported row-crop cultivation on 100% of their acres.

It is important for us to promote the maintenance and stewardship of our weed control tools in sugarbeet. We surveyed sugarbeet growers on their best management practices to protect the viability of current sugarbeet pesticides. Twenty-four percent of respondents utilize rotating herbicides by planting a diverse crop rotation (Table 19). Growers also protect herbicides by applying herbicide-mixtures with multiple modes of action (20%) so as not to select for resistant weed biotypes and by layering soil residual herbicide (19%) so that weed seed is not able to emerge and establish itself against the few registered POST sugarbeet herbicide options. Full herbicide rates (17%) and integrated weed management (18%) remain equally important to responsibly manage resistant weed biotypes.

Table 1. 2025 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2024.

County	Number of Responses	Percent of Responses
Becker	1	4
Cass	8	29
Clay	10	36
Norman[1]	5	18
Traill	4	14
Total	28	100

[1]Includes Mahnomen County

Table 2. 2025 Grafton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2024.

County	Number of Responses	Percent of Responses
Cavalier	1	3
Kittson	6	16
Marshall	6	16
Pembina	9	24
Walsh	16	42
Total	38	100

Table 3. 2025 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2024.

County	Number of Responses	Percent of Responses
Grand Forks	10	23
Marshall	2	5
Polk	17	40
Traill	4	9
Walsh	4	9
Other	6	14
Total	43	100

Table 4. 2025 Wahpeton Grower Seminar - Number of survey respondents by county growing sugarbeet in 2024.

County	Number of Responses	Percent of Responses
Cass	2	4
Clay	3	6
Grant	10	21
Richland	8	17
Roberts	1	2
Traverse	2	4
Wilkin	22	46
Total	48	100

Table 5. 2025 Willmar Grower Seminar - Number of survey respondents by county growing sugarbeet in 2024.

County	Number of Responses	Percent of Responses
Chippewa	33	38
Kandiyohi	8	9
Redwood	3	4
Renville	26	29
Stevens	3	4
Swift	7	8
Yellow Medicine	1	1
Other	6	7
Total	87	100

Table 6. Total sugarbeet acreage operated by respondents in 2024.

		Acres of sugarbeet									
Location	Responses	<99	100-199	200-299	300-399	400-599	600-799	800-999	1000-1499	1500-1999	2000+
		-------------------------------------% of responses----------------------------									
Fargo	25	4	0	4	24	20	16	4	16	4	8
Grafton	36	14	8	8	0	17	19	8	8	6	11
Grand Forks	40	8	8	5	2	18	18	10	12	12	8
Wahpeton	45	2	7	16	4	31	11	13	9	7	0
Willmar	87	6	8	13	7	20	16	3	15	9	3
Total	233	7	6	9	7	21	16	8	12	8	6

Table 7. Tillage system used in sugarbeet in 2024.

Location	Responses	Conventional Tillage	Strip Tillage	No Tillage
		--------------------% of responses-----------------		
Fargo	27	100	0	0
Grafton	38	97	3	0
Grand Forks	45	96	2	2
Wahpeton	48	98	2	0
Willmar	88	94	5	1
Total	246	96	3	1

Table 8. Crop grown in 2023 that preceded sugarbeet in 2024.

		Previous Crop					
Location	Responses	Sweet Corn	Field Corn	Dry Bean	Peas	Soybean	Wheat
		-------------------------------% of responses---------------------------------------					
Fargo	22	0	0	0	0	0	100
Grafton	35	0	0	11	0	0	89
Grand Forks	40	0	0	0	0	0	100
Wahpeton	46	0	30	0	0	13	57
Willmar	87	20	72	0	0	6	1
Total	230	7	34	2	0	5	52

Table 9. Nurse or cover crop used in sugarbeet in 2024.

Location	Responses	Spring Barley	Spring Oat	Winter Rye	Spring Wheat	Winter Wheat	Other[1]	None
		---------------------------------% of responses------------------------------------						
Fargo	27	41	0	4	11	7	0	37
Grafton	36	28	2	3	22	3	3	39
Grand Forks	42	40	0	12	19	2	2	23
Wahpeton	46	39	0	13	24	0	2	22
Willmar	87	1	40	1	23	3	3	28
Total	238	24	15	6	21	3	2	29

[1]Includes Mustard and 'Other'.

Table 10. Most serious production challenge in 2024.

Location	Responses	Aph[2]	CLS[1]	Emerg[3]	Herbicide injury	Rhizoct[4]	Weeds	Root maggot
		-----------------------------------% of responses---						
Fargo	29	3	21	14	3	10	48	0
Grafton	44	2	16	5	2	12	59	5
Grand Forks	44	0	9	20	5	7	59	0
Wahpeton	65	2	17	11	5	24	40	2
Willmar	88	1	17	7	6	13	56	1
Total	270	1	16	10	4	14	52	1

[1]Cercospora Leaf Spot
[2]Aphanomyces
[3]Emergence/Stand
[4]Includes all root diseases.

Table 11. Most serious weed problem in sugarbeet in 2024.

Location	Responses	grasses	colq[1]	cora	kochia	gira	rrpw	RR Canola	wahe	other
		-----------------------------------% of responses--								
Fargo	25	0	0	24	8	8	0	0	60	0
Grafton	35	3	0	3	37	3	0	3	51	0
Grand Forks	46	0	2	11	20	0	0	0	67	0
Wahpeton	47	0	4	2	13	0	2	0	79	0
Willmar	88	0	1	0	0	0	0	1	98	0
Total	241	0	2	5	12	1	0	1	78	0

[1]colq=common lambsquarters, cora=common ragweed, gira=giant ragweed, rrpw=redroot pigweed, wahe=waterhemp.

Table 12. Preplant incorporated or preemergence herbicides used in sugarbeet in 2024.

		PPI or PRE Herbicides Applied					
Location	Responses	*S*-metolachlor	ethofumesate	Ro-Neet SB	*S*-metolachor +ethofumesate	Other	None
		--------------------------------------% of responses----------------------------------					
Fargo	30	23	40	0	30	0	7
Grafton	32	53	6	3	6	0	31
Grand Forks	56	34	29	2	11	2	23
Wahpeton	54	20	30	0	48	0	2
Willmar	104	15	48	0	31	1	5
Total	276	25	35	1	27	1	11

Table 13. Activation method of ethofumesate applied preplant incorporated in 2024.

Location	Responses	Field Cultivator	Multi-weeder	Harrow-packer	Vertical Tillage	Other	Etho PRE	Did not apply etho
		--------------------------------% of responses--------------------------------------						
Fargo	24	0	13	4	13	0	63	8
Grafton	30	13	20	7	0	0	3	57
Grand Forks	47	4	11	6	4	11	19	45
Wahpeton	49	10	4	4	4	16	37	24
Willmar	88	24	1	0	2	10	50	15
Total	238	13	7	3	4	9	37	27

Table 14. Satisfaction in weed control from preplant incorporated and preemergence herbicides in 2024.

		PPI or PRE Weed Control Satisfaction					
Location	Responses	Excellent	Good	Fair	Poor	Unsure	None Used
		------------------------------% of responses-------------------------					
Fargo	25	24	68	8	0	0	0
Grafton	34	21	24	15	6	3	32
Grand Forks	47	19	57	6	0	2	15
Wahpeton	49	29	53	16	2	0	0
Willmar	88	9	48	33	7	0	3
Total	243	18	49	19	4	1	9

Table 15. Soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2024.

		Lay-by Herbicides Applied			
Location	Responses	*S*-metolachlor	Outlook	Warrant	None
		------------------------% of responses---------------------------------------			
Fargo	27	78	7	11	4
Grafton	34	65	12	6	18
Grand Forks	48	77	10	2	10
Wahpeton	53	64	32	4	0
Willmar	114	6	69	25	0
Total	276	44	39	13	4

Table 16. Rescue treatments used for escaped waterhemp in sugarbeet in 2024.[3]

Location	Responses	IRC[1]	Ultra Blazer	Hand labor	Electric weeder	Left[2]	No escapes
		------------------------------------% of responses---------------------------------					
Fargo	29	10	10	45	14	7	14
Grafton	34	3	3	62	0	6	26
Grand Forks	51	8	10	47	2	14	20
Wahpeton	47	9	19	19	0	38	15
Willmar	122	17	5	48	15	16	0
Total	283	12	8	44	8	17	11

[1]Inter-row cultivation
[2]Waterhemp escape left in field
[3] Methods used following failure of glyphosate applied POST.

Table 17. Percent of sugarbeet acres hand-weeded in 2024.

Location	Responses	% Acres Hand-Weeded				
		0	< 10	10-50	51-100	>100
		------------------------------------% of responses------------------------------				
Fargo	26	31	42	19	8	0
Grafton	36	25	58	3	3	11
Grand Forks	45	33	56	9	2	0
Wahpeton	48	60	35	2	0	2
Willmar	89	26	18	22	13	18
Total	244	34	37	13	7	9

Table 18. Percent of sugarbeet acres row-crop cultivated in 2024.

Location	Responses	% Acres Row-Cultivated				
		0	< 10	10-50	51-100	>100
		-----------------------------------% of responses------------------------------				
Fargo	26	85	8	8	0	0
Grafton	33	76	15	9	0	0
Grand Forks	47	70	26	4	0	0
Wahpeton	48	75	17	4	0	4
Willmar	87	47	14	15	16	8
Total	241	65	16	9	6	4

Table 19. Best management practices used to protect the viability of current sugarbeet pesticides in 2024.

Location	Responses	Full Herbicide Rates	Tank Mixing	Herbicide Rotation across Crops	Herbicide Layering	Integrated Pest Management[1]	Other
		-------------------------------------% of responses-----------------------------------					
Fargo	45	4	22	38	24	11	0
Grafton	62	29	21	19	10	18	3
Grand Forks	79	20	30	22	8	16	4
Wahpeton	72	18	15	24	21	21	1
Willmar	160	15	16	23	27	19	1
Total	418	17	20	24	19	18	2

[1]Includes a combination of chemical, cultural, and mechanical practices, etc.

WATERHEMP CONTROL WITH ETHOFUMESATE BRANDS IN SUGARBEET

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Summary

1. Preemergence (PRE) waterhemp control from Maxtron 4SC, Ethotron, and Ethofumesate 4SC was the same as Nortron at Moorhead, MN. Waterhemp control was less with Ethofumesate 4SC at Renville, MN.
2. All ethofumesate brands evaluated were safe to sugarbeet.
3. We conclude ethofumesate across brands provide similar waterhemp control and sugarbeet safety.

Introduction

Ethofumesate is one of the most valuable and flexible herbicides for sugarbeet weed control in the Red River Valley. Ethofumesate provides control of small seeded broadleaves, including waterhemp, at PRE rates ranging from 4 to 7.5 pint per acre and contributes to a 'layered residual' program for sugarbeet weed control (Peters et al. 2022). Recently, Albaugh, LLC received approval for their ethofumesate product called Maxtron 4SC for use in sugarbeet. The approval of Maxtron 4SC provides five ethofumesate options on the market in sugarbeet. Additional options include Ethofumesate 4SC from Farm Business Network, Ethotron from UPL NA, Inc., Nortron from Bayer CropScience, and Nektron from Atticus, LLC.

Sugarbeet growers utilize a strategic criteria specific to their operational needs to select products. Some criteria examples include relationships with ag retailers, product formulation, and price per gallon. The objective of this experiment was to evaluate sugarbeet tolerance and waterhemp control with Maxtron 4SC compared with other ethofumesate products on the market to determine if brand should be a consideration in selection criterion.

Materials and Methods

Experiments were conducted on indigenous populations of waterhemp in fields near Moorhead and Renville, MN in 2024. The experimental area was prepared for planting by applying the appropriate fertilizer and conducting tillage across the experimental area at each location. Sugarbeet was planted on May 11 and May 14, 2024 at Moorhead and Renville, respectively. Sugarbeet was seeded in 22-inch rows at approximately 63,500 seeds per acre with 4.6 inch spacing between seeds.

Herbicide treatments were applied PRE and POST. All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002XR nozzles (TeeJet® Technologies, Glendale Heights, IL) pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length. The treatment list can be found in Table 1.

Table 1. Herbicide treatments and rates in trials at Renville and Moorhead, MN in 2024.

Herbicide Treatment	Rate (fl oz/A)[1]	Sugarbeet Stage (lvs)
Control - Weedy Check / RUPM3[2] / RUPM3	0 / 25/ 25	PRE / 2-4 / 6-8
Maxtron 4SC / RUPM3 / RUPM3	101.6 / 25/ 25	PRE / 2-4 / 6-8
Nortron SC / RUPM3 / RUPM3	96 / 25/ 25	PRE / 2-4 / 6-8
Ethotron / RUPM3 / RUPM3	96 / 25/ 25	PRE / 2-4 / 6-8
Ethofumesate 4SC / RUPM3 / RUPM3	96 / 25/ 25	PRE / 2-4 / 6-8

[1]Active ingredient applied was consistent across products. Maxtron has a different product formulation, resulting in an increased application rate.
[2]Roundup PowerMax3 plus ethofumesate applied with Destiny HC HSMOC at 1.5 pt/A plus Amsol Liquid AMS at 2.5% v/v.

The experimental area at Moorhead received tremendous rainfall. Accumulated rainfall was 1.9-inch, 4.7-inch, 5.4-inch and 7.2-inch at 7, 14, 21 and 28 days, respectively, after PRE application. Unfortunately, the site could not absorb the rainfall amount over such a short time period, resulting in standing water the week of May 19. The experimental area was broadcast sprayed with Gramoxone to kill emerged vegetation, including sugarbeet, that survived the excessive rainfall conditions and was replanted June 17.

Visible sugarbeet growth reduction injury was evaluated using a 0 to 100% scale (0 is no visible injury and 100 is complete loss of plant / stand) and visible waterhemp control using a 0 to 100% scale (0 is no injury and 100 is complete control). Visible sugarbeet growth reduction was collected approximately 7 and 14 days (+/- 3 days) after sugarbeet emergence and 7 and 14 days (+/- 3 days) after the early POST (EPOST) application. Visible waterhemp control from at planting and POST application was collected 7, 14, 28, 42, and 56 days (+/- 3 days) after sugarbeet emergence. Sugarbeet tolerance and waterhemp control are reported as days after planting (DAP). Experiment was a randomized complete block design and four replications. The experiment was analyzed using Agricultural Research Manager (ARM) Revision 2024.4.

Results

Waterhemp control was influenced by herbicide treatments (P < 0.10) at Renville and Moorhead (Table 2 Figure 1, Figure 2). At Renville, no growth reduction was observed in any of the ethofumesate treatments, 28 DAP. At Moorhead, PRE treatments were applied on May 14. However, evaluations were not collected until July 20; 33 days after sugarbeet replanting or 68 days after the PRE application. We observed similar waterhemp control from ethofumesate brands 68, 76, and 83 DAP at Moorhead. No growth reduction data were collected due to replanting.

Table 2. Waterhemp control and sugarbeet growth reduction in response to herbicide treatment at Renville and Moorhead, MN, 2024.[1]

Herbicide Treatments	Sugarbeet Injury	Waterhemp Control				
	Renv 28 DAP	Renv 28 DAP	Renv 57 DAP	Moor 68 DAP	Moor 76 DAP	Moor 83 DAP
	%	------------------------------%------------------------------				
RUPM3[2] / RUPM3	0	5 c	5 d	10 b	8 b	3 b
Maxtron 4SC / RUPM3 / RUPM3	0	90 a	70 b	74 a	74 a	63 a
Nortron SC / RUPM3 / RUPM3	0	94 a	85 a	75 a	65 a	60 a
Ethotron / RUPM3 / RUPM3	0	89 a	74 ab	76 a	65 a	59 a
Ethofumesate 4SC / RUPM3 / RUPM3	0	78 b	48 c	75 a	64 a	60a
P-value 0.10	-	0.0001	0.0001	0.0001	0.0001	0.0001

[1]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.
[2]Roundup PowerMax3 plus ethofumesate applied with Destiny HC HSMOC at 1.5 pt/A plus Amsol Liquid AMS at 2.5% v/v.

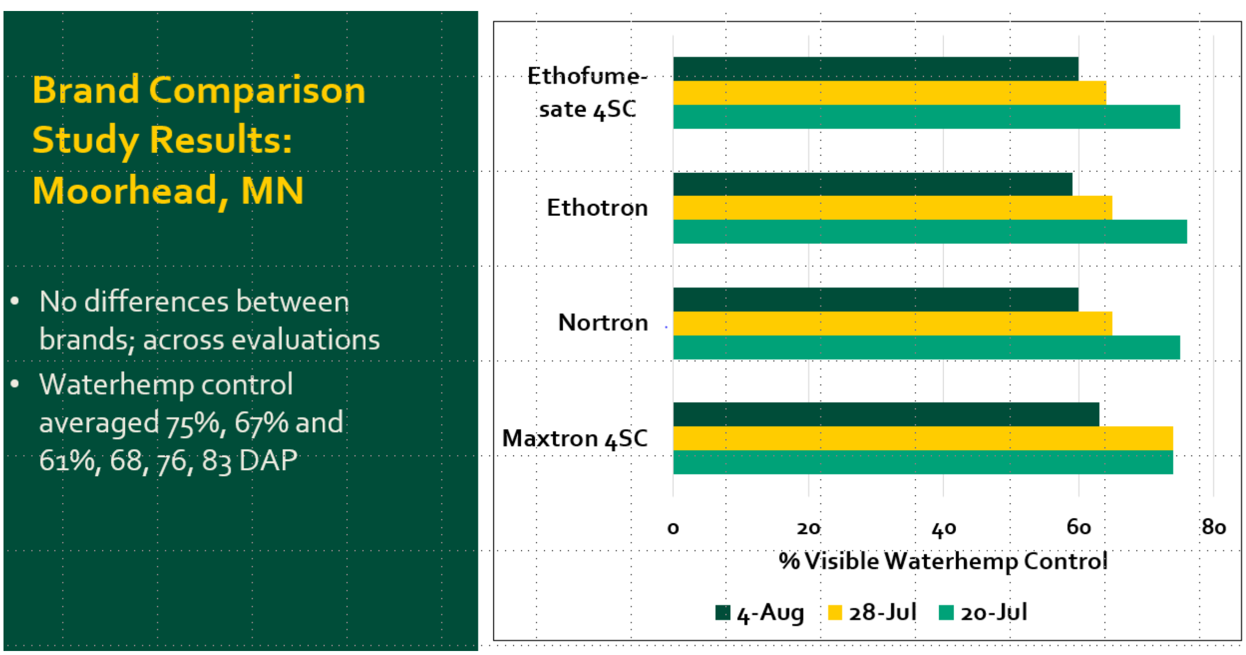

Figure 1. Waterhemp control from Ethofumesate 4SC, Ethotron, Nortron, and Maxtron on July 20, July 28, and August 4, or 68, 76, and 83 DAP, respectively, at Moorhead MN, 2024.

Ethofumesate 4SC provided less waterhemp control, 28 and 57 DAP, at Renville (Table 2, Figure 2). We attribute this difference to position affect in the field rather than herbicide treatment. The waterhemp infestation tended to be more severe in the southwest side of the experiment area, requiring increased product performance compared with other areas with lower weed populations. Our experiments are evaluated against a running control that borders each treatment. However, waterhemp ground cover may have caused bias that was reflected in the evaluations. Further, flooding from Beaver Creek compromised the Renville experiment, and adversely affected waterhemp control after 28 DAP by saturating the soil and potentially bringing in more weed seed to control.

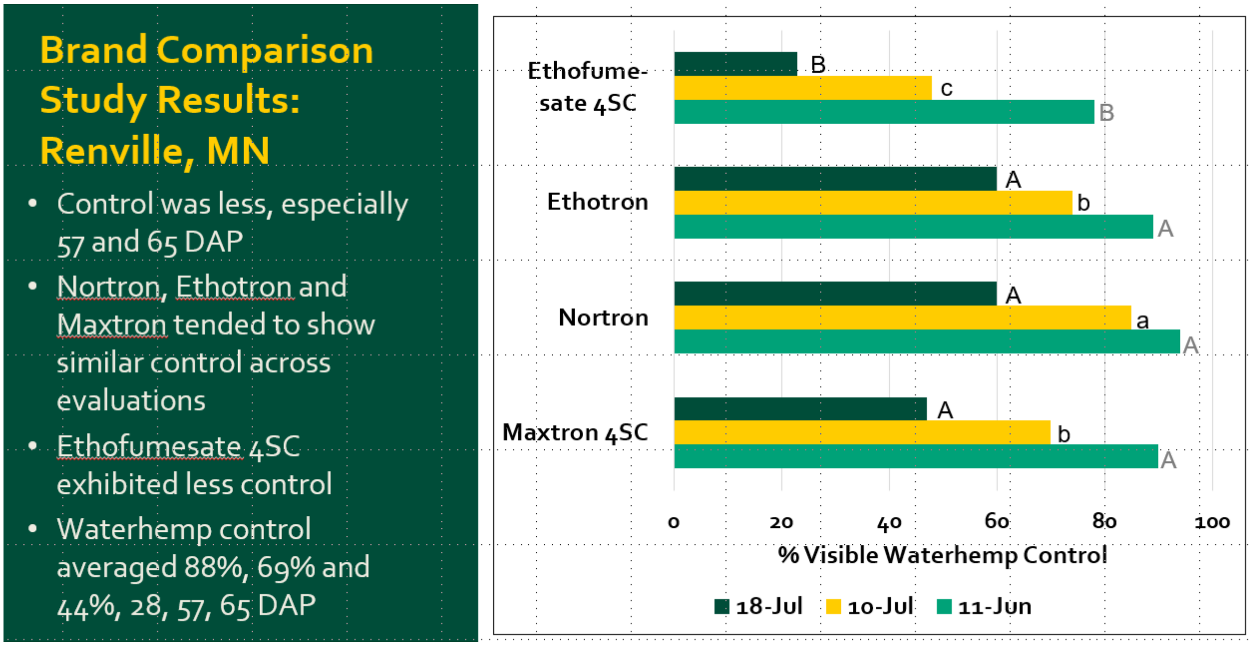

Figure 2. Waterhemp control from Ethofumesate 4SC, Ethotron, Nortron, and Maxtron on July 20, July 28 and August 4, or 68, 76, and 83 DAP, respectively, at Renville MN, 2024.

Ethofumesate has a relatively high soil adsorption coefficient (KOC) value compared with chloroacetamide herbicides to which sugarbeet growers are familiar. KOC is the ratio of herbicide bound to soil collides versus what is free in the water. The higher the KOC value, the greater the adsorption to soil colloids. Likewise, ethofumesate is relatively less water soluble compared with other sugarbeet soil residual herbicides. The combination of a high KOC value and low water solubility means rainfall is required to incorporate the ethofumesate products into the soil. While all ethofumesate brands used in this study were suspension concentrates (SC) types, variations in their specific formulations, such as particle size, stabilizers, or adjuvant systems, could influence their performance. Our field experiments received abundant rainfall in 2024, removing any potential separation from formulation and ease of incorporation into soil.

Conclusions

These experiments indicate that all ethofumesate brands available on the market provide similar waterhemp control. The sugarbeet grower will elect to purchase one brand over another based on his/her established criterion; however, waterhemp control or sugarbeet tolerance should not be a criterion for purchase decision.

References

Peters TP, Lystad AL, Mettler D (2022) Waterhemp control from soil residual preemergence and postemergence herbicides in 2022. Sugarbeet Res Ext Rep 53:12-17.

INTEGRATING RO-NEET AND EPTAM BACK INTO THE WATERHEMP CONTROL PROGRAM IN SUGARBEET

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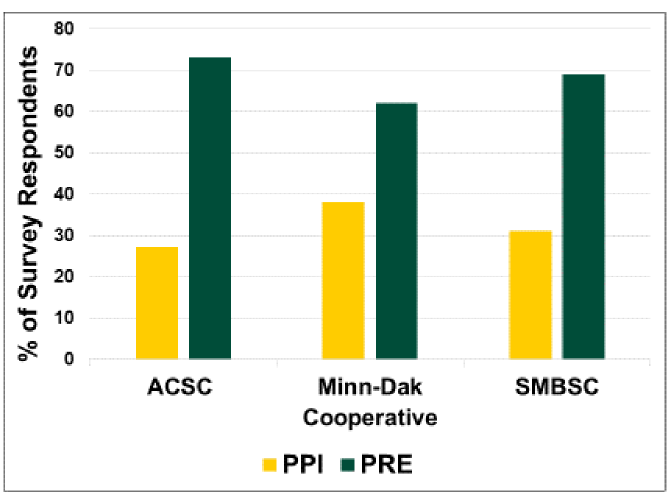
Summary

1. Ro-Neet plus Eptam and Eptam applied pre-plant incorporated (PPI) followed by ethofumesate applied preemergence (PRE) followed by Outlook and Warrant POST caused early season sugarbeet growth reduction, however, Ro-Neet plus Eptam and ethofumesate PRE following Eptam applied PPI followed by Outlook and Warrant POST did not reduce root yield or % sucrose.
2. Ro-Neet plus Eptam or Eptam integrated into the waterhemp control strategy that includes ethofumesate or *S*-metolachlor products, Outlook, and Warrant potentially may improve waterhemp control, especially in dry environments.

Introduction

Researchers and agriculturalists favor ethofumesate over Eptam (EPTC) and Ro-Neet (cycloate) for at planting waterhemp control since Eptam and Ro-Neet must be incorporated immediately and uniformly into the soil after application to prevent herbicide loss due to volatility and optimize weed control. Historically, sugarbeet growers have utilized multiple options to incorporate EPTC and/or cycloate into the soil. The first included two tillage operations, either with a disk or field cultivator. The first pass ran in one direction and the second pass in a different direction. Another option was a single pass with a roto-tiller. In both examples, this aggressive use of tillage prior to planting compromised the seedbed and reduced the uniformity of sugarbeet stand establishment. Aggressive tillage to incorporate herbicides can also break soils into fine particles which are susceptible to movement and loss from wind and water erosion.

Ethofumesate preemergence (PRE) provides acceptable weed control when applied at ‘full’ rates or when mixed with *S*-metolachlor followed by split layby applications of chloroacetamide herbicides. However, waterhemp control from ethofumesate is dependent on rainfall after application for incorporation into the soil. Erratic rainfall patterns have compelled some growers to shallow incorporate ethofumesate before planting. Survey of production practices at the 2024 Willmar Growers’ Seminar indicated approximately 30% of ethofumesate applied in 2023 was preplant incorporated (PPI) (Figure 1). Further, ethofumesate incorporated or ethofumesate applied at rates ranging from 3 to



- Incorporation strategies across location/COOP
- Early season kochia or waterhemp control is critical to season long control
- Aided by:
  - Timely incorporation into soil
  - Tillage or rainfall

[a]Turning Point survey at 2024 grower seminars; ACSC database

Figure 1. Ethofumesate incorporation technique across cooperatives in 2023 as determined by survey at the 2024 Growers seminars at Willmar, MN and Wahpeton, ND, 2024; ACSC grower production practices database.

7.5 pt/A adversely affected oat, barley, or wheat seeded as a nurse crop to protect sugarbeet from wind or blowing soil damage. The question is: if our production practices are once again requiring PPI techniques, are growers incorporating the best herbicide for waterhemp control?

Integrating Ro-Neet and Eptam into the current waterhemp control program might be an effective way to improve overall waterhemp control in sugarbeet. That is, Ro-Neet, Eptam, and/or ethofumesate at planting and chloroacetamide herbicides with Roundup PowerMax3 and ethofumesate early postemergence (EPOST) and postemergence (POST). The objective of these experiments was to evaluate waterhemp control and sugarbeet tolerance from Ro-Neet and Eptam integrated with the layby program.

Materials and Methods
Sugarbeet tolerance and waterhemp control experiments were conducted at multiple locations in 2024.

Sugarbeet Tolerance. Experiment was conducted at Crookston, Hendrum, and Murdock, MN and Prosper, ND in 2024. The experimental area was prepared for planting by applying the appropriate fertilizer and conducting tillage across the experimental area at each location. Herbicide treatments were applied PPI, PRE, and POST (Table 1). All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002XR nozzles (XR TeeJet® Flat Fan Spray Tips; TeeJet® Technologies, Glendale Heights, IL) pressurized with CO2 at 40 psi to the center four rows of six row plots 40 feet in length. Ro-Neet and Eptam were incorporated into the soil as soon as possible following application using a field cultivator operated parallel to sugarbeet rows and at a slight angle with a 2-inch preset (tillage equipment set 4-inch deep).

Table 1. Herbicide treatments, herbicide rate, and sugarbeet stage at application.

PPI/PRE Herbicide	POST Herbicide[a]	Rate (pt or fl oz/A)	Sugarbeet stage (lvs)
Ro-Neet + Eptam		2.67 + 1.14	PPI
Eptam / Nortron		1.14 / 4	PPI / PRE
	Outlook / Warrant	0.75 / 3	2 / 6
Ro-Neet + Eptam	Outlook / Warrant	2.67 + 1.14 / 0.75 / 3	PPI / 2 / 6
Eptam / Nortron	Outlook / Warrant	1.14 / 4 / 0.75 / 3	PPI / PRE / 2 / 6
	RUPM3 + etho / RUPM3 + etho	25 + 6 / 25 + 6	2 / 6

[a]Roundup PowerMax3 + ethofumesate applied at 25 + 6 fl oz/A with NIS and Amsol liquid AMS at 0.25% and 2.5% v/v.

Sugarbeet was planted on April 24, June 10, and May 10 at Crookston, Hendrum, and Murdock, MN, respectively, and May 29 at Prosper, ND. Sugarbeet was seeded in 22-inch rows at approximately 63,500 seeds per acre with 4.6 inch spacing between seeds.

Sugarbeet stand was collected by counting the number of sugarbeet in 10-ft row in rows 3 and 4 of the plot when sugarbeet were at the 2- to 4-lf stage. Visible sugarbeet necrosis, malformation, and growth reduction were evaluated as 'sugarbeet injury' approximately 7 and 14 days after treatment (DAT) using a 0 to 100% injury scale (0% denoting no sugarbeet injury and 100% denoting complete loss of sugarbeet stature). All evaluations were a visual estimate of injury in the four treated rows compared with the adjacent, two-row, untreated strip. At harvest, sugarbeet was defoliated, harvested mechanically from the center two rows of each plot, and weighed. A root sample (about 20 lbs) was collected from each plot and analyzed for sucrose content and sugar loss to molasses by American Crystal Sugar Company (East Grand Forks, MN) and the Quality Lab at Southern Minnesota Beet Sugar Cooperative (Renville, MN). Experiments were a randomized complete block design with six replications. Data were combined across Crookston and Murdock, MN and Prosper, ND experiments and compared with Hendrum, MN since the Hendum experiment was planted later than the other experiments. Data was analyzed using the GLIMMIX procedure in Statistical Analysis Software (SAS 9.4) (Cary, NC).

Waterhemp Control. Experiments were conducted at Blomkest and Moorhead, MN in 2024. The experimental area was prepared for planting by applying the appropriate fertilizer and conducting tillage across the experimental area at each location. Herbicide treatments were applied PPI, PRE, and POST (Table 2). All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002XR nozzles (XR TeeJet® Flat Fan Spray Tips; TeeJet® Technologies, Glendale Heights, IL) pressurized with CO2 at 40 psi to the center four rows of six row plots 40 feet in length. Ro-Neet and Eptam were incorporated into the soil as soon as possible following application using a field

Table 2. Herbicide treatments, herbicide rate, and sugarbeet stage at application.

Herbicide treatment[a]	Rate (pt or fl oz/A)	Sugarbeet stage (lvs)
Ro-Neet / RUPM3 + etho[b] / RUPM3 + etho	2.67 / 25 + 6 / 25 + 6	PPI/EPOST/POST
Eptam / RUPM3 + etho / RUPM3 + etho	1.14 / 25 + 6 / 25 + 6	PPI/EPOST/POST
Ro-Neet + Eptam / RUPM3 + etho / RUPM3 + etho	2.67 + 1.14 / 25 + 6 / 25 + 6	PPI/EPOST/POST
Ethofumesate / RUPM3 + etho / RUPM3 + etho	7.5 / 25 + 6 / 25 + 6	PRE/EPOST/POST
Etho + *S*-meto / Outlook + RUPM3 + etho[c] / Warrant + RUPM3 + etho	2.5 + 0.75 / 12 + 25 + 6 / 3 + 25 + 6	PRE/EPOST/ POST
Ro-Neet / ethofumesate / Outlook + RUPM3 + etho / Warrant + RUPM3 + etho	2.67 / 4 /12 + 25 + 6 / 3 + 25 + 6	PPI/PRE/EPOST/ POST
Eptam / ethofumesate / Outlook + RUPM3 + etho / Warrant + RUPM3 + etho	1.14 / 4 /12 + 25 + 6 / 3 + 25 + 6	PPI/PRE/EPOST/ POST
Ro-Neet + Eptam + / Outlook + RUPM3 + etho / Warrant + RUPM3 + etho	2.67 + 1.14 /12 + 25 + 6 / 3 + 25 + 6	PPI/EPOST/ POST

[a]RUPM3 = Roundup PowerMax3. S-meto = *S*-metolachlor.
[b]Roundup PowerMax3 + ethofumesate applied at 25 + 6 fl oz/A, respectively, mixed with high surfactant methylated oil concentrate (HSMOC) at 1.5 pt/A and Liquid AMS at 2.5 % v/v.
[c]Outlook + Roundup PowerMax3 + ethofumesate applied at 12 + 25 + 6 fl oz/A, respectively, mixed with high surfactant methylated oil concentrate (HSMOC) at 1.5 pt/A and Liquid AMS at 2.5 % v/v.

cultivator operated parallel to sugarbeet rows and at a slight angle with a 2-inch preset (tillage equipment set 4-inches deep). Sugarbeet was planted on May 11 and May 14 at Moorhead and Blomkest MN, respectively. Sugarbeet was seeded in 22-inch rows at approximately 63,500 seeds per acre with 4.6 inch spacing between seeds.

The experimental area at Moorhead received tremendous rainfall. Accumulated rainfall was 1.9-inches, 4.7-inches, 5.4-inches, and 7.2-inches at 7, 14, 21, and 28 days, respectively, after PRE applications. Unfortunately, the Moorhead site could not take this rainfall and standing water prevailed the week of May 19. The experimental area was broadcast sprayed with Gramoxone to kill emerged vegetation, including sugarbeet, that survived the excessive rainfall conditions and was replanted June 17.

Visible sugarbeet growth reduction injury was evaluated using a 0 to 100% scale (0 is no visible injury and 100 is complete loss of plant / stand). Visible waterhemp control was evaluated using a 0 to 100% scale (0 is no control and 100 is complete control). Visible sugarbeet growth reduction was collected approximately 7 and 14 days (+/- 3 days) after sugarbeet emergence and 7 and 14 days (+/- 3 days) after early EPOST application. Visible waterhemp control from at planting and POST applications were collected 7, 14, 28, 42, and 56 days (+/- 3 days) after sugarbeet emergence. Sugarbeet tolerance and waterhemp control are reported as days after planting (DAP). Experiment was a randomized complete block design and four replications. The experiments were analyzed individually using Agricultural Research Manager (ARM) Revision 2024.4.

Results

Sugarbeet Tolerance. At planting or POST herbicides did not affect early season or preharvest sugarbeet stands (Table 3); however, caused significant sugarbeet growth reduction (Table 4). Sugarbeet growth reduction injury was

Table 3. Sugarbeet stand in response to at planting and postemergence treatments, data averaged across four environments, 2024.

Herbicide treatment PPI/PRE	Herbicide treatment POST	Rate	Early Season Stand	Pre-Harvest Stand
		------pt or fl oz/A------	-----------100 ft row--------	
Ro-Neet + Eptam		2.67 + 1.14	225	228
Eptam / ethofumesate		1.14 / 4	215	232
	Outlook / Warrant	0.75 / 3	230	240
Ro-Neet + Eptam	Outlook / Warrant	2.67 + 1.14 / 0.75 / 3	210	230
Eptam / ethofumesate	Outlook / Warrant	1.14 / 4 / 0.75 / 3	220	227
	RUPM3 + etho / RUPM3 + etho	25 fl oz + 6 fl oz / 25 fl oz + 6 fl oz	230	232
P-value (0.05)			0.2521	0.4276

Table 4. Visible sugarbeet growth reduction in response to at planting and postemergence treatments, data averaged across four environments, 2024.[a]

Herbicide treatment PPI/PRE	Herbicide treatment POST	Rate	Days after Planting 40-45	47-51	60-63	75-89
		------pt or fl oz/A------	-------------------------%-------------------------			
Ro-Neet + Eptam		2.67 + 1.14	8 b	9 b	9 bc	5
Eptam / ethofumesate		1.14 / 4	10 b	9 b	6 c	7
	Outlook / Warrant	0.75 / 3	6 b	4 b	4 c	3
Ro-Neet + Eptam	Outlook / Warrant	2.67 + 1.14 / 0.75 / 3	20 a	18 a	4 c	8
Eptam / ethofumesate	Outlook / Warrant	1.14 / 4 / 0.75 / 3	21 a	18 a	15 a	7
	RUPM3 + etho / RUPM3 + etho	25 fl oz + 6 fl oz / 25 fl oz + 6 fl oz	8 b	5 c	5 c	4
P-value (0.05)			0.0013	0.0076	0.0010	0.1599

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.

greatest 40 to 45 DAP and decreased with subsequent evaluations. Ro-Neet mixed with Eptam or Eptam followed by ethofumesate at planting or Outlook followed by Warrant postemergence caused negligible injury across evaluations. However, Ro-Neet mixed with Eptam or Eptam followed by ethofumesate at planting followed by Outlook EPOST and Warrant POST injured sugarbeet at both 40-45 and 47-51 DAP. Injury from Eptam PPI and ethofumesate PRE followed by Outlook EPOST and Warrant POST was significant from other treatments up to 60-63 DAP evaluations. Sugarbeet canopy was uniform across treatments with no evidence of growth reduction injury 75-89 DAP. Two applications of Roundup PowerMax3 plus ethofumesate POST remains the industry standard for safety and caused less than 10% growth reduction injury across evaluations. There was no evidence of chlorosis, malformation, or greater susceptibility to Cercospora leaf spot from herbicide treatments.

Sugarbeet yield data from Crookston and Murduck, MN and Prosper, ND experiments were combined across environments (Table 5). Sugarbeet yield data from Hendrum, MN is presented separate from the combined analysis due to the differences in root yield weights, which is credited to late planting. We did not observe differences in root yield or % sucrose credited to herbicide treatment in either data set. We also observed similar root yield trends across treatments with both experiments.

Table 5. Root yield and % sucrose in response to herbicide treatment, averaged across Crookston, Prosper, and Murdock, and Hendrum, 2024.

			Crookston/Prosper/ Murdock		Hendrum	
Herbicide treatment PPI/PRE	Herbicide treatment POST	Rate	Root Yield	Sucrose	Root Yield	Sucrose
		------pt /A------	---TPA[a]---	---%---	---TPA---	---%---
Ro-Neet + Eptam		2.67 + 1.14	38.0	16.77	23.3	18.79
Eptam / etho		1.14 / 4	36.3	16.63	23.5	18.92
	Outlook / Warrant	0.75 / 3	36.7	16.82	24.5	18.52
Ro-Neet + Eptam	Outlook / Warrant	2.67 + 1.14 / 0.75 / 3	36.9	16.70	24.1	18.84
Eptam / etho	Outlook / Warrant	1.14 / 4 / 0.75 / 3	36.6	16.72	24.1	18.41
	RUPM3 + etho / RUPM3 + etho	25 fl oz + 6 fl oz / 25 fl oz + 6 fl oz	37.3	16.45	25.8	18.16
P-value (0.05)			0.4925	0.3141	0.2177	0.1715

[a]TPA=Tons per acre.

Root yield was greatest with two applications of Roundup PowerMax3 plus ethofumesate POST. We did not observe any differences from Ro-Neet plus Eptam or Eptam followed by ethofumesate at planting, Outlook EPOST followed by Warrant POST or Ro-Neet plus Eptam or Eptam followed by ethofumesate at planting followed by Outlook EPOST and Warrant POST. Interestingly, we observed slightly less sucrose from two applications of Roundup PowerMax3 POST as compared with treatments including PPI and POST soil residual herbicides.

Waterhemp Control. Data for each location were analyzed separately since standing water compromised the Moorhead experiment, forcing replant. We did not observe differences with treatment groupings at Moorhead. We attribute this to terminating the experiment with paraquat due to standing water and replanting in June. Paraquat application may have eliminated waterhemp germinating in treatments before excessive rainfall. This summary will focus on results from the Blomkest experiment.

Ethofumesate PRE followed by two applications of Roundup PowerMax3 plus ethofumesate POST provided greater than 95% control, 28 DAP, but control decreased as the number of days increased after application (Figure 1). These data indicate Ro-Neet plus Eptam followed by two applications of Roundup PowerMax3 plus ethofumesate POST might last longer than initially thought, although Ro-Neet and Eptam did not provide full season weed control. Further, the Ro-Neet plus Eptam treatment had the same rates as the treatments where Ro-Neet and Eptam were applied singly.

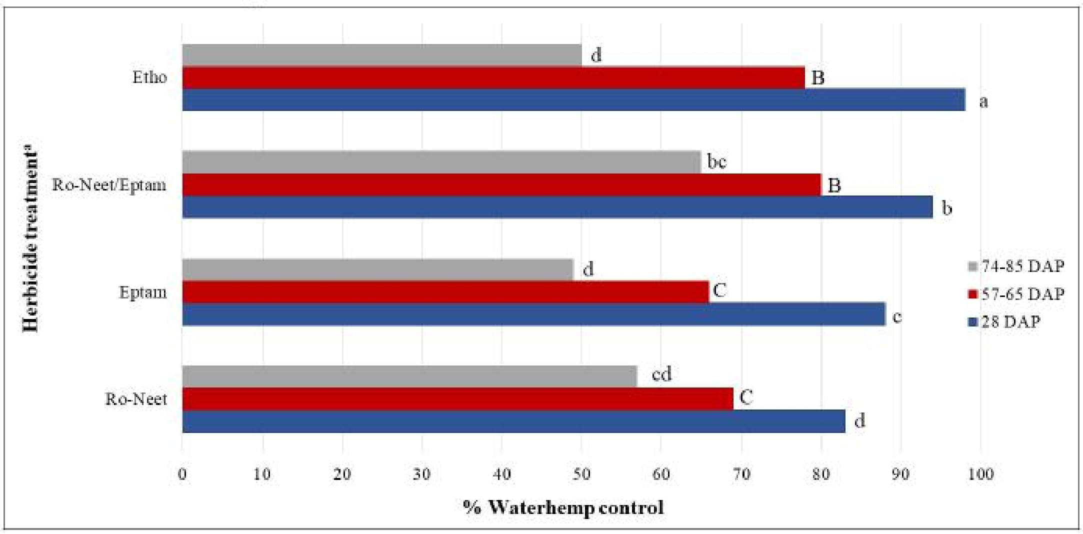


Figure 1. Waterhemp control from soil residual herbicides applied at planting, Blomkest MN, 2024. Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance. Each treatment includes two applications of Roundup PowerMax3 plus ethofumesate POST and HSMOC plus liquid AMS.

Soil residual treatments applied at planting were followed by Outlook mixed with Roundup PowerMax3 plus ethofumesate at the 2-lf sugarbeet stage and Warrant mixed with Roundup PowerMax3 plus ethofumesate at the 6-lf sugabeet stage (Figure 2). The current waterhemp control standard, ethofumesate plus Dual Magnum followed by Outlook mixed with Roundup PowerMax3 plus ethofumesate at the 2-lf sugabeet stage and Warrant mixed with Roundup PowerMax3 plus ethofumesate at the 6-lf sugabeet stage provided very good control in this experiment.

The experiment received timely and sufficient rainfall to incorporate the at planting and POST residual herbicide treatments into the soil (rainfall data not presented). We would likely see more of a benefit to Eptam, Ro-Neet or Eptam mixed with Ro-Neet in a season with less timely and less cumulative rainfall. This further emphasizes the challenge sugarbeet growers face. Ethofumesate alone or ethofumesate mixed with Dual Magnum provide good (80 to 90%) to excellent (90 to 99%) control when rainfall is timely and at an intensity to be incorporated into the soil. However, these same treatments may provide poor control (40 to 65%) or fair control (65 to 80%) when rainfall fails to occur or is less timely (Peters and Lystad 2024).

The chloroacetamide herbicides applied postemergence following Ro-Neet, Eptam or Ro-Neet plus Eptam provided good waterhemp control, suggesting these herbicides integrated into the weed management plan for waterhemp control have promise (Figure 2). Ideally, we would prefer to apply ethofumesate in mixtures with Ro-Neet or Eptam in this experiment; however, differences in incorporation requirements present a challenge. For example, Ro-Neet and Eptam should be incorporated to a depth of 2-inches (equipment set to a depth of 4-inches to incorporate them

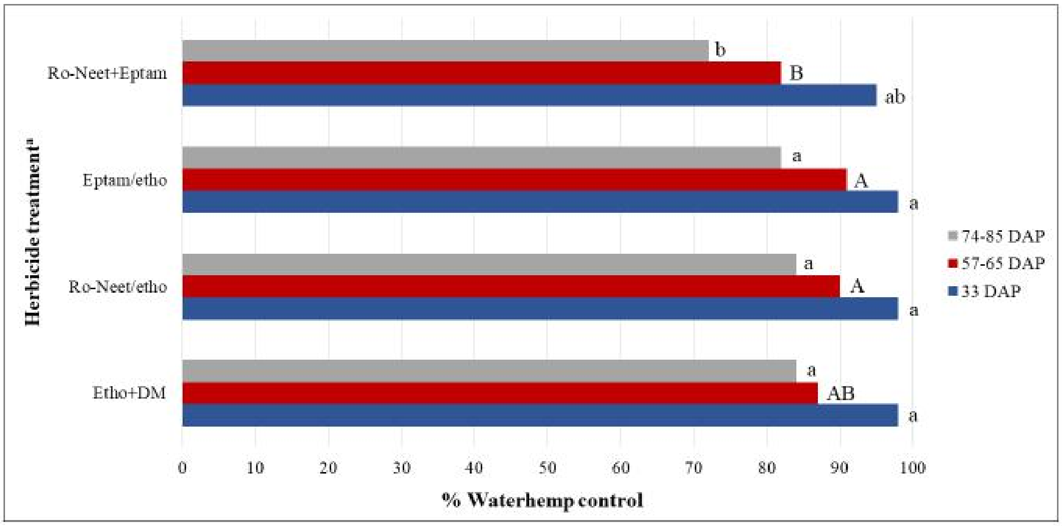


Figure 2. Waterhemp control from soil residual herbicides applied at planting, Blomkest MN, 2024. Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance. Treatment fb Outlook mixed with Roundup PowerMax3 plus ethofumesate and HSMOC plus liquid AMS at the 2-lf sugabeet stage and Warrant mixed with Roundup PowerMax3 plus ethofumesate and HSMOC plus liquid AMS at the 6-lf sugabeet stage.

and to reduce the likelihood of volatility loses); however, 2-inches is too deep to incorporate ethofumesate. Thus, ethofumesate was applied PRE, immediately following Ro-Neet or Eptam PPI application.

Conclusions

Ro-Neet, Eptam or Ro-Neet plus Eptam integrated into the weed management plan for waterhemp control has merit. However, we struggled to find a place for ethofumesate in this system since waterhemp control is most effective with ethofumesate when applied PRE or shallow incorporated. Ro-Neet and Eptam should be incorporated to a depth of 2-inches (equipment set to 4-inches) to eliminate volatility losses. Ro-Neet and Eptam were two-pass incorporated in this experiment. However, recent communication with Gowan Company, the manufacturer of Eptam, indicates one pass incorporation to a depth of 2-inches is sufficient.

Ethofumesate, Eptam, and Dual Magnum were fall applied in experiments initiated at multiple locations in 2024. Fall herbicide application is a waterhemp control strategy that growers have inquired about. Based on our results, fall application may remedy some of the spring application challenges with incorporating Ro-Neet and Eptam into the waterhemp control strategies that currently include ethofumesate, Dual Magnum, Outlook, and Warrant.

Literature Cited

Peters TJ and Lystad AL (2024) A compendium of our ethofumesate knowledge. Sugarbeet Res Ext Rep 54:16-23

PALMER AMARANTH CONTROL IN SUGARBEET

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Summary

1. Soil residual herbicides applied postemergence (POST) was more important than preemergence (PRE) herbicides for Palmer amaranth control.
2. Three-times soil residual herbicides applied POST was more efficacious for Palmer amaranth control than two-times soil residual herbicides applied POST.
3. Preliminary data suggests integrating Ultra Blazer into the program would improve overall Palmer amaranth control.
4. Cultural control practices, specifically sugarbeet planting date and stand establishment, will delay Palmer amaranth population since weed emergence was late June or 45 to 75 days after when sugarbeet typically are planted.
5. The best herbicide treatments in sugarbeet provided *only* fair to good (65% to 80%) Palmer amaranth control.

Introduction

The anticipation of Palmer amaranth has created a mystic about weeds we seldom see in agriculture. By now, growers have read the press clippings indicating 2- to 3-inch of growth a day in June, a base so large that it can damage the sickle bar on a combine, and Palmer amaranth's ability to produce a million seed per plant. Department of Agriculture and Extension in Minnesota and North Dakota have created awareness and have assisted in eradicating Palmer amaranth before it has a chance to establish. To our knowledge, there are no incidences of Palmer amaranth in sugarbeet in Minnesota or North Dakota.

Successful organizations create contingency plans in the event something happens. It seems that weed management in sugarbeet should operate similarly. We need to know how our current weed management programs perform in sugarbeet and what programs would be implemented in the event Palmer amaranth establishes in fields to be planted to sugarbeet. A greenhouse experiment was conducted in 2016 to evaluate Betamix mixtures with ethofumesate and UpBeet for Palmer amaranth control. Betamix, ethofumesate and UpBeet were applied at 3 pt/A + 12 fl oz/A + 1 oz/A when Palmer amaranth was 2-, 4- and 8-inches tall. We found control was best when Palmer amaranth was 2-inches tall (Figure 1). However, control was not consistent across experiments and decreased significantly when Palmer amaranth was 4- or 8-inches at application.

Herbicide treatment	Height (inch)	Control 5 DAT	Control 24 DAT
		---------(%)---------	
Betamix+ethofumesate+UpBeet (3 pt + 12 fl oz + 1 oz)	2	99 a	99 a
Betamix+ethofumesate+UpBeet (3 pt + 12 fl oz + 1 oz)	4	56 b	57 b
Betamix+ethofumesate+UpBeet (3 pt + 12 fl oz + 1 oz)	8	34 c	24 c

Herbicide treatment	Height (inch)	Control 20 DAT	Control 28 DAT
		---------(%)---------	
Betamix+ethofumesate+UpBeet (3 pt + 12 fl oz + 1 oz)	2	70 a	23
Betamix+ethofumesate+UpBeet (3 pt + 12 fl oz + 1 oz)	4	43 b	17
Betamix+ethofumesate+UpBeet (3 pt + 12 fl oz + 1 oz)	8	38 b	13

Figure 1. Palmer amaranth control in response to herbicide treatment applied on 2-, 4- and 8-inch Palmer amaranth, two greenhouse runs, 2016.

The Sugarbeet Research and Education Board funded a field experiment at the University of Nebraska-Lincoln and Scotts Bluff Research Stations in collaboration with Dr. Nevin Lawrence in 2018. The objective of the experiment was to determine Palmer amaranth control in response to ethofumesate preemergence (PRE) followed by soil residual herbicides applied at the 2-lf, 6-lf, and 2- followed by 6-lf sugarbeet stage. The experiment considered three soil residual herbicide treatments: a) Warrant at 3 pt/A; b) ethofumesate at 2 pt/A; and c) Warrant + ethofumesate at 1.5 + 2 pt/A. We learned that Warrant, a site of action (SOA) 15 chloroacetamide herbicide, was effective for Palmer amaranth control (Figure 2). However, soil types in Nebraska are unique from soil types in the Red River Valley so reproducing similar results was difficult in Minnesota and North Dakota.

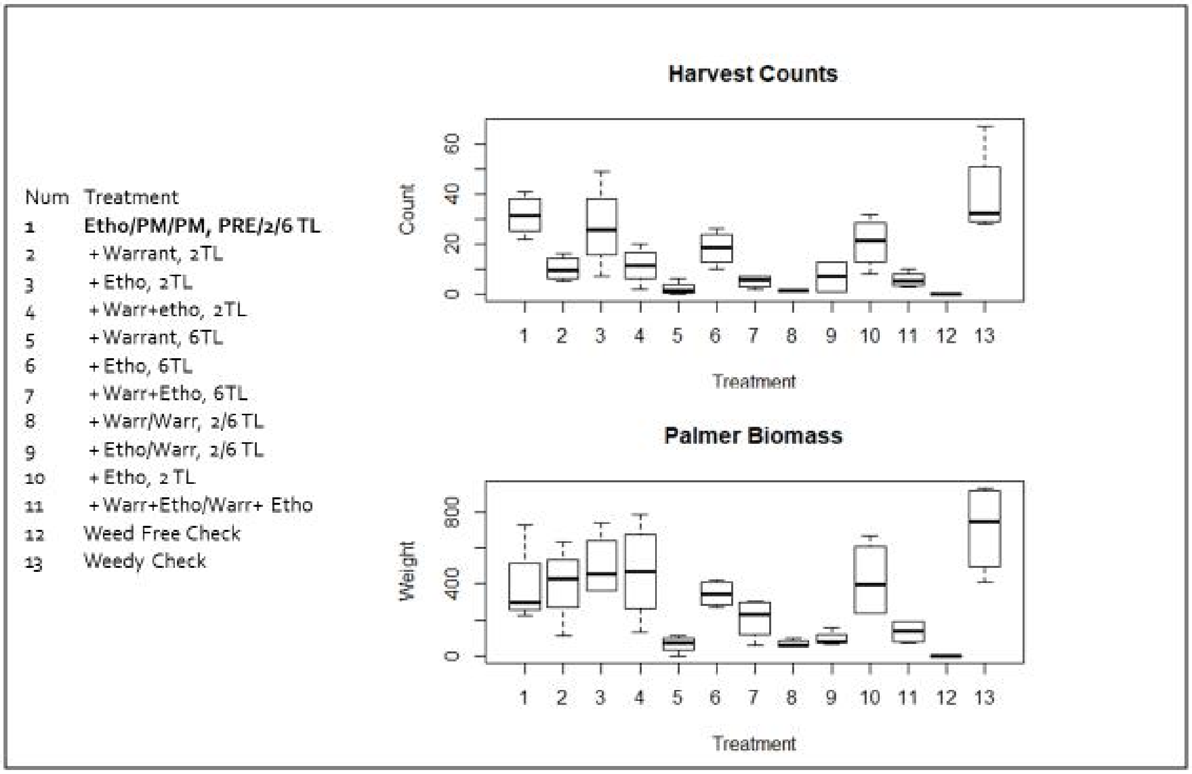

Figure 2. Palmer amaranth plant biomass and harvest counts in response to herbicide treatments, University of Nebraska, Scottsbluff, NE, 2018.

Palmer amaranth was first identified in Minnesota in 2016 and identified in North Dakota in 2018. We identified a field location inhabited with Palmer amaranth and suitable for a sugarbeet experiment near Eckelson, ND in Barnes County for the 2024 field season. The objectives of the experiment were to a) to evaluate soil residual herbicides in soils indicative of those where sugarbeet are produced in Minnesota and North Dakota and: b) to evaluate Palmer amaranth control with layered soil residual herbicides applied preemergence and postemergence (POST) in sugarbeet.

Materials and Methods

The experimental area was prepared for planting with spring tillage. Sugarbeet was planted on June 1, 2024. Sugarbeet was seeded in 30-inch rows at approximately 51,500 seeds per acre with 4-inch spacing between seeds.

Herbicide treatments were applied PRE and POST. All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002XR nozzles (TeeJet® Technologies, Glendale Heights, IL) pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length. The treatment list can be found in Table 1.

Table 1. Herbicide treatment, treatment rates and sugarbeet stage at application, Eckelson ND, 2024.

Herbicide Treatment	Rate (pt or fl oz/A)	Sugarbeet Stage (lvs)
RUPM3[a] + etho[b] / RUPM3 + etho /	25 + 4 / 25 + 4 /	2 / 6 /
RUPM3 + etho	20 + 4	10
Etho + Dual Magnum / RUPM3 + etho /	3p + 12 / 25 + 4 /	PRE / 2 /
RUPM3 + etho / RUPM3 + etho	25 + 4 / 20 + 4	6 / 10
Etho + Torero / RUPM3 + etho /	8 + 8p / 25 + 4 /	PRE / 2 /
RUPM3 + etho / RUPM3 + etho	25 + 4 / 20 + 4	6 / 10
Etho / RUPM3 + etho / RUPM3 + etho /	7.5p / 25 + 4 / 25 + 4 /	PRE / 2 / 6 /
RUPM3 + etho	20 + 4	10
Outlook + RUPM3 + etho /	18 + 25 + 4 /	2 /
Warrant + RUPM3 + etho / RUPM3 + etho	4p + 25 + 4 / 20 + 4	6 / 10
Etho + Dual Magnum / Outlook + RUPM3 + etho /	3p + 12 / 18 + 25 + 4 /	PRE / 2 / 6 /
Warrant + RUPM3 + etho / RUPM3 + etho	4p + 25 + 4 / 20 + 4	10
Etho / Outlook + RUPM3 + etho / Warrant + RUPM3 +	7.5p / 18 + 25 + 4 /	PRE / 2 /
etho / RUPM3 + etho	4p + 25 + 4 / 20 + 4	6 / 10
Etho + Torero / Outlook + RUPM3 + etho /	8 + 8p / 18 + 25 + 4 /	PRE 2 /
Warrant + RUPM3 + etho / RUPM3 + etho	4p + 25 + 4 / 20 + 4	6 / 10
Outlook + RUPM3 + etho / Warrant + RUPM3 + etho /	18 + 25 + 4 / 4p + 25 + 4 / 1.25p	2 /
Dual Magnum + RUPM3 + etho	20 + 4	6 / 10
Etho + Dual Magnum / Outlook + RUPM3 + etho /	3 p + 12 / 18 + 25 + 4 /	PRE / 2 /
Warrant + RUPM3 + etho /	4p + 25 + 4 /	6 /
Dual Magnum + RUPM3 + etho	1.25p + 20 + 4	10
Etho + Torero / Outlook + RUPM3 + etho /	8 + 8p / 18 + 25 + 4 /	PRE / 2 /
Warrant + RUPM3 + etho /	4p + 25 + 4 /	6 /
Dual Magnum + RUPM3 + etho	1.25p + 20 + 4	10
Etho / Outlook + RUPM3 + etho /	7.5p / 18 + 25 + 4 /	PRE / 2 /
Warrant + RUPM3 + etho /	4p + 25 + 4 /	6 /
Dual Magnum + RUPM3 + etho	1.25p + 20 + 4	10

[a]RUPM3 = Roundup PowerMax3; etho = ethofumesate.
[b]Roundup PowerMax3 and ethofumesate applied with high surfactant methylated oil concentrate at 1.5 pt/A plus liquid AMS at 2.5% v/v.

Sugarbeet injury and Palmer amaranth control was collected subjectively and objectively. Visible percent sugarbeet injury (0 to 100%, 0%, no injury and 100% complete loss of sugarbeet stand) and visible percent Palmer amaranth control (0 to 100%, 0% is no control and 100% complete control) was assessed 14, 21, 28, 56, and 70 (+/- 3) days after planting (DAP). Palmer amaranth infestation was classified into three groups: '1' or heavy Palmer amaranth infestation; '2' or moderate Palmer amaranth infestation and '3' or light Palmer amaranth infestation. The number of Palmer amaranth plants between rows 2 and 3 in the length of the plot was collected 70 DAP.

Experiment design was a randomized complete block design with four replications. Treatment arrangement was a two-factor factorial experiment with four replications. Main affects were PRE herbicide(s) and POST herbicide treatment. The experiment was analyzed using Agricultural Research Manager (ARM) revision 2024.4.

Results

The experiment was analyzed as a factorial treatment arrangement. ANOVA indicated Factor A, PRE herbicide was not significant; however, Factor B, POST herbicide treatment, was significant. The interaction of both A and B factors was not significant. Factor A considered PRE herbicide treatment. There were four treatments: 1) no herbicide treatment; 2) Nortron+Dual Magnum; 3) Nortron+Torero; and 4) Nortron alone. To be clear, treatment one is the average of the three Factor B treatments not receiving a PRE herbicide.

Sugarbeet growth reduction was evaluated but will not be discussed in this report. Growth reduction tended to be random across treatments and was compromised by Palmer amaranth infestation.

PRE treatment did not influence Palmer amaranth control (Table 2). Palmer amaranth control collected 58-69 DAP was marginally significant, indicating PRE herbicide application tended to improve control. Palmer amaranth control collected 43-52 DAP, both visible score or Palmer amaranth count, were not influenced by PRE treatment.

Table 2. Palmer amaranth control, population score, and stand count in response to herbicide treatment applied PRE averaged over POST treatments, Eckelson ND, 2024.

		Palmer Amaranth Control			
Herbicide treatment	**Rate**	**43-52 DAP**	**58-69 DAP**	**Score[b]**	**Stand Count[c]**
	---pt/A---	----------------%---------------		---------Number--------	
Untreated		67	49 b	2.6	23
Nortron + Dual Magnum	3 + 0.75	74	64 a	2.3	14
Nortron +Torero	0.5 + 8	80	63 a	2.2	14
Nortron	7.5	78	70 a	2.2	14
P-value (0.10)		0.1319	0.1020	0.4756	0.2276

[a]Palmer amaranth population density score: 1= heavy, 2= moderate, 3 = light.
[b]Palmer amaranth control group by plot: 1 = heavy, poor control; 2 = moderate infestation and control; 3= light infestation, good control.
[c]Number of Palmer amaranth between rows 2 and 3, length of plot.

POST application at the 2-lf sugarbeet stage was sprayed on June 17. On the same day, glyphosate was broadcast applied across the experimental area to control redroot pigweed, grasses, velvetleaf, and other weeds. The experimental area was void of weeds, including Palmer amaranth, when we returned for visit on June 25. However, Palmer amaranth emerged shortly there after and grew vigorously in July and August (Figure 3).

Image capture July 29 | Image capture August 8

Figure 3. A wire flag measured Palmer amaranth height on July 24, 2024. Images collected on July 29, or 5 days after flagging, and on August 8, or 15 days after flagging, to demonstrate rapid Palmer amaranth growth.

POST treatment influenced Palmer amaranth control both 43-52 DAP and 58-69 DAP. Likewise, herbicides applied POST improved Palmer amaranth control. Further, a 3-times POST program tended to improve control as compared with a 2-times POST program, and number of Palmer amaranth between rows 2 and 3 measured the length of the plot (Table 3). In general, a 3-times soil residual program improved Palmer amaranth control as compared with a 2-times soil residual program.

Table 3. Palmer amaranth control, population score, and stand count in response to herbicide treatment applied POST averaged over PRE treatments, Eckelson ND, 2024.[a]

		Palmer Amaranth Control			
Herbicide treatment	**Rate**	**43-52 DAP**	**58-69 DAP**	**Score[b]**	**Stand Count[c]**
	---pt/A---	---------------%-------------		------Number------	
RUPM3 + etho[d] (3x)	1.6 + 0.25	68 b	52 b	2.4	23 b
Outlook/Warrant (3x)	1.1 / 4	76 ab	60 b	2.3	16 ab
Outlook/Warrant/Dual Magnum (3x)	1.1 / 4/ 1.3	82 a	72 a	2.3	10 a
P-value (0.10)		0.0257	0.0255	0.7119	0.0153

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]Palmer amaranth control group by plot: 1 = heavy, poor control; 2 = moderate infestation and control; 3= light infestation, good control.
[c]Number of Palmer amaranth between rows 2 and 3, length of plot.
[d]RUMP3 = Roundup PowerMax3; etho = ethofumesate.

Interaction of factor A (PRE treatment) and factor B (POST treatment) was not significant (Table 4). Each individual PRE herbicide with its respective POST herbicide are listed to inform the reader of rank order. Palmer amaranth control tended to be best when ethofumesate was applied at full rates and when Outlook, Warrant, and Dual Magnum were applied with a 3-times application with Roundup PowerMax3 and ethofumesate (Figure 4). By accident, Roundup PowerMax3 was mixed with Ultra Blazer and applied at the V6 stage (Table 4). Roundup PowerMax3 mixed with Ultra Blazer provided 88% Palmer amaranth control or numerically, the greatest control 43-53 DAP. Control was less 58-69 DAP and the number of Palmer amaranth plants tended to be greater than the ethofumesate PRE or 3-times Roundup PowerMax3 and ethofumesate with Outlook, Warrant, and Dual Magnum.

Table 4. Palmer amaranth control, population score, and stand count in response to herbicide treatment, Eckelson ND, 2024.

Herbicide Treatment				Palmer Amaranth Control			
Preemergence	**Rate**	**Postemergence[a,b]**	**Rate**	**43-52 DAP**	**58-69 DAP**	**Score[c]**	**Stand Count[d]**
	-pt/A-		--pt/A--	-------------%-----------		---Number---	
-		-		53	35	2.8	27
-		Outlook/Warrant	1.1/4	75	55	2.3	23
-		Outlook/Warrant/Dual Magnum	1.1/4.0/1.3	75	59	2.8	18
Etho + D Mag	2 + 0.5	-		64	48	2.3	24
Etho + D Mag	2 + 0.5	Outlook/Warrant	1.1/4	75	65	2	12
Etho + D Mag	2 + 0.5	Outlook/Warrant/Dual Magnum	1.1/4.0/1.3	83	79	2.8	6
Etho + Torero[b]	0.5 + 8	-		***88***	***75***	***2.3***	***14***
Etho + Torero	0.5 + 8	Outlook/Warrant	1.1/4	68	42	2.5	22
Etho + Torero	0.5 + 8	Outlook/Warrant/Dual Magnum	1.1/4.0/1.3	83	73	1.8	6
Ethofumesate	7.5	-		66	52	2.5	27
Ethofumesate	7.5	Outlook/Warrant	1.1/4	84	80	2.3	7
Ethofumesate	7.5	Outlook/Warrant/Dual Magnum	1.1/4.0/1.3	85	78	1.8	10
P-value				0.0912	0.0931	0.4404	0.4234

[a]All plots received Roundup PowerMax3 and Nortron with HSMOC and liquid AMS alone or mixed with soil residual herbicides POST. Application applied at 2-4-, 6-8- and 10-12-lf stage.
[b]Application applied at 6-8-lf stage contained Ultra Blazer by accident.
[c]Palmer amaranth control group by plot: 1 = heavy, poor control; 2 = moderate infestation and control; 3= light infestation, good control.
[d]Number of Palmer amaranth between rows 2 and 3, length of plot.

Figure 4. Palmer amaranth control assessed July 22, 2024 or 6 days after application D (DAAD). Images were A: 3-times Roundup PowerMax3 plus ethofumesate, POST; B) ethofumesate PRE followed by 3-times Roundup PowerMax3 plus ethofumesate; B) ethofumesate PRE followed by 2-times Roundup PowerMax3 plus ethofumesate, first application with Outlook and second application with Warrant; and D) ethofumesate PRE followed by 3-times Roundup PowerMax3 plus ethofumesate, first application with Outlook and second application with Warrant and third application with Dual Magnum, Eckelson, ND, 2024.

Conclusion

The Palmer amaranth biotype at Eckelson, ND germinated and emerged in late June. It is likely each incidence of Palmer amaranth in Minnesota or North Dakota will be a population that may respond uniquely to local environmental conditions. These data demonstrate the importance of the POST treatment. The experiment was planted on wide rows due to equipment availability. Sugarbeet planted in mid-April or early May, in 22-inch rows and with stand densities averaging 175 plants per 100 ft of row, will be the best defense against Palmer amaranth.

This experiment provided positive outcomes but demonstrated the growth potential of Palmer amaranth and the need to aggressively manage throughout the growing season. Overall, the experiment provided fair (65% to 80%) to good (80% to 90%) control and provides a base-line for Palmer amaranth control in sugarbeet. Commercial fields will demand greater than 90% control, indicating the challenges and importance of developing robust future programs.

TOLERANCE FROM SPIN-AID IN SUGARBEET

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Summary

1. Kochia control experiments indicated 2- or 3-times Spin-Aid applications with ethofumesate at 4 fl oz/A is needed for kochia control with the first application applied to 5-leaf stage kochia followed by (fb) sequential applications in 5 to 7-day intervals.
2. Greenhouse and field observations indicated daily maximum air temperature has greater effect on sugarbeet vegetation or root yield rather than Spin-Aid rate.
3. Sugarbeet vegetative injury increases with 3-times Spin-Aid plus ethofumesate applications as compared with one or two applications. Two- or three-times Spin-Aid applications did not reduce sugarbeet root yield at Hendrum and Crookston as compared with one Spin-Aid application.
4. Applying ethofumesate preemergence (PRE) before Spin-Aid applications improves kochia control but may reduce sugarbeet root yield.

Introduction

Sugarbeet growers used ‘Betanal’ for kochia, common ragweed, common lambsquarters, and wild mustard control in sugarbeet from 1970 to 1981. Betanal was discontinued following the development of ‘Betamix’, a premixture of Betanal and Betanex. The active ingredient in Betanal is phenmedipham.

Belchim Crop Protection USA acquired phenmedipham in 2022. Phenmedipham, marketed under the trade name ‘Spin-Aid’, and combined with ethofumesate, has been used by sugarbeet growers primarily for glyphosate-resistant (GR) kochia control since 2023. Other potential uses may include GR common ragweed control and control of weather-stressed common lambsquarters in sugarbeet.

Preliminary research indicates Spin-Aid use rate will be dependent on sugarbeet growth stage, size of target weed species, and air temperature at or following application. That is, Spin-Aid may cause more sugarbeet injury and may be more efficacious on target species when maximum daily air temperatures are 80F. Likewise, we believe Spin-Aid will be more efficacious when it is applied with ethofumesate, in 2- or 3-sequential applications on 5- to 7-day intervals, and following ethofumesate preemergence (PRE).

Spin-Aid and ethofumesate likely will be mixed with Stinger HL and/or Dual Magnum for broad spectrum control in sugarbeet. However, previous research indicates complex mixtures of multiple actives can increase the specter of sugarbeet injury, especially in cool and wet conditions, or conditions when metabolism of actives is slowed as compared with the same actives applied singly to sugarbeet.

This sugarbeet tolerance report, and the accompanying kochia and common ragweed control reports, serve as a compendium of experiments with Spin-Aid conducted in the greenhouse in 2023, 2024 and 2025 and in the field in 2024. This research report summarizes sugarbeet vegetative tolerance and root and sucrose yield following 1-time, 2-time, and 3-time Spin-Aid applications with ethofumesate alone, or in mixtures, or alone and in mixtures, following ethofumesate PRE. The outcome of this research (and the companion kochia and common ragweed control report) are our best management practices for how we intend to use Spin-Aid in sugarbeet.

Materials and Methods

Greenhouse Tolerance Experiments. Betaseed 8927 sugarbeet in 2024 and Crystal 793 sugarbeet in 2025 were grown in 4 × 4 inch pots with a 1:1 mixture of Wheatville silt loam from the Northwest Research and Outreach Center, Crookston and PROMIX greenhouse media at 75 to 81F under natural light supplemented with a 16 h photoperiod of artificial light. Herbicide treatment list was designed to evaluate sugarbeet injury from 1-time, 2-time or 3-time Spin-Aid + ethofumesate application at the proposed labeled use rates alone, at 2X safety use rates alone, or at proposed use rates mixed with Roundup PowerMax3 and Stinger HL, Dual Magnum and Stinger HL, and Dual Magnum (Tables 1 and 2).

Table 1. Herbicide treatment, herbicide rate, and timing of herbicide application, greenhouse.

Postemergence Herbicide[a]	Rate (fl oz/A)	Sugarbeet stage (lvs)
Spin-Aid + ethofumesate	16 + 4	Cotyledon
Spin-Aid + etho / Spin-Aid + etho	16 + 4 / 20 + 4	Cotyledon
Spin-Aid + etho / Spin-Aid + etho	16 + 4 / 24 + 4	Cotyledon
Spin-Aid + etho / Spin-Aid + etho / Spin-Aid + etho	16 + 4 / 20 + 4 / 28 + 4	Cotyledon
Spin-Aid + etho / Spin-Aid + etho / Spin-Aid + etho	16 + 4 / 24 + 4 / 32 + 4	Cotyledon
Spin-Aid + etho / Spin-Aid + etho / Spin-Aid + etho / Spin-Aid + etho	16 + 4 /20 + 4 / 28 + 4 / 32 +4	Cotyledon
Untreated Control		

[a]Herbicide treatments with Methylated Seed Oil (MSO) at 1 pt/A.

Table 2. Herbicide treatment, herbicide rate, and timing of herbicide application, greenhouse.

Postemergence Herbicide[a]	Rate (fl oz/A)	Sugarbeet stage (lvs)
SA + etho	12 + 4	Cotyledon
SA + etho / SA + etho + RUPM3	12 + 4 / 16 + 4 + 25	Cotyledon / 5-7 d
SA + etho / SA + etho + RUPM3 + Stinger HL	12 + 4 / 16 + 4 + 25 + 1.8	Cotyledon / 5-7 d
SA + etho / SA + etho + RUPM3 + DM	12 + 4 / 16 + 4 + 25 +16	Cotyledon / 5-7 d
SA + etho / SA + etho + RUPM3 + DM + SHL	12 + 4 / 16 + 4 + 25 +16 + 1.8	Cotyledon / 5-7 d
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 16 + 4 + 25 / 24 + 4	Cotyledon / 5-7 d / 5-7 d
SA + etho / SA + etho + RUPM3 + SHL / SA + etho	12 + 4 / 16 + 4 + 25 + 1.8 / 24 +4	Cotyledon / 5-7 d / 5-7 d
SA + etho / SA + etho + RUPM3 + DM / SA + etho	12 + 4 / 16 + 4 + 25 +16 / 24 + 4	Cotyledon / 5-7 d / 5-7 d
SA + etho / SA + etho + RUPM3 + DM + SHL / SA + etho	12 + 4 / 16 + 4 + 25 +16 + 1.8 / 24 + 4	Cotyledon / 5-7 d / 5-7 d

[a]SA= Spin-Aid, Etho = ethofumesate, RUPM3 = Roundup PowerMax3, DM = Dual Magnum, SHL = Stinger HL. Spin-Aid and ethofumesate with HSMOC at 1 pt/A. Spin-Aid, ethofumesate, Roundup PowerMax3, Stinger HL or Dual Magnum or Spin-Aid, ethofumesate, Roundup PowerMax3, Stinger HL and Dual Magnum with HSMOC and Amsol liquid AMS at 1 pt/A+2.5% v/v.

Herbicide treatments were applied using a spray booth (Generation III, DeVries Manufacturing, Hollandale, MN) equipped with a TeeJet® 8002 even banding nozzle (TeeJet Technologies, Glendale Heights, IL) calibrated to deliver 15 gpa spray solution at 25 psi and 3 mph when sugarbeet were at the cotyledon, cotyledon with developing true leaves (horns) and sugarbeet 2-lf stage (Figure 1). Visible sugarbeet injury noted as necrosis, malformation or growth reduction were evaluated using a 0% to 100%. A score of 0% indicated no sugarbeet injury and a score of 100% indicating complete loss of sugarbeet in pot approximately 5, 10, and 15 days after treatment (DAT). Experimental design was a RCBD with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2024.4 software package.

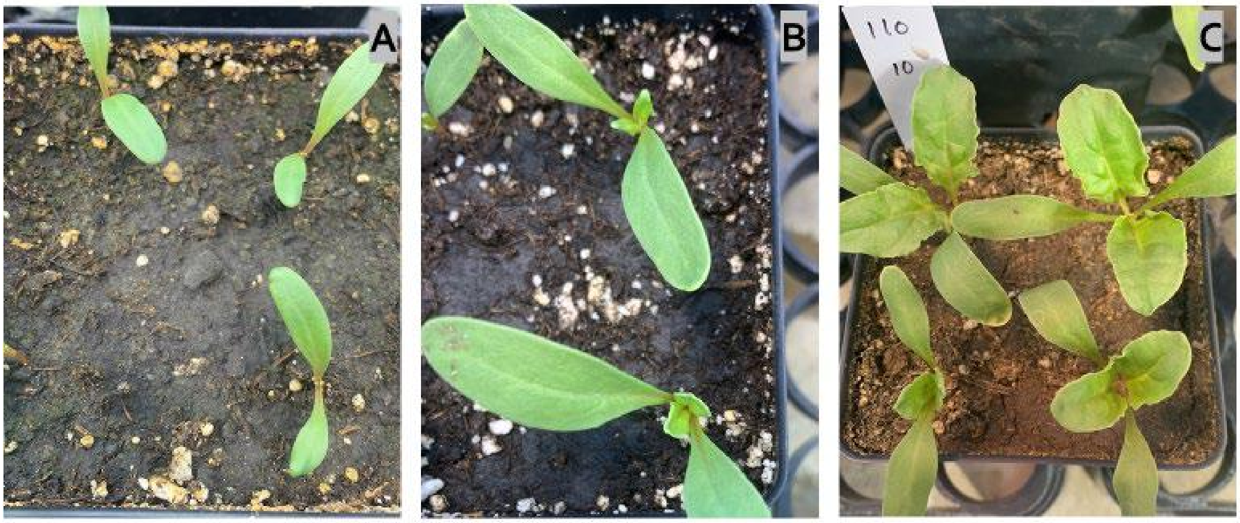

Figure 1. Cotyledon sugarbeet (A), cotyledon sugarbeet with horns (B) and 2-lf sugarbeet (C), greenhouse, NDSU.

<u>Field Tolerance and Root and Sucrose Yield Experiments.</u> Sugarbeet field experiments were conducted near Crookston, Hendrum, and Brushvale, MN and Prosper, ND in 2024. Herbicide treatments are detailed in Table 3. Primary tillage in the fall was followed by secondary tillage with a field cultivator in the spring to prepare the seedbed for sugarbeet planting. Fertilization followed local practices for sugarbeet production. Betaseed 8018 CR+ sugarbeet was seeded in 22-inch rows at approximately 64,000 seeds per acre or approximately 4.5-inch spacing between seeds. A soil residual herbicide was applied across the experimental area at all locations to control waterhemp. Treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002XR flat fan nozzles (XR TeeJet® Flat Fan Spray Tips (TeeJet® Technologies, Glendale Heights, IL)) pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length. Other grass and broadleaf weeds, insects, and diseases were managed throughout the growing season.

Table 3. Sugarbeet tolerance herbicide treatments.

Herbicide Treatment[a]	Rate (fl oz/A)	Sugarbeet stage (lvs)
Spin-Aid + ethofumesate / RUPM3	24 + 4 / 25	2-4 lf / 5-7 d
Spin-Aid + etho / Spin-Aid + etho + RUPM3	24 + 4 / 32 + 4 + 25	2-4 lf / 5-7 d
Spin-Aid + etho / Spin-Aid + etho + RUPM3	24 + 4 / 48 + 4 + 25	2-4 lf / 5-7 d
Spin-Aid + etho / Spin-Aid + etho + RUPM3 /	24 + 4 / 32 + 4 + 25 /	2-4 lf / 5-7 d /
Spin-Aid + etho	48 + 4	5-7 d
Etho[b] / Spin-Aid + etho / Spin-Aid + etho + RUPM3	6 / 24 + 4 / 32 + 4 + 25	PRE / 2-4 lf / 5-7 d
RUPM3 + etho / RUPM3 + etho	25 + 4 / 25 + 4	2-4 lf / 6-8 lf

[a]RUPM3 = Roundup PowerMax3; SA = Spin-Aid; etho = ethofumesate. Roundup PowerMax3 with Prefer 90 non-ionic surfactant (NIS) and Amsol liquid AMS at 0.25% + 2.5% v/v. Spin-Aid and ethofumesate or Spin-Aid, ethofumesate, and Roundup PowerMax3, with HSMOC at 1 pt/A. Roundup PowerMax3 mixtures applied with Amsol liquid AMS at 2.5% v/v.
[b]Ethofumesate PRE at 6 pt/A.

Sugarbeet counts (middle 2 rows x 20' plot length) at 2- to 4-leaf stage and preharvest and % visible necrosis and growth reduction injury (0 to 100% scale, 0 is no visible necrosis or growth reduction injury compared with a glyphosate control and 100% complete loss of plant / stand compared with the glyphosate control) were collected 7 days after the first Spin-Aid application (DAAB) and 4 to 7, 10 to 14, 21 to 28, and 38 to 42 days after the 3-times Spin-Aid application (DAAD). Sugarbeet were defoliated with a four-row topper and harvested with a two-row sugarbeet harvester. The sugarbeet roots were weighed and a 15-pound sugarbeet sample for each plot was analyzed at American Crystal Sugar Company, East Grand Forks, ND, for percent sucrose and sugar loss to molasses (SLM). Experimental design was randomized complete block with six replications. Data were analyzed using the PROC GLIMMIX procedure in SAS, version 9.4 software package.

Results and Discussion

Greenhouse and Field Tolerance experiments. Greenhouse and field tolerance experiments were conducted to evaluate sugarbeet safety following Spin-Aid application. Our earliest experiments focused on a single Spin-Aid application at rates up to 144 fl oz/A or 64 fl oz/A with two sequential applications on 5- to 7-day intervals. Sugarbeet injury was greatest with 144 fl oz/A in a single application, 5 days after application (data not presented). Injury 10- and 16-days after application was greater with Spin-Aid applied 2-times at 64 fl oz/A. Subsequent greenhouse experiments focused on 1-, 2- and 3-time Spin-Aid applications with ethofumesate and highlighted the importance of adjusting the Spin-Aid rate with sugarbeet growth stage.

The maximum Spin-Aid use rate is 96 fl oz/A in a single application, or cumulative total with three applications. Dr. Alan Dexter once stated sugarbeet injury from phenmedipham was hybrid dependent. Extension Sugarbeet conducted an experiment to evaluate sugarbeet tolerance of Spin-Aid with today's hybrids from different genetic backgrounds in 2023. Results indicated that growth reduction injury from Spin-Aid was not related to sugarbeet hybrid or genetic background (data not presented). Additionally, harvest stand, root yield, percent sucrose, and sugarbeet purity following Spin-Aid applications were the same across sugarbeet hybrids.

Four experiments considered sugarbeet tolerance from single or multiple Spin-Aid applications plus Ethofumesate (Table 4). Depending on experiment, Spin-Aid rate is either a 1X or 2X rate applied at sugarbeet growth stage. Sugarbeet injury increased as the number of Spin-Aid applications increased from 1 to 4, with application number defining sugarbeet tolerance rather than Spin-Aid rate at application (Table 4). However, more striking was the importance of maximum daily air temperature at Spin-Aid application. Table 4 shows sugarbeet visible growth reduction injury five to 11 days after the third Spin-Aid application (application 'C'). Sugarbeet injury increased as the number of applications increased from one to three. Experiment 3 coincided with above average air temperatures in late January/early February 2024. The air temperatures in the greenhouse exceeded 90F during multiple Spin-Aid applications. We didn't observe differences between treatments in the fourth experiment conducted in 2025, indicating we finally had dialed in the appropriate Spin-Aid use rate.

Table 4. Visible sugarbeet growth reduction injury in response to Spin-Aid and ethofumesate, NDSU Greenhouse, 2024 and 2025.[a]

Postemergence Herbicide	Rate	Exp. 1 5 DAAC[b]	Exp. 2 11 DAAC	Exp. 3 10 DAAC	Exp. 4 9 DAAC
	-----fl oz/A-----	---------------------------%---------------------------			
SA + etho[b]	12 + 4	-[c]	-	8 f	-
SA + etho	16 + 4	-	-	21 e	5
SA + etho	24 + 4	21 d	21 d	-	-
SA + etho / SA + etho	12 + 4 / 16 + 4	-	-	35 cd	-
SA + etho / SA + etho	16 + 4 / 16 + 4	-	-	33 de	-
SA + etho / SA + etho	16 + 4 / 20 + 4	-	-	-	8
SA + etho / SA + etho	16 + 4 / 24 + 4	-	-	39 cd	11
SA + etho / SA + etho	24 + 4 / 36 + 4	41 c	30 c	-	-
SA + etho / SA + etho	24 + 4 / 48 + 4	45 bc	30 c	-	-
SA + etho / SA + etho / SA + etho	16+4/20+4/28+4	-	-	-	8
SA + etho / SA + etho / SA + etho	16+4/24+4/24+4	-	-	46 bc	-
SA + etho / SA + etho / SA + etho	16+4/24+4/32+4	-	-	68 a	8
SA + etho / SA + etho / SA + etho	16+4/24+4/40+4	-	-	58 ab	-
SA + etho / SA + etho / SA + etho	24+4/36+4/48+4	60 ab	44 b	-	-
SA + etho / SA + etho / SA + etho	24+4/36+4/60+4	69 a	40 b	-	-
SA + etho / SA + etho / SA + etho	24+4/48+4/48+4	55 abc	44 b	-	-
SA + etho / SA + etho / SA + etho	24+4/48+4/60+4	58 ab	50 a	-	-
SA + etho / SA + etho / SA + etho / SA + etho	16 + 4 /20 + 4 / 28 + 4 / 32 +4	-	-	-	14
Untreated control		20 d	3 e	0 f	5
P Value (0.10)		0.0001	0.0001	0.0001	0.5822

[a]Means with different letters are different at alpha = 0.10.
[b]DAAC=Days after application C; SA=Spin-Aid; etho=ethofumesate.
[c]'-' means treatment was not include in experiment

It is likely Spin-Aid will be applied in fields with other weed species. Greenhouse experiments were conducted to evaluate Spin-Aid and ethofumesate mixed with Roundup PowerMax3 and Stinger HL, Roundup PowerMax3 and *S*-metolachlor, or Roundup PowerMax3, Stinger HL, and *S*-metolachlor. Five experiments were conducted in 2024 and 2025. Results from three experiments are featured in Table 5.

Stinger HL, *S*-metolachlor or Stinger mixed with *S*-metolachlor and Roundup PowerMax3 plus Spin-Aid and ethofumesate tended to increase sugarbeet as compared with Spin-Aid and ethofumesate alone (Table 5). In general, Stinger HL or *S*-metolachlor alone, or Stinger HL plus *S*-metolachlor, similarly increased sugarbeet injury with Spin-Aid plus ethofumesate as compared with Spin-Aid and ethofumesate alone. Sugarbeet injury, in all cases, was negligible (Table 5). We did observe malformation injury from Stinger HL when mixed with Spin-Aid, ethofumesate, and Roundup PowerMax3 that generally does not occur from Roundup PowerMax3 and ethofumesate (observations from other experiments).

These greenhouse experiments suggest we have the appropriate rate titration for Spin-Aid plus ethofumesate and mixtures with Roundup PowerMax3, Stinger HL, *S*-metolachlor, or Stinger HL and *S*-metolachlor.

Table 5. Herbicide treatment, herbicide rate and timing of herbicide application, greenhouse.[a]

Postemergence Herbicide[b]	Rate	Exp. 1 10 DAC[c]	Exp. 2 16 DAC	Exp 3. 5 DAC
	---------------fl oz/A-------------		---------------%--------------	
SA + etho[d]	12 + 4	5	16 bcd	8
SA + etho / SA + etho + RUPM3	12 + 4 / 16 + 4 + 25	10	8 d	14
SA + etho / SA + etho + RUPM3 + SHL[e]	12 + 4 / 16 + 4 + 25 + 1.8	10	9 d	21
SA + etho / SA + etho + RUPM3 + DM	12 + 4 / 16 + 4 + 25 +16	10	10 cd	13
SA + etho / SA + etho + RUPM3 + DM + SHL	12 + 4 / 16 + 4 + 25 +16 + 1.8	14	16 bcd	21
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 16 + 4 + 25 / 24 + 4	9	20 b	5
SA + etho / SA + etho + RUPM3 + SHL / SA + etho	12 + 4 / 16 + 4 + 25 + 1.8 / 24 +4	9	25 ab	19
SA + etho / SA + etho + RUPM3 + DM / SA + etho	12 + 4 / 16 + 4 + 25 +16 / 24 + 4	11	30 a	19
SA + etho / SA + etho + RUPM3 + DM + SHL / SA + etho	12 + 4 / 16 + 4 + 25 +16 + 1.8 / 24 + 4	10	19 bc	21
P Value (0.10)		0.6673	0.0030	0.2756

[a]Means with different letters are different at alpha = 0.10
[b]SA= Spin-Aid, Etho = ethofumesate, RUPM3 = Roundup PowerMax3, DM = Dual Magnum, SHL = Stinger HL.
[c]DAC=Days after application C.
[d]Spin-Aid and ethofumesate with HSMOC at 1 pt/A.
[e]Spin-Aid, ethofumesate, Roundup PowerMax3, Stinger HL or Dual Magnum or Spin-Aid, ethofumesate, Roundup PowerMax3, Stinger HL and Dual Magnum with HSMOC and Amsol liquid AMS at 1 pt/A+2.5% v/v.

<u>Field Experiments.</u> Maximum day-time air temperature on the day of Spin-Aid application influenced sugarbeet injury. Maximum day-time air temperatures on date of Spin-Aid application exceeded 80F at Brushvale, MN and Prosper, ND, whereas Spin-Aid applications at Hendrum and Crookston, MN occurred when maximum daily air temperatures was 80F or less than 80F (Figure 2).

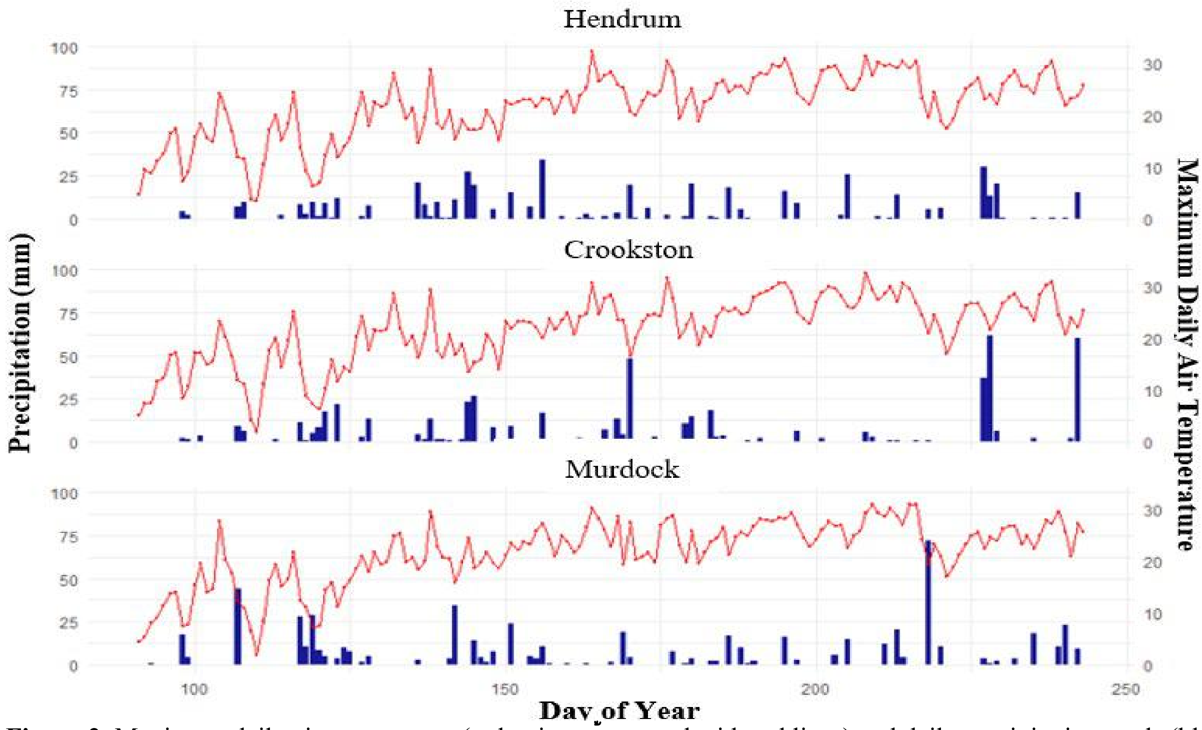

Figure 2. Maximum daily air temperature (red points connected with red lines) and daily precipitation totals (blue bars) from April 1 to August 31, 2024 at Hendrum, Crookston, and Murdock, MN. NDAWN stations near each field site. Figure created with R package ggplot2 (Wickham et al. 2023).

Visual sugarbeet injury was greater at Brushvale and Prosper at 10- to 14- and 21- to 28-days after application D (DAAD, the third Spin-Aid POST application). Thus, Hendrum and Crookston data (Table 6, Figure 3) was analyzed separately from Brushvale and Prosper (Table 7, Figure 3).

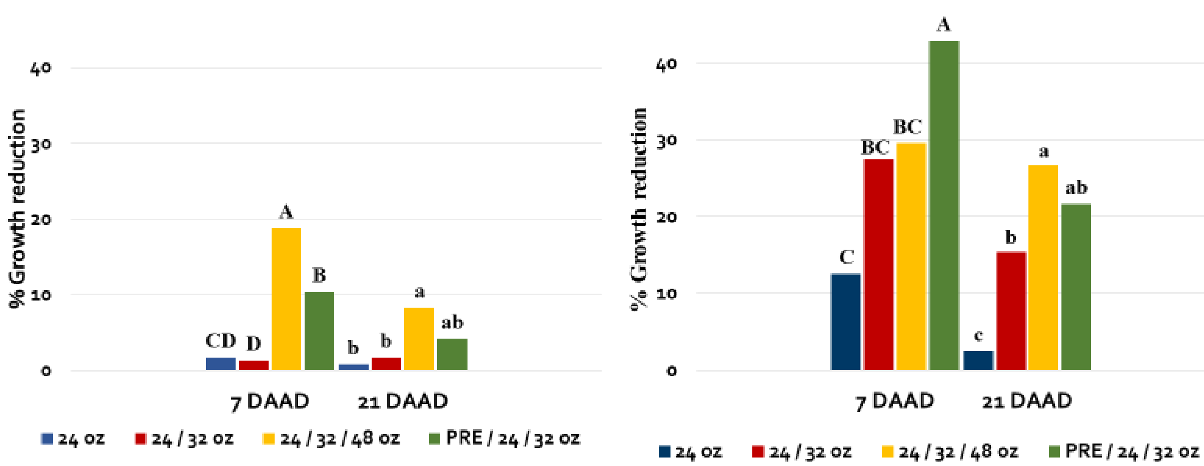

Figure 3. Sugarbeet growth reduction in response to Spin-Aid at Crookston and Hendrum, MN (left) and Brushville, MN and Prosper ND, 2024 (right). Ethofumesate at 4 fl oz/A was mixed with Spin-Aid and Roundup PowerMax3 at 25 fl oz/A POST or following ethofumesate PRE. Means with different letters are different at alpha = 0.05.

Table 6. Sugarbeet growth reduction and yield components in response to Spin-Aid combined at Hendrum and Crookston, MN, 2024.[a]

Herbicide Treatment[b]	Rate	Sugarbeet Stage	Growth Reduction 10-14 DAAD[c]	Growth Reduction 21-28 DAAD	Root Yield	Sucrose
	----fl oz/A---	---leaf/days---	-------------------%	-----------------	--Ton/A--	---%---
SA / RUPM3[d]	24 / 25	2-4 lf / 5-7 d	2 cd	1 c	40.4 ab	17.79
SA / SA + RUPM3	24 / 32 + 25	2-4 lf / 5-7 d	9 b	5 b	39.9 ab	18.02
SA / SA + RUPM3	24 / 48 + 25	2-4 lf / 5-7 d	8 bc	2 bc	39.9 ab	18.16
SA / SA + RUPM3 / SA	24 / 32+25 / 48	2-4 lf / 5-7 d / 5-7 d	18 a	9 a	39.8 bc	18.04
Etho / SA / SA + RUPM3	6 / 24 / 32 + 25	PRE[e] / 2-4 lf / 5-7 d	11 b	4 bc	38.4 c	18.07
RUPM3 / RUPM3	25 / 25	2-4 lf / 6-8 lf	1 d	1 bc	41.3 a	17.84
P value (0.05)			<0.0001	0.0012	0.0124	0.5790

[a]Means with different letters significant at P=0.05.
[b]Spin-Aid applications applied with ethofumesate at 4 fl oz/A and High Surfactant Methylated Seed Oil (HSMOC) at 1 pt/A. Spin-Aid and ethofumesate with RUPM3 applied with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.
[c]DAAD= Days after third Spin-Aid application.
[d]SA = Spin-Aid; RUPM3 = Roundup PowerMax3.
[e]Ethofumesate PRE at 6 pt/A.

Table 7. Sugarbeet growth reduction and yield components in response to Spin-Aid combined at Brushvale, MN and Prosper, ND, 2024.[a]

Herbicide Treatment[b]	Rate	Sugarbeet Stage	Growth Reduction 10-14 DAAD[c]	Growth Reduction 21-28 DAAD	Root Yield	Sucrose
	----fl oz/A---	---leaf/days---	-------------------%	-----------------	--Ton/A--	---%---
SA / RUPM3[d]	24 / 25	2-4 lf / 5-7 d	4 b	2 c	35.3 ab	17.45
SA / SA + RUPM3	24 / 32 + 25	2-4 lf / 5-7 d	21 a	10 ab	33.9 c	17.58
SA / SA + RUPM3	24 / 48 + 25	2-4 lf / 5-7 d	25 a	10 ab	34.8 bc	17.49
SA / SA + RUPM3 / SA	24 / 32+25 / 48	2-4 lf / 5-7 d / 5-7 d	25 a	15 a	33.9 c	17.46
Etho / SA / SA + RUPM3	6 / 24 / 32 + 25	PRE[e] / 2-4 lf / 5-7 d	29 a	7 bc	34.4 bc	17.62
RUPM3 / RUPM3	25 / 25	2-4 lf / 6-8 lf	4 b	3 c	36.3 a	17.29
P value (0.05)					0.0055	0.5495

[a]Means with different letters significant at P=0.05.
[b]Spin-Aid applications applied with ethofumesate at 4 fl oz/A and High Surfactant Methylated Seed Oil (HSMOC) at 1 pt/A. Spin-Aid and ethofumesate with RUPM3 applied with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.
[c]DAAD= Days after third Spin-Aid application.
[d]SA = Spin-Aid; RUPM3 = Roundup PowerMax3.
[e]Ethofumesate PRE at 6 pt/A.

Sugarbeet growth reduction injury averaged across treatments at Crookston and Hendrum was negligible even with 3-times Spin-Aid application at 24, 32, and 48 fl oz/A with ethofumesate at 4 fl oz/A, 7 DAAD (Table 6). Conversely, the same treatment at Brushville and Prosper caused 30% sugarbeet growth reduction (Table 7). Spin-Aid following ethofumesate PRE caused even more sugarbeet injury across all locations. Several observations concluded ethofumesate and other soil residual herbicides may alter the structure of cuticular waxes, increasing injury potential from POST herbicides (Devine et al. 1993; Dexter 1994).

Sugarbeet root yield averaged 40.0 ton per acre at Hendrum and Crookston (locations with cooler daytime air temperatures at Spin-Aid application) as compared with 34.8 ton per acre at Prosper and Brushville (locations with warmer daytime air temperatures at Spin-Aid application) (Table 6 and 7, Figure 4). Root yield from 1-time and 2-time Spin-Aid application was similar to 2-times Roundup PowerMax3 applications at Crookston and Hendrum. Root yield was less with 3-times Spin-Aid application or ethofumesate PRE followed by 2-times Spin-Aid applications.

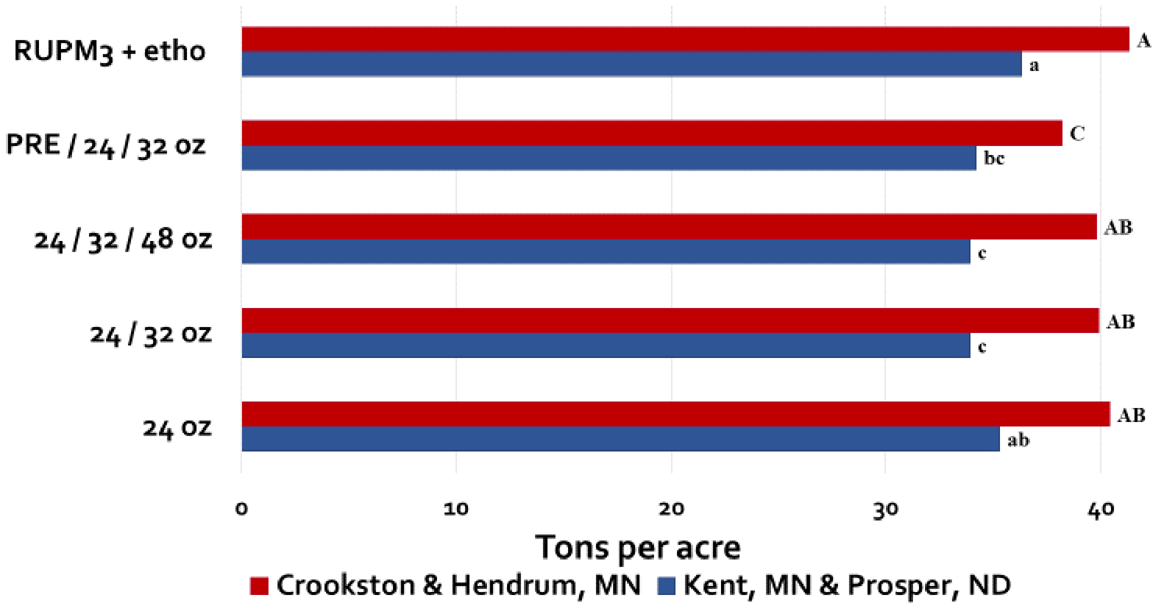

Figure 4. Sugarbeet root yield in response to Spin-Aid. Means with different letters significant at alpha = 0.05.

At Brushville and Prosper, or environments more conducive to sugarbeet injury, root yield from 1-time Spin-Aid application was similar to 2-times Roundup PowerMax3 (Figure 4). Two-times and 3-times Spin-Aid applications resulted in yields less that 1-time Spin-Aid application. Although Spin-Aid may be injurious to sugarbeet in some environments, it is important to note herbicide rates used in this experiment were 2X labeled rates.

Conclusion

Results from greenhouse and field experiments conducted in 2023, 2024, and 2025 support use rates in Table 8. Repeat Spin-Aid rates are needed to control kochia and are dependent on sugarbeet stage and daily maximum air temperatures. The importance of adjusting Spin-Aid rate, depending on maximum daily air temperature, has been observed in both greenhouse and field experiments. More experience may indicate the importance of other variables including co-herbicides.

Table 8. Recommended Spin-Aid use rates.[a]

Sugarbeet Stage (lvs)	Cold (<80F) at application	Warm (>80F) at application	Mixes with Stinger HL and *S*-metolachlor[b]
	------------	fl oz/A	------------
Cotyledon	16	12	12
Early 2-lf (horns)	20	16	16
2-4-lf	28	24	24
4-lf	32	28	28
6-lf	40	36	36

[a]Spin-Aid applied on 5- to 7-day intervals when sugarbeet actively growing or on 10-day intervals when sugarbeet not growing.
[b]Spin-Aid mixed with ethofumesate at 4 fl oz per acre with MSO or HSMOC at 1 pt/A.

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KOCHIA CONTROL FROM SPIN-AID AND ETHOFUMESATE ALONE OR MIXTURES WITH STINGER HL, DUAL MAGNUM OR STINGER HL AND DUAL MAGNUM

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Summary

1. Kochia control with Spin-Aid requires repeat Spin-Aid applications as compared with a single application at any rate.
2. Spin-Aid and ethofumesate applied three times improved kochia control compared to a 1- or 2-time Spin-Aid application in the greenhouse and in the field. Spin-Aid applied 4 times tended not to improve kochia control as compared with a 3-time application.
3. Kochia control was fair (65-80%) in field experiments at Glyndon and Felton from 3-time Spin-Aid application. Increasing the rate within 3-time application did not improve kochia control.
4. Mixing Stinger HL, *S*-metolachlor or Stinger HL plus *S*-metolachlor with Spin-Aid and ethofumesate did not improve kochia control in field experiments. However, ethofumesate PRE followed by Spin-Aid tended to improve kochia control.

Introduction

Glyphosate resistant (GR) kochia, especially in Drayton Factory District, has emerged as a significant weed control challenge. We have implemented a four-step herbicide program for growers identifying GR kochia as their most important weed control challenge: a) ethofumesate at 6 pint per acre preemergence (PRE); b) paraquat for control of emerged kochia before sugarbeet emergence; c) full rates of glyphosate combined with the best available adjuvant system for populations with mixed alleles; and d) Spin-Aid herbicide postemergence (POST).

Kochia control will be the ‘trademark’ of Spin-Aid in sugarbeet. Kochia control experiments were conducted in the greenhouse in 2023, 2024, and 2025 and at field locations near Felton and Glyndon, MN in 2023 and 2024. Kochia is a difficult weed control target. We know from 2023 field experiments that kochia cannot be defeated by a single Spin-Aid application at any rate. Kochia control will require 2-, 3- and perhaps 4-times Spin-Aid applications. The question is: what other factors will influence the Spin-Aid rate or the program we choose for acceptable kochia control?

We know kochia size is the most important variable for control. Kochia must be dime-size or less at first application. We prefer 5-leaves at application (Figure 1) regardless of sugabeet stage. Our research indicates a micro-rate strategy, or multiple applications of Spin-Aid at rates commensurate with sugarbeet size, applied on 5- to 7-day intervals, delivers best control. Greenhouse results indicate three Spin-Aid applications provide better kochia control than one or two Spin-Aid applications. Further, ethofumesate at 4 fl oz/A mixed with Spin-Aid increases the efficacious nature of Spin-Aid by loosening the leaf cuticles and readily absorbing the herbicide (Devine et al. 1993, Dexter 1994). We also need to be mindful of sugarbeet stage; sugarbeet are most sensitive to Spin-Aid when they are at the ‘horn’ stage. The objectives of these experiments were to determine kochia control from one, two, or three Spin-Aid applications mixed with ethofumesate alone, Spin-Aid and ethofumesate mixed with Stinger HL or *S*-metolachlor alone, or Stinger HL plus *S*-metolachlor, or Spin-Aid plus Stinger HL following ethofumesate PRE.

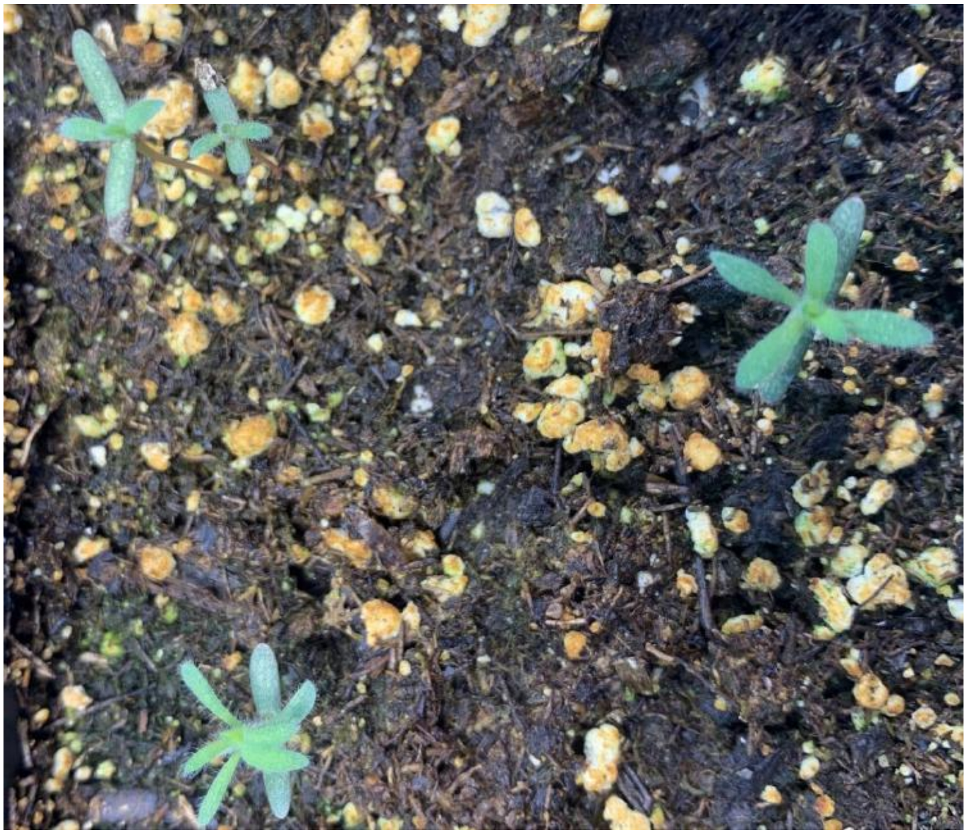

Figure 1. Kochia size at Spin-Aid application, NDSU Greenhouse. Image is from a November, 2024 experiment.

Materials and Methods

Greeenhouse experiments. Greenhouse experiments were conducted using a glyphosate sensitive kochia seed source collected at North Dakota State University (NDSU) field research facilities. Kochia was grown in a plastic flat filled with PROMIX general purpose greenhouse media (Premier Horticulture, Inc., Quakertown, PA) to 1-inch and transplanted in 4 × 4-inch pots and grown at 75F to 81F under natural light supplemented with a 16 h photoperiod of artificial light. Herbicide treatments were applied using a spray booth (Generation III, DeVries Manufacturing, Hollandale, MN) equipped with a TeeJet® 8002 even banding nozzle (TeeJet Technologies, Glendale Heights, IL) calibrated to deliver 15 gpa spray solution at 25 psi and 3 mph when kochia was approximately at the 5-lf or 'dime' size in diameter (Figure 1). Multiple runs of three greenhouse experiments were conducted to evaluate kochia control. Herbicide treatments for experiments are listed in Table 1 and Table 2. Visible kochia control (0% to 100%, 0% indicating no control and 100 indicating complete control) were evaluated approximately 4, 7, and 14 days after application C (DAAC) or the third POST Spin-Aid application. Data were analyzed as a RCBD with the ANOVA procedure of ARM software package.

Table 1. Kochia control herbicide treatments, NDSU Greenhouse, 2024 and 2025.

Herbicide treatment[a,b]	Rate (fl oz/A)	Kochia stage (lvs/days)
Untreated Control	0	5-lf
SA + etho	16 + 4	5-lf / 5-7d
SA + etho / SA + etho	16 + 4 / 24 + 4	5-lf / 5-7d
SA + etho / SA + etho	16+ 4 / 32 + 4	5-lf / 5-7 d
SA + etho / SA + etho / SA + etho	16 + 4 / 24 + 4 / 32 + 4	5-lf / 5-7 d / 5-7 d
SA + etho / SA + etho / SA + etho	16 + 4 / 24 + 4 / 40 + 4	5-lf / 5-7 d / 5-7 d
SA + etho / SA + etho / SA + etho	16 + 4 / 32 + 4 / 32 + 4	5-lf / 5-7 d / 5-7 d
SA + etho / SA + etho / SA + etho	16 + 4 / 32 + 4 / 40 + 4	5-lf / 5-7 d / 5-7 d

[a]SA = Spin-Aid, etho = ethofumesate.

[b]Spin-Aid and etho with High Surfactant Methylated Oil Concentrate (HSMOC) or Methylated Seed Oil (MSO) at 1 pt/A.

Table 2. Kochia control herbicide treatments, NDSU Greenhouse, 2024 and 2025.

Herbicide Treatment[a,b]	Rate (fl oz/A)	Sugarbeet stage (lvs/days)
SA + etho	12 + 4	Cotyledon
SA + etho / SA + etho	12 + 4 / 16 + 4	Cotyledon / 5-7 d
SA + etho / SA + etho + Stinger HL	12 + 4 / 16 + 4 + 1.8	Cotyledon / 5-7 d
SA + etho / SA + etho + DM	12 + 4 / 16 + 4 + 16	Cotyledon / 5-7 d
SA + etho / SA + etho + DM + SHL	12 + 4 / 16 + 4 + 16 + 1.8	Cotyledon / 5-7 d
SA + etho / SA + etho / SA + etho	12 + 4 / 16 + 4 / 24 + 4	Cotyledon / 5-7 d / 5-7 d
SA + etho / SA + etho + SHL / SA + etho	12 + 4 / 16 + 4 + 1.8 / 24 +4	Cotyledon / 5-7 d / 5-7 d
SA + etho / SA + etho + DM / SA + etho	12 + 4 / 16 + 4 +16 / 24 + 4	Cotyledon / 5-7 d / 5-7 d
SA + etho / SA + etho + DM + HL / SA + etho	12 + 4 / 16 + 4 +16 + 1.8 / 24 + 4	Cotyledon / 5-7 d / 5-7 d

[a]SA = Spin-Aid, etho = ethofumesate, DM = Dual Magnum, SHL = Stinger HL.
[b]Spin-Aid treatments contained HSMOC or MSO at 1 pt/A.

Field experiments. Weed control experiments were conducted near Felton and Glyndon, MN to evaluate kochia control in sugarbeet. Herbicide treatments are listed in Table 3. Experiments considered sugarbeet tolerance and kochia control from one, two, and three Spin-Aid plus ethofumesate applications with or without ethofumesate PRE. Experiments were prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in 22-inch rows at approximately 64,000 seeds per acre with 4.5 inch spacing between seeds. Dual Magnum at 1 pt/A was applied PRE across the experimental area to control waterhemp. Treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 35 psi to the center four rows of six row plots 40 feet in length.

Table 3. Kochia control treatments in field experiments, 2024.

Herbicide Treatments[a,b]	Rate (fl oz/A)	Kochia stage (lvs/days)
SA + etho	12 + 4	5-lf
SA + etho / SA + etho + RUPM3	12 + 4 / 16 + 4 + 25	5-lf / 5-7 d
SA + etho / SA + etho + RUPM3	12 + 4 / 24 + 4 + 25	5-lf / 5-7 d
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 16 + 4 + 25 / 24 + 4	5-lf / 5-7 d / 5-7 d
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 16 + 4 + 25 / 32 + 4	5-lf / 5-7 d / 5-7 d
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 24 + 4 + 25 / 24 + 4	5-lf / 5-7 d / 5-7 d
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 24 + 4 + 25 / 32 + 4	5-lf / 5-7 d / 5-7 d
Etho / SA + etho / SA + etho + RUPM3	6 / 12 + 4 / 16 + 4 + 25	PRE / 5-lf / 5-7 d
Etho / SA + etho / SA + etho + RUPM3 / SA + etho	6 / 12 + 4 / 16 + 4 + 25 / 24 + 4	PRE / 5-lf / 5-7 d

[a]SA = Spin-Aid, etho = ethofumesate, DM = Dual Magnum, SHL = Stinger HL.
[b]Spin-Aid mixed with ethofumesate and Roundup PowerMax3 plus HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.

Sugarbeet growth reduction injury and kochia control was evaluated approximately 4, 12, 28, and 35 to 36 days after treatment (DAAD) with a 0 to 100% scale (0% denoting no sugarbeet injury or kochia control and 100% denoting complete loss of sugarbeet stature/stand or kochia control). All evaluations were a visible estimate of injury or control in the four treated rows compared to the adjacent, two-row, untreated strip. Experimental design was randomized complete block (RCBD) with four replications. Data were analyzed as a RCBD with the ANOVA procedure of ARM, version 2024.4 software package.

Results and Discussion

Greenhouse efficacy. Multiple kochia control experiments were conducted in December, 2023 and January, February, and March, 2024 to investigate kochia control from Spin-Aid. We observed improved kochia control as the Spin-Aid rate increased from 48 fl oz/A to 144 fl oz/A. However, kochia control was best from 2-times Spin-Aid applications as compared with a single Spin-Aid application (data not presented).

Spin-Aid applied singly or in 2 sequential applications, mixed with ethofumesate, did not provide acceptable kochia control (Table 4 and Figure 2). Kochia control was improved with 3-times application of Spin-Aid. In general, number of Spin-Aid plus ethofumesate applications was more effective than the Spin-Aid rate.

Table 4. Kochia control in response to Spin-Aid and ethofumesate, greenhouse, 2024 and 2025.[a]

Herbicide Treatments[b]	Rate	Kochia stage	Exp. 1 14 DAAC[c]	Exp. 2 11 DAAC	Exp. 3 12 DAAC
	-----fl oz/A-----	---lvs/days---	------------------------------%-------------------------		
Untreated Control		5-lf	0 f	0 e	8 e
SA + etho	16 + 4	5-lf / 5-7d	40 e	33 d	28 d
SA + etho / SA + etho	16 + 4 / 20 + 4	5-lf / 5-7d	-[d]	-	54 c
SA + etho / SA + etho	16 + 4 / 24 + 4	5-lf / 5-7d	59 d	60 c	53 c
SA + etho / SA + etho	16 + 4 / 32 + 4	5-lf / 5-7 d	76 c	65 c	-
SA + etho / SA + etho / SA + etho	16 + 4 / 24 + 4 / 32 + 4	5-lf / 5-7 d / 5-7 d	-	-	67 b
SA + etho / SA + etho / SA + etho	16 + 4 / 24 + 4 / 32 + 4	5-lf / 5-7 d / 5-7 d	85 ab	81 b	73 ab
SA + etho / SA + etho / SA + etho	16 + 4 / 24 + 4 / 40 + 4	5-lf / 5-7 d / 5-7 d	83 b	85 ab	-
SA + etho / SA + etho / SA + etho	16 + 4 / 32 + 4 / 32 + 4	5-lf / 5-7 d / 5-7 d	90 a	88 a	-
SA + etho / SA + etho / SA + etho	16 + 4 / 32 + 4 / 40 + 4	5-lf / 5-7 d / 5-7 d	84 b	89 a	-
SA + etho / SA + etho / SA + etho / SA + etho	16 + 4 / 20 + 4 / 28 + 4 / 32 + 4	5-lf / 5-7 d / 5-7 d	-	-	78 a
P-Value (0.10)			0.0001	0.0001	0.0001

[a]Means with different letters are different at alpha = 0.10.
[b]Spin-Aid mixed with ethofumesate plus HSMOC or MSO at 1 pt/A.
[c]DAAC=Days after application C.
[d] '-' indicates treatment was not included in experiment.

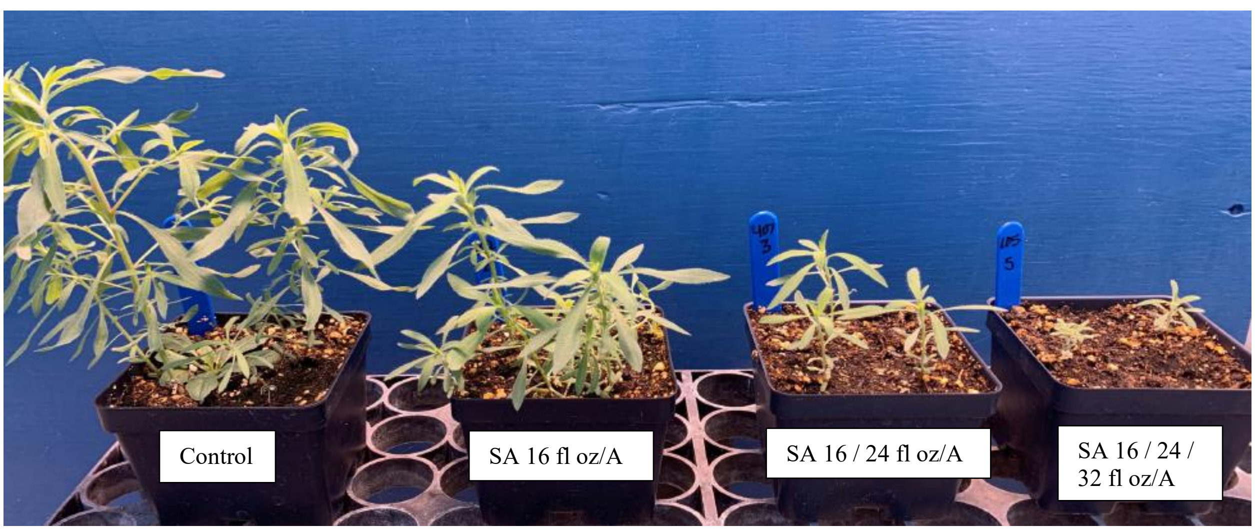

Figure 2. Kochia control from Spin-Aid mixed with ethofumesate, 21 days after application C (DAAC), NDSU Greenhouse, December to January, 2023 to 2024.

We elected to conduct a fourth experiment in December and January, 2024 and 2025, respectively, considering 4-times Spin-Aid plus ethofumesate applications. We did not observe improved kochia control from 4-times Spin-Aid applications as compared with a 3-times Spin-Aid plus ethofumesate application (Figure 3 and Figure 4).

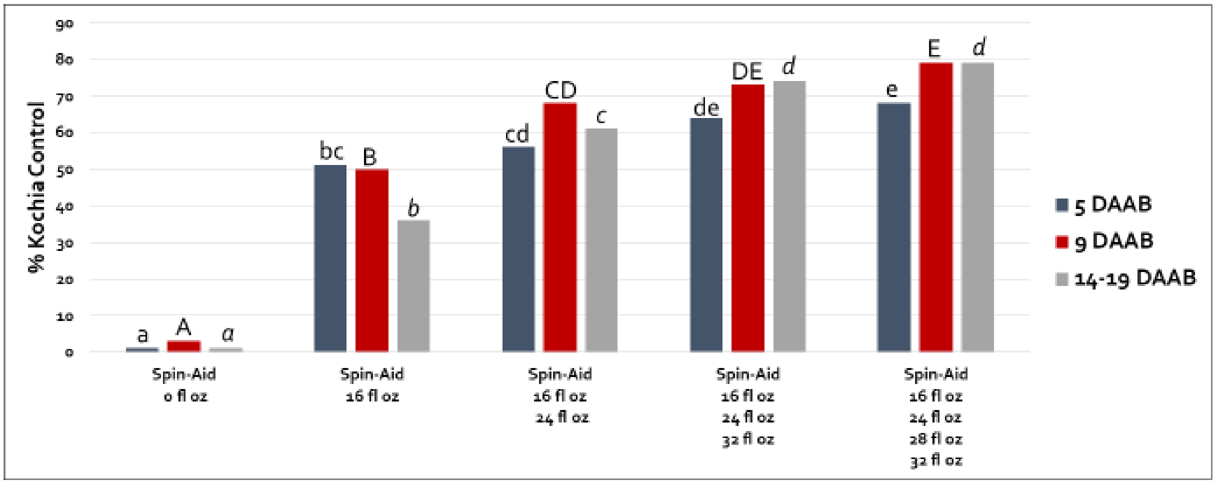

Figure 3. Kochia control in response to 1-time, 2-times, 3-times, or 4-times Spin-Aid plus ethofumesate and high surfactant methylated seed oil treatments, NDSU greenhouse, 2025. Means within a rating timing that do not share any letter are significantly different by the LSD at the 10% level of significance.

Figure 4. Kochia control in response to Spin-Aid plus ethofumesate, NDSU greenhouse, 2025. Image collected 10 days after application C (DAAC).

Kochia control was not improved when Stinger HL, *S*-metolachlor, or Stinger HL plus S-metolachlor were mixed with Spin-Aid and ethofumesate (Table 5). Kochia control was greater with 3-times Spin-Aid plus ethofumesate applications as compared with 2-time applications. Stinger HL, *S*-metolachlor, and Stinger HL plus *S*-metolachlor mixed with Spin-Aid and ethofumesate tended to improve kochia control. Overall, kochia control was less in this experiment as compared with other experiments. We have no explanation as to why.

Table 5. Kochia control in response to Spin-Aid and ethofumesate mixtures with Stinger HL and S-metolachlor, greenhouse, 2025.[a]

Herbicide Treatments[b]	Rate	Kochia Control	
		4 DAAC	9 DAAC
	----------fl oz/A-------------	----------------%----------------	
SA + etho[c]	12 + 4	0 d	0 d
SA + etho / SA + etho + RUPM3	12 + 4 / 16 + 4 + 25	44 c	0 d
SA + etho / SA + etho + RUPM3	12 + 4 / 24 + 4 + 25	61 ab	33 bc
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 16 + 4 + 25 / 24 + 4	51 c	23 c
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 16 + 4 + 25 / 32 + 4	53 bc	25 c
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 24 + 4 + 25 / 24 + 4	61 ab	28 c
SA + etho / SA + etho + RUPM3 / SA + etho	12 + 4 / 24 + 4 + 25 / 32 + 4	69 a	45 a
Etho / SA + etho / SA + etho + RUPM3	6 / 12 + 4 / 16 + 4 + 25	65a	43 ab
Etho / SA + etho / SA + etho + RUPM3 / SA + etho	6 / 12 + 4 / 16 + 4 + 25 / 24 + 4	68 a	33 bc
P Value (0.10)		0.0001	0.0001

[a]Means with different letters are significantly different at alpha = 0.10.
[b]Spin-Aid mixed with ethofumesate plus HSMOC at 1 pt/A.
[c]SA=Spin-Aid; etho=ethofumesate; RUPM3=Roundup PowerMax3.

Field Efficacy. Kochia germination and emergence was different in 2024 field locations. Kochia emerged immediately after planting at Felton, MN and Spin-Aid treatments were applied 19 days after planting (DAP). At Glyndon, Spin-Aid treatments were applied 7 days later, or 26 DAP.

It is clear that kochia control requires multiple Spin-Aid applications. Spin-Aid applied in two applications improved kochia control as compared with a single application, but two sprays provided less than 70% kochia control at both locations (Tables 6, 7). Spin-Aid applied three times pushed control into the upper 70s and lower 80s percent, 14 day after application ‘D’ (DAAD) at Felton and Glyndon, respectively. However, control fell into the 70s and 60s percent, 28 DAAD, at Glyndon and Felton, respectively. We observed mixed results when Spin-Aid was applied following ethofumesate PRE.

Table 6. Kochia control in response to herbicide treatment, Glyndon MN, 2024.[a]

Herbicide Treatment[b]	Rate	Kochia stage	Kochia Control	
			14 DAAD[c]	28 DAAD
	-----fl oz/A-----	----lvs/days---	-------------------%---------------	
SA[d]	12	5-lf	40 d	36 c
SA / SA	12 / 16	5-lf / + 5-7d	66 b	66 ab
SA / SA	12 / 24	5-lf / + 5-7d	55 c	54 bc
SA / SA / SA	12 / 16 / 24	5-lf / + 5-7 d / + 5-7 d	74 ab	69 ab
SA / SA / SA	12 / 16 / 32	5-lf / + 5-7 d / + 5-7 d	78 a	73 ab
SA / SA / SA	12 / 24 / 24	5-lf / + 5-7 d / + 5-7 d	83 a	78 a
SA / SA / SA	12 / 24 / 32	5-lf / + 5-7 d / + 5-7 d	79 a	75 a
PRE[e] / SA / SA	6 / 12 / 16	PRE / + 5-lf / + 5-7d	75 ab	74 ab
PRE / SA / SA / SA	6 / 12 / 16 / 24	PRE / + 5-lf / + 5-7d	76 ab	78 a

[a]Means with different letters are different at alpha = 0.10.
[b]Spin-Aid with ethofumesate at 4 fl oz/A. 2-times Spin-Aid with ethofumesate and glyphosate at 25 fl oz/A plus Amsol liquid AMS at 2.5% v/v and HSMOC at 1 pt/A.
[c]DAAD= Days after third Spin-Aid application or fourth total application.
[d]SA=Spin-Aid.
[e]Ethofumesate PRE at 6 pt/A.

Table 7. Kochia control in response to herbicide treatment, Felton MN, 2024.[a]

Herbicide Treatment[b]	Rate	Kochia stage	Kochia Control 14 DAAD[c]	Kochia Control 28 DAAD
	-----fl oz/A----	-----lvs/days----	-----------------%-------------	
SA[d]	12	5-lf	50 d	25 d
SA / SA	12 / 16	5-lf / + 5-7d	66 cd	44 cd
SA / SA	12 / 24	5-lf / + 5-7d	68 bcd	50 bc
SA / SA / SA	12 / 16 / 24	5-lf / + 5-7 d / + 5-7 d	80 abc	53 bc
SA / SA / SA	12 / 16 / 32	5-lf / + 5-7 d / + 5-7 d	85 ab	69 ab
SA / SA / SA	12 / 24 / 24	5-lf / + 5-7 d / + 5-7 d	79 abc	69 ab
SA / SA / SA	12 / 24 / 32	5-lf / + 5-7 d / + 5-7 d	78 abc	66 ab
PRE[e] / SA / SA	6 / 12 / 16	PRE / + 5-lf / + 5-7d	80 abc	65 ab
PRE / SA / SA / SA	6 / 12 / 16 / 24	PRE / + 5-lf / + 5-7d	89 a	84 a

[a]Means with different letters are different at alpha = 0.10.
[b]Spin-Aid with ethofumesate at 4 fl oz/A. 2-times Spin-Aid with ethofumesate and glyphosate at 25 fl oz/A plus Amsol liquid AMS at 2.5% v/v and HSMOC at 1 pt/A.
[c]DAAD= Days after third Spin-Aid application or fourth total application.
[d]SA=Spin-Aid.
[e]Ethofumesate PRE at 6 pt/A.

A series of images (Figure 5-9) chronicles kochia control across time at Felton, MN. As was stated in the Spin-Aid tolerance report, air and soil temperatures were below normal in 2024, resulting in prolonged kochia germination and emergence. Images are: A) Spin-Aid at 12 fl oz/A with ethofumeate; B) 2-times Spin-Aid application, the second application with Roundup PowerMax3 and ethofumesate at 25+4 fl oz/A; C) 3-times Spin-Aid application, the third at 32 fl oz/A with etho; and D) ethofumesate PRE at 6 pt/A followed by 2-times Spin-Aid application as previously described.

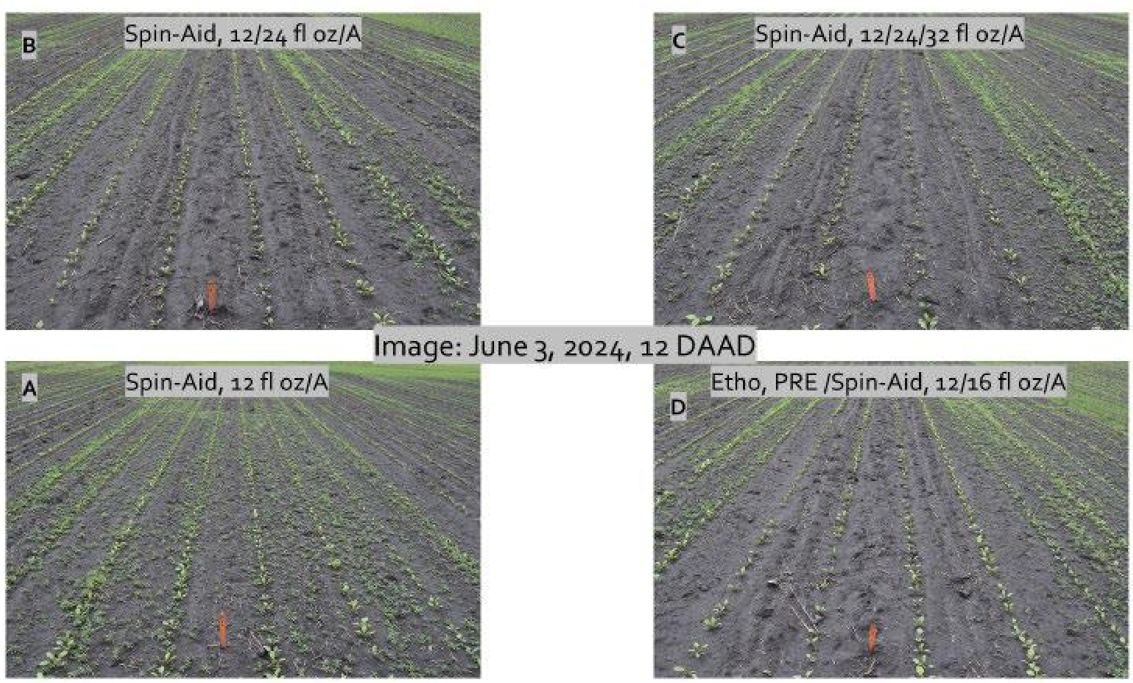

Figure 5. Kochia control in response to Spin-Aid and ethofumesate at 4 fl oz/A with high surfactant methylated oil concentrate, Felton MN, 2024. A) 1-time Spin-Aid application, B) 2-times Spin-Aid application, second application with Roundup PowerMax3 at 25 fl oz/A, C) 3-times Spin-Aid application, second application with Roundup PowerMax3 at 24 fl oz/A, D) ethofumesate at 6 pt/A PRE followed by 2-time Spin-Aid, second application with Roundup PowerMax3 at 25 fl oz/A.

We were pleased by kochia control in May and early June. However, new kochia emergence and growth from previously emerged kochia was evident on June 19, or 28 DAAD. Kochia is most common in fields with medium or course textured soils in Minnesota and North Dakota. These soils are also prone to moving soil which delays sugarbeet growth and development in the spring. We have observed a condition called 'sand syndrome' or slowed sugarbeet growth and development. Researchers have linked this poor sugarbeet growth with inherent low nutrient availability in course textured soils and have suggested spent lime and supplementary nutrient applications to overcome this condition (Sims, 2008; Overstreet et al., 2008). We did not fertilize the experimental area in 2024 which may have slowed sugarbeet growth and development. Spin-Aid reduces kochia growth and development but does not kill all plants. However, the competitive advantage achieved by reducing kochia growth enables sugarbeet to outcompete the kochia. That did not occur in our 2024 experiments.

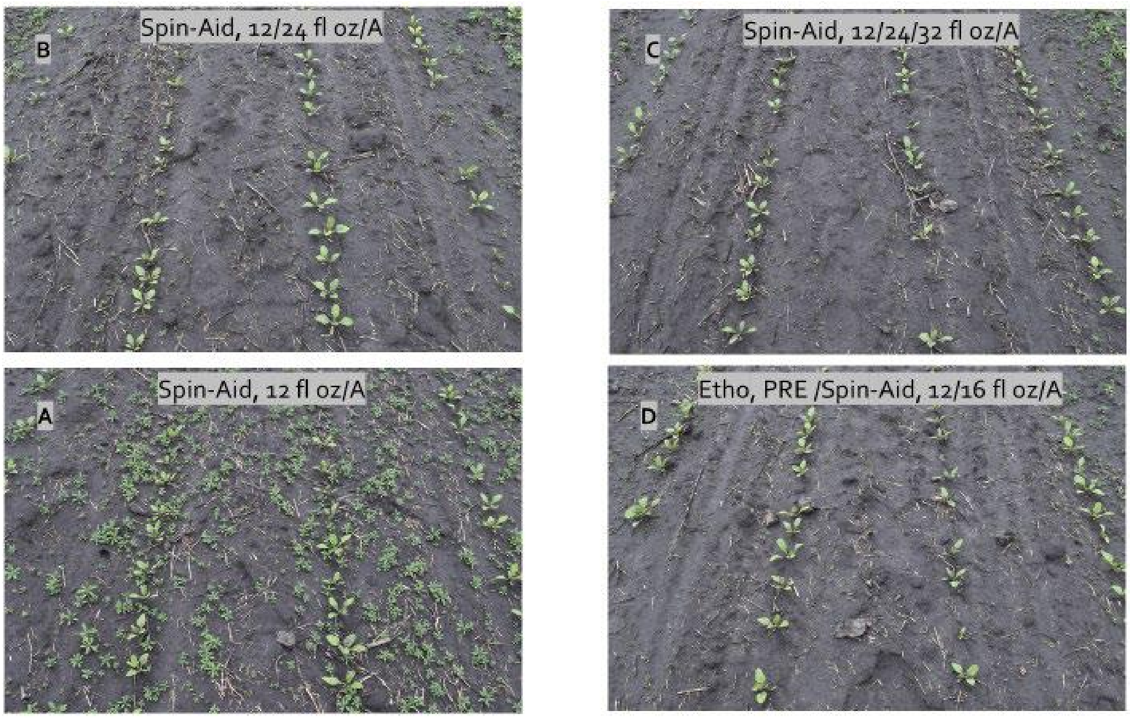

Figure 6. Kochia control in response to Spin-Aid and ethofumesate at 4 fl oz/A with high surfactant methylated oil concentrate, 12 days after application D (DAAD), Felton MN, 2024.

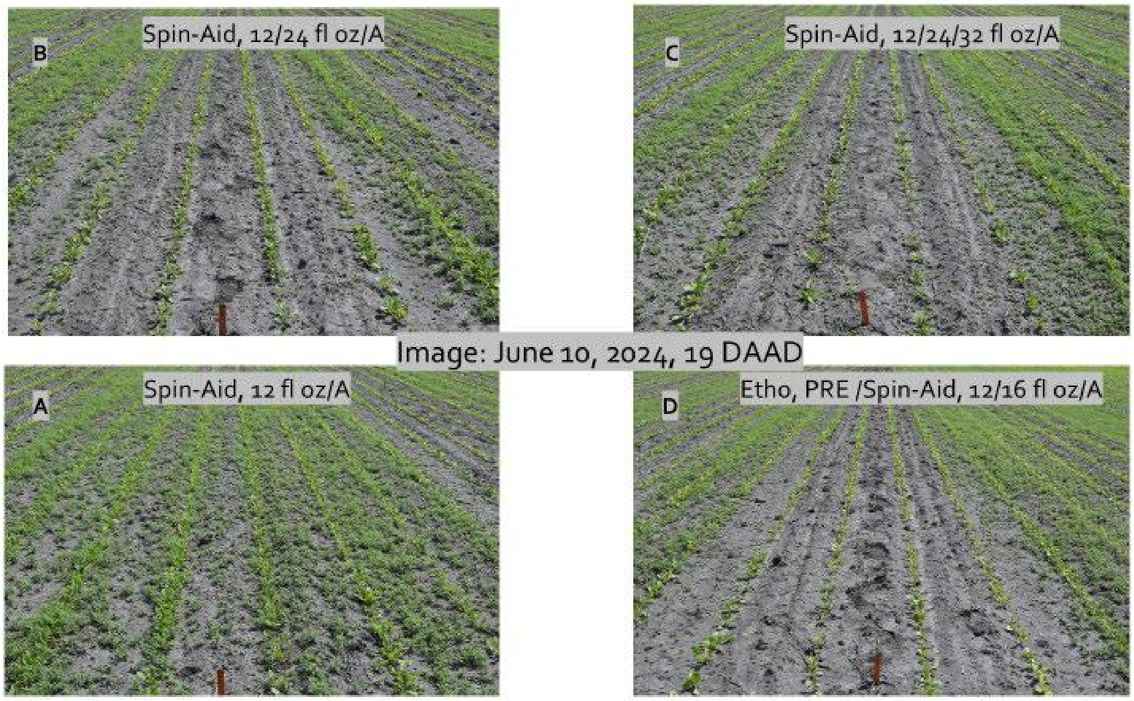

Figure 7. Kochia control in response to Spin-Aid and ethofumesate at 4 fl oz/A with high surfactant methylated oil concentrate, 19 days after application D (DAAD), Felton MN, 2024.

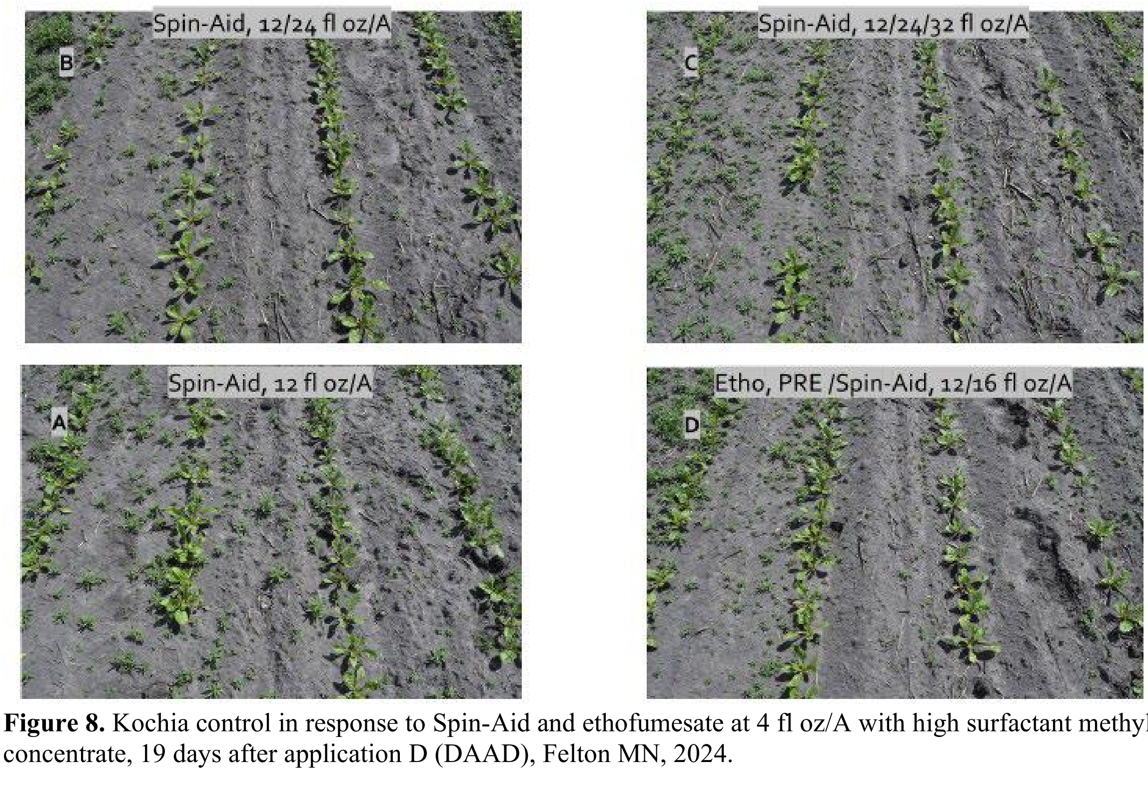

Figure 8. Kochia control in response to Spin-Aid and ethofumesate at 4 fl oz/A with high surfactant methylated oil concentrate, 19 days after application D (DAAD), Felton MN, 2024.

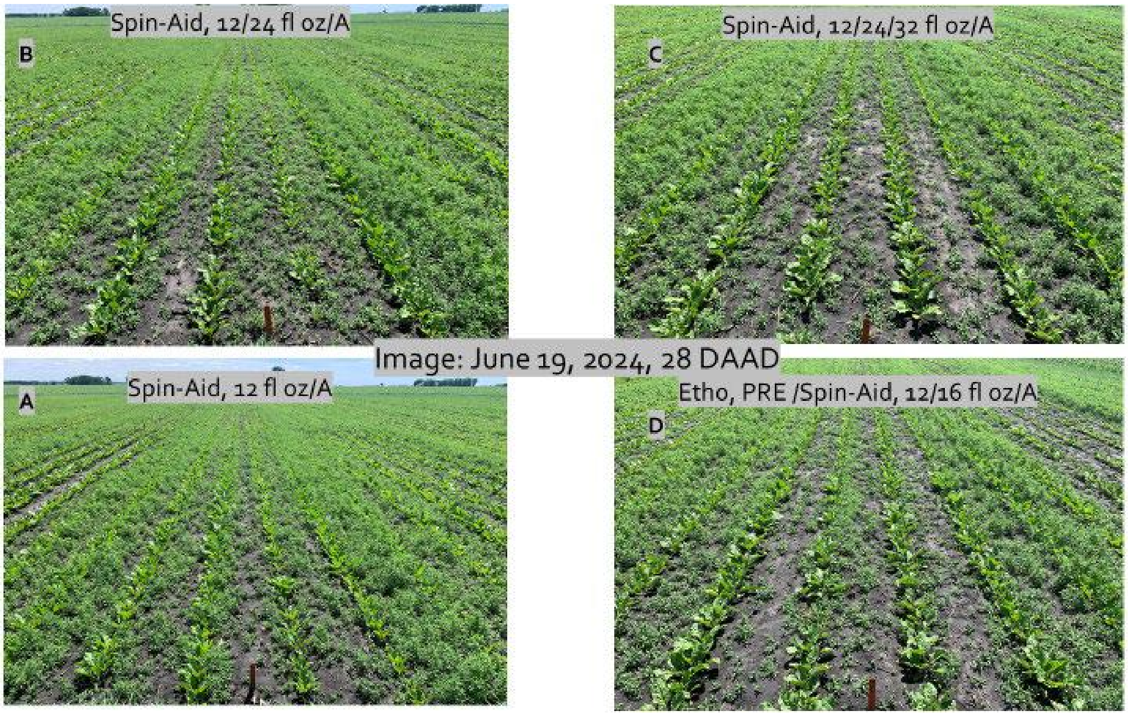

Figure 9. Kochia control in response to Spin-Aid and ethofumesate at 4 fl oz/A with high surfactant methylated oil concentrate, 19 days after application D (DAAD), Felton MN, 2024.

Conclusion

Fields with kochia must be very carefully managed. We believe kochia control is a meticulously planned strategy involving kochia size, evaluation of maximum daily air temperature, Spin-Aid rate at application, sugarbeet growth stage, and how other co-herbicides will be deployed. Sugarbeet fields usually contain several weed species, so Roundup PowerMax3, Stinger HL, and a chloroacetamide herbicide, like Dual Magnum, often are used and potentially will be mixed with Spin-Aid. We elected to use Spin-Aid with ethofumesate on 5-lf kochia, waiting until the second application to deploy Stinger HL, *S*-metolachlor and/or Roundup PowerMax3. Finally, growing conditions in the season will dictate whether to apply two or three Spin-Aid applications. Currently, our best recommendations follow in Table 7.

Table 8. Recommended Spin-Aid use rates.[a]

Sugarbeet Stage (lvs)	Cold (<80F) at application	Warm (>80F) at application	Mixed with Stinger HL and *S*-metolachlor[b]
	-----------------------------------	fl oz/A	-----------------------------------
Cotyledon	16	12	12
Early 2-lf (horns)	20	16	16
2-4-lf	28	24	24
4-lf	32	28	28
6-lf	40	36	36

[a]Spin-Aid applied on 5- to 7-day intervals when sugarbeet actively growing or on 10-day intervals when sugarbeet not growing.
[b]Spin-Aid mixed with ethofumesate at 4 fl oz per acre with MSO or HSMOC at 1 pt/A.

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SELECTIVE COMMON RAGWEED CONTROL FROM SPIN-AID OR SPIN-AID MIXED WITH STINGER HL IN SUGARBEET

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Summary

1. A one-time Spin-Aid application does not provide acceptable common ragweed control.
2. A two-time Spin-Aid application controlled common ragweed better than a one-time Spin-Aid application, but did not consistently deliver greater than 90% common ragweed control, especially greater than 30 days after the first Spin-Aid application.
3. One or two-time Stinger HL applications mixed with Spin-Aid may improve tough to control common ragweed populations or slightly larger common ragweed.
4. Spin-Aid mixed with Stinger HL rather than Roundup PowerMax3 might be a good strategy for early season common ragweed control without harming small grain nurse crop.

Introduction

North Dakota State University researchers have evaluated Spin-Aid (phenmedipham) since 2022. Most of our effort has been on control of glyphosate resistant (GR) kochia in sugarbeet since it is an unmet need expressed by our growers in surveys conducted at annual grower seminars.

The original Betanal label (Nor-Am Agricultural Products, Inc.) indicated common ragweed, common lambsquarters and wild mustard control, in addition to kochia, from phenmedipham. Control of GR common ragweed is an important weed control challenge in sugarbeet production, especially in Traill and Grand Forks counties in North Dakota and Norman and Polk counties in Minnesota. GR common ragweed control is especially important since control from Stinger HL (clopyralid) was inconsistent in 2023 and 2024. Our best management practices for common ragweed control are: a) Stinger HL at 2.4 fl oz/A in a single application or Stinger HL at 1.8 fl oz/A fb (followed by) a repeat Stinger HL at 1.8 fl oz/A application; and b) apply Stinger HL application to ragweed size rather than sugarbeet stage, targeting common ragweed less than 2-inches. Stinger HL often is applied in combination with Roundup PowerMax3 for broad spectrum control. However, herbicide treatment often is delayed beyond 2-inch common ragweed because producers do not want to terminate grass nurse crops.

Spin-Aid alone or Spin-Aid mixed with Stinger HL might be an effective strategy for common ragweed control. Spin-Aid would reduce the selection pressure on clopyralid, which is a component of several products/premixes used in corn and wheat production in the cropping sequence, in addition to sugarbeet. Nurse crops also would tolerate Spin-Aid. The objective of this field research was to evaluate common ragweed control from Spin-Aid alone and Spin-Aid mixed with Stinger HL in sugarbeet.

Materials and Methods

Experiments were conducted near Shelly, MN in 2024 to evaluate common ragweed control from Spin-Aid. Treatments are detailed in Table 1 and Table 2. Primary tillage in the fall was followed by secondary tillage with a field cultivator in the spring to prepare the seedbed for sugarbeet planting. Sugarbeet was seeded in 22-inch rows at approximately 64,000 seeds per acre or approximately 4.5-inch spacing between seeds on April 25, 2024. Dual Magnum was broadcast applied across the experimental area to control grass and broadleaf weeds since common ragweed was the focus of the experiment. Treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002XR flat fan nozzles (TeeJet® Technologies, Glendale Heights, IL) pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length. Environmental conditions, sugarbeet growth stage, and common ragweed size at application are in Tables 3 and 4.

Table 1. Herbicide treatments, Spin-Aid for common ragweed control.

Postemergence Herbicide[a]	Rate (fl oz/A)	Sugarbeet stage (lf stage)
Spin-Aid + ethofumesate	12 + 4	2
Spin-Aid + ethofumesate	16 + 4	2
Spin-Aid + ethofumesate	24+ 4	2
Spin-Aid + etho / Spin-Aid + etho + RUPM3	12 + 4 / 16 + 4 + 25	2 / 5-7d
Spin-Aid + etho / Spin-Aid + etho + RUPM3	12 + 4 / 24 + 4 + 25	2 / 5-7d
Spin-Aid + etho / Spin-Aid + etho + RUPM3	16 + 4 / 16 + 4 + 25	2 / 5-7 d
Spin-Aid + etho / Spin-Aid + etho + RUPM3	16 + 4 / 24 + 4 + 25	2 / 5-7 d /
Etho / Spin-Aid + etho	6 / 12 + 4	PRE / 2
Etho / Spin-Aid + etho / Spin-Aid + etho + RUPM3	6 / 12 + 4 / 16 + 4 + 25	PRE / 2 / 5-7d

[a]RUPM3 = Roundup PowerMax3; etho = ethofumesate. Spin-Aid and ethofumesate with high surfactant methylated oil concentrate (HSMOC) at 1 pt/A. Roundup PowerMax3 with NIS and Amsol liquid AMS at 0.25% + 2.5% v/v. Roundup PowerMax3, Spin-Aid and ethofumesate with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.

Table 2. Herbicide treatments, Spin-Aid and Stinger HL alone and Spin-Aid mixed with Stinger HL.

Postemergence Herbicide[a]	Rate (fl oz/A)	Sugarbeet (lf stage)	Common ragweed (inches)
Spin-Aid	24	2-4 lf	2
Spin-Aid / Spin-Aid	16 / 16	2-4 lf / 5-7 d	2 / 5-7 day
Stinger HL	1.8	2-4 lf	2
Stinger HL / Stinger HL	1.5 / 1.5	2-4 lf / 5-7 d	2 / 5-7 day
Spin-Aid + Stinger HL	24 + 1.8	2-4 lf	2
Spin-Aid + Stinger HL / SA + SHL	16 + 1.5 / 16 + 1.5	2-4 lf / 5-7 d	2 / 5-7 day
Spin-Aid + Stinger HL + RUPM3	24 + 1.8 + 25	2-4 lf	2
Spin-Aid + Stinger HL / Spin-Aid + Stinger HL +RUPM3	16 + 1.5 / 16 + 1.5 + 25	2-4 lf /5-7 day	2 / 5-7 day
Etho / Spin-Aid + Stinger HL	6/ 24 + 1.8	PRE/ 2-4 lf	PRE/ 2 in

[a]RUPM3 = Roundup PowerMax3. Spin-Aid, Stinger HL or Spin-Aid plus Stinger HL with HSMOC at 1 pt/A. Spin-Aid + Stinger HL + PowerMax3 with HSMOC and Amsol liquid AMS at 1 pt/A + 2.5% v/v.

Table 3. Weather at application, Spin-Aid, Shelly, MN, 2024.

	Application Timing		
	PRE_Application A	**EPOST_Application B**	**POST_Application C**
Date of Application	April 30	May 22	May 28
Time of Day	1:00 PM CST	1:00 PM CST	3:30PM CST
Air Temperature (F)	52	63	57
Relative Humidity (%)	62	58	69
Wind Velocity (mph)	9	19	13
Wind Direction	E	NNE	N
Soil Temp. (F at 6-inch)	44	-	-
Soil Moisture	Slightly wet	Wet	Very Wet
Cloud Cover (%)	-	70	100
Sugarbeet stage	-	2-lf	4-lf
Common ragweed size (inch)	-	2-lf	4-lf

Table 4. Weather at application, Spin-Aid and Stinger HL, Shelly, MN, 2024.

	Application Timing		
	PRE_Application A	**EPOST_Application B**	**POST_Application C**
Date of Application	April 30	May 29	June 3
Time of Day	-	-	-
Air Temperature (F)	52	71	64
Relative Humidity (%)	62	42	75
Wind Velocity (mph)	9	10	3
Wind Direction	E	S	W
Soil Temp. (F at 6-inch)	44	-	-
Soil Moisture	Slightly Wet	Dry	Very Wet
Cloud Cover (%)	-	0	100
Sugarbeet stage	-	2-lf	4-lf
Common ragweed size (inch)	-	2- to 4-inch	2- to 4-inch

Data Collection Spin-Aid. Visible sugarbeet growth reduction injury was evaluated 20 and 27 days after application B (DAAB) by comparing sugarbeet stature in the treated area to the untreated borders. Notes were collected with a 0 to 100% scale, 0% denoting no sugarbeet injury and 100% denoting complete loss of sugarbeet stand. Visible common ragweed control was evaluated 20, 27, 35, 41, and 51 DAAB by comparing control in the treated area to the untreated area. Experimental design was randomized complete block (RCBD) with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2024.4 software package.

Data Collection Spin-Aid mixed with Stinger HL. Visible sugarbeet growth reduction injury was evaluated 13 and 21 DAAB by comparing stature in the treated area to the untreated border rows. Notes were collected using a 0 to 100% scale, with 0% denoting no sugarbeet injury and 100% denoting complete loss of sugarbeet stature/stand. Visible common ragweed control was evaluated 13, 21, 38, 34, and 44 DAAB by comparing control in the treated area to the untreated area. Experimental design was a RCBD with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2024.4 software package.

Results

Spin-Aid. We did not observe any sugarbeet injury from 1- or 2-time Spin-Aid plus ethofumesate application or ethofumesate PRE followed by Spin-Aid plus ethofumesate (Table 5). We observed less sugarbeet injury 21 DAAB than 13 DAAB. Sugarbeet injury less than 30% is considered negligible injury and will not reduce yield parameters.

Table 5. Sugarbeet growth reduction and common ragweed control in response to treatment, Shelley, MN, 2024.[a]

		Sugarbeet Injury		Common Ragweed Control			
Herbicide Treatment[a]	**Rate**	**13 DAB**	**21 DAB**	**20 DAB**	**27 DAB**	**35 DAB**	**51 DAB**
	---fl oz/A---	-------------%------------		--------------------------%--------------------------			
Spin-Aid + ethofumesate	12 + 4	13	4	59 c	53 d	45 e	33 c
Spin-Aid + ethofumesate	16 + 4	15	3	59 c	56 d	44 e	36 c
Spin-Aid + ethofumesate	24+ 4	13	5	68 c	68 c	55 d	46 b
Spin-Aid + etho / Spin-Aid + etho + RUPM3	12 + 4 / 16 + 4 + 25	24	15	84 ab	84 ab	71 abc	69 a
Spin-Aid + etho / Spin-Aid + etho + RUPM3	12 + 4 / 24 + 4 + 25	14	9	89 ab	86 ab	68 bc	66 a
Spin-Aid + etho / Spin-Aid + etho + RUPM3	16 + 4 / 16 + 4 + 25	16	9	83 b	81 b	69 abc	68 a
Spin-Aid + etho / Spin-Aid + etho + RUPM3	16 + 4 / 24 + 4 + 25	18	15	93 a	91 a	75 ab	73 a
Etho / Spin-Aid + etho	6 / 12 + 4	19	9	66 c	68 c	63 cd	50 b
Etho / Spin-Aid + etho / Spin-Aid + etho + RUPM3	6 / 12 + 4 / 16 + 4 + 25	28	14	89 ab	89 a	78 a	72 a
P value (0.10)		0.3258	0.4294	0.0001	0.0001	0.0001	0.0001

[a]Means not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]DAB = Days after application B; RUPM3 = Roundup PowerMax3; etho = ethofumesate.

Spin-Aid at 12, 16, or 24 fl oz/A plus ethofumesate did not provide acceptable control (90% or greater) in this experiment (Table 5, Figure 1).

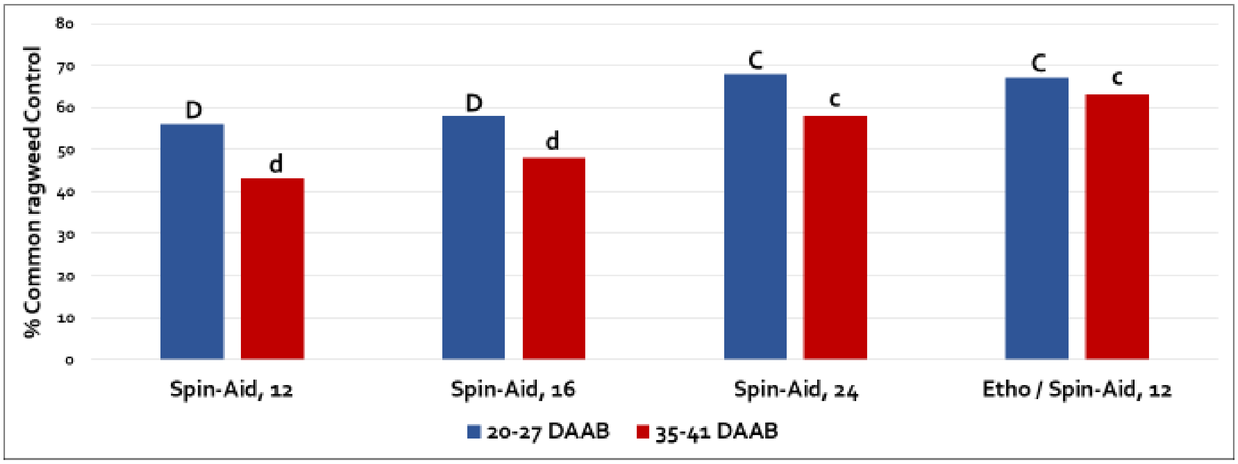

Figure 1. Common ragweed control in response to Spin-Aid + ethofumesate, Shelly MN 2024. Spin-Aid plus ethofumesate at 16 + 4 fl oz/A, respectively. Common ragweed less than 2-inches tall; sugarbeet at 2-lf stage. Ethofumesate at 6 pt/A PRE.

Two-times Spin-Aid plus ethofumesate application or ethofumesate PRE followed by Spin-Aid plus ethofumesate applications met or exceeded our 90% threshold for common ragweed control (Table 5, Figure 2). Two-times Spin-Aid application provided the greatest common ragweed at 20 or 27 DAAB (14 or 21 DAAC). Unfortunately, control was less at 35 and 51 DAAB. The 2-times Spin-Aid application for common ragweed control results are encouraging. However, sustained control was not enough indicating 2-times Spin-Aid plus ethofumesate or ethofumesate fb 2-times Spin-Aid application is not a common ragweed control solution.

Phenmedipham use rates were much different in the 1970s than today. The previous Betanal label indicated an application at 6 to 9 pints per acre over 4-lf sugarbeet. A prohibition indicated Betanal at 9 pt/A only on "well established" sugarbeet and sugarbeet not under stress. Two-times Betanal applications were generally reserved for a second flush of weeds.

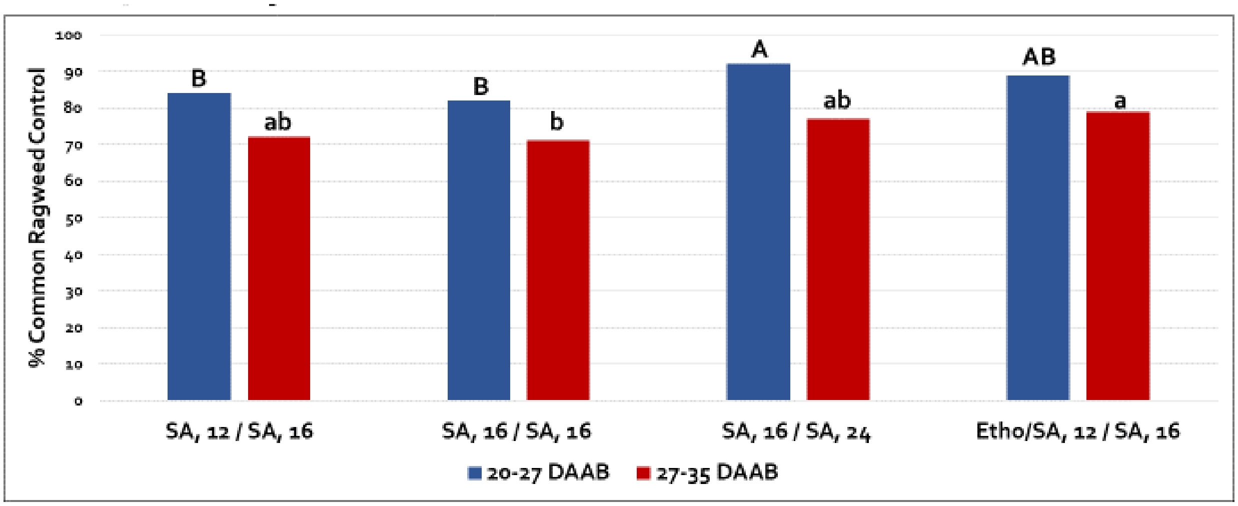

Figure 2. Common ragweed control in response to Spin-Aid + ethofumesate, Shelly MN 2024. Spin-Aid plus Ethofumesate at 16 + 4 fl oz/A, respectively. Common ragweed less than 2-inches tall; sugarbeet at 2-lf stage and a repeat application, 6 days later. Ethofumesate at 6 pt/A PRE.

Spin-Aid mixed with Stinger HL. We observed a trend towards greater sugarbeet injury from Spin-Aid mixed with Stinger HL as compared with Spin-Aid or Stinger HL alone (Table 6). Spin-Aid plus Stinger HL at 16 + 1.5 fl oz/A, respectively, followed by Spin-Aid plus Stinger HL and Roundup PowerMax3 at 16 + 1.5 + 25 fl oz/A, respectively, caused greater than 30% sugarbeet injury, 13 DAAB. However, injury decreased to 15% at 21 DAAB.

Table 6. Sugarbeet growth reduction and common ragweed control in response to treatment, Shelley, MN, 2024.[a]

		Sugarbeet Injury		Common Ragweed Control			
Postemergence Herbicide[a]	**Rate**	**13 DAB**	**21 DAB**	**13 DAB**	**21 DAB**	**34 DAB**	**44 DAB**
	----fl oz/A----	----------%----------		--------------------------%--------------------------			
Spin-Aid	24	8 de	5	60 d	55 e	40d	38 e
Spin-Aid / Spin-Aid	16 / 16	15 cd	11	90 ab	79 d	73 d	68 d
Stinger HL	1.8	0 e	11	74 c	88 bc	88 ab	81 c
Stinger HL / Stinger HL	1.5 / 1.5	21 bc	8	76 c	84 cd	93 a	94 a
Spin-Aid + Stinger HL	24 + 1.8	9 de	5	75 c	79 d	74 c	70 d
Spin-Aid + Stinger HL / Spin-Aid + Stinger HL	16 + 1.5 / 16 + 1.5	24 abc	14	95 a	95 a	94 a	95 a
Spin-Aid + Stinger HL + RUPM3	24 + 1.8 + 25	26 ab	13	75 c	86 bc	83 b	84 bc
Spin-Aid + Stinger HL / Spin-Aid + Stinger HL +RUPM3	16 + 1.5 / 16 + 1.5 + 25	32 a	15	89 ab	93 ab	94 a	93 ab
Etho / Spin-Aid + Stinger HL	6/ 24 + 1.8	15 cd	13	88 b	86 bc	82 b	81 c
P value (0.10)		0.0013	0.8354	0.0001	0.0001	0.0001	0.0001

[a]Means not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]DAB = Days after application B; RUPM3 = Roundup PowerMax3; etho = ethofumesate.

In general, common ragweed control was improved or tended to be improved from a 2-times application of either Spin-Aid or Stinger HL. (Table 6, Figure 3). The tank mix of Spin-Aid plus Stinger HL had mixed results. We observed or tended to observe less common ragweed control from Spin-Aid mixtures with Stinger HL as compared with Stinger HL alone. However, 2-times Spin-Aid plus Stinger HL application or 2-times Spin-Aid plus Stinger HL with Roundup PowerMax3 resulted in greater than 90% common ragweed control at 13 through 44 DAAB. Mixing PowerMax3 with Spin-Aid plus Stinger HL did not affect common ragweed control as compared with 2-times Spin-Aid and Stinger HL application alone. Ethofumesate PRE fb Spin-Aid plus Stinger HL improved common ragweed control compared with Spin-Aid plus Stinger HL alone; however, control did not achieve our 90% threshold.

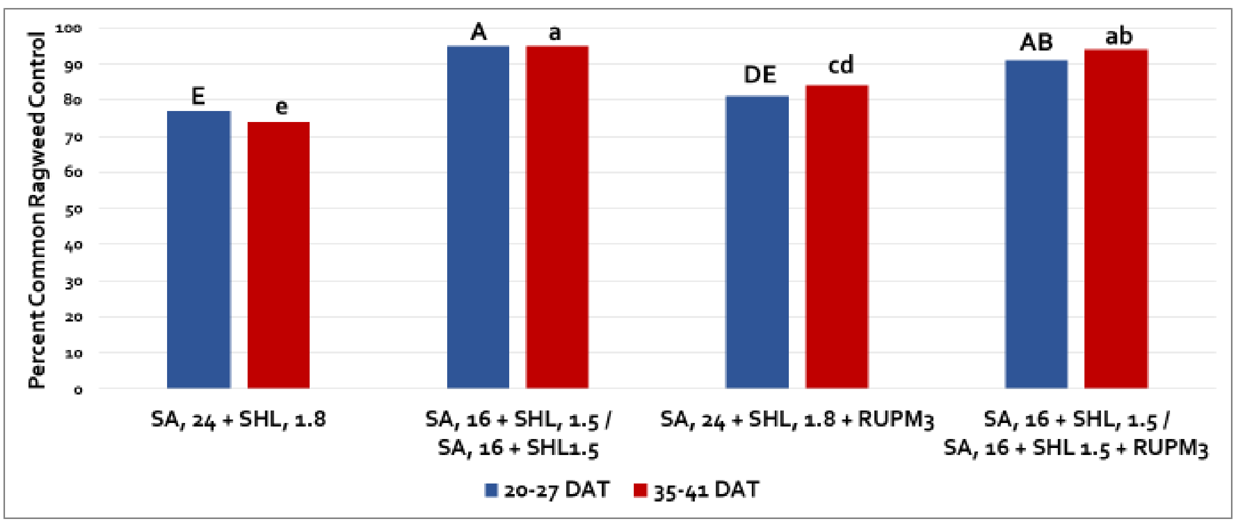

Figure 3. Common ragweed control in response to 1-time or 2-time Spin-Aid plus Stinger HL, Shelly MN, 2024. Spin-Aid plus Stinger HL at 16 + 1.5 fl oz/A, repectively; Spin-Aid and Stinger HL plus Roundup PowerMax3 at 16 + 1.5 + 25 fl oz/A, repectively. Common ragweed less than 2-inches tall; sugarbeet at 2-lf stage with a repeat application, 6 days later.

Conclusions
Overall, the experiments delivered mixed results. A 1-time or 2-time Spin-Aid application will not provide commercially acceptable common ragweed control, or 90% threshold, we are pursuing. Increasing the Spin-Aid rate is not an option based on our extensive experience evaluating sugarbeet safety of Spin-Aid mixtures with ethofumesate. We observed encouraging common ragweed control results of Spin-Aid mixtures with Stinger HL. The mixture potentially is a resistance management strategy and may also provide growers early season flexibility for common ragweed control as compared with Stinger HL mixed with Roundup PowerMax3, which also killed off grass nurse crops.

There is suggestion that Spin-Aid plus Stinger HL does not offer incremental common ragweed control as compared with common ragweed control from Stinger HL alone. Future experiments will continue to evaluate Spin-Aid mixtures with Stinger HL for improved common ragweed control and improved length of common ragweed control.

EVALUATING ON-FARM STRIP TILLAGE IN SUGARBEET

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Summary

1. Sugarbeet stand density, NDVI, root yield, sucrose content, and recoverable sucrose were similar between strip tillage and conventional tillage.
2. Slight differences in soil temperature and water content were observed between tillage systems but did not influence sugarbeet development.
3. Strip tillage offers growers the ability to leave greater amounts of crop residue on the soil surface compared to conventional tillage that can offer protection against wind erosion and plant stand loss while preserving sugarbeet production.

Introduction

Conventional tillage (CT) is predominantly used for sugarbeet production in Minnesota and North Dakota; however, interest in strip tillage (ST) is increasing for multiple reasons including soil conservation, agronomic production, and cost savings. Conventional tillage typically includes multiple tillage passes during the preceding fall and the following spring prior to sugarbeet planting to incorporate previous crop residue, incorporate broadcast spread fertilizers, and for seedbed preparation. Strip tillage can apply fertilizers and create a seedbed in a single field pass; thus, reducing fuel, time, and field operations needed for seedbed preparation (Khan and McVay 2014).

Strip tillage is a form of soil conservation since less surface area is disturbed by tillage reducing erosion by wind and water. The tilled strips of soil are approximately 20 cm wide which leaves approximately 60% of the soil undisturbed in sugarbeet rows that have 56 cm row spacing (Licht and Al-Kaisi 2005). Previous crop residue remains in the inter-row area which can provide wind protection during sugarbeet emergence and early vegetative growth (Overstreet et al. 2010). Therefore, strip tillage could allow producers to reduce tillage for conservation benefits, and still complete tillage intra-row to help the soil dry out and warm up quicker in the spring compared with no-tillage.

Overstreet et al. (2010) compared sugarbeet production using ST and CT in small plots in Minnesota and North Dakota and observed similar yields between tillage systems. This research expands on that work by evaluating sugarbeet stand density and production on-farm using commercial scale equipment. Crop yields in corn and soybean were reportedly similar between ST and CT in Minnesota, North Dakota, Wisconsin, and Illinois (Daigh et al. 2019; Lauer 2016; Hendrix et al. 2004). Continuous improvements in equipment mechanization and GPS have allowed for improved accuracy of planting into ST (Afshar et al. 2019; Khan and McVay 2014).

Objectives

The following three objectives were identified to compare ST to CT for sugarbeet production in on-farm experiments: 1) determine root yield, sucrose content, and recoverable sucrose; 2) estimate plant stand density and plant vigor from normalized difference vegetation index (NDVI); and 3) evaluate soil temperature and soil water content.

Materials and Methods

Experiments were conducted in producer fields near Hillsboro (HI21), Park River (PR21), and Warsaw (WA21) in North Dakota in 2021, and near Eldred (EL22) in Minnesota, and Ardoch (AR22), Park River (PR22), and Warsaw (WA22) in North Dakota in 2022, for a total of seven sites across two years. The producers used their standard farming practices for tillage, soil fertility management, seed selection, and pest management. Strip tillage was completed in the fall at each experimental site. The previous crop was spring wheat at all sites, except for WA22 which was corn. Each field was split with ST on one side and CT on the other side with four replicates stacked vertically the length of the field. While this design provides less statistical power than randomized replicated plots, it does allow us to evaluate the systems in realistic farm scenarios.

Sugarbeet stand density at the 4-leaf (4-lf) stage and plant vigor from NDVI using a handheld instrument at multiple timings were collected. Data loggers were placed at three positions (CT between, ST furrow, and ST between) at two sites in 2021, PR21 and WA21, and at two sites in 2022, AR22 and EL22, to collect continuous soil temperature shortly after planting for 30 days or roughly until canopy closure. Soil volumetric water content was measured at three mid-season timings using a handheld soil moisture sensor inserted into the soil 12 cm. Root yield, sucrose content, and recoverable sucrose were calculated after harvest. Data were analyzed as a RCBD with the ANOVA procedure of SAS version 9.4. Soil temperature and soil water content were analyzed by individual site due to differences in soil type and rainfall.

Results and Discussion

Sugarbeet stand density was not affected by tillage when combined across the seven sites (Table 1). Data are also shown for each site since occasional differences were observed. Extremely low counts were observed at the 4-lf stage at PR21, so a second count was collected two weeks later for two reasons. First, sugarbeet seed were laying in dry soil that would germinate following adequate rainfall, and second, a minimum air temperature of 30 F recorded at the nearby weather station (NDAWN; https://ndawn.ndsu.nodak.edu/) five days earlier suggesting emerged seedlings had frost injury that would likely reduce plant stand.

Table 1. Sugarbeet stand density in response to conventional tillage (CT) and strip tillage (ST) at sites and across sites, 2021 and 2022.

	HI21	**PR21**	**WA21**	**AR22**	**EL22**	**PR22**	**WA22**	**Combined**
Tillage	---plants 100 ft^{-1}--							
CT	151	200	186	189	199	187	203	188
ST	153	159	210	187	189	180	187	181
LSD (0.05)	NS	13	16	NS	NS	NS	11	NS
P-value	**0.86**	**<0.0001**	**0.003**	**0.75**	**0.10**	**0.29**	**0.01**	**0.37**

Lower stand density in ST at WA22 may have been due to the greater amount of residue from previous crop corn. Corn produces an abundance of residue during development. This grower used a chopping corn head at harvest that cuts the stalks close to the soil surface and chops up the senesced plant material leaving it lying on the surface that may have delayed soil warming in the spring (no soil temperature data collected at this site). Increased stand density in ST at WA21 may have been the result of greater available water content in ST since this grower used a land roller to firm the soil surface prior to planting. The rolling was only completed within ST and this firming of the soil may have reduced water evaporative loss and improved seed-to-soil contact in a dry spring. Sugarbeet plant vigor from NDVI was similar between ST and CT across sites at each collection timing (Table 2).

Table 2. Sugarbeet NDVI 1, NDVI 2, and NDVI 3 values in response to conventional tillage (CT) and strip tillage (ST) across sites, 2021 and 2022.

	NDVI 1	**NDVI 2**	**NDVI 3**
Tillage			
CT	0.33	0.66	0.76
ST	0.35	0.67	0.76
LSD (0.05)	NS	NS	NS
P-value	**0.42**	**0.76**	**0.61**

Tillage generally influenced daily soil temperature at each site; however, the differences between collection positions were not always consistent across sites indicating that ST is not always warmer or colder than CT. Tillage also influenced hourly soil temperature at each site and the differences between positions were again not consistent across sites. Temperature differences at PR21 had greater variance in magnitude among CT between, ST furrow, and ST between than the other three sites which was attributed to lower soil water content and that drier soils have the potential to warm and cool faster than wet soils (Licht and Al-Kaisi 2005). At PR21, during the hours of 00:00-

05:59, soil temperature was similar within ST furrow and ST between which were both lower than CT between (Table 3). During the hours of 06:00-11:59, temperature was similar within ST furrow and ST between, and both were lower than CT between. As the day continued into the hours of 12:00-17:59, soil temperature was higher in the ST furrow than CT between and ST between, and from 18:00-23:59, the soil temperature was lower in ST furrow than in CT between but was higher than ST between (Figure 1).

Table 3. Soil temperature averaged by quarter of day (00:00-05:59, 06:00-11:59, 12:00-17:59, 18:00-23:59) across 30 days in response to tillage effect at site PR21, 2021.

	Quarter of day (hours)			
	00:00-05:59	**06:00-11:59**	**12:00-17:59**	**18:00-23:59**
Tillage	---F---			
CT between	68.9	68.2	78.4	77.0
ST furrow	66.4	66.7	78.8	75.2
ST between	66.7	66.6	75.4	73.6
LSD (0.05)	0.4	0.4	0.4	0.4
P-value	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**

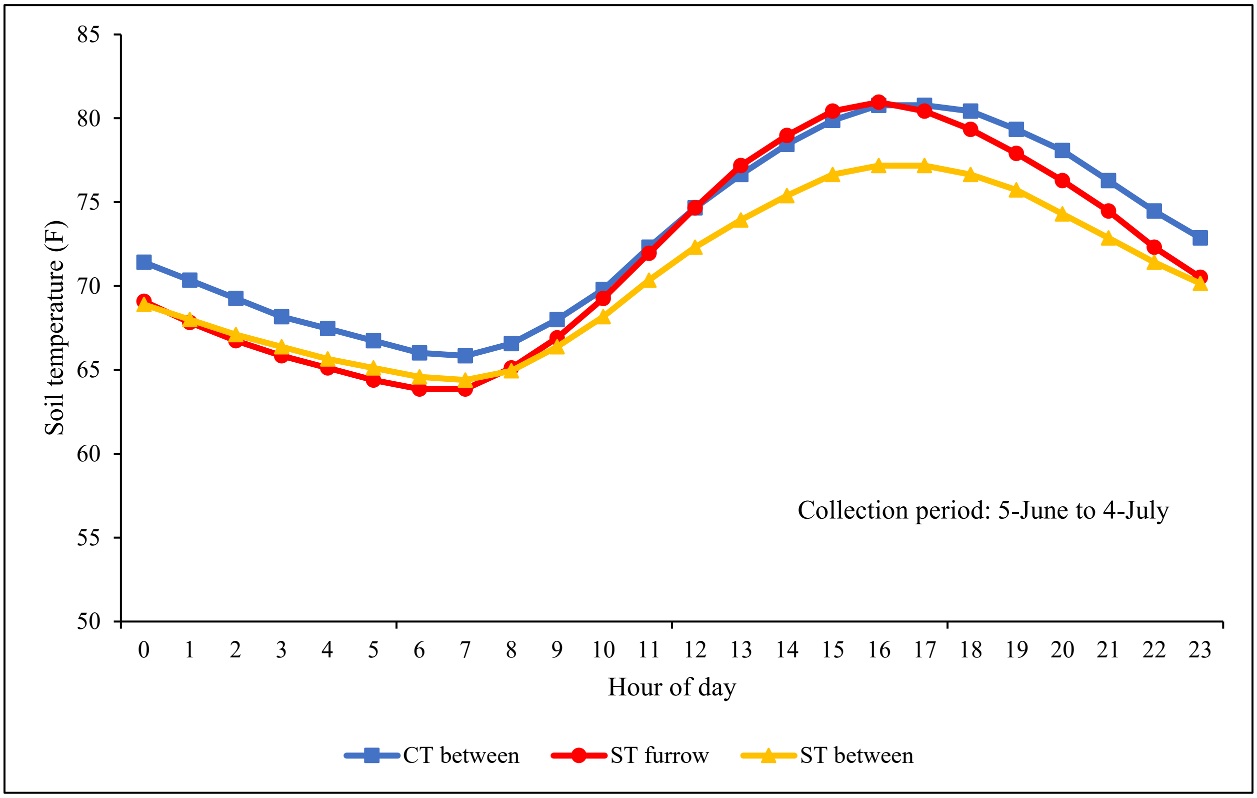

Figure 1. Hourly soil temperature averaged across 30 days in response to tillage effect (CT between, ST furrow, and ST between) at site PR21, 2021.

At WA21, soil temperature in ST furrow was similar to CT between but CT between was lower than ST between during the hours of 00:00-05:59 (Table 4). From 06:00-11:59, soil temperature in the ST furrow was higher than ST between which was higher than CT between. During 12:00-17:59, soil temperature in the ST furrow was lower than CT between and ST between which were similar to each other, and from 18:00-23:59, the soil temperature was similar across tillage positions (Figure 2).

Table 4. Soil temperature averaged by quarter of day (00:00-05:59, 06:00-11:59, 12:00-17:59, 18:00-23:59) across 30 days in response to tillage effect at site WA21, 2021.

	Quarter of day (hours)			
	00:00-05:59	**06:00-11:59**	**12:00-17:59**	**18:00-23:59**
Tillage	--	--F--	--	
CT between	65.5	64.4	73.0	71.4
ST furrow	65.7	65.3	72.5	71.6
ST between	66.0	64.9	73.2	71.4
LSD (0.05)	0.4	0.4	0.4	NS
P-value	**<0.0001**	**<0.0001**	**0.01**	**0.33**

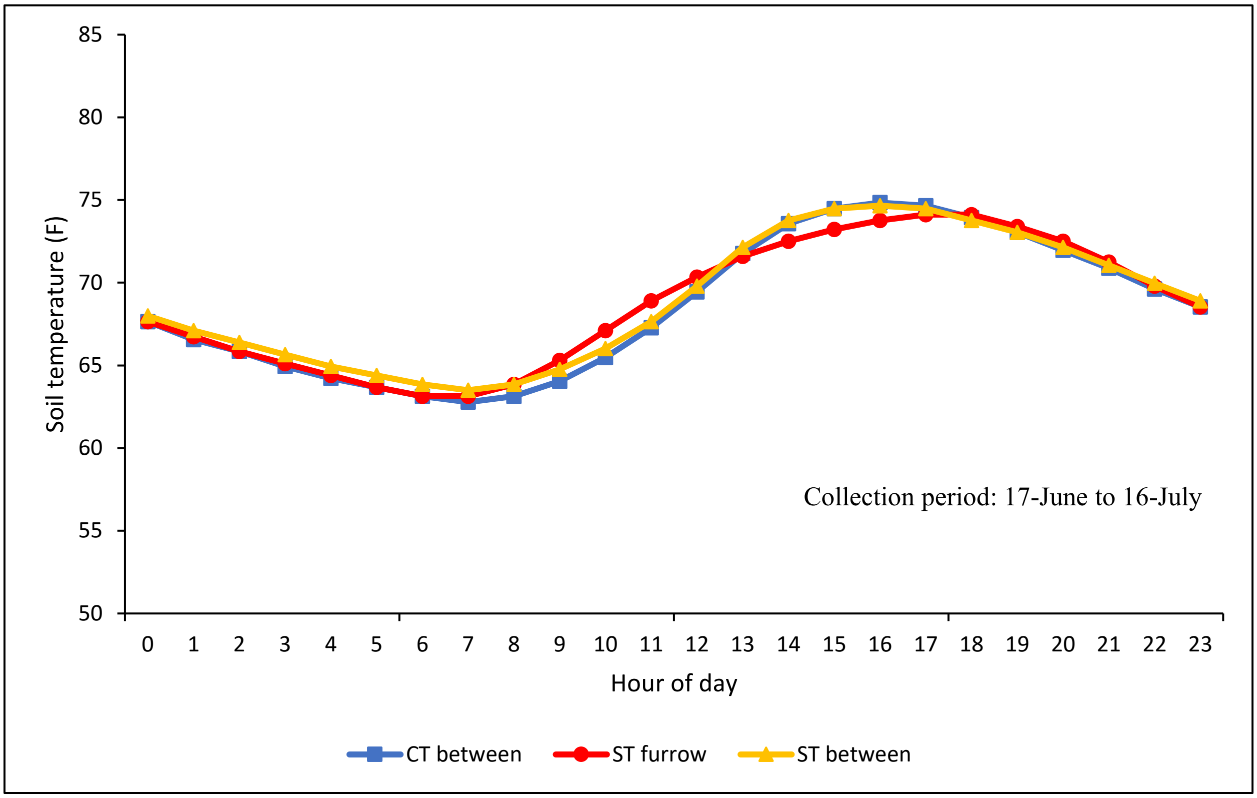

Figure 2. Hourly soil temperature averaged across 30 days in response to tillage effect (CT between, ST furrow, and ST between) at site WA21, 2021.

The soil types at the sites could have influenced soil temperature since the soil type at PR21 was comprised of Lankin loam, WA21 and AR22 were comprised of silty clay, and EL22 was comprised of silty clay loam. Clayey soils contain greater surface area allowing for greater water holding capacity which requires more solar energy to influence temperature. Soil temperature can influence plant growth and development, yet small differences were detected in this large dataset across 30 days. Small daily differences can add up over time that soil growing degree day units were calculated. At PR21, the soil temperature was warmer in CT between, followed by ST furrow, and ST between (Table 5). Differences were also observed at EL22 with the soil temperature in ST between being warmer than CT between and followed by ST furrow. The abundance of surface residue in ST between may slow soil warming, yet the residue may also limit the cooling of soil at night due to the residue acting as insulation preventing soil heat loss to the atmosphere. These observed differences in soil temperature did not contribute to changes in sugarbeet yield.

Table 5. Daily soil growing degree day units across 30 days in response to tillage effect at sites PR21, WA21, AR22, and EL22, 2021 and 2022.

	PR21	WA21	AR22	EL22
Tillage	----------------------	----------------------F	----------------------	----------------------
CT between	71.6	67.1	71.2	70.5
ST furrow	70.9	66.9	70.9	69.8
ST between	68.9	67.5	71.6	71.1
LSD (0.05)	0.7	NS	NS	0.5
P-value	**<0.0001**	**0.405**	**0.052**	**<0.0001**

Soil volumetric water content differences were observed among collection positions (furrow vs between) at each of the three collection timings for all three sites in 2021. Rainfall in 2021 was below the 30-year average in April and May and considerably below average in June and July when measurements were collected which likely accentuated differences between collection positions. Soil water content was generally lower in ST furrow than ST between and CT between. Timlin et al. (2001) noted soil water content intra-row to be drier due to transpiration of soybean, thus, lower water content in the ST furrow could be attributed to water uptake and transpiration needs of sugarbeet. Fewer differences were observed for soil water content among positions in 2022. Rainfall was above the 30-year average in April and May and near and slightly below average in July and August when measurements were collected. The furrow positions likely dried from sugarbeet development but recharged upon rainfall with the likelihood to equalize water content of the between row position, especially following sugarbeet canopy closure that would reduce the amount of rainfall infiltration in the between row position.

Sugarbeet root yield, sucrose content, and recoverable sucrose were similar across tillage systems when analyzed across sites (Table 6). Yield was lowest at PR21 in 2021 and attributed to lower rainfall than the other sites. Although stand density was low in ST at PR21, yield was not limited. Yield was lowest at WA22 in 2022 and attributed to earlier harvest date than the other sites. Other harvest components of sugar loss to molasses, purity, and soil tare were similar for tillage effect.

Table 6. Sugarbeet root yield, sucrose content, and recoverable sucrose in response to conventional tillage (CT) and strip tillage (ST) at sites and across sites, 2021 and 2022.

	HI21	PR21	WA21	AR22	EL22	PR22	WA22	Combined
Root yield								
Tillage				Tons ac^{-1}				
CT	35.7	19.4	28.9	28.6	28.4	29.8	19.8	27.3
ST	35.2	20.6	28.3	29.5	29.6	28.9	19.8	27.2
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
P-value	**0.89**	**0.66**	**0.85**	**0.51**	**0.28**	**0.54**	**0.98**	**0.63**
Sucrose content								
Tillage				%				
CT	15.2	17.1	18.6	16.2	17.4	18.3	15.6	16.9
ST	15.3	17.0	18.8	15.8	17.1	18.4	15.4	16.7
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
P-value	**0.87**	**0.80**	**0.67**	**0.54**	**0.65**	**0.77**	**0.48**	**0.40**
Recoverable sucrose								
Tillage				Lbs ac^{-1}				
CT	9993	6067	9993	8476	9190	10260	5621	8387
ST	9814	6335	9993	8565	9368	9993	5532	8297
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
P-value	**0.86**	**0.67**	**0.99**	**0.88**	**0.70**	**0.70**	**0.83**	**0.85**

Conclusion

Strip tillage preserved sugarbeet stand density, root yield, sucrose content, and recoverable sucrose. Plant vigor measured through NDVI was not affected by tillage. Slight differences for soil temperature and soil volumetric water content were observed; however, these variables did not influence sugarbeet production. Observing no differences in sugarbeet production is a valuable outcome and demonstrates that similar yields can be achieved with ST. One noteworthy observation is that weed control may need to be performed earlier in strip tillage since spring secondary tillage is not performed to control early emerging weeds; thus, an herbicide burndown application may be necessary prior to or shortly after planting. Historically, sugarbeet stand density can be reduced from wind erosion occurring early in the season when using CT. Strip tillage reduces tillage leaving greater amounts of crop residue on the soil surface that can offer protection against wind erosion and stand loss (Figure 3).

Figure 3. Conventional tillage on the left and strip tillage on the right showing the contrast in the amount of residue that remained on the soil surface in spring 2022.

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SUGARBEET PHYSIOLOGY AND STORAGE

A PRELIMINARY REPORT ON POSTHARVEST STORAGE PATHOGENS OF SUGARBEET

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In most of the sugarbeet producing states in the U.S. including Minnesota and North Dakota, harvested sugarbeet roots require storage as the high tonnage of the crop exceeds immediate sugar factory processing capabilities. Sugarbeet roots are piled in factory yards, piling stations, or ventilated sheds to allow industry flexibility in sugar processing. Maintaining healthy sugarbeet roots in storage is essential to limit storage loss. Root pathogens in the production field, environmental conditions during harvest, varietal differences, and mechanical injuries from harvest and downstream operations all contribute to postharvest losses (Bugbee 1979; Klotz and Finger 2004; Strausbaugh 2018). Postharvest pathogens predominately infect injured sites on the root and can rapidly rot roots depending on environmental conditions in the piles causing elevations in respiration rate and temperature inside the pile (Campbell and Klotz 2006; Mumford and Wyse 1976). These postharvest pathogens not only decrease sugar yield but also increase costs, as severely decayed roots may need to be disposed of without processing. Also, the roots that are processed typically might have higher concentrations of contaminants that can increase sucrose loss to molasses. Genetic resistance to storage diseases may alleviate postharvest losses, however, such resistance in sugarbeet cultivars has not been explored. The lack of knowledge of the predominant pathogens causing postharvest sugarbeet disease in each factory district has slowed the development of host resistance to storage diseases. Multiple fungal and bacterial strains are reported as causal agents for storage rots in sugarbeet growing areas in the US. However, limited information is available on the spectrum of postharvest pathogens in sugarbeet piles throughout the storage duration or if the factory districts have unique storage pathogens. Scientific understanding of the identity and abundance of postharvest pathogens will be the first key step to implement management strategies to minimize postharvest losses in sugarbeet storage. This study was conducted to understand the incidence of plant pathogens infecting sugarbeet roots in storage during the 2023/24 processing campaign.

Materials and Methods

Sugarbeet roots with aerial mycelium (roots were frequently rotted under the mycelia), and visible storage rot (wet and dry) symptoms were collected from factory yards and non-ventilated piles. Samples were collected from the top, middle, and bottom positions of the piles from three factory yards/sites. A total of 270 sugarbeet roots i.e., 30 root samples x three sample collection dates (mid-October, November and December) for each site x three sites (Renville in Minnesota (MN), Moorhead in MN and Wahpeton in North Dakota (ND)). Samples were transported to the USDA-ARS facility, Fargo, ND, and stored at 4 °C until processing. disinfected in 2% sodium hypochlorite for three minutes and then rinsed three times in sterile Milli-Q water. Pieces of internal root tissue (2 mm x 5mm diameter) from the margins between rotted tissue and white, healthy-appearing tissue as shown in Fig. 1 (Strausbaugh 2018) were plated on potato dextrose agar (PDA; Difco^{TM}, Sparks, MD, USA) with streptomycin (200 mg/L) + Penicillin G (200 mg/L) and incubated on the laboratory bench at ambient temperature (Strausbaugh 2018). Cultures were purified by either single spore or hyphal tipping transfer methods (Leslie and Summerell, 2006). After purification, fungal (filamentous) isolates were grown and maintained on PDA prior to preservation as a cryostock (blocks of mycelia) in 15% glycerol. For isolation of yeasts (non-filamentous fungi), internal rot tissues were plated on yeast potato dextrose (YPD) agar (Difco^{TM}, Sparks). Representative yeast colonies from each root tissue were streaked onto the YPD agar plates after 3 to 7 days to obtain pure cultures (used for DNA extraction). Yeast isolates were preserved as cryostocks in liquid YPD medium with 30% glycerol at -80 °C. Individual colonies with diverse colony morphology were recovered and purified on de Man, Rogosa, and Sharpe (MRS; EMD Millipore Corporation, Burlington, MA) and nutrient agar (Neogen, Lansing, MI) plates and established the single colony axenic culture by streaking. Cryovials of pure culture of bacterial isolates were prepared in 30% glycerol and stored at -80 °C until further processing.

The representative pathogen isolates were used to amplify and sequence ITS or 16S rRNA genes for fungi and bacteria (on going), respectively, using sanger sequencing platform (Azenta Life Sciences, South Plainfield, NJ; Molecular Cloning Lab, South San Francisco, CA). The ITS or 16S rRNA gene sequences were submitted for BLASTN search into the National Center for Biotechnology Information nucleotide database to identify the pathogen isolates.

Following this, roots (three roots for each isolate) of a sugarbeet variety (BTS 27RR20, BetaSeed Inc.) were washed with tape water and inoculated separately with five different yeast species (obtained from the 2022/23 survey) by placing 500 µL of cell suspensions (OD_{600}: 0.5) of each yeast species into the 15-mm-deep holes on the shoulder of the root and incubated for 42 days. After incubation, the roots were bisected longitudinally through the inoculation plug and the diameter (in millimeters and measured by a ruler) as well as the weight (grams) of the rotted beet tissue (collected by cutting out discolored tissue surrounding the site of inoculation on each sugarbeet root) was recorded. The data on lesion diameter and weight of rotten sugarbeet tissues after inoculation with fungal and bacterial isolates were analyzed using the Generalized Linear Models procedure (Proc GLM) of SAS (version 9.4, SAS Institute Inc., Cary, NC). Univariate procedure was used to test normality. Means were separated by Fisher's least significant difference test at P < 0.05.

Results and discussions

A total of 50 filamentous fungal isolates and 17 species were identified from the root samples received in October from storage piles in Renville (MN). *Alternaria alternata* (26%) was identified as the most prevalent fungal species followed by *Geotrichum candidum* (16%). (Fig. 1). In addition to this, six different *Fusarium* species including *F. oxysporum*, *F. equiseti*, and *F. acuminatum* were also isolated from symptomatic roots obtained from storage piles in Renville. From Moorhead, 29 isolates and 15 different fungal species were obtained from symptomatic root samples in October (Fig. 2). Of these, over 20% were identified as *F. oxysporum* and 14% as *A. alternata*. In addition to *F. oxysporum* and *F. sporotrichiodes* (7%), four other *Fusarium* species were also associated the storage rot symptoms in Moorhead. This included, *F. equiseti*, *F. proliferatum*, *F. solani* and *Fusarium* sp. all in equal abundance (3.4%). About 29 fungal isolates (6 species) were retrieved in October from symptomatic roots from Wahpeton (ND) (Fig. 3A). Almost 29% of these isolated were identified as *G. candidum*. The rest of the other four species were present at 14.3% prevalences. From the same site, 50% of the isolates (n = 50) obtained in November were *Penicillium paneum*, previously reported as a sugarbeet postharvest pathogen. *G. candidum* amongst the other five other species from November was noted as the second most prevalent (36%) fungal species (Fig. 3B).

Significant differences (P < 0.05) were observed in lesion size and weight of rotted tissue after inoculating sugarbeet roots with different yeast isolates and incubation for 42 days. *P. fermentans* (isolate MH 4_1B) showed a significantly larger lesion diameter (48.3 mm) and weight of rotted tissue (166.2 g) compared to other yeast species (Fig. 6). The lesion diameters (<24 mm) and weight of rotted tissues (<41 g) did not differ significantly between most of the other yeast isolates while the untreated control showed no symptoms of storage rots.

The study is ongoing to characterize additional isolates (fungal and bacterial) from the rest of the survey and conduct pathogenicity tests in sugarbeet. Furthermore, analysis of more DNA barcoding genes such as beta-tubulin, translation elongation factor 1 alpha gene etc., for fungal isolate characterization is yet to be completed.

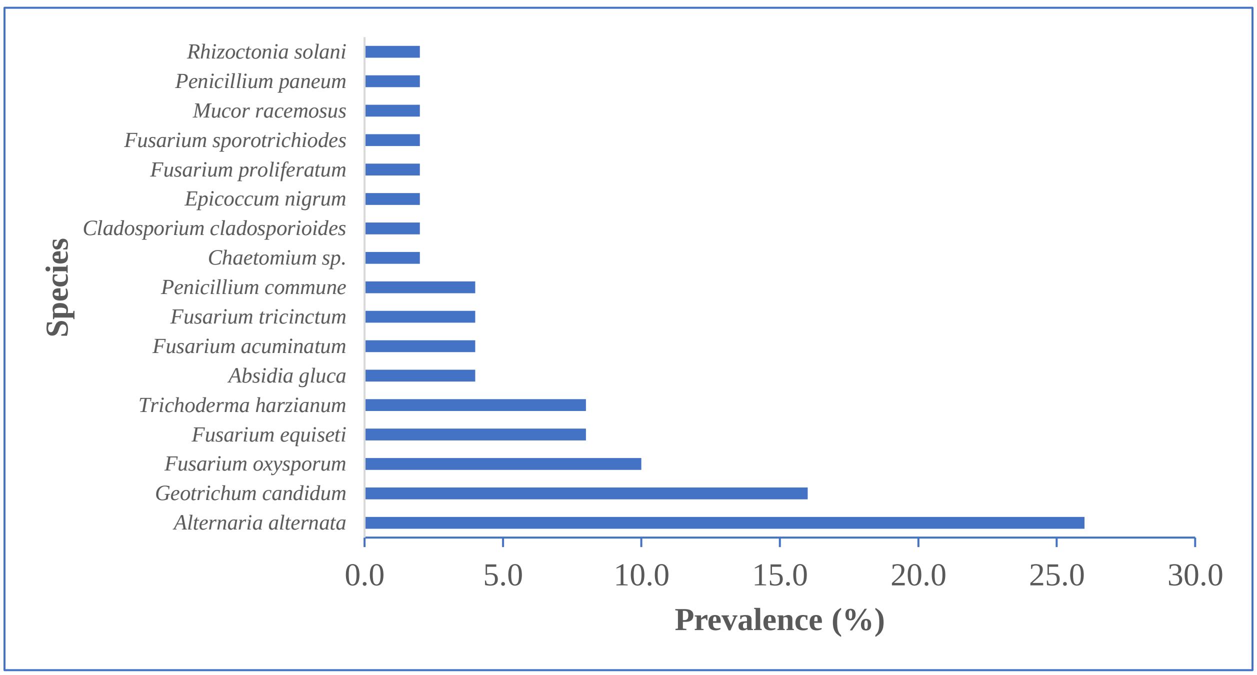

Fig. 1. Incidence of fungal isolates associated with the decaying tissues of sugarbeet roots from storage piles in Renville in October 2023.

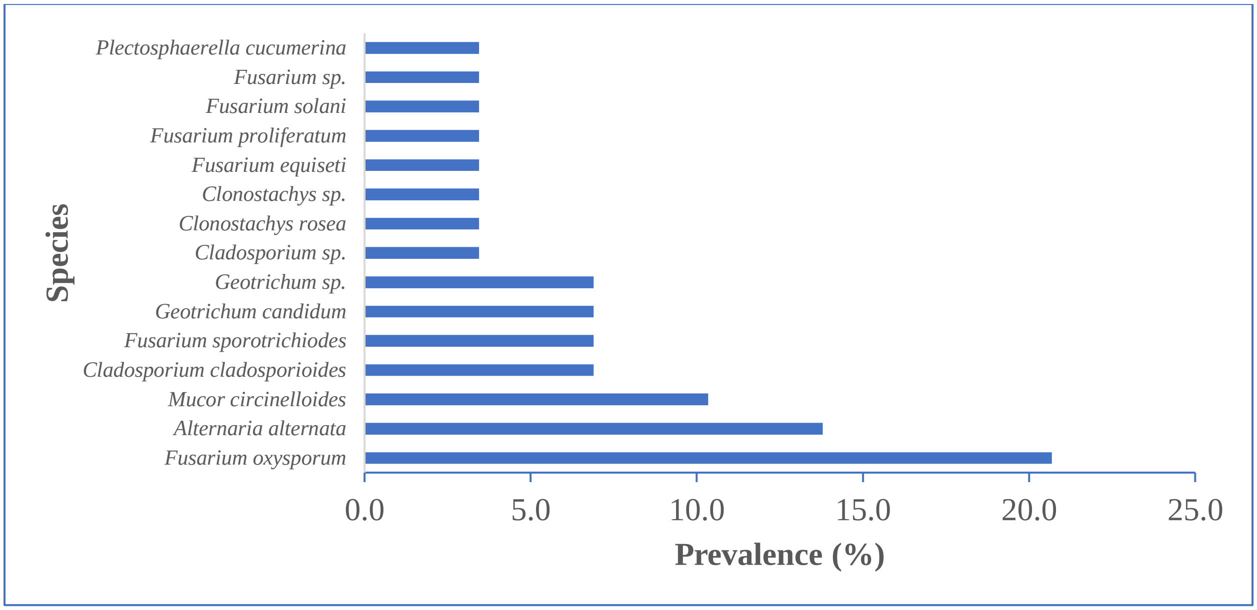

Fig. 2. Incidence of fungal isolates associated with the decaying tissues of sugarbeet roots from storage piles in Moorhead (MN) in October 2023.

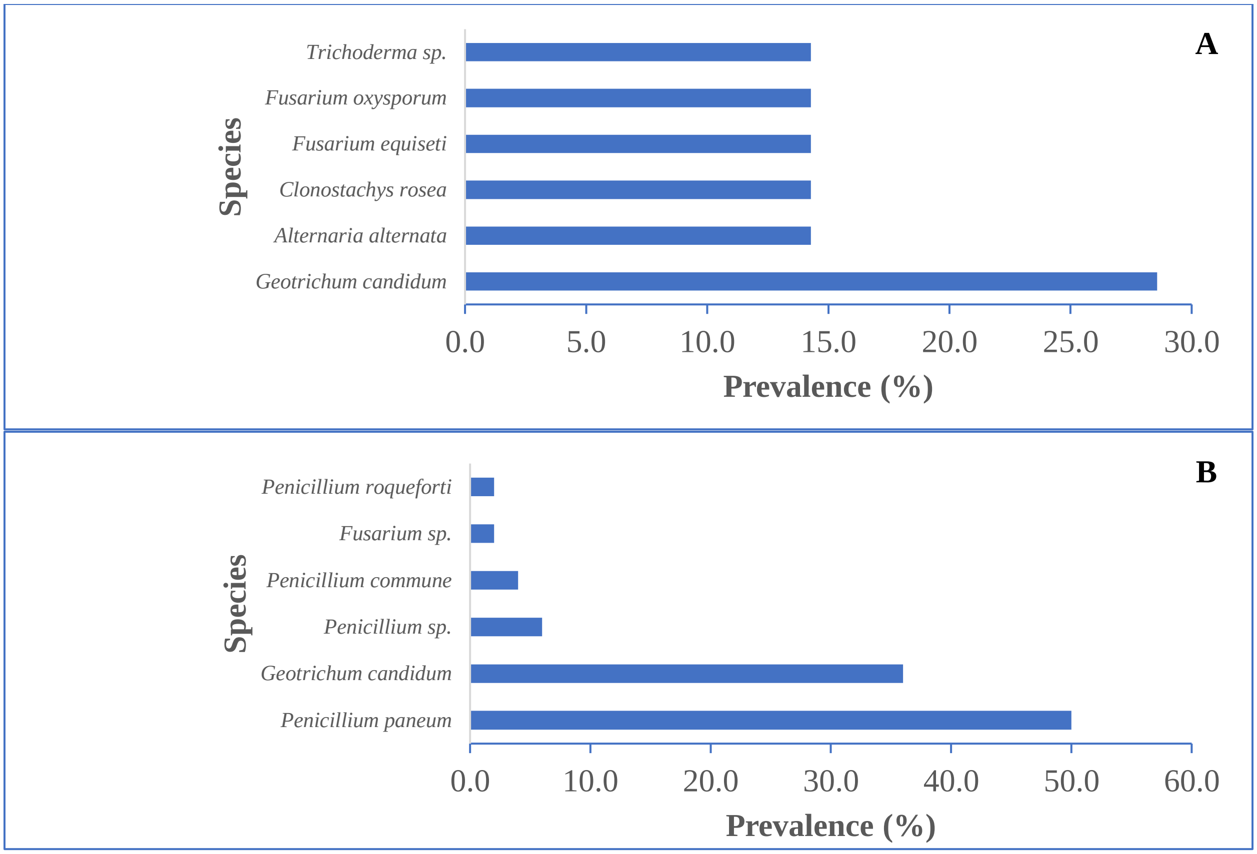

Fig. 3. Incidence of fungal isolates associated with the storage rots of sugarbeet roots from storage piles in Wahpeton (ND) in (A) October and (B) November 2023.

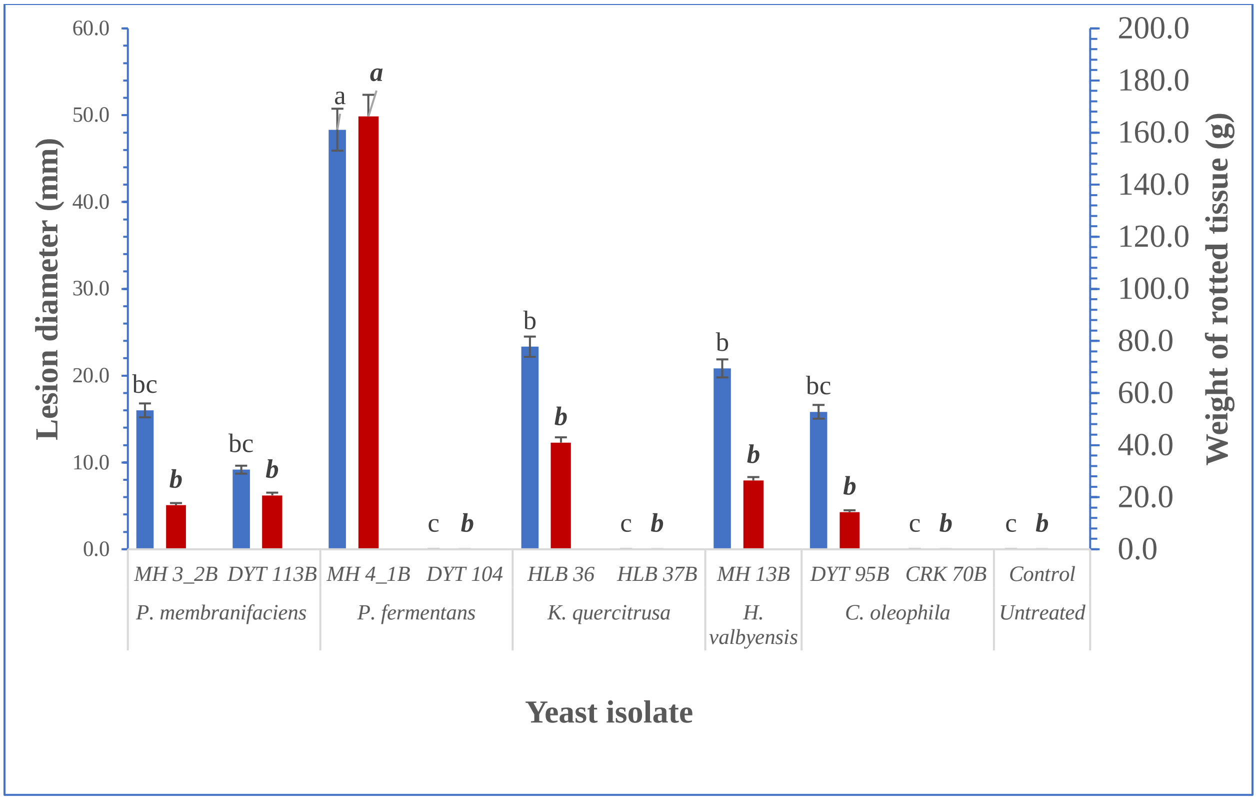

Fig. 4. Pathogenicity of yeast species (from 2022/23 survey) in a cultivated sugarbeet variety (BTS 27RR20, BetaSeed Inc.). *, means there are significant differences between the mean lesion diameter and weight of rotten tissue values.

ACKNOWLEDGEMENTS

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ENTOMOLOGY

TURNING POINT® SURVEY OF SUGARBEET INSECT PEST PROBLEMS AND MANAGEMENT PRACTICES IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2024

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Attendees of the 2025 Winter Sugarbeet Grower Seminars held at Fargo, Grafton, Grand Forks, and Wahpeton, ND were asked about their 2024 insect pest issues and associated management practices in a live polling session by using Turning Point®, an interactive personal response system that displays response data in real time while the poll is being conducted.

Initial questioning involved identifying the county in which grower respondents produced the majority of their sugarbeet crop in 2024. Those results are presented in Tables 1-4. Most (54%) of Fargo seminar attendees indicated that the majority of their sugarbeet crop was grown in Clay, Norman, or Mahnomen counties of Minnesota. An additional 28% and 14% of Fargo attendees reported having produced most of their crop in Cass and Traill Counties of North Dakota, respectively (Table 1). The remaining producers (4% of Fargo attendees) responded that they produced the majority of their sugarbeet crop in Becker County, MN.

Table 1. 2025 Fargo Grower Seminar – county in which sugarbeet was grown in 2024

County	Number of responses	Percent of responses
Becker	1	4
Cass	8	28
Clay	10	36
Norman/Mahnomen	5	18
Traill	4	14
Totals	28	100

The majority of attendees at the Grafton grower seminar reported that most of their sugarbeet production acreage was located in either Walsh (42%) or Pembina (24%) County, ND (Table 2) in 2024. Kittson and Marshall counties of Minnesota were represented by 16% each of the Grafton attendees, MN. An additional 2% of Grafton attendees reported that most of their sugarbeet crop in 2024 was grown in Cavalier County, ND.

Table 2. 2025 Grafton Grower Seminar – county in which sugarbeet was grown in 2024

County	Number of responses	Percent of responses
Cavalier	1	2
Kittson	6	16
Marshall	6	16
Pembina	9	24
Walsh	16	42
Totals	38	100

The largest portion (40%) of Grand Forks grower seminar attendees indicated that the majority of their sugarbeet production occurred in Polk County, MN (Table 3). An additional 23% of grower attendees at Grand Forks responded that most of their sugarbeet was grown in Grand Forks County, ND. Other counties represented by grower attendees at Grand Forks included Traill and Walsh County, ND (9% of grower respondents each), and Marshall County, MN (5%). A sizeable amount (14%) of Grand Forks grower attendees reported that they grew the majority of their beet crops in counties that were not represented in the choice list for this question.

Table 3. 2025 Grand Forks Grower Seminar – county in which sugarbeet was grown in 2024

County	Number of responses	Percent of responses
Grand Forks	10	23
Marshall	2	5
Polk	17	40
Traill	4	9
Walsh	4	9
Other	6	14
Totals	43	100

Responses to this question at the Wahpeton winter sugarbeet grower seminar indicated that 46% of the attending producers grew the majority of their sugarbeet crop in Wilkin County, MN, with another 21% of respondents reporting that most of their crop was produced in Grant County, MN (Table 4). An additional 17% of grower attendees at the Wahpeton seminar indicated that most of their sugarbeet production occurred in Richland County, MN, with the remainder of respondents responding that they produced the majority of their beet crop in Clay County, MN (6%), Cass County, ND (4%), Traverse County, ND (4%), or Roberts County, SD (2%) in 2024.

Table 4. 2025 Wahpeton Grower Seminar – county in which sugarbeet was grown in 2024

County	Number of responses	Percent of responses
Cass	2	4
Clay	3	6
Grant	10	21
Richland	8	17
Roberts	1	2
Traverse	2	4
Wilkin	22	46
Totals	48	100

This report is based on grower responses about their production activities on an estimated 112,450 acres of sugarbeet grown in 2024 by 146 grower respondents that attended the 2025 Fargo, Grafton, Grand Forks, and Wahpeton Winter Sugarbeet Grower seminars (Table 5). The majority (38%) of respondents reported growing sugarbeet on between 400 and 799 acres during the 2024 production season. That represents a shift upward in acres per grower from 2022, when the majority of growers produced sugarbeet on an average of between 300 and 599 acres. An additional 26% of producers grew sugarbeet on between 600 and 999 acres, and 21% produced beets on between 800 and 1,500 acres. A total of 13% of respondents reported growing sugarbeet on 1,500 acres or more in 2024, whereas 22% of respondents produced sugarbeet on 299 or fewer acres.

Table 5. Ranges of sugarbeet production acreage in 2024 by 2025 Winter Sugarbeet Grower Seminar Respondents

		Acres of sugarbeet									
Location	Number of responses	<99	100-199	200-299	300-399	400-599	600-799	800-999	1000-1499	1500-1999	2000+
		-----% of responses-----									
Fargo	25	4	0	4	24	20	16	4	16	4	8
Grafton	36	14	8	8	0	17	19	8	8	6	11
Grand Forks	40	8	8	5	3	18	18	10	13	13	8
Wahpeton	45	2	7	16	4	31	11	13	9	7	0
Totals	146	7	6	9	6	22	16	10	11	7	6

The 2025 Sugarbeet Winter Grower Seminar series marked the first year in which grower attendees were asked to provide the age demographic to which they belong. From a combined total of 150 respondents at the Fargo, Grafton, Grand Forks, and Wahpeton seminars, 46% identified as Millennials, whereas 31% responded as belonging to Generation X (Table 6). An additional 15% responded as being Baby Boomers, followed by 5 and 3% identifying as Generation Z and Traditionalists, respectively. For the most part, the composition of different age groups was very similar across seminar locations; however, a substantially greater proportion of Baby Boomer-aged growers (25% of respondents) attended the Grand Forks seminar than at other seminar locations (≤15%).

Table 6. *Generational demographics* of the 2025 Winter Sugarbeet Grower Seminar attendees

Location	Number of responses	Traditionalist 1928-1945	Baby Boomer 1946-1964	Gen. X 1965-1980	Millennial 1981-1996	Gen. Z 1997-2010
		---------% of responses---------				
Fargo	25	0	12	40	44	4
Grafton	39	5	10	21	56	8
Grand Forks	40	5	25	28	40	3
Wahpeton	46	2	13	37	43	4
Totals	150	3	15	31	46	5

From a combined total of 132 respondents at the Fargo, Grafton, Grand Forks, and Wahpeton seminars, 31% identified the sugarbeet root maggot (SBRM) as their worst insect pest problem in 2024 (Table 7). That was a 24% decrease compared to the responses recorded during the previous survey regarding the 2024 growing season. Additionally, about 21% of all seminar location respondents viewed springtails as their worst insect pest problem during the 2024 growing season. Grasshoppers were rated as the worst insect pest during 2024 by 16% of all seminar location respondents. Other insect groups identified by grower respondents across all four seminar locations as causing problems in 2024 included cutworms, wireworms, and white grubs, (11, 5, and 3%, of respondents, respectively).

Table 7. Worst insect pest problem in sugarbeet in 2024

Location	No. of responses	Army-worms	Cut-worms	Grass-hoppers	Lygus Bugs	Root maggot	Spring-tails	White Grubs	Wire-worms	Other
		---------% of responses---------								
Fargo	20	10	5	10	5	30	30	0	10	0
Grafton	31	0	0	16	0	55	16	6	3	3
Grand Forks	42	0	2	12	5	40	29	0	7	5
Wahpeton	39	3	33	23	0	3	13	5	3	18
Totals	132	2	11	16	2	31	21	3	5	8

Grower respondents at the Fargo seminar reported that either the SBRM (30%) or springtails (30%) were their most problematic insect pest in 2024. Similarly, an even split of producer respondents at the Fargo seminar indicated that either armyworms, grasshoppers, or wireworms were their worst insect pest problem (10% each).

The majority of respondents at Grafton (55%) and Grand Forks (40%) identified the SBRM as their worst insect pest problem. Those responses equated to 26 and 38% decreases in the numbers of those seminar attendees identifying root maggots as their key insect problem when compared to that reported for 2024. That corresponds well with the reduced overall SBRM fly activity observed in the root maggot fly monitoring program during the 2024 growing season (see following report). Grasshoppers and springtails were also reported as being the most important insect pest problem by 16% of Grafton respondents. In addition to reporting root maggots as being very problematic, 29% of Grand Forks respondents indicated that springtails were their worst insect pest, and 12% reported grasshoppers as being most problematic.

Cutworms were viewed as the most significant insect pest problem by 33% of Wahpeton seminar attendees, and an additional 23% of Wahpeton respondents viewed grasshoppers as being their most significant insect pest. Additionally, about 13% of survey respondents at the Wahpeton seminar reported that springtails were their worst insect pest.

A combined total of 82% of all grower respondents across all winter grower seminars indicated that they used some form of planting-time insecticide protection to manage insect pests in 2024, which was very similar to that which was reported for 2023 (84%), but down slightly from 89% as reported for the 2022 growing season (Table 8). The majority (38%) of respondents from all grower seminar locations reported that they planted seed treated with Poncho Beta insecticidal seed treatment in 2024, which was comparable to the overall use rate of Poncho Beta-treated seed in 2023 (36%). An average of 19% of grower respondents across all seminar locations reported using Counter 20G for at-plant protection from insect pests, and the remaining producers indicated that they applied either Midac FC (12%) or Mustang Maxx (5%), or they used either Cruiser (4%) or NipsIt Inside (3%) seed treatment, all of which were very similar to the usage rates of those products in 2023. The majority of planting-time insecticide use in 2024 was carried out by growers that attended the Fargo, Grafton, and Grand Forks seminars, at which 100, 90, and 95% of respondents, respectively, reported using some form of planting-time insecticide protection. Substantially lower numbers (i.e., 44% overall) of Wahpeton seminar respondents responded as having used an insecticide at planting.

Table 8. *Planting-time* insecticide use for sugarbeet insect pest management in 2024

Location	Number of responses	Counter 20G	Midac FC	Mustang Maxx	Poncho Beta	Cruiser	NipsIt Inside	Other	None
		----------	----------	----------	% of responses	----------	----------	----------	----------
Fargo	36	31	8	11	44	3	0	3	0
Grafton	41	22	15	0	49	0	5	0	10
Grand Forks	74	16	19	3	45	7	5	0	5
Wahpeton	50	12	4	8	14	4	0	2	56
Totals	201	19	12	5	38	4	3	1	18

At the Fargo seminar, 44% of producers reported using Poncho Beta insecticidal seed treatment for at-plant protection from insect pests in 2024, which was a 33% increase compared to the previous year. An additional 31% of Fargo attendees applied Counter 20G for at-plant protection from insect pests, which amounted to a 55% increase in use of Counter 20G for those producers when compared to 2023. Other reported at-plant insecticide usage by Fargo attendees in 2024 included Mustang Maxx (11% of respondents; a 59% decrease from Mustang usage in 2023), and Midac FC (8% of respondents; a 14% usage increase).

Forty-nine percent of Grafton respondents reported planting Poncho Beta insecticide-treated seed as at least part of their planting-time insect control program in 2024, which was by far the most commonly used at-plant protection reported by Grafton attendees of the 2025 seminar. Cruiser-treated seed was used by an additional 6% of Grafton attendees. A surprisingly low proportion (21%) of Grafton seminar attendees reported using Counter 20G for planting-time protection from insect pest damage, and that was very similar to the reported use of Counter 20G during the 2022 and 2023 growing seasons (19% each). An additional 25% of respondents at Grafton indicated that they used a sprayable liquid insecticide, which involved applications of Midac FC (15% of respondents).

At the Grand Forks seminar location, 45% of respondents reported that they used Poncho Beta-treated seed for at-plant insect control, and NipsIt Inside-treated seed was used by 5% of respondents. Counter 20G was reported as being used at planting by 16% of grower respondents at Grand Forks, which was identical the reported use of Counter in 2023, but 45% lower to the use of that insecticide in 2022. Midac FC was reported as being used at planting by 19% of Grand Forks respondents in 2024, which was comparable to the reported use of Midac in 2023 (17%), when an 89% increase in use of that product was observed when compared to that from the 2022 growing season. Use of Mustang Maxx in 2024, as reported by Grand Forks respondents, was at 3%, which was a slight increase from the 1% of respondents that reported having used Mustang Maxx for this purpose in 2023.

At the Wahpeton seminar location, 8% of respondents indicated that they had applied Mustang Maxx for planting-time protection from insect pests in 2024, which was a 56% decrease. Additionally, just 12% of Wahpeton attendees reported using a planting-time application of Counter 20G for insecticide protection in 2024. That reflected a 33% reduction in the use of Counter 20G in that growing area. An additional 14% reported that they used Poncho Beta-treated seed for insect pest management. Four percent of Wahpeton respondents reported using Midac FC for a planting-time insecticide in 2024, which was comparable to the reported usage in the area during the 2023 growing season.

Averaged across the Fargo, Grafton, Grand Forks, and Wahpeton seminar locations, the moderate (7.5 lb product/ac) rate of Counter 20G was used more frequently (13% of respondents) than any other granular insecticide rate for insect management in 2024 (Table 9). Thimet 20G was used by just 1% of grower respondents, as averaged across all seminar locations. The majority of Fargo (54%), Grafton (69%), Grand Forks (67%), and Wahpeton (80%) respondents reported no use of a granular insecticide in 2024. However, 54% of the Fargo respondents that did use a granular insecticide applied Counter 20G at the 5.25-lb rate and 36% used the 7.5-lb rate, but no one at the Fargo seminar location reported applying Counter 20G at its high (8.9 lb product/ac) labeled rate in 2024.

Table 9. Application rates of *granular* insecticides used for sugarbeet insect pest management in 2024

Location	Number of responses	Counter 20G 8.9 lb	Counter 20G 7.5 lb	Counter 20G 5.25 lb	Thimet 20G 7 lb	Thimet 20G 4.5 lb	Other	None
		--------------------------------------			% of responses			--------------------------------------
Fargo	24	0	17	25	0	0	4	54
Grafton	32	6	19	3	3	0	0	69
Grand Forks	46	2	15	7	2	0	7	67
Wahpeton	46	0	4	7	0	0	9	80
Totals	148	2	13	9	1	0	5	70

At the Grafton seminar location, 31% of producers reported applying a granular insecticide in 2024, which was a 31% decrease in granular insecticide use by Grafton attendees from the previous year. Twenty percent of Grafton respondents who used a granular insecticide at planting for sugarbeet insect control applied Counter at its high (8.9 lb) labeled rate, and 60% used Counter at the moderate rate of 7.5 lb product per acre.

At the Grand Forks grower seminar, 33% of respondents reported using a granular insecticide at planting in 2024, which reflected a 15% increase in planting-time insecticide use over that reported by Grand Forks respondents in 2023. Forty-seven percent of the Grand Forks attendees that used a granular insecticide at planting in 2024 indicated that they applied Counter 20G at its moderate labeled rate (7.5 lb product/ac), and an additional 20% of respondents applied Counter at the low labeled rate of 5.25 lb product per acre.

Use of granular insecticides by Wahpeton seminar attendees (20% of respondents) was, as in previous years, low in comparisons to responses at other seminar locations. Most (56%) of the Wahpeton seminar respondents who reported using a granular insecticide at planting in 2024 used Counter 20G at either 7.5 or 5.25 lb product per acre.

Averaged across the Fargo, Grafton, Grand Forks, and Wahpeton survey locations, 37% of respondents reported using a postemergence insecticide to manage the sugarbeet root maggot (SBRM) in 2024 (Table 10). That usage rate was nearly identical to the 38% reported usage for this purpose in 2023. At the Fargo seminar site, 25% of respondents reported that they had applied Mustang Maxx for postemergence root maggot control in 2024, which reflected a reduction from 33% of respondents during the previous seminar series regarding Mustang Maxx use in 2023. That decline was apparently due to the reinstatement of chlorpyrifos registration for use in sugarbeet for 2024, as chlorpyrifos usage for postemergence SBRM control accounted for 13% of Fargo respondents. No other postemergence insecticide use was reported by Fargo seminar attendees for the 2024 growing season.

Table 10. *Postemergence* insecticide use for *sugarbeet root maggot* management in 2024

Location	Number of responses	Asana XL	Chlorpyrifos	Mustang Maxx	Counter 20G	Thimet 20G	Other	None
		--------------------------------------			% of responses			--------------------------------------
Fargo	24	0	13	25	0	0	0	63
Grafton	41	2	15	7	2	37	0	37
Grand Forks	49	0	18	14	2	2	4	59
Wahpeton	44	2	5	0	0	0	2	91
Totals	158	1	13	10	1	10	2	63

At the Grafton seminar location, 63% of grower respondents indicated that they used some form of postemergence insecticide for SBRM control in 2024, which reflected an 8% decrease in postemergence insecticide use by Grafton respondents when compared to the reported use for the 2023 growing season. The majority (37%) of Grafton seminar respondents applied Thimet 20G for postemergence root maggot management, which was 58% of all respondents who used a postemergence insecticide for that purpose in 2024. Fifteen percent of the Grafton respondents reported that they applied a chlorpyrifos product for postemergence SBRM control, and other materials used for this purpose included Mustang Maxx (7% of respondents) and Asana XL (2% of respondents) for this purpose.

A total of 41% of Grand Forks seminar attendees reported using a postemergence insecticide for root maggot management in 2024, which was nearly identical to the reported use (40%) for this purpose during the previous growing season. About 45% of the producer respondents at Grand Forks that did apply an insecticide for postemergence SBRM control indicated that they used a chlorpyrifos-based insecticide, whereas 35% used Mustang Maxx, and an additional 5% each used either Counter 20G or Thimet 20G for this purpose in 2024. Only 9% of the Wahpeton seminar attendees reported using a postemergence-applied insecticide for SBRM control in 2024, of which 50% reported using a chlorpyrifos insecticide product, 25% indicated that they used Asana XL, and an additional 25% responded as applying another product that was not included as a choice for this question.

Averaged across the Fargo, Grafton, Grand Forks, and Wahpeton seminar locations, 84% of respondents rated their satisfaction with the insecticide applications they made for root maggot control in 2024 as good to excellent, which was a 3.7% increase in grower satisfaction with SBRM management efforts when compared to survey results for the 2023 growing season (Table 11). An average of 5% of growers that attended the 2024 seminars rated the SBRM control performance of their insecticide program as being fair, and only 1% of respondents across all locations viewed their insecticide performance as poor for this purpose. An additional 9% of attendees across all grower seminar locations responded as being unsure of the success of their control programs for SBRM control.

Table 11. *Satisfaction* with insecticide treatments for sugarbeet root maggot management in 2024

Location	Number of responses	Excellent	Good	Fair	Poor	Unsure
		----------------	----------------	% of responses	----------------	----------------
Fargo	22	38	38	0	8	15
Grafton	33	36	59	5	0	0
Grand Forks	46	33	48	9	0	9
Wahpeton	46	29	43	0	0	29
Totals	147	35	49	5	1	9

Individually, grower satisfaction with insecticide performance for root maggot control in 2024 was rated as good to excellent by 76, 95, 81, and 72% of Fargo, Grafton, Grand Forks, and Wahpeton respondents, respectively. Satisfaction with insecticide performance for SBRM control was rated as fair by 0, 5, 9, and 0% of respective respondents at the Fargo, Grafton, Grand Forks, and Wahpeton seminar locations. The only reports of poor insecticide performance for SBRM control during the 2024 growing season were recorded for attendees of the Fargo seminar (8% of respondents).

As presented in Table 12, a combined average of 58% of grower respondents at the Fargo, Grafton, Grand Forks, and Wahpeton grower seminar locations used an insecticide for planting-time protection against springtails in 2024, which is about the same as reported for this use in 2023 (60%). The majority (52%) of respondents that used an insecticide for this purpose in 2024, as averaged across all seminar locations, planted seed treated with Poncho Beta insecticide. An additional 20% of the growers that used a planting-time insecticide for springtail control in 2024 used Counter 20G, which was identical to the use rate of that product for springtail control in 2023. An additional 17% applied Midac FC for this purpose, which was about double the usage rate for Midac in 2023.

Table 12. Insecticide use for *springtail* management in 2024

Location	Number of responses	Poncho Beta	Cruiser	NipsIt Inside	Midac FC	Mustang Maxx	Counter 20G	Other	None
		--	% of responses	--					
Fargo	26	27	0	0	12	8	31	0	23
Grafton	35	34	3	0	3	0	6	3	51
Grand Forks	63	46	0	3	19	5	13	0	14
Wahpeton	44	7	0	0	2	0	5	2	84
Totals	168	30	1	1	10	3	12	1	42

A relatively small portion (5%) of respondents, as reported across all seminar locations, used Mustang Maxx for springtail control, and 42% of growers across all locations reported no insecticide use for springtail control, which was about the same proportion of producers that opted to forgo a springtail control product in 2023.

At the Fargo seminar, Poncho Beta and Counter 20G were reported as being used for springtail control by 27 and 31% of respondents, respectively. About 12% of Fargo respondents indicated that they had applied Midac FC and 8% of them used Mustang Maxx for this purpose in 2024. There was no other reported insecticide use for springtail management by respondents at the Fargo grower seminar.

Most of the insecticide use for springtail management (34% of all respondents), as reported by Grafton seminar attendees, involved planting seed treated with Poncho Beta. Cruiser insecticide seed treatment was also used by some Grafton respondents, but at a relatively low usage rate of 3%, and there was no reported use of NipsIt Inside-treated seed by Grafton respondents. Counter 20G was reported as being used in 2024 for springtail control by 6% of Grafton respondents. The remaining use of insecticides for springtail control by attendees of the Grafton seminar included Midac FC (3% of respondents) and insecticide products not included as choices for this question (3% of respondents). Forty-nine percent of Grafton attendees indicated that they did not use an insecticide for protection from springtail injury in 2024.

The highest incidence of insecticide use for springtail management in our surveys was reported by Grand Forks attendees, 86% of which used some form of insecticidal protection in their sugarbeet crop. A large majority (54%) of grower respondents at the Grand Forks seminar location who used an insecticide for springtail control indicated that Poncho Beta insecticidal seed treatment was their choice during the 2024 growing season. That figure was nearly identical to the use rate indicated by Grand Forks attendees (i.e., about 52%) regarding their insecticide use in 2023. Most of the remaining reported insecticide applications for springtail control by Grand Forks respondents who used an insecticide for this purpose involved applications of either Midac FC (22% of respondents) or Counter 20G (15% of respondents).

Results from the Wahpeton seminar location indicated that only 16% of respondents used an insecticide at planting time for springtail in 2024. Of those respondents, 43% indicated that they used Poncho Beta, 29% used Counter 20G, and 14% used Midac FC for this purpose in 2024.

As shown in Table 13, an overall average of 64% of grower respondents surveyed at the Fargo, Grafton, Grand Forks, and Wahpeton seminar locations rated their insecticide performance for springtail management as good to excellent, and only 3% of respondents across all locations viewed their insecticide performance for this purpose as poor. The majority (56%) of Fargo seminar attendees rated their insecticide performance for springtail control as good to excellent, but 25% viewed the performance of their springtail management practice as fair, and an additional 19% of Fargo respondents indicated that they were not sure about the effectiveness of their insecticide product for this purpose.

Table 13. *Satisfaction* with insecticide treatments for springtail management in 2024

Location	Number of responses	Excellent	Good	Fair	Poor	Unsure
		------------------------------------	% of responses	------------------------------------		
Fargo	23	31	25	25	0	19
Grafton	28	64	18	9	0	9
Grand Forks	45	26	35	13	6	19
Wahpeton	41	33	33	0	0	33
Totals	137	34	30	14	3	19

Grower respondents at the Grand Forks seminar expressed a mixed rate of satisfaction with their springtail control during 2024, with 61% rating it as good to excellent, 13% rating it as fair, and an additional 6% assessing their springtail control as being poor.

Survey results from the Wahpeton seminar location indicated that 66% of grower respondents viewed their springtail control as being either good or excellent, which reflected a 22% increase in positive views on insecticide performance for this purpose. An additional 14% of Wahpeton respondents rated their springtail control success as fair, and 3% viewed it as poor. Additionally, 19% of Wahpeton respondents were uncertain about their springtail control success.

As was the case in 2022 and 2023, Lygus bugs were not a major production problem for Red River Valley producers in 2024. This was clearly illustrated by the combined average of 98% of survey respondents across the Fargo, Grafton, Grand Forks, and Wahpeton winter grower seminars reporting that they did not use an insecticide for Lygus bug control in 2023 (Table 14).

Table 14. Insecticide use for Lygus *bug* management in 2024

Location	Number of responses	Asana XL	Dibrom	Movento	Mustang Maxx	Transform	Other	None
		--------------------------------------			% of responses		---	
Fargo	20	0	0	0	0	0	0	100
Grafton	26	4	0	0	0	0	0	96
Grand Forks	42	0	0	0	0	0	0	100
Wahpeton	44	0	0	0	0	0	2	98
Totals	132	1	0	0	0	0	1	98

No insecticide use for Lygus bug control was reported for the 2024 growing season by Fargo or Grand Forks seminar respondents, and just 4% of Grafton seminar attendees reported using Asana XL for this purpose. Similarly, at the Wahpeton seminar location, only 2% of respondents indicated that they used an insecticide for Lygus bug control in 2024, and they reported using an insecticide that was not provided in the list for this question.

Survey results on satisfaction with insecticide performance for Lygus bug control are presented in Table 15. These results should be interpreted with a high degree of discretion because the exceptionally low frequency of insecticide use for that purpose resulted in a very small sample size. Overall, the results showed that an average of 75% of respondents across all seminar locations viewed the success of their Lygus bug management insecticide in 2024 as good to excellent; however, 25% of them were unsure about the success of their efforts.

There were no responses to this question at the Fargo and Grand Forks seminar locations; however, 100% of the respondents at Grafton that used an insecticide for Lygus bug management in 2024 viewed its performance as excellent. At the Wahpeton seminar, 50% of grower respondents assessed the performance of the insecticide they applied for Lygus bug control as excellent, and the remaining 50% viewed its effectiveness as good.

Table 15. *Satisfaction* with insecticide treatments for Lygus *bug* management in 2024

Location	Number of responses	Excellent	Good	Fair	Poor	Unsure
		------------------------------------		% of responses	------------------------------------	
Fargo	21	0	0	0	0	0
Grafton	30	100	0	0	0	0
Grand Forks	42	0	0	0	0	0
Wahpeton	46	50	50	0	0	0
Totals	139	50	25	0	0	25

Grasshoppers were not as problematic for area sugarbeet producers in 2024, which was evidenced by the overall average of 70% of respondents across all seminar locations reporting that they did not use any insecticide for this purpose (Table 16). The most commonly used products growers throughout the growing area chose for grasshopper management in 2024 were chlorpyrifos-based insecticides (13% of respondents overall). An additional 8% and 3% of respondents indicated that they used Mustang Maxx or Asana XL for this purpose, respectively.

Table 16. Insecticide use for *grasshopper* management in 2024

Location	Number of responses	Asana XL	Chlor-pyrifos	Dibrom	Mustang Maxx	Vantacor	Other	None
		---	---	---	% of responses	---	---	---
Fargo	24	17	17	0	0	0	0	67
Grafton	32	3	28	3	9	3	6	47
Grand Forks	41	0	10	0	2	0	2	85
Wahpeton	48	0	4	0	17	0	4	75
Totals	145	3	13	1	8	1	3	70

A total of 33% of the Fargo grower seminar respondents reported that they had used an insecticide for grasshopper control in 2024. Survey responses at Fargo also indicated that, among producers that used an insecticide for this purpose, usage rates were evenly split at 50% each between Asana XL and chlorpyrifos-containing insecticide products.

At the Grafton winter grower seminar, 53% of respondents indicated that they had used a foliar insecticide for grasshopper management in 2024. Of those producers that used an insecticide for this purpose, 53% applied a chlorpyrifos-containing insecticide, 18% used Mustang Maxx, and usage of Asana XL, Dibrom, and Vantacor was evenly split at 6% each.

The Grand Forks seminar survey results indicated that only 15% of respondents used an insecticide to control grasshoppers in 2024. Of those respondents who used an insecticide for this purpose, 67% reported that they applied chlorpyrifos, and just 17% used Mustang Maxx. Also, 17% of producers that reported using an insecticide for grasshopper control indicated that they used an insecticide that was not included as a choice in the survey.

Sixty-seven percent of grower respondents at the Wahpeton seminar indicated that they had applied an insecticide for grasshopper control in 2024, and 67% of those respondents indicated that they used Mustang Maxx. Chlorpyrifos was reported as being applied to control grasshoppers in sugarbeet by 17% of those respondents that had used an insecticide for this purpose in 2024, and an additional 17% reported that they had used an insecticide that was not included in our survey for their grasshopper control.

Good to excellent grasshopper control in 2024 was reported by 72% of all respondents that attended the four winter grower seminar locations (Table 17); however, 20% of all grower seminar respondents who used an insecticide for grasshopper control viewed its performance as being fair to poor. At the Fargo winter grower seminar, 67% of respondents that used an insecticide for this purpose rated it as having provided good to excellent grasshopper control in 2024, but 33% of respondents indicated that they viewed it as fair. No Fargo seminar respondents that used an insecticide for grasshopper control in 2024 rated its performance as poor.

Table 17. *Satisfaction* with insecticide treatments for *grasshopper* management in 2024

Location	Number of responses	Excellent	Good	Fair	Poor	Unsure
		---	---	% of responses	---	---
Fargo	22	50	17	33	0	0
Grafton	32	38	50	13	0	0
Grand Forks	42	0	83	0	0	17
Wahpeton	47	18	27	18	18	18
Totals	143	28	44	15	5	8

Of the Grafton seminar respondents that applied an insecticide for grasshopper control in 2024, most (88%) viewed its performance as either good or excellent. Thirteen percent of survey respondents at the Grafton seminar location rated their insecticide performance for grasshopper management as fair, and none of them rated their grasshopper insecticide performance as poor.

The majority (83%) of respondents at the Grand Forks grower seminar viewed their insecticide performance in managing grasshopper infestations as being good, but no respondents rated their grasshopper control as excellent. Similarly, no Grand Forks attendees rated their grasshopper control as fair or poor. Seventeen percent of those respondents who applied an insecticide to manage grasshoppers were unsure of its success in 2024.

Survey results from the Wahpeton grower seminar were somewhat different from those at the other locations. Just 45% of growers that used an insecticide for grasshopper control in 2024 viewed its performance as good to excellent, whereas 36% of Wahpeton attendees responded with the assessment that the performance of their insecticide program for grasshopper control was fair to poor, and 18% of respondents were unsure of the effectiveness of their insecticide for this purpose in 2024.

Attendees of the 2025 winter sugarbeet grower seminars were also asked about how their insecticide use for insect pest management compared to previous years. Overall, 63% of respondents at all (Fargo, Grafton, Grand Forks, and Wahpeton) seminar locations combined reported that their insecticide usage in 2024 did not differ from that of the previous five years (Table 18). The most significant insecticide use change throughout the growing area, as observed with responses to this question, was that 24% of producers reported using less insecticide in 2024 than in the previous five years. This figure was influenced most by respondents at the Grafton and Wahpeton seminars, in which 33% of attendees at both locations answered that their insecticide usage in 2024 was lower than the previous five years. Similarly, although most (83%) of Fargo seminar attendees reported no change in their insecticide use, 17% indicated that their insecticide use had decreased in 2024. Similarly, 81% of Grand Forks seminar attendees reported that their insecticide usage had not changed in 2024 when compared to the previous five years, but 11% of those respondents indicated a decrease in insecticide use. The only significant increase in insecticide during the 2024 growing season was observed with Grafton seminar attendees, of which 12% said their usage increased in comparison with previous years. The frequency of reported decreases in insecticide usage rates among producers could have been a result of the perceived reduction in sugarbeet root maggot flight activity observed by many growers and crop scouts in 2024. Contrarily, the reported increases in insecticide usage by grower attendees of the Grafton seminar could have been associated with the occurrence of several grasshopper outbreaks in the northern Red River Valley in 2024.

Table 18. Insecticide use in sugarbeet during 2024 compared to the previous 5 years

Location	Number of responses	Increased	Decreased	No Change	No Insecticide Use
		-----% of responses-----			
Fargo	23	0	17	83	0
Grafton	33	12	33	52	3
Grand Forks	47	6	11	81	2
Wahpeton	49	4	33	45	18
Totals	152	6	24	63	7

Acknowledgement:

The authors greatly appreciate the valued and essential contributions of responses to this survey by the sugarbeet producers that attended and participated in the winter sugarbeet grower seminars. We are also grateful to the Sugarbeet Research and Education Board of Minnesota and North Dakota for providing significant funding to support this project.

SUGARBEET ROOT MAGGOT FLY MONITORING IN THE RED RIVER VALLEY IN 2024

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Sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), fly activity was monitored at 128 grower field sites throughout the Red River Valley during the 2024 growing season. This effort was carried out as a collaborative effort between the NDSU School of Natural Resource Sciences, American Crystal Sugar Company, and the Minn-Dak Farmers Cooperative.

Fly activity during the 2024 growing season was unusual because activity levels on a Valley-wide basis, according to sticky trap capture rates was substantially lower than that recorded in the previous six years of monitoring this pest (Figure 1). The most intense SBRM fly activity observed in 2024 occurred in the central and northern Red River Valley.

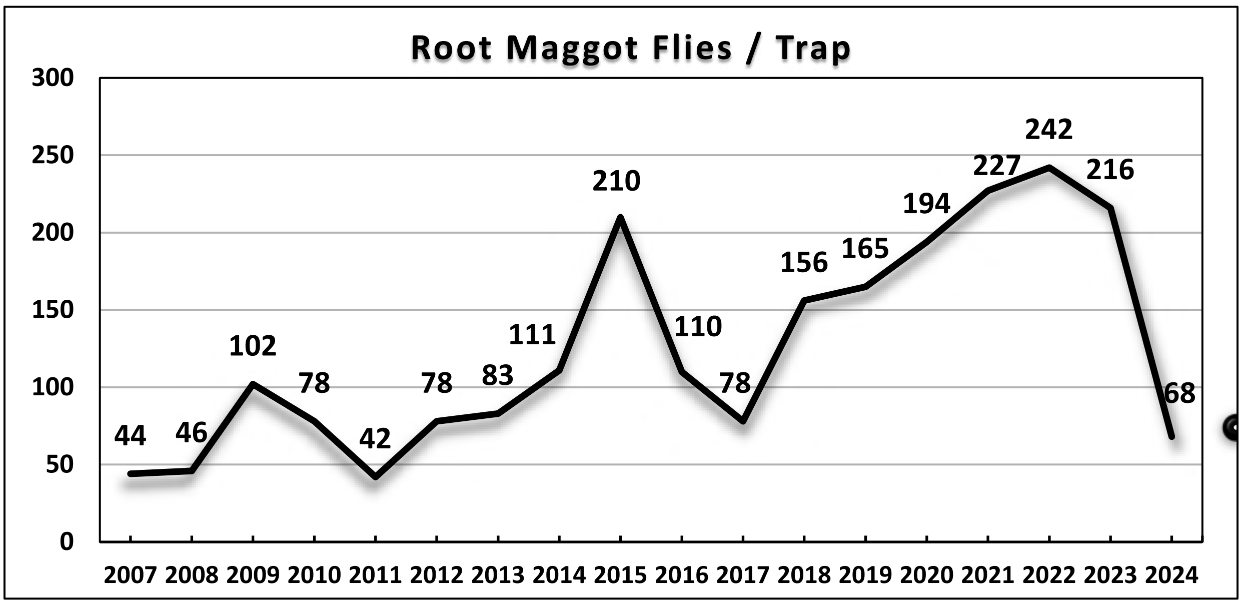

Figure 1. Yearly averages of sugarbeet root maggot flies captured on sticky-stake traps (Blickenstaff and Peckenpaugh, 1976) in the Red River Valley from 2007 to 2024.

High to severe levels of SBRM fly activity (i.e., cumulative captures of at least 200 flies per sticky stake) were observed in 2024 in fields near the following communities (cumulative flies per stake in parentheses): Auburn (361), Buxton (279), Cavalier (214), Crystal (243), Reynolds (406), and St. Thomas (201), ND, as well as Crookston, MN (278). Moderately high levels of activity (i.e., cumulative captures of between 43 and 199 flies per sticky stake) were also recorded near Ardoch, Cashel, Drayton, Grafton, Grand Forks, Hoople, Hensel, Leroy, Oakwood, Thompson, Vesleyville, and Warsaw, ND, and near Ada, Argyle, Borup, Bygland, Climax, Downer, East Grand Forks, Eldred, Euclid, Fisher, Glyndon, Kennedy, Lockhart, Oslo, Sabin, Sherack, Stephen, and Warren, MN. Fly activity was either considered economically insignificant or was undetectable in most other areas during 2024.

Figure 2 presents SBRM fly monitoring results from three representative sites (i.e., Ada and East Grand Forks, MN and St. Thomas, ND) during the 2024 growing season. Fly emergence began slightly later and at lower levels than what is considered normal, and the main Valley-wide peak in fly activity occurred on about June 16, which was about three days later than the historical average.

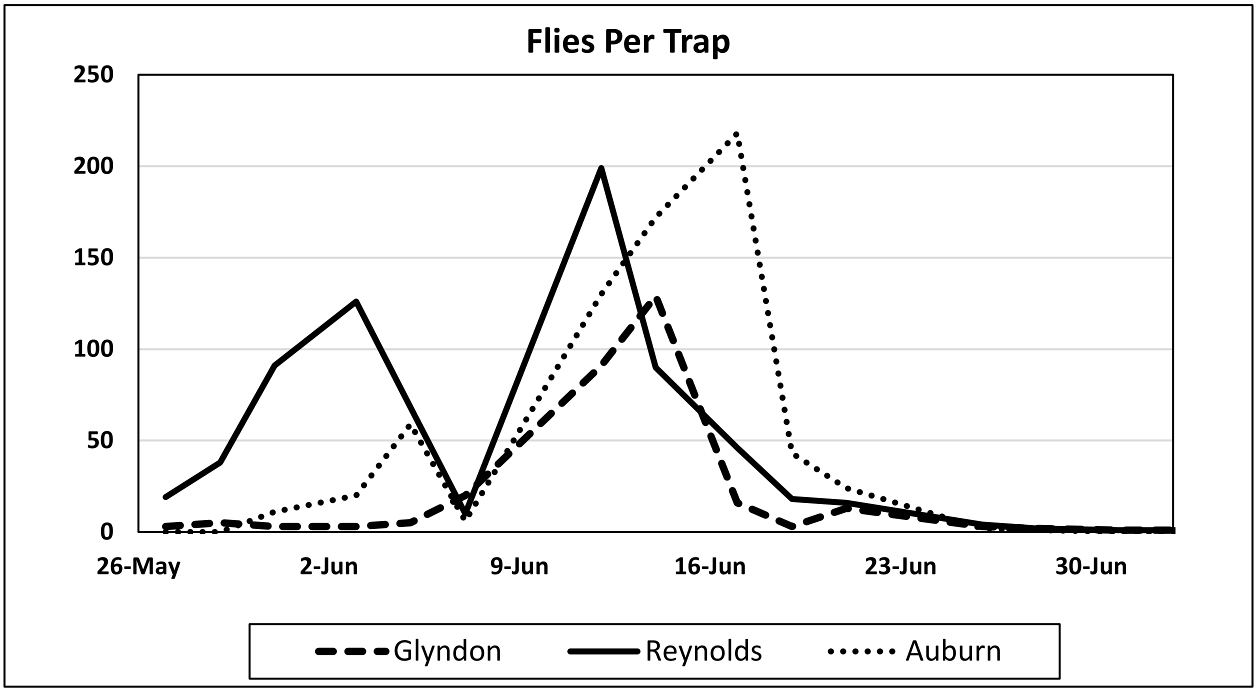

Fig. 2. Sugarbeet root maggot flies captured on sticky-stake traps at selected Red River Valley sites, 2024.

In late-August and early September of 2024, after the sugarbeet root maggot larval feeding period had ended, 41 of the fly monitoring sites were rated for SBRM feeding injury in accordance with the 0-9 scale of Campbell et al. (2000) to assess whether fly outbreaks and larval infestations were managed effectively. Two additional fields near Borup were also rated due to concerns about extremely high SBRM activity in the area in 2024. A total of 40 roots from each field sampled were rated for SBRM injury. The resulting data was subsequently overlaid with corresponding fly count data to develop the root maggot risk forecast map for the subsequent growing season (the SBRM risk forecast for next year is presented in the report that immediately follows this one).

Root maggot feeding injury, averaged across all RRV fields that exceeded the generalized economic threshold (43 cumulative flies per trap), averaged 2.99 on the 0 to 9 rating scale, which amounted to a 62% decrease over the same figure recorded in 2023. A list of RRV locations where the highest average root injury ratings were observed is presented in Table 1. Cumulative SBRM fly activity in those fields ranged from 70 flies/trap near Forest River, ND to 634 flies/trap near Crystal, ND.

Table 1. Sugarbeet root maggot fly activity and larval feeding injury in Red River Valley commercial sugarbeet fields where injury exceeded 2.5, 2021

Nearest City	Township	State	Flies/stake	Average Root Injury Rating[a]
Borup	Rockwell	MN	n/a	7.75
Ada	Pleasant View	MN	47	5.03
Cashel	Martin	ND	61	4.45
Crookston	Crookston	MN	38	4.33
Sabin	Elmwood	MN	54	4.05
Borup	Rockwell	MN	n/a	3.90
Vesleyville	Ops	ND	175	3.83
Auburn	Farmington	ND	361	3.6

[a]Sugarbeet root maggot feeding injury rating based on the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

The relatively high root injury ratings observed at a few of the locations listed in Table 1 are of concern, and somewhat unusual, given that relatively low levels of SBRM fly activity were observed in those fields. This suggests two very important things for consideration. First, weather conditions were frequently characterized by persistently moderate to high winds during the week leading up to peak SBRM fly activity and into the following week. Those conditions could have resulted in SBRM adults flying at very low heights and spending an unusually high amount of time near or on the ground surface as they moved into sugarbeet fields to mate and, in the case of females, lay eggs. That behavioral response to the windy conditions could have resulted in falsely low capture rates on sticky stake traps used to monitor the flies. However, the moderately high to even severe levels of SBRM larval feeding injury observed on roots in several fields suggests that fields planted to sugarbeet in 2024 that are located in the immediate vicinity of such fields will likely experience high to severe SBRM fly activity and, consequently, larval feeding pressure.

Careful monitoring of fly activity in moderate- and high-risk areas (see Forecast Map [Fig. 1] in subsequent report) will be critical to preventing economic loss in 2025. Vigilant monitoring and effective SBRM management on an individual-field basis by sugarbeet producers could also help prevent significant population increases from one year to another, because even moderate levels of root maggot survival in one year can be sufficient to result in economically damaging infestations in the subsequent growing season.

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The authors extend sincere appreciation to the following staff from American Crystal Sugar Company and Minn-Dak Farmers Cooperative for monitoring several additional fields for sugarbeet root maggot fly activity (in alphabetical order): Zach Berube, Spencer Billings, Alysia Boen, Emma Burt, Andrew Clark, Todd Cymbaluk, Thomas Cymbaluk, Tyler Driscoll, Mike Doeden, Jon Fuqua, Tyler Hegg, Austin Holy, Bob Joerger, Josh Knaack, Holly Kowalski, Kody Kyllo, Kyle Lindberg, Curt Meyer, Chris Motteberg, Brandon Reierson, Nolan Rockstad, Andrew Tweten, Dan Walters, and Scott Younggren.

The authors are also thankful to the following NDSU summer aides for providing assistance with fly monitoring activities: Amber Eken, Rylie Gustafson, Devin Lockerby, Hayden Vandal, and Nyla Wright. We also thank the Sugarbeet Research and Education Board of Minnesota and North Dakota, and American Crystal Sugar Company for providing significant funding support for this project. This work was also partially supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture under Hatch project number ND02374.

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SUGARBEET ROOT MAGGOT FORECAST FOR THE 2025 GROWING SEASON

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The 2025 forecast map for anticipated risk of sugarbeet root maggot (SBRM) fly activity and potential economic damage in the Red River Valley appears in the figure below. Root maggot fly activity has been on an upward trend for several the past several years; however, the activity observed during the 2024 growing season was the lowest recorded by the NDSU monitoring program in the past 13 years.

On the surface, this finding would seemingly suggest that the risk of economically damaging SBRM populations should be lower for the 2025 crop year. However, it is believed that the low capture rates recorded during 2024 were somewhat of a false negative, because SBRM infestations still managed to inflict major feeding injury in dozens of fields throughout the growing area. Average root maggot feeding injury ratings in growers' sugarbeet fields during the 2024 growing season were 62% higher than those recorded in 2023.

An examination of prevailing weather patterns that coincided with the rise into and beyond peak SBRM fly activity indicated that windy conditions persisted throughout much of the growing area for several days within the period when SBRM adults would have been emerging, mating, searching out sugarbeet fields, and laying eggs. It is conceivable that the frequent and persistent windy conditions stimulated adult SBRM flies to fly lower to the ground and in more of a hopping pattern than their more typical flight heights. That could explain why lower-than-expected numbers of SBRM flies were captured on sticky stakes than otherwise would have been under more calm, low-wind conditions. Therefore, it is believed that many areas in the production area continue to be at high risk for experiencing economically damaging SBRM infestations in 2025.

Areas at highest risk of economic loss due to SBRM feeding injury in 2025 include rural Auburn, Buxton, Cavalier, Cashel, Crystal, Reynolds, St. Thomas and Vesleyville, ND, as well as Ada, Borup, Crookston, Glyndon and Sabin, MN (see figure below). Moderate risk is expected in areas bordering high-risk zones, as well as fields near Ardoch, Drayton, Grafton, Grand Forks, Hensel, Hoople, Leroy, Oakwood, Thompson and Warsaw, ND, and Argyle, Bygland, Climax, Downer, East Grand Forks, Eldred, Fisher, Euclid, Fisher, Kennedy, Lockhart, Oslo, Sherack, Stephen and Warren, MN. The remainder of the area is at low risk.

Proximity to previous-year beet fields where populations were high and/or control was unsatisfactory can increase risk for damaging SBRM infestations. Areas where high fly activity occurred in 2024 should be monitored closely in 2025. Growers in high-risk areas should use an aggressive at-plant insecticide treatment (e.g., granular insecticide or a combination of tools) and expect the need to apply a postemergence rescue insecticide.

Those in moderate-risk areas using insecticidal seed treatments for at-plant protection should monitor fly closely in their area and be ready to apply additive protection if justified. Pay close attention to fly activity levels in late May through June to determine the need for a postemergence insecticide application.

NDSU Entomology personnel will continue to inform growers regarding SBRM activity levels and hot spots each year through radio reports, the NDSU "Crop and Pest Report" web postings, and notification of sugar cooperative agricultural staff when appropriate. Root maggot fly counts for the current growing season and those from previous years can be viewed at https://tinyurl.com/SBRM-FlyCounts.

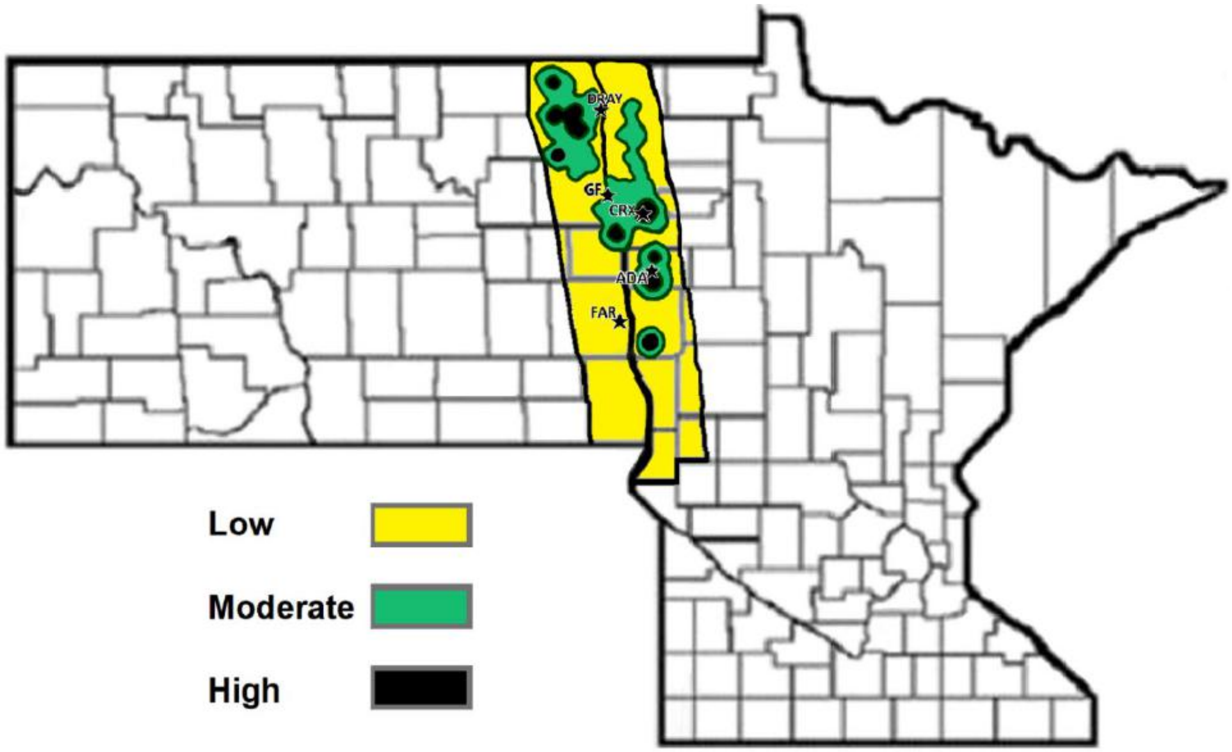

Fig. 1. Anticipated risk of SBRM fly activity and damaging larval infestations in the Red River Valley.

Acknowledgments:

The authors extend sincere appreciation to the following staff from American Crystal Sugar Company and Minn-Dak Farmers Cooperative for monitoring several additional fields for sugarbeet root maggot fly activity (in alphabetical order): Zach Berube, Spencer Billings, Alysia Boen, Emma Burt, Andrew Clark, Todd Cymbaluk, Thomas Cymbaluk, Tyler Driscoll, Mike Doeden, Jon Fuqua, Tyler Hegg, Austin Holy, Bob Joerger, Josh Knaack, Holly Kowalski, Kody Kyllo, Kyle Lindberg, Curt Meyer, Chris Motteberg, Brandon Reierson, Nolan Rockstad, Andrew Tweten, Dan Walters, and Scott Younggren.

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ONE-PASS INSECTICIDE, FUNGICIDE, AND STARTER FERTILIZER APPLICATIONS: AN EVALUATION OF SUGARBEET ROOT MAGGOT CONTROL AND PLANT SAFETY

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Introduction:

The practice of combining pesticide and fertilizer applications into a single implement pass through the field, either during planting operations or after emergence of the crop, can be a valuable and cost-effective strategy for producers. However, the impacts of such combinations on plant health or pest control efficacy should be thoroughly investigated before the practices can be recommended for implementation.

Insect pests that attack the roots of sugarbeet, including the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), springtails, wireworms, and white grubs are annual threats to the crop throughout much of the Red River Valley (RRV) production area. Producers typically manage these pests by applying a prophylactic insecticide during sugarbeet planting. This at-plant protection usually involves a granular or sprayable liquid insecticide, insecticide-treated seed, or a combination of these tools. In situations where high SBRM fly activity and associated risk of economic loss due to larval feeding pressure are expected, most producers also supplement at-plant insecticide(s) with a postemergence granular or sprayable liquid insecticide application.

Fungicides are also frequently used to manage soil-borne root diseases of sugarbeet such as Rhizoctonia damping off, crown rot, and root rot, all of which are caused by the pathogen *Rhizoctonia solani* Kühn. Similar to the insecticides used to manage root-feeding insect pests, fungicides targeting Rhizoctonia management in sugarbeet also can be delivered as planting-time and/or early-season postemergence applications.

The use of starter fertilizer at planting time is also a common practice of the region's sugarbeet producers. There is strong interest among producers in combining the application of these materials into single passes across the field at sugarbeet planting; however, little is known about the crop safety of the combinations or if they either complement or impair pesticide performance. If demonstrated as safe for the crop and at least neutral with respect to the impacts on pest management performance, consolidating the delivery of these products into tank-mixed combinations or concurrent (i.e., single-pass) applications would provide major time savings and reduce application-associated input costs for sugarbeet growers. This project involved two studies that were carried out to evaluate the impact of multicomponent application systems on sugarbeet root maggot control. A secondary objective was to monitor for any potential symptoms of phytotoxic effects of the treatment combinations, including impacts on plant emergence and survival.

Materials and Methods:

These experiments were conducted during the 2024 growing season in a commercial sugarbeet field site near St. Thomas in rural Pembina County, ND. Study I was planted on May 20, 2024, and Study II was planted on May 17. Betaseed 8018, a glyphosate- and Cercospora leaf spot-tolerant seed variety, was used for all treatments in both experiments. A 6-row Monosem NG Plus 4 7x7 planter set to deliver seed at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length was used to plant the trial. Plots were six rows (22-inch spacing) wide by 35 ft long with the four centermost rows treated. The outer "guard" row on each side of the plot served as an untreated buffer. Thirty-five-foot tilled, plant-free alleys were maintained between replicates throughout the growing season. Both experiments were arranged in a randomized complete block design with four replications.

<u>Planting-time insecticide applications</u>. Planting-time applications of Counter 20G in both experiments were applied by using band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders. Granular application rates were regulated by using planter-mounted SmartBox™ electronic insecticide delivery system that had been calibrated on the planter before all applications.

Planting-time liquid spray applications applied concurrently to the Counter applications in Study I included AZteroid fungicide (active ingredient: azoxystrobin), either alone or tank-mixed with starter fertilizer (i.e., either 6-24-0 or 10-34-0), and they were delivered by using dribble in-furrow (DIF) placement. Dribble in-furrow treatments were applied in a 3:2-gallon ratio of three gallons starter fertilizer to two gallons water spray solution, and the applications were made by orienting a microtube (1/4" outside diam.) directly into the open seed furrow. An electric ball valve system, equipped with inline Teejet™ No. 20 orifice plates was used to propel spray output from the microtubes at a finished volume of five gallons per acre (GPA).

Postemergence insecticide applications. Postemergence foliar liquid insecticides evaluated (Study II only) included Mustang Maxx (active ingredient: zeta-cypermethrin) and Pilot 4E (active ingredient: chlorpyrifos), and the fungicides tank-mixed with them included either Elatus (active ingredients: a combination of azoxystrobin and benzovindiflupyr), Excalia (active ingredient: indiflin), or Quadris (active ingredient: azoxystrobin). Treatment combinations that included postemergence insecticides and fungicides in Study II were applied on June 11, which was about five days before peak SBRM fly activity (i.e., "pre-peak"). Postemergence liquid treatments were delivered with a tractor-mounted CO_2-propelled spray system equipped with TeeJet™ XR 110015VS nozzles. The system was calibrated to deliver a finished output volume of 10 GPA.

Plant Stand Counts: To determine at-plant treatment impacts on seedling emergence and survival throughout the growing season, surviving plant stands were counted in Study I on May 30, June 25, July 8, and July 17 2024 (i.e., 10, 36, 49, and 58 days after planting [DAP], respectively). Those assessments involved counting all living plants within each 35-ft-long row. Raw stand counts were then converted to plants per 100 linear row feet for the analysis.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in Study I on August 8, 2024 and in Study II on August 9, 2024. Sampling consisted of randomly collecting ten beet roots per plot (five from each of the outer two treated rows), hand-washing them, and scoring them in accordance with the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

Harvest: Treatment performance was also compared on the basis of sugarbeet yield parameters. Study I was harvested on October 2 and Study II was harvested on October 3, 2024. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were extracted from soil using a mechanical harvester and weighed in the field using a digital scale. A representative subsample of 12-18 beets was collected from each plot and sent to the American Crystal Sugar Company Tare Laboratory (East Grand Forks, MN) for sucrose content and quality analysis.

Data analysis: All data from plant stand counts, root injury ratings, and harvest samples were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

Study I. The results from a series of four counts of surviving plant stands in Study I are shown in Table 1. At the first stand count, which was carried out at 10 days after planting (DAP), most treatments, including the untreated check, hovered at around 45 to 55% of expected stand, and there were no significant differences among treatments. At the second stand count (36 DAP), the lowest stands were recorded in the 6-24-6 and 10-34-0 fertilizer controls, and the 10-34-0 control plots had significantly lower stands per 100 ft than the untreated no-fertilizer untreated check. There were no other consistent treatment-related responses involving the fungicide/insecticide/ fertilizer combination treatments at the second stand count date.

There were no significant stand count differences among treatments, including the fertilizer controls, at the third (49 DAP) and fourth (58 DAP) stand count dates. However, trends suggest that 6-24-6 starter fertilizer is safer and less negatively impactful on seedling survival than 10-34-0 fertilizer. Stand count data from the last two dates also suggests that tank mixing AZteroid fungicide with 10-34-0 starter fertilizer and combining the application with a planting-time application of Counter 20G could reduce surviving plant populations, although the observed differences were not statistically significant.

Table 1. *Plant stand counts* from an evaluation of at-plant insecticide, azoxystrobin fungicide, and starter fertilizer combinations in sugarbeet, St. Thomas, ND, 2024 (Study I)							
Treatment/form.	**Placement[a]**	**Rate[b] (product/ ac)**	**Rate (lb a.i./ac)**	**Stand count[c] (plants / 100 ft)**			
				10 DAP[c]	**36 DAP[c]**	**49 DAP[c]**	**58 DAP[c]**
Counter 20G + 6-24-6	B DIF	7.5 lb 5 GPA	1.5 ---	108.4 a	215.4 ab	219.3 a	211.3 a
Counter 20G + 6-24-6	B DIF	8.9 lb 5 GPA	1.8 ---	114.6 a	214.1 abc	216.6 a	208.8 a
Counter 20G + AZteroid FC 3.3 + 6-24-6	B DIF DIF	7.5 lb 5.7 fl oz 5 GPA	1.5 0.15 ---	98.0 a	210.9 abcd	223.0 a	208.6 a
Counter 20G + AZteroid FC 3.3 + 6-24-6	B DIF DIF	8.9 lb 5.7 fl oz 5 GPA	1.8 0.15 ---	96.3 a	217.9 ab	214.1 a	207.5 a
Counter 20G	B	7.5 lb	1.5	98.9 a	221.1 a	220.5 a	206.3 a
Counter 20G	B	8.9 lb	1.8	101.4 a	219.1 ab	219.5 a	206.3 a
Counter 20G + 10-34-0	B DIF	8.9 lb 5 GPA	1.8 ---	95.4 a	208.0 abcd	214.1 a	202.3 a
Counter 20G + 10-34-0	B DIF	7.5 lb 5 GPA	1.5 ---	103.9 a	211.8 abc	215.2 a	201.6 a
Untreated	---	---	---	103.6 a	211.3 abc	204.5 a	201.1 a
6-24-6	DIF	5 GPA	---	88.0 a	201.4 cd	201.4 a	198.4 a
Counter 20G + AZteroid FC+ 10-34-0	B DIF DIF	8.9 lb 5.7 fl oz 5 GPA	1.8 0.15 ---	80.0 a	206.3 bcd	209.5 a	197.3 a
Counter 20G + AZteroid FC 3.3 + 10-34-0	B DIF DIF	7.5 lb 5.7 fl oz 5 GPA	1.5 0.15 ---	84.6 a	208.2 abcd	209.8 a	196.3 a
10-34-0	DIF	5 GPA	---	90.5 a	197.3 d	202.3 a	190.4 a
LSD (0.05)				NS	13.6	NS	NS

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch at-plant band; DIF = dribble in-furrow.
[b]At-plant sprays were delivered in a 10-34-0 or 6-24-6 starter fertilizer/water carrier (3:2 gal. H_2O to fertilizer) at an output volume of 5 GPA.
[c]Surviving plant stands were counted on May 30, June 25, July 8, and July 17, 2024 (i.e., 10, 36, 49, and 58 days after planting [DAP], respectively).

Sugarbeet root maggot feeding injury results from Study I appear in Table 2. The average SBRM feeding injury sustained in the no-fertilizer untreated check plots (6.0, respectively, on the 0 to 9 scale of Campbell et al. [2000]) indicated the presence of a moderate SBRM larval infestation for the experiment. Root maggot feeding injury in the 6-24-6 and 10-34-0 fertilizer controls averaged 5.7 and 5.9 on the 0 to 9 scale, respectively, neither of which was significantly different from the untreated control. This suggests that the fertilizer applications did not have a negative or positive effect on SBRM larval survival or feeding behavior.

All insecticide-treated entries in the trial provided significant reductions in SBRM feeding injury when compared to the untreated check and the fertilizer-only check; however, the feeding injury sustained by roots in the treatment combination of Counter 20G at 7.5 lb product per acre plus a concurrent application of AZteroid tank mixed with 10-34-0 starter fertilizer was not significantly different from the feeding injury that occurred in the 10-34-0 fertilizer-only control. This could indicate that the fungicide/10-34-0 combination could have interfered with the performance of Counter 20G. The lowest overall average SBRM feeding injury (i.e., the highest level of root protection) in Study I was observed in plots that received the combination of a planting-time application of Counter 20G at its high labeled rate (8.9 lb product/ac) with a concurrent application of AZteroid FC that was tank mixed with 6-24-6 starter fertilizer. This was an encouraging result, as it suggests that 6-24-6 starter fertilizer could be safer and less phytotoxic on sugarbeet seedlings than 10-34-0 when tank mixed with an a strobilurin fungicide like AZteroid FC.

Table 2. *Larval feeding injury* in an evaluation of at-plant insecticide, azoxystrobin fungicide, and starter fertilizer combinations in sugarbeet, St. Thomas, ND, 2024 (Study I)				
Treatment/form.	**Placement[a]**	**Rate[b] (product/ac)**	**Rate (lb a.i./ac)**	**Root injury (0-9)**
Counter 20G + AZteroid FC 3.3 + 6-24-6	B DIF DIF	8.9 lb 5.7 fl oz 5 GPA	1.8 0.15 ---	3.1 d
Counter 20G + 10-34-0	B DIF	7.5 lb 5 GPA	1.5 ---	3.3 cd
Counter 20G + 6-24-6	B DIF	7.5 lb 5 GPA	1.5 ---	3.5 cd
Counter 20G	B	8.9 lb	1.8	3.5 cd
Counter 20G + 10-34-0	B DIF	8.9 lb 5 GPA	1.8 ---	4.0 cd
Counter 20G + AZteroid FC 3.3 + 6-24-6	B DIF DIF	7.5 lb 5.7 fl oz 5 GPA	1.5 0.15 ---	4.1 cd
Counter 20G + 6-24-6	B DIF	8.9 lb 5 GPA	1.8 ---	4.1 cd
Counter 20G	B	7.5 lb	1.5	4.1 cd
Counter 20G + AZteroid FC+ 10-34-0	B DIF DIF	8.9 lb 5.7 fl oz 5 GPA	1.8 0.15 ---	4.2 cd
Counter 20G + AZteroid FC 3.3 + 10-34-0	B DIF DIF	7.5 lb 5.7 fl oz 5 GPA	1.5 0.15 ---	4.5 bc
6-24-6	DIF	5 GPA	---	5.7 ab
10-34-0	DIF	5 GPA	---	5.9 ab
Untreated	---	---	---	6.0 a
LSD (0.05)				1.3

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]At-plant sprays were delivered in a 10-34-0 starter fertilizer/water carrier (3:2 gal. H_2O to fertilizer) at an output volume of 5 GPA.
[b]B = 5-inch at-plant band; DIF = dribble in-furrow.

Yield data from Study I are presented in Table 3. All treatments in the experiment that included Counter 20G insecticide provided significant increases in recoverable sucrose yield when compared to the untreated check. Performance patterns among the various treatment combinations corresponded well with the findings from stand counts and root maggot feeding injury results. The highest overall recoverable sucrose and root tonnage yields in the experiment were recorded in plots treated with Counter 20G at its high (8.9 lb product/ac) rate and a concurrent application of 6-24-6 starter fertilizer. Other treatments in the trial that generated comparable recoverable sucrose and root yields which were not statistically different from that combination included the following:

1) Counter 20G (7.5 lb/ac), banded + AZteroid FC, tank mixed with 6-24-6 starter fertilizer, DIF;
2) Counter 20G (8.9 lb/ac), banded + 10-34-0 starter fertilizer, DIF; and
3) Counter 20G (7.5 lb/ac), banded + 6-24-6 starter fertilizer, DIF.

Although the highest yields in this experiment frequently occurred when plots were treated with a planting-time application of Counter 20G at 8.9 lb product per acre and a concurrent application of 6-24-6 starter fertilizer, one concerning contrast was observed. In similar plots that received Counter at 8.9 lb product per acre plus a concurrent application of 6-24-6 starter fertilizer, the addition of AZteroid FC fungicide to the fertilizer solution resulted in a significant reduction in both recoverable sucrose yield (i.e., 12.5% loss) and root yield (i.e., 3.7 tons/ac reduction) when compared to similar plots where the AZteroid was excluded. Slight, but not statistically significant reductions in recoverable sucrose and root yield were also observed in plots treated at planting with Counter 20G at the high (8.9 lb product/ac) rate plus 10-34-0 starter fertilizer when AZteroid FC was tank mixed with the fertilizer solution.

As mentioned above, the treatment combination of Counter 20G at its moderate (7.5 lb/ac) rate and a concurrent DIF spray of AZteroid FC tank mixed with 6-24-6 starter fertilizer was one of the highest-yielding treatment combinations in this experiment; however, there was numerical (i.e., not statistically significant) reduction in recoverable sucrose yield (i.e., a 4.7% loss) in plots treated with a similar combination, but where Counter 20G was applied at its full (8.9 lb/ac) application rate and combined with the same concurrent tank mixture of AZteroid plus 6-24-6 starter fertilizer. Despite the lack of statistical significance in that comparison, the root tonnage loss, albeit not statistically significant, was 1.9 tons per acre, and the disparity led to a revenue loss of $100 per acre.

Table 3. *Yield parameters* from an evaluation of at-plant insecticide, azoxystrobin fungicide, and starter fertilizer combinations in sugarbeet, St. Thomas, ND, 2024 (Study I)

Treatment/form.	Placement[a]	Rate[b] (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Counter 20G + 6-24-6	B DIF	8.9 lb 5 GPA	1.8 ---	12,216.6 a	38.7 a	17.0 a	2,709
Counter 20G + AZteroid FC 3.3 + 6-24-6	B DIF DIF	7.5 lb 5.7 fl oz 5 GPA	1.5 0.15 ---	11,226.5 ab	36.9 ab	16.5 a	2,388
Counter 20G + 10-34-0	B DIF	8.9 lb 5 GPA	1.8 ---	11,074.0 ab	37.1 ab	16.3 a	2,304
Counter 20G + 6-24-6	B DIF	7.5 lb 5 GPA	1.5 ---	11,056.6 ab	35.9 ab	16.6 a	2,385
Counter 20G + AZteroid FC 3.3 + 10-34-0	B DIF DIF	7.5 lb 5.7 fl oz 5 GPA	1.5 0.15 ---	10,986.4 b	36.4 ab	16.4 a	2,316
Counter 20G + 10-34-0	B DIF	7.5 lb 5 GPA	1.5 ---	10,941.4 b	37.0 ab	16.2 a	2,254
Counter 20G + AZteroid FC+ 10-34-0	B DIF DIF	8.9 lb 5.7 fl oz 5 GPA	1.8 0.15 ---	10,926.1 b	35.8 ab	16.5 a	2,332
Counter 20G	B	8.9 lb	1.8	10,774.1 bc	35.1 bc	16.6 a	2,317
Counter 20G	B	7.5 lb	1.5	10,724.8 bcd	34.8 bc	16.7 a	2,317
Counter 20G + AZteroid FC 3.3 + 6-24-6	B DIF DIF	8.9 lb 5.7 fl oz 5 GPA	1.8 0.15 ---	10,695.2 bcd	35.0 bc	16.5 a	2,288
6-24-6	DIF	5 GPA	---	9,614.2 cde	31.8 cd	16.4 a	2,033
10-34-0	DIF	5 GPA	---	9,531.5 de	31.0 d	16.6 a	2,052
Untreated	---	---	---	9,221.2 e	31.8 cd	15.8 a	1,846
LSD (0.05)				1,205.3	3.4	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]At-plant sprays were delivered in a 10-34-0 starter fertilizer/water carrier (3:2 gal. H_2O to fertilizer) at an output volume of 5 GPA.
[b]B = 5-inch at-plant band; DIF = dribble in-furrow.

Study II. Sugarbeet root maggot feeding injury results from Study II appear in Table 4. The average SBRM feeding injury sustained in the untreated check plots was 6.0 on the 0 to 9 scale of Campbell et al. [2000]), which indicated that a moderate SBRM larval infestation was present for the experiment. NOTE: given that all insecticide-treated entries in Study II received a base planting-time application of Counter 20G at 8.9 lb product per acre, the discussion of results from this experiment will focus on the postemergence insecticide and fungicide components of each treatment. All insecticide-treated entries in the trial provided significant reductions in SBRM feeding injury when compared to the untreated check, but the lowest average SBRM feeding injury (i.e., the highest level of root protection) in Study II was observed in plots that received the postemergence tank-mixed combination of Pilot 4E plus Elatus fungicide. The average SBRM feeding injury that occurred in those plots was significantly lower than the injury sustained in plots treated at postemergence with Pilot 4E alone (i.e., no fungicide component). That finding may suggest that Elatus could have provided some level of insecticidal activity which complemented the root protection provided by Pilot 4E.

Excellent levels of root protection from SBRM feeding injury were provided by Mustang Maxx alone, the tank-mixed combination of Pilot 4E and Quadris, and the combination of Mustang Maxx plus Quadris. None of those postemergence treatment entries were significantly outperformed by the top-performing Pilot/Elatus tank mixture with respect to protection from SBRM feeding injury. However, plots treated at postemergence with a tank mixture of Pilot 4E plus Excalia sustained significantly greater levels of root maggot feeding injury than those treated with the Pilot 4E/Elatus tank mixture. Similarly, plots that received the postemergence tank-mixed combination of Mustang Maxx plus Excalia combination had significantly greater SBRM feeding injury ratings than the Mustang Maxx-only plots.

Table 4. ***Larval feeding injury*** **in an evaluation of postemergence insecticide and fungicide tank mixtures for sugarbeet root maggot control, St. Thomas, ND, 2024 (Study II)**				
Treatment/form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Root injury (0-9)**
Counter 20G + Pilot 4E + Elatus	B 5d Pre-Peak Band	8.9 lb 2 pts 7.1 fl oz	1.8 1.0 0.2	1.8 e
Counter 20G + Mustang Maxx	B 5d Pre-Peak Band	8.9 lb 4 fl oz	1.8 0.025	2.1 de
Counter 20G + Pilot 4E + Quadris	B 5d Pre-Peak Band	8.9 lb 2 pts 10 fl oz	1.8 1.0 0.16	2.2 de
Counter 20G + Mustang Maxx + Quadris	B 5d Pre-Peak Band	8.9 lb 4 fl oz 10 fl oz	1.8 0.025 0.16	2.5 cde
Counter 20G + Mustang Maxx + Elatus	B 5d Pre-Peak Band	8.9 lb 4 fl oz 7.1 fl oz	1.8 0.025 0.2	2.5 cde
Counter 20G + Pilot 4E	B 5d Pre-Peak Band	8.9 lb 2 pts	1.8 1.0	2.9 bcd
Counter 20G + Pilot 4E + Excalia	B 5d Pre-Peak Band	8.9 lb 2 pts 0.64 oz	1.8 1.0 0.01	3.0 bcd
Counter 20G	B	8.9 lb	1.8	3.3 bc
Counter 20G + Mustang Maxx + Excalia	B 5d Pre-Peak Band	8.9 lb 4 fl oz 0.64 oz	1.8 0.025 0.01	3.6 b
Untreated	---	---	---	6.0 a
LSD (0.05)				1.0

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch at-plant band; 5d Pre-Peak = 7" postemergence band, applied five days before peak SBRM fly activity.

Yield results from Study II are presented in Table 3. All treatment combinations in the experiment that included an insecticide provided significant increases in both recoverable sucrose yield and root yield when compared to the untreated check, but there were no significant differences in recoverable sucrose or root tonnage yield among the insecticide treatments or the insecticide/fungicide combinations. Generally speaking, that is a positive overall finding of this experiment, because it suggests that the insecticide/fungicide combinations evaluated in this experiment are not likely to result in serious negative consequences for producers that choose to use them for combined one-pass operations for insect and disease management in their sugarbeet crop. The gross economic return figures from this trial offer some reasons for caution and concern.

Overall patterns of performance suggest that Elatus fungicide may be a safer tank-mix partner than Quadris and, to a lesser extent, Excalia, for combining with either Mustang Maxx or Pilot 4E for postemergence foliar sprays in sugarbeet. Plots treated with a combination of Mustang Maxx plus Elatus generated numerically greater recoverable sucrose and root yield when compared to the yields obtained in the Mustang Maxx-only plots. The increased yield provided by the Mustang Maxx/Elatus combination resulted in a gross revenue increase of $15 per acre when compared to the Mustang Maxx-only treatment. Although the revenue increase observed in this comparison could be considered modest, this a positive and important finding. The fact that the experiment was conducted under moderate SBRM pressure and in the absence of any major foliar disease pressure suggests that the economic return from the Mustang Maxx/Elatus treatment combination would likely have been substantially greater in a commercial grower field scenario under more significant insect and foliar disease pressure.

Table 5. *Yield parameters* from an evaluation of postemergence insecticide and fungicide tank mixtures for sugarbeet root maggot control, St. Thomas, ND, 2024 (Study II)							
Treatment/form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Sucrose yield (lb/ac)**	**Root yield (T/ac)**	**Sucrose (%)**	**Gross return ($/ac)**
Counter 20G + Mustang Maxx + Elatus	B 5d Pre-Peak Band	8.9 lb 4 fl oz 7.1 fl oz	1.8 0.025 0.2	11,134.7 a	35.1 a	17.0 a	2,488
Counter 20G + Mustang Maxx	B 5d Pre-Peak Band	8.9 lb 4 fl oz	1.8 0.025	11,087.4 a	35.0 a	17.0 a	2,473
Counter 20G + Pilot 4E + Elatus	B 5d Pre-Peak Band	8.9 lb 2 pts 7.1 fl oz	1.8 1.0 0.2	10,904.8 a	34.3 a	17.1 a	2,442
Counter 20G + Pilot 4E + Excalia	B 5d Pre-Peak Band	8.9 lb 2 pts 0.64 oz	1.8 1.0 0.01	10,904.7 a	35.3 a	16.6 a	2,368
Counter 20G + Mustang Maxx + Excalia	B 5d Pre-Peak Band	8.9 lb 4 fl oz 0.64 oz	1.8 0.025 0.01	10,875.4 a	34.7 a	16.9 a	2,400
Counter 20G + Pilot 4E	B 5d Pre-Peak Band	8.9 lb 2 pts	1.8 1.0	10,732.3 a	35.1 a	16.5 a	2,298
Counter 20G + Mustang Maxx + Quadris	B 5d Pre-Peak Band	8.9 lb 4 fl oz 10 fl oz	1.8 0.025 0.16	10,710.6 a	34.3 a	16.8 a	2,354
Counter 20G + Pilot 4E + Quadris	B 5d Pre-Peak Band	8.9 lb 2 pts 10 fl oz	1.8 1.0 0.16	10,590.4 a	34.1 a	16.7 a	2,308
Counter 20G	B	8.9 lb	1.8	10,151.9 a	33.1 a	16.6 a	2,183
Untreated	---	---	---	9,033.7 b	28.2 b	17.2 a	2,039
LSD (0.05)				1,051	2.8	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch at-plant band; 5d Pre-Peak = 7" postemergence band, applied five days before peak SBRM fly activity.

More concerning was our observation that tank mixing Quadris with Mustang Maxx resulted in a recoverable sucrose yield reduction of 377 lb per acre when compared with the Mustang Maxx-only treatment. That disparity, although not statistically significant, translated to a gross revenue loss of $119 per acre when Quadris was tank mixed with Mustang Maxx. A similar, albeit less substantial, negative result in Study II was our finding that combining Excalia with Mustang Maxx led to a 212 lb per acre reduction in recoverable sucrose yield and a gross revenue reduction of $73 per acre when compared to the Mustang Maxx-only treatment. No apparent negative impacts on yield or revenue were observed with foliar insecticide/fungicide tank mixtures involving Pilot 4E as the insecticide component. Moreover, when Elatus fungicide was tank mixed with Pilot 4E, average recoverable sucrose yield increased by about 143 lb per acre. Although the increase was modest and not statistically significant, it suggests that combining Elatus with Pilot 4E is likely to be a safe approach as a single-pass operation for sugarbeet insect and disease management.

Summary:

The results of Study I suggest that 6-24-6 starter fertilizer appears to be a slightly safer product than 10-34-0 to apply concurrently with a planting-time application of Counter 20G, especially when Counter is applied at its high labeled rate (8.9 lb product/ac), which is commonly used in areas at risk of high SBRM infestations. These results also suggest that risk of crop injury and associated yield and revenue losses will be greater if Counter is applied at the 8.9-lb rate and AZteroid FC (or a similar strobilurin fungicide product) is included with starter fertilizer, irrespective of whether the fertilizer product used is 10-34-0 or 6-24-6. If a grower prefers combining applications of Counter 20G, a starter fertilizer, and a strobilurin fungicide at sugarbeet planting, the Counter should be applied at no more than 7.5 lb product per acre, and the starter fertilizer product should be a product with lower nitrogen and phosphorus concentrations such as 6-24-6.

In Study II, one of our most encouraging results occurred when plots that were initially treated with Counter 20G were treated with a postemergence foliar tank mixture of Pilot 4E insecticide plus Elatus fungicide, roots incurred significantly lower levels of SBRM feeding injury than when Pilot 4E was applied without Elatus. This suggests that Elatus fungicide either independently has a degree of insecticidal activity on SBRM larvae or it had a synergistic impact on Pilot 4E. However, our experiment was not designed to specifically determine the nature of this relationship. An alarming result from this experiment was that tank mixing Excalia with Mustang Maxx allowed significantly greater levels of SBRM larval feeding injury to occur than when the Excalia was excluded. This suggests at least the possibility of some form of antagonism between Excalia and Mustang Maxx that resulted in interference with the performance of the latter for protection from root maggot larval feeding injury.

Overall, the harvest results from Study II suggest that Elatus may be a safer fungicide tank-mix partner than Quadris and, to a lesser extent, Excalia, for combining with either Mustang Maxx or Pilot 4E in sugarbeet; however, statistical differences between the various insecticide/fungicide tank mixtures were lacking. The potential for augmented SBRM control by including Elatus fungicide with Pilot 4E, as well as the possible antagonism between Mustang Maxx and Excalia, should be more thoroughly investigated in future research.

The combined results from these two experiments suggest that one-pass systems for delivering starter fertilizer, insecticides, and fungicides can be effective and economically beneficial operations. However, caution and careful consideration of these results should be taken to ensure the success of the applications. Both beneficial and seriously detrimental impacts of various combinations were observed in these experiments, but statistically significant differences were not always detected. Further research on the fertilizer/insecticide/fungicide combinations evaluated in these experiments is needed to more thoroughly evaluate their safety and efficacy. It is likely that additional research will also be needed to perform similar assessments on new crop management products as they come to the marketplace for grower consideration as tools in their insect pest and disease management portfolio for sugarbeet.

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EVALUATION OF EXPERIMENTAL PLANTING-TIME AND POSTEMERGENCE RESCUE INSECTICIDES SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder) is the most serious economic insect pest of sugarbeet in the Red River Valley (RRV) production area of North Dakota and Minnesota. Unfortunately, on a national scale, sugarbeet is a relatively small-acreage commodity, so there is a correspondingly small number of insecticide products currently registered by the U.S. Environmental Protection Agency (EPA) for insect pest management in sugarbeet. This long-standing situation has forced RRV sugarbeet producers to rely heavily on the same insecticide mode of action (i.e., acetylcholinesterase [ACHE] inhibition) to manage the SBRM for over 50 years. Additionally, the severe SBRM infestations that frequently develop in central and northern portions of the RRV often necessitate two to three applications of these materials each growing season to protect the crop from major economic loss.

This long-term use of repeated applications of ACHE-inhibiting insecticides in the growing region has exerted intense selection pressure for the development of insecticide resistance in RRV root maggot populations. Although SBRM resistance to these materials has not yet been detected in the production area, research is critically needed to develop alternative management tools to ensure the long-term sustainability and profitability of sugarbeet production for growers affected by this pest. This research was carried out to achieve the following objectives: 1) compare the efficacy of experimental insecticides with that of insecticides currently registered for use in sugarbeet; and 2) evaluate commercially available, EPA-registered conventional chemical insecticides that are currently not registered for use in sugarbeet to determine if their performance would warrant future pursuit of labeling for sugarbeet root maggot control.

Materials and Methods:

This experiment was carried out on a commercial sugarbeet field site near St. Thomas (Pembina County), ND. Plots were planted on May 21, 2024, by using a 6-row Monosem NG Plus 7x7 planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Betaseed 8018 CR+, a glyphosate- and Cercospora leaf spot-tolerant seed variety, was used for all treatments.

Each individual treatment plot was six rows (22-inch spacing) wide by 35 feet long. The four centermost rows of each plot received an assigned treatment, whereas the outer "guard" rows (i.e., planter rows one and six) on each side of the plot were untreated, and served as buffer rows. Thirty-five-foot-wide alleys between replicates were maintained plant-free via periodic cultivation throughout the growing season. Treatments were arranged in a randomized complete block design with four replications. Counter 20G (granular) insecticide was used for comparative purposes as a planting-time SBRM management standard, and it was applied by using band (B) placement (Boetel et al. 2006). Banding consisted of delivering 5-inch swaths of granules through Gandy™ row banders. Granular application rates were regulated by using a planter-mounted SmartBox™ electronically-controlled insecticide delivery system calibrated on the planter immediately before all applications.

Experimental planting-time insecticides evaluated in the experiment included the following: 1) Aztec 4.67G (active ingredients: tebupirimifos [an organophosphate insecticide] and cyfluthrin [a pyrethroid insecticide]); 2) Index (active ingredients: chlorethoxyfos [an organophosphate] and bifenthrin [a pyrethroid]); 3) Smart Choice 5G (active ingredients: chlorethoxyfos and bifenthrin [a pyrethroid insecticide]); and 4) Verimark (active ingredient: cyantraniliprole [a anthranilic diamide insecticide]). All planting-time liquid insecticides were delivered in 3-inch T-bands over the open seed furrow by using a planter-mounted spray system calibrated to deliver a finished spray volume output of 5 gallons per acre (GPA) through TeeJet™ 400067E nozzles. Water used as a carrier for all planting-time liquid insecticide applications was adjusted to pH 6.0 at least one week before planting.

Pilot 4E (active ingredient: chlorpyrifos, an organophosphate insecticide) was used as the postemergence broadcast SBRM management standard. Experimental postemergence insecticides evaluated included the following: 1) Endigo ZCX (active ingredients: thiamethoxam [a neonicotinoid insecticide] and lambda cyhalothrin [a pyrethroid]); and 2) Exirel (active ingredient: cyantraniliprole [a anthranilic diamide]. Postemergence sprays were broadcast-applied on June 14 (i.e., about 2 days before peak SBRM fly activity) by using a tractor-mounted, CO_2-propelled spray system equipped with an 11-ft boom calibrated to deliver a finished spray volume output of 10 GPA through TeeJet™ 110010VS nozzles. The water used as a carrier for all postemergence liquid insecticide sprays was adjusted to pH 6.0 at least one week before applications.

Root injury ratings: Sugarbeet root maggot feeding injury ratings were carried out in this trial on August 12 by randomly collecting ten beet roots per plot (five from each of the outer two treated rows), hand-washing them, and scoring them in accordance with the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or a dead plant) of Campbell et al. (2000).

Harvest: Treatment performance was also compared on the basis of sugarbeet yield parameters. All plots in the experiment were harvested on October 3, 2024. Immediately before harvest, all foliage was removed from plants by using a tractor-drawn commercial-grade mechanical defoliator. All roots from the center two rows of each plot were extracted from the soil using a mechanical harvester and weighed in the field using a digital scale. A representative subsample of 12-18 beets was collected from each plot and sent to the American Crystal Sugar Company Tare Laboratory (Moorhead, MN) for sucrose content and quality analyses.

Data analysis: All data from root injury ratings and harvest samples were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance

Results and Discussion:

It is important to note that all insecticide entries in this experiment were single-component (i.e., either at-plant-only or postemergence-only) control tools, a practice that is not recommended in areas such as the central and northern Red River Valley where severe root maggot infestations commonly develop. Sugarbeet root maggot feeding injury rating results for this experiment appear in Table 1. Root injury ratings in the untreated check plots averaged 5.7 on the 0 to 9 scale of Campbell et al. (2000), which indicated the presence of a moderate SBRM infestation for this experiment.

Table 1. ***Larval feeding injury*** **from an evaluation of registered and experimental insecticides for sugarbeet root maggot control, St. Thomas, ND, 2024**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G	B	7.5 lb	1.5	2.8 f
Counter 20G	B	8.9 lb	1.8	3.1 ef
Aztec Smartbox 4.67G	B	7.4 lb	0.21	3.3 def
Index	DIF	17.1 fl oz	0.3	3.3 def
Verimark	DIF	10 fl oz	0.13	3.9 cde
Pilot 4E	2 d Pre-Peak Broadcast	2 pts	1.0	4.3 bcd
Smart Choice 5G	B	4.45 lb	0.37	4.7 abc
Endigo ZCX + NIS	2 d Pre-Peak Broadcast	4.5 fl oz 0.25% v/v	0.3 ---	5.2 ab
Pilot 4E	2 d Pre-Peak Broadcast	1 pt	0.5	5.4 a
Exirel Insect Control	2 d Pre-Peak Broadcast	20 fl oz	0.1	5.6 a
Untreated check	---	---	---	5.7 a
LSD (0.05)				1.0

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch at-plant band; DIF = dribble in-furrow at planting; 2 d Pre-Peak Broadcast = postemergence broadcast, applied two days before peak SBRM fly activity.

Treatments that provided the highest levels of root protection (i.e., lowest SBRM feeding injury ratings) were planting-time insecticide applications, and included the following (listed in descending order of SBRM control performance): Counter 20G (7.5 lb product/ac), Counter 20G (8.9 lb product/ac), Aztec 4.67G (7.4 lb product/ac), and Index (17.1 fl oz/ac). There were no significant differences in levels of root protection from SBRM feeding injury among those treatments. Other treatments in the experiment that provided statistically significant reductions in SBRM feeding injury when compared to the untreated check included Verimark (10 fl oz product/ac, applied at planting time using DIF placement) and a postemergence broadcast application of Pilot 4E at its maximum labeled rate (2 pts product/ac). The remaining treatments, including Exirel Insect Control, Pilot 4E (7.5 lb product/ac), Endigo ZCX, and Smart Choice, incurred levels of SBRM feeding injury that were not significantly different from the injury sustained by the untreated check plots.

Yield data from the experiment are shown in Table 2. The highest recoverable sucrose yield and root tonnage in the experiment was achieved by band-applying Counter 20G at its high rate of 8.9 lb product/ac. Excellent performance was also achieved with the following treatments, which were not significantly different with respect to recoverable sucrose yield from the high rate of Counter: 1) Aztec 4.67G (banded, 4.45 lb product/ac); 2) Counter 20G (banded, 7.5 lb/ac); and 3) Smart Choice 5G (banded, 7.4 lb/ac). Although Verimark (applied DIF at 10 fl oz/ac) and Index (applied DIF at 17.1 fl oz/ac) also resulted in high recoverable sucrose yields that were not significantly different from the top-performing 8.9-lb rate of Counter 20G, the sucrose yields produced by plots treated with Verimark and Index were also not significantly different from the untreated check. As such, their performance in this experiment should probably be considered as moderate.

One interesting pattern from the yield results in this experiment was that the best-performing treatments, all of which provided significant sucrose yield increases when compared to the untreated check, involved planting-time applications. Unfortunately, all of the postemergence broadcast insecticide treatments in the trial, including Pilot 4E (i.e., the postemergence SBRM management standard), failed to produce statistically significant increases in either recoverable sucrose yield or root yield.

Table 2. *Yield parameters* f from an evaluation of registered and experimental insecticides for sugarbeet root maggot control, St. Thomas, ND, 2024

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Counter 20G	B	8.9 lb	1.8	11,184.4 a	36.0 a	16.6 a	2,441
Aztec Smartbox 4.67G	B	7.4 lb	0.21	10,994.5 a	34.3 ab	16.9 a	2,476
Counter 20G	B	7.5 lb	1.5	10,326.0 ab	34.2 ab	16.2 a	2,179
Smart Choice 5G	B	4.45 lb	0.37	10,096.1 abc	32.0 bcd	16.8 a	2,239
Verimark	DIF	10 fl oz	0.13	9,995.2 abcd	33.0 abc	16.2 a	2,114
Index	DIF	17.1 fl oz	0.3	9,937.9 abcd	31.8 bcd	16.7 a	2,180
Pilot 4E	2 d Pre-Peak Broadcast	2 pts	1.0	9,312.9 bcd	30.3 cde	16.5 a	2,004
Pilot 4E	2 d Pre-Peak Broadcast	1 pt	0.5	9,140.2 bcd	29.9 cde	16.5 a	1,960
Exirel Insect Control	2 d Pre-Peak Broadcast	20 fl oz	0.1	9,016.1 bcd	28.7 de	16.8 a	1,989
Endigo ZCX + NIS	2 d Pre-Peak Broadcast	4.5 fl oz 0.25% v/v	0.3 ---	8,755.4 cd	28.2 e	16.6 a	1,911
Untreated check	---	---	---	8,710.3 d	29.6 cde	15.9 a	1,779
LSD (0.05)				1,385	3.6	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch at-plant band; DIF = dribble in-furrow at planting; 2 d Pre-Peak Broadcast = postemergence broadcast, applied two days before peak SBRM fly activity.

In addition to providing favorable levels of protection from SBRM feeding injury that led to statistically significant recoverable sucrose and root yield increases, the top-performing treatments in this experiment also generated high gross economic returns per acre. For example, the planting-time banded application of Aztec 4.67G resulted in $697 more gross return than the untreated check. Similarly, the high and moderate rates of Counter 20G (8.9 and 7.5 lb product/ac) and Smart Choice 5G generated revenue increases of $662, $400, and $460 per acre, respectively, above the revenue generated by the untreated check plots.

As was stated above in the results on both SBRM feeding injury and yield data shown in Tables 1 and 2, planting-time insecticide treatments performed consistently better, at least numerically, than the postemergence broadcast treatments. This differential performance pattern is not surprising, as planting-time insecticide treatments usually perform somewhat better than postemergence sprays. However, a postemergence product should be able to provide a statistically significant level of root protection and/or yield increase to justify its use. One factor that could have negatively impacted the efficacy of the postemergence spray applications was that they were applied just two days before peak fly activity. Although that timing can be effective in a typical growing season, it may not have been in 2024 because over 50% of the season's total SBRM fly activity for the entire growing season at St. Thomas had occurred before the postemergence sprays were applied. As such, a significant proportion of the season total of SBRM eggs would have already been deposited in the field before the insecticide applications were made. This experiment was not designed to assess the impact of postemergence broadcast insecticide application timing, however, it is at least conceivable that the performance of those treatments might have been better, had they been applied one to two days sooner.

One very important aspect of this experiment that was stated above, but should be reiterated, is that all insecticide treatments involved a single application, irrespective of whether they were planting-time or postemergence broadcast treatments. This practice is never recommended for SBRM management by producers under the high to severe root maggot infestations that commonly occur in central and northern RRV. The overall goal of this experiment was simply to determine if any of the experimental products tested have potential to provide a measurable level of root protection from SBRM feeding injury and an associated yield increase. Once candidate insecticide materials with favorable performance are identified, future research should focus on integrating them into multicomponent control programs that include both a planting-time insecticide (i.e., a granular, sprayable liquid, or seed treatment) and a postemergence additive control tool to optimize SBRM management and maximize the profitability of sugarbeet production in areas affected by this pest.

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GRANULAR, SPRAYABLE LIQUID, AND SEED-APPLIED INSECTICIDES FOR MANAGING SUBTERRANEAN SPRINGTAILS IN SUGARBEET

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Introduction:

Subterranean (soil-dwelling) springtails continue to be a significant production challenge for many producers in the River Valley (RRV) of Minnesota and North Dakota. Springtails belong to the order Collembola, a group of organisms that share some anatomical features with insects, but are so anatomically and functionally different that they cannot be classified as true insects. These tiny, nearly microscopic, blind, and wingless pests spend their entire lives below the soil surface (Boetel et al. 2001). This obscure group of insect relatives has been recognized as an economic pest of sugarbeet in since the late-1990s. They are capable of affecting major economic loss in sugarbeet due to early-season root injury and associated plant stand losses.

Springtails are present in fields throughout much of the RRV, however, the occurrence of damaging infestations tends to be spotty and is most commonly associated with heavy-textured, high organic matter soils. Persistently cold and wet spring weather conditions can be conducive to springtail infestation buildups, because those conditions slow sugarbeet seed germination and seedling development, rendering plants more vulnerable to attack by springtails. This research was conducted to evaluate the performance of granular, sprayable liquid, and seed-applied insecticide products for springtail control in sugarbeet.

Materials & Methods:

This field experiment was carried out on the NDSU Experiment Farm near Prosper (Cass County), ND. Plots were planted on June 2, 2024 by using a 6-row Monosem NG Plus 7x7 planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Betaseed 8018 CR+, a glyphosate- and Cercospora leaf spot-tolerant seed variety, was used for all treatments.

Individual treatment plots were two rows (22-inch spacing) wide by 35 feet in length, and 35-ft wide tilled alleys were maintained between replicates throughout the growing season. The experiment was arranged in a randomized complete block design with 16 replications of the treatments. Two-row plots are the preferred experimental unit size in springtail trials because infestations of these pests are typically patchy in distribution. Therefore, a smaller test area increases the likelihood of having a sufficiently uniform springtail infestation among plots within each test replicate.

Counter 20G, the planting-time granular insecticide evaluated in the experiment was applied by using band placement (Boetel et al. 2006), which consisted of 5-inch swaths that were delivered through Gandy™ row banders. Output rates of Counter were regulated by using a planter-mounted SmartBox™ electronic insecticide delivery system that was calibrated on the planter immediately before all applications. Midac FC and Mustang Maxx were applied by using dribble in-furrow (DIF) placement through microtubes directed into the open seed furrow. Delivery of planting-time liquid insecticides was achieved by using a planter-mounted, CO_2-propelled spray system calibrated to deliver a finished spray volume output of 5 GPA. Teejet® No. 20 orifice plates were installed inline within check valves to achieve the correct spray output volume. A postemergence application of Movento HL insecticide was also evaluated in this trial. Movento HL was delivered in 7-inch bands (as opposed to 10-inch bands in previous years) by using a CO_2-propelled spray system mounted on a tractor-drawn four-row toolbar. The spray system was calibrated to at a finished spray volume output of 10 GPA through Teejet® 8001E nozzles.

Treatments were compared according to surviving plant stands and yield parameters because subterranean springtails can cause stand reductions that lead to yield loss. Stand counts involved counting all live plants in both 35-ft long rows of each plot. Surviving plant stands were counted on June 13, June 27, and July 11, 2024 (i.e., 10, 24, and 38 days after planting [DAP], respectively, and raw stand counts were converted to plants per 100 linear row feet for the analysis.

Harvest operations, which were conducted on September 19, involved initially removing the foliage from all plots by using a commercial-grade mechanical defoliator immediately (i.e., between 10 and 60 minutes) beforehand. Plots were harvested by using a 2-row mechanical harvester to collect all beets from both rows of each plot. Representative subsamples of 12-18 randomly selected beets were sent to the American Crystal Sugarbeet Quality Laboratory (East Grand Forks, MN) for quality analyses. All stand and yield data were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

Data from counts of surviving plant stands for this trial are presented in Table 1. The highest plant densities per 100 row feet at the first stand count date (10 DAP) were observed in the combination treatment comprised of Poncho Beta insecticidal seed treatment plus a postemergence banded spray application of Movento HL at 2.5 fl oz of product per acre. Results from the first stand count also indicated that most of the other insecticide treatments resulted in sugarbeet seedlings getting off to a favorable start to the growing season. The exception to that was in plots treated at planting with Midac FC, which had significantly lower numbers of plants per 100 row feet at 10 DAP than all other insecticide treatments in the experiment. Additionally, Midac was the only insecticide treatment in the trial that did not result in significantly greater surviving plant stands than the untreated check.

Performance patterns among treatments at the second stand count date (24 DAP) followed similar patterns to those collected on the first count date. The highest surviving plant densities per unit row length were recorded for the following insecticide treatments (listed in descending order of surviving stand count):

1) Poncho Beta-treated seed plus Mustang Maxx (3-inch T-band, 4 fl oz/ac);
2) Poncho Beta-treated seed plus Mustang Maxx (DIF, 4 fl oz/ac); and
3) Mustang Maxx (3-inch T-band, 4 fl oz/ac).

These treatments were not significantly different from each other with respect to surviving plant stands at 24 DAP; however, the two Poncho Beta/Mustang combination treatments resulted in significantly greater numbers of surviving plants per 100 ft than all other treatments, apart from the top-performing 3-inch T-band application of Mustang Maxx at planting. Comparatively low surviving plant stands were recorded for plots treated with Midac FC and Counter 20G at its two lowest application rates (i.e., 4.5 and 5.9 lb product/ac). Interestingly, the moderate rate (7.5 lb product/ac) rate of Counter 20G resulted in numerically greater stand counts than all other rates of that product at 10 DAP, including the high (8.9-lb) rate, and plant densities in plots treated with Counter at the 7.5-lb rate were significantly greater than those in plots that received the 4.5-lb rate.

Performance patterns related to plant stand protection at 38 DAP corresponded closely to those of the first two stand counts. All insecticide treatments at this assessment date resulted in significantly greater numbers of surviving plants than those recorded for the untreated check. The top three treatments at 38 DAP, with regard to protection from springtail-associated stand losses, included the two Poncho Beta/Mustang Maxx combination treatments and the individual T-banded treatment of Mustang Maxx. Also reflective of results from earlier stand count assessments was that plots treated with either Midac FC or the lower application rates of Counter 20G (i.e., 4.5 and 5.9 lb/ac) had significantly lower numbers of surviving plants at 38 DAP than nearly all other insecticide treatments. Similar to our observations in earlier stand counts, the moderate rate (7.5 lb product/ac) rate of Counter 20G resulted in significantly greater surviving plant stands at 38 DAP than the 4.5-lb rate.

Table 1. ***Plant stand counts*** **from an evaluation of planting-time granular, liquid, and seed treatment insecticides, and a postemergence sprayable liquid for springtail control, Prosper, ND, 2024**						
Treatment/form .	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Stand count[b] (plants / 100 ft)**		
				10 DAP[c]	**24 DAP**	**38 DAP**
Poncho Beta + Mustang Maxx	Seed 3" T-band	--- 4 fl oz	68 g ai/unit seed 0.025	113.2 abc	188.6 a	176.1 a
Poncho Beta + Mustang Maxx	Seed DIF	--- 4 fl oz	68 g ai/unit seed 0.025	115.3 ab	188.3 a	176.0 a
Mustang Maxx	3" T-Band	4 fl oz	0.025	114.6 abc	182.9 ab	172.3 ab
Poncho Beta	Seed	---	68 g ai/unit seed	113.2 abc	175.6 bc	164.0 b
Mustang Maxx	DIF	4 fl oz	0.025	104.3 bcd	172.1 bc	163.0 b
Poncho Beta + Movento + MSO	Seed Post B (4-leaf)	--- 2.5 fl oz 0.25% v/v	68 g ai/unit seed 0.035 ---	123.7 a	167.5 c	162.3 b
Poncho Beta + Midac	Seed DIF	--- 13.6 fl oz	68 g ai/unit seed 0.18	105.5 bcd	173.6 bc	162.1 b
Counter 20G	B	7.5 lb	1.5	114.3 abc	153.0 d	147.5 c
Counter 20G	B	8.9 lb	1.8	110.4 bcd	152.9 d	147.5 c
Counter 20G	B	5.9 lb	1.2	102.3 cd	144.0 de	138.9 cd
Counter 20G	B	4.5 lb	0.9	99.5 d	130.2 f	131.3 d
Midac FC	DIF	13.6 fl oz	1.2	85.5 e	134.6 ef	130.0 d
Untreated check	---	---	---	77.2 e	97.2 g	97.5 e
LSD (0.05)				12.7	12.2	11.6

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]Seed = insecticidal seed treatment; B = 5-inch band at planting; 3" TB = 3-inch band over open seed furrow at planting; DIF = dribble in-furrow at planting; POST B = 7-inch band applied to sugarbeet seedlings at 4-leaf stage.
[b]Surviving plant stands were counted on June 13, June 27, and July 11, 2024 (i.e., 10, 24, and 38 days after planting [DAP], respectively).

Yield and gross revenue results from this experiment are presented in Table 2. Performance patterns among the treatments, according to the yield responses, corresponded closely to those observed with the stand count results. For example, the top-performing treatment in this trial, with regard to recoverable sucrose yield and root tonnage, was the combination involving Poncho Beta-treated seed plus Mustang Maxx applied as a 3-inch T-band.

Other treatments that performed comparably to, and were not significantly outperformed by, the Poncho Beta/Mustang T-band treatment included Poncho Beta plus Midac FC, Poncho Beta/Mustang Max applied DIF, Counter 20G at either 7.5 or 8.9 lb product per acre, Mustang Maxx alone (T-band or DIF), Poncho Beta seed treatment alone, and the combination of Poncho Beta plus a postemergence rescue application of Movento HL. Although encouraging results were achieved in previous testing on Movento, the results of this large field experiment (i.e.., 16 replications) suggest that the insecticide was not providing additive springtail control to plots established with Poncho Beta-treated seed because yields in the Poncho Beta-only plots were numerically higher than those in plots treated with the Poncho Beta/Movento HL combination.

Yield responses among Counter treatments followed somewhat similar patterns to those observed in stand counts, although the two higher application rates (i.e., 7.5 and 8.9 lb produc/ac) of Counter 20G resulted in recoverable sucrose and root yields that were comparable to and not significantly different from the best-performing treatments in the entire experiment. However, the lower application rates of Counter 20G (i.e., 4.5 and 5.9 lb product/ac) were among the lowest-performing treatments in the experiment regarding recoverable sucrose yield and root tonnage produced. Additionally, as observed with stand count data, the yield results for Midac FC indicated that it was also among the lower-performing products with respect to recoverable sucrose and root yield.

Gross economic return results from this trial followed similar patterns to those observed in plant stand and yield results. The combination treatment consisting of Poncho Beta plus a 3-inch T-band of Mustang Maxx at planting time generated a total of $1,825/ac in gross economic return, which was a gain of $424/ac over that recorded for the untreated check. Similarly, Poncho Beta plus a Mustang Maxx applied DIF generated $1,804 in gross revenue, which amounted to $413/ac in increased revenue above that generated by the untreated check. In comparing those treatments with their single stand-alone components for springtail control, the combinations of Poncho Beta with T-band and DIF applications of Mustang Maxx increased gross economic returns by $41 and $16/ac, respectively when compared to their corresponding Mustang Maxx-only treatments. Likewise, including Mustang Maxx T-band and DIF resulted in revenue increases of $61 and $40 when compared with the revenue from

Poncho Beta-treated seed alone. Applying a planting-time application of Midac FC while planting with Poncho Beta-treated seed was also economically beneficial, as the combination resulted in $50/ac more revenue than when Poncho Beta alone, and $142/ac more revenue than the Midac-only treatment.

Table 2. *Yield parameters* from an evaluation of planting-time granular, liquid, and seed treatment insecticides, and a postemergence sprayable liquid for springtail control, Prosper, ND, 2024

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Poncho Beta + Mustang Maxx	Seed 3" T-band	--- 4 fl oz	68 g ai/unit 0.025	9584.1 a	34.3 a	15.6	1,825
Poncho Beta + Midac	Seed DIF	--- 13.6 fl oz	68 g ai/unit 0.18	9410.9 a	33.6 ab	15.6	1,814
Poncho Beta + Mustang Maxx	Seed DIF	--- 4 fl oz	68 g ai/unit 0.025	9317.8 ab	33.2 abc	15.6	1,804
Counter 20G	B	7.5 lb	1.5	9315.2 ab	32.8 abc	15.8	1,798
Counter 20G	B	8.9 lb	1.8	9308.4 ab	33.0 abc	15.7	1,796
Mustang Maxx	DIF	4 fl oz	0.025	9301.6 ab	32.9 abc	15.7	1,788
Mustang Maxx	3" T-Band	4 fl oz	0.025	9217.7 abc	32.6 a-d	15.7	1,784
Poncho Beta	Seed	---	68 g ai/unit	9178.6 abc	32.8 a-d	15.6	1,764
Poncho Beta + Movento + MSO	Seed 10" Band 4 leaf	--- 2.5 fl oz 0.25 % v/v	68 g ai/unit 0.035 ---	9049.2 abc	31.9 b-e	15.7	1,757
Counter 20G	B	5.9 lb	1.2	8817.4 bcd	31.4 cde	15.7	1,690
Midac FC	DIF	13.6 fl oz	0.18	8704.7 cd	31.0 de	15.6	1,672
Counter 20G	B	4.5	0.9	8445.9 d	30.6 e	15.4	1,579
Untreated	---	---	---	7349.8 e	26.3 f	15.6	1,401
LSD (0.05)				589.26	1.85	NS	

Means within a column sharing a letter are not significantly (P = 0.1) different from each other (Fisher's Protected LSD test).

[a]Seed = insecticidal seed treatment; B = 5-inch band at planting; 3" TB = 3-inch band over open seed furrow at planting; DIF = dribble in-furrow at planting; POST B = 7-inch band applied to sugarbeet seedlings at 4-leaf stage.

Despite having somewhat lower surviving plant stands, encouraging results on economic return were achieved with Counter 20G, especially when the insecticide was applied at higher (7.5 and 8.9 lb product/ac) rates. There were no significant differences between those rates of Counter according to recoverable sucrose yield or root tonnage, and they generated nearly identical revenue figures. Plots treated for springtail control with the high rate (8.9 lb product/ac) of Counter 20G generated a total of $1,796/ac in gross economic return and the return from plots treated with Counter 20G at 7.5 lb/ac was $1,798, which amounted to net benefits above the untreated check of $395 and $397/ac for the 8.9- and 7.5-lb rates, respectively.

The gross economic benefits from lower rates of Counter 20G were substantially lower, but still easily justified the applications. For example, applying Counter at 5.9 lb product per acre increased revenue by $289 over that calculated for the untreated check plots, and applying the insecticide at the low, 4.5-lb rate increased gross revenue by $178/ac. Those figures easily justified the use of Counter 20G under the springtail infestation pressure that developed for this experiment. However, by increasing the rate of Counter to 7.5 lb of product per acre, gross revenue was between $108 and $289 greater per acre than the two lower rates. Also, given that the 7.5-lb rate of Counter 20G generated favorable yield values and economic returns, which were nearly identical to those produced by using the full, 8.9-lb rate, it is clear that 7.5 lb of the insecticide is not only sufficient for springtail control in sugarbeet, but it is optimal for minimizing input costs and maximizing revenue in areas at risk from this pest group.

Contrary to occasional observations in previous trials on springtail control tools, the treatment combination of Poncho Beta plus a postemergence rescue band application of Movento HL did not provide significant increases in yield or revenue. This combination generated a gross economic benefit of $308/ac when compared to the untreated check and $212 in additional gross revenue when compared to that from the Poncho Beta-only treatment.

The benefits of plant stand protection, as well as increased yield and revenue provided by the better-performing insecticide treatments in this experiment demonstrate that effective, economically justified tools are currently available to producers for managing subterranean springtails in sugarbeet. Most notable was that the highest-performing insecticide treatment in the experiment generated gross economic return increases that exceeded $400/ac. Thus, the findings from this research trial clearly demonstrate the significance of subterranean springtails as serious economic pests of sugarbeet in this production area, as well as the economic benefits that can be achieved by effectively managing them with tools outlined in this experiment.

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PLANT PATHOLOGY

TURNING POINT SURVEY OF FUNGICIDE USE AND DISEASE MANAGEMENT IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2024

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The tenth annual fungicide practices and disease management live polling questionnaire was conducted using Turning Point Technology at the Sugarbeet Growers' Seminars held during January and February 2025. Responses are based on production practices from the 2024 growing season. The survey focuses on responses from growers in attendance at the Fargo, Grafton, Grand Forks, Wahpeton, ND and Willmar, MN Grower Seminars. Respondents from each seminar indicated the county in which the majority of their sugarbeets were produced (Tables 1-5). The average sugarbeet acreage per respondent grown in 2024 was calculated to be 855 acres (Table 6). In addition, the age of respondents was evaluated using the arbitrary categories: a) 1922-1945; b) 1946-1964; c) 1965-1980; d) 1981-2000; and e) 2001-2020 (Table 7). Regarding other background information for sugarbeet operations, respondents indicated that field corn and wheat were the most frequent crops preceding sugarbeet in rotation (34% and 52%, respectively, Table 8). Most growers (96%) utilized conventional tillage rather than strip tillage or no-till methods (Table 9).

Out of 270 growers surveyed at all five seminar locations, 31% answered that plant diseases were their most serious production problems. Specifically, 16% indicated Cercospora leaf spot (CLS) was the most serious production problem (Table 10). 10%, 4%, and 1% of growers indicated Rhizoctonia, Rhizomania, or Aphanomyces was the most serious production problem, respectively. The remaining 69% of survey respondents indicated that weed or insect pests were most serious production problems in 2024 rather than diseases (Table 10).

Survey respondents were asked about soilborne disease and control practices. Across all the seminar locations, 51% of sugarbeet growers said their fields were affected by Rhizoctonia, 17% percent said Aphanomyces was the biggest issue, 3% percent said they had issues with fusarium and 5% percent listed rhizomania as a plant disease affecting production (Table 11). 10% of growers noted multiple disease issues including Rhizoctonia, Aphanomyces, Fusarium and Rhizomania, and 14% said they had no soilborne disease issues (Table 11).

Participants were asked about the prevalence of Rhizoctonia in 2024 sugarbeet fields following specific crops during the 2023 season. 53% of respondents said they saw more rhizoctonia when soybeans preceded sugarbeet (Table 12). 13% reported more Rhizoctonia following dry edible beans, 19% noted more Rhizoctonia following field corn or sweet corn, 10% said any crop, and only 5% noted small grains as the preceding crop associated with Rhizoctonia (Table 12). 74% of respondents across all locations indicated that a specialty variety was used to control Rhizoctonia diseases (Table 13).

Fungicide use to control Rhizoctonia diseases was assessed among the sugarbeet growers in attendance. 40% of attendees responded that they used a seed treatment only to manage Rhizoctonia (Table 14). 22% used a seed treatment plus an in-furrow application, and 24% used a post-emergent application in addition to the seed treatments (Table 14). 13% of respondents used seed treatment, in-furrow and one post-emergent application, and only 1% of those surveyed added a second post-emergent application to control Rhizoctonia (Table 14). Of the subset of approximately 133 (58%) growers that applied post-emergent fungicides to control Rhizoctonia, the most frequently utilized product was Quadris or generic azoxystrobin, followed by Excalia, then Proline and Azteroid (Table 15). Participants were then asked to grade the effectiveness of the POST fungicides that were used. 38% were unsure of the results, 37% indicated good results, 9% reported fair results, 12% said the fungicides performed excellently and 4% said they performed poorly (Table 16). 68% of growers that applied post-emergent fungicides used broadcast equipment while the remainder made banded applications (Table 17).

69% of respondents did not apply precipitated calcium carbonate (waste lime) in 2024, while 12% applied less than 5 tons per acre and 19% applied between 5 and 10 tons per acre (Table 18). Here, regional difference in liming practices was apparent since growers attending the Willmar seminar mostly applied less than five tons per acre, while sugarbeet growers in more northern regions applied between 5 and 10 tons per acre (Table 18). Overall, 6% of growers rated the effectiveness of waste lime at controlling Aphanomyces to be excellent, 18% rated effectiveness as good, 5% indicated fair, 1% noted poor control of Aphanomyces, and 10% of respondents were not sure (Table 19).

Questions about Cercospora leaf spot (CLS) management were often broken down between CR+ and non-CR+ sugarbeet varieties. Overall, 78% of growers made 3 or 4 fungicide applications to control CLS on CR+ sugarbeet (25% and 39% respectively, Table 20). Non-CR+ sugarbeet acres mostly received 4, 5, or 6 fungicide applications (31%, 23%, and 18% respectively, Table 21). Growers attending the Wahpteton seminar did not use non-CR+ varieties in 2024. In CR+ sugarbeet, 19% of respondents made their first application of fungicides to control CLS in prior to June 25 (Table 22). 46% made first applications for CLS control between June 25th and July 1st, while 28% started CLS fungicide programs between July 2nd and July 10th. Most final application to manage CLS in CR+ sugarbeet was either September 1-10 (40% of responses) or September 11-20 (30%). In non-CR+ sugarbeet, the first application date for fungicides to manage CLS was prior to June 25th for 24% of respondents, June 25th-July 1st for 43%, and July 2nd-July 10th for 11% (Table 24). Similarly, the last application on non-CR+ sugarbeet was mostly September 1-10th (39%) and September 11-20th (41%, Table 25). When asked about the effectiveness of CR+ varieties at controlling CLS, 19% of respondents overall reported excellent control, 45% noted good control, 20% reported fair control, while 11% rated the effectiveness of CR+ as poor or were unsure (Table 26).

Spray practices were addressed with two questions. First, 55% of respondents did not have any CLS fungicide applications made by an aerial applicator. 29% reported 1-20% of total fungicide applications were made by an aerial applicator (Table 27). Next, 24% of growers using the survey reported using 11-15 gallons of water per acre to apply CLS fungicides, 20% reported 16-19 gallons per acre, and 47% of sugarbeet growers at the seminars applied 20 gallons per acre (Table 28).

Table 1. 2025 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2024

County	Number of responses	Percent of responses
Becker	1	4
Cass	8	29
Clay	10	36
Norman/Mahnomen	5	18
Traill	4	14
Totals	28	100

Table 2. 2025 Grafton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2024

County	Number of responses	Percent of responses
Cavalier	1	2
Kittson	6	16
Marshall	6	16
Pembina	9	24
Walsh	16	42
Totals	38	100

Table 3. 2025 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2024

County	Number of responses	Percent of responses
Grand Forks	10	23
Marshall	2	5
Polk	17	40
Traill	4	9
Walsh	4	9
Other	6	14
Totals	43	100

Table 4. 2025 Wahpeton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2024

County	Number of responses	Percent of responses
Cass	2	4
Clay	3	6
Grant	10	21
Richland	8	17
Roberts	1	2
Traverse	2	4
Wilkin	22	46
Totals	48	100

Table 5. 2025 Willmar Grower Seminar - Number of survey respondents by county growing sugarbeet in 2024.

County	Number of Responses	Percent of Responses
Chippewa	33	38
Kandiyohi	8	9
Redwood	3	3
Renville	26	30
Stevens	3	4
Swift	7	8
Yellow Medicine	1	1
Other	6	7
Total	87	100

Table 6. Total sugarbeet acreage operated by respondents in 2024.

		Acres of sugarbeet									
Location	Responses	<99	100-199	200-299	300-399	400-599	600-799	800-999	1000-1499	1500-1999	2000+
		---% of responses---									
Fargo	25	4	0	4	24	20	16	4	16	4	8
Grafton	36	14	8	8	0	17	19	8	8	6	11
Grand Forks	40	8	8	5	2	18	18	10	12	12	8
Wahpeton	45	2	7	16	4	31	11	13	9	7	0
Willmar	87	6	8	13	7	20	16	3	15	9	3
Total	233	7	6	9	7	21	16	8	12	8	6

Table 7. Demographics, by birth year, of sugarbeet growers at the 2025 Grower Seminars

Location	Number of responses	1922-1945	1946-1964	1965-1980	1981-2000	2001-2020
		--------------------	% of responses	--------------------		
Fargo	25	0	12	40	44	4
Grafton	39	5	10	21	56	8
Grand Forks	40	5	25	28	40	3
Wahpeton	46	2	13	37	43	4
Willmar	87	1	14	45	37	3
Totals	237	2	15	36	43	4

Table 8. Crop (grown in 2023) preceding sugarbeet (grown in 2024).

		Previous Crop					
Location	Responses	Sweet Corn	Field Corn	Dry Bean	Peas	Soybean	Wheat
		--------------------	% of responses	--------------------			
Fargo	22	0	0	0	0	0	100
Grafton	35	0	0	11	0	0	89
Grand Forks	40	0	0	0	0	0	100
Wahpeton	46	0	30	0	0	13	57
Willmar	87	20	72	0	0	6	1
Total	230	7	34	2	0	5	52

Table 9. Primary method of tillage used by sugarbeet growers in 2024.

Location	Responses	Conventional Tillage	Strip Tillage	No-Till
		--------------------	% of responses	--------------------
Fargo	27	100	0	0
Grafton	38	97	3	0
Grand Forks	45	96	2	2
Wahpeton	48	98	2	0
Willmar	88	94	5	1
Total	246	96	3	1

Table 10. Sugarbeet growers' most serious production problem in 2024.

Location	Responses	Aph[1]	CLS[2]	Emergence	Herbicide injury	Rhizoctonia	Rhizomania	Weeds	Root maggot
		--------------------	% of responses	--------------------					
Fargo	29	3	21	14	3	0	10	48	0
Grafton	44	2	16	5	2	5	7	59	5
Grand Forks	44	0	9	20	5	5	2	59	0
Wahpeton	65	2	17	11	5	18	6	40	2
Willmar	88	1	17	7	6	13	0	56	1
Total	270	1	16	10	5	10	4	52	2

[1] Aphanomyces
[2]Cercospora Leaf Spot

Table 11. Soilborne diseases affecting sugarbeet production in 2024.

Location	Responses	Rhizoctonia	Aphanomyces	Fusarium	Rhizomania	All	None
		----------------------------------% of responses-------------------------------------					
Fargo	21	43	5	5	0	38	10
Grafton	33	49	12	3	0	9	27
Grand Forks	44	36	14	7	2	0	41
Wahpeton	48	62	17	2	4	8	6
Willmar	88	55	22	2	9	11	1
Total	234	51	17	3	5	10	14

Table 12. Preceding crop (grown in 2023) most associated with Rhizoctonia diseases in sugarbeet in 2024.

Location	Responses	Dry edible beans	Corn (field)	Corn (sweet)	Small grains	Soybeans	Any crop
		------------------------------------% of responses---------------------------------------					
Fargo	22	5	18	0	5	68	5
Grafton	25	36	0	8	4	52	0
Grand Forks	37	35	3	0	14	37	11
Wahpeton	43	0	12	0	5	67	16
Willmar	76	4	31	3	0	50	12
Total	203	13	17	2	5	53	10

Table 13. Use of specialty varieties to control Rhizoctonia diseases in sugarbeet in 2024.

Location	Responses	Yes	No
		-------------------% of responses------------------	
Fargo	25	76	24
Grafton	24	62	38
Grand Forks	45	60	40
Wahpeton	44	84	16
Willmar	88	80	20
Total	226	74	26

Table 14. Methods used to control Rhizoctonia diseases in sugarbeet in 2024.

Location	Responses	Seed treatment ONLY	Seed treatment + in-furrow	Seed treatment + POST	Seed treatment + In-furrow + POST	Seed Treatment + In-Furrow + 2x POST
		-------------------------------% of responses----------------------------------				
Fargo	25	24	24	48	4	0
Grafton	31	29	16	19	33	3
Grand Forks	39	33	26	28	13	0
Wahpeton	43	93	5	2	0	0
Willmar	87	25	31	27	15	2
Total	225	40	22	24	13	1

Table 15. Post-emergent fungicides used to control Rhizoctonia diseases in 2024.

Location	Responses	Azteroid	Azterknot	Excalia	Quadris or generic	Proline	Elatus	Other	None
		---------------	---------------	---------------	% of responses	---------------	---------------	---------------	---------------
Fargo	25	12	0	36	24	0	0	0	28
Grafton	31	23	0	13	19	19	3	0	23
Grand Forks	44	5	9	9	36	14	0	0	27
Wahpeton	46	2	0	2	4	13	0	2	76
Willmar	84	11	1	14	25	6	0	1	42
Total	230	10	2	13	22	10	0	1	42

Table 16. Effectiveness of post-emergent fungicides used to control Rhizoctonia diseases in 2024.

Location	Responses	Excellent	Good	Fair	Poor	Unsure
		---------------	---------------	% of responses	---------------	---------------
Fargo	19	11	68	5	0	16
Grafton	29	28	55	0	3	14
Grand Forks	43	14	56	9	2	19
Wahpeton	35	9	6	0	3	83
Willmar	78	5	27	18	8	42
Total	204	12	37	9	4	38

Table 17. Application methods of post-emergent fungicides used to control Rhizoctonia diseases in 2024.

Location	Responses	Band	Broadcast	None applied
		---------------	% of responses	---------------
Fargo	24	50	21	29
Grafton	30	13	60	27
Grand Forks	46	15	61	24
Wahpeton	47	2	17	81
Willmar	85	21	38	41
Total	232	18	39	43

Table 18. Application rates of precipitated calcium carbonate (waste lime) applied in 2024

Location	Responses	None	< 5 tons/A	5-10 tons/A
		---------------	% of responses	---------------
Fargo	25	48	0	52
Grafton	24	82	3	15
Grand Forks	43	79	0	21
Wahpeton	48	62	6	31
Willmar	86	70	28	2
Total	226	69	12	19

Table 19. Effectiveness of waste lime at controlling Aphanomyces in 2024.

Location	Responses	Excellent	Good	Fair	Poor	Unsure	No lime
		---------------	---------------	---------------	% of responses	---------------	---------------
Fargo	25	16	28	8	4	0	44
Grafton	35	9	23	3	3	3	59
Grand Forks	43	9	9	7	0	7	68
Wahpeton	44	9	23	2	0	11	55
Willmar	86	0	14	6	1	17	62
Total	233	6	18	5	1	10	59

Table 20. Total number of fungicide applications made to control CLS on CR+ sugarbeet varieties in 2024.

Location	Responses	0	1	2	3	4	5	6	7	> 7
		----------% of responses----------								
Fargo	25	0	0	4	28	52	16	0	0	0
Grafton	33	0	36	36	25	3	0	0	0	0
Grand Forks	41	0	12	22	32	29	5	0	0	0
Wahpeton	49	0	0	2	24	59	14	0	0	0
Willmar	86	0	0	6	20	42	23	7	1	1
Total	234	0	7	12	25	39	14	3	<1	<1

Table 21. Total number of fungicide applications made to control CLS on non-CR+ sugarbeet varieties in 2024.

Location	Responses	0	1	2	3	4	5	6	7	> 7
		----------% of responses----------								
Fargo	18	0	0	0	11	28	56	6	0	0
Grafton	30	0	3	17	27	47	3	0	3	0
Grand Forks	37	0	0	5	25	46	19	5	0	
Wahpeton	-	-	-	-	-	-	-	-	-	-
Willmar	61	0	0	2	3	16	25	38	11	5
Total	146	0	1	6	14	31	23	18	5	2

Table 22. First application date of fungicides to control CLS in CR+ sugarbeet varieties in 2024.

Location	Responses	Before June 25	June 25-July 1	July 2-10	After July 10
		----------% of responses----------			
Fargo	25	8	64	28	0
Grafton	31	10	29	32	29
Grand Forks	40	12	32	38	18
Wahpeton	48	17	67	17	0
Willmar	85	31	40	28	1
Total	229	19	46	28	7

Table 23. Last application date of fungicides to control CLS in CR+ sugarbeet varieties in 2024.

Location	Responses	Before Aug. 21	Aug. 21-31	Sept. 1-10	Sept. 11-20	After Sept. 20
		----------% of responses----------				
Fargo	24	4	4	50	33	8
Grafton	32	12	31	19	31	6
Grand Forks	41	0	22	39	29	10
Wahpeton	44	9	15	50	22	4
Willmar	84	1	24	41	32	2
Total	225	4	21	40	30	5

Table 24. First application date of fungicides to control CLS in non-CR+ sugarbeet varieties in 2024.

Location	Responses	Before June 25	June 25-July 1	July 2-10	After July 10
		-----------------------------% of responses------------------------------			
Fargo	16	12	56	31	0
Grafton	27	14	30	30	26
Grand Forks	37	5	46	35	14
Wahpeton	-	-	-	-	-
Willmar	61	43	43	11	3
Total	141	24	43	23	10

Table 25. Last application date of fungicides to control CLS in non-CR+ sugarbeet varieties in 2024.

Location	Responses	Before Aug. 21	Aug. 21-31	Sept. 1-10	Sept. 11-20	After Sept. 20
		--------------------------------% of responses------------------------------------				
Fargo	17	0	6	47	41	6
Grafton	27	0	26	19	48	7
Grand Forks	36	0	11	44	42	3
Wahpeton	-	-	-	-	-	-
Willmar	61	2	11	43	38	6
Total	141	1	13	39	41	6

Table 26. Effectiveness of CR+ sugarbeet varieties in controlling CLS in 2024.

Location	Responses	Excellent	Good	Fair	Poor	Unsure	No CR+ planted
		-------------------------------------% of responses--					
Fargo	25	12	72	12	0	0	4
Grafton	34	41	44	3	3	0	9
Grand Forks	43	33	44	9	2	7	5
Wahpeton	46	23	64	9	2	2	0
Willmar	83	4	27	40	23	1	5
Total	231	19	45	20	9	2	2

Table 27. Percentage of total fungicide applications for CLS made by an aerial applicator in 2024.

Location	Responses	0%	1-20%	21-40%	41-60%	61-80%	81-99%	100%
		--------------------------------------% of responses---------------------------------------						
Fargo	24	71	21	0	0	4	0	4
Grafton	33	70	15	9	0	0	0	6
Grand Forks	45	67	18	7	4	2	2	0
Wahpeton	46	57	17	9	9	4	0	4
Willmar	85	37	51	9	1	0	0	2
Total	233	55	29	8	3	2	0	3

Table 28. Gallons of water per acre used to apply CLS fungicides (ground application) in 2024.

Location	Responses	11-15	16-19	20	> 20
		------------------------------% of responses--------------------------------			
Fargo	24	54	29	17	0
Grafton	31	39	23	26	13
Grand Forks	46	52	22	17	9
Wahpeton	47	9	28	55	9
Willmar	83	2	11	76	11
Total	231	24	20	47	9

EVALUATION OF FUNGICIDE SPRAY PROGRAMS TO MANAGE CERCOSPORA LEAF SPOT IN A CR+ SUGARBEET VARIETY, 2024

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INTRODUCTION

Cercospora leaf spot (CLS), caused by *Cercospora beticola*, is endemic to sugarbeet growing regions in Minnesota and North Dakota, and can cause dramatic economic losses when conditions are conducive for disease development. There is evidence that seedborne *C. beticola* can initiate CLS (Spanner et al. 2022) and may be associated with genetic diversity within *C. beticola* populations (Knight et al. 2018). However, infected leaf residue from previous sugarbeet crops is considered the primary inoculum source of *C. beticola* (Jones and Windels 1991) as conidia of *C. beticola* can been detected in spore traps in early May (Secor et al. 2022; Secor and Rivera 2024). CLS symptoms typically become visible in late June to early July and are correlated with the timing of sugarbeet canopy closure. In recent years however, DNA of *C. beticola* has been detected in asymptomatic sugarbeet leaves several weeks before initial CLS symptoms are visible in the field (Bloomquist et al. 2021; Secor et al. 2022), and initial infection of sugarbeet leaves by *C. beticola* primarily occurs throughout June (Wyatt 2024). Disease can rapidly progress following rainfall events along with warm and humid environments (Tedford et al. 2018), whereas drought conditions result in slower progression of CLS and reduced severity. This increased understanding in the epidemiology of CLS reinforces recommendations to apply effective fungicide treatments in a timely manner to significantly delay CLS development and reduce the extent of economic losses. Effective fungicide treatments include, but are not limited to, using full labeled rates, tank-mixing multiple modes of action, and rotating modes of action throughout a spray program. Initial applications should be timed preventatively (i.e., prior to the onset of visible CLS symptoms). Typically, intervals between subsequent applications should be 10- to 14-days; however, frequent rainfall can and rapid growth of sugarbeet foliage may warrant shorter intervals. A majority of currently approved sugarbeet varieties have low to moderate tolerance to CLS (Brantner and Deschene 2024); however, sugarbeet varieties with high tolerance to CLS (CR+ varieties) have been available to growers beginning in 2021. Since then, the acreage in Minnesota and North Dakota that has been planted with CR+ varieties each year has steadily increased (Hastings *personal communication*; Bloomquist *personal communication*; Metzger *personal communication*). Studies have shown that infection by *C. beticola* is not completely stopped in CR+ varieties, but rather delayed (Bhuiyan et al 2023; Bhandari et al 2023). With delayed infection and lower overall CLS severity in CR+ varieties, there is desire to reduce the cost of fungicide management by decreasing the number of total fungicide applications on these varieties. Previous field trials have shown that CR+ varieties have not needed the same rigorous fungicide programs that moderately susceptible varieties need to prevent economic loss from CLS (Mettler and Bloomquist 2021, 2022, 2023; Lien et al. 2023, 2024)

OBJECTIVES

The trial objective was to evaluate the efficacy of fungicide spray programs with differential application timing for in a highly tolerant (CR+) sugarbeet variety in which spray programs had an early or delayed initial application containing a DMI, EBDC, or copper fungicide and extended spray intervals or a standard 14-day interval for 1) the relative control of CLS disease on sugarbeet, and 2) the effect on harvestable root yield and sucrose quality.

MATERIALS AND METHODS

The field trial was established in Crookston, MN (47.81403°, -96.61279°), at the University of Minnesota Northwest Research and Outreach Center (NWROC) as a randomized complete block design with four replications. Seeds of 'Crystal 260RR', which have a 2-year CLS susceptibility rating of 2.1 (Brantner and Deschene 2024), were planted in 6-row by 25-ft long plots at a 4.5-in. spacing in 22-in rows on April 24. Plant stands were evaluated on June 24 by counting the number of live plants in the center two rows of each plot. On July 03, when plots were at approximately 90% row closure, all rows of the trial were inoculated with a mixture of fine talc and dried CLS-infected sugarbeet leaves (1:2 w/w) using a Nalgene® 1L bottle to deliver a rate of 4.5 lb/A, equivalent to 3 g of mixture per 35 ft of row. CLS-infected sugarbeet leaves used for the inoculum were collected from nontreated plants moderately susceptible to CLS at the end of the 2023 growing season and dried in burlap bags at 95±5°F for 48 hours and stored in the dark at 68±5°F. Prior to inoculation, leaves in burlap bags were dried for an addition 24 hours at 95±5°F and ground with a Wiley Mill and passed through a 2mm sieve. Fungicides were applied to the center four rows using a tractor-mounted sprayer with XR TeeJet 11002 VS flat fan nozzles calibrated to deliver 16.8 gal water/A at 90 psi. Fungicides were applied on June 26 (**A**; 7 days prior to inoculation), July 03 (**B**; immediately following inoculation), July 16 (**C**; 13 days after inoculation; DAI), July 29 (**D**; 26 DAI), August 12 (**E**; 40 DAI), and August 25 (**F**; 53 DAI); applications were approximately every 13-14 days, with the exception of extended intervals ranging from 28, 42, or 55 days between applications. A majority of fungicide programs began on July 16 (13 DAI), which followed conditions conducive for disease development and coincided with canopy-closure. CLS disease severity was evaluated beginning 22 Jul and continued through 18 Sep, for a total of 8 evaluations, using a scale based on infected leaf area (Jones and Windels 1991); wherein, 1=0.1% (1-5 spots/leaf), 2=0.35% (6-12 spots/leaf), 3=0.75% (13-25 spots/leaf), 4=1.5% (26-50 spots/leaf), 5=2.5% (51-75 spots/leaf), 6=3%, 7=6%, 8=12% 9=25%, 10=50%. Five locations within each plot were rated on each evaluation date. The average CLS ratings from each evaluation date were used to calculate the standardized area under the disease progress stairs (sAUDPS; Simko and Piepho 2012) using the IdeTo Excel calculator (Simko 2021) for statistical analysis. On 20 Sep, plots were defoliated and the center two rows of each plot were harvested mechanically and weighed for root yield. Ten representative roots from each plot were analyzed for sugar quality at the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN. Statistical analysis was conducted in R (v 4.3.1, R Core Team 2023). A mixed-model analysis of variance was performed using the package *lmerTest* (v 3.1-3), with treatment defined as the fixed factor and replication as the random factor. Means were separated at the 0.10 significance level using the package *emmeans* (v 1.8.7) with no adjustments. Weather data was retrieved from the North Dakota Agricultural Weather Network (NDAWN) Eldred, MN Station (47.68769°, -96,82221°).

RESULTS AND DISCUSSION

Above-average rainfall in April and May (Supplementary Table 1) provided adequate soil moisture to facilitate good plant emergence resulting in an average plant population of 228 plants per 100 ft row, equivalent to 85.5% emergence; there were no significant differences among treatments (P = 0.6773). Following inoculation, a period of temperatures and high humidity resulted in moderate daily infection values indicating a favorable environment for CLS development (Supplementary Fig. 1). Disease pressure in the nontreated control increased during the month of August and September (Fig. 1) following several rainfall events (Supplementary Fig. 1). CLS severity for this highly tolerant variety in the nontreated control reached 4.0 which is lower than the economic threshold rating of 6.0 (Table 1). There were significant differences present for both the final CLS rating on September 18 (Table 1), and overall CLS severity reported as the sAUDPS (Table 2). Nearly all fungicide spray programs resulted in a lower final CLS rating and overall CLS severity than the non-treated control. The spray program beginning with the Experimental copper was numerically lower than the nontreated control but not significantly different. The lowest CLS severity resulted from the 'standard program', which was a 5-spray program with 14-day application intervals and an initial application beginning on July 3 (Fig. 2). CLS severity was slightly higher when one 28-day interval was introduced in the middle of standard program (i.e., exempting application **D**), but was not significantly different from the standard program (Fig. 2) and similar to the spray program that was initiated on June 26 and contained two 28-day intervals (i.e., exempting applications **C** and **E**) and the 4-spray program that was initiated on July 13. Generally, CLS severity increased as multiple extended intervals were introduced and when intervals extended beyond 28 days. Spray programs that were initiated with a copper-based fungicide on July 16 and programs initiated on August 12 resulted in CLS severity significantly greater than the standard program. Starting with a DMI generally resulted in slightly lower CLS severity when comparing similar spray programs that were initiated on July 16, July 29, or August 12 with either a DMI or EBDC. Interestingly, the programs that were initiated on June 26 and July 3 show that starting with EBDC resulted in slightly lower CLS severity. There were no significant differences between treatments for percent sugar, percent sugar loss to molasses (SLM), root yield, or recoverable sucrose yield. However, numerical differences show that the nontreated control resulted in the lowest root yield (Table 2).

Table 1. Select Cercospora leaf spot (CLS) 0-10 ratings associated with fungicide spray programs to manage CLS of sugarbeets in a CLS-inoculated field trial planted on April 24, 2024 and inoculated on July 03, 2024 at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

Program [z]	Treatment(s) and timing[y]	CLS ratings (0-10)					
		Jul 25	Aug 9	Aug 19	Aug 28	Sept 6	Sept 18
Non-Treated Control	Nontreated Control	0.0	1.0	1.6	1.8	3.4	4.0
6 Spray (Skip 3 & 5)	Inspire XT **A** + Manzate Pro-Stick **AD** + Super Tin **BF** + Topsin 4.5 FL **B** + Proline 480 SC **D** + Priaxor **F**	0.2	1.0	0.8	0.6	1.3	1.6
5 Spray	Inspire XT **B** + Manzate Pro-Stick **BDE** + Super Tin **CF** + Topsin 4.5 FL **C** + Proline 480 SC **D** + Priaxor **F**	0.0	1.1	0.8	0.4	1.0	1.2
5 Spray (Skip 3)	Inspire XT **B** + Manzate Pro-Stick **BE** + Super Tin **CF** + Topsin 4.5 FL **C** + Proline 480 SC **E** + Priaxor **F**	0.0	1.0	0.9	0.9	0.9	1.6
4 Spray	Inspire XT **C** + Manzate Pro-Stick **CE** + Super Tin **DF** + Topsin 4.5 FL **D** + Proline 480 SC **E** + Priaxor **F**	0.2	1.2	0.9	0.7	1.1	1.4
4 Spray (Skip 3)	Inspire XT **C** + Manzate Pro-Stick **C** + Super Tin **D** + Topsin 4.5 FL **D** + Proline 480 SC **F** + Priaxor **F**	0.2	1.1	1.0	0.9	1.2	1.8
3 Spray	Inspire XT **D** + Manzate Pro-Stick **D** + Super Tin **E** + Topsin 4.5 FL **E** + Proline 480 SC **F** + Priaxor **F**	0.2	1.0	1.0	0.8	1.1	1.4
3 Spray (Skip 2; DMI Start)	Inspire XT **D** + Manzate Pro-Stick **D** + Super Tin **F** + Priaxor **F**	0.0	1.2	1.0	0.8	1.9	1.8
3 Spray (Skip 2; EBDC Start)	Manzate Pro-Stick **D** + Super Tin **F** + Priaxor **F**	0.2	1.0	1.1	1.0	2.5	2.7
2 Spray (DMI Start)	Inspire XT **E** + Manzate Pro-Stick **E** + Super Tin **F** + Priaxor **F**	0.1	1.2	1.1	1.2	1.8	2.6
2 Spray (EBDC Start)	Manzate Pro-Stick **E** + Super Tin **F** + Priaxor **F**	0.2	1.0	1.1	1.4	1.9	2.6
6 Spray (Skip 3, 4, & 5; (EBDC Start)	Inspire XT **A** + Manzate Pro-Stick **AB** + Super Tin **F** + Priaxor **F**	0.0	0.8	1.0	0.9	1.4	2.0
6 Spray (Skip 3, 4, & 5; DMI Start)	Manzate Pro-Stick **AB** + Inspire XT **B** + Super Tin **F** + Priaxor **F**	0.1	0.8	1.2	1.2	1.8	2.0
5 Spray (Skip 3 & 4; DMI Start)	Inspire XT **B** + Manzate Pro-Stick **BC** + Super Tin **F** + Priaxor **F**	0.0	1.2	1.1	0.8	1.5	2.1
5 Spray (Skip 3 & 4; EBDC Start)	Manzate Pro-Stick **BC** + Inspire XT **C** + Super Tin **F** + Priaxor **F**	0.0	1.1	1.0	0.8	1.2	1.8
4 Spray (Skip 3; DMI Start)	Inspire XT **C** + Manzate Pro-Stick **CD** + Super Tin **F** + Priaxor **F**	0.1	0.9	1.1	0.8	1.2	1.9
4 Spray (Skip 3; EBDC Start)	Manzate Pro-Stick **CD** + Inspire XT **D** + Super Tin **F** + Priaxor **F**	0.2	1.0	1.0	0.7	1.6	1.9
4 Spray (Skip 3; Badge SC Start)	Badge SC **C +** Manzate Pro-Stick **D** + Inspire XT **D** + Super Tin **F** + Priaxor **F**	0.2	1.2	1.1	1.1	2.3	2.5
4 Spray (Skip 3; Cuprofix Start)	Cuprofix **C +** Manzate Pro-Stick **D** + Inspire XT **D** + Super Tin **F** + Priaxor **F**	0.2	0.9	1.0	1.0	2.0	2.6
4 Spray (Skip 3; Exp. Copper Start)	Experimental Copper **C +** Manzate Pro-Stick **D** + Inspire XT **D** + Super Tin **F** + Priaxor **F**	0.2	1.0	1.2	1.6	2.2	3.0
	P-value	-	.	***	***	***	***

[z] Description of spray program; Crystal 260RR with two-year Cercospora rating of 2.1 (CR+) was used for all treatments.

[y] Treatment rates per acre are as follows: Inspire XT = 7 fl oz, Manzate Pro-Stick = 2 lb, Super Tin = 8 fl oz, Topsin 4.5 FL = 10 fl oz, Proline 480 SC = 5.7 fl oz, Priaxor = 6.7 fl oz, Badge SC = 32 fl oz, Cuprofix = 3 lb, Experimental Copper = 20 fl oz; Non-ionic surfactant (NIS; Activator90) was used at a rate of 0.125% v/v with Provysol and Proline 480 SC; letters represent the following dates: **A**= Jun 26 (-7 DAI), **B**= Jul 3 (0 DAI), **C**= Jul 16 (13 DAI), **D**= Jul 29 (26 DAI), **E**= Aug 12 (40 DAI), **F**= Aug 25 (53 DAI)

[x] Significance codes: 0.001 (***), 0.01 (**), 0.01 (*), 0.05 (.), >0.05 (-)

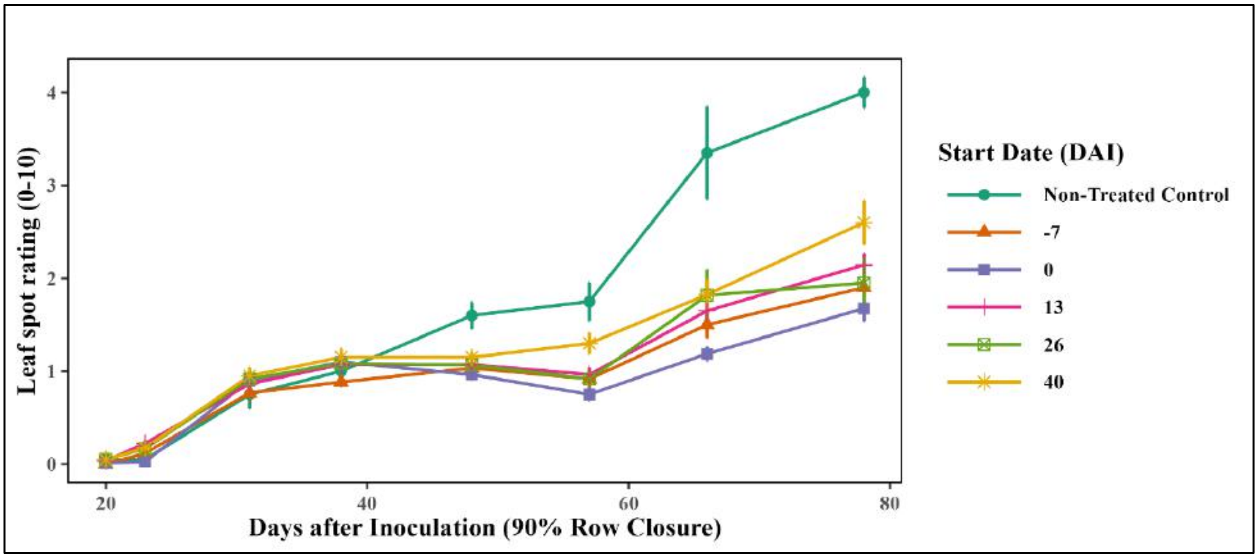

Fig. 1. Effect of foliar fungicide programs grouped by the initial application in respect to days after inoculation (DAI), equivalent to 90% row closure, in sugarbeets highly tolerant to CLS (CR+) on development of CLS on sugarbeets in a CLS-inoculated field trial planted April 23, 2024, and inoculated on July 03, 2024.

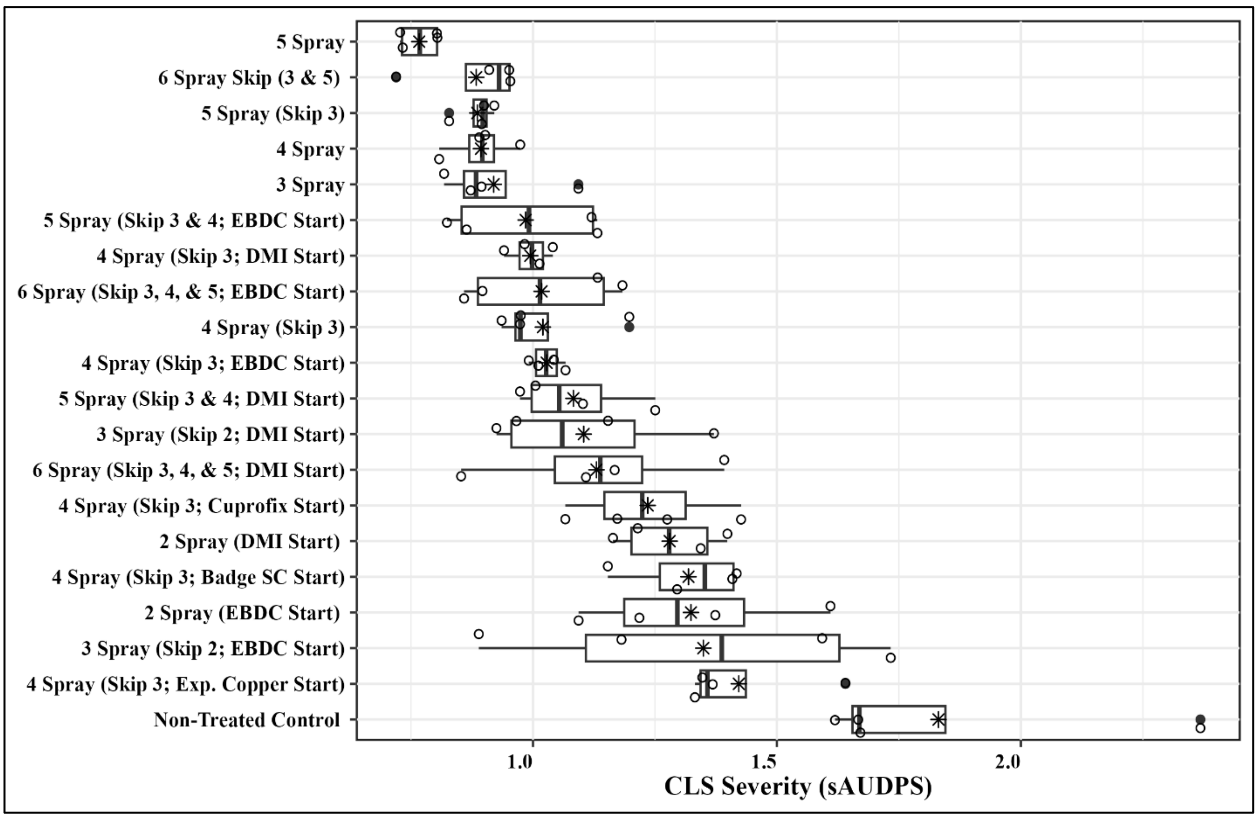

Fig. 2. Effect of foliar fungicide programs in sugarbeets highly tolerant to CLS (CR+) on total CLS severity (sAUDPS) on sugarbeets in a CLS-inoculated field trial planted April 23, 2024, and inoculated on July 03, 2024. Box-whisker plots display the distribution of data for each treatment (minimum, first quartile, median, third quartile, and maximum); filled dots represent outliers; asterisks represent treatment means; hollow dots represent individual data points in respect to replications

Table 2. Effects of fungicide spray programs on CLS disease, root yield, and sucrose quality of sugarbeets in a CLS-inoculated field trial planted on April 23, 2024 and inoculated July 03, 2024 at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

Spray Program[z]	CLS Severity (sAUDPS) [y,x]	Sugar (%)	SLM (%)	Root Yield (tons/A)	Sucrose Yield (lb/A)
Non-Treated Control	1.8 f	16.50	1.39	26.6	8022
6 Spray (Skip 3 & 5)	0.9 ab	15.54	1.40	29.0	8210
5 Spray	0.8 a	15.41	1.45	28.2	7883
5 Spray (Skip 3)	0.9 a-c	15.85	1.40	27.6	7960
4 Spray	0.9 ab	16.26	1.39	28.9	8573
4 Spray (Skip 3)	1.0 a-d	15.59	1.47	29.3	8275
3 Spray	0.9 ab	15.75	1.39	27.4	7884
3 Spray (Skip 2; DMI Start)	1.1 a-e	15.69	1.43	28.2	8018
3 Spray (Skip 2; EBDC Start)	1.4 de	16.06	1.32	28.0	8231
2 Spray (DMI Start)	1.3 c-e	16.13	1.37	27.1	7998
2 Spray (EBDC Start)	1.3 c-e	15.73	1.40	27.0	7757
6 Spray (Skip 3, 4, & 5; (EBDC Start)	1.1 a-e	16.00	1.40	26.9	7855
6 Spray (Skip 3, 4, & 5; DMI Start)	1.0 a-e	16.14	1.33	27.3	8070
5 Spray (Skip 3 & 4; DMI Start)	1.1 a-e	16.04	1.32	27.2	8005
5 Spray (Skip 3 & 4; EBDC Start)	1.0 a-d	16.22	1.33	27.7	8250
4 Spray (Skip 3; DMI Start)	1.0 a-e	15.73	1.38	27.8	7993
4 Spray (Skip 3; EBDC Start)	1.0 a-e	15.55	1.40	28.4	8024
4 Spray (Skip 3; Badge SC Start)	1.3 b-e	16.06	1.38	28.5	8359
4 Spray (Skip 3; Cuprofix Start)	1.2 b-e	16.24	1.37	27.1	8073
4 Spray (Skip 3; Exp. Copper Start)	1.4 ef	15.69	1.47	27.5	7824
P-value	<0.0001	0.2857	0.4870	0.3678	0.9673

[z] Crystal 260RR with two-year Cercospora rating of 2.1 (CR+) was used for all treatments; fungicides and application dates for each program are listed in Table 1.

[y] Standardized Area Under Disease Progress Stairs (sAUDPS) is a mid-point combination of all CLS ratings and represents total CLS severity.

[x] Means within a column followed by a common letter are not significantly different by Estimated Marginal Means (EMMs) at the 0.10 significance level.

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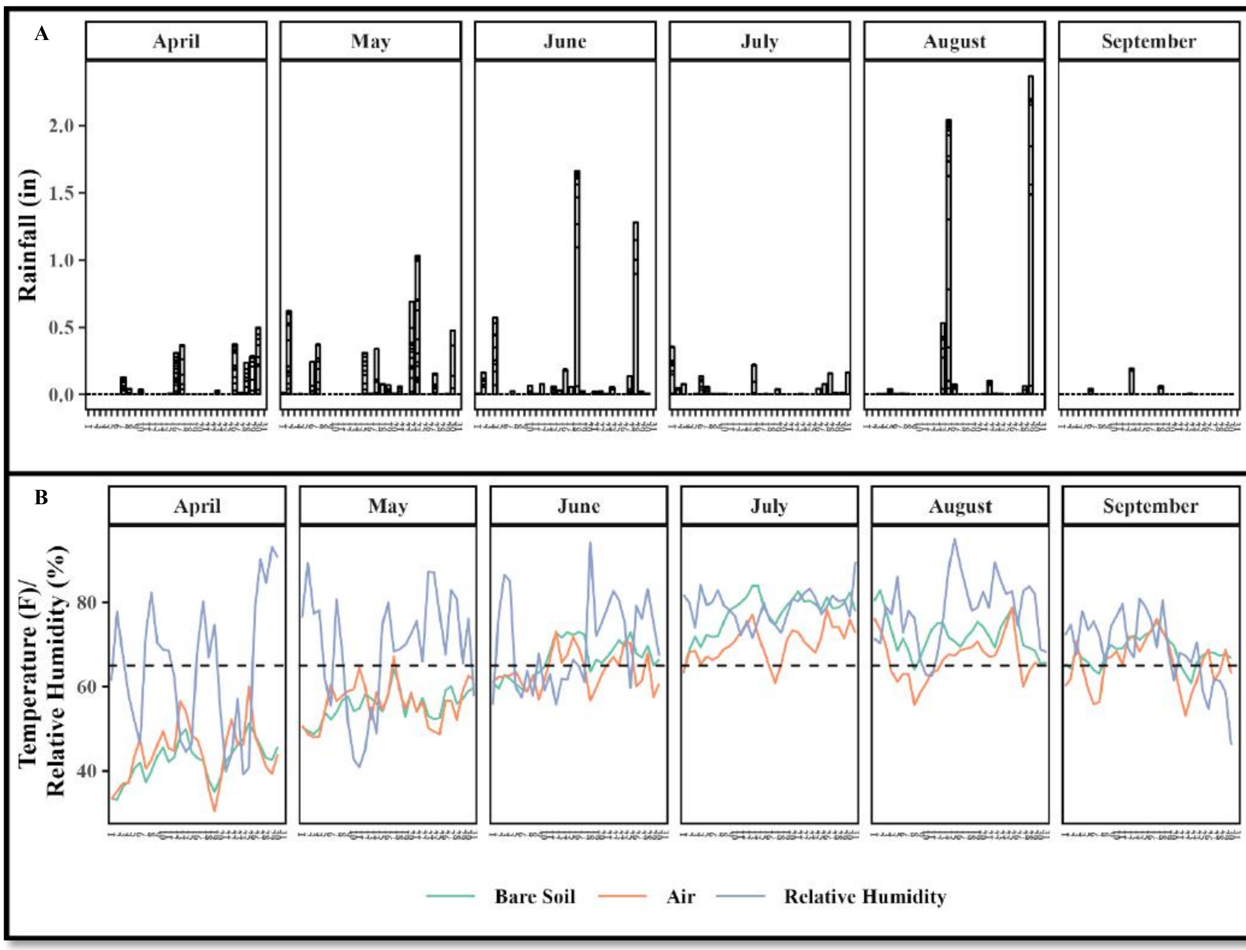
SUPPLEMENTARY WEATHER TABLE AND FIGURE

Supplementary Table S1. Weather data for the 2024 growing season compared to the normal (30-year average). Data was retrieved from the North Dakota Agricultural Weather Network Eldred, MN station (47.68769, -96.82221), located approximately 12.8 miles southwest of the Northwest Research and Outreach Center, Crookston, MN.

Month	Total Rainfall (inch)		Average Air Temperature (°F)	
	2024	Normal [z]	2024	Normal
April	2.33	1.41	44.3	41.7
May	4.49	2.86	55.5	55.4
June	4.48	4.01	63.4	65.8
July	1.42	3.45	70.0	69.8
August	5.26	2.86	66.6	68.0
September	0.31	2.03	66.0	60.2

[z] Normals are interpolated from National Weather Service (NWS) Cooperative stations (1991-2020) and are defined as the average of a variable for a continuous 3-decade (30-year) period.



Supplementary Fig. S1. Daily rainfall totals in which stacked bars represent 1-hour intervals (A) and daily mean air temperature, 4-in. bare soil temperature, and relative humidity (B) for the 2024 growing season retrieved from the Eldred North Dakota Agricultural Weather Network station (47.68769, -96.82221), located approximately 12.8 miles southwest of the Northwest Research and Outreach Center, Crookston, MN. The dotted horizontal line represents 65°F.

IDENTIFICATION OF NEW GENETIC SOURCES FROM SEA BEET TO IMPROVE SUGARBEET RESISTANCE TO CERCOSPORA LEAF SPOT

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Introduction

Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola* Sacc., is the most widespread foliar disease in sugarbeet (*Beta vulgaris* L.) and yield losses due to CLS can be as high as 42 - 50% (Verreet et al., 1996). Application of host resistance for CLS control would be more effective with a lower cost (Smith and Gaskill, 1970). Vogel et al. (2018) found that recent breeding efforts have made CLS resistant cultivars comparable to susceptible ones in terms of yield performance, consequently, the resistant cultivars thus have a relatively better economic performance since no fungicide needs to be applied.

Many studies were conducted to identify germplasms resistant to CLS (Nilsson et al., 1999; Smith and Gaskill, 1970; Ruppel et al., 1971; Schäfer-Pregl et al., 1999) and some accessions of *Beta vulgaris* spp. *maritima*, the wild ancestor of sugar beet, were found to have a high level of resistance and were used as a source of CLS resistance (Leuterbach et al., 2004). Genetic diversity analysis in Tehseen et al. (2023) also proved the potential of publicly available germplasm for improving sugarbeet resistance to CLS. Due to dynamic change of *C. beticola* isolates in field each year, identification and application of resistance from diverse genetic resources will lead to a long-last resistance.

In this research, we will focus on identifying CLS resistance from both sugarbeet and wild sea beet from publicly available germplasm lines. We also used 300 *B. maritima* to form an association panel to detect genomic regions associate with CLS resistance through genome-wide association study (GWAS). In this report, we focus on reporting CLS evaluations conducted in 2024 for both sugarbeet lines and *B. maritima* accessions.

Materials and methods

A total of 300 *B. vulgaris* L. ssp. *maritima* accession selected through genetic diversity analysis (Tehseen et al., 2024) were originally collected from 23 countries (Table 1) and 20 sugarbeet lines selected from previous years based on CLS resistance (Table 2) were used for this research. Materials were planted in field nurseries at Fargo, ND, and Foxhome and Meadows, MN to evaluate their resistance to Cercospora leaf spot.

Field evaluation of CLS resistance was conducted as randomized complete block designs with two replications included. The two-row plots were 15 feet long, with 22-inch row spacing and 8 – 10 inches for plant space within a row. The trial was planted on May 17th at Fargo, ND, June 13th at Foxhome, MN, and June 12th at Meadows, MN in 2024. Inoculation was performed on July 18th and repeated after three weeks by spraying ground disease leaf mixed with Talca powder at the ratio of 1:3. Disease ratings were made during Oct 5th - 8th using a 0 – 9 scale with 0 as no CLS spots observed, 1 – 3 as resistant (a few scattered spots to some dieback on lower leaves), 4 - 6 as moderately resistant/susceptible (increasing amounts of dead and disease tissue on several to most plants of the row), and 7 - 9 as susceptible (diseased leaf has 50 - 100% of area necrosed on most plants of the row) (Ruppel & Gaskill, 1971). Weed control was conducted by spraying non-glyphosate herbicides at micro-rate weekly during June to late August.

Table 1. Origin of 300 wild beet accessions used in the association panel.

Country	Accession
Belgium	1
Croatia	1
Cyprus	1
Denmark	1
Egypt	19
France	58
Germany	1
Greece	44
India	2
Ireland	11
Israel	1
Italy	81
Morocco	32
Portugal	6
Russian	1
Sardinia	2
Sicily	2
Spain	6
Tunisia	1
Turkey	5
UK	13
USA	10
Unknown	1

Table 2. List of sugarbeet lines used in this research

Selection	Description
CL24002	Selection from the cross SP69260/F1014
CL24003	Selection from the cross SP69550/L19
CL24004	Selection from population SP8030-0
CL24008	Selection from ND PI mix 1
CL24009	Selection from ND PI mix 2
CL24010	Selection from population BW1-4
CL24011	Selection from population FC709-2
CL24015	Selection from population EL50
CL24017	Selection from the cross SP69260/F1014
CL24018	Selection from the cross SP69550/L19
CL24025	Selection from the cross CIM mix/Y577
CL24026	Selection from the cross FC607 cms/F1001
CL24027	Selection from the cross EL44CMS/SP69550
CL24028	Selection from the cross SP69269-/ F1011
CL24029	Selection from the cross SP6926CMS/F1013
CL24030	Selection from the cross F1010/SP69559-01
CL24031	Selection from the cross FC712/SP69550-01
CL24032	Selection from the cross F1015/961009H2
CL24033	Selection from the cross F1015/951013
CL24034	Selection from the cross F1015/SP69550-01

Results & discussion

CLS evaluation in *B. maritima* accessions

Accessions of *B. maritima* showed phenotypic segregation when grow in field. Accessions were purified according to morphological traits such as leaf color, stem color, root color, etc. A total of 393 plant types were obtained after classified from 300 accessions, and uniformity of plants within each plant type was obviously improved (Fig. 1).

Fig. 1. Example of classified plant types from 300 *B. maritima* accessions according to morphological traits. Each circle indicates one plant type.

Field condition in 2024 was good for CLS development, and disease symptoms were easily observed in all three locations. Disease in Fargo, ND is severer than those in the other two locations, this might be due to Fargo location was planted earlier and row gaps were closed earlier, which provided a longer period of favorite condition for CLS development. Distribution of CLS severity in three locations was shown in Fig. 2, and plants with severity ratings of 3 or below were considered resistant.

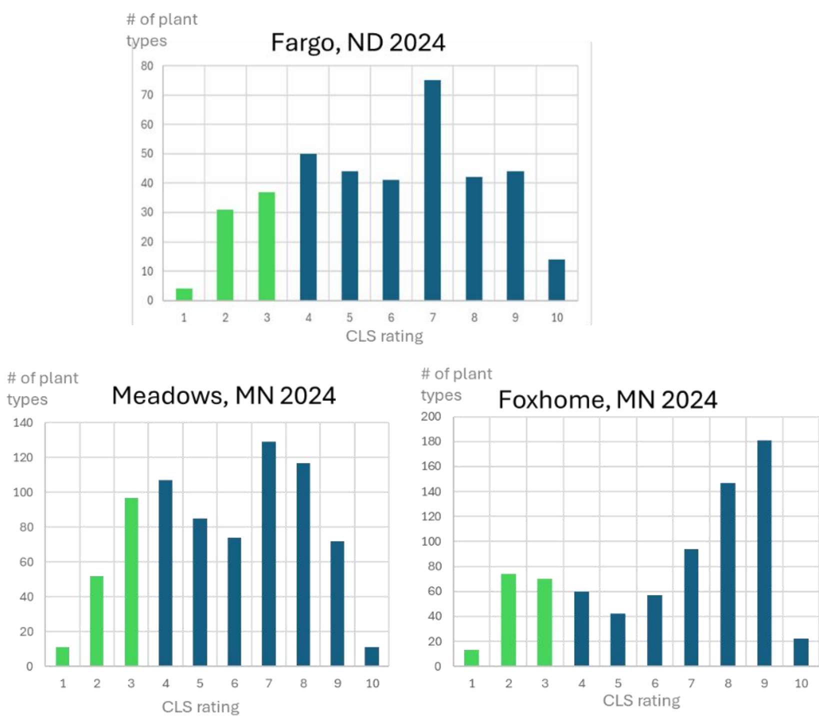

Fig. 2. Distribution of Cercospora leaf spot (CLS) ratings in 393 *B. maritima* plant types evaluated in field nurseries located at Fargo, ND and Foxhome and Meadows, MN in 2024.

When combine CLS evaluation results from three disease nurseries, 53 plant types were considered resistant in both locations at Meadows and Foxhome, and 13 plant types were resistant across all three locations. Very few disease lesions can be found in the resistant plant types (Fig. 3), indicated those plant types can be used for breeding to improve CLS resistance.

Fig. 3. Example of *B. maritima* plants with excellent Cercospora leaf spot (CLS) resistance (right) compared to the susceptible check (left). Photo were taken in 2024 at Foxhome, MN. S = susceptible, R = resistant.

CLS evaluation in sugarbeet selections

The selected sugarbeet lines all showed much slighter disease than the susceptible check (Fig. 4) though segregations were observed in some selections, agrees to these sugarbeet lines were selected in previous years based on CLS resistance, which proves that selection based on CLS resistance is an effective way to lower disease severity and the resistance in the selected lines was controlled by genetic factors. CLS resistance identified in wild sea beet and cultivated sugarbeet might be different, and cross between resistant plants from two sub-species will be conducted to pyramid resistance genes to let resistance stable and last longer. The ongoing genome-wide association mapping will be conducted to confirm if the resistance conferred by different genes. CLS evaluation will be repeated in 2025 at three locations to confirm the resistance.

Fig. 4. Example of plants in selected sugarbeet breeding lines with excellent Cercospora leaf spot (CLS) resistance (right) compared to the susceptible check (left). Photo were taken in 2024 at Foxhome, MN. S = susceptible, R = resistant.

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SENSITIVITY OF *CERCOSPORA BETICOLA* TO FOLIAR FUNGICIDES IN 2024

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Leaf spot, caused by the fungus *Cercospora beticola*, is an endemic disease of sugarbeet produced in the Northern Great Plains area of North Dakota and Minnesota that reduces both yield and sucrose content. The disease is controlled by crop rotation, resistant varieties and timely fungicide applications. *Cercospora* leaf spot usually appears in the last half of the growing season, and multiple fungicide applications are necessary for disease management. Fungicides are used at high label rates and are alternated or used as mixture for best efficacy. The most frequently used fungicides are Tin (fentin hydroxide), Topsin (thiophanate methyl), Eminent /Minerva(tetraconazole), Proline (prothioconazole), Inspire (difenoconazole), Provysol (mefentrifluconazole) and Headline (pyraclostrobin). In 2022, most of the DMI fungicides were applied as mixtures with either mancozeb or copper.

Like many other fungi, *C. beticola* has the ability to become less sensitive (resistant) to the fungicides used to control them after repeated exposure, and increased disease losses can result. Because both *C. beticola* and the fungicides used for management have histories of fungicide resistance in our production areas and other production areas in the US, Europe and Chile, it is important to monitor our *C. beticola* population for changes in sensitivity to the fungicides in order to achieve maximum disease control. We have monitored fungicide sensitivity of field isolates of *C. beticola* collected from fields representing the sugarbeet production area of the Red River Valley region to the commonly used fungicides in our area annually since 2003. In 2024, extensive sensitivity monitoring was conducted for Tin, Eminent, Inspire, Proline, Provysol and Headline.

OBJECTIVES

1) Monitor sensitivity of *Cercospora beticola* isolates to Tin (fentin hydroxide)

2) Monitor sensitivity of *Cercospora beticola* to four triazole (DMI) fungicides: Eminent/Minerva (tetraconazole) and Inspire (difenoconazole) and Proline (prothioconazole) and Provysol (mefentrifluconazole)

3) Monitor *Cercospora beticola* isolates for the presence of the G143A mutation that confers resistance to Headline (pyraclostrobin) fungicide

4) Distribute results of sensitivity monitoring in a timely manner to the sugarbeet industry in order to make fungicide recommendations for disease management and fungicide resistance management for Cercospora leaf spot disease in our region.

METHODS AND MATERIALS

In 2024, with financial support of the Sugarbeet Research and Extension Board of MN and ND, we tested 675 *C. beticola* field isolates collected from throughout the sugarbeet production regions of ND and MN for sensitivity testing to Tin, Eminent, Inspire, Proline, Provysol and Headline. For this report we use the commercial name of the fungicides, but all testing was conducted using the technical grade active ingredient of each fungicide, not the formulated commercial fungicide. The term µg/ml is equivalent to ppm.

Sugarbeet leaves with Cercospora leaf spot (CLS) are collected from commercial sugarbeet fields by agronomists from American Crystal Sugar Company, Minn-Dak Farmers Cooperative and Southern Minnesota Beet Sugar Cooperative representing all production areas in ND and MN and delivered to our lab for processing. From each field sample, *C. beticola* spores were collected from a minimum of five spots per leaf from five leaves and mixed to make a composite of approximately 2500 spores. For Tin testing, a subsample of the spore composite was transferred to a Petri plate containing water agar amended with Tin at 1 ug/ml. Germination of 100 spores on the Tin amended water agar plates were counted 16 hours later and percent germination calculated. Germinated spores are considered resistant.

For triazole fungicide sensitivity testing, a radial growth procedure is used. A single spore subculture from the spore composite is grown on water agar medium amended with serial ten-fold dilutions of each technical grade triazole fungicide from 0.01 – 100 ppm. A separate test is conducted for each triazole fungicide. After 15 days, inhibition of radial growth is measured, and compared to the growth of *C. beticola* on non-amended water agar medium. This data is used to calculate an EC_{50} value for each isolate; EC_{50} is a standardized method of measuring fungicide resistance and is calculated by comparing the concentration of fungicide that reduces radial growth of *C. beticola* by 50% compared to the growth on non-amended media. Higher EC_{50} values mean reduced sensitivity to the fungicide. An RF (resistance factor) is calculated for each DMI fungicide by dividing the EC_{50} value by the baseline value so fungicides can be directly compared. Beginning in 2016, RF value calculations were increased to 10 ppm and in 2019 were increased to100 ppm to accommodate increased number of isolates with resistance to the DMI fungicides higher than 10 ppm.

For Headline resistance testing a PCR based molecular procedure was used to test for the presence of a specific mutation in *C. beticola* that imparts resistance to Headline. This procedure detects a specific mutation, G143A, which results in complete resistance to Headline. DNA is extracted from the remaining spore composite and tested by real-time PCR using primers specific for the G143A mutation. The test enables us to estimate the percentage of spores with the G143A mutation in each sample. The results are placed in five categories based on an estimate of the percentage of spores with the G143A mutation: S = no spores with G143A; S/r = <50 of the spores with G143A; S/R = equal number of spores with G143A; R/s >50% of the spores with G143A; and R = all spores with G143A**.** Each sample tested contains approximately 2500-5000 spores and the DNA from this spore pool will test for the G143A mutation from each spore. The PCR test is more sensitive and requires less interpretation than the previously used spore germination test. The PCR test will estimate the incidence of resistance in the population of spores tested, and give a better indication of Headline resistance in a field.

RESULTS AND DISCUSSION

CLS pressure was moderate with a long growing season in most locations in 2024 and many growers applied first fungicide application earlier than normal based on recommendations by cooperative agronomists. The majority of the CLS samples were delivered to our lab at the end of the season in September and early October. Field samples (n=675) representing all production areas and factory districts were tested for sensitivity to six fungicides: fentin hydroxide (Tin), tetraconazole (Eminent), difenoconazole (the most active part of Inspire), prothioconazole (Proline), mefentrifluconazole (Provysol) and pyraclostrobin (Headline).

TIN. Tolerance (resistance) to Tin was first reported in 1994 at concentrations of 1-2 µg/ml. At these levels, disease control in the field is reduced. The incidence of fields with isolates resistant to Tin at 1.0 µg/ml increased between 1997 and 1999, but the incidence of fields with resistant isolates has been declining since the introduction of additional fungicides for resistance management, including Eminent in 1999, Gem in 2002 and Headline in 2003. In 1998, the incidence of fields with isolates resistant to Tin at 1.0 µg/ml was 64.6%, and declined to less than 10% from 2002 to 2010. From 2011 to 2014 there was an increase in the number of fields with resistance and from 2015 to 2017, the incidence of fields with isolates resistant to Tin increased from 38.5% to 97% (**Figure 1**). In 2018, the incidence of fields with isolates resistant to tin declined to 65.2% and declined again to 21.3% in 2019 (**Figure 1**). The incidence of fields with resistance to tin increased dramatically in 2020, 2021 and 2022 and declined in 2023 (**Figure 1)**. In 2024 the percentage of fields with tin resistance increased to 97% (**Figure 1**). The severity of resistance, as expressed as percent germination of spores from fields with resistant isolates, was 65% in 2022, but declined to 31% in 2023 and to 30% in 2024 (**Figure 1**). The incidence of fields with tin resistance was high in all factory districts (**Figure 2**).This increase in resistance is likely due to the increased and widespread use of tin. Because there is a fitness penalty with tin resistance, resistance will decline as tin usage declines.

DMI (triazoles). Resistance as measured by RF values in 2024 increased for for Provysol and decreased slightly for Inspire, Proline and Eminent (**Figure 3**). Percent of isolates with EC_{50} values >100 ppm were between 5 and 19 %, but were higher for Provysol at 58% (**Figure** 4).

HEADLINE. Beginning in 2012, a PCR based molecular procedure was used to test for the presence of the G143A mutation in *C. beticola* using a composite spore sample containing approximately 2500-5000 spores. The presence of this mutation indicates absolute resistance to Headline. The G143A mutation was first detected in the RRV production area in 2012 and increased from 2013 to 2015. Resistance to Headline in field populations increased dramatically from 2016 to 2020, and continued in 2024 (**Figure 5**). Resistance to Headline did not decline in 2024 (**Figure 5**). We will continue to monitor for resistance to Headline in the RRV production area, particularly because Headline is often the only fungicide used, and is used annually even in the absence of disease. There may be a fitness penalty associated with the G143A mutation, because we observe that EC50 values are lower at the beginning of the growing season and increase to higher levels at the end of the sgrowing season.

SUMMARY

1. Resistance to Tin at 1.0 µg/ml almost disappeared in our region from 2003-2010, but has increased since 2011, probably due to increased use. Tin resistance declined in 2018 and 2019, increased in 2020 to 2021, and stabilized in 2022. The percentage of spores with resistance/field doubled in 2020 and increased by 144% in 2021 and stabilized in 2022 at 65%, decreased in 2023 and 2024 to about 30%. Almost all field have tin resistance in 2024 and efforts should continue to preserve this fungicide for CLS management.

2. Resistance as measured by RF and EC^{50} values in 2024 increased for for Provysol and decreased slightly for Inspire, Proline and Eminent.We now have four DMI fungicides available: Eminent, Proline, Inspire and Provysol. Some isolates have EC_{50} values >100 ppm, which is very high, but Eminent levels >100 are actually decreasing. Resistance to DMI fungicides is present in all factory districts with some differences.. DMI fungicides should be applied a mancozeb or copper mixing partner. A PCR test has been developed to detect DMI resistance, and we continue to validate this test for futue use.

3. The presence of isolates in a population with the G143A mutation that results in resistance to Headline continued to be prevalent and widespread in 2024 as in past years. These findings precluded the effective use of Headline for CLS management in 2024. Headline is not recommended for CLS management, but is used for frost protection.

4. We recommend continuing disease control recommendations currently in place including fungicide rotation, using high label rate of fungicides, mixtures with mancozeb or copper, scouting at end of the season to decide the necessity of a late application, using fungicide resistance maps for fungicide selection, using a resistant variety, spray intervals of 14 days, and applying fungicides to insure maximum coverage. Improvements in fungicide coverage using proper spray nozzles and spray parameters such as timing, rate, interval and coverage should be implemented.

5. We also recommend first fungicide application much earlier than previously recommended as we have detected C. beticola spores in commercial fields even prior to emergence. Since the fungicides used are all protectants, they need to be in place before spore arrive. We recommend early fungicide application befroe the end of June or just prior to row closure for best management of CLS. Work is ongoing to add to the forecasting model environmental factors affecting spore germination and latent infection.

6 .New varieties with higher levels of resistance were evaluated in the field with excellent disease resistance profiles. We urge the use of varieties with better CLS resistance. Because we observed CLS+ varieties at the end of the growing season, fungicides are necessary on both conventional and CR+ varieties.

Figure 1. Incidence and severity of tin resistance in *C. beticola* isolates collected from sugarbeet fields in ND and MN from 1998 to 2024

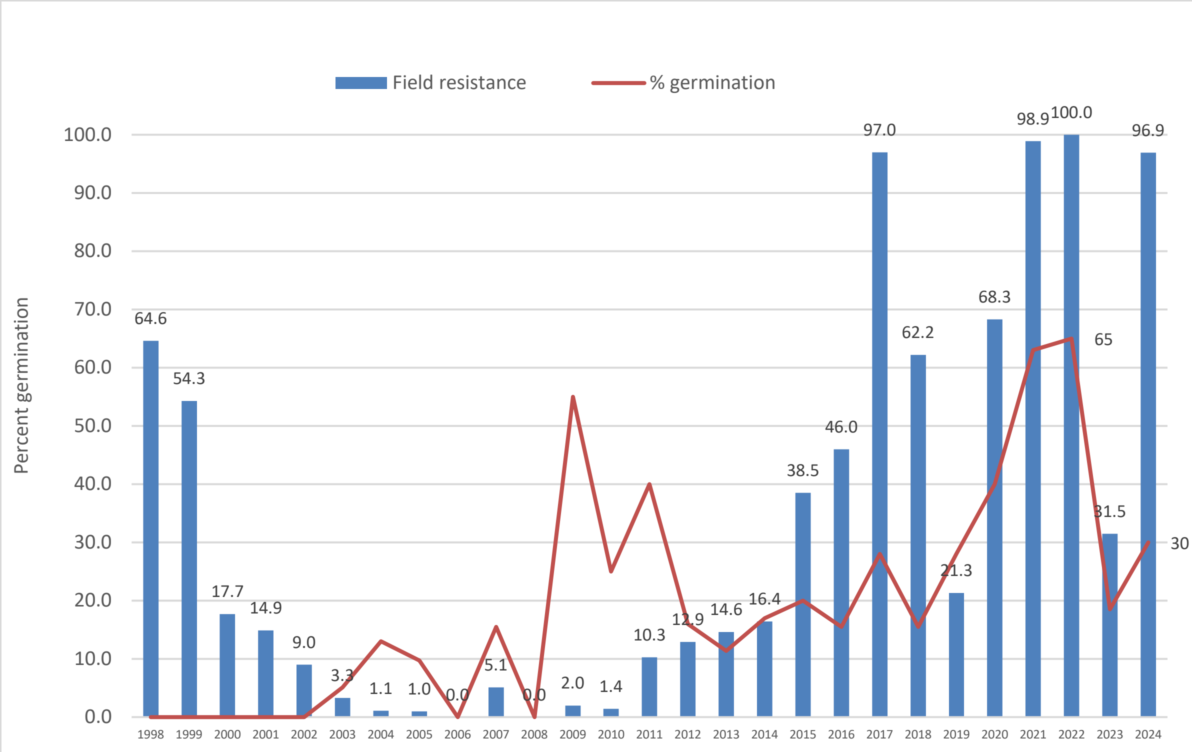


Figure 2. Incidence of fields with *C. beticola* isolates resistant to tin collected in ND and MN from 2022 to 2024 by factory district

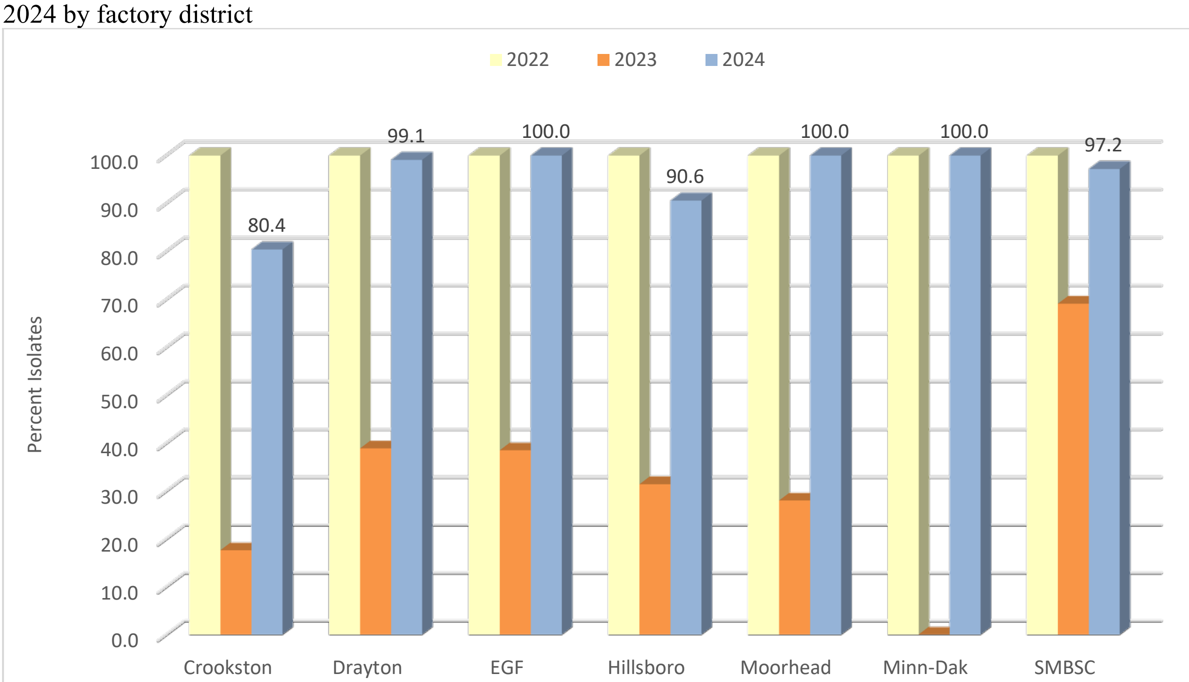


Figure 3. Resistance Factor of *C. beticola* isolates collected in ND and MN from 2018 to 2022 to Eminent, Inspire, Proline and Provysol

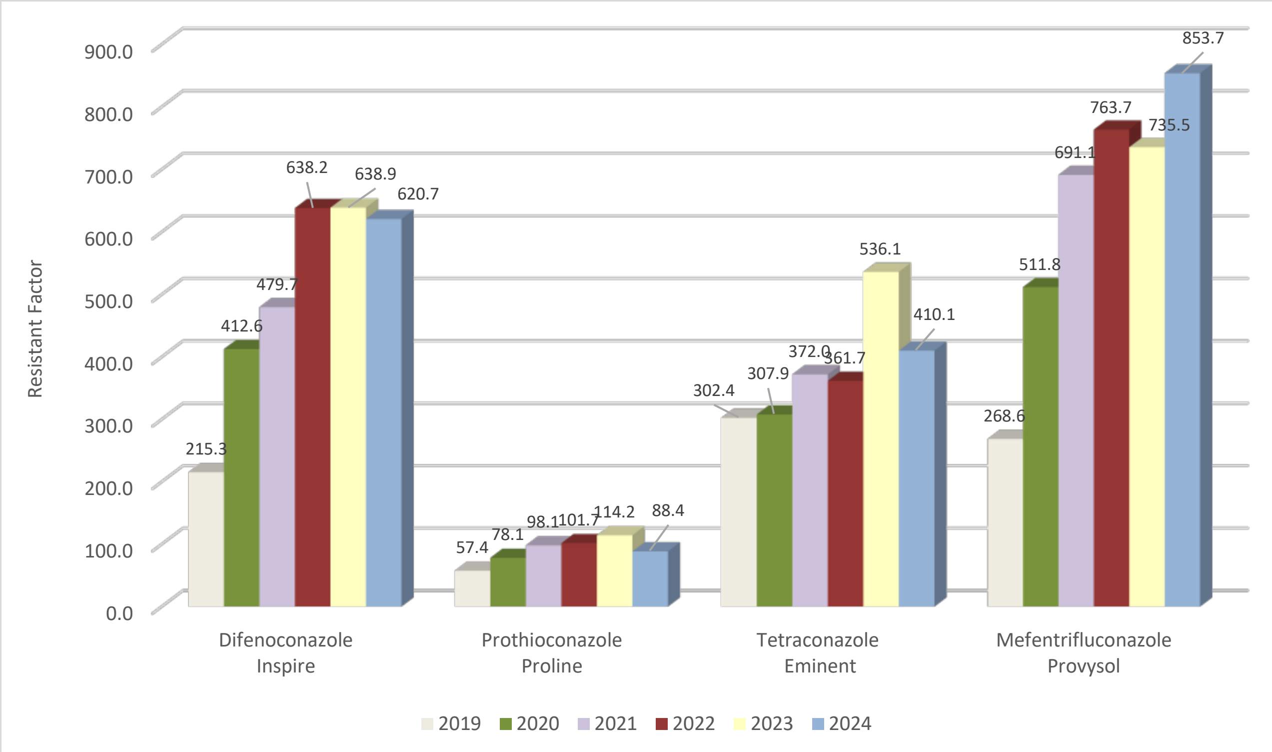


Figure 4. Distribution of sensitivity to Eminent, Inspire, Proline and Provysol of *C. beticola* isolates collected in 2024 as expressed by EC_{50} values

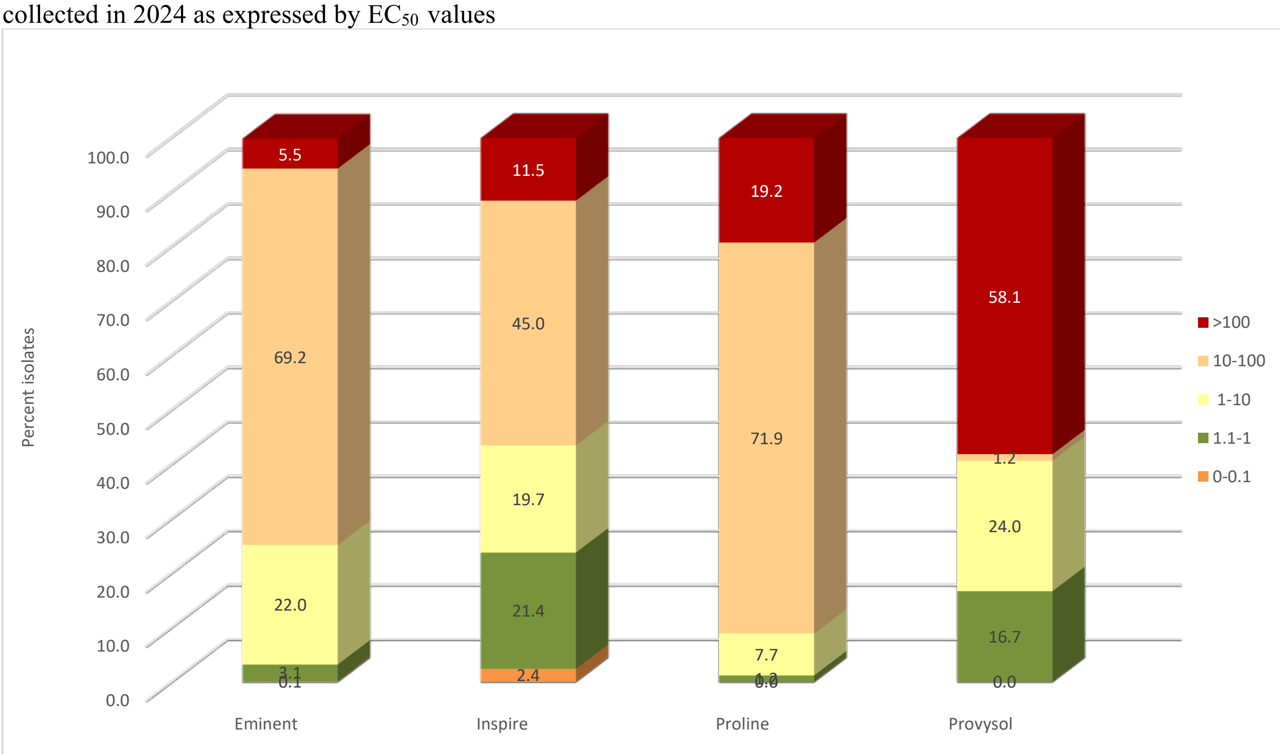
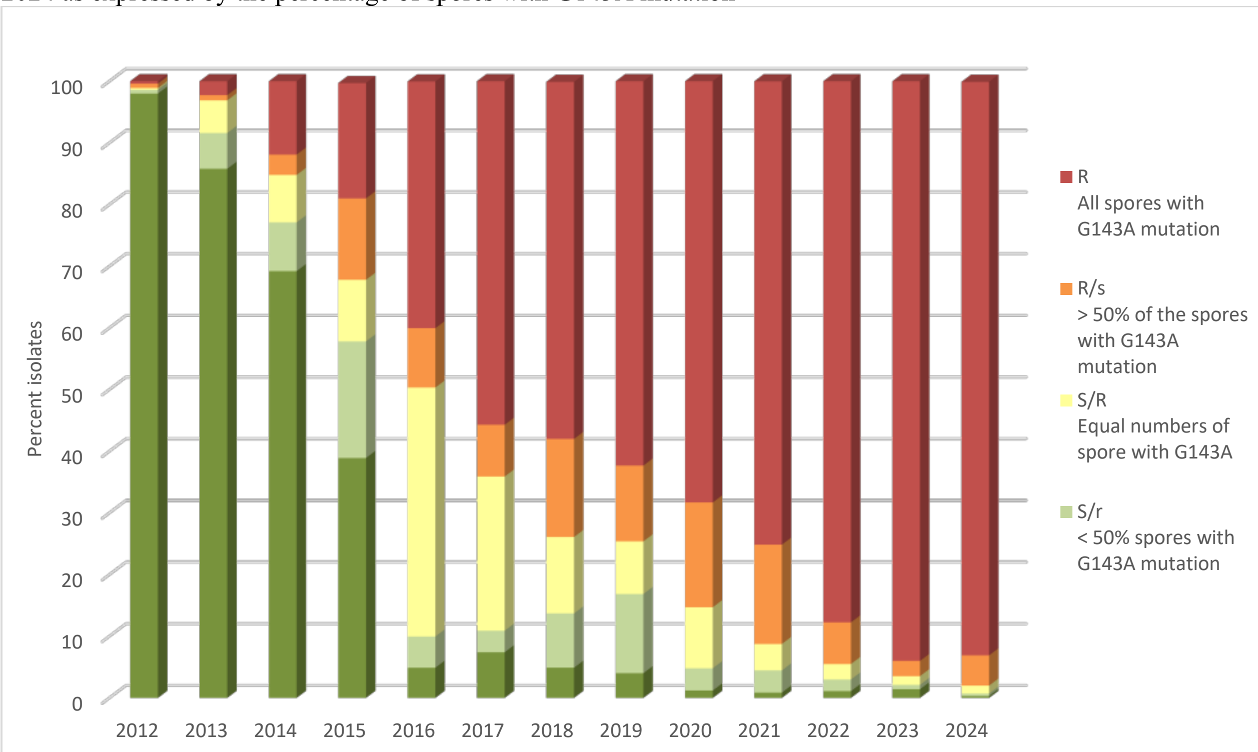


Figure 5. Sensitivity of *C. beticola* isolate populations collected in ND and MN to Headline from 2012 to 2024 as expressed by the percentage of spores with G143A mutation



Early detection of *Cercospora beticola* asymptomatic infection in commercial sugarbeet fields in 2024

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Cercospora leaf spot (CLS) on sugarbeet, caused by the fungus *Cercospora beticola,* is a devastating leaf spot disease of sugar beet that is endemic in the Red River Valley (RRV). CLS severity varies with environmental conditions and causes serious economic losses if not managed. Management of CLS relies on a combination of crop rotation, cultural practices, resistant cultivars, and timely fungicide applications. In the RRV, *C. beticola* has developed decreased sensitivity at varying levels to all fungicides used, including organotin compounds, strobilurin fungicides like Headline, benzimidazoles like Topsin, and triazole fungicides that include Proline, Inspire, and Provysol.

Timing of fungicide applications, especially the first application is highly variable and subsequent fungicide applications are often based on daily infection values (DIVs) calculated from relative humidity and temperature in the region. As DIVs increase, disease favorability increases, and fungicide applications are recommended when a threshold is reached. Recent results from field surveys of asymptomatic leaf samples from commercial sugarbeet fields have shown that CLS infection is occurring earlier and at wider prevalence than previously thought. Since 2021, annual surveys of CLS infection detection have been facilitated via molecular assays that detect the presence of *C. beticola* growing asymptomatically in sugarbeet fields. Here we present the results of this survey in 2024.

OBJECTIVES

1) Detect the onset of CLS asymptomatic infection across the entire RRV growing region.

METHODS AND MATERIALS

From 2021 - 2024, with financial support of the Sugarbeet Research and Extension Board of MN and ND, we tested samples collected for 5-6 weeks from 280 commercial sugarbeet fields in MN and ND. Agriculturalist staff from the region were asked to collect five leaf samples from seven fields weekly to be mailed or dropped off to the USDA-ARS Sugarbeet and Potato Research Unit located in Fargo, ND. Upon sample arrival, leaves are hole punched for a total of 10 leaf disks from each of the five leaves submitted per field location. These leaf punches are batch processed as a single sample for DNA extraction using a KingFisher™ Flex Purification System (ThermoFisher: 5400630) with the sbeadex™ plant nucleic acid purification kit (LGC: NAP41620) after freeze drying samples. Sample DNA is then subjected to qPCR assays designed to detect the G143A mutation associated with Strobilurin fungicide resistance (Bolton et al. 2013), The E170 and L144F mutations associated with Triazole fungicide resistance (Spanner et al. 2021, Shrestha et al. 2022), and the E198A mutation associated with Benzimidazole fungicide resistance. A probe designed to detect the wild type at the G143A locus is also incorporated to ensure that *C. beticola* DNA is detected in either of the two forms this mutation is present as. Results from each weekly sample set and assay batches are compiled into weekly reports and distributed back to the regional sugar cooperatives.

RESULTS AND DISCUSSION

Detection of latent CLS infection steadily rose as the sampling season progressed (Figure 1). In each of 2021 – 2024, the frequency of latent CLS detected in submitted samples approached 100% during the first week of July, approximately corresponding to row closure events. These results have been used to inform best practices for the start of CLS fungicide management. By looking at historical data on recoverable sucrose for fields with different fungicide management start dates, a clear trend of earlier applications correlating with higher recoverable sucrose presents itself (Figure 2). On average, fields that had fungicide applications the week prior to 100% asymptomatic CLS infection produced the most sugar and waiting just one additional week lead to a drop of 5% in recoverable sucrose per acre. This trend was more pronounced in years with higher CLS pressure as exemplified by data from the year 2020 (Figure 2).

SUMMARY

Across four sampling years, a consistent pattern of latent CLS progression has been observed, leading to near 100% prevalence of CLS detection just prior to or at sugarbeet row closure. These results have implications for the initial timing of fungicide applications for CLS management. Control of primary infection is important to mitigate the exponential increase in inoculum levels that can occur when CLS symptoms begin to arise. Data collected across multiple growing seasons has revealed that growers who apply fungicides prior to or at row closure have experienced the highest recoverable sucrose relative to those who wait until symptoms arise. This data adds to the robust evidence that management of the primary infection is paramount in CLS management.

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Figure 1: Prevalence of latent CLS detection in years 2021, 2022, and 2023 across sampling weeks. Sampling week 5 (W5) corresponds to the first week in July.

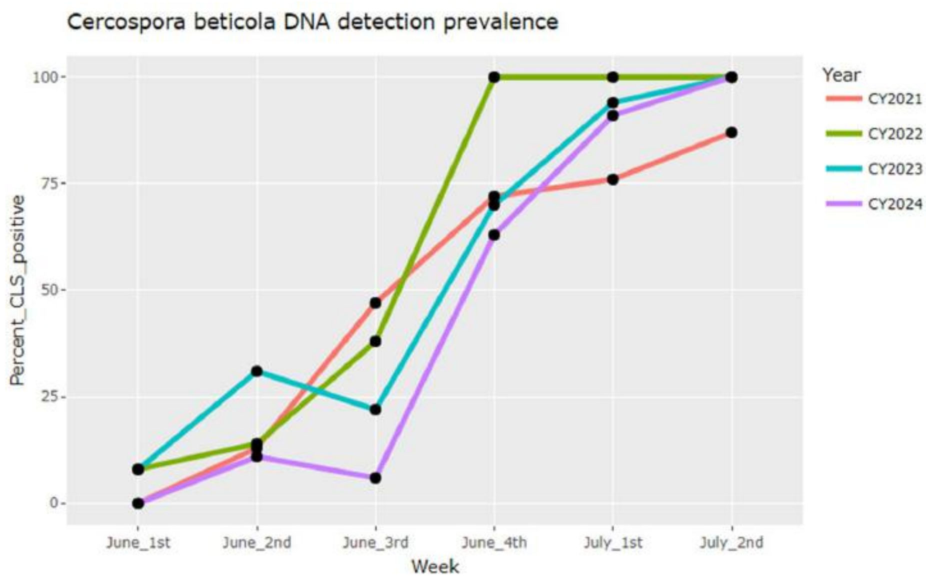
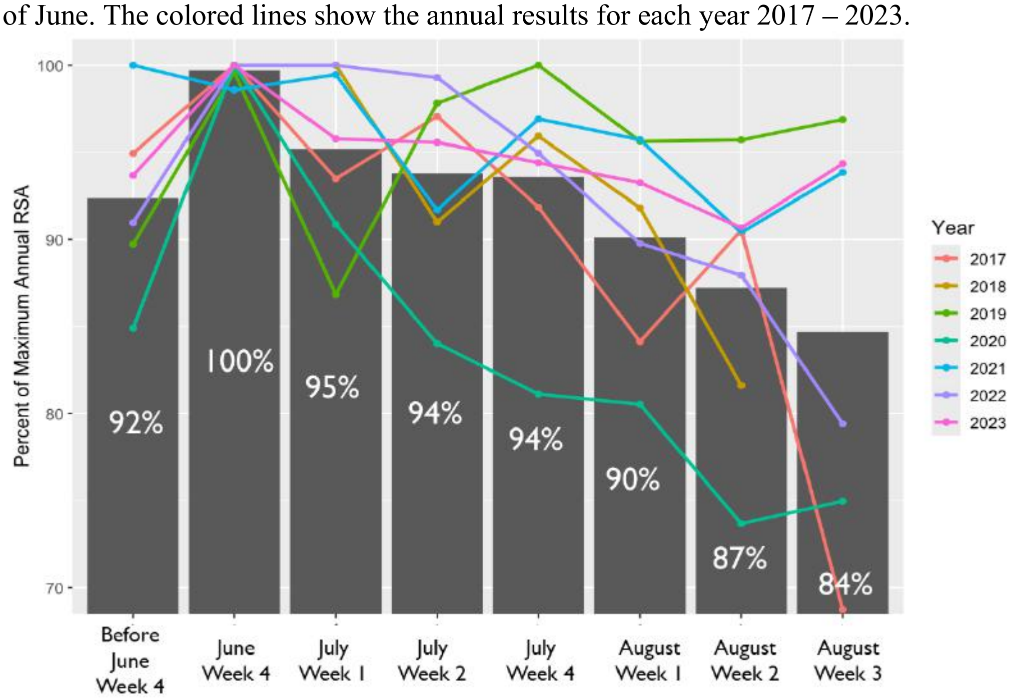


Figure 2: Average recoverable sucrose per acre (RSA) in commercial sugarbeet fields. Fields collected into weekly bins and the highest value was set to 100%. Each additional week is shown as the relative percent compared to the best. On average the best weekly bin was the fourth week of June. The colored lines show the annual results for each year 2017 – 2023.



EVALUATING FUNGICIDE PROGRAMS FOR CONTROL OF CERCOSPORA LEAF SPOT AND RELATIONSHIP TO LATENT INFECTION AND FUNGICIDE RESISTANCE PROFILES DURING THE GROWING SEASON

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SUMMARY

INTRODUCTION

Cercospora leaf spot (CLS) caused by the fungal pathogen, *Cercospora beticola*, continues to limit sugarbeet yields and economic returns for growers and cooperatives in North Dakota and Minnesota (Khan 2021). Multiple factors contribute to the severity of CLS in sugarbeet each year, including selection of tolerant varieties, timely use of preventative fungicides, and temperature and moisture conditions. Given the inherent variability in the success of cultural practices, such as crop rotation and residue management, and weather conditions in and around the sugarbeet canopy, fungicide applications play a key role in management of CLS. Two to six fungicide applications to control CLS may be made in a typical season, depending on the date of onset of disease symptoms and how conducive the environment is to spore germination and infection.

Large numbers of infectious spores are produced in the CLS lesions, leading to the asexual production of multiple generations of *C. beticola* per season. When coupled with frequent use of fungicides with the same mode of action, the polycyclic nature and prolific sporulation are risk factors for fungicide resistance development (van den Bosch 2014). In *C. beticola* populations, decreased fungicide sensitivity has been detected in several of the active ingredients relied upon for season-long control, including tin (Fungicide Resistance Action Committee; FRAC 30), thiophanate methyl or methyl benzimidazole carbamate (MBC; FRAC 1), multiple demethylation inhibitors (DMI; FRAC 3), and strobilurins (QoI fungicides; FRAC 11) (Secor et al. 2023). Although DMI- and QoI-resistant isolates may have reduced ability to infect sugarbeet than sensitive isolates in the absence of fungicides, this fitness penalty is small enough that populations of fungicide-resistant isolates are likely to persist (Liu et al. 2023). Mode of action rotation and tank mixing of fungicides allow for multiple active ingredients to be applied during each spray event, limiting the survival and growth of fungicide-resistant *C. beticola* isolates. Evaluation of fungicide selection, timing, and application sequence in spray programs to control CLS has consistently been a priority of growers and cooperatives in ND and MN.

Previous trials in ND and MN have indicated improved control of CLS when fungicide programs include a first application earlier in the season (Bhandari et al. 2023; Lien et al. 2023). Based in part on early-season monitoring of *C. beticola* DNA in sugarbeet leaves prior to onset of symptoms (Secor et al. 2022), fungicide programs from sugarbeet cooperatives in MN and ND recommend starting applications earlier in the growing season. These sprays are applied prior to symptom development, and well before the 3-5% CLS severity threshold is reached. However, more data is needed on how latent infections relate to CLS epidemics later in the year. The purpose of this project is to assess performance of spray programs with early first applications and to generate preliminary data on the relationship between different fungicide programs, latent *C. beticola* infections, presence of fungicide-resistant isolates, and root yield and quality at harvest.

Objectives

1) **Assess the ability of different fungicide programs to control Cercospora leaf spot on CR+ and non-CR+ varieties and effect on yield and quality at harvest**
2) **Evaluate the relationship between latent *C. beticola* infections and pre-symptomatic fungicide applications**
3) **Investigate changes in resistance profiles of *C. beticola* populations following fungicide applications throughout the growing season.**

Alongside increasing awareness of the importance of *C. beticola* latent infections and variable fungicide resistance profiles of *C. beticola* populations, the results of this project will be essential to the development and refinement of practical steps growers in MN and ND can take to improve management CLS.

METHODS AND MATERIALS

Field Trials

This experiment was conducted at two locations utilized by the Extension Plant Pathology program: near Foxhome, MN and near Kragnes, MN (approximately five miles north of Moorhead, MN). At each location, two identical trials were conducted, one planted with Beta 7231, a CR+ variety that had a 2-year-average CLS rating of 2.0, and the other planted with Crystal 912, a non-CR+ variety that had a 2-year-average CLS rating of 5.0 (Brantner and Moomjian 2023). Standard seed treatments were used. Counter 20G was applied at planting at the Kragnes location to control insects. Each plot consisted of six 30-foot long rows with 22-inch spacing. Plots (experimental units) were arranged in a randomized complete block design with four replications. Throughout the season, data was collected including stand counts and CLS severity ratings. The scale developed by Jones and Windels (1991) was used to rate disease severity in the center two rows of each plot. Briefly, scores of 1-10 correspond to 0.1%-50% of infected area per leaf. Area under the disease progress stairs (AUDPS) was calculated from CLS severity and used to compare severity between plots (Simko and Piepho 2023).

Plots were inoculated by appling *Cercospora beticola*-infested plant material from the 2023 season, mixed with talc (3:2 ratio) at a rate of 5.0 lbs per acre. Inoculations were conducted at the Kragnes location on July 9th and the Foxhome location on July 10th. Fungicide treatments (Table 1) were applied to the center four rows (rows 2-5) of each plot using a tractor-mounted CO2-pressurized boom sprayer calibrated to 17 gallons per acre at 60 psi. The same fungicide products made up each treatment program (Table 2). Only application start date and interval varied between treatments. Yield and recoverable sugar were assessed at harvest on September 16th (Kragnes location) and September 25th (Foxhome location). Plots were defoliated and the center two rows were harvested within three hours. Approximately 25 pounds of harvested roots selected at random were sent to the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN, and analyzed for sugar quality. The effect of treatment on AUDPS, yield, and recoverable sugar was evaluated using a generalized linear mixed model with means separated by a Fisher's protected least significant difference test suitable for multiple comparisons ($P = 0.05$; Steel et al. 1997) in R version 4.2.3 (R Core Team 2023).

Table 1. Treatment list and application schedule description of treatments for the sugarbeet field trials conducted near Kragnes, MN, and Foxhome, MN in 2024. One CR+ and one CLS-susceptible variety were used at each location.

Treatment	Timing of first application	Application Interval	Number of Applications	Application Month/Day	
				Foxhome location	Kragnes location
1	10-14 days prior to row closure	Every 10-14 days	6	6/14, 6/28, 7/12, 7/29, 8/12, 9/6	6/14, 6/26, 7/17, 8/1, 8/13, 9/4
2	Prior to row closure	Every 10-14 days	5	6/28, 7/12, 7/29, 8/12, 9/6	6/26, 7/17, 8/1, 8/13, 9/4
3	Prior to row closure	As indicated by DIV*	4	6/28	6/26
4	Prior to row closure	10-14 days; 21-28 days;	4	6/28, 7/12, 8/12, 9/6	6/26, 7/17, 8/13, 9/4
5	At row closure	Every 10-14 days	4	7/12, 7/29, 8/12, 9/6	7/17, 8/1, 8/13, 9/4
6	At row closure	10-14 days; 21-28 days	3	7/12, 7/29, 9/6	7/17, 8/1, 9/4
7	At row closure	10-14 days; as indicated by DIV	3	7/12, 7/29, 9/6	7/17, 8/1, 9/4
8	Disease onset	10-14 days; as indicated by DIV	3	7/29, 8/12, 9/6	8/1, 8/13, 9/4
9	3-5% CLS severity	Every 10-14 days	2	8/12, 9/6	8/13, 9/4
10	Nontreated check	NA	0	NA	NA

*DIV = Daily Infection Value

Table 2. The same fungicide modes of action and tank mix partners were used for all treatments each trial conducted in 2024. Treatments with later fungicide program start dates did not use all six applications.

Application	Mode(s) of action	Product (Rate/Acre)
1st	EBDC	Koverall (2 lbs)
2nd	DMI (tetraconazole) + EBDC	Minerva (13 fl oz) + Koverall (2 lbs)
3rd	Tin + EBDC	Super Tin (8 fl oz) + Koverall (2 lbs)
4th	DMI (difenoconazole, Propiconazole) + EBDC	Inspire XT (7 fl oz) + Koverall @ 2 lbs)
5th	Tin + EBDC	Super Tin (8 fl oz) + Koverall (2 lbs)
6th	Copper + EBDC	Badge SC (2 pt) + Koverall (2 lbs)

Molecular assays for CLS detection and fungicide resistance profiling

Throughout the growing season, sugarbeet leaf samples were collected from each of the center two rows prior to the earliest fungicide application, and again prior to each subsequent fungicide application and after the final fungicide application. Each sample consisted of three leaves taken at approximately 5-foot intervals from within the row. Following each leaf sampling event, *Cercospora beticola* DNA was extracted and processed by the Wyatt lab at the USDA-ARS Sugarbeet Unit in Fargo, ND per previously described protocols (Wyatt 2024). Briefly, 10 leaf disks were hole-punched from each leaf sample and freeze-dried. Following DNA extraction, sample DNA was subjected to qPCR assays to detect QoI fungicice resistance (G143A mutation) (Bolton et al. 2013), DMI fungicide resistance (E170 and L144F mutations) (Spanner et al. 2021; Shrestha et al. 2022), and benzimidazole (MBC) fungicide resistance (E198A). DNA extractions were conducted within 24 hours of leaf sample collection and stored frozen until qPCR was completed.

RESULTS AND DISCUSSION

Rainfall during the growing season totaled 20.1 and 17.8 inches from the date of planting until harvest at the Foxhome and Kragnes sites, respectively. Excessive rainfall in the May at the Kragnes site likely delayed growth of the emerging seedlings but affected all plots equally. There was no significant difference in crop stand at emergence or at harvest among the trials at each location (data not shown). At the Foxhome site, the average CLS rating in the nontreated control plots was 7.9 at harvest, while the equivalent plots at the Kragnes site had a rating of 5.7. This difference in CLS pressure may be attributed to the environment. North Dakota Agricultural Weather Network (NDAWN) recorded cumulative DIVs of 173 at Foxhome and 134 near the Kragnes site (Glyndon weather station). Notably, the fall of 2024 experienced average daily high and low temperatures in September almost identical to those in August. At Foxhome, the average daily temperature high and low was 78°F and 57°F in August, and 79°F and 53°F in September (through harvest on September 25th). At the Kragnes location, average temperatures were 78°F and 59°F in August, then 80°F and 56°F (through harvest on September 16th).

At the Foxhome location the fungicide program that began in mid June, six applications throughout the season at 10-14 day intervals, reduced CLS disease severity the most compared to the nontreated control (Table ___). However, other treatments that begin either mid June, late June, or even early July resulted in statistically similar levels of CLS control as the mid June program start date provided spray intervals were kept to 10-14 days. This was significantly different from the nontreated control in the case of the CR+ variety at Foxhome ($P < 0.05$). Similarly, at the Kragnes location, the mid-June start date resulted in the lowest CLS disease severity calculated as AUDPS (Table 3).

Both the CR+ and non-CR+ varieties, greatest recoverable sugar per acre (RSA) was associated with the fungicide program that began in mid-June (Table 3). This was observed at both locations, despite differences in CLS pressure. However, in only the CR+ variety at Foxhome was this difference significant at the $\alpha = 0.05$ level. Generally, each program that began in late June resulted in similar RSA as the mid-June start program. At the Foxhome location, increased CLS severity was significantly correlated to lower RSA for both CR+ and non-CR+ varieties ($P = 0.01$ and $P = 0.02$, respectively). Given this correlation, it is expected that later harvest dates for each location (such as commercial stockpile harvest) would likely result in further separation of treatments and may as CLS disease progression has a chance to increase. Future work may also address the extent of economic benefits to fungicide applications made in mid June, approximately 10-14 days prior to row closure.

Table 3. Effect of fungicide program start date and interval on Cercospora leaf spot disease severity (area under the disease progress stairs), yield, recoverable sugar per acre (RSA), and gross revenue per acre (using ACSC formulas, fall 2024) in CR+ sugarbeet at a replicated field trial near Foxhome, MN in 2024.

Location / Variety	Program start date / Intervals[1]	CLS severity (AUDPS[2])	Yield (tons/A)	RSA[3] (lbs)	Gross $/A[4]
Foxhome / CR+	Mid June / Standard	67 a[5]	37.4 abc	13,439 a	$3,381
	Late June / Standard	86 ab	38.4 ab	13,171 ab	$3,180
	Late June / DIV	115 abc	36.1 abcd	12,464 abc	$3,038
	Late June / Extended	79 bcd	38.2 ab	13,118 ab	$3,174
	Early July / Standard	100 cd	37.3 abc	12,619 abc	$3,006
	Early July / Extended	155 de	38.5 a	12,399 abc	$2,816
	Early July / DIV	145 e	37.3 abc	12,614 abc	$3,002
	Disease onset / DIV	127 e	35.4 bcd	12,144 bc	$2,940
	3-5% severity / Standard	200 f	34.7 cd	11,476 cd	$2,674
	Nontreated check	216 f	33.1 d	10,637 d	$2,390
	***P* =**	**< 0.001**	**< 0.001**	**< 0.001**	
Foxhome / non-CR+	Mid June / Standard	154 a	42.0	12,286	$2,470
	Late June / Standard	174 ab	40.4	11,934	$2,449
	Late June / DIV	284 abc	38.1	10,525	$1,947
	Late June / Extended	219 abc	42.3	12,097	$2,354
	Early July / Standard	227 abc	38.9	11,346	$2,250
	Early July / Extended	311 bc	38.8	10,730	$2,015
	Early July / DIV	280 c	34.6	10,178	$2,082
	Disease onset / DIV	249 c	39.1	11,176	$2,160
	3-5% severity / Standard	235 c	33.8	9,164	$1,664
	Nontreated check	306 c	38.5	10,663	$2,035
	***P* =**	**0.02**	**NS[6]**	**NS**	
Kragnes / CR+	Mid June / Standard	29.5 a	32.5	10,575	$1,816
	Late June / Standard	57.1 ab	30.8	9,779	$1,608
	Late June / DIV	58.7 ab	32.6	10,204	$1,610
	Late June / Extended	46.5 ab	28.8	9,550	$1,718
	Early July / Standard	37.9 a	27.6	9,934	$2,021
	Early July / Extended	58.2 ab	23.9	8,504	$1,687
	Early July / DIV	51.8 ab	23.5	8,307	$1,639
	Disease onset / DIV	49.5 ab	28.4	9,941	$1,736
	3-5% severity / Standard	62.4 ab	28.4	10,228	$2,087
	Nontreated check	93.4 b	28.0	9,829	$1,916
	***P* =**	**0.03**	**NS**	**NS**	
Kragnes / non-CR+	Mid June / Standard	58.5 a	35.9	12,160	$2,350
	Late June / Standard	50.3 a	32.0	10,437	$1,828
	Late June / DIV	80.8 a	34.2	11,617	$2,182
	Late June / Extended	92.0 a	30.1	10,482	$1,934
	Early July / Standard	57.1 a	33.2	11,253	$2,117
	Early July / Extended	87.6 a	33.0	11,491	$2,254
	Early July / DIV	77.9 a	32.9	11,152	$2,073
	Disease onset / DIV	88.1 a	32.7	11,427	$2,243
	3-5% severity / Standard	156.1 b	30.0	10,486	$2,041
	Nontreated check	196.1 b	29.2	10,011	$1,307
	***P* =**	**< 0.001**	**NS**	**NS**	

[1]Standard = 10-14 days; Extended = 10-14 days, then 21-28 days; DIV = applications made as indicated by Daily Infection Value
[2]Area under the disease progress stairs
[3]Recoverable sugar per acre
[4]Gross revenue per acre, calculated using the fall 2024 American Crystal Sugar Company payment calculator.
[5]Means followed by the same letter within a column are not significantly different (Fishers protected least significant difference (LSD), P = 0.05)
[6]NS = not significant at α = 0.05

CLS latent infections

For all treatments of both CR+ and non-CR+ trials at the Kragnes location, the first detection of *C. beticola* DNA from leaf samples occurred for the July 8th collection date (Table 4). July 8th was around the time of row closure at the Kragnes location, and early July is when most samples from across the Red River Valley test positive for CLS infections (Wyatt 2024). At the non-CR+ variety at the Foxhome location, there were two treatments where *C. beticola* DNA was detected on the June 14th sampling date. The CR+ variety at Foxhome only had . The remaining treatments at the Foxhome location tested positive for *C. beticola* in the June 25th samples. Latent infection detections all occurred prior to inoculation. Follwing one season of data collection, there is no clear trend in the association between latent infection and fungicide treatment.

Table 4. Date of first detection of latent, asymptomatic *Cercospora beticola* infections by qPCR analysis of leaf tissue DNA extractions.

Program start date / Intervals[1]	**Date of first latent CLS detection at each location**			
	Foxhome CR+	**Foxhome non-CR+**	**Kragnes CR+**	**Kragnes non-CR+**
Mid June / Standard	6/25	6/14	7/8	7/8
Late June / Standard	6/25	6/25	7/8	7/8
Late June / DIV	6/14	6/25	7/8	7/8
Late June / Extended	6/25	6/25	7/8	7/8
Early July / Standard	6/25	6/25	7/8	7/8
Early July / Extended	6/25	6/14	7/8	7/8
Early July / DIV	6/25	6/25	7/8	7/8
Disease onset / DIV	6/25	6/25	7/8	7/8
3-5% severity / Standard	6/25	6/25	7/8	7/8
Nontreated check	6/25	6/25	7/8	7/8

[1]Standard = 10-14 days; Extended = 10-14 days, then 21-28 days; DIV = applications made as indicated by Daily Infection Value

Fungicide resistance within C. beticola samples

Within each trial, qPCR assays provided for approximations of the proportion of sensitive and resistant isolates over time to QoI, DMI, and MBC fungicides. The most significant shift during the season was evident in resistance to the DMI group (L144F mutation) increasing abruptly for the second sampling onward. Also notable was that nontreated check plots, in both varieties and at both locations, were infected with at least some susceptible *C. beticola* populations. Regional differences between the Foxhome location and the Kragnes location were evident for QoI resistance and MCB resistance.

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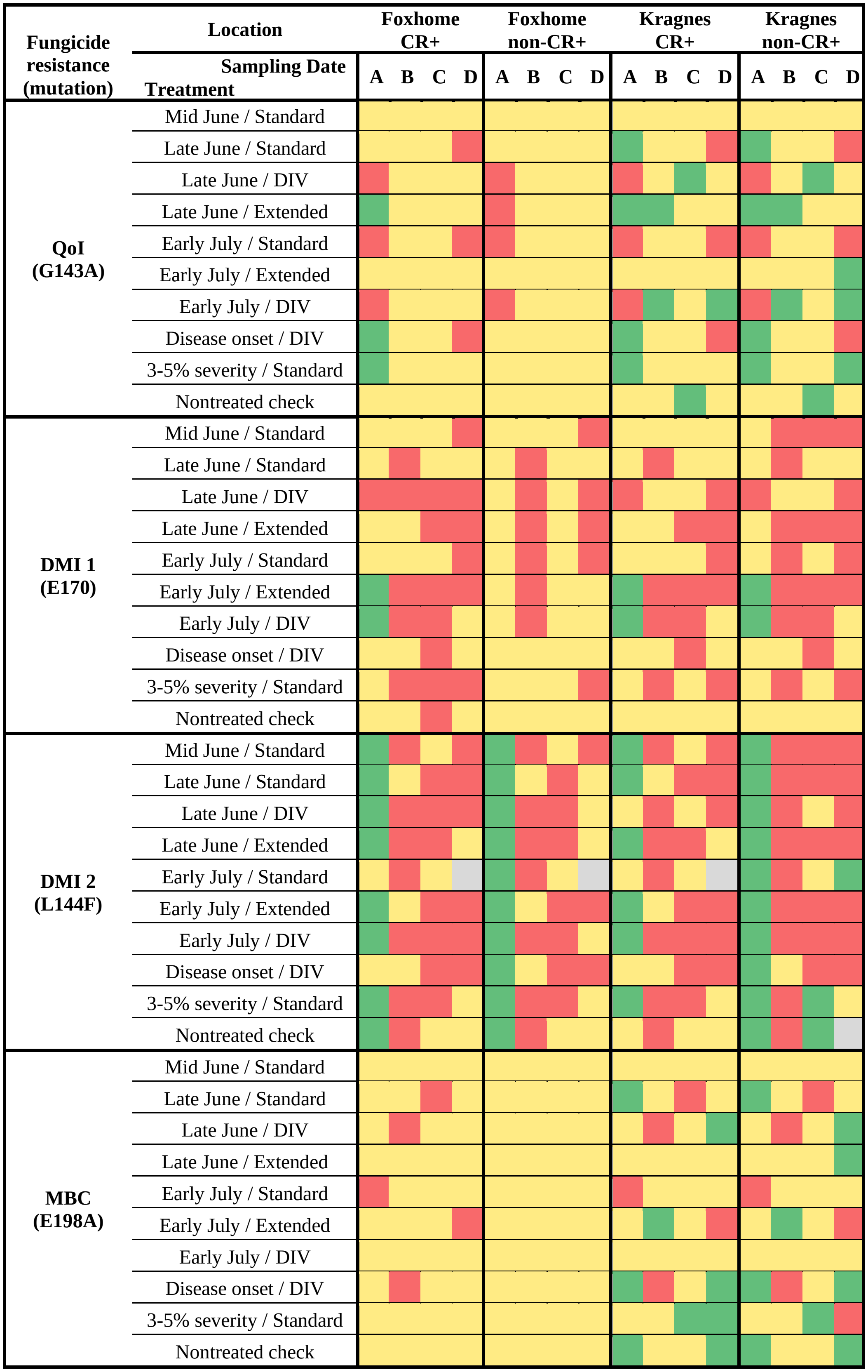

= only susceptible isolates present

= both resistant and susceptible isolates

= only resistant isolates present

[1]Sampling dates were A: 6/25; B – 7/12; C – 7/26; D – 9/5 at Foxhome and A – 7/8, B – 8/1, C – 8/13, D – 8/23 at the Kragnes location.

Figure 1. Illustration of resistance profiles based on qPCR analysis *Cercospora beticola* recovered from leaf samples collected in 2024 from multiple sugarbeet trials in Minnesota.

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EVALUATION OF SEED TREATMENTS, IN-FURROW FUNGICIDES, AND IN-FURROW BIOCONTROL AGENTS FOR CONTROL OF *RHIZOCTONIA SOLANI* IN SUGARBEET, 2024

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INTRODUCTION

For over the past decade, the most common root disease of sugarbeet in Minnesota and North Dakota diagnosed by the Sugarbeet Plant Pathology lab has been Rhizoctonia crown and root rot (RCRR) and damping-off caused *Rhizoctonia solani* AG 2-2 (Brantner and Windels 2009, 2011; Crane et al. 2013; Brantner 2015; Brantner and Chanda 2017, 2019; Lien et al. 2022; Lien et al. 2024). Environmental factors such as abundant soil moisture and warm temperatures are favorable for pathogen growth. Preemergence damping-off can lead to reduced plant emergence early in the season, while disease occurring throughout the growing season can result in reduced plant stands, root yield, and sucrose quality. Moderate to severely infected roots can also have greater sugar loss during storage and increased respiration may increase losses in nearby healthy roots as well (Campbell et al. 2013). The pathogen is presumed to be present in most agricultural soils in Minnesota and Eastern North Dakota, with more than half of survey respondents reporting that their fields were affected by RCRR in 2023 (Hakk et al. 2024). The widespread prevalence of this pathogen is likely due to its wide host range, affecting the primary crops grown in the area (e.g., soybeans, edible beans, and corn) (Windels and Brantner 2006, 2010a, 2010b). The pathogen can also survive multiple years in soil as sclerotia and infected crop residues and can be dispersed by water and soil movement (e.g., surface runoff and tare soils containing root chips and tailings). An integrated management strategy for diseases caused by *R. solani* should incorporate multiple control options, which can include rotating with non-host crops (e.g., small grains), planting partially resistant varieties, planting early when soil temperatures are cool, improving soil drainage, and applying fungicides as seed treatments, in-furrow (IF), and/or postemergence (Windels et al. 2009; Chanda et al. 2016, 2017 and 2019; Brantner and Chnada 2018 and 2020; Lien et al. 2022, 2023 and 2024). It is an industry standard for commercially available sugar beet seed to come treated with a fungicide labelled for control of *R. solani*; however, each brand offers a unique fungicide. Additionally, growers have the flexibility to choose and apply an in-furrow fungicide at the time of planting. In-furrow fungicides can provide added protection and typically have greater persistence in the soil compared to seed treatments, increasing the length of protection through the growing season. In addition, there are increased interest in the use of biocontrol agents in place of chemical control methods for their reduced environmental impact.

OBJECTIVES

A field trial was established to evaluate various at-planting fungicide treatments (seed treatment, in-furrow fungicides, and in-furrow biocontrol agents) for 1) control of early-season damping-off and RCRR and 2) effect on plant stand, yield, and quality of sugarbeet.

MATERIALS AND METHODS

The trial was established at the University of Minnesota, Northwest Research and Outreach Center (NWROC), Crookston on a Hegne-Fargo silty clay soil with an organic matter content of 4.6%. Field plots were fertilized for optimal yield and quality. A moderately susceptible variety (Crystal 793RR) with a 2-year average Rhizoctonia rating of 4.5 (Brantner and Moomjian 2023) was used. Treatments were arranged in a randomized complete block design with four replicates. Seed treatments and rates are summarized in Table 1 and were applied by Germains Seed Technology, Fargo, ND. In-furrow fungicides (Table 1) (mixed in 3 gal water) were applied down the drip tube in 6 gallons total volume/A. The nontreated control did not include any seed or in-furrow fungicide treatment that would suppress or control *Rhizoctonia*. Prior to planting, soil was infested with *R. solani* AG 2-2-infested (a mixture of four isolates) whole barley (50 kg/ha) by hand-broadcasting in plots and incorporating with an 11-ft Rau seedbed finisher. The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 10 at 4.5-inch seed spacing.

Counter 20G (7.5 lb/A) was applied at planting followed by postemergence application of Asana XL + Exponent (9.6 + 8 fl/A) on Jun 10(10 gal/A, 30 psi, Teejet 8002 nozzles) for control of sugarbeet root maggot. For the control of weeds, ethofumesate (6 pt/A) was applied before planting using a spray boom mounted to the front of the Rau seedbed finisher to incorporate the product parallel with the direction of rows, followed by Sequence (glyphosate + S-metolachlor, 8 fl oz + 2.5 pt/A) on June 12. Cercospora leaf spot was controlled by applying Inspire XT + Manzate Pro-Stick (7 fl oz + 2 lbs/A) on July 09, SuperTin 4L + Topsin 4.5FL (8 + 10 fl oz/A) on July 23, Proline 480 SC + Manzate Pro-Stick (5.7 fl oz + 2 lbs/A) on Aug 06, and SuperTin 4L + Priaxor Xemium (8 + 6.7 fl oz/A) on Aug 19.

Plant stands were evaluated beginning May 17 (7 days after planting [DAP]) through June 13 (34 DAP) by counting the number of plants in the center two rows of each plot. On Sept 17, plots were defoliated and the center two rows of each plot were harvested mechanically and weighed for root yield. Data was also collected for root rot severity and number of harvested roots immediately following harvest. Twenty roots per plot were arbitrarily selected, and root surfaces were rated for the severity of Rhizoctonia crown and root rot (RCRR) using a 0 to 10 scale with a 10% incremental increase per each unit of rating (i.e., 0=0%, 5 = 41-50%, 10=91-100%). Each rating was mid-point transformed to percent severity for statistical analysis. Ten representative roots from each plot were analyzed for sugar quality at the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN. Statistical analysis was conducted in SAS (version 9.4; SAS Institute, Cary, NC). A mixed-model analysis of variance was performed using the GLIMMIX procedure, with treatments defined as the fixed factor and replication as the random factor. Treatment means were separated based on the least square means test at the 0.10 significance level using the *emmeans* (v 1.8.7) with no adjustments. The CONTRAST statement was used to compare the means of seed treatments vs. in-furrow treatments.

Table 1. Application type, product names, active ingredients, and rates of fungicides used at planting in a field trial for control of *Rhizoctonia solani* AG 2-2 on sugarbeet.

Application[Z]	Product[Y]	Active ingredient (FRAC Group)	Rate[X]
Nontreated	-	-	-
Seed	Kabina ST	Penthiopyrad (7)	14 g a.i./unit seed
Seed	Systiva	Fluxapyroxad (7)	5 g a.i./unit seed
Seed	Vibrance	Sedaxane (7)	1.5 g a.i./unit seed
Seed	Zeltera	Inpyrfluxam (7)	0.1 g a.i./unit seed
In-furrow	AZteroid FC3.3	Azoxystrobin (11)	5.7 fl oz product/A
In-furrow	Quadris	Azoxystrobin (11)	9.5 fl oz product/A
In-furrow	Headline SC	Pyraclostrobin (11)	9.0 fl oz product/A
In-furrow	Elatus WG	Azoxystrobin (11) + Benzovindiflupyr (7)	7.1 oz product/A
In-furrow	Proline 480 SC	Prothioconazole (3)	5.7 fl oz product/A
In-furrow	Propulse	Fluopyram (7) + Prothioconazole (3)	13.6 fl oz product/A
In-furrow	Priaxor	Fluxapyroxad (7) + Pyraclostrobin (11)	6.7 fl oz product/A
In-furrow	Zironar	*Bacillus licheniformis* FMCH001 + *B. subtilis* FMCH002 (BM02)	12 fl oz product/A
In-furrow	Bexfond	*B. amyloliquefaciens* subsp. *plantarum* FZB42 (BM02)	14 fl oz product/A
In-furrow	Serenade ASO	Bacillus subtilis. (BM 02)	128 fl oz product/A

[Z] In-furrow fungicides were mixed in 3 gal water prior to mixing with 3 gal water.

[Y] Standard rates of Allegiance + Thiram and 45 g/unit Tachigaren were on all seeds.

[X] 5.7 fl oz AZteroid FC3.3 and 9.5 fl oz Quadris contain 67 and 70 g azoxystrobin, respectively; 9.0 fl oz Headline EC contain 67 g pryaclostrobin; 7.1 oz Elatus WG contains 60 g azoxystrobin and 30 g benzovindiflupyr; 5.7 fl oz Proline 480 SC contains 81 g prothioconazole; 13.6 fl oz Propulse contains 80 g each of fluopyram and prothioconazole; 6.7 fl oz Priaxor contains 33 g fluxapyroxad and 66 g pyraclostrobin

RESULTS AND DISCUSSION

The average plant populations across all treatments was 222 plants per 100 ft of row on 13 June (34 DAP). There were significant ($P = 0.0276$) differences among treatments for plant stands only on 20 May (10 DAP) in which Zironar and Bexfond had a greater number of plants than only Priaxor (Table 2). Analysis of application type showed a significant ($P = 0.0005$) difference on 20 May (10 DAP) in which the in-furrow biocontrol agents had a greater number of plants compared to the other in-furrow fungicide treatments and fungicide seed treatments, but not the nontreated control (Fig 1). By 13 June (34 DAP), seed treatments had the greatest number of plants and was significantly ($P = 0.0349$) greater than the in-furrow fungicide treatments, but not the in-furrow biocontrol agents or the nontreated control (Table 2). There were no significant differences ($P > 0.10$) among treatments for RCRR severity, percent sugar, percent sugar loss to molasses (SLM), root yield, or recoverable sucrose (Table 3). Significant differences were present for RCRR incidence in which Elatus was the lowest, but different from only Zironar and Quadris (Table 3). Analysis of application type showed significant differences for only RCRR severity and percent sugar (Table 3). Generally, in-furrow fungicide treatments resulted in the lowest RCRR severity and the in-furrow biocontrol agents resulted in the greatest sugar percentage. Overall, in-furrow biocontrol agents were safer on plant emergence compared to in-furrow fungicide treatments and seed treatments and also led to higher concentration of sugar in the roots; however, the efficacy in managing RCRR was lower than traditional in-furrow fungicide treatments.

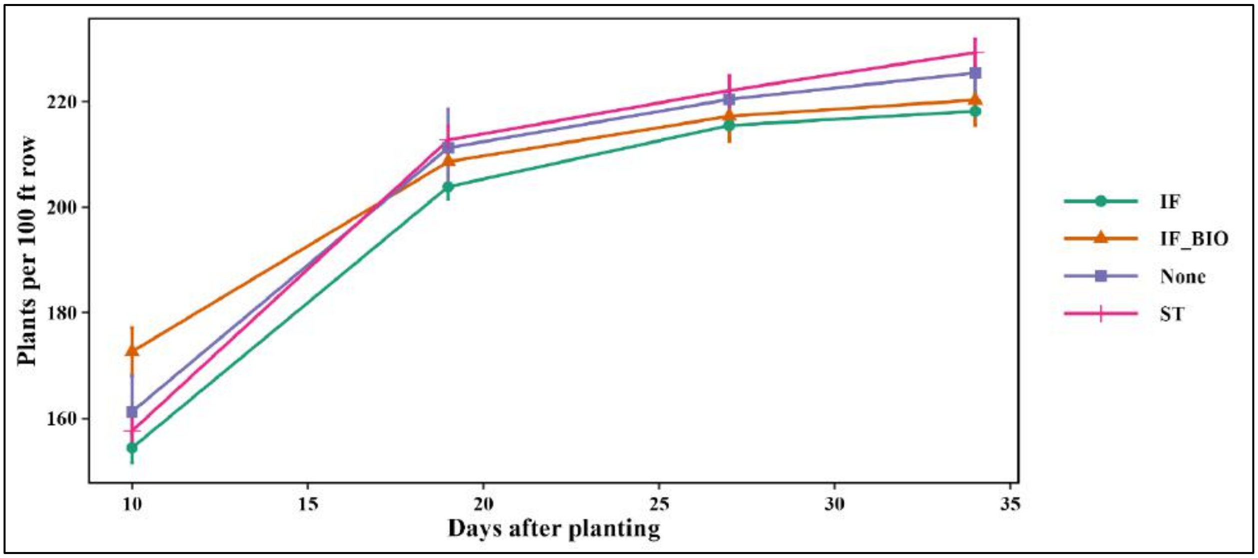

Fig. 1. Emergence and stand establishment of seed treatments (ST), in-furrow fungicides (IF), and in-furrow biocontrol agents (IF_BIO) compared to the nontreated control (None) in a sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2 in Crookston, MN planted on May 10, 2024.

Table 2. Effects of at-planting fungicide treatments on emergence and stand establishment in a *Rhizoctonia*-infested field trial planted on May 10, 2024 at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

Treatment and (rate)[z]	**Plants per 100-ft row[y]**				
	May 17 (7 DAP)[x]	**May 20 (10 DAP)[w]**	**May 29 (19 DAP)**	**June 6 (27 DAP)**	**June 13 (34 DAP)**
Nontreated Control	18	161 ab	211	220	225
Kabina ST (14 g) [v]	15	156 ab	217	232	238
Systiva XS (5 g) [v]	21	164 ab	211	215	230
Vibrance (1.5 g) [v]	14	152 ab	208	217	222
Zeltera (0.1 g) [v]	15	158 ab	214	224	227
Quadris (9.5 fl oz) [u]	19	160 ab	210	223	227
Elatus WG (7.1 oz) [u]	22	160 ab	205	219	224
AZteroid FC3.3 (5.7 fl oz) [u]	18	158 ab	206	212	216
Headline SC (9 fl oz) [u]	12	155 ab	204	216	221
Priaxor (6.7 fl oz) [u]	14	145 a	199	210	211
Proline 480 SC (5.7 fl oz) [u]	11	152 ab	202	216	218
Propulse (13.6 fl oz) [u]	16	152 ab	201	212	210
Zironar (12 fl oz) [t]	20	178 b	203	212	215
Bexfond (14 fl oz) [t]	22	175 b	213	220	224
Serenade ASO (128 fl oz) [t]	21	165 ab	210	220	222
P-value	0.0604	**0.0276**	0.8307	0.5325	0.1617

Contrast analysis of Treatment Types					
Nontreated Control	18	161 ab	211	220	225 ab
Fungicide Seed Treatments	16	158 a	213	222	229 b
In-furrow Fungicide Treatments	16	154 a	204	215	218 a
In-furrow Biocontrol Agents	21	173 b	209	217	220 ab
P-value	0.0600	**0.0005**	0.1580	0.3509	**0.0349**

[z] Treatments were applied as a seed treatment [ST] or in-furrow application [IF]; the active ingredient and FRAC group of each product is as follows: Kabina ST is penthiopyrad (7), Systiva XS is fluxapyroxad (7), Vibrance is sedaxane (7), Zeltera is inpyrfluxam (7), Elatus WG is azoxystrobin (11) + benzovindiflupyr (7), Quadris and AZteroid FC3.3 are azoxystrobin (11), Headline SC is pyraclostrobin (11), Priaxor is fluxapyroxad (7) + pyraclostrobin (11), Proline 480 SC is prothioconazole (3), Propulse is fluopyram (7) + prothioconazole (3), Zironar is *Bacillus licheniformis* FMCH001 + *B. subtilis* FMCH002 (BM02), Bexfond is *B. amyloliquefaciens* subsp. *plantarum* FZB42 (BM02), and Serenade ASO is *B. subtilis* QST713 (BM02).

[y] Plant stands based on the number of plants in the center two rows of each plot.

[x] Days after planting; DAP.

[w] Means within a column followed by a common letter are not significantly different by Estimated Marginal Means (EMMs) at the 0.10 significance level.

[v] Fungicide seed treatments; rates are per unit of seed (100,000 seeds); applied by Germains Seed Technology, Fargo, ND

[u] In-furrow fungicide treatments; rates are per acre and applied down a drip tube in 6 gallons total volume/acre.

[t] In-furrow biocontrol agents; rates are per acre and applied down a drip tube in 6 gallons total volume/acre.

Table 3. Effects of at-planting treatments on Rhizoctonia crown and root rot (RCRR) and sugarbeet yield and quality in a *Rhizoctonia*-infested field trial at the University of Minnesota, Northwest Research and Outreach Center, Crookston planted on May 10, 2024.

Treatment and (rate)[z]	Harvested Roots [y]	Plant Loss (%)[x]	RCRR Severity (%)[w,v]	RCRR Incidence (%)[u]	Sugar (%)	SLM (%)[t]	Root Yield (tons/A)	Sucrose (lb/A)[s]
Nontreated Control	200	11.6	3.7	15.0 ab	16.88	1.85	33.1	9955
Kabina ST (14 g) [r]	212	10.9	2.5	16.3 ab	16.45	2.02	34.0	9824
Systiva XS (5 g) [r]	191	16.9	2.0	8.8 ab	16.68	1.90	32.7	9662
Vibrance (1.5 g) [r]	203	9.0	2.2	6.3 ab	16.87	1.92	33.2	9907
Zeltera (0.1 g) [r]	195	14.7	3.0	15.0 ab	16.52	1.92	31.0	9051
Quadris (9.5 fl oz) [q]	199	12.9	2.9	18.8 b	16.87	1.90	32.5	9742
Elatus WG (7.1 oz) [q]	206	9.3	0.2	1.3 a	16.95	1.85	33.6	10132
AZteroid FC3.3 (5.7 fl oz) [q]	190	12.2	2.7	11.3 ab	16.65	1.91	31.0	9145
Headline SC (9 fl oz) [q]	180	19.5	2.8	10.0 ab	16.66	1.93	32.1	9494
Priaxor (6.7 fl oz) [q]	186	12.1	1.2	10.0 ab	16.88	1.85	32.5	9751
Proline 480 SC (5.7 fl oz) [q]	189	14.5	0.5	3.8 ab	17.09	1.85	30.4	9251
Propulse (13.6 fl oz) [q]	172	19.0	1.3	3.8 ab	16.93	1.93	29.3	8793
Zironar (12 fl oz) [p]	179	17.3	5.5	18.8 b	16.89	1.90	31.4	9424
Bexfond (14 fl oz) [p]	188	16.5	3.6	10.0 ab	17.30	1.80	31.3	9712
Serenade ASO (128 fl oz) [p]	188	16.2	3.5	11.3 ab	16.97	1.87	30.7	9265
P-value	0.2228	0.1924	0.3120	**0.0162**	0.5084	0.3479	0.2172	0.4678

Contrast analysis of Treatment Types								
Nontreated Control	200	11.6	3.7 ab	15.0	16.88 ab	1.85	33.1	9955
Fungicide Seed Treatments	200	12.9	2.4 ab	11.6	16.63 a	1.94	32.7	9611
In-furrow Fungicide Treatments	189	14.2	1.7 a	8.4	16.86 ab	1.89	31.6	9473
In-furrow Biocontrol Agents	185	16.7	4.2 b	13.3	17.05 b	1.85	31.1	9467
P-value	0.1194	0.3066	**0.0227**	0.1882	**0.0886**	0.1044	0.2030	0.6510

[z] Treatments were applied as a seed treatment [ST] or in-furrow application [IF]; the active ingredient and FRAC group of each product is as follows: Kabina ST is penthiopyrad (7), Systiva XS is fluxapyroxad (7), Vibrance is sedaxane (7), Zeltera is inpyrfluxam (7), Elatus WG is azoxystrobin (11) + benzovindiflupyr (7), Quadris and AZteroid FC3.3 are azoxystrobin (11), Headline SC is pyraclostrobin (11), Priaxor is fluxapyroxad (7) + pyraclostrobin (11), Proline 480 SC is prothioconazole (3), Propulse is fluopyram (7) + prothioconazole (3), Zironar is *Bacillus licheniformis* FMCH001 + *B. subtilis* FMCH002 (BM02), Bexfond is *B. amyloliquefaciens* subsp. *plantarum* FZB42 (BM02), and Serenade ASO is *B. subtilis* QST713 (BM02).

[y] Harvested roots are equal to number of roots per 100 ft of row.

[x] Plant loss percent equals 100 * (Maximum number of live plants – number of harvested roots) / (Maximum number of live plants).

[w] Percent severity of Rhizoctonia crown and root rot based on a 0 to 10 scale with a 10% incremental increase per each unit of rating (i.e., 0=0%, 5 = 41-50%, 10=91-100%). Each rating was mid-point transformed to percent severity for statistical analysis.

[v] Means within a column followed by a common letter are not significantly different by Estimated Marginal Means (EMMs) at the 0.10 significance level.

[u] Percent incidence of rated roots with > 0% of rot on the root surface.

[t] Percent sugar loss to molasses (SLM).

[s] Recoverable sucrose per acre; equal to yield*(percent sugar – percent SLM)*20.

[r] Fungicide seed treatments; rates are per unit of seed (100,000 seeds); applied by Germains Seed Technology, Fargo, ND

[q] In-furrow fungicide treatments; rates are per acre and applied down a drip tube in 6 gallons total volume/acre.

[p] In-furrow biocontrol agents; rates are per acre and applied down a drip tube in 6 gallons total volume/acre.

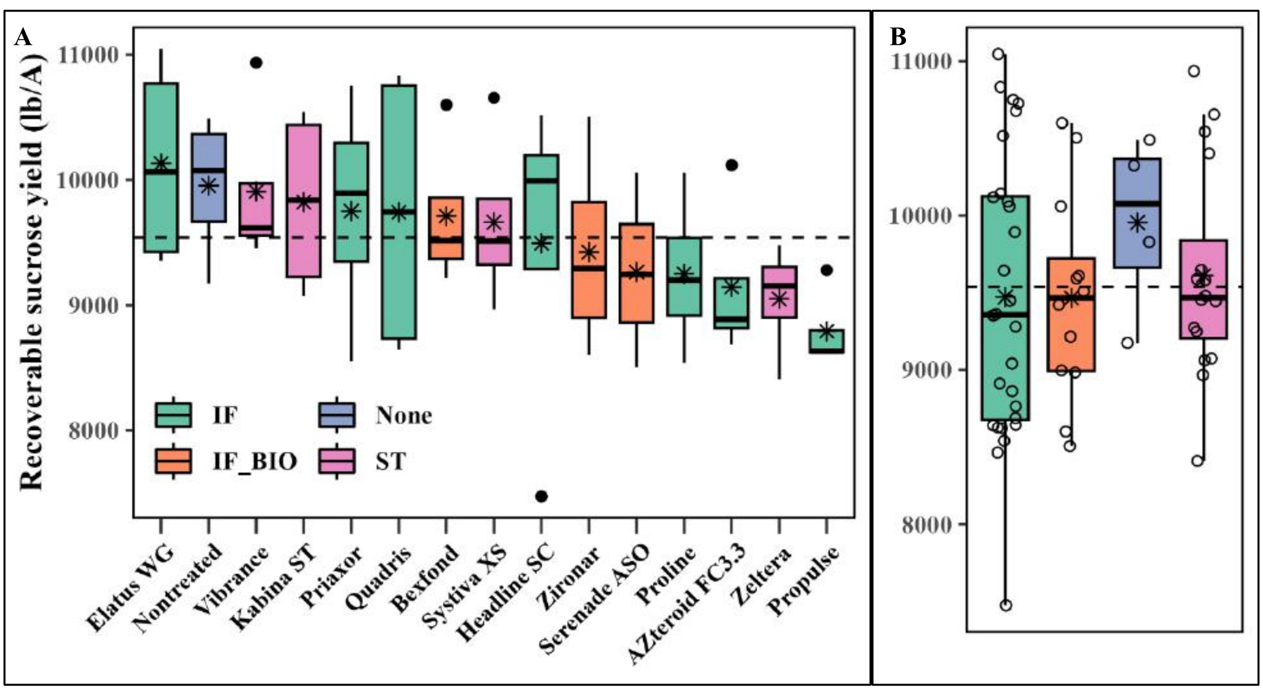

Fig. 2. Effect of at-planting treatments on recoverable sucrose (lbs/A) in sugarbeets (A) and averages by seed treatments (ST), and in-furrow fungicides (IF), in-furrow biocontrol agents (IF_BIO) compared to the nontreated control (None) (B) in a sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2 in Crookston, MN. Boxplots display the distribution of data for each treatment based (minimum, first quartile, median, third quartile, and maximum); filled dots represent outliers; hollow dots represent each data point; asterisks represent treatment means. The dashed horizontal line represents the mean of all treatments in this trial.

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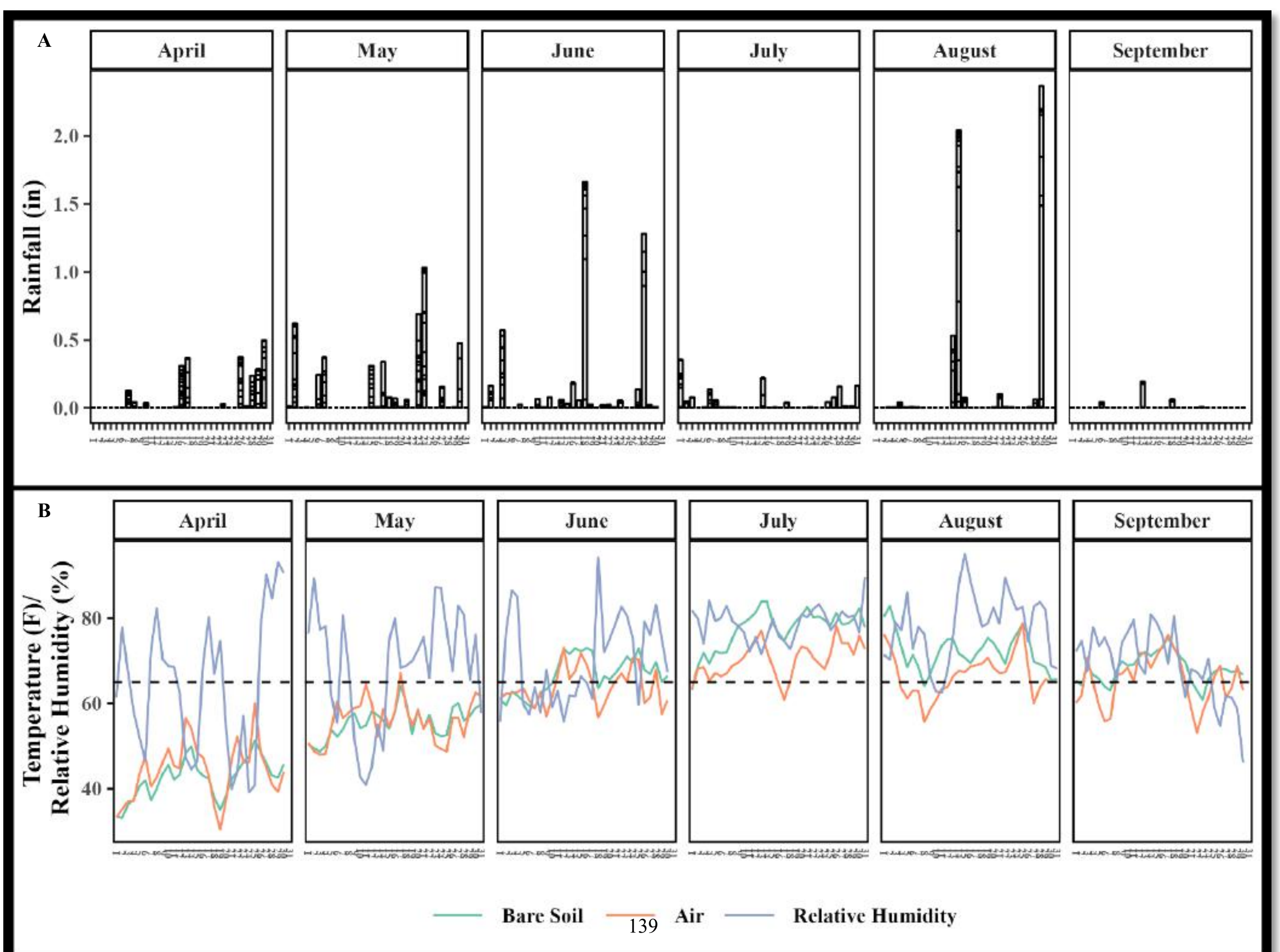
Supplementary Weather Table and Figure

Supplementary Table S1. Weather data for the 2024 growing season compared to the normal (30-year average). Data was retrieved from the Eldred North Dakota Agricultural Weather Network station (47.68769, -96.82221), located approximately 12.8 miles southwest of the Northwest Research and Outreach Center (NWROC), Crookston, MN.

	Total Rainfall (inch)		Average Air Temperature (°F)	
Month	**2024**	**Normal** [z]	**2024**	**Normal**
April	2.33	1.42	44.3	41.7
May	4.49	2.86	55.5	55.3
June	4.48	4.01	63.4	65.8
July	1.42	3.45	70.0	69.8
August	5.26	2.86	66.6	68.0
September [y]	0.31	2.03	66.0	60.2

[z] Normals are interpolated from National Weather Service (NWS) Cooperative stations (1991-2020) and are defined as the average of a variable for a continuous 3-decade (30-year) period.



Supplementary Fig. S1. Daily rainfall totals in which stacked bars represent 1-hour intervals (A) and daily mean air temperature, 4-in. bare soil

EVALUATION OF RHIZOMANIA RESISTANCE-BREAKING STRAINS OF *BEET NECROTIC YELLOW VEIN VIRUS* IN SUGARBEET FIELDS ON MINNESOTA AND NORTH DAKOTA

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Rhizomania is an economically important disease of sugarbeet that impacts sugarbeet productivity and growers' economy. The disease is caused by beet necrotic yellow vein virus (BNYVV), an RNA virus that belongs to the family *Benyvirus* (Tamada and Baba, 1973). The BNYVV is transmitted by *Polymyxa betae* a soilborne organism of sugarbeet. In the USA, rhizomania was first identified in the early 1980s and within a few years had spread to all sugarbeet production areas (Duffus, 1984; Wisler et al. 1997). The disease is managed through resistance genes, *Rz1* and other sources of resistance, that were introduced to the commercial cultivars. In a few years, the *Rz1*-mediated resistance has been compromised with the appearance of resistance-breaking strains of BNYVV. The appearance of rhizomania disease started as blinkers and later spreading to large diseased area in fields planted with *Rz1* resistance carrying cultivars (Scholten et al. 1996). Further research indicated that the ability for BNYVV overcoming the *Rz1*-mediated resistance was mapped to BNYVV RNA 3, to a highly variable 'tetrad' amino acid of the p25 gene. A recent survey on the distribution and prevalence of BNYVV strains and p25 mapping in North Dakota and Minnesota area revealed no correlation between the p25 tetrad signature and the ability to compromise *Rz1*-mediated resistance (Weiland et al., 2019).

Though the rhizomania disease is managed by host resistance introduced into commercial cultivars, symptoms of rhizomania are being observed in sugarbeet production fields indicating the appearance of resistance-breaking (RB) variants of BNYVV. Identification of the RB-variants of BNYVV is important for developing new disease management strategies for the future. Next-generation high-throughput sequencing (HTS) is a powerful technology that can provide the sequence information of known and unknown viruses. Rhizomania suspicious sugarbeet fields were identified and soil samples were collected. The soil samples were evaluated for rhizomania resistance breaking in soil-bating assays with susceptible, *Rz1*, and *Rz1* plus *Rz2* seeds under laboratory conditions. Virus detection was accomplished using ELISA specific for BNYVV. Then, application of HTS to identify the changes in the nucleotide sequences of BNYVV to understand the RB-variants in comparison to nonresistance-breaking strains of BNYVV. Identification of the nucleotide changes and the associated amino acids will allow the characterization of the resistance-breaking variants of BNYVV.

Materials and Methods

Survey of rhizomania disease was conducted in coordination with agriculturists and cooperatives of Minnesota and North Dakota sugarbeet growing areas: American Crystal Sugar Company, Minn-Dak Farmers' Cooperative, and Southern Minnesota Beet Sugar Cooperative. Soil samples were collected from around the roots of sugarbeet plants those are suspicious for rhizomania disease from the fields of Minnesota and North Dakota. The sugarbeet seeds with different genotypes were kindly provided by the seed company, SESVandeHave. Soil-baiting assay was carried out as follows: sugarbeet plants were grown in a greenhouse under standardized conditions at 24°C/18°C day/night with 8 hours of supplemental light per day, and water was added directly as needed. Six weeks after planting in infested soil, plants were harvested and root sample consisting of three to four plants was taken from each pot.

Roots were washed gently in a tray containing water taking care to retain fine root hairs, damp dried on paper towel and stored for ELISA testing of BNYVV or stored at -80°C until used for RNA extraction and library construction to accomplish high-throughput sequencing. Roots from soil-bait plants were carefully collected and washed gently to remove tare attached to it. After damp drying, a portion of it was ground in ELISA extraction buffer in a volume of 600 uL and loaded 150 uL in one well of ELISA plate in three replicates. Each ELISA plate was included with a positive and negative controls to confirm the assay reagents in the diagnosis.

Results and Discussion

Rhizomania disease prevalence was monitored in the sugarbeet growing area of Minnesota and North Dakota in collaboration with the cooperatives and agriculturists of sugarbeet industries. Rhizomania symptoms were observed and soil samples from that locations were collected from multiple sugarbeet fields of Minnesota and North Dakota. Resistance-breaking was evaluated in soil-baiting assay by growing sugarbeet varieties such as susceptible, Rz1, and Rz1Rz2 seeds. ELISA detection of BNYVV in the root tissue of bait-plants reveals the detection of rhizomania. The presence of BNYVV only in the susceptible and not in the Rz1 andRz1Rz2 varieties indicate that the soil has rhizomania. In contrast, if BNYVV was detected in the resistance varieties including the susceptible indicate that the soil has resistance-breaking strains of BNYVV. Out of 34 soil samples, BNYVV was detected in 14 samples, among those 13 soil samples showed positive for BNYVV in the Rz1 variety, and only 5 samples turned out to be Rz1Rz2 positive indicating the presence of BNYVV that can overcome the host resistance (Table 1). The ELISA assay was conducted in three replicates and an average was used for analysis. After completing the analysis, rhizomania resistance-breaking evaluation results were communicated to cooperatives that can be used for making informed decision such as crop rotation, cultural practices, and varietal selection. In summary, evaluation of rhizomania resistance-breaking in field soil samples will provide important information to growers to make informed decisions on disease management strategies.

Table 1. Evaluation of rhizomania resistance-breaking. Detection of BNYVV was carried out using ELISA. In the table symbol ++ refers to highly positive for BNYVV, + symbol stands for moderately positive for BNYVV, +/- slightly positive, and – symbol denotes negative for BNYVV.

Sam ID#	Soil samples	Susceptible	Rz1	Rz1+Rz2	Location
128	Rhizo	-	-	-	ND
143	Rhizo	-	-	-	MN
144	Rhizo	++	++	-	MN
145	Rhizo	+	+	-	MN
146	Rhizo	-	-	-	MN
148	Rhizo	++	++	++	MN
150	Rhizo	++	++	+	MN
151	Rhizo	++	++	+	MN
153	Rhizo	++	+	+	MN
156	Healthy	-	-	-	ND
157	Rhizo	+	+	-	ND
158	Rhizo	+	+/-	-	ND
160	Rhizo	+	+	-	ND
161	Rhizo	+/-	+/-	-	ND
162	Rhizo	-	-	-	ND
163	Rhizo	-	-	-	ND
165	Rhizo	++	++	++	ND
166	Healthy	-	-	-	ND
167	Rhizo	-	-	-	ND
169	Rhizo	+	-	-	ND
170	Rhizo	+/-	+/-	-	ND
172	Rhizo	-	-	-	MN
173	Rhizo	+/-	+/-	-	MN
174	Rhizo	-	-	-	MN
175	Rhizo	-	-	-	MN
176	Rhizo	-	-	-	MN

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EVALUATION OF POSTEMERGENCE FUNGICIDES AND APPLICATION METHOD ON SUGAR BEET FOR CONTROL OF RHIZOCTONIA CROWN AND ROOT ROT, 2024

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Rhizoctonia crown and root (RCRR), caused by *Rhizoctonia solani* AG 2-2, is a major root disease of sugarbeet in Minnesota and North Dakota (Brantner and Windels 2009, 2011; Crane et al. 2013; Brantner 2015; Brantner and Chanda 2017, 2019; Lien et al. 2022 and 2024). Management of damping-off caused by *R. solani* is primarily achieved through the use of seed treatments on commercially available seed and the application of in-furrow fungicides at the time of planting. Regardless of the at-planting method used, efficacy is likely to last only a few weeks after planting. In addition, RCRR can cause significant loss of plants, root yield, and sucrose quality throughout the growing season, especially when warm and wet soils provide conditions conducive for the pathogen's development. Planting sugarbeet varieties that are tolerant to RCRR is a key management strategy, especially when *R. solani* has been an issue in the past. However, resistance to *R. solani* in sugarbeet is age-dependent and all varieties are susceptible to disease for the first few weeks after planting (Liu et al. 2019). Postemergence fungicides often can often provide added protection beyond at-planting methods when applied at the 4- to 8-leaf stage and result in the reduction of root rot and prevention of yield loss (Windels et al. 2009; Chanda et al., 2016, 2017, 2018, 2019, 2020 and 2021). Currently, a limited number of field trials have compared fungicides labelled for postemergence management of RCRR and it is unclear if efficacy is reduced when fungicides are applied as a broadcast application compared to a 7-in. band.

OBJECTIVES

A field trial was established to evaluate various postemergence fungicide treatments as a 7-in. band or broadcast application for 1) control of early-season damping-off and RCRR and 2) effect on plant stand, yield, and quality of sugarbeet.

MATERIALS AND METHODS

The trial was established at the University of Minnesota, Northwest Research and Outreach Center (NWROC), Crookston on a Hegne-Fargo silty clay soil with an organic matter content of 4.6 %. Field plots were fertilized in the fall for optimal yield and quality. A moderately susceptible variety (Crystal 793RR) with a 2-year average Rhizoctonia rating of 4.5 (Brantner and Moomjian 2023) was used. All seeds were treated with standard rates of Allegiance, Thiram, Tachigaren (45g/unit), and Kabina (14g/unit). Treatments were arranged in a randomized complete block design with four replicates. The trial was sown in six-row plots (22-in. row spacing, 30-ft rows) with a 4.5-in. seed spacing on May 06 with a Monosem NG plus planter. XLR-rate starter fertilizer (7-23-5) was applied in-furrow at a rate of 3 gal/A with a total application volume of 6 gal/A. Counter 20G (7.5 lb/A) was applied at planting followed by postemergence application of Asana XL + Exponent (9.6 + 8 fl/A) on Jun 10(10 gal/A, 30 psi, Teejet 8002 nozzles) for control of sugarbeet root maggot. For the control of weeds, ethofumesate (6 pt/A) was applied before planting using a spray boom mounted to the front of the Rau seedbed finisher to incorporate the product parallel with the direction of rows, followed by Sequence (glyphosate + S-metolachlor, 8 fl oz + 2.5 pt/A) on June 12. Cercospora leaf spot was controlled by applying Inspire XT + Manzate Pro-Stick (7 fl oz + 2 lbs/A) on July 09, SuperTin 4L + Topsin 4.5FL (8 + 10 fl oz/A) on July 23, Proline 480 SC + Manzate Pro-Stick (5.7 fl oz + 2 lbs/A) on Aug 06, and SuperTin 4L + Priaxor Xemium (8 + 6.7 fl oz/A) on Aug 19.

Fungicides (see Table 1) were applied on June 20 (8-10 leaf stage) to the center four rows within plots with an application volume of 10 gal/A using a CO_2 sprayer with TeeJet 8002 flat fan nozzles. Fungicide treatments were evaluated as both a 7-in band and a broadcast application. Following the appropriate re-entry intervals, the center four rows within each plot were inoculated on June 20 at a rate of 0.71 oz/row by spreading ground *R. solani*-infested barley directly over the sugarbeet crowns. Two isolates of *R. solani* AG 2-2 IIIB and two isolates of *R. solani* AG 2-2 IV were used to colonize autoclaved barley grains; barley infested with each isolate was then air-dried and mixed. Prior to inoculation, barley was ground using a Wiley mill and passed through a 3mm sieve. Plant stands were evaluated on June 21 (46 days after planting) by counting the number of live plants in the center two rows of each plot. On September 12, plots were defoliated, the center two rows of each plot were harvested and weighed for root yield, and ten representative roots from each plot were analyzed for sugar quality at the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN. Following harvest, twenty roots per plot were arbitrarily selected and rated for the severity of root rot, and the remaining number of harvested roots were counted. RCRR severity was based on a 0 to 10 scale with a 10% increase per unit of rating (i.e., 0 = no visible rot, 1 = 1-10%, 5 = 41-50%, 10 = 91-100%). Each rating was mid-point transformed to percent severity for statistical analysis. Statistical analysis was conducted in R (v 4.3.1). A mixed-model analysis of variance was performed using *lmerTest* (v 3.1-3), with treatment defined as the fixed factor and replication as the random factor. Estimated marginal means (EMMs) were separated at the 0.10 significance level with no adjustments and contrast analysis of EMMs were performed using *emmeans* (v 1.8.7).

RESULTS AND DISCUSSION

Near the trial site, 2.03 in. of rainfall was recorded following fungicide applications and inoculation, which provided favorable conditions for moderate disease pressure. There were significant differences among treatments for the percent plant loss ($P = 0.0215$) in which the nontreated control was the greatest and higher than both the Excalia treatments, AZteroid FC3.3 7-in. band, AZterknot 7-in. band, and Proline 480 SC 7-in band (Table 1). Significant ($P < 0.0001$) differences among treatments were also present for severity and incidence of RCRR where all fungicide treatments resulted in lower disease than the nontreated control (Table 1). Significant ($P = 0.0010$) differences were present for percent sugar, in which the nontreated control was the lowest and different than both Elatus WG treatments which was the greatest (Table 1). There were no significant differences ($P > 0.10$) in the number of harvested roots, sugar loss, root yield, or recoverable sucrose yield. However, there were numerical differences in which the nontreated control resulted in the lowest number of harvested roots, root yield and recoverable sucrose yield. When comparing the means of the 7-in. band applications vs. the broadcast applications according to the contrast analysis, RCRR incidence was greater for the broadcast treatments (Table 1). Overall, both 7-in. band applications and broadcast applications reduce the severity and incidence of RCRR; however, 7-in. band applications may provide a greater level of control than broadcast applications in years with moderate to high disease pressure.

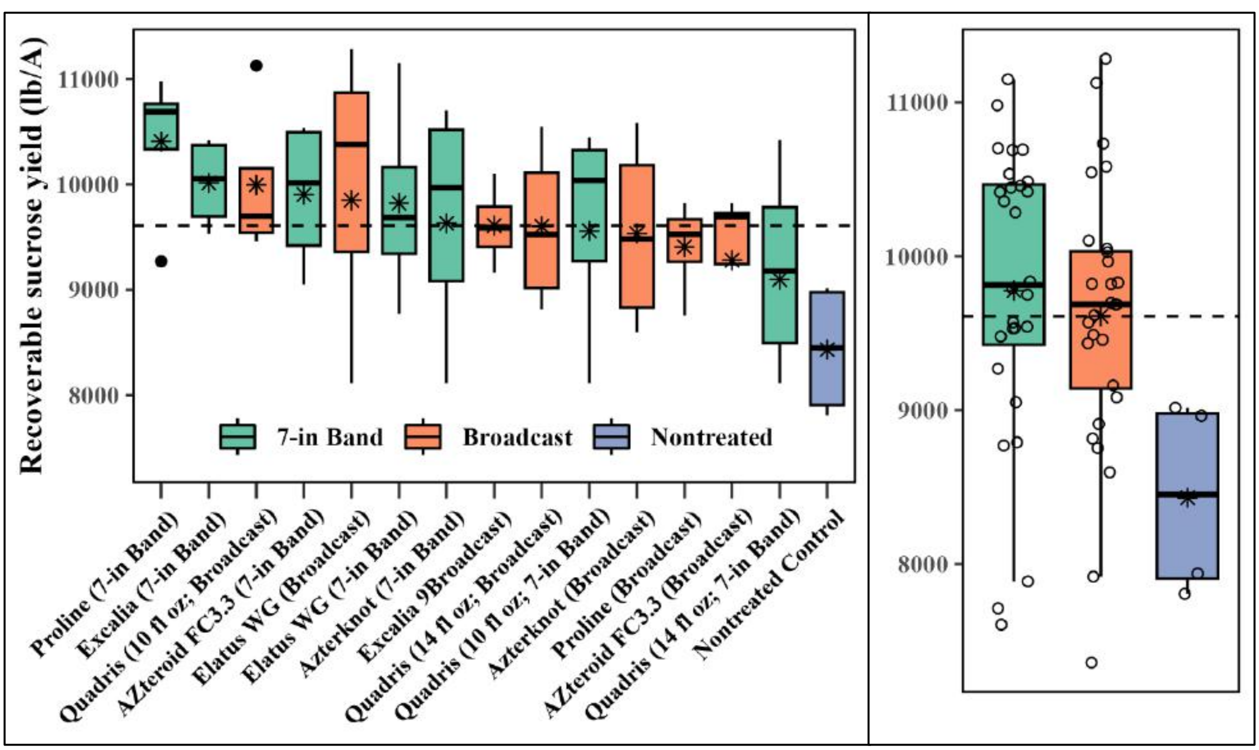

Fig. 1. Effect of postemergence fungicide treatments on recoverable sucrose (lbs/A) in sugarbeets (A) and averages of 7-in. band applications and broadcast applications compared to the nontreated control (B) in a sugarbeet field trial inoculated with *Rhizoctonia solani* AG 2-2 in Crookston, MN. Boxplots display the distribution of data for each treatment (minimum, first quartile, median, third quartile, and maximum); filled dots represent outliers, hollow dots represent each data point; asterisks represent treatment means. The dashed horizontal line represents the mean of all treatments in this trial.

Table 1. Effects of postemergence fungicide treatments applied as either a 7-in band or broadcast application on Rhizoctonia crown and root rot and sugarbeet yield and quality in a field trial inoculated with *Rhizoctonia solani* at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

Treatment and (rate/acre) [z]	Harvested Roots [y]	Plant Loss (%)[x,w]	RCRR Severity (%)[v]	RCRR Incidence (%)[u]	Sugar (%)	SLM (%)[t]	Yield (tons/A)	Sucrose (lb/A)[s]
Nontreated	172	24.7 b	16.7 b	37.5 c	16.13 a	1.88	29.6	8432
Elatus WG (7.1 oz) [r]	203	12.0 ab	0.3 a	2.5 ab	17.10 b	1.75	32.0	9823
Elatus WG (7.1 oz) [q]	203	12.1 ab	0.1 a	1.3 ab	17.09 b	1.82	32.3	9851
Excalia (0.64 fl oz) [r]	204	7.2 a	0.0 a	0.0 a	16.61 ab	1.81	33.9	10014
Excalia (2 fl oz) [q]	203	8.7 a	0.3 a	1.3 ab	16.32 ab	1.83	33.2	9610
Quadris (10 fl oz) [r]	189	18.0 ab	0.1 a	1.3 ab	16.34 ab	1.80	32.9	9559
Quadris (10 fl oz) [q]	199	12.3 ab	1.0 a	3.8 ab	16.34 ab	1.78	34.4	9996
Quadris (14.5 fl oz) [r]	203	12.2 ab	0.5 a	3.8 ab	16.29 ab	1.83	31.4	9097
Quadris (14.5 fl oz) [q]	201	9.3 ab	0.4 a	1.3 ab	16.31 ab	1.84	33.3	9603
AZteroid FC[3.3] (9.2 fl oz) [r]	208	3.6 a	0.0 a	0.0 a	16.18 ab	1.79	34.4	9904
AZteroid FC[3.3] (9.2 fl oz) [q]	194	12.2 ab	0.3 a	2.5 ab	16.22 ab	1.86	32.3	9281
AZterknot (16.6 fl oz) [r]	198	7.8 a	0.3 a	1.3 ab	16.41 ab	1.83	33.0	9632
AZterknot (16.6 fl oz) [q]	186	12.4 ab	1.7 a	6.3 ab	16.25 ab	1.83	33.1	9534
Proline 480 SC (5.7 fl oz) [r]	210	6.3 a	0.5 a	2.5 ab	16.92 ab	1.75	34.3	10408
Proline 480 SC (5.7 fl oz) [q]	196	10.4 ab	2.9 a	10.0 b	16.46 ab	1.83	32.1	9407
P- value	0.2543	**0.0215**	**<0.0001**	**<0.0001**	**0.0010**	0.8778	0.6347	0.4562
Contrast analysis of 7-in. Band Treatments vs. Broadcast Treatments								
7-in. Band	202	9.6	0.2	1.6	16.55	1.80	33.1	9777
Broadcast	197	11.1	1.0	3.8	16.43	1.83	32.9	9612
P- value	0.3041	0.4142	0.2704	**0.0670**	0.2560	0.2237	0.8125	0.5013

z The active ingredient and FRAC group of each treatment follows: Excalia SC is inpyrfluxam (7), Quadris and AZteroid FC[3.3] is azoxystrobin (11), Proline 480 SC is prothioconazole (3), AZterknot is azoxystrobin (11) + extract of *Reynoutria sachalinensis* (P 05), and Elatus WG is azoxystrobin (11) + benzovindiflupyr (7)

y Harvest roots are equal to number of roots per 100 ft of row.

x Plant loss percent equals 100 * (live plants per 100 ft row on 21 Jun [46 DAP] – number of harvested roots) / live plants per 100 ft row on 21 Jun [46 DAP]

w Means within a column followed by a common letter are not significantly different by Estimated Marginal Means (EMMs) at the 0.10 significance level.

v Percent severity of Rhizoctonia crown and root rot based on a 0 to 10 scale with a 10% incremental increase per each unit of rating (i.e., 0=0%, 5 = 41-50%, 10=91-100%). Each rating was mid-point transformed to percent severity for statistical analysis.

u Percent incidence of rated roots with > 0% of rot on the root surface.

t Percent sugar loss to molasses (SLM).

s Recoverable sucrose per acre; equal to yield*(percent sugar – percent SLM)*20.

r 7-inch band application

q Broadcast application

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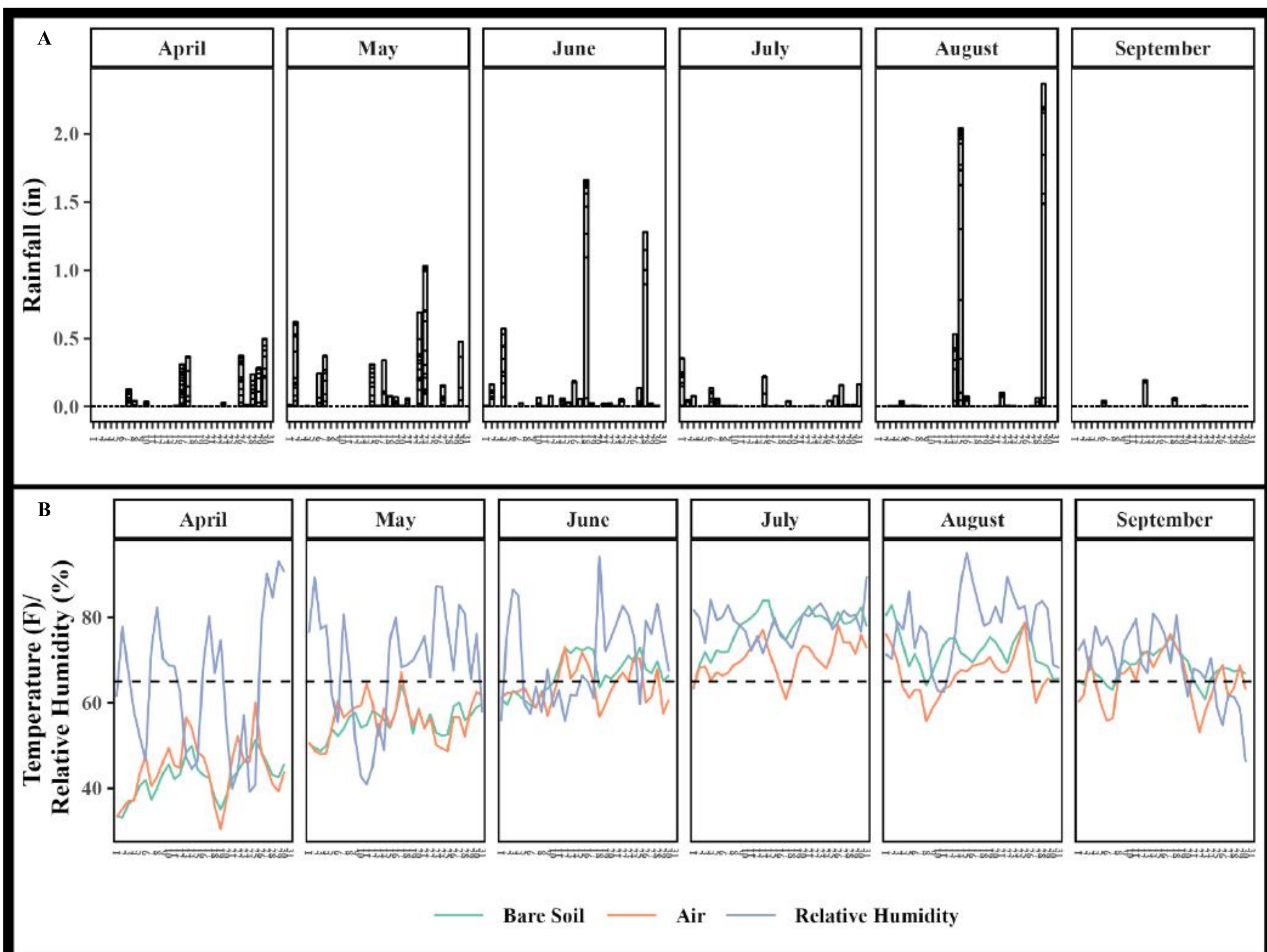
Supplementary Weather Table and Figure

Supplementary Table S1. Weather data for the 2024 growing season compared to the normal (30-year average). Data was retrieved from the Eldred North Dakota Agricultural Weather Network station (47.68769, -96.82221), located approximately 12.8 miles southwest of the Northwest Research and Outreach Center (NWROC), Crookston, MN.

	Total Rainfall (inch)		Average Air Temperature (°F)	
Month	**2024**	**Normal [z]**	**2024**	**Normal**
April	2.33	1.42	44.3	41.7
May	4.49	2.86	55.5	55.3
June	4.48	4.01	63.4	65.8
July	1.42	3.45	70.0	69.8
August	5.26	2.86	66.6	68.0
September [y]	0.31	2.03	66.0	60.2

[z] Normals are interpolated from National Weather Service (NWS) Cooperative stations (1991-2020) and are defined as the average of a variable for a continuous 3-decade (30-year) period.



Supplementary Fig. S1. Daily rainfall totals in which stacked bars represent 1-hour intervals (A) and daily mean air temperature, 4-in. bare soil temperature, and relative humidity (B) for the 2024 growing season recorded 12.8 miles southwest of Crookston, MN. The dotted horizontal line represents 65°F.

SOIL MANAGEMENT PRACTICES

EVALUATION OF NITROGEN FERTILIZER TECHNOLOGIES AND FERTILIZER TIMING FOR SUGAR BEET PRODUCTION

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Justification: Nitrogen is the single most researched nutrient for sugar beet as nitrogen is the nutrient most likely to limit production. Numerous trials in Minnesota and North Dakota have been conducted studying nitrogen rate and the impact of residual nitrate on sugar beet yield and quality. Most of these studies have included spring nitrogen rates usually applied as urea. Nitrogen suggestions assume the same amount of N is required for fall versus spring application on N if best management practices are followed. As nitrogen is applied in the fall in some cases, more research needs to be conducted to determine if fall application of nitrogen can continue to be an acceptable practice.

While spring application of nitrogen is generally suggested for most crops to limit the potential for spring N losses, wet springs present challenges to plant crops at optimal times amid getting fertilizer applied and fields prepared for planting. Fall application of all fertilizer is advantageous to limit the number of field operations which must be completed prior to planting. Current nitrogen best management practices for much of the sugar beet growing regions in Minnesota maintain fall nitrogen application as an acceptable practice. Anhydrous ammonia is the source of nitrogen encouraged for use in the fall due to the impacts anhydrous ammonia has on soil nitrifying bacteria. Fall application of urea has been considered acceptable in Western and Northwestern Minnesota but the practice is being increasingly questioned due to increased rainfall in areas presenting a greater risk for nitrogen loss.

Urea and anhydrous ammonia when applied to the soil both result in the accumulation of ammonia and ammonium in the soil. Urea differs in that it must be hydrolyzed by the enzyme urease before ammonium is forms. The urease enzyme is ubiquitous in soils and hydrolysis of urea can be rapid if the appropriate conditions exist in the soil. Since urea does not impact soil microorganisms the same as anhydrous ammonia the conversion of urea can be quicker presenting greater risks for nitrate loss while shallow application can present volatility issues also representing a potential loss for the product. More recent data collected from multiple locations in Western Minnesota has shown a significant yield penalty for identical rates of nitrogen applied to corn in the fall versus in the spring. The corn yield penalty is greater when corn follows corn which could be partially due to immobilization of nitrogen by the corn residue. With typical rotations of sugar beet following corn a comparison of fall versus spring nitrogen applied as urea is needed to determine the efficiency of fall versus spring application or urea to determine if changes to nitrogen best management practices are warranted, or if sugar beet differs enough where fall urea can still be an acceptable practice even if it is not suggested for corn.

Nitrification inhibitors are currently available to be used for urea which could limit the potential for nitrate accumulation in the soil profile. Research with N-serve applied with anhydrous ammonia has demonstrated that nitrapyrin is an effective nitrification inhibitor. The primary nitrification inhibitor for urea historically was dicyandiamide (DCD). Mobility of the DCD molecule has led to inconsistent results with this product. More recently Dow has released Instinct which is an encapsulated nitropyrin product for use with urea. Research has shown no overall benefit for Instinct applied with broadcast urea for corn, but the product is still sold to growers with a promise of reducing nitrogen loss from fall urea applications. Inhibitor research is needed in sugar beet production to determine if the additional cost of the products justifies their use for fall application.

Polymer coated urea is available in Minnesota as the product ESN. Polymer coated urea differs from inhibitors as the polymer coating provides a barrier which slows the release of nitrogen to the soil. Water moves into the polymer coating dissolving urea which then diffuses through the coating into the soil. The rate of release of urea through the polymer coating is related to soil moisture and temperature. Cool or dry soils can limit release subsequently resulting in a deficiency of nitrogen for the plant even through there may be adequate nitrogen in the soil for the crop. The lack of predictability of release and higher cost of the product has resulted in polymer coated urea suggested for application as a blend rather than 100% of the nitrogen required applied as ESN. However, ESN has been demonstrated as being effective at limiting nitrogen loss in high loss environments and thus may be better suited for fall application than urea treated with an inhibitor. Data reporting fall application of polymer coated products on sugar beet is scare and is needed to determine if this practice is better and what the optimal blend rate may be.

Objectives:

1. Evaluate nitrogen fertilizer requirement for sugar beet.
2. Compare the efficiency of fall versus spring application of urea for the southern and northern growing region through impacts on root yield and sugar content.
3. Determine if polymer coated urea (ESN) blends with urea results in greater root yield and recoverable sugar per acre when applied in the fall.
4. Determine if root yield and recoverable sugar are greater when commercially available nitrification and/or urease inhibitors marketed for use with urea when applied in the fall.

Materials and Methods: Two field locations were established in at new locations in Fall 2020, 2021, 2022, and 2023 (Table 1). Each year, one of the field trials was in the northern growing region at the Northwest Research and Outreach Center at Crookston following wheat in 2021 and 2022 and soybean in 2023 and 2024. The second location was an on-farm trial location in the southern growing region following corn near Hector in 2021, near Renville in 2022 and 2023, and near Raymond in 2024. There are two separate studies at each location.

Study 1 consists of six N rates at Crookston (0 to 200 lbs) and eight in the southern region (0 to 210 lbs). All N is applied as urea in the fall and in the spring. Trials consist of a split plot design where main plots consist of N rate and sub-plots within each main plot will be N timing such that the same rate can be applied side by side for comparison. Fall application are targeted to the end of October or when the soil has stabilized below 50°F and incorporated as soon as possible after application. Spring fertilizer application was made just prior to- and incorporated before planting (Table 2).

Study 2 consists of multiple fertilizer sources applied at a sub-optimal N rate applied in fall and spring. The target rate was 45 lbs of N only which, including the four-foot nitrate test, the total N should account for roughly two-thirds to three quarters of the suggested N needed for sugar beet production. The 45 lb rate was not meant to represent an optimal rate of N applied to sugarbeet. Rather, the 45 lb N rate should be on the more responsive part of the N response curve allowing for easier detection of smaller differences related to N availability from the sources used. A split plot design is used for the source trial where main plots will consist of N source and sub-plots will be time of application.

N sources consist of:

1. 0 N control
2. Urea only
3. 33% ESN/66% urea
4. 66% ESN/33%urea
5. 100% ESN
6. Super U [NBPT (urease inhibitor) +DCD (nitrification inhibitor)]
7. Agrotain (urease inhibitor) – 0.45 qt/ton (low rate similar to the NBPT rate in Super U)
8. Anvol (urease inhibitor) – 1.5 qt/ton
9. Instinct (nitrification inhibitor) – 24 oz/ac
10. Ammonium sulfate

Initial site-composite soil samples were collected from each study at each location to a depth of four feet. A summary of soil test information is given in Table 2. Stand counts were taken early in the growing season to assess phytotoxicity of the urea rates and sources. In season plant tissue samples are collected near the end of June to early July depending on planting date. Leaf blade and petiole samples are collected, and extractable nitrate-N is determined in Dr. Kaiser's lab following extraction with water or 2% acetic acid. Petiole and leaf blade samples are additionally sent out to a private lab for total N analysis by dry combustion. The uppermost fully developed leaf blade and petiole were sampled which is consistent with what is suggested for petiole nitrate analysis. Plots were harvested at the end of the growing season and root samples will be analyzed for quality parameters.

A single variety is planted at each location and differed by location. All practices, weed and disease control, planting, and tillage will be consistent with common practices for the growing regions. Additional P, K, and S is applied as needed based on current fertilizer guidelines.

Results

A summary of the main effect significance is given in Table 3a, 3b, 3c, and 3d for the urea rate trial and Table 4a, 4b, 4c, and 4d for the urea source trial for the 2021, 2022, 2023, and 2024 growing seasons, respectively. Figures 1 through 5 summarize sugar beet response to N for the rate trials only. Data are summarized across all rate or treatments when the statistical analysis indicated no N rate or source by time interaction for a given locations. The summary of the main effect of time for the rate and source trials is given in Table 5a, 5b, 5c, and 5d for 2021, 2022, 2023, and 2024respectively.

An application error resulted in the loss of all fall treatments for the urea source trial at Crookston 2021. The spring treatments were applied as planned and the source main effect at Crookston only summarizes the spring treatments. There was also a misapplication of treatments at the Renville 2022 site. I am still sorting through the treatments to know what can be used so none of the Renville 2022 data are reported other than the petiole nitrate data will be summarized in the graph comparing petiole nitrate-N to relative root yield. All 2023 data were collected as planned.

Sugar beet emergence was significantly impacted by N rate at nearly all locations (Tables 3a to 3d and Figure 1a to 1d). Sugar beet emergence was less as the rate of N applied as spring urea increased. Fall urea had a slight impact on sugarbeet emergence in some cases but the impact was mostly seen in the fall with the highest rates of urea application. When decreased, sugarbeet emergence decreased linearly as fertilizer rate increased. Emergence was poor at Crookston in 2022 (Tables 3b and Figure 1b) but nitrogen rate and timing did not impact emergence at this location.

Urea source impacted emergence at both locations (Table 6a) in 2021, but seldom affected emergence in future years. In 2021, all sources reduced emergence at Crookston while emergence was greater for most urea sources compared to the control at Hector. Due to the differences in response between the two locations, the ranking of sources generally differed except for urea treated with instinct which resulted in the lowest emergence of all treatments. Urea sources did not impact emergence at Crookston in 2022 (Table 6b). The lack of impact of sources on sugar beet emergence is not unexpected as only 45 lbs of N were applied which may have not been enough N to impact emergence.

Sugar beet root yield as impacted by N application rate at Hector but not at Crookston and time was not significant at either site (Table 3a). Root yield responded to 130 lbs of total N (applied N plus nitrate-N in a four-foot soil sample) at Hector (Figure 2a). Dry soils at Crookston resulted in less and more variable root yield. If root yield did vary by N rate the likely would not have been any additional yield produced passed around 120 lbs of total N at Crookston. The fact that timing of application did not impact root yield likely resulted from the dry soils and a lack of potential for leaching of nitrate.

Root yield was not impacted by nitrogen rate and timing at Crookston in 2022 (Table 3b). Residual nitrate in the soil in Fall of 2021 was extremely high (Table 2). No- or very little nitrogen would be suggested based on the fall four-foot soil nitrate test at Crookston.

Root yield was highly affected by N rate in 2023 at both locations (Table 3c and Figure (2c). Residual nitrate in the soil profile was relatively low at both locations (Table 2). Time of application was significant at Crookston. However, the fall urea application tended to outyield the spring application. It is not clear why the fall application of urea produced greater root yield but it could be due to shallow incorporation of urea in dry soils. It also took less N to maximize root yield when urea was applied in the fall at Crookston, but the total N required was still within current suggestions for sugar beet in the Northern growing region. Root yield exceeded expectations at Renville and the response to N was slightly greater than suggested.

Root yield was affected by N rate and timing only at the Raymond site in 2024 (Table 3d and Figure 2c). Root yield was greater when N was applied in the spring at Raymond and the amount of N that maximized root yield was much less (roughly half) when N was applied in the spring. There was no impact of N rate and timing at Crookston even though the residual N concentration was not that high (Table 2). There was some indication of an interaction between rate and time of application at Crookston, but no clear differences could be determined with the data provided in Figure 2d.

Root yield varied by urea source only at Hector (Table 6a) in 2021. Almost all urea sources increased root yield over the non-fertilized control. The greatest yield was produced with the 33% ESN, urea plus Anvol, and urea plus Agrotain treatments. Anvol and Agrotain are urease inhibitors which slow volatility of ammonia by reducing the rate of hydrolysis of the urea. Super-U also contains NBPT, the active ingredient in Agrotain, but at a lower rate that what is applied with the suggested application rate of Agrotain. Issues with coating of the fertilizer resulted in a NBPT rate applied that was roughly 2x that of the amount of NBPT in Super-U (Agrotain rate was targeted to supply the same NBPT rate as in Super-U). It should be noted that this dataset is limited in that it is one site-year total. The addition of more site-years of data is needed to make a conclusion of the optimal urea source. Urea sources did not impact root yield in 2022 at Crookston (Table 6b). In 2023, sources impacted sugar beet root yield at both locations (Table 6c). Similar to the rate trial, fall application outyielded spring at Crookston. In 2024 (Table 6d), again both source at time affected root yield with higher root yield for spring application at both locations. A overall analysis of the data factoring in responses across the northern and southern locations will be further discussed below.

The decrease in plant population did not impact sugar beet root yield. The loss of population was compensated for by the sugar beet plants which increased the mass of roots per plant (not shown). While higher rates of N as spring urea could reduce yield the effect on root yield should be minimal if the variety planted can compensate by growing larger roots. A reduction in emergence without a resulting decrease in yield was also seen in 2020.

Recoverable sucrose per ton was affected by urea rate and timing at both 2021 locations, but the time by rate interaction was not significant. Fall urea application resulted in 3% more recoverable sucrose at both locations. Urea rate resulted in a general decrease in recoverable sucrose at both locations in 2021 and 2024 (Figures 3a and 3d). In both cases, the increasing urea rate decreased recoverable sucrose per ton. The decrease was relatively minor at the rate where root yield was maximized at Hector. There was no impact of urea rate and timing on recoverable sucrose at Crookston in 2022 (Figure 3b) or both locations in 2023 (Figure 3c).

Urea sources had a relatively minor impact on recoverable sucrose (Table 6a to 6d). Most sources did not differ from the non-fertilized control except for Super-U which resulted in the lowest recoverable sucrose per ton at both locations.

Recoverable sucrose per acre is summarized for the rate study in Figure 4a, 4b, 4c, and 4d. Recoverable sucrose per acre typically followed a similar response as root yield where RSA increased to a maximum but did not decrease as N rate increased like what was found for recoverable sucrose per ton. If the time or N rate impacted root yield RSA was also increased. For the source trial, the time of urea application did not impact recoverable sucrose per acre at most locations (Table 5a to 5d). Again, RSA was typically impacted by time or source if root yield was impacted. A low rate of N was applied for the source trial so I did not expect any major impact on recoverable sucrose per ton where the impact would be evident on RSA.

Petiole and leaf blade nitrate concentrations were determined following sampling in early to late-July. The targeted sampling time was 40-50 days after planting at each site. Nitrogen rate and timing affected petiole and leaf blade nitrate-N concentration in 2021 (Table 3a) while only rate impacted blade and petiole nitrate-n concentration in 2022 (Table 3b). Both petiole (Tables 5a and 5b) and leaf blade (Table 6a and 6b) nitrate-N concentration increased with increasing N application rate. In general, petiole and leaf blade nitrate-N concentrations did not plateau and increased beyond the highest rate of N applied even at Crookston in 2022 where the residual nitrate-N content in the soil was high and the relative amounts of nitrate-N in the leaf blade and petiole samples were extremely high compared to samples collected from the 2021 locations. While the main effect of timing was significant in 2021, there was no timing x rate interaction indicating that in general fall application of urea resulted in less nitrate-N in the plant tissue, but the effect of N and the shape of the N response curves were similar even though the maximum values achieved were different based on timing.

Nitrogen rate impacted both petiole and leaf blade nitrate-N concentration at both locations in 2023 (Figures 5c and 6c). Time of application impacted only petiole nitrate N concentration at Crookston where petiole nitrate-N concentration was greater with fall urea application. In all cases the concentration of nitrate-N increased with increasing rate of applied N and was not maximized with the greatest rate of urea applied. There was an interaction between rate and timing for petiole nitrate-N concentration at Crookston, However, the interaction was generally due to no difference in nitrate-N concentration based on time of application with the lowest rates of urea applied.

Petiole and leaf blade nitrate concentrations were relatively larger in 2024 compared to previous years (Table 5d). Time of application impacted petiole nitrate concentration at both 2024 locations while leaf blade nitrate concentration was impacted by time only at Raymond. Nitrogen rate affected both petiole and leaf blade nitrate concentration at both 2024 locations (Figures 5d and 6d, respectively). Petiole and leaf blade nitrate concentrations plateaued at lower N rates at Raymond and Crookston, respectively.

Source effects on petiole and leaf blade nitrate-N concentration are summarized in Tables 6a through 6d. The timing main effects on leaf blade nitrate-N concentration differed for all locations in 2021 and 2022 (Tables 5a and 5b) but did not differ in 2023 (Table 5c). The 2024 growing season in 2024 was slightly different in that source and time did not impact petiole nitrate concentration at Crookston; however, source and time impacted petiole nitrate concentration at Raymond and blade nitrate concentration at both locations (Table 4d). Petiole nitrate-N only varied based on time of application for the two 2021 locations (Table 5a) and not at any of the other locations. The relative rankings among the sources varied by site and individual site effects will not be discussed but are given in Tables 6a through 6d. A source x time interaction occurred at Hector in 2021 and Raymond in 2024 for petiole nitrate-N concentration and at Crookston in 2021 for leaf blade nitrate-N concentration. Again, these individual effects will not be discussed on a site-by-site basis in lieu of an analysis across locations.

Data summary across sites and years.

The urea source data was analyzed across the five field locations. It should be noted that only the spring application from Crookston in 2021 was utilized while both fall and spring data from the remaining locations except for Renville in 2022 which was omitted from the combined analysis. There was no significant impact of time or source on sugarbeet emergence (Figures 7). Since only 45 lbs of N was applied across treatments I was not expecting any major impacts on emergence in the source trial as most of the rate trial data shows that emergence was impacted with higher rates of N (a combined analysis of the data will be given below for the rate trial)

Root yield data was separated for the northern and southern locations (Figure 8). Nitrogen application impacted root yield at both locations. However, there was no difference between urea and the other sources of N at the Crookston location but there was one source, Anvol, that produced greater root yield across all the southern locations. In general, the urease inhibitors tended to produce slightly greater root yield in the south along with the 1/3 ESN: 2/3 urea treatment and AMS. Nitrification inhibitors did not produce yield greater than urea alone. One hypothesis that I had is that the loss of urea N may be greater via ammonia volatility. The data would support that hypothesis. However, there was no interaction between source and time for the southern sites, so the relative ranking of the sources was similar regardless of when the N was applied. I did expect that there may be less of an impact of sources on spring urea which was not the case. I would expect that a follow up trial would be needed to look more closely at the efficiency of the sources that would need to compare multiple rates of N for fall and spring. Spring applied N did yield more for the southern sites but there was no impact of timing for the northern sites. There was no impact of timing and source no recoverable sucrose per ton averaged across all the locations (Figure 9).

Petiole and leaf blade nitrate-N concentrations were analyzed and are summarized in Figures 10 and 11, respectively. Both main effects of time and source significantly differed for petiole nitrate-N concentration, but the interaction between time and source was not significant. For the time main effect, petiole nitrate-N concentration was 16% greater following spring application. For sources, the greatest increase in petiole nitrate-N concentration was produced with Agrotain and was least with 100% ESN. All other sources did not differ amongst each other, including the non-treated urea treatment. I have not looked at grouping the data by inhibitor type however it's likely that the urease inhibitors would give a slightly greater increase in petiole nitrate-N concentration compared to the other sources. Leaf blade concentration was more variable with some sources resulting in a lower concentration of nitrate-N in the leaf blade than urea (Figure 11). Untreated urea tended to produce one of the highest nitrate N concentration of all sources.

Data for the rate trial was summarized for the northern and southern locations. Root yield results are summarized in Figure 12. Rate and timing impact root yield in both regions with interactions occurring across all sites. For the northern locations, root yield was greater for fall applied urea which was unexpected. Looking at individual years, fall applications tended to produce higher yield in 2022 and 2023 but there was no difference in 2021 and 2024. What is interesting is that the rate of N that maximized yield was less for spring applied N even though spring applied N did not reach the same yield potential on average compared to fall applied N. In the south less N was needed also for the spring application, but the maximum yield produced was similar between the fall and spring N applications. It took about half the N applied in the spring to maximize root yield across all sites and years in the south compared to fall applied N. The rate of N needed factoring in a 4' soil test was consistent with what is currently suggested for both regions. I would caution growers from using the rate data in this study alone for making management decisions. A larger, more robust database is needed to more accurately target an optimal rate of N to apply.

Recoverable sucrose response to urea rate and timing for the northern and southern regions are summarized in Figure 13. There was a poorer relationship between recoverable sucrose per ton (presented as % of site-year maximum) and urea nitrogen rate across the locations. For both the Northern and Southern sites, recoverable sucrose per ton decreased with increased rate of urea applied and there was no difference regardless of when the urea was applied (fall versus spring). I summarized the data as % of maximum in this case to reduce the variability of the achieved recoverable sucrose per ton for each site year. Raw data was more variable and did not show any clear relationship between recoverable sucrose and N rate. I expected to see recoverable sucrose to not decrease until the optimal rate of N that maximized root yield was exceeded. In this case the relationships were more linear. Individually, most sites did show relatively similar recoverable sucrose values for N rates below that which maximized root yield for individual sites. The data more or less confirms past results on the impact of N application rates on recoverable sucrose.

The effect of urea rate on relative emergence of sugar beet is summarized in Figure 14. From the data it is clear that spring applied urea has a greater overall impact on the percentage of seeds that emerged. In general, the effect of urea on emergence is much greater when N rates exceed the amount required for maximizing root yield. However, the loss of stand seldom if ever impacted root yield. For example, root yield was greater when urea was applied in the spring yet there was a significant loss in stand with increasing rate of applied urea. I would have more concerns with loss of stand on sandy soil which were not included in this study. The sugar beet root seems to compensate well for a loss of stand in our studies. The loss in root yield from applying N in the fall in the southern locations would outweigh any potential loss in stand from spring applied urea.

Petiole nitrate concentration was regressed with relative yield from previous studies and the data are given in Figure 15. The model that fits the data was poor and may not represent an accurate critical level. I had little success fitting models to the data particularly after I added the 2024 nitrate data when tended to be elevated compared to past years. Past data analysis indicated that 100% of maximum root yield was achieved with a petiole nitrate concentration near 850 ppm. However, relative root yield for plots ranged from 50-110% for petiole nitrate concentration less than 850 ppm. The high range in relative yield levels for petiole nitrate concentration does present some issues for using petiole nitrate concentration to assess nitrate sufficiency to direct supplemental application of N for sugar beet. The range in relative yield values is like what is seen with other tests such as the corn basal stalk N test. While we could say that 850 ppm would be a sufficient petiole nitrate concentration for sugar beet what to do if you concentration is below that level is more difficult to determine. As we continue the nitrogen work, we will add more data to the dataset. One item of note is that root yield at Lake Lillian did not respond to nitrogen and yield levels were 40+ tons like Wood Lake, yet many of the petiole nitrate concentration were less than 850 ppm. Past research has also not been able to calibrate the petiole nitrate test. The petiole nitrate test may work to help manage nitrogen at specific locations, but it may not be possible to determine which locations it may work until yield data is available at a given location.

The petiole nitrate-N data was also compared to the difference in the amount of nitrogen applied relative to the rate that maximized root yield at each location (Figure 16). The optimal rate of N was achieved when petiole nitrate-N concentration was roughly 600 ppm. I do not find the data we have to be clear enough to use petiole nitrate concentration to aid in N management for sugar beet. It should be noted that petiole nitrate concentration can be highly affected by plant stress, including moisture stress, around the time of sampling. In addition, concentrations are diurnal meaning they can fluctuate from daytime to nighttime. Sampling should be collected at or near the same time of the day. Most samples in this study were collected between 10 am and 2 pm the day of sampling.

Petiole nitrate-N concentration was also related to recoverable sucrose per ton (Figure 17). The relationship between recoverable sucrose and petiole nitrate-N concentration was poorer but maximum recoverable sucrose was generally achieved when petiole nitrate-N concentration was roughly 650 ppm which is like the concentration at optimal N rate. I also compared recoverable sucrose to the percentage of sugar beet emerged (Figure 18). However, emergence could not predict recoverable sucrose. I was curious if the size of the beet root would impact recoverable sucrose but, in this case, there was no relationship.

Conclusions and overall data summary

Overall, this data does indicate that there may be more flexibility for time of urea application for the norther region that would include the Minn-Dak and Crystal regions. The southern region data matches much of what we find for corn production where there is a clear loss in yield for fall applied N compared to spring N application. I would suggest following up research at some point that would combine the source and rate trials. If growers are looking to treat urea, I would suggest considering a urease inhibitor and not a nitrification inhibitor. We have found in other trials that Instinct does not perform well with broadcast urea and I think that may be due to most of the N loss occurring through ammonia volatility which occurs before nitrification of N would occur in the soil.

Spring applied urea will reduce sugar beet emergence. As noted, I did not find that any reduction in emergence results in less root yield. The source data also did not show any clear indication that utilizing an inhibitor would result in less impacts on emergence. A follow up study of treated urea applied at different rates would be needed to determine if a slower conversion of urea would reduce the impact of spring applied urea on sugar beet emergence.

The petiole nitrate data was no clear as to whether it can be utilized to predict root yield and recoverable sucrose concentration. There is a lot of variation in nitrate concentration that is a result of factors such as environmental conditions that can impact nitrate concentration more than the N applied. I will continue to combine data from other sources to evaluate the use of petiole nitrate but at this time I would not suggest it being a sole indicator of nitrogen sufficiency in sugar beet.

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Table 1. Location, planting and sampling information and dominant soil series for each location.

		Date of					Soil		
Year	Location	Urea Application		Planting	Tissue Sampling	Harvest	Series	Texture†	Classification‡
2021	Crookston	29-Oct	4-May	4-May	8-Jul	14-Sept	Wheatville	FSL	Ae. Calciaquoll
	Hector	6-Nov	30-Apr	30-Apr	12-Jul	29-Sept	Canisteo-Glencoe	CL	T. Endoaquoll
2022	Crookston	1-Nov	27-May	27-May	22-Jul	20-Sept	Wheatville	FSL	Ae. Calciaquoll
	Renville	3-Nov	21-May	24-May	19-Jul	19-Sept	Normania	L	Aq. Hapludoll
2023	Crookston	4-Nov	10-May	10-May	11-Jul	14-Sept	Wheatville	FSL	Ae. Calciaquoll
	Renville	1-Nov	3-May	3-May	12-Jul	9-Oct	Leen-Okaboji	SiCL	T. Calciaquoll
2024	Crookston	14-Nov	24-Apr	24-Apr	17-Jun	13-Sept	Wheatville	FSL	Ae. Calciaquoll
	Raymond	2-Nov	23-Apr	24-Apr	24-Jun	1-Oct	Canisteo-Harps	CL	T. Endoaquoll

† CL, clay loam; FSL, fine sandy loam; SiCl, silty clay loam.

‡Ae, aeric; Aq, aquic; T, typic

Table 2. Summary of soil test results for 2021, 2022, 2023, and 2024 locations.

		0-6" Soil Test				Soil Test Nitrate-N	
Year	Location	Olsen P	Ammonium Acetate K	pH	SOM	0-2'	2-4'
		----------ppm----------			----%----	--------------------lb/ac--------------------	
				Urea Rate Trials			
2021	Crookston	9	159	8.2	3.0	25	43
	Hector	8	168	7.3	5.4	21	39
2022	Crookston	9	140	8.2	2.7	135	9
	Renville	11	155	7.1	3.9	22	8
2023	Crookston	6	113	8.3	2.8	15	24
	Renville	11	181	8.1	7.1	31	30
2024	Crookston	5	93	8.4	2.8	11	12
	Raymond	9	183	8.2	5.2	12	4
				Urea Source Trials			
2021	Crookston	12	140	8.2	2.3	39	70
	Hector	7	151	7.6	4.0	25	68
2022	Crookston	9	140	8.2	2.7	135	9
	Renville	13	222	7.3	4.0	30	14
2023	Crookston	6	113	8.3	2.8	15	24
	Renville	11	181	8.1	7.1	31	30
2024	Crookston	5	93	8.4	2.8	11	12
	Raymond	9	183	8.2	5.2	12	4

Table 3a. Summary of analysis of variance for main effects of nitrogen application rate (N rate) and time of application (Time) and their interaction at Crookston (CRX) and Hector (H), MN in 2021.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Recoverable Sugar (ton)	
Effect	CRX	H	CRX	H	CRX	H	CRX	H	CRX	H
	--*P*>F--									
N rate	***	0.10	***	***	***	***	0.50	**	0.10	*
Time	***	***	**	***	*	*	0.66	0.88	**	**
N ratexTime.	***	***	0.13	0.16	0.88	0.45	0.13	0.90	0.25	0.46

†Asterisks represent significance at *P*<0.05,*; 0.01, **; and 0.001, ***.

Table 3b. Summary of analysis of variance for main effects of nitrogen application rate (N rate) and time of application (Time) and their interaction at Crookston (CRX) and Renville (R), MN in 2022.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Recoverable Sugar (ton)	
Effect	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	--*P*>F--									
N rate	0.50	na	0.07	na	*	na	0.69	na	0.25	na
Time	*	na	0.20	na	0.07	na	**	na	0.38	na
N ratexTime.	0.34	na	0.87	na	0.80	na	0.42	na	0.88	na

†Asterisks represent significance at *P*<0.05,*; 0.01, **; and 0.001, ***.

Table 3c. Summary of analysis of variance for main effects of nitrogen application rate (N rate) and time of application (Time) and their interaction at Crookston (CRX) and Renville (R), MN in 2023.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Recoverable Sugar (ton)	
Effect	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	------	------	------	------	------	*P*>F	------	------	------	------
N rate	***	*	***	***	0.13	***	***	**	0.44	0.68
Time	***	***	0.08	0.25	0.92	0.70	***	0.20	0.66	0.92
N ratexTime.	***	***	*	0.61	0.08	0.17	0.08	0.38	0.60	0.83

†Asterisks represent significance at $P<0.05$,*; 0.01, **; and 0.001, ***.

Table 3d. Summary of analysis of variance for main effects of nitrogen application rate (N rate) and time of application (Time) and their interaction at Crookston (CRX) and Raymond (R), MN in 2024.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Recoverable Sugar (ton)	
Effect	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	------	------	------	------	------	*P*>F	------	------	------	------
N rate	*	0.85	***	***	***	***	0.34	***	0.07	*
Time	*	0.39	**	**	0.52	***	0.60	***	0.11	*
N ratexTime.	***	0.90	0.08	0.28	0.17	***	0.07	*	0.38	0.56

†Asterisks represent significance at $P<0.05$,*; 0.01, **; and 0.001, ***.

Table 4a. Summary of analysis of variance for main effects of urea source (Source) and time of application (Time) and their interaction at Crookston (CRX) and Hector (H), MN in 2021.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Recoverable Sugar (ton)	
Effect	CRX	H	CRX	H	CRX	H	CRX	H	CRX	H
	--*P*>F--									
Source	***	**	0.10	0.07	0.06	0.12	0.18	**	*	*
Time	na	0.58	na	***	na	**	na	0.26	na	0.63
SourcexTime.	na	0.55	na	*	na	0.40	na	0.62	na	0.95

†Asterisks represent significance at *P*<0.05,*; 0.01, **; and 0.001, ***.

Table 4b. Summary of analysis of variance for main effects of urea source (Source) and time of application (Time) and their interaction at Crookston (CRX) and Renville (R), MN in 2022.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Recoverable Sugar (ton)	
Effect	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	--*P*>F--									
Source	0.99	na	0.81	na	*	na	0.99	na	0.23	na
Time	0.08	na	0.43	na	0.35	na	*	na	*	na
SourcexTime.	0.08	na	0.44	na	*	na	0.08	na	0.42	na

†Asterisks represent significance at *P*<0.05,*; 0.01, **; and 0.001, ***.

Table 4c. Summary of analysis of variance for main effects of urea source (Source) and time of application (Time) and their interaction at Crookston (CRX) and Renville (R), MN in 2023.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Recoverable Sugar (ton)	
Effect	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	--*P*>F--									
Source	0.14	0.96	0.16	0.18	0.56	0.12	0.10	*	0.17	0.31
Time	0.18	0.86	0.56	0.41	0.71	0.08	***	0.88	0.43	0.28
SourcexTime.	0.57	0.13	0.35	0.22	0.40	0.27	0.19	0.19	0.64	0.34

†Asterisks represent significance at *P*<0.05,*; 0.01, **; and 0.001, ***.

Table 4d. Summary of analysis of variance for main effects of urea source (Source) and time of application (Time) and their interaction at Crookston (CRX) and Raymond (R), MN in 2024.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Recoverable Sugar (ton)	
Effect	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	--*P*>F--									
Source	0.69	0.97	0.14	*	0.08	**	**	*	0.18	*
Time	0.89	0.26	0.34	***	***	*	**	*	0.60	0.61
SourcexTime.	0.25	0.41	0.16	**	0.38	0.27	0.50	0.33	0.33	0.42

†Asterisks represent significance at *P*<0.05,*; 0.01, **; and 0.001, ***.

Table 5a. Summary of the main effect of in-urea timing or source for selected variables at Crookston (CRX) and Hector (H), MN in 2021. Letters indicating the least significant difference are only listed in the table when the main effect of timing was significant. Data are given separately for the urea rate and source trials at each location. Fall treatments for the Crookston source trial were not included in this dataset.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Rec. Sugar (ton)		Rec Sugar (acre)	
Time	CRX	H	CRX	H	CRX	H	CRX	H	CRX	H	CRX	H
	------%------		----ppm----				--tons/ac--		---lb/ton---		----lb/ac----	
						Urea Rate Trial						
Fall	79a	86a	1702b	764b	478b	89b	19.4	39.5	326a	246a	6340	9690
Spring	72b	74b	2147a	1307a	622a	125a	19.1	39.6	316b	240b	6027	9479
						Urea Source Trial						
Fall	--	84	--	647b	--	47b	--	33.9	--	261	--	8587b
Spring	--	83	--	1005a	--	90a	--	34.6	--	260	--	8859a

†Numbers followed by the same letter are not significantly different at the $P \leq 0.10$ probability level.

Table 5b. Summary of the main effect of in-urea timing or source for selected variables at Crookston (CRX) and Renville (R), MN in 2022. Letters indicating the least significant difference are only listed in the table when the main effect of timing was significant. Data are given separately for the urea rate and source trials at each location. Fall treatments for the Crookston source trial were not included in this dataset.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Rec. Sugar (ton)		Rec Sugar (acre)	
Time	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	------%------		----ppm----				--tons/ac--		---lb/ton---		----lb/ac----	
						Urea Rate Trial						
Fall	72a	na	5299	na	1372b	Na	23.5a	na	316	na	7409a	na
Spring	56b	na	5740	na	1593a	Na	20.5b	na	312	na	6400b	na
						Urea Source Trial						
Fall	60.3b	na	567	na	3447	Na	21.7b	na	306b	na	6664	na
Spring	68.5a	na	599	na	3322	Na	23.3a	na	312a	na	7263	na

†Numbers followed by the same letter are not significantly different at the $P \leq 0.10$ probability level.

Table 5c. Summary of the main effect of in-urea timing or source for selected variables at Crookston (CRX) and Renville (R), MN in 2023. Letters indicating the least significant difference are only listed in the table when the main effect of timing was significant. Data are given separately for the urea rate and source trials at each location. Fall treatments for the Crookston source trial were not included in this dataset.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Rec. Sugar (ton)		Rec Sugar (acre)	
Time	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	------%------		----ppm----				--tons/ac--		---lb/ton---		----lb/ac----	
						Urea Rate Trial						
Fall	78a	87a	908a	1017	119	390	18.1a	43.1	344	276	6217a	11885
Spring	69b	79b	779b	1154	122	372	15.0b	44.2	342	276	5087b	12196
						Urea Source Trial						
Fall	81.8	84.8	501	81	77	43b	18.8a	23.5	341	279	6337a	6570
Spring	80.1	84.6	554	109	71	55a	16.5b	23.4	339	278	5506b	6512

†Numbers followed by the same letter are not significantly different at the *P*≤0.10 probability level.

Table 5d. Summary of the main effect of in-urea timing or source for selected variables at Crookston (CRX) and Raymond (R), MN in 2024. Letters indicating the least significant difference are only listed in the table when the main effect of timing was significant. Data are given separately for the urea rate and source trials at each location. Fall treatments for the Crookston source trial were not included in this dataset.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Rec. Sugar (ton)		Rec Sugar (acre)	
Time	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	------%------		----ppm----				--tons/ac--		---lb/ton---		----lb/ac----	
						Urea Rate Trial						
Fall	79a	87	7862b	5101b	1347	615b	33	36b	289a	300b	9591	11022b
Spring	74b	85	8697a	6206a	1359	964a	32	38a	280b	303a	9248	11425a
						Urea Source Trial						
Fall	82	82	7782	2624b	1046b	252b	31.9b	33.6b	306	312	9416b	10374b
Spring	82	80	8327	3134a	1321a	318a	34.0a	34.2a	304	312	9939a	10532a

†Numbers followed by the same letter are not significantly different at the *P*≤0.10 probability level.

Table 6a. Summary of the main effect of urea source for selected variables at Crookston (CRX) and Hector (H), MN in 2021. Letters indicating least significant difference are only listed in the table when the main effect of timing was significant.

Source	Emergence CRX	Emergence H	Petiole NO_3-N CRX	Petiole NO_3-N H	Blade NO_3-N CRX	Blade NO_3-N H	Yield CRX	Yield H	Rec. Sugar (ton) CRX	Rec. Sugar (ton) H	Rec Sugar (acre) CRX	Rec Sugar (acre) H
	------%------		----ppm----				--tons/ac--		---lb/ton---		----lb/ac----	
None	86.4a	78.6cd	100c	471d	317c	33	18.1	29.9f	345.6a	261.5ab	6259	7092d
Urea	69.7ef	88.1a	227bc	625bcd	725bc	35	16.7	31.6def	336.2ab	261.9ab	5612	8639abcd
AMS	78.9bc	86.6a	154bc	888abc	674c	53	19.5	36.7abc	325.1bc	270.1a	6339	9768ab
33% ESN	73.7de	85.6ab	214bc	950ab	589c	79	15.7	39.0a	329.0b	263.5ab	5163	9839a
66% ESN	77.1bcd	80.1bcd	174bc	524cd	681c	53	18.5	30.7ef	329.9b	260.1b	6104	8094bcd
100% ESN	80.8b	88.5a	214bc	1064a	545c	92	19.6	34.2bcde	332.1b	262.0ab	6510	7596cd
Instinct	68.4f	75.2d	196bc	1162a	466c	104	17.9	34.0bcde	329.2b	257.1b	5909	8412abcd
Super-U	74.1cde	84.8ab	310ab	924abc	1332a	82	19.0	33.1cdef	314.8c	246.0c	5965	8922abc
Agrotain	77.3bcd	84.6abc	262bc	786abcd	744bc	48	18.7	37.6ab	327.7b	259.8b	6145	8909abc
Anvol	72.5def	80.4bcd	463a	867abcd	1214ab	109	18.9	35.5abcd	333.4b	259.4b	6282	9955a

†Numbers followed by the same letter are not significantly different at the P<0.10 probability level.
Na, data are not available

Table 6b. Summary of the main effect of urea source for selected variables at Crookston (CRX) and Renville (R), MN in 2022. Letters indicating least significant difference are only listed in the table when the main effect of timing was significant.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Rec. Sugar (ton)		Rec Sugar (acre)	
Source	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	------%------		----ppm----				--tons/ac--		---lb/ton---		----lb/ac----	
None	67	na	467	na	2502c	na	22.4	na	323	na	7252	na
Urea	68	na	608	na	3715ab	na	22.7	na	309	na	7017	na
AMS	64	na	536	na	2845c	na	23.0	na	304	na	6992	na
33% ESN	64	na	614	na	3700ab	na	22.9	na	308	na	7050	na
66% ESN	66	na	578	na	3652ab	na	22.4	na	310	na	6953	na
100% ESN	64	na	537	na	3086bc	na	23.3	na	301	na	7022	na
Instinct	65	na	586	na	3212abc	na	22.2	na	313	na	6951	na
Super-U	69	na	641	na	3829a	na	22.5	na	305	na	6893	na
Agrotain	61	na	626	na	3635ab	na	21.5	na	307	na	6664	na
Anvol	61	na	636	na	3670ab	na	22.1	na	310	na	6845	na

†Numbers followed by the same letter are not significantly different at the P<0.10 probability level.
Na, data are not available

Table 6c. Summary of the main effect of urea source for selected variables at Crookston (CRX) and Renville (R), MN in 2023. Letters indicating least significant difference are only listed in the table when the main effect of timing was significant.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Rec. Sugar (ton)		Rec Sugar (acre)	
Source	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	------%------		----ppm----				--tons/ac--		---lb/ton---		----lb/ac----	
None	84	85	224	12	34	18b	13.8c	19.7c	328	275	4448	5411
Urea	81	87	452	307	65	121a	16.0bc	22.8bc	351	276	5563	6302
AMS	83	86	495	28	80	27b	17.8ab	25.2ab	329	281	5732	7105
33% ESN	84	85	798	53	102	33b	18.0ab	23.2abc	342	280	6035	6503
66% ESN	77	85	555	129	86	36b	18.3ab	20.6c	334	275	6036	5683
100% ESN	80	83	325	71	75	36b	17.4ab	25.9ab	351	279	6032	7235
Instinct	81	82	555	124	59	81ab	19.0ab	21.7c	343	276	6432	6037
Super-U	81	85	824	119	115	72ab	16.8bc	23.1abc	348	279	5757	6458
Agrotain	83	84	593	87	89	26b	20.3a	26.5a	334	279	6687	7405
Anvol	75	85	453	19	35	20b	19.2ab	25.7ab	344	283	6493	7272

†Numbers followed by the same letter are not significantly different at the P<0.10 probability level.
Na, data are not available

Table 6d. Summary of the main effect of urea source for selected variables at Crookston (CRX) and Raymond (R), MN in 2024. Letters indicating least significant difference are only listed in the table when the main effect of timing was significant.

	Emergence		Petiole NO_3-N		Blade NO_3-N		Yield		Rec. Sugar (ton)		Rec Sugar (acre)	
Source	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R	CRX	R
	------%------		----ppm----				--tons/ac--		---lb/ton---		----lb/ac----	
None	82	80	5372	1628b	612c	51c	28.1e	32.7c	294	305c	8244c	9969c
Urea	81	81	9138	3179a	1139ab	327ab	33.1bcd	35.1ab	291	310ab	9658b	10871ab
AMS	82	81	9196	2606a	1069b	298ab	30.9de	35.8b	303	307bc	9349b	11014b
33% ESN	84	83	7991	3095a	1263ab	229ab	33.4abcd	36.5b	299	315a	9962ab	11471ab
66% ESN	85	82	8135	2765a	1232ab	266ab	34.7abc	36.2ab	300	305c	10423b	11047ab
100% ESN	83	82	7241	3217a	1417ab	361a	36.3a	37.0ab	299	308bc	10795a	11392ab
Instinct	83	81	7995	3037a	1178ab	307ab	32.9cd	35.5ab	298	306bc	9779b	10871ab
Super-U	83	80	7746	3214a	1167ab	367a	36.1ab	35.0ab	295	310bc	10649a	10840ab
Agrotain	82	83	9495	3181a	1235ab	290ab	31.1de	36.3a	313	306bc	9712b	11114a
Anvol	80	80	8397	2896a	1522a	346a	32.8cd	35.4ab	288	310bc	9449bc	10969ab

†Numbers followed by the same letter are not significantly different at the P<0.10 probability level.
Na, data are not available

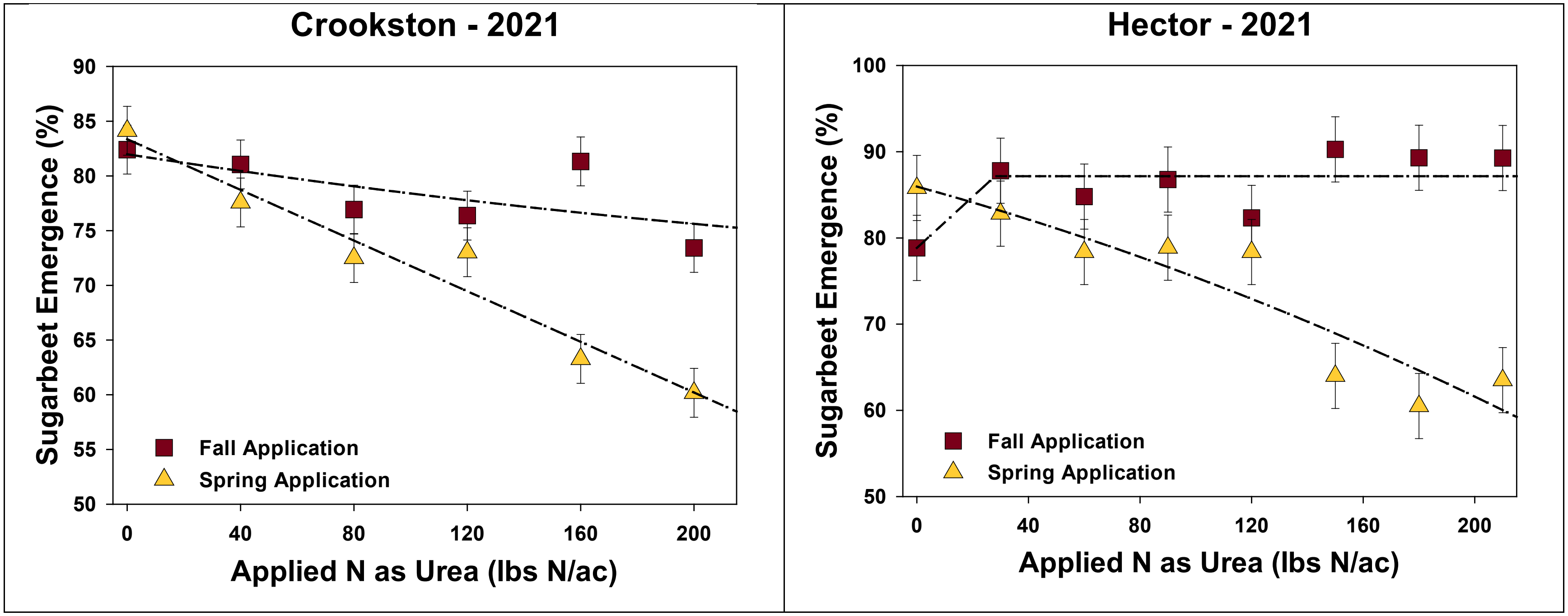


Figure 1a. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet emergence at two Minnesota locations during the 2021 growing season.

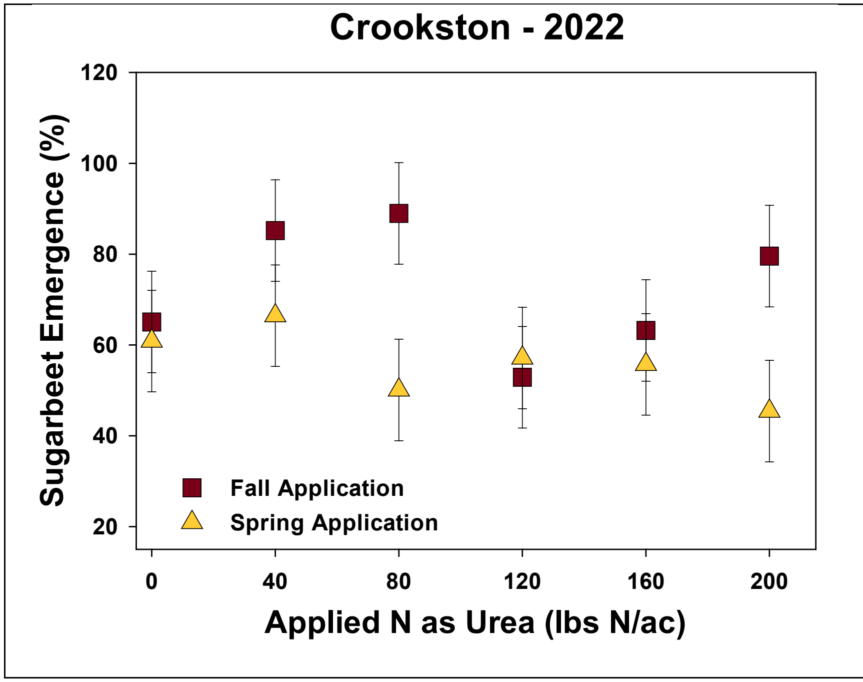


Figure 1b. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet emergence at two Minnesota locations during the 2022 growing season.

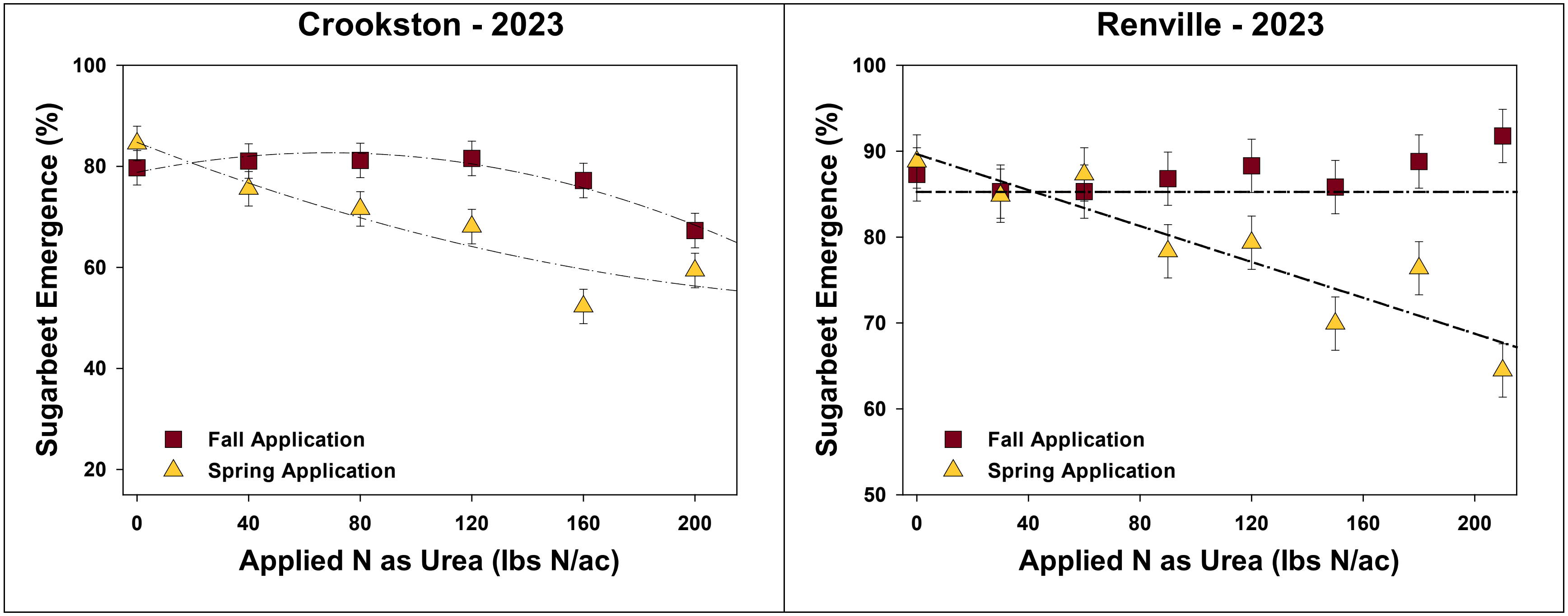


Figure 1c. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet emergence at two Minnesota locations during the 2023 growing season.

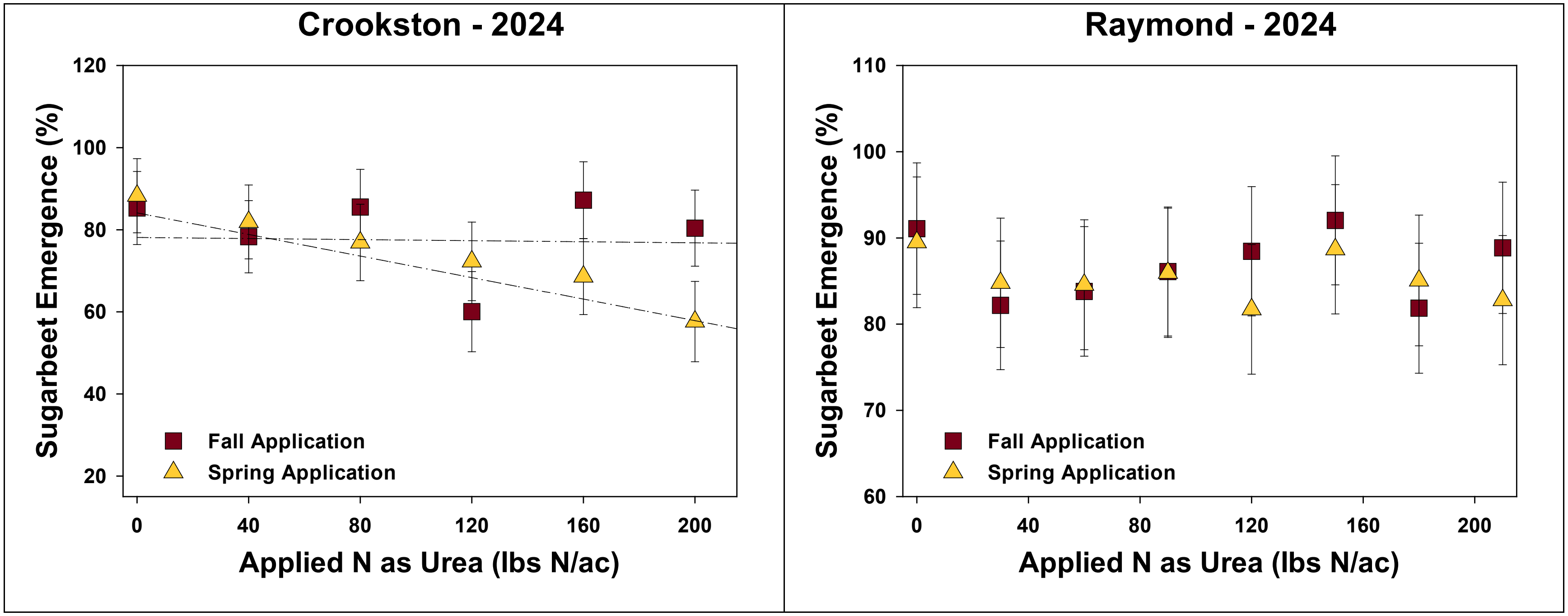


Figure 1d. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet emergence at two Minnesota locations during the 2024 growing season.

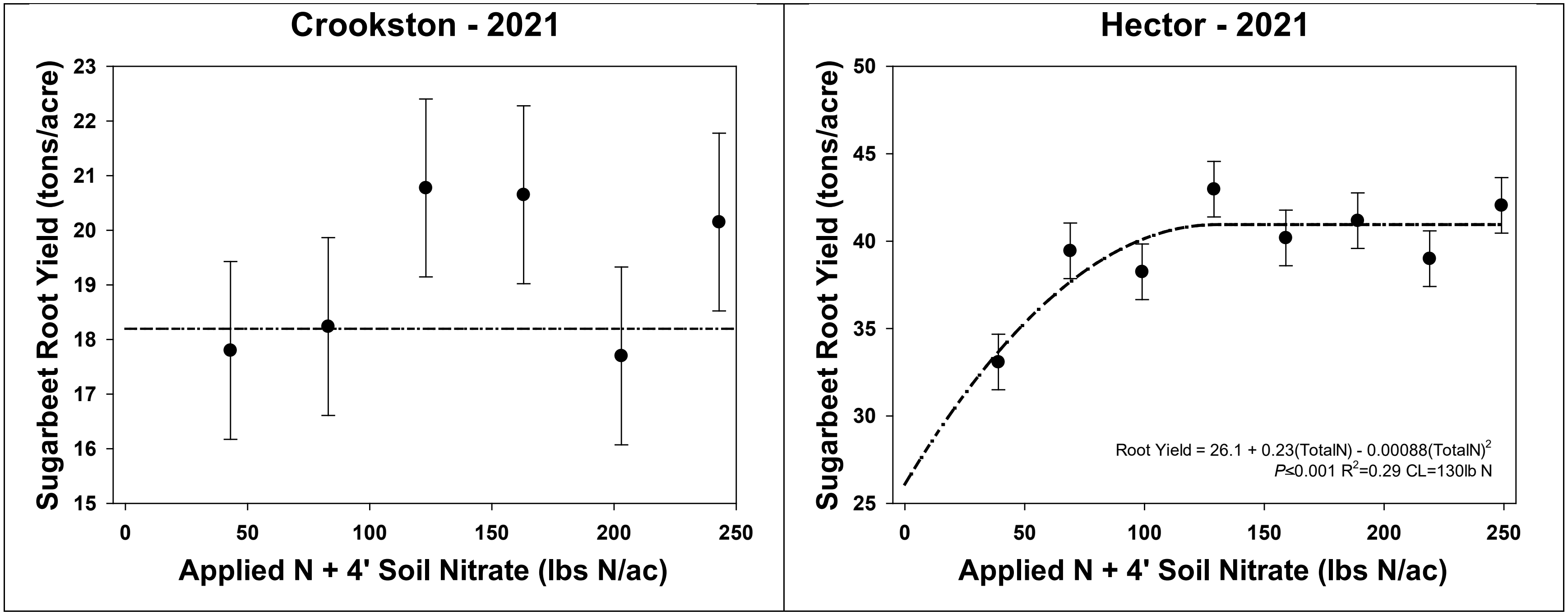


Figure 2a. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) plus the nitrate in a four-foot on sugar beet root yield at two Minnesota locations during the 2021 growing season.

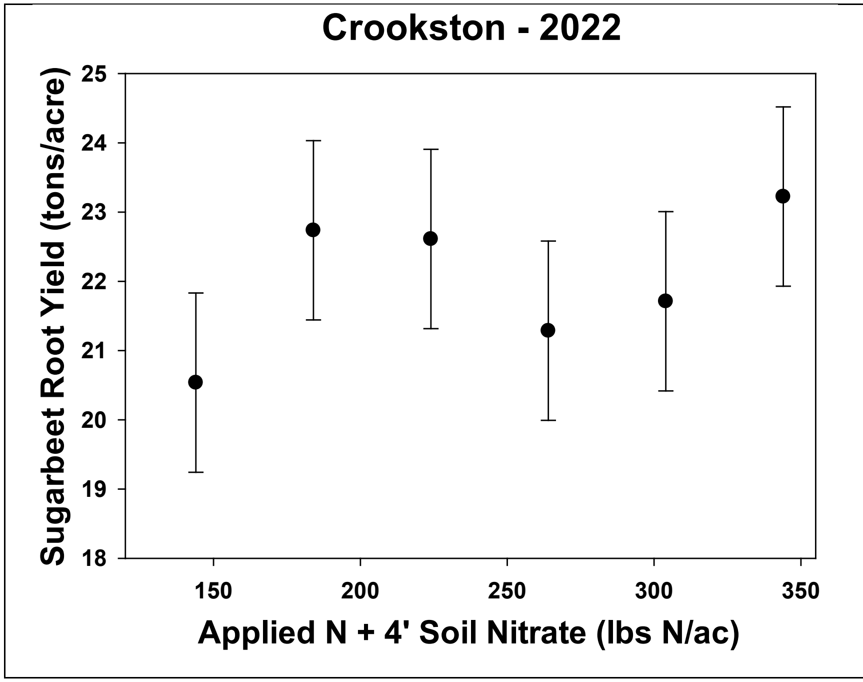


Figure 2b. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) plus the nitrate in a four-foot on sugar beet root yield at two Minnesota locations during the 2022 growing season.

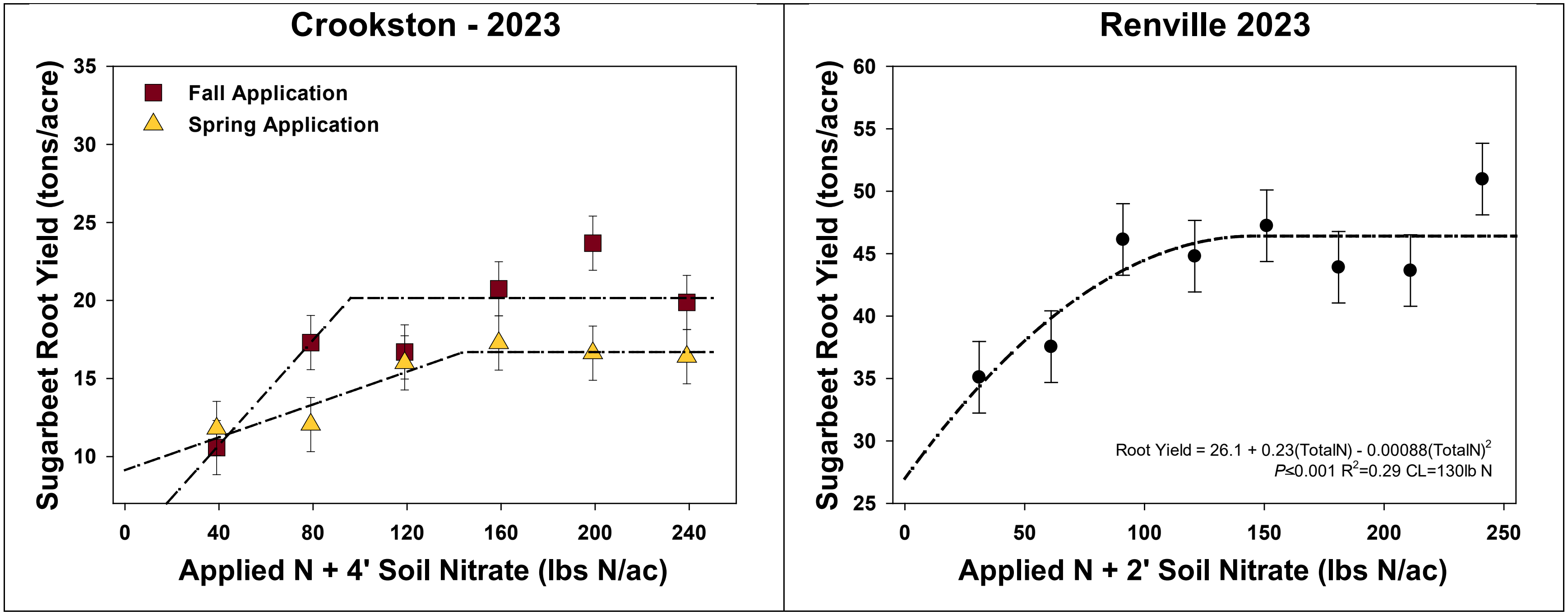


Figure 2c. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) plus the nitrate in a four-foot on sugar beet root yield at two Minnesota locations during the 2023 growing season.

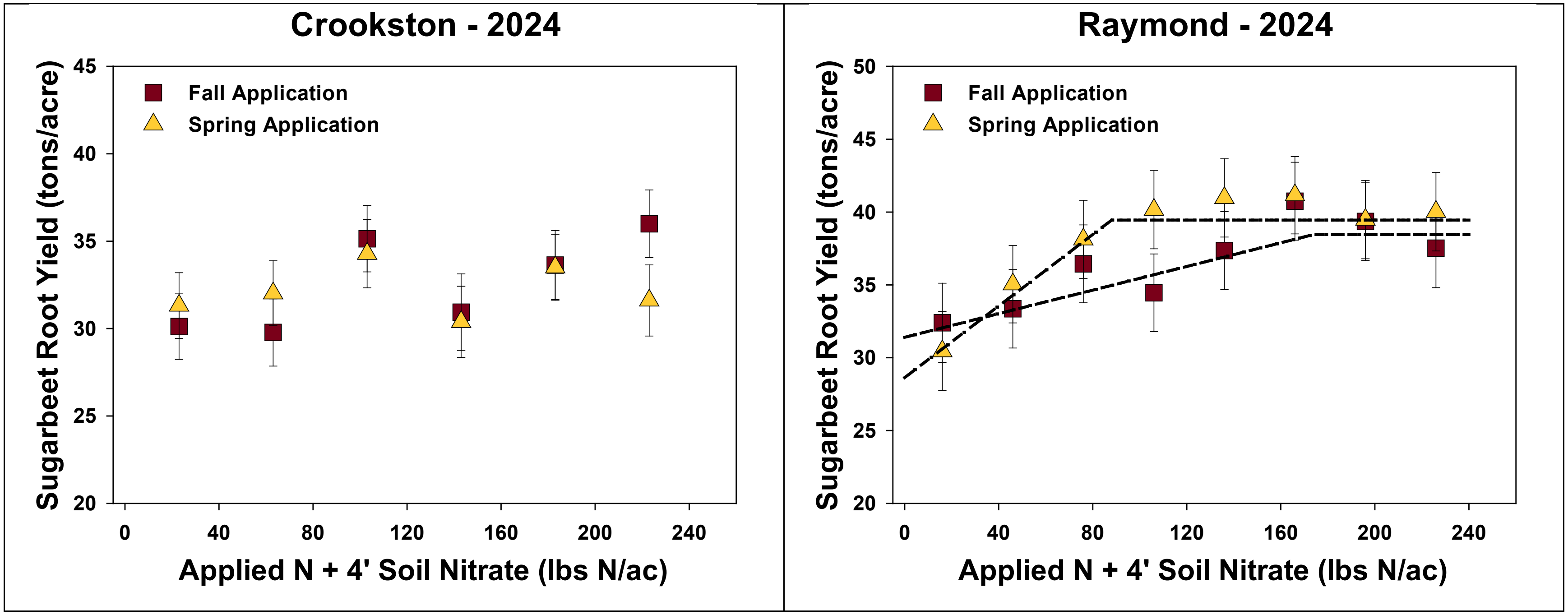


Figure 2d. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) plus the nitrate in a four-foot on sugar beet root yield at two Minnesota locations during the 2024 growing season.

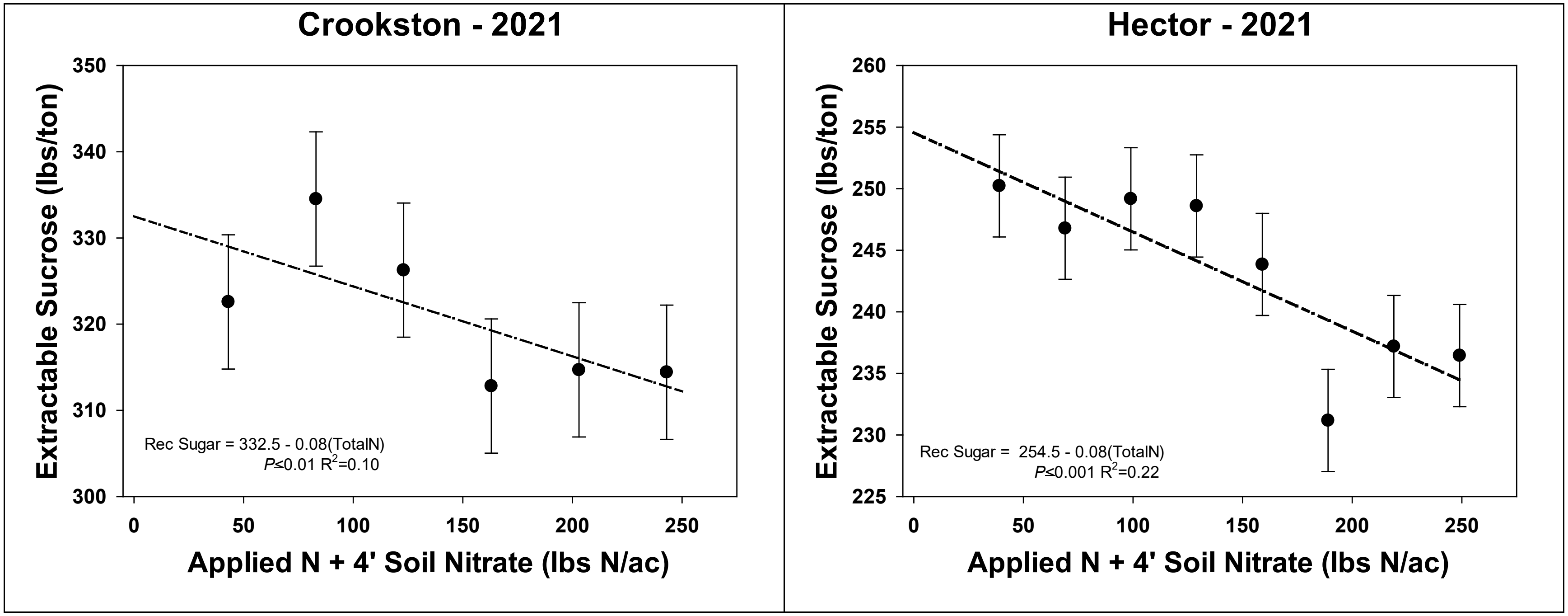


Figure 3a. Effect of nitrogen applied as spring urea plus the nitrate in a four-foot on sugar beet extractable sucrose per ton at two Minnesota locations during the 2021 growing season.

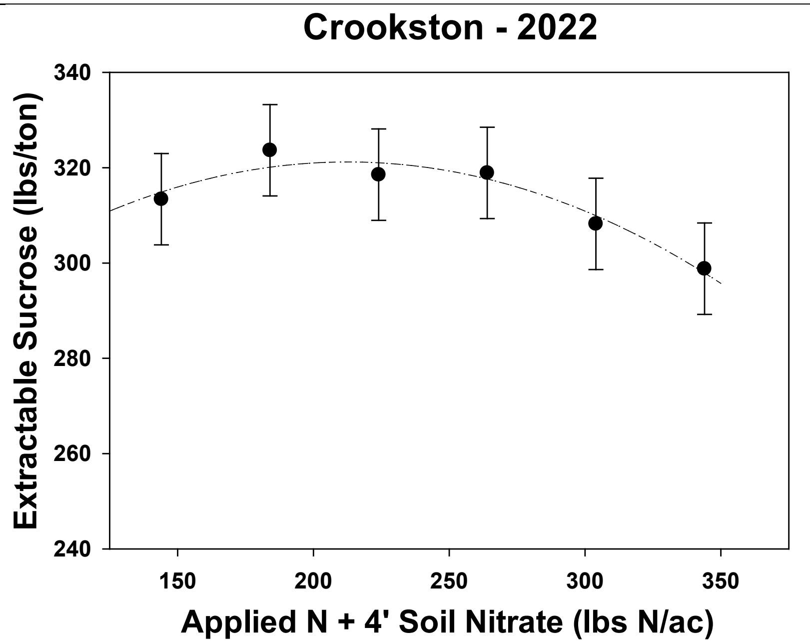


Figure 3b. Effect of nitrogen applied as spring urea plus the nitrate in a four-foot on sugar beet extractable sucrose per ton at two Minnesota locations during the 2022 growing season.

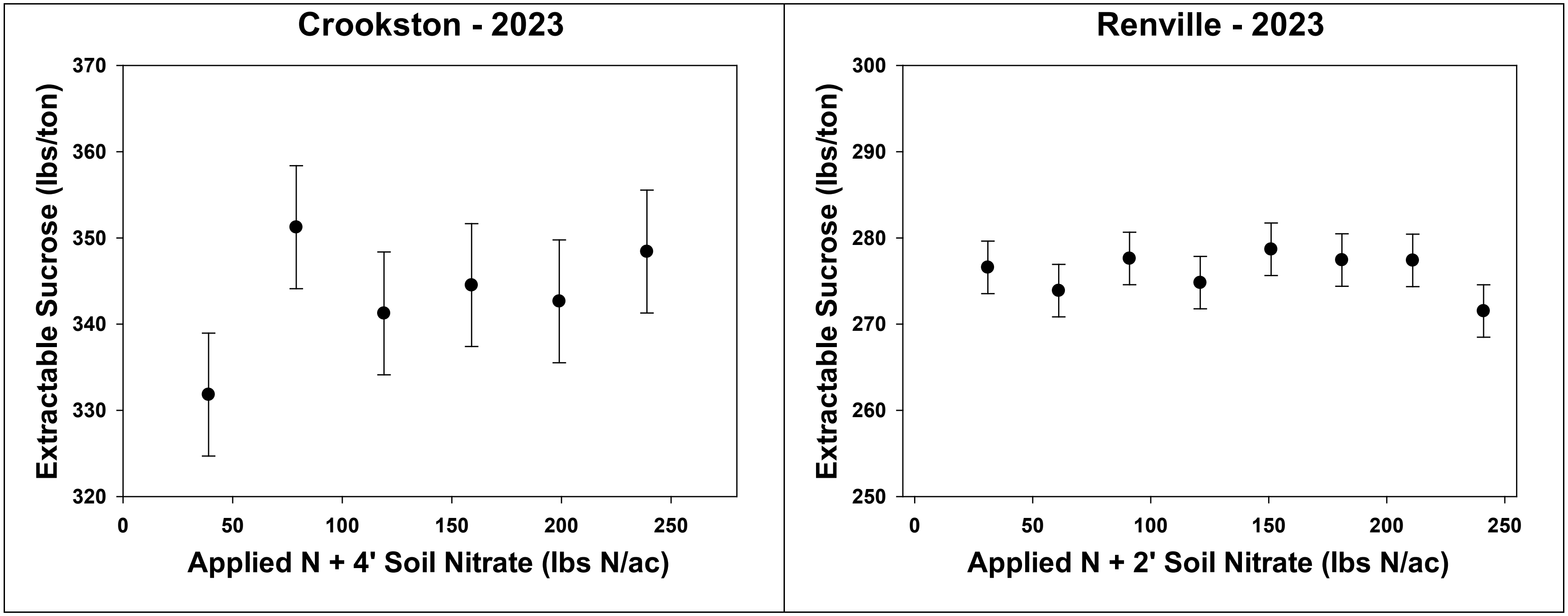


Figure 3c. Effect of nitrogen applied as spring urea plus the nitrate in a four-foot on sugar beet extractable sucrose per ton at two Minnesota locations during the 2023 growing season.

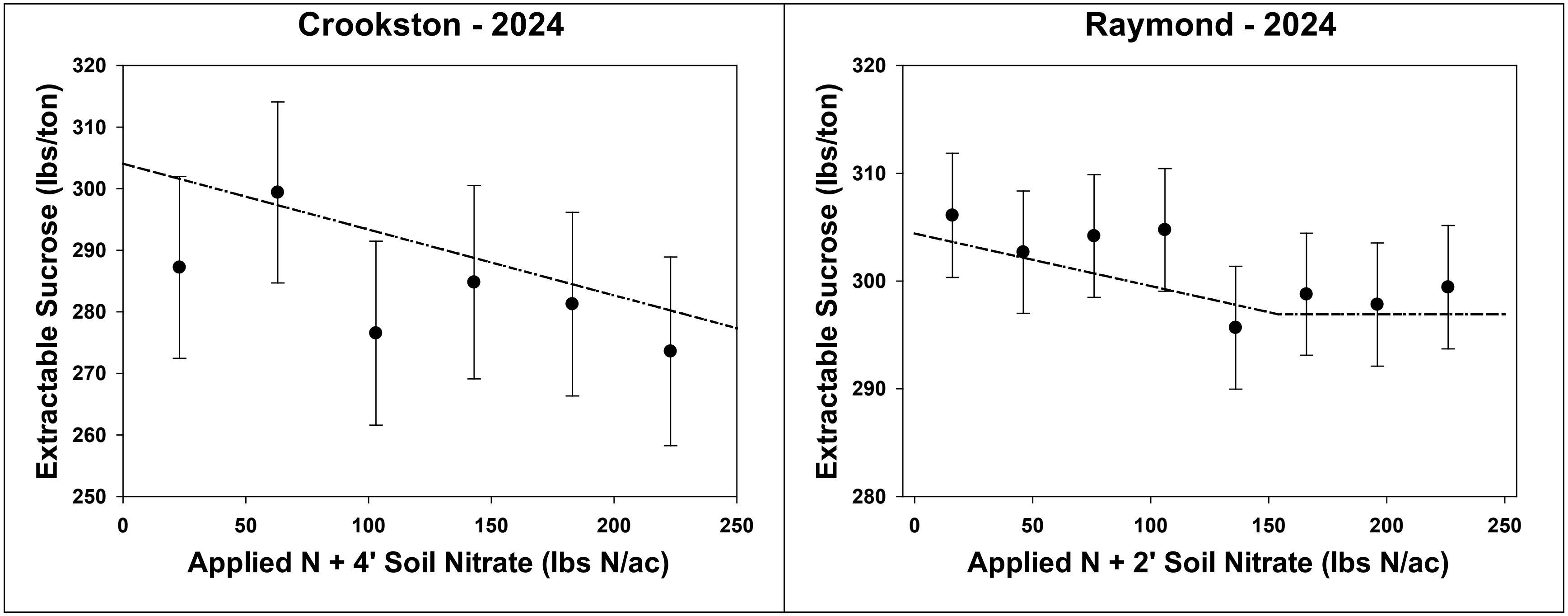


Figure 3d. Effect of nitrogen applied as spring urea plus the nitrate in a four-foot on sugar beet extractable sucrose per ton at two Minnesota locations during the 2024 growing season.

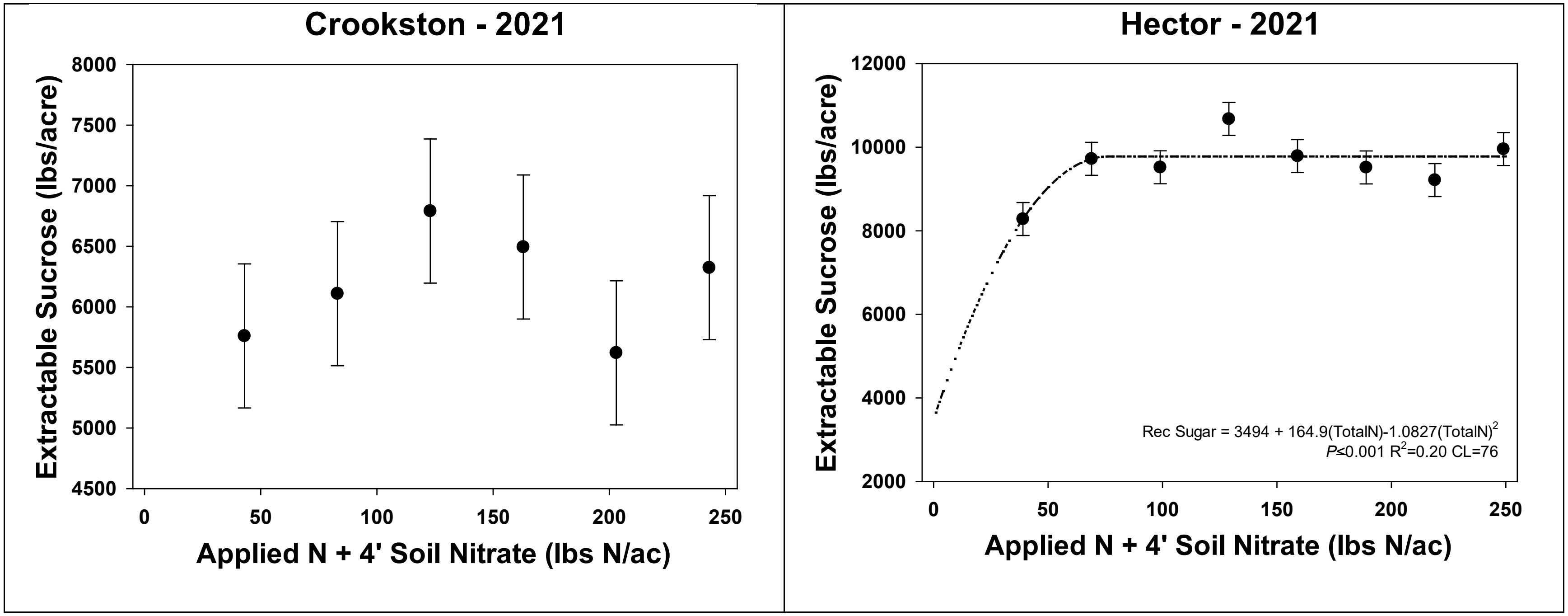


Figure 4a. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) plus the nitrate in a four-foot on sugar beet total extractable sucrose per acre at two Minnesota locations during the 2021 growing season.

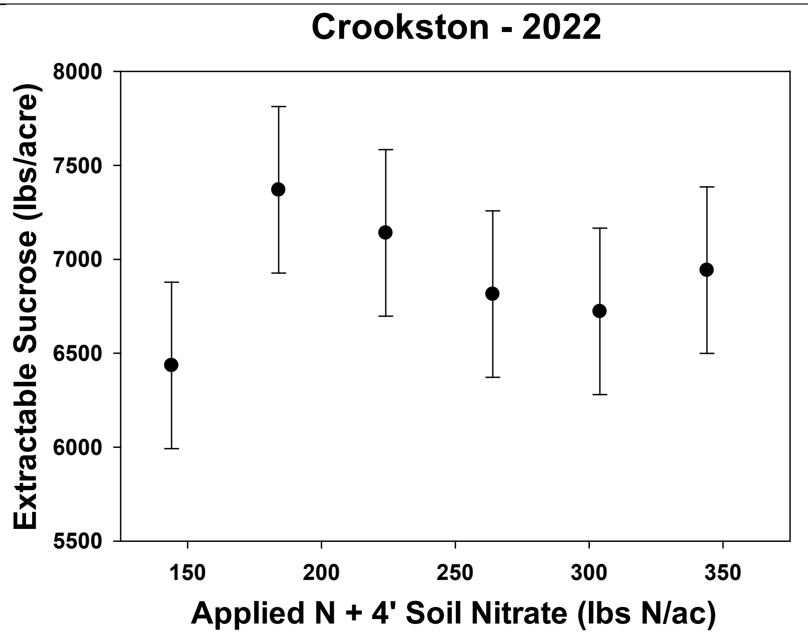


Figure 4b. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) plus the nitrate in a four-foot on sugar beet total extractable sucrose per acre at two Minnesota locations during the 2022 growing season.

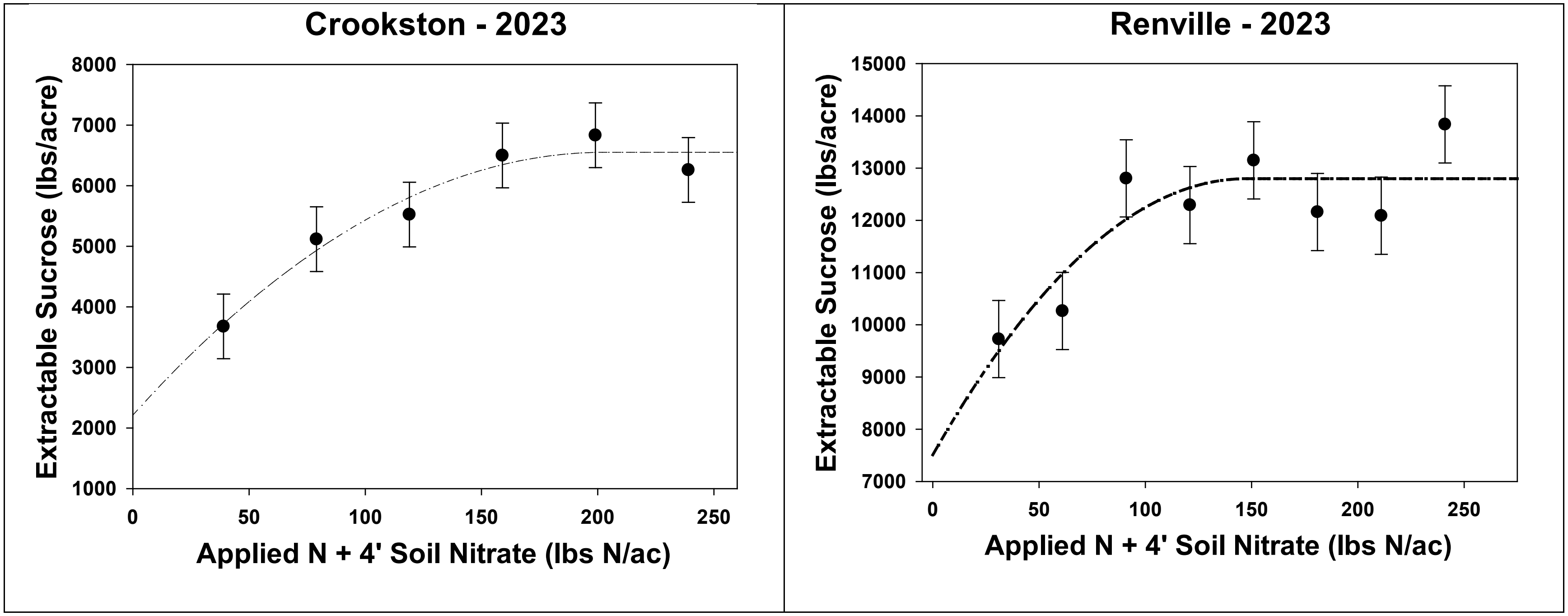


Figure 4c. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) plus the nitrate in a four-foot on sugar beet total extractable sucrose per acre at two Minnesota locations during the 2023 growing season.

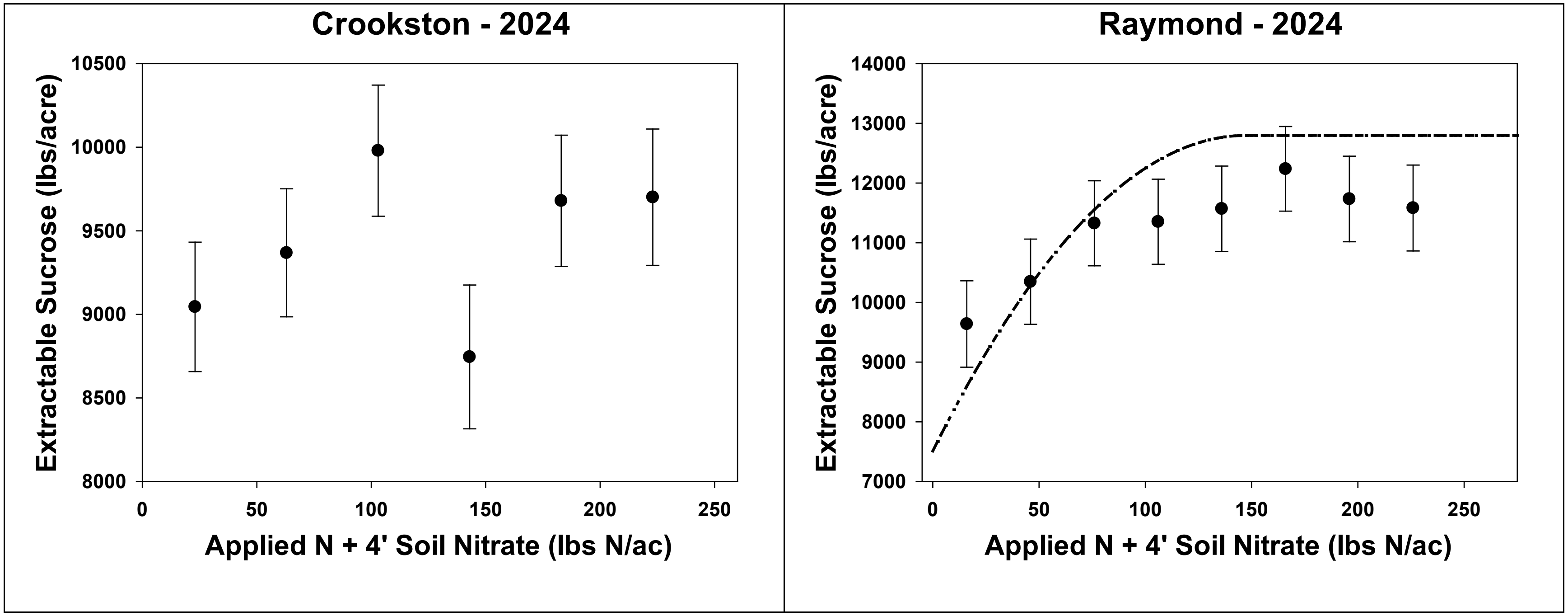


Figure 4d. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) plus the nitrate in a four-foot on sugar beet total extractable sucrose per acre at two Minnesota locations during the 2024 growing season.

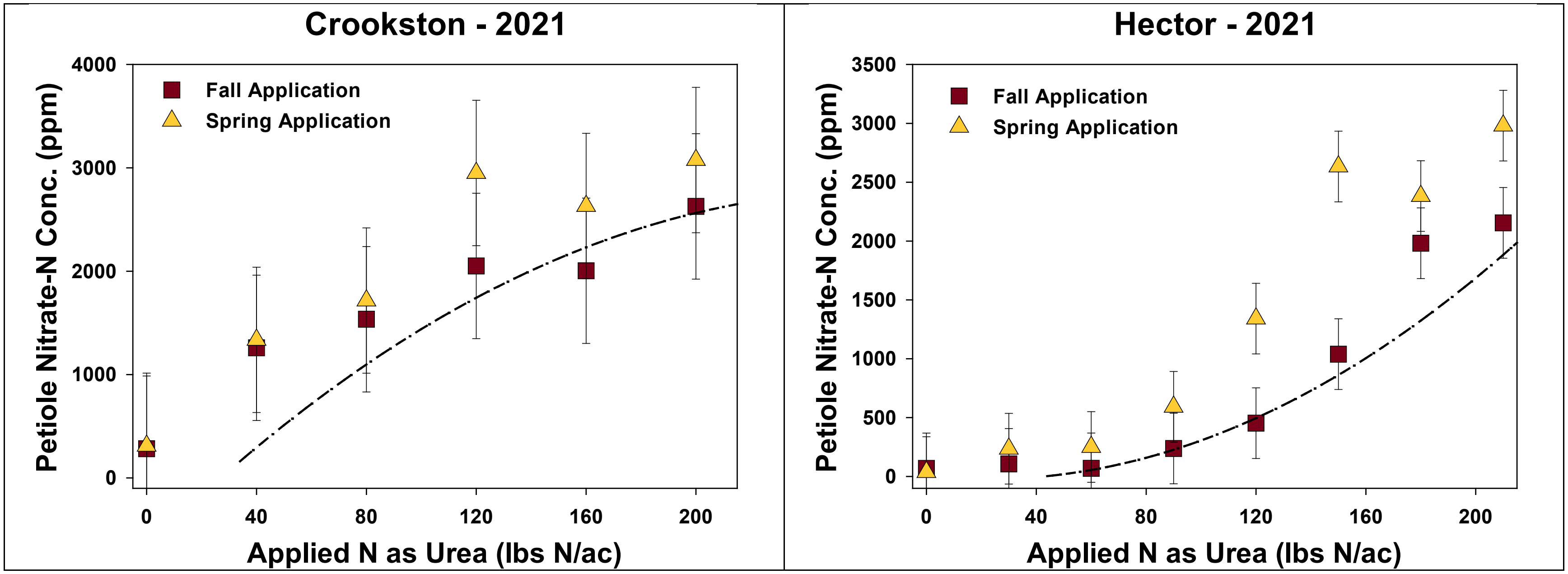


Figure 5a. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet early to mid-July petiole nitrate measured from the newest fully developed leaf at two Minnesota locations during the 2021 growing season.

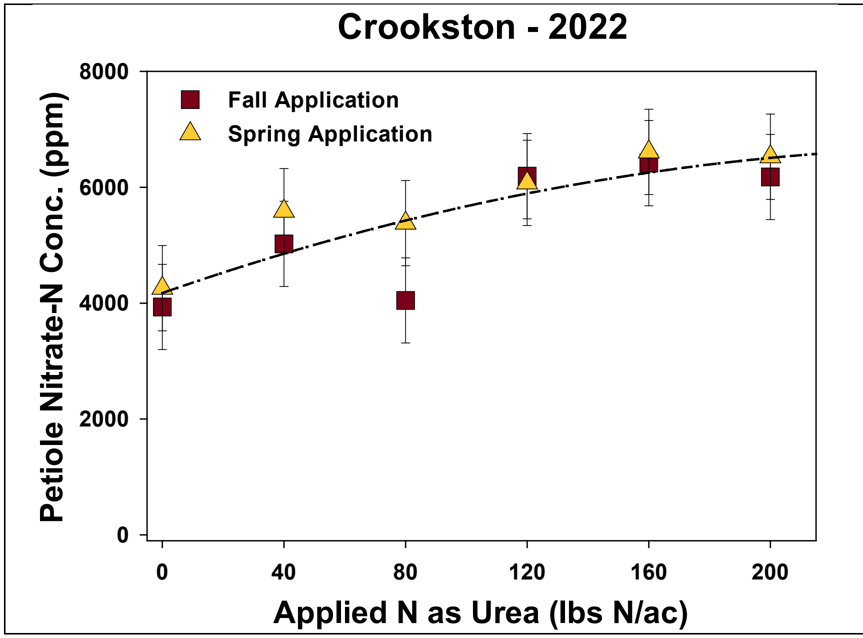


Figure 5b. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet early to mid-July petiole nitrate measured from the newest fully developed leaf at two Minnesota locations during the 2022 growing season.

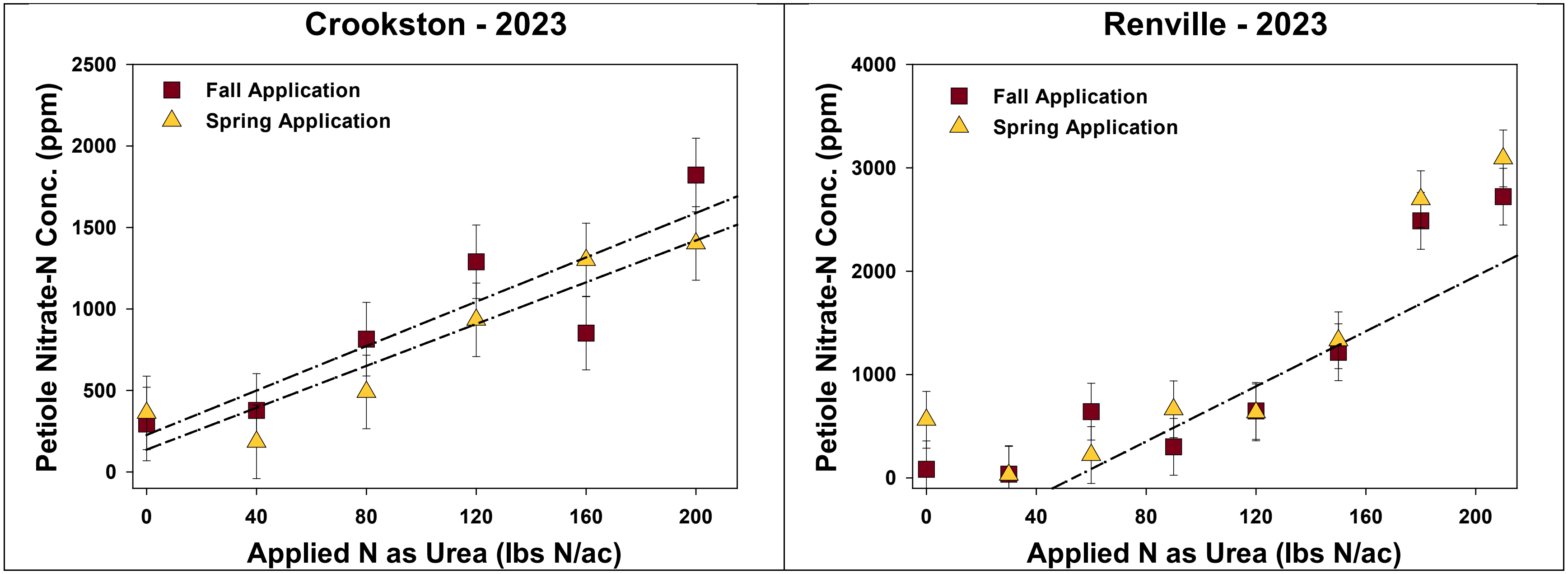


Figure 5c. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet early to mid-July petiole nitrate measured from the newest fully developed leaf at two Minnesota locations during the 2023 growing season

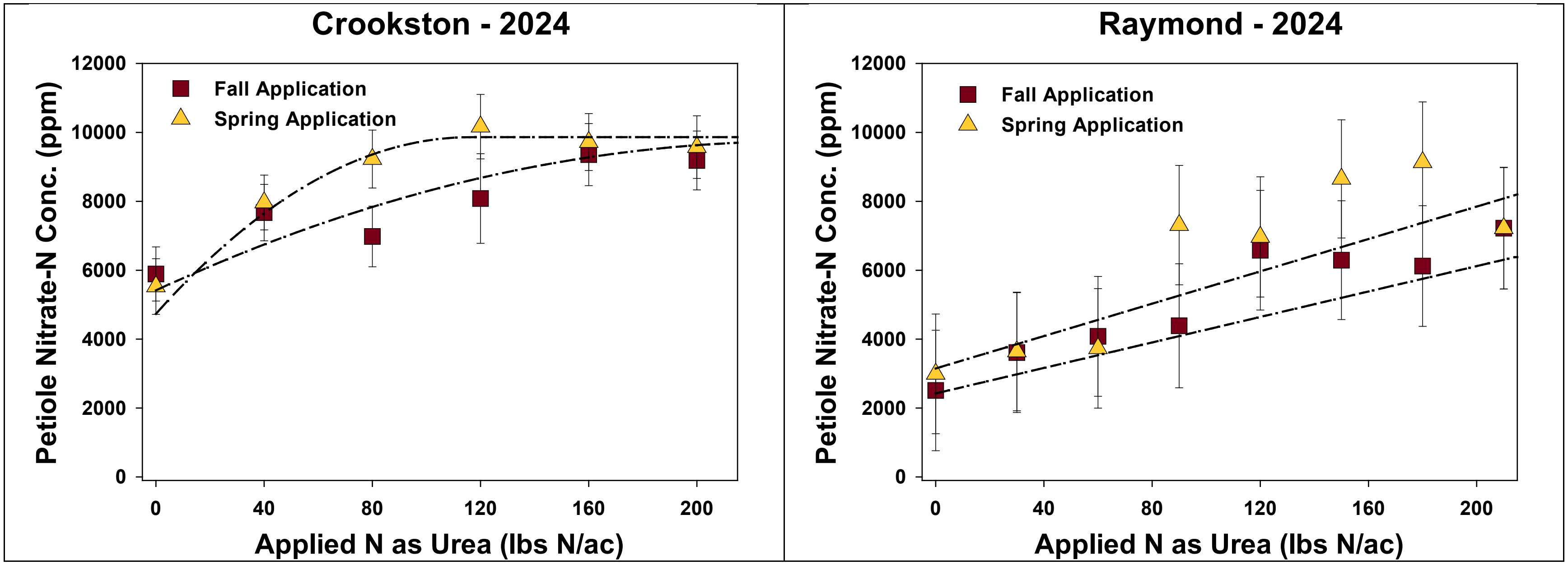


Figure 5d. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet early to mid-July petiole nitrate measured from the newest fully developed leaf at two Minnesota locations during the 2024 growing season.

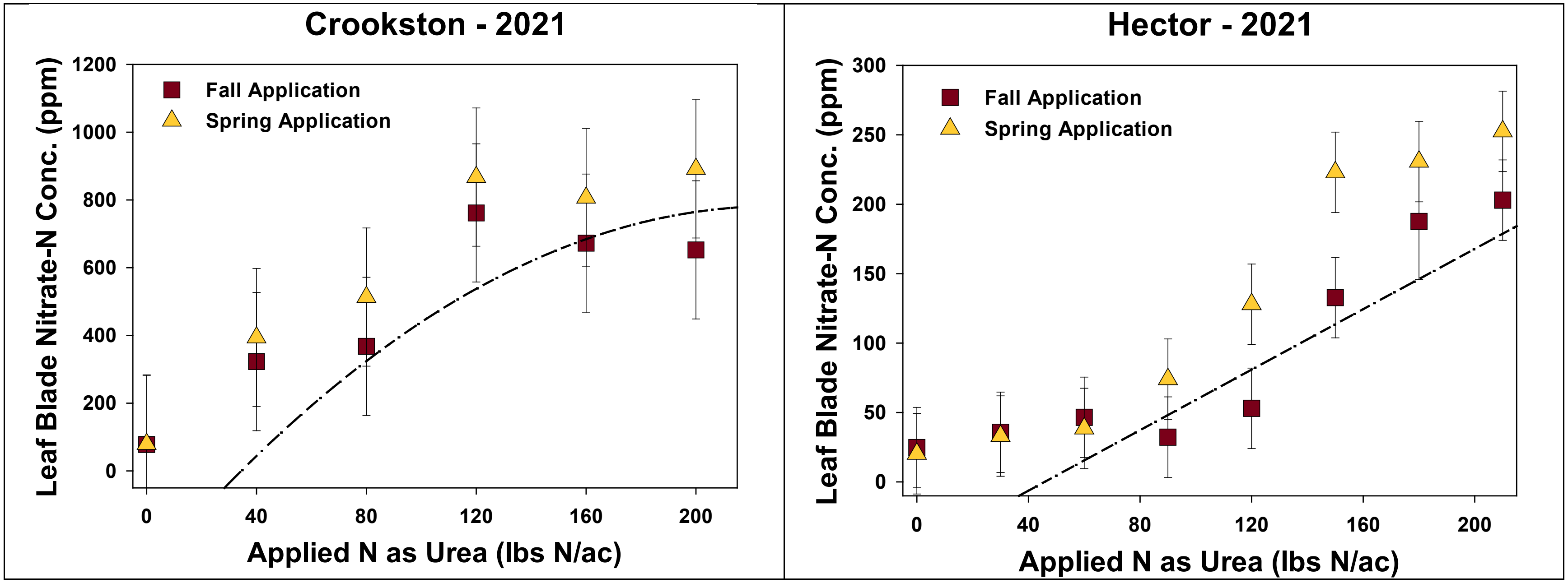


Figure 6a. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet early to mid-July leaf blade nitrate measured from the newest fully developed leaf at two Minnesota locations during the 2021 growing season.

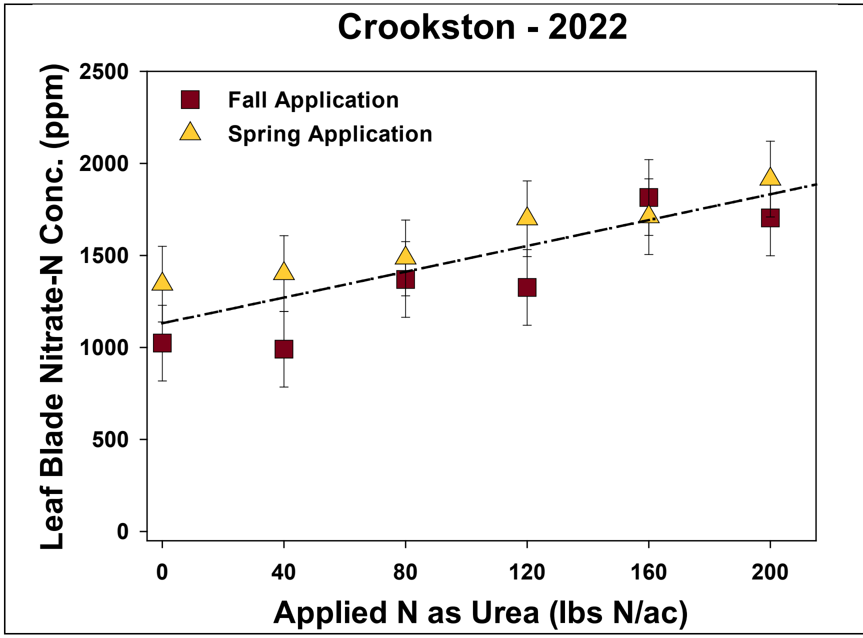


Figure 6b. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet early to mid-July leaf blade nitrate measured from the newest fully developed leaf at two Minnesota locations during the 2022 growing season

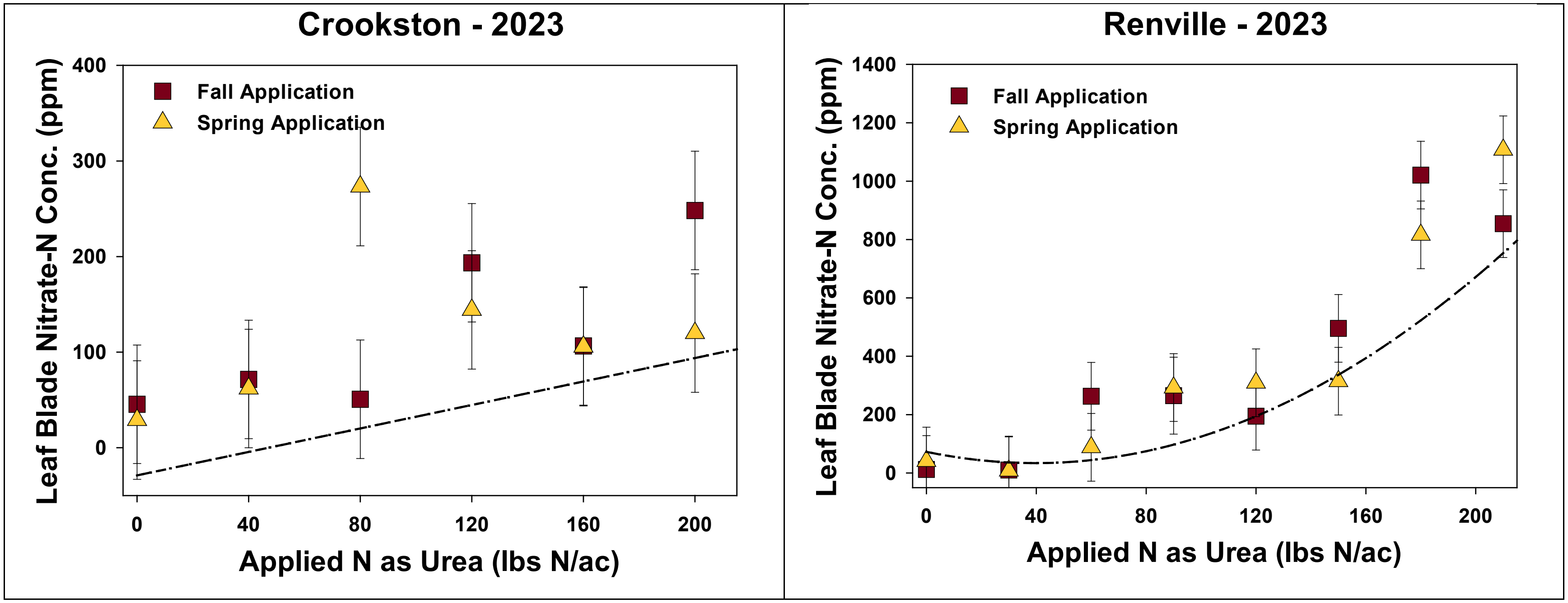


Figure 6c. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet early to mid-July leaf blade nitrate measured from the newest fully developed leaf at two Minnesota locations during the 2023 growing season.

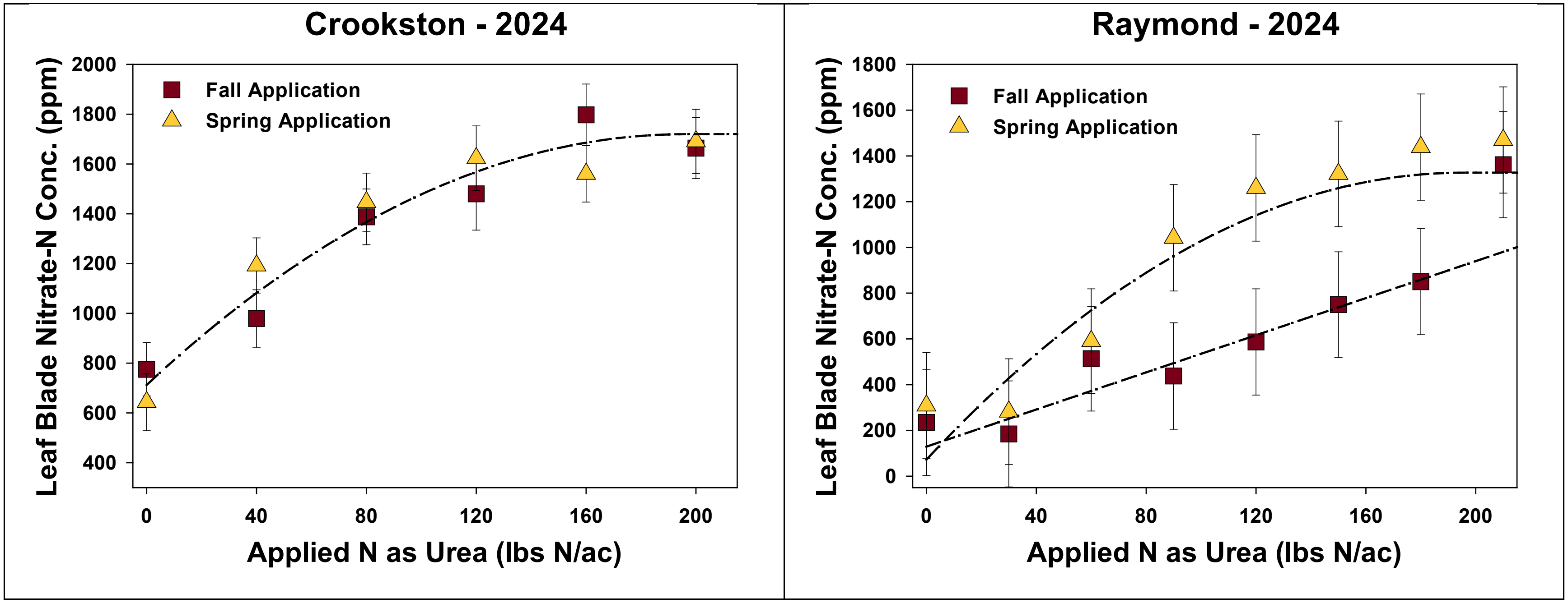


Figure 6d. Effect of nitrogen applied as fall or spring urea (data averaged for both timings) on sugar beet early to mid-July leaf blade nitrate measured from the newest fully developed leaf at two Minnesota locations during the 2024 growing season.

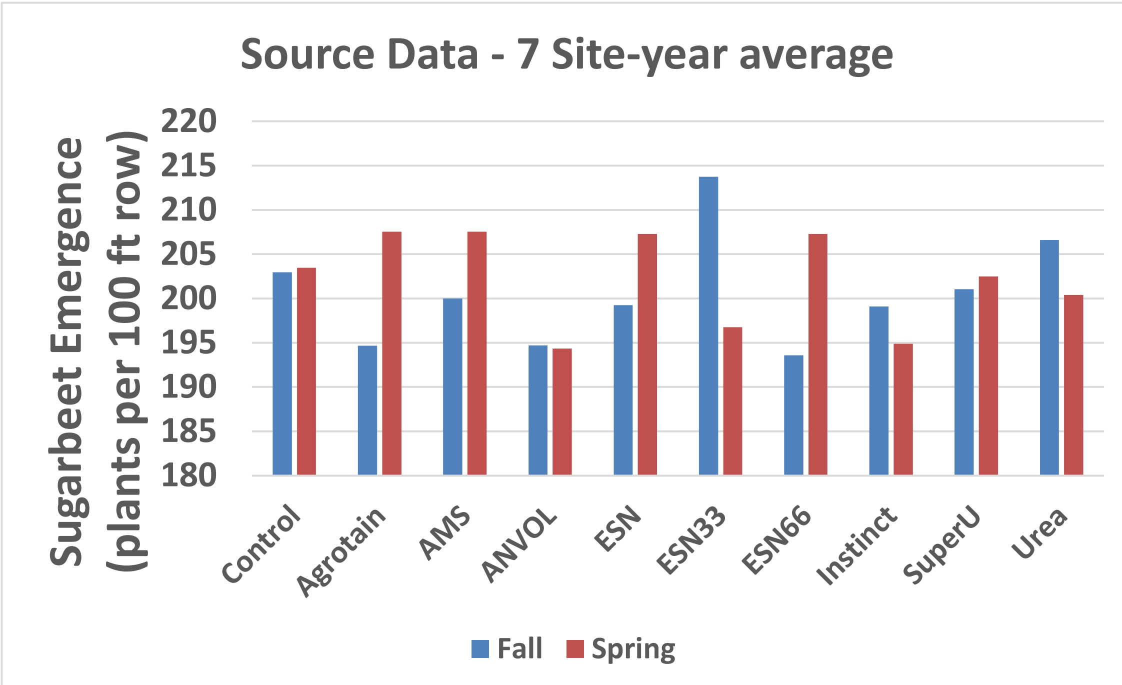
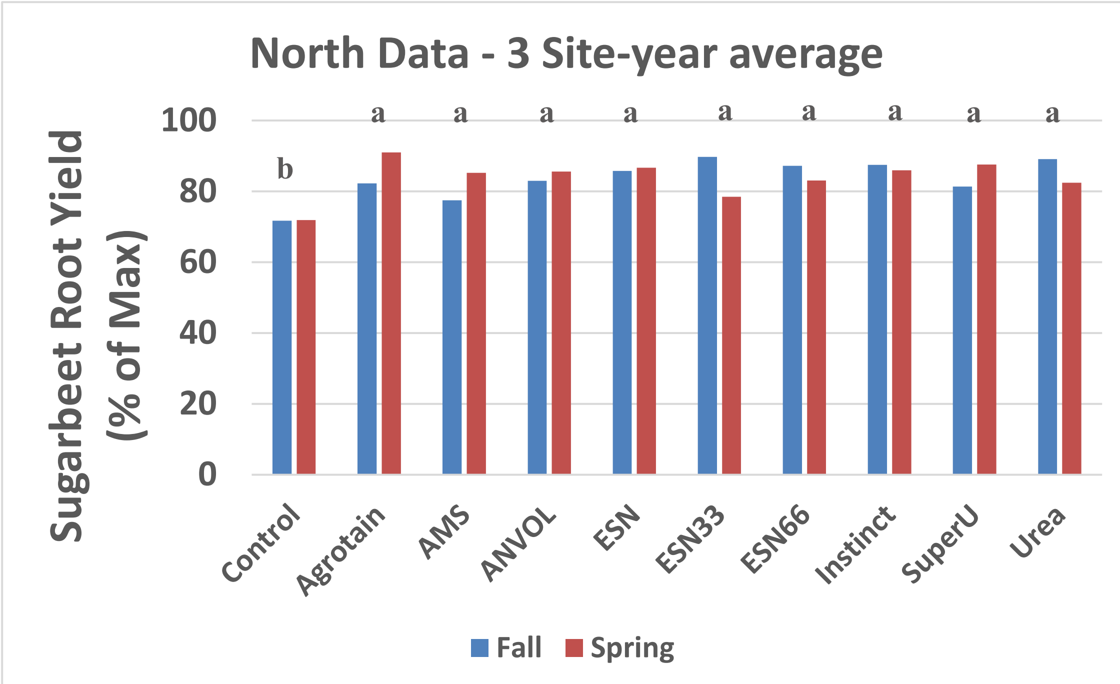


Figure 7. Summary of the impact of urea timing and source impacts on sugarbeet emergence following application of multiple urea sources and ammonium sulfate applied at 45 lbs. of N per acre summarized across 7 site-years for northern and southern Minnesota locations.



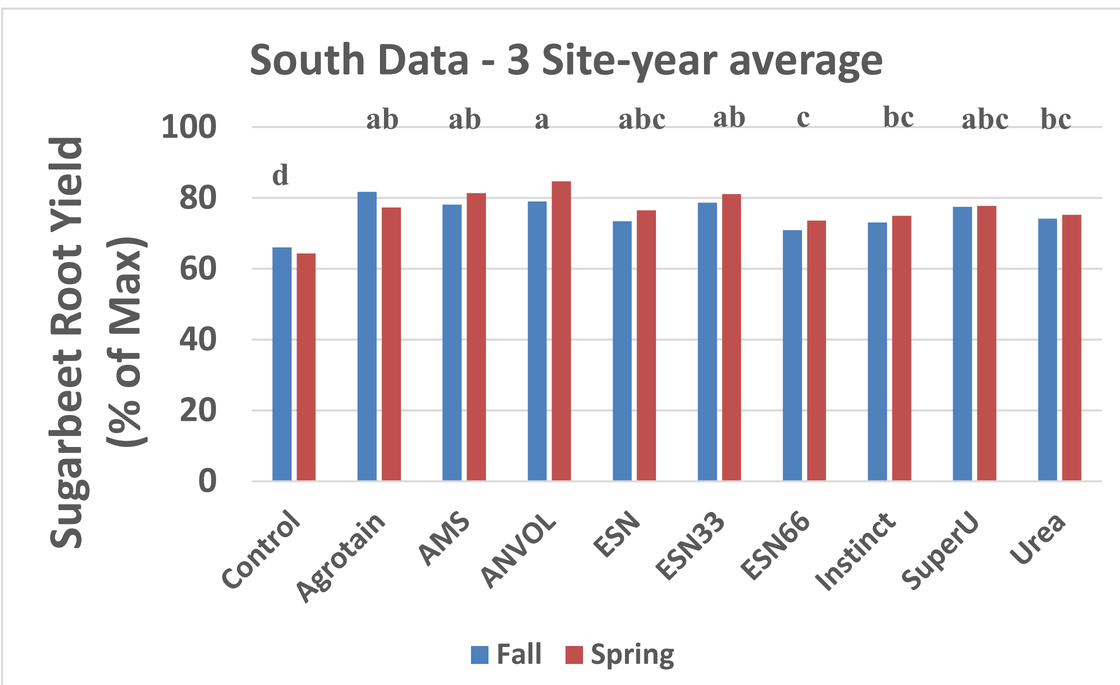


Figure 8. Summary of the impact of urea timing and source impacts on sugarbeet root yield following application of multiple urea sources and ammonium sulfate applied at 45 lbs. of N per acre summarized by northern and southern Minnesota locations.

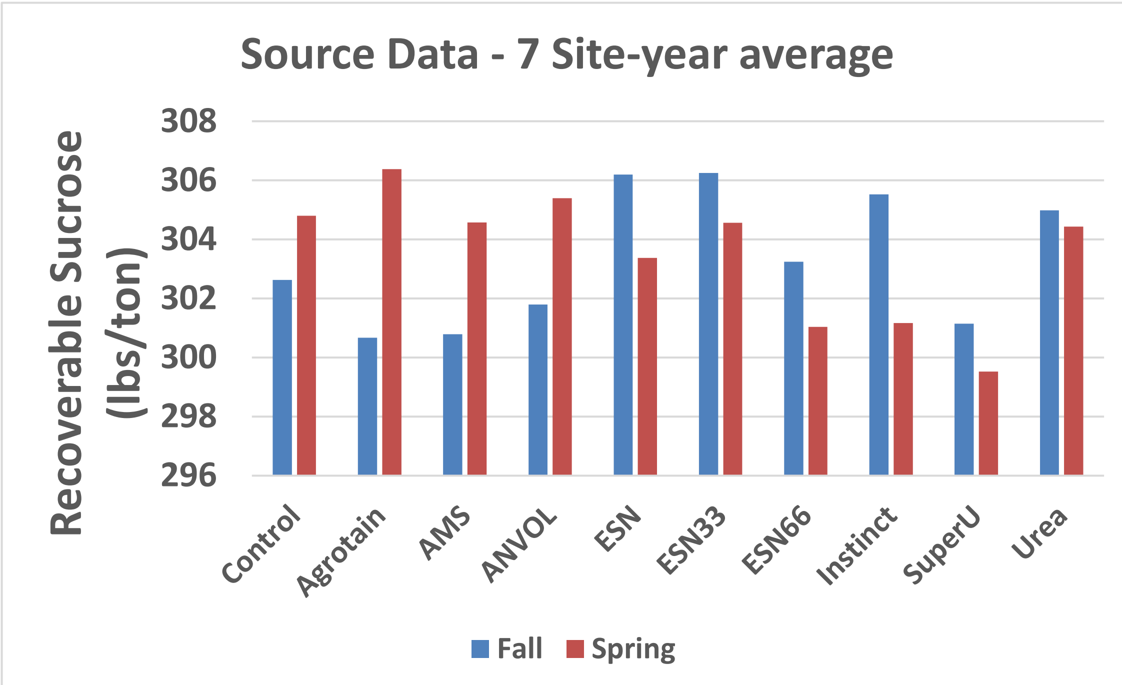


Figure 9. Summary of the impact of urea timing and source impacts on sugarbeet extractable sucrose per ton following application of multiple urea sources and ammonium sulfate applied at 45 lbs. of N per acre summarized across 7 site-years for northern and southern Minnesota locations.

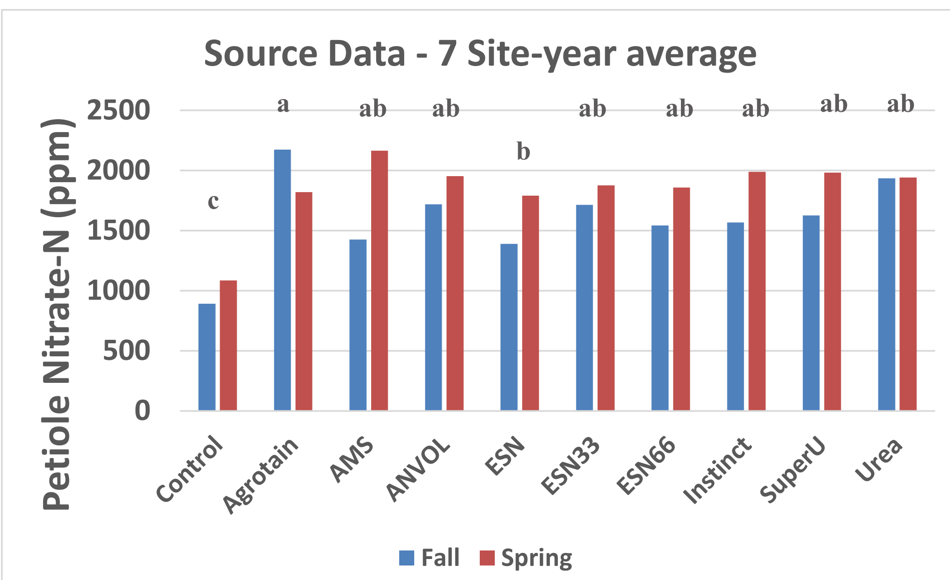


Figure 10. Summary of the impact of urea timing and source impacts on sugarbeet petiole nitrate-N concentration from the uppermost fully developed leaf 40-50 days after planting following application of multiple urea sources and ammonium sulfate applied at 45 lbs. of N per acre summarized across 7 site-years for northern and southern Minnesota locations.

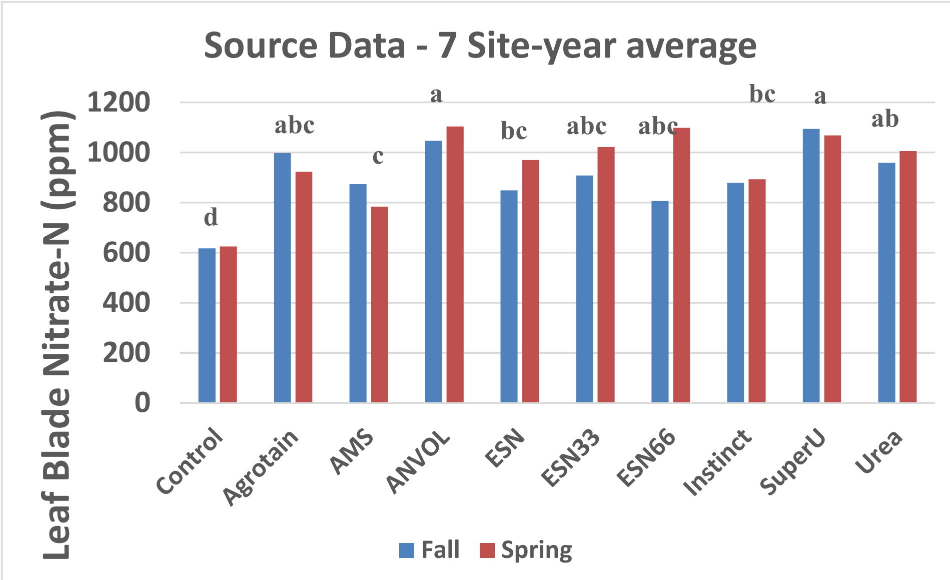
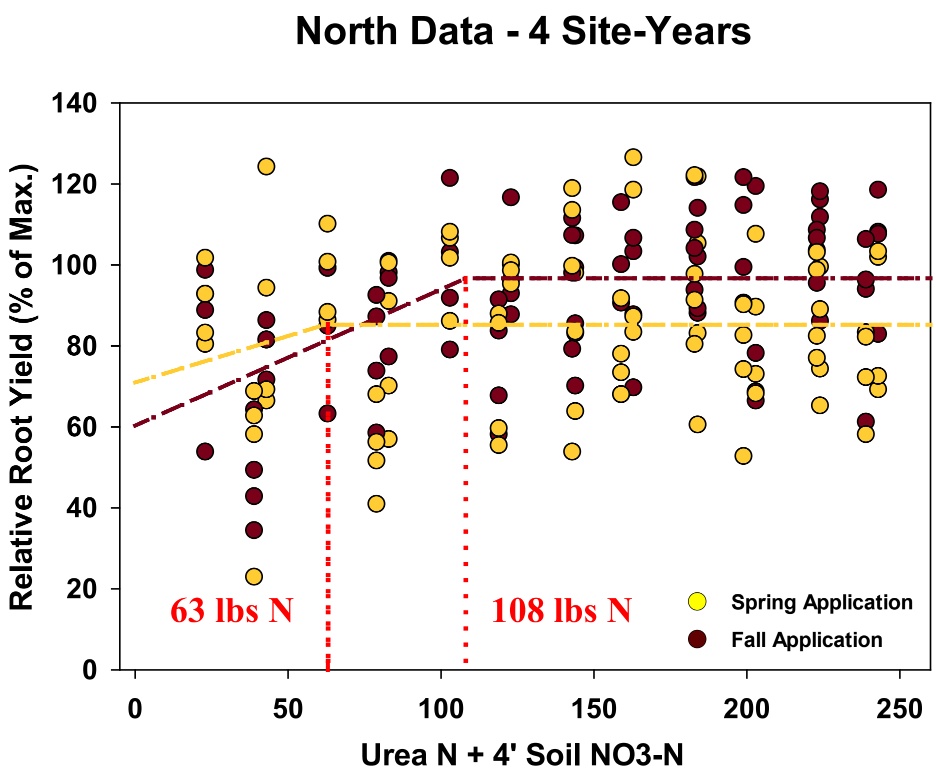


Figure 11. Summary of the impact of urea timing and source impacts on sugarbeet leaf blade nitrate-N concentration from the uppermost fully developed leaf 40-50 days after planting following application of multiple urea sources and ammonium sulfate applied at 45 lbs. of N per acre summarized across 7 site-years for northern and southern Minnesota locations.



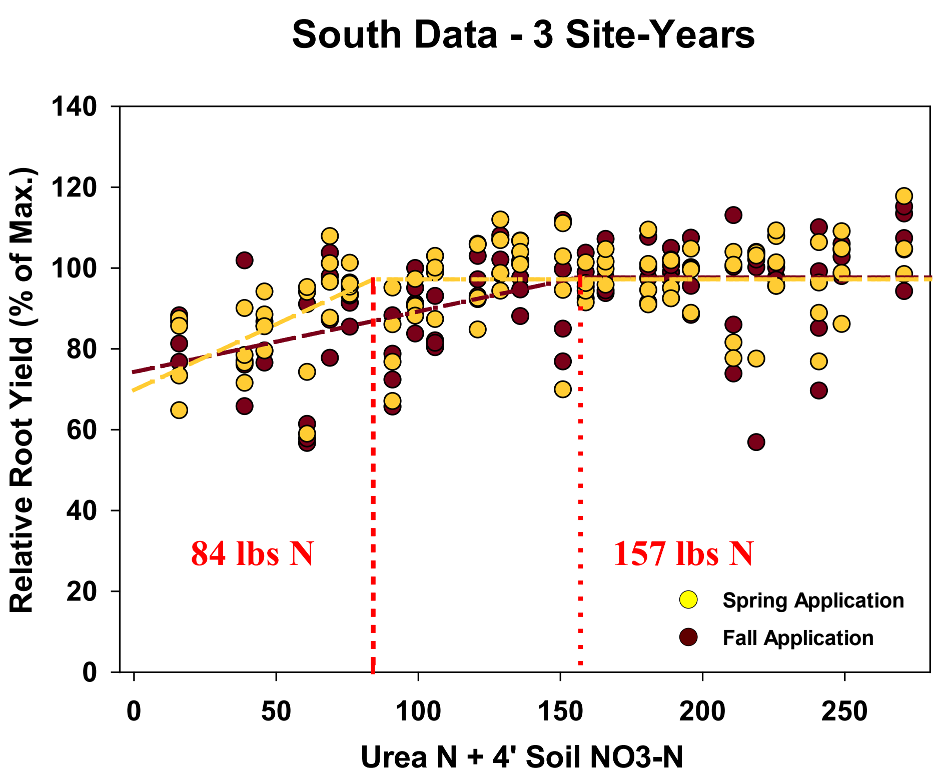
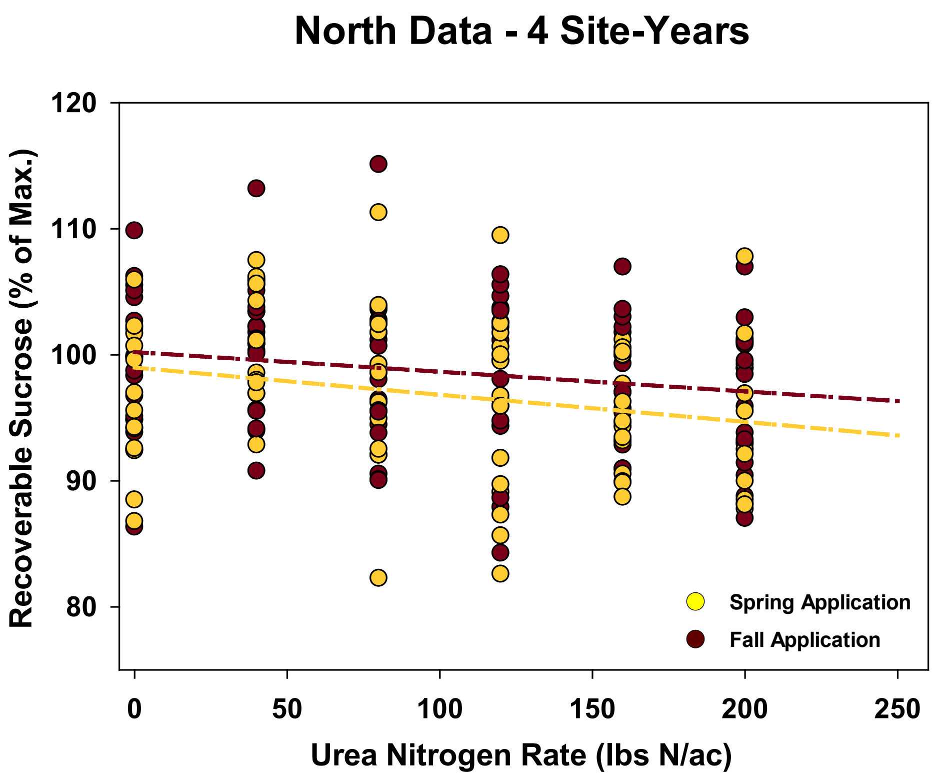


Figure 12. Summary of the impact of urea timing and rate on root yield summarized for data collected in the Northern and Southern growing regions from 2021 through 2024 growing seasons.



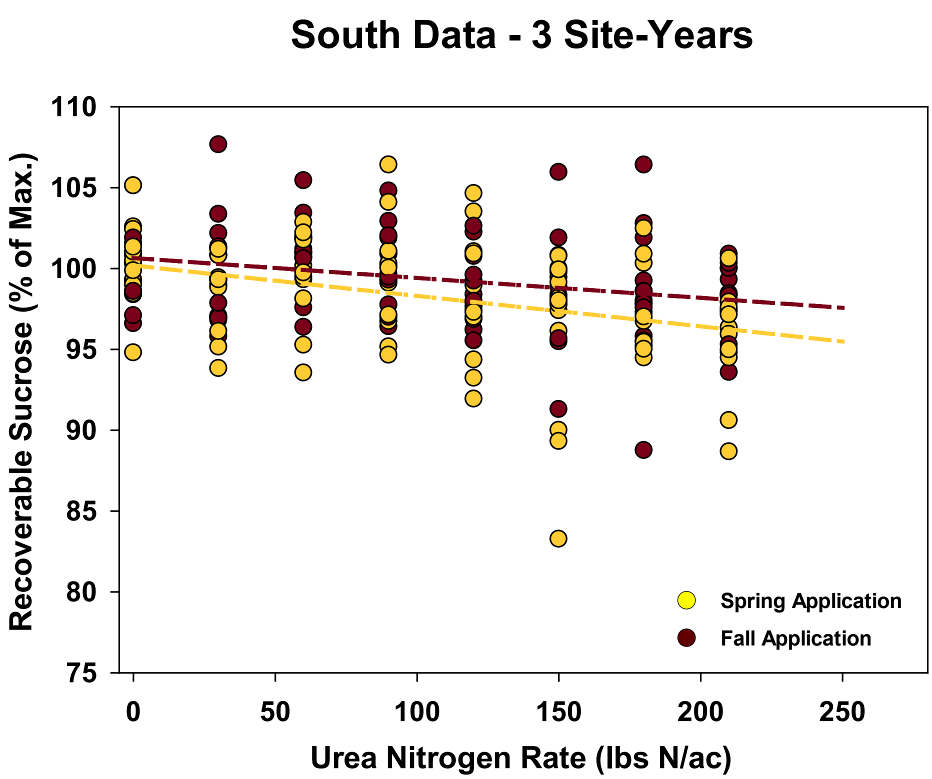
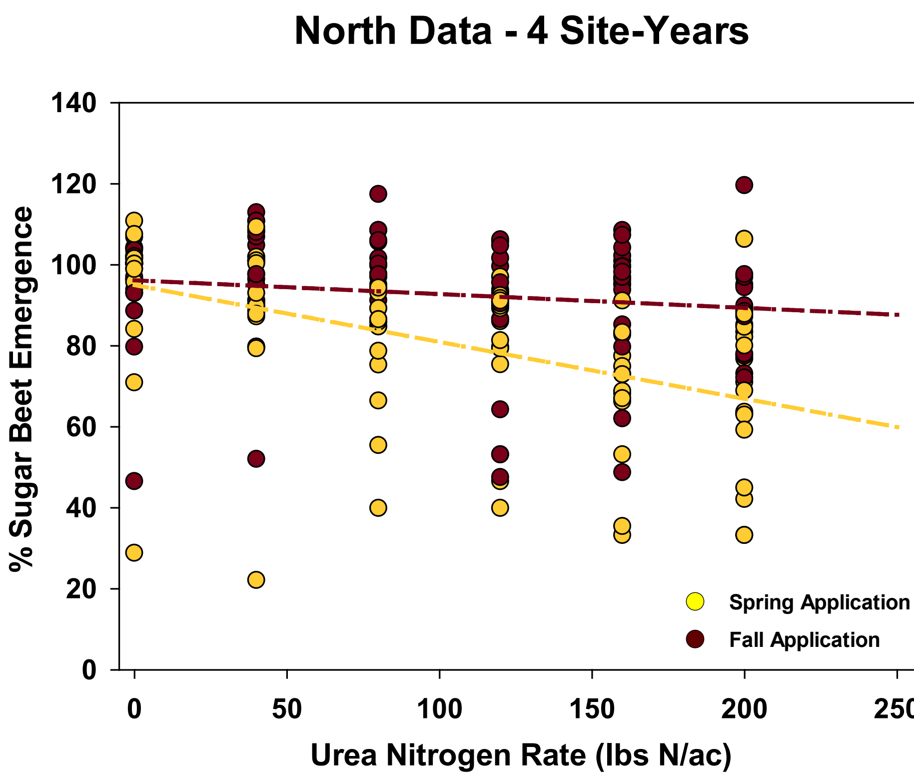


Figure 13. Summary of the impact of urea timing and rate on recoverable sucrose per ton summarized on data collected in the Northern and Southern growing regions from 2021 through 2024 growing seasons.



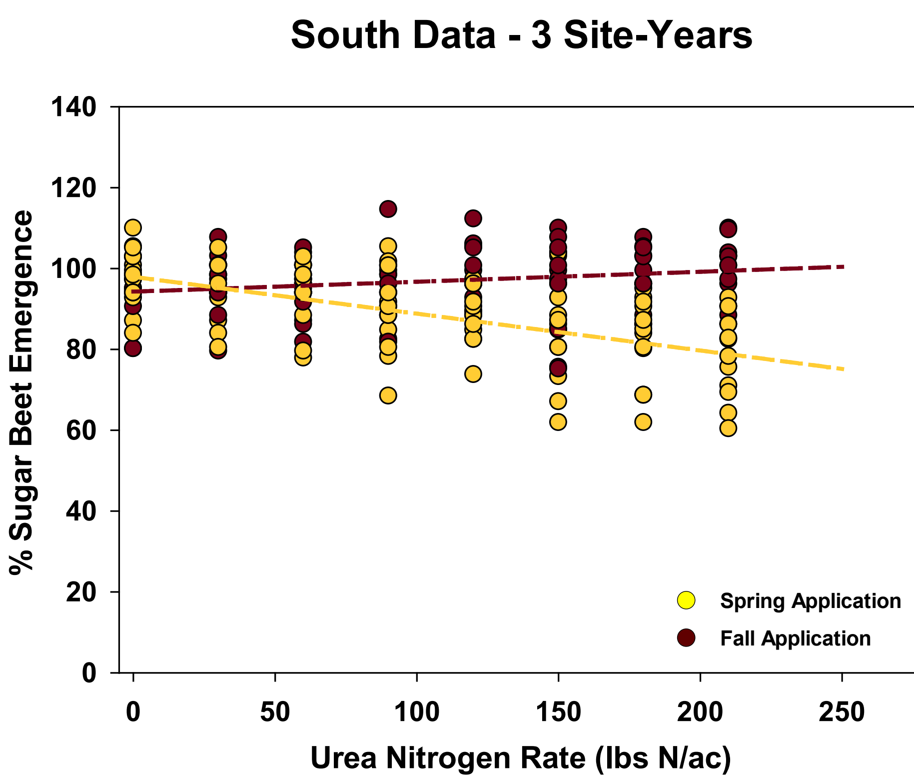


Figure 14. Summary of the impact of urea timing and rate on sugarbeet emergence summarized on data collected in the Northern and Southern growing regions from 2021 through 2024 growing seasons.

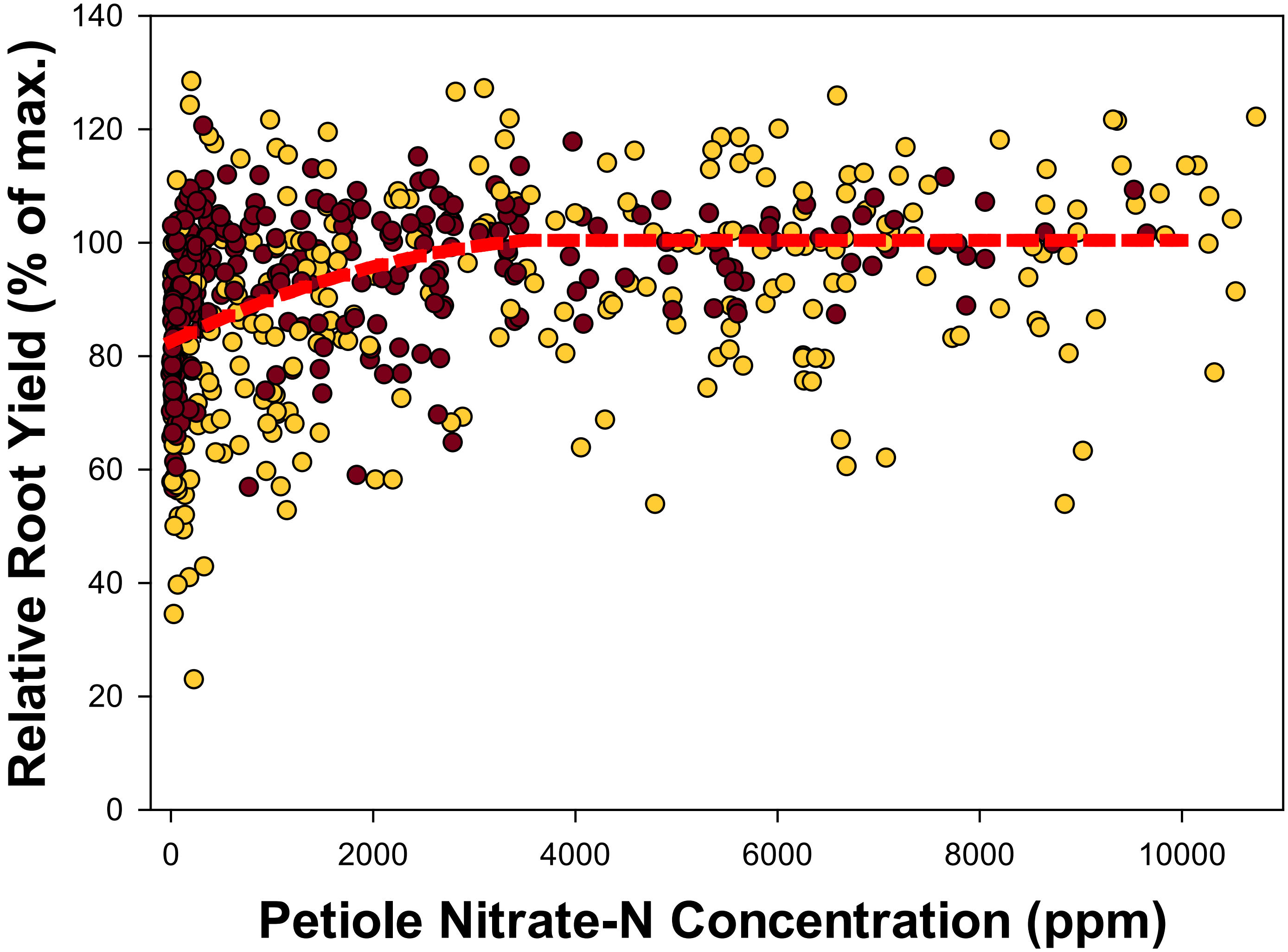


Figure 15. Relationship between relative sugar beet root yield (% of site maximum yield) and nitrate concentration in the uppermost fully developed petiole sampled in early- to mid-July roughly 40 to 50 days after planting. Maroon dots represent southern MN locations. Gold dots represent data from Crookston.

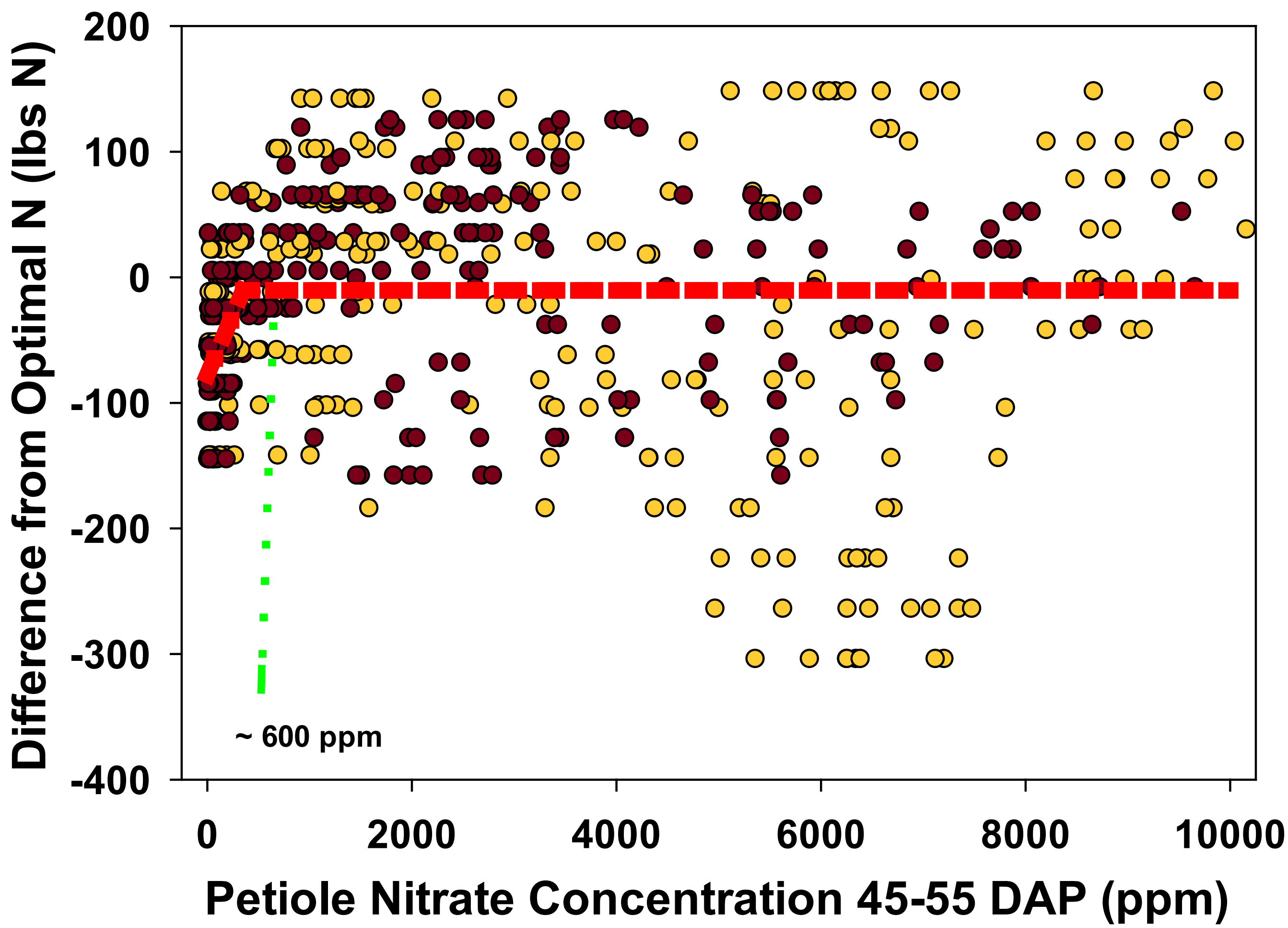


Figure 16. Relationship between the difference in the amount of N applied per plot and the amount of N required for optimum root yield and nitrate concentration in the uppermost fully developed petiole sampled in early- to mid-July roughly 40 to 50 days after planting. Maroon dots represent southern MN locations. Gold dots represent data from Crookston.

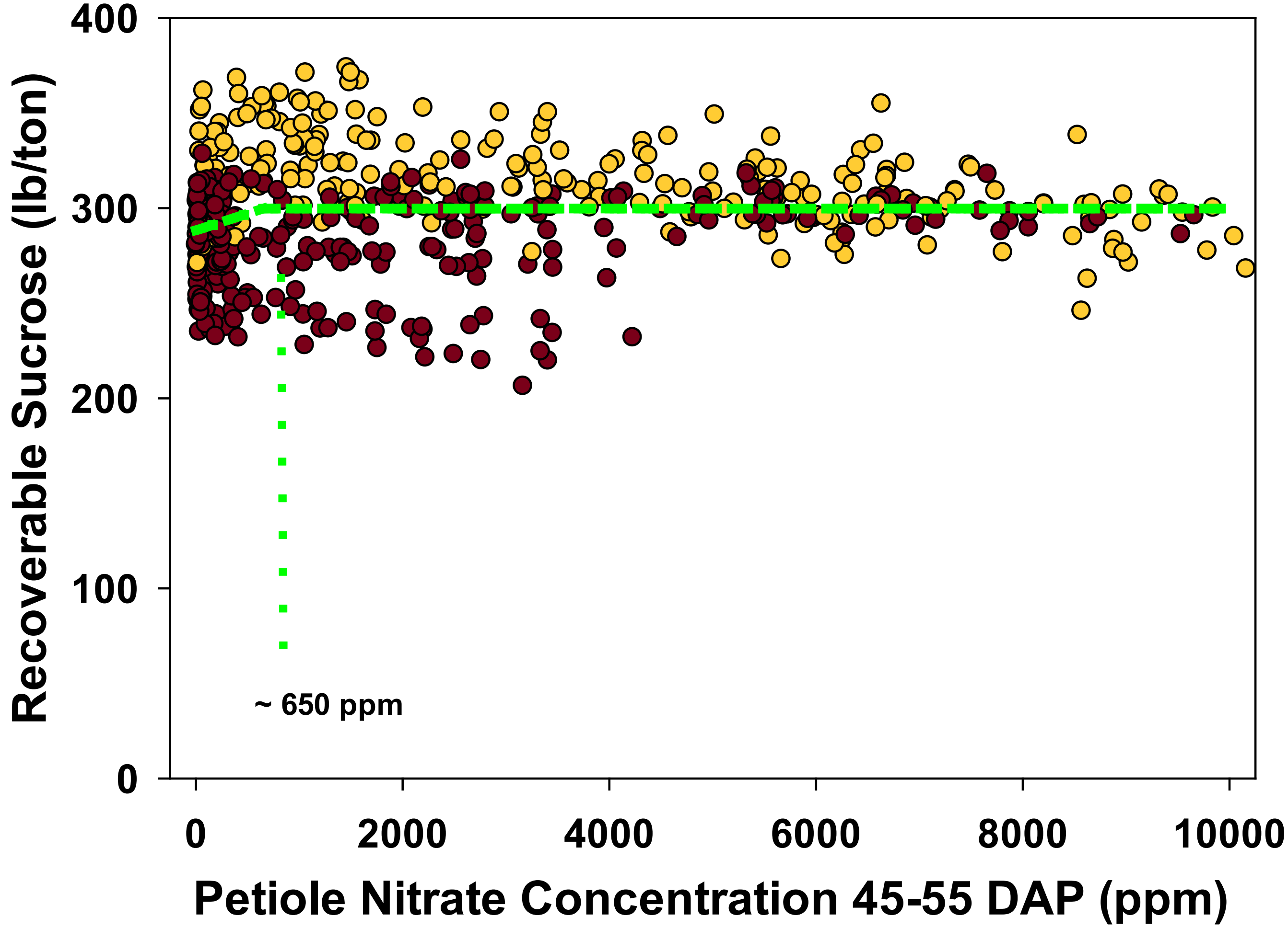


Figure 17. Relationship between recoverable sucrose per ton and nitrate concentration in the uppermost fully developed petiole sampled in early- to mid-July roughly 40 to 50 days after planting. Maroon dots represent southern MN locations. Gold dots represent data from Crookston.

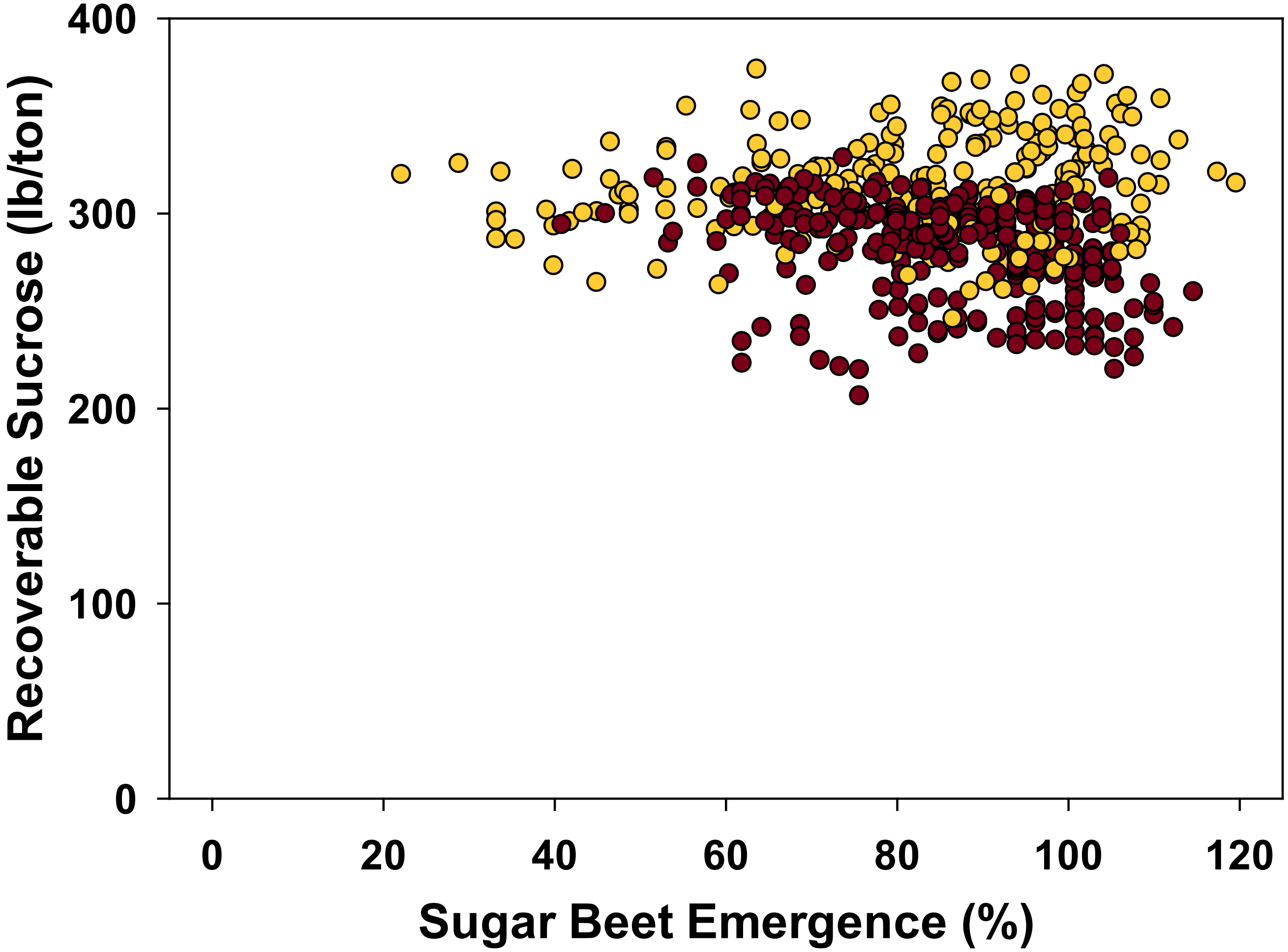


Figure 18. Relationship between recoverable sucrose per ton and sugar beet emergence presented and the % of planted seeds. Maroon dots represent southern MN locations. Gold dots represent data from Crookston.

MID- TO LATE-SEASON N MINERALIZATION POTENTIAL OF NORTHWEST MINNESOTA AND NORTH DAKOTA SOILS

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Introduction:

Optimization of nitrogen (N) fertility for sugar beet production is critical for maximizing relative sugar yields, but establishing economically optimum N application rate is challenging. In-season mineralization of organic nitrogen affects sugar yield and N fertilizer requirements of sugar beets. Yet, variability in soil conditions both within and across sites limits our ability to accurately predict N mineralization potential. Weather conditions, soil moisture, soil characteristics, and crop residue can all affect N mineralization rates in corn and soybeans (Fernandez et al., 2017). However, available knowledge on how these processes might affect N mineralization in sugar beets is limited.

Previous studies in sugar beets have evaluated whether the previous crop and crop residues may affect N mineralization rates and/or recoverable sugar. Moraghan et al. (2003) found that while mature wheat straw decreased relative sugar yields (RSY) by using up available N during decomposition, volunteer wheat residue increased RSY. Sims (2007) found that N mineralization rates were similar following either wheat or soybeans but were lower when following corn. Similarly, Chatterjee et al. (2019) found that sugar beets following corn required up to 100 lb/ac of additional N to account for residue decomposition when compared to sugar beets following spring wheat.

Objectives:

To improve our understanding of the site-specific characteristics that affect mineralization potential, we pursued the following objectives:

1. Estimate the quantity of N mineralized in sugar beet plots during the growing season
2. Determine if N mineralized is affected by site-specific factors such as subsurface drainage, soil texture, or tillage system

Materials and Methods:

This experiment was conducted across various sugar beet plots at the Northwest Research & Outreach Center in Crookston, MN. We monitored N mineralization in sugarbeet plots for two soil textures (loam and silty clay), two drainage conditions (drained and undrained), two tillage systems (strip-till and conventional till), and three cover crop conditions (spring oat nurse crop, fall rye, and no cover crop) (table 1). Wheat preceded sugarbeets in each test plot area.

Table 1. Site characteristics of sugarbeet plots used in mineralization sampling in 2024

Site	Soil	Drainage	Tillage	Cover Crop	n	Planting Date	Harvest Date	Mineralization Start	Mineralization End	Incubation Periods
A1	Silty clay	Tile	Conventional	Spring Oat	3	4/24/24	9/17/24	6/06/24	9/13/24	7
A2	Silty clay	No tile	Conventional	Spring Oat	3	4/24/24	9/17/24	6/06/24	9/13/24	7
A3	Silty clay	Tile	Conventional	Spring Oat	3	4/24/24	9/17/24	6/06/24	9/13/24	7
A4	Silty clay	No tile	Conventional	Spring Oat	3	4/24/24	9/17/24	6/06/24	9/13/24	7
B1	Silty clay	Tile	Conventional	No Cover	3	5/14/24	9/13/24	6/16/24	9/13/24	7
B2	Silty clay	No tile	Conventional	No Cover	3	5/14/24	9/13/24	6/16/24	9/13/24	7
C1	Loam	No tile	Conventional	No Cover	6	5/02/24	9/16/24	6/07/24	9/13/24	7
C2	Loam	No tile	Strip-till	Spring Oat	6	5/02/24	9/16/24	6/07/24	9/13/24	7
C3	Loam	No tile	Strip-till	No Cover	6	5/02/24	9/16/24	6/07/24	9/13/24	7
C4	Loam	No tile	Strip-till	Fall Rye	6	5/02/24	9/16/24	6/07/24	9/13/24	7

We used an in-situ incubation method to evaluate nitrogen mineralization potential under different soil and management conditions throughout the growing season (Raison, 1987; Fernandez et al., 2017). In-situ incubation cores were replaced approximately every 21 days during the growing season (June to September). Each time incubation cores were replaced we collected soil moisture and soil temperature within 6 inches of the ground surface.

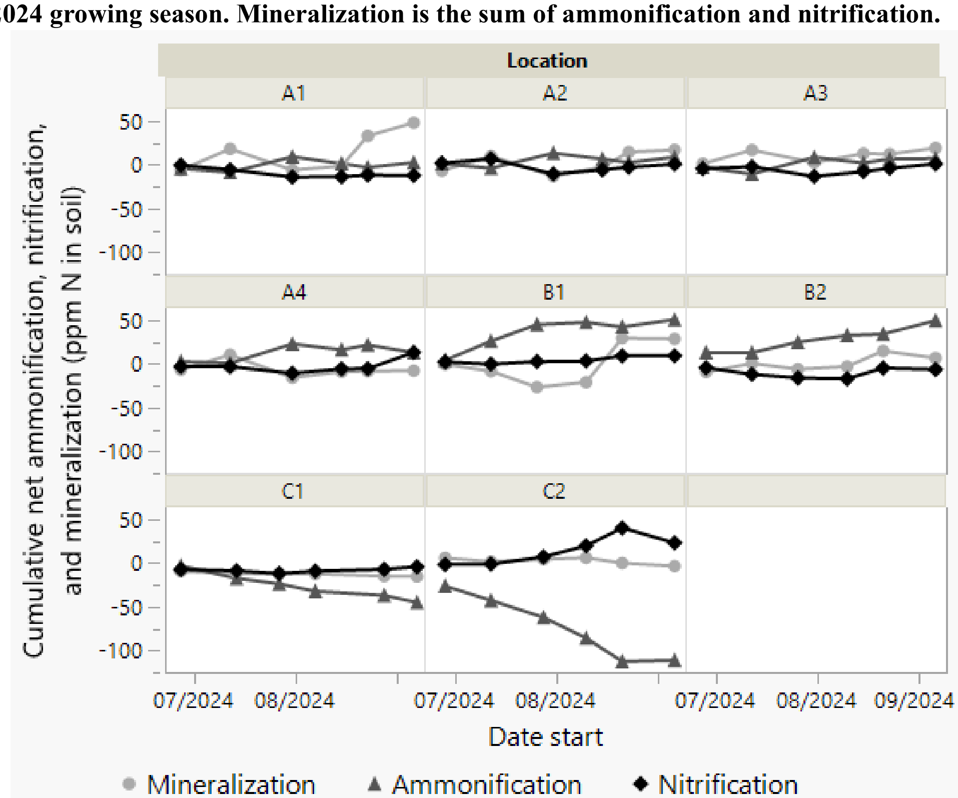
Soils from the incubation cores were air-dried and ground prior to analysis. Soils were extracted with KCl solution followed by analysis on a SEAL discrete analyzer to determine inorganic N content (ammonium- and nitrate-N). Net ammonification and net nitrification were calculated by subtracting post-incubation ammonium- and nitrate-N from initial values for each incubation period. Cumulative net mineralization was calculated by summing net mineralization from each incubation period.

Differences in cumulative mineralization across plots were evaluated using a multiple linear regression approach. The response variable “cumulative mineralization” was approximately normally distributed. The main factors “soil type,” “tillage,” “drainage,” and “fall cover,” and “spring cover” were evaluated for collinearity using variance inflation factor (VIF) testing. None of the main factor terms found to be collinear with VIF > 5. Statistical analyses were carried out in JMP PRO 17.2.0 (JMP Statistical Discovery, 2023). Initial selection of model terms was conducted using a forward selection procedure with the minimum Corrected Akaike’s Information Criterion (AICc) to define the “optimal” model (Akaike, 1974; Burnham and Anderson, 2004) using Stepwise Fit within the Fit Model Platform in JMP. This procedure systematically evaluated factors for inclusion in the model and was used to improve the model’s goodness of fit while adjusting for increased model complexity to reduce the probability of overfitting the model.

Results and Discussion:

Cumulative net ammonification, nitrification, and mineralization varied by location (figure 1). In most plot locations, N accumulated throughout the growing season, but N cycling was not always accumulating. This indicates that both immobilization and mobilization processes were happening during the growing season.

Figure 1: Cumulative net ammonification, nitrification, and mineralization collected within each field location during the 2024 growing season. Mineralization is the sum of ammonification and nitrification.



One main factor was significantly associated with mineralization during the 2024 growing season: tillage. Cumulative net mineralization was lower for strip-till plots by the end of the growing season than conventionally tilled plots. This means that overall, more inorganic nitrogen was immobilized in these plots compared to the other soil treatments (Raison et al., 1987). Lower cumulative mineralization in strip-till plots may have been slowed due to retention of crop residue (wheat stubble from the 2023 growing season) on the ground surface (e.g., Raison et al., 1987; Salahin et al., 2010). This result is in line with the findings of previous work on sugarbeets and suggests that strip-tillage may require some adjustments in N crediting to account for decreased carbon in the root zone (Moraghan et al., 2003; Lamb et al. 2009). Further research is needed to determine the impact of nitrogen cycling and its timing on sugarbeet yield.

Acknowledgements:

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IS STARTER P NEEDED AT "MEDIUM" SOIL TEST FERTILITY LEVELS?

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Introduction:

Typical fertility recommendations suggest that soils may show a fertility response to starter phosphorus (P) even at higher soil test P (STP) levels. Given these recommendations combined with P fertilizer prices in 2023 trending lower than in 2022, many growers are likely planning to apply starter P at-planting as a low-cost way to boost root yield and recoverable sugar. Nevertheless, there is limited evidence on the benefits of starter P at higher STP levels. Further research is needed to evaluate whether starter P application is economically beneficial at higher soil fertility levels. In year 1, this project would explore the efficacy of starter P on a “medium” STP Wheatville loam in Crookston. This project would be expanded to other soil types and/or to include different starter formulations in 2025. This project is intended to be an initial step toward validating P fertility recommendations for sugarbeets.

Prior soil fertility work conducted in the Red River Valley has demonstrated that a 3 gal/ac application of 10-34-0 starter to “very low” to “low” testing soils (STP < 8 ppm Olsen P) can be beneficial to boosting sugarbeet yield and recoverable sugar (e.g., Franzen et al., 2008; Sims, 2010; Chatterjee and Cattanach, 2017). However, these same studies suggest limited to no response to starter P when applied above these fertility levels. Preliminary data collected at NWROC in 2023 also suggested that starter fertilizer application on soil with a “medium” STP did not result in increased yield or recoverable sugar at harvest. Sugarbeet stand generally improved with starter P application during the first month after planting, but this did not translate to greater yields by the end of the season.

Objectives:

The goal of this research is to validate current P fertility guidelines and evaluate whether adjustments are needed by:

- Evaluating whether starter P provides a substantial benefit above a 0 P control when soils are at the “medium” soil fertility level.

Materials and Methods:

This trial evaluated six P rate x timing treatments on a Wheatville loam soil at the Northwest Research & Outreach Center in Crookston, MN (table 1).

Table 1. Rate x treatment timings for P-starter Trial in 2024

Treatment	Product(s)	Rate	P_2O_5 Applied (lb ac^{-1})	
			Fall	Spring
Starter 1	10-34-0	3 gal ac^{-1}	40	12
Starter 2	XLR-Rate (7-23-5)	3 gal ac^{-1}	40	8
Broadcast	MAP (11-52-0)	83 lb ac^{-1}	40	43
Control	Control	0 lb ac^{-1}	40	0
Starter 1 + Broadcast	10-34-0 + MAP	3 gal ac^{-1} + 60 lb ac^{-1}	40	43
Starter 2 + Broadcast	XLR-Rate + MAP	3 gal ac^{-1} + 67 lb ac^{-1}	40	43

General soil fertility analysis was conducted for the plot area in Fall 2023. All plots received fall fertilizer at a rate of 40 lb ac^{-1} and this was incorporated with tillage. In the spring, broadcast fertilizer treatments were hand-applied across the plot area and incorporated with tillage. Starter treatments were applied in-furrow at planting on May 2, 2024. Treatments were arranged in a randomized complete block design with five replicates. Plots followed standard herbicide and pesticide treatments through the growing season according to university recommendations. The middle two rows of each plot were mechanically harvested at the end of the season on September 16, 2024 and were analyzed for root yield and quality. Root yield and quality were evaluated using a one-way ANOVA and a post-hoc Tukey test to evaluate significant differences among treatments. Treatments were considered significantly different at $\alpha < 0.1$.

Results and Discussion:

There were no significant differences in sugarbeet yield and quality by treatment during the 2024 growing season (table 2). This confirms previous work in sugarbeet fertility that finds a minimal yield benefit to applying additional P fertilizer once the "medium" fertilizer threshold is reached. While additional applications of P fertilizer do not appear to be detrimental to yields, it did not provide a substantial monetary benefit during the 2024 growing season.

Table 2. Sugarbeet yield and quality metrics by treatment

Treatment	Root Yield (t ac^{-1})	Recoverable sucrose (%)	Recoverable sucrose per acre (RSA)	Recoverable sucrose per ton (RST)
Starter 1	34.2	13.8	9400	276.6
Starter 1 + Broadcast	33.6	13.3	8921	265.6
Control	32.2	13.5	8708	270.1
Broadcast	34.9	13.2	9218	264.6
Starter 2	34.6	14.1	9755	282.5
Starter 2 + Broadcast	34.1	13.2	8995	264.5
Overall	33.9	13.5	9166	270.6
	n.s.	n.s.	n.s.	n.s.

Acknowledgements:

We thank the Sugarbeet Research and Education Board of Minnesota and North Dakota for providing funding for this work.

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ASSESSING BEET YIELD AND QUALITY AFTER FALL AND SPRING COVER CROPS

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Summary

1. Yield tonnage and sugar content were similar after fall, or spring, or no cover crops
2. Fall-seeded cover crops grew more biomass than spring-seeded cover crops, lowering erosion risk but not altering any soil parameters measured prior to beet planting in the spring.

Abstract

Here, we worked with SBREB to complete a two-year project exploring the effects of cover crops before and after sugar beets in rotation. Specifically, we focused on comparing beet outcomes and soil health after fall and spring cover crops or no cover crops. Successful fall cover crops reduce soil, phosphorus, and nitrogen losses during the fallow period. This presents an opportunity for savings on fertilizer costs and reducing water quality impacts. In addition, a robust pre-beet cover crop suppresses competitive herbicide-resistant weeds (Florence et al. 2019, Camargo Silva and Bagavathiannan 2023), which are spreading throughout the Upper Midwest (Singh et al. 2024). In order to mitigate risk for farmers adopting these new practices, our research evaluated different planting and termination timings of various cover crop species in strip-till sugarbeets. By combining on-farm trials across Minnesota’s beet-growing region and plot-scale trials at the University of Minnesota Northwest Research and Outreach Center (NWROC) in Crookston, MN, we were able to test the practice across a range of environmental conditions, and found minimal discernible difference in sugarbeet yield or sugar content. In one of seven site-years across farm and NWROC experiments, beets planted after a fall-seeded rye cover crop yielded greater tonnage than a control plot with no cover crop. Similarly, we observed only one small difference in soil organic proteins, where in one site-year cover crops led to lower levels. We hope these null results, alongside SBREB data showing competitive yields between strip- and full-width tillage sugarbeets (Hoppe et al), can help growers feel confident of agronomic success with soil conservation practices in beet production.

Summary of Literature Review: Sugar beet is a substantial cash crop for sugar production in the US, and Minnesota is the leading state in sugar beet production. Cover crops are often seeded early in the spring prior to beet planting to protect seedlings from wind erosion. Recently cover crops have gained attention for their potential benefits in boosting soil health (soil chemical, biological and physical properties (Jian et al. 2020)) and reducing erosion, and seeding in the fall is purported to maximize these benefits (De Baets et al. 2011). However, limited research has investigated the impacts of fall-seeded cover crops on beet yield and environmental benefits. Based on the limited data available, cover crops may decrease sugar beet yield and stand with lower soil water content (Leiva 2022). Or, they may have no effect on sugar beet yield (Petersen and Rover 2005). Undoubtably species selection and planting date drive cover crop biomass and subsequent effects (Finney et al. 2016, Huddell et al. 2024), so more research is needed evaluating varying cover crop systems in varying environmental contexts. Cover crops may increase resiliency to varying climate conditions by improving soil structure (Leuthold et al. 2021), which can increase days available for field work (Fletcher and Featherstone 1987). These potentially positive outcomes are predicated on economically sustainable farming operations, however, so agronomic outcomes are the primary focus here. Understanding the relationship between cover crop types, planting times, and sugar beet yield and quality in Minnesota is vital for adjusting agricultural management and maintaining sustainable sugar beet production on our specific soils and climates.

Objectives

The primary objective of this study is to compare spring- and fall-seeded cover crop effects on sugar beet yield, beet sugar content, and soil health indicators. By performing this research in both on-farm and replicated, small-plot trials, we expect to generate robust information to guide grower decision-making in subsequent years.

Materials and Methods

On-farm trials

On-farm experiments were conducted in three Minnesota counties (Wilkin, Renville, and Swift) from late summer 2022 through fall 2024 (two growing seasons). Each experiment had three treatments (Rye, Barley, Control) with three replications, using field-length plots and the farmers' equipment to plant, control weeds and disease, and harvest the crop. Rye was established in the fall after the 2022 wheat harvest in Polk and after the 2022 and 2023 corn harvest in Swift, Renville, and Wilkin counties. Barley was planted with sugar beet in the springs of 2023 and 2024. Soil samples were taken in the spring prior to cover crop termination around 3 randomly selected sample points in the field. Biomass sampling of cover crops was completed before chemical termination in May 2024, using a 30 cm x 30 cm placed between beet rows in 6 locations around two soil sampling locations in each plot. Sugar beets were harvested within the treatment strips and weighed in the truck. (Harvest varied by date and year, but was in the pre-pile acreage allotted to each grower.) Subsamples were removed, tagged, weighed, and assessed for sugar content and purity at the factories of Southern Minnesota Beet Sugar Cooperative (Renville and Swift), American Crystal Sugar (Polk), or MinnDak Farmers' Cooperative (Wilkin).

Small plot trials

Small plot experiments were conducted at the Northwest Research & Outreach Center (NWROC) in Polk County, MN. The experiment was established after the wheat harvest in 2022 and 2023 in a randomized block design of 6 treatments (control, fall hairy vetch, fall oats and radish, fall oats, fall winter rye, and spring oats) with 6 replications. Each plot was 25 by 30 feet including 12 rows of sugar beets planted with a six-row planter. Fall cover crops were drilled while spring cover crops were broadcast. Biomass samples of cover crops were collected prior to chemical cover crops termination using one 30 cm x 30 cm in each plot. Soil samples were taken at the same time, with 3 cores composited per plot. During September of 2023 and 2024, sugar beets from each block were sampled from the central 4 rows of the planter for sugar beet yield and quality. Bags were tagged, weighed, and assessed for sugar content and purity at American Crystal.

Soil analysis

Two soil organic matter pools were selected as indicators of the cover crop effect on soil biological processes, specifically through changing levels and timing of C inputs to the soil food web. Autoclaved-citrate extractable soil protein (ACE protein) is a pool of organic N which has been shown to change with management (Geisseler et al. 2019, Martin and Sprunger 2022). Permanganate oxidizable carbon (POXC), as described by Lucas and Weil (2012), was used to estimate the amount of readily oxidizable organic matter in soil samples. While the permanganate oxidation does not precisely mimic biological oxidation of organic matter, this pool has been shown to respond to management (Culman et al. 2012, Woodings and Margenot 2023). Soil analysis was completed at the University of Minnesota.

For ACE protein, two operationally defined fractions of soil protein, easily extractable (e-ACE) and total protein (t-ACE) were obtained (Zhang et al. 2015, Singh et al. 2017). While e-ACE has been used across the Midwest as an indicator of soil health, Blair et al. (2024) found samples from high-clay, high-pH areas of the Red River Valley did not have high levels of e-ACE despite high organic matter levels. Since organic matter and e-ACE are usually strongly correlated, we suspected proteins were more strongly bound in these soils and used an alternate procedure with higher concentration citrate and higher pH to facilitate protein removal (cite). The e-ACE fraction was obtained with autoclaving of soil in 20 mM sodium citrate at pH 7 while the t-ACE was obtained with autoclaving of soil in 50 mM sodium citrate at pH 8. Soil:solution ratio was always 1:8 (3 g soil + 24 ml sodium citrate). After cooling, soil and solution were clarified by centrifugation at 10 000 g for 3 min. A mixture of sample and BCA working reagent was used to quantify the protein in GEN5 (10 µl sample + 200 µl reagent). The absorbance was read at 562 nm for e-ACE and 590 nm for t-ACE (Batterman et al. 2022).

For soil permanganate oxidizable carbon (POXC), soil samples (2.50 ± 0.05 g, air-dried) were placed in 50 mL centrifuge tubes. To each tube, 18.0 mL of nanopure water and 2.0 mL of a freshly prepared 0.2 M $KMnO_4$ solution (in 1.0 M $CaCl_2$) were added, yielding a 20 mL reaction mixture. After vortexing briefly to disperse the soil, the tubes were shaken at 120 rpm for 2 min and then allowed to settle in the dark for an additional 10 min. Immediately after settling, a 0.5 mL aliquot of the clear supernatant was transferred to a dilution tube containing 49.5 mL nanopure water. Absorbance measurements at 550 nm were obtained in a spectrophotometric plate reader (GEN5, Lucas and Weil 2012).

Statistical data analysis:
To compare beet yields and sugar content among cover crop treatments, Kruskal-Wallis tests were used to identify significant differences among the treatments for NWROC and on-farm experiments. No analysis was completed for Polk 2023 due to missing data reducing replication substantially. A linear mixed-effects model was used to assess the impact of treatments on soil parameters, with treatment as a fixed effect and location and year as a random intercept for on-farm experiments. To analyze the effects of treatments on soil parameters at NWROC, a linear mixed-effects model was used with treatment as a fixed effect and years (2023 and 2024) as a random intercept.

Results

Cover crops, yield and sugar content
Generally, we observed more cereal rye biomass than spring-planted barley (Table 1, difference was significant in Polk 2023 and Swift 2024). Due to weather conditions (drought or cold), cover crop biomass weights were moderate to low for the region on farms (Strock et al. 2004). We weren't able to collect biomass from the rye plots in the first year in Wilkin County. At NWROC in the spring of 2023, differences in cover crop biomass were observed among treatments (Figure 1), particularly between winter rye and oats (p value <0.05), winter rye and oat/radish mixture (p value <0.05). A large amount of volunteer wheat biomass was collected along with cover crop species. In 2024, cover crop biomass was minimal and unevenly distributed, likely due to weather and field conditions, so no data was collected.

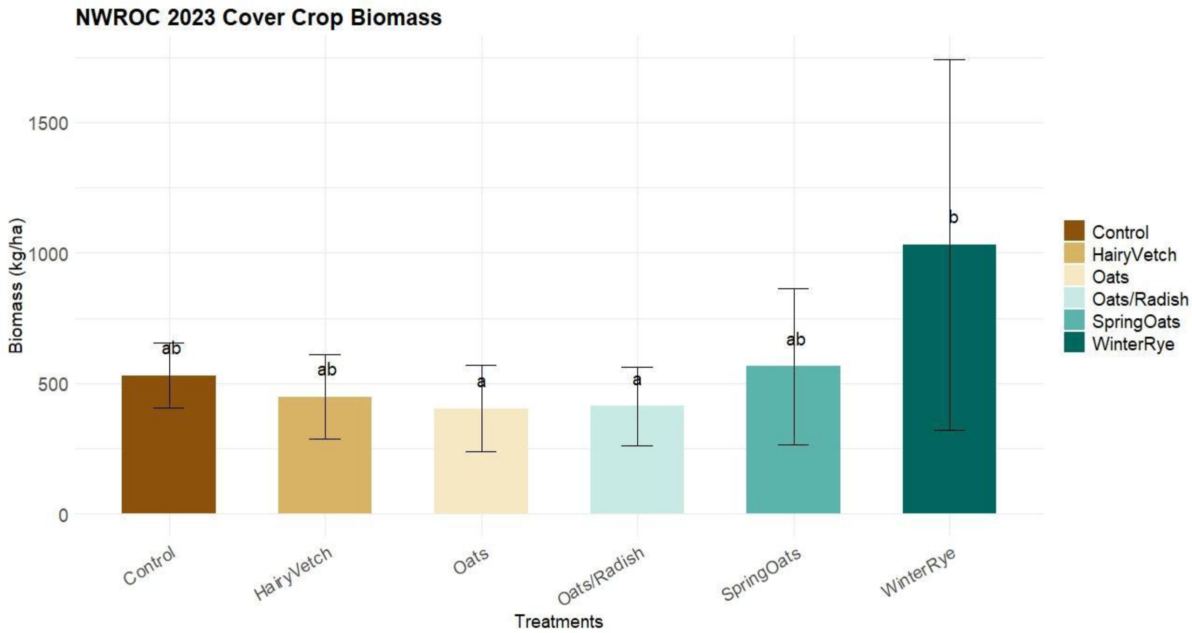

Figure 1: Cover crop biomass distribution with means and standard deviations between the treatments are shown for the 2023 of the NWROC.

The yield and sugar content of sugar beets over three on-farm site-years in three counties were usually not different among treatments (fall-seeded rye, spring-seeded barley, and control, Figures 2-6). However, in Wilkin County 2023, yield was greater in plots with fall-seeded rye than control and spring-seeded barley (Figure 3).

Similar to the on-farm experiments, cover crops had no effect on sugar beet yield and sugar content at NWROC over two years. In 2023, the yield of sugar beets was significantly lower than in subsequent years and compared to the results of on-farm experiments. This decline was attributed to the presence of volunteer wheat in all plots, which reduced the number of sugar beets in a given row and competed with them for water during the dry season. The volunteer wheat also diluted our cover crop treatments, but we are confident that the non-effect of cover crops on sugarbeet productivity is robust, as it was consistent across treatments and years on-farm and at the NWROC.

Table 1: Cover crop biomass and heights were measured for each treatment in the on-farm experiments. Values followed by different lowercase letters are significantly different by treatment within site and year

	County	Cover Crop	Height (cm)	Biomass (kg/ha)
2023	Polk	Barley	12	115 b
		Rye	22	245 a
	Wilkin	Barley	10	238
2024	Swift	Barley	10	40.4 b
		Rye	22.9	671 a
	Wilkin	Barley	10	37.0
		Rye	19.3	313

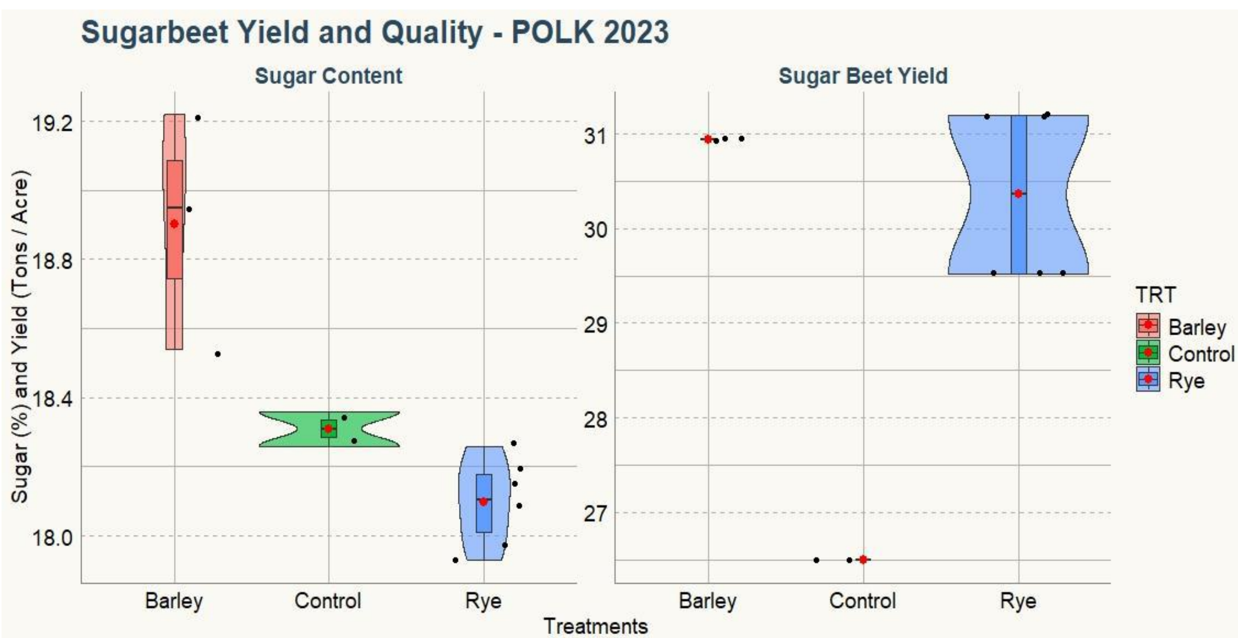

Figure 2: Sugar beet yield and sugar content for Polk County in 2023.

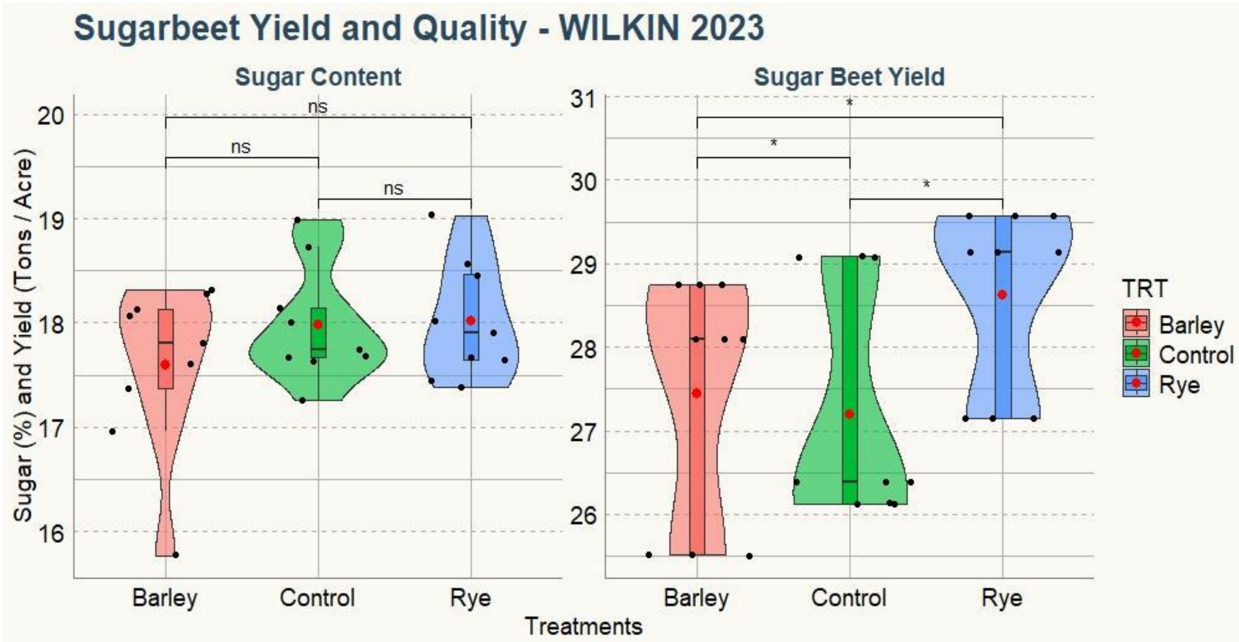

Figure 3: Sugar beet yield and sugar content for Wilkin County in 2023.

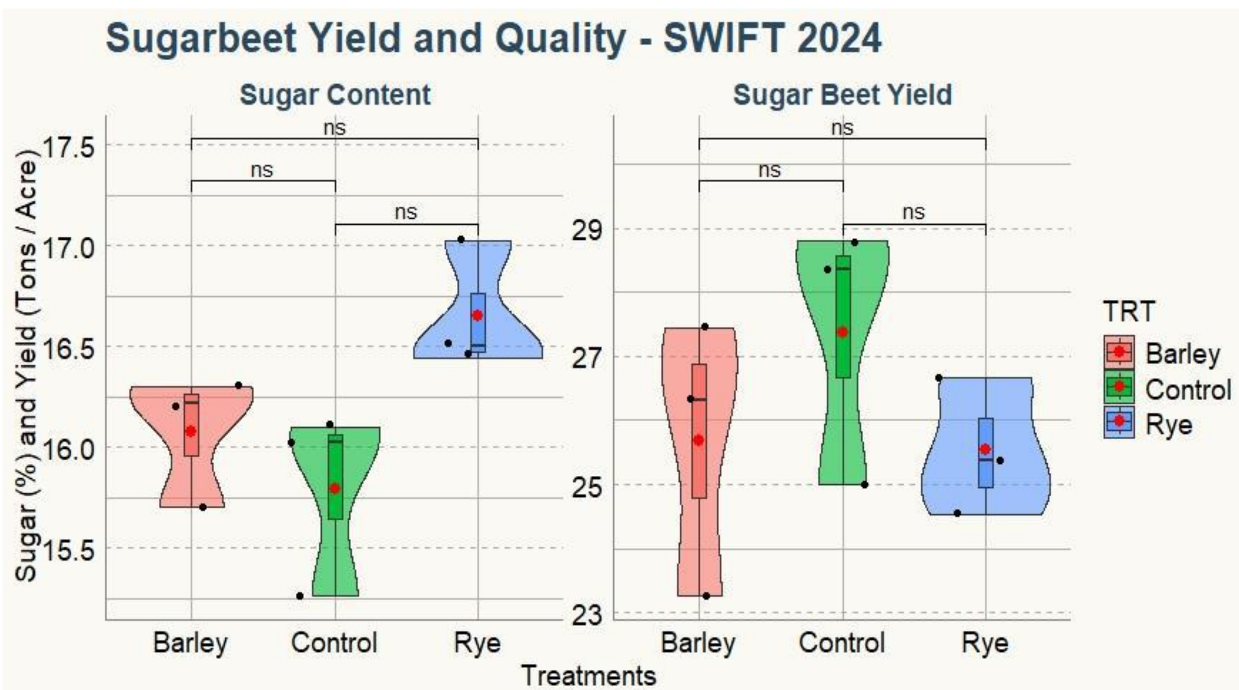

Figure 4: Sugar beet yield and sugar content for Swift County in 2024.

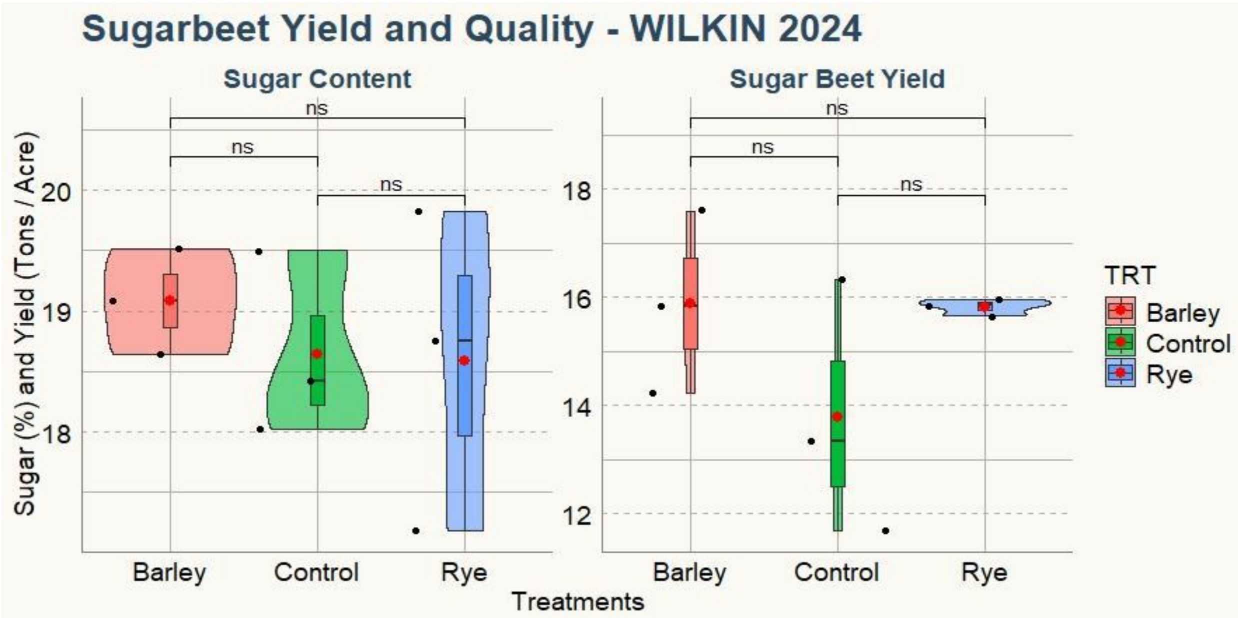

Figure 5: Sugar beet yield and sugar content for Wilkin County in 2024.

Figure 6: Sugar beet yield and sugar content for NWROC in 2023.

Figure 7: Sugar beet yield and sugar content for NWROC in 2024.

Soil parameters

On farms, e-ACE was slightly higher at control plots than rye, averaged across locations. ($p = 0.042$, Tukey-adjusted, Figure 8). The random intercept for Location accounted for substantial between-location variability, as expected across several farms in different counties (variance = 62%), while differences among years accounted for 22% of the total variance. No differences among treatments were observed at NWROC in either ACE pool or POXC (Table 3), and POXC did not differ among treatments on farms (Table 2). Although these and other soil parameters have proved sensitive to cover crops in studies in some regions (Ghimire et al. 2019, Martin and Sprunger 2022), they have rarely responded to field application of cover crops or other soil health practices in Minnesota, likely due to naturally high organic matter content, which would obscure minimal changes after short-term treatments (Gutknecht et al. 2022, Blair et al. 2024). We did observe that total ACE was consistently greater than easily-extractable ACE, confirming earlier observations that easily-extractable ACE may not sufficiently extract protein from high-clay, high-pH soils (Blair et al. 2024).

Conclusions

We did not find effects of cover crop treatments on sugarbeet yield and or sugar content, except one site-year where winter cereal rye increased yield relative to spring barley or no cover crops. While these fall-planted cover crops generally produced more biomass, this did not hinder beet tuber development. However, lower yields in 2023 at NWROC were attributed to poor stand establishment in the high-residue planting environment across treatments, highlighting the importance of careful planter adjustment and calibration in these systems, as previously observed by Overstreet (2009) in this region. We observed no effect of cover crops on soil organic matter pools, suggesting that changes in soil health may not occur after a single year in cover crops, especially in the high organic matter soils studied here. Overall, adding winter cover crops to a strip-till operation may maximize soil conservation without risking yield or quality of sugar beet crops.

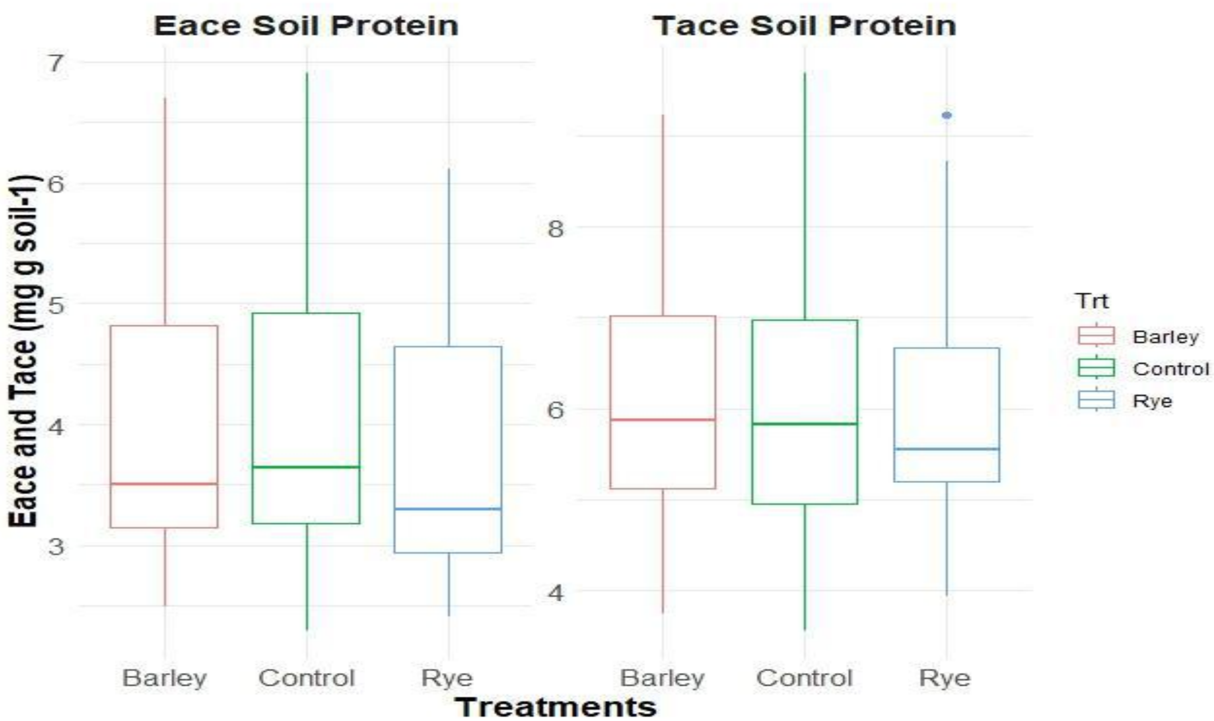

Figure 8: The box plot shows the distribution of soil proteins (e-ACE and t-ACE) in barley, rye and control treatments.

Table 2: The mean values of POXC and standard deviations for the on-farm experimental sites.

	Polk 2023	Swift 2024	Wilkin 2023	Wilkin 2024
		POXC (mg kg^{-1} soil)		
Barley	632.78±49.71	699.26±44.44	676.39±65.11	464.52±58.99
Control	610.61±71.21	716.60±65.46	629.40±74.97	489.45±72.48
Rye	616.28±80.60	682.52±54.78	649.52±41.68	547.55±82.84

Table 3: The mean values and standard deviations of soil protein fractions (e-ACE and t-ACE) and POXC at NWROC.

	2023			2024		
	e-ACE (mg kg^{-1} soil)	t-ACE (mg kg^{-1} soil)	POXC (mg kg^{-1} soil)	e-ACE (mg kg^{-1} soil)	t-ACE (mg kg^{-1} soil)	POXC (mg kg^{-1} soil)
Control	4.27±0.24	8.42±0.66	837.71±47.01	3.85±0.34	6.57±0.73	669.84±45.41
Hairy Vetch	4.14±0.41	8.14±0.88	802.77±63.40	3.77±0.25	6.94±0.70	648.82±70.26
Oats	4.05±0.25	8.11±0.91	805.85±74.35	3.82±0.28	6.75±0.77	659.63±113.51
Oats/ Radish	3.99±0.48	7.80±1.15	794.24±67.43	3.82±0.43	6.73±0.58	661.33±119.42
Spring Oats	3.89±0.44	7.64±0.67	806.00±80.91	3.68±0.36	6.68±0.65	674.32±79.38
Winter Rye	4.10±0.57	8.14±1.13	819.91±43.74	3.69±0.38	6.68±1.06	674.08±61.97

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SUGARBEET VARIETY TRIALS

RESULTS OF AMERICAN CRYSTAL SUGAR COMPANY'S 2024 CODED OFFICIAL VARIETY TRIALS

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American Crystal Sugar Company's coded Official Variety Trials (OVT) are designed to provide an unbiased evaluation of the genetic potential of sugarbeet variety entries under several different environments. The two-year averages of these evaluations are then used to establish a list of approved varieties which ensures the use of high quality, productive varieties to maximize returns for growers and the cooperative as a whole.

This report presents data from the 2024 American Crystal Sugar Company (ACSC) OVTs and describes the procedures and cultural practices utilized in the trials.

Table	Information in the table
1	ACSC approved varieties for 2025
2	Multi-year performance of approved varieties (all locations combined)
3	Performance of approved varieties under Aphanomyces disease pressure
4	2017-2019 Conventional variety combined trials
5	Multi-year disease ratings for approved varieties against multiple diseases
6	Multi-year root aphid ratings
7	Official trial sites, cooperators, planting and harvest dates, soil types, and disease notes
8	Seed treatments applied to seed used in the OVTs
9-21	2024 Combined and individual yield trial site results
22-25	Variety approval tables for ACSC market
26	Aphanomyces disease nursery ratings
27	Cercospora disease nursery ratings
28	Fusarium disease nursery ratings
29	Rhizoctonia disease nursery ratings
30	Herbicides and fungicides applied to official trials

Procedures and cultural practices

All official trials utilize seed identified by code numbers which prevents ACSC personnel from knowing variety names when conducting trials. All entries were assigned code numbers by KayJay Ag Services. The seed then was sent to ACSC Technical Services Center at Moorhead for official testing.

Sugarbeet official variety yield trials and disease nurseries were conducted across the ACSC growing region of the Red River Valley with additional disease nurseries conducted by third party cooperators. The 2024 official coded variety performance trials included 13 yield trials and 11 disease nurseries planted at a total of 19 sites by ACSC personnel. Seven additional disease/insect nurseries were planted by third party cooperators.

Results from the Official Variety Trial sites were excellent overall. Planting dates ranged from April 21 to May 17 for non-disease yield trial sites; the Aphanomyces yield trial site at Perley was planted June 10. Stands in the trials were excellent at most locations. Twelve sites were used for variety approval calculations. The site at Perley was used for yield under Aphanomyces conditions. Rhizoctonia crown and root rot was minimal in 2024. Cercospora leaf spot was well-controlled in yield trials. Revenue calculations in 2024 are based on a hypothetical $54.53 payment (5-year rolling average) assuming 17.5% sugar and 1.5% SLM, not considering hauling or production costs.

Aphanomyces root rot ratings are from the naturally infested nurseries at Perley (ACSC), Glyndon (Magno) and Shakopee, (KWS), MN. Rainfall and resulting soil moisture were high in the Red River Valley during the early part of the growing season, resulting in moderate early-season disease pressure at Aphanomyces nursery sites. Cercospora leafspot ratings are from inoculated nurseries at Foxhome (ACSC) and Randolph (KWS), MN and Saginaw, MI (BSDF) as well as non-inoculated nurseries at Forest River, ND and Averill, MN (ACSC). Correlation of Cercospora ratings among sites varied due to differences in efficacy of CR+ entries at different locations. Rhizoctonia crown and root rot ratings are from inoculated nurseries at Crookston and Moorhead (two trials), MN (ACSC) and Saginaw, MI (BSDF). Fusarium ratings are from naturally infested sites at Moorhead and Sabin, MN (ACSC). Root aphid ratings are from a field trial at Longmont, CO (Magno) and greenhouse assays at Moorhead (ACSC) and Shakopee (KWS), MN.

2024 harvest conditions were dry overall, despite excessive soil moisture early in the growing season. The dry soil provided some challenging conditions for keeping pinch wheels deep enough without bogging down the tractor. Overall, sugarbeet roots lifted well.

The 2024 data have been combined with previous years' data for several tables. Results from 2024 for the yield trials from individual sites are included in this report and available on the internet at www.crystalsugar.com/agronomy/crystal-beet-seed/official-coded-trials/.

Conventional trials were not planted in the 2024 OVT trials. Conventional varieties tested in 2017-2019 that were approved for 2020-2024 sales are permitted to continue in 2025 sales.

Yield trials were planted to stand at 4.5 inches. Starter fertilizer (10-34-0, 3 GPA) and AZteroid fungicide (5.7 fl oz/A) were applied in-furrow (6 GPA total volume) in all yield trials. Counter 20G (8.9 lb/A) was applied in a band after planting at all yield trial sites. Plots were planted perpendicular to the cooperators' normal farming operations, where possible. Plot row lengths for all official trials were maintained at 47 feet with about 40 feet harvested. Planting was performed with a 12-row SRES vacuum planter. The GPS controlled planter gave good single seed spacing which facilitated emergence counting. Seed companies had the option of treating seed with an Aphanomyces seed treatment, insecticide and a Rhizoctonia seed treatment fungicide. Emergence counts were taken on 24 feet of each plot. Multiple seedlings were counted as a single plant if they emerged less than one inch apart. The stands in all yield trials were refined by removing doubles (multiple seedlings less than 1.5 inch apart) by hand but were not further reduced.

Ethofumesate (Nortron, 6 pt/A) was applied pre-emerge at most yield trial sites (Table 30). Roundup PowerMAX 3 with Class Act (surfactant) and full rates of Cercospora fungicides were applied by ACSC technical staff using a pickup sprayer driven down the alleys. Two applications of Roundup (25 oz/A) were made at the 2-4 and 6-10 leaf stages in 10 GPA using 50-60 psi. Hand weeding was used as necessary. In addition to AZteroid at planting (see above), all yield trials were treated with Quadris in a band during the 6-10 leaf stage (10 oz/A) for Rhizoctonia control. Mustang Maxx (4 oz/A) was applied postemergence for additional root maggot control at Ada, Grand Forks, and St Thomas. Treatments used for Cercospora control in 2024 included Inspire XT/Manzate Max, Agri Tin/T-Methyl, Proline/Manzate Max, Manzate Max, and Priaxor/Agri Tin. Cercospora fungicides were applied in 20 GPA using 75-80 psi.

Roundup Ready (RR) entries with commercial seed available were planted in four-row plots with six replicates. The RR experimental entries were planted in two-row plots with four replicates.

All plot ranges were measured for total length after approximately 3.5 feet at each end were removed at the end of August, with skips greater than 60 inches being measured for yield adjustment purposes. Harvest was performed with one custom six- row harvester with increased cleaning capacity. All harvested beets of each plot were used for yield determination while one sample (approximately 20 lbs.) was obtained from each plot for sugar and impurity analysis. Quality analysis was performed at the ACSC Technical Services Quality Lab in Moorhead, MN.

Varieties were planted in nurseries in North Dakota, Minnesota, Michigan, and Colorado to evaluate varieties for disease and insect susceptibility. ACSC adjusts the Aphanomyces, Cercospora, Rhizoctonia, and Fusarium nursery data each year to provide a consistent target for variety approval criteria.

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Table 1.
Varieties Meeting ACSC Approval Criteria for the 2025 Sugarbeet Crop

Roundup Ready ®	Full Market	Aph Spec	Rhc Spec	Rhizomania
BTS 8018	Yes	Yes		MG
BTS 8034	Yes	Yes		MG
BTS 8156	Yes	Yes		MG
BTS 8226	Yes	Yes	Yes	MG
BTS 8270	Yes	Yes	New	MG
BTS 8328	New	New		MG
BTS 8359	No	New		MG
BTS 8365	New	New	New	MG
BTS 8927	Yes	Yes	New	MG
Crystal 022	Yes	Yes	Yes	MG
Crystal 130	Yes	Yes	New	MG
Crystal 137	Yes	Yes		MG
Crystal 138	Yes	Yes	Yes	MG
Crystal 260	Yes	Yes	Yes	MG
Crystal 262	Yes	Yes	Yes	MG
Crystal 269	Yes	Yes		MG
Crystal 360	New	New		MG
Crystal 361	New	New	New	MG
Crystal 364	New	New	New	MG
Crystal 369	New	New		MG
Crystal 793	Yes	Yes		MG
Crystal 912	Yes	Yes	Yes	MG
Hilleshög HIL2479	New			MG
Hilleshög HIL2480	No		New	MG
Hilleshög HIL2386	Yes		Yes	MG
Hilleshög HIL2389	Yes	Yes		MG
Hilleshög HIL9920	Yes	Yes++		MG
Maribo MA717	Yes			MG
SV 203	Yes	Yes++		MG
SV 231	New		New	MG
SX 1815	Yes			MG
SX 1818	Yes			MG
SX 1835	No		New	MG

Aph Spec = variety meets Aphanomyces specialty requirements
Rhc Spec = variety meets Rhizoctonia specialty requirements
MG (Multigenic) = Contains multiple genes for Rhizomania resistance
SG (Single gene) = Contains a single gene for Rhizomania resistance

2019 Conventional	Full Market	Rhizomania
Crystal R761	Yes	MG
Crystal 620	Yes	MG
Crystal 840	Yes	MG
Crystal 950	Yes	MG
Hilleshög HM3035Rz	Yes	SG
SX 8869 Cnv	Yes	MG
SV 48777	Yes	MG

Created 10/25/2024

++ 2nd Year of not meeting Specialty Approval of previously approved Specialty variety. According to Approval Policy, may be sold as Specialty in 2025
+ 1st Year of not meeting Specialty Approval of previously approved Specialty variety. According to Approval Policy, may be sold as Specialty in 2025
Roundup Ready ® is a registered trademark of Bayer Group.
Roundup Ready ® sugarbeets are subject to the ACSC RRSB Bolter Destruction Policy

Table 2. Performance Data of RR Varieties During 2023 & 2024 Growing Seasons (All Locations Combined) Approved for Sale to ACSC Growers in 2025 +++

Variety	Yrs	Rev/Ton ++			Rev/Acre ++			Rec/Ton		Rec/Acre		Yield		Sugar		Molasses		Emergence +		Cerc. *		Aphan. *		Rhizoc. *		Fusarium *		Rzm *
	Com	24	2 Yr	2Y%	24	2 Yr	2Y%	24	2 Yr	24	2 Yr	24	2 Yr	24	2 Yr	24	2 Yr	24	2 Yr	24	2 Yr	24	2 Yr	24	2 Yr	24	2 Yr	
Number of locations →		12	23		12	23		12	23	12	23	12	23	12	23	12	23	12	23	5	8	3	4	4	6	2	4	
Previous Approved																												
BTS 8018	3	59.82	59.38	100	2101	2031	105	336	342	11803	11710	35.1	34.3	17.81	18.12	1.01	1.01	84	81	3.4	2.9	3.7	3.8	3.7	3.9	2.2	2.7	MG
BTS 8034	3	55.87	55.87	94	1978	1937	100	324	331	11477	11491	35.4	34.7	17.35	17.69	1.15	1.13	85	83	3.7	3.1	4.5	4.1	4.4	4.2	1.9	2.3	MG
BTS 8156	2	58.42	58.63	99	2015	1953	101	332	340	11437	11321	34.4	33.4	17.66	18.05	1.07	1.06	82	79	3.9	3.2	4.3	4.1	4.3	4.1	2.2	2.5	MG
BTS 8226	1	63.19	62.13	105	2146	2046	105	346	351	11762	11540	34.0	32.9	18.27	18.49	0.96	0.95	82	78	3.5	2.9	3.8	3.8	3.5	3.6	2.6	3.2	MG
BTS 8270	1	60.32	60.23	101	2064	2015	104	338	345	11565	11542	34.3	33.5	17.92	18.29	1.04	1.04	79	79	3.3	2.9	3.8	3.8	3.9	3.8	2.4	2.9	MG
BTS 8927	4	62.78	61.67	104	2124	2036	105	345	349	11680	11536	33.9	33.1	18.22	18.44	0.97	0.97	85	84	4.5	4.4	4.4	3.8	3.6	3.8	2.1	2.6	MG
Crystal 022	3	62.44	62.21	105	2044	2010	104	344	351	11253	11343	32.7	32.4	18.20	18.54	1.00	0.99	80	79	4.7	4.8	4.0	3.8	3.6	3.7	2.7	3.1	MG
Crystal 130	2	60.31	60.40	102	2077	2043	105	338	345	11615	11694	34.4	33.9	17.90	18.27	1.03	1.01	81	80	3.6	3.1	3.7	3.9	3.5	3.6	2.8	3.2	MG
Crystal 137	2	59.19	59.25	100	1998	1960	101	334	342	11272	11306	33.7	33.1	17.79	18.16	1.09	1.07	82	81	3.8	3.2	3.8	4.0	4.1	4.0	2.5	2.6	MG
Crystal 138	1	59.07	59.16	100	2024	2004	103	334	342	11424	11556	34.2	33.8	17.77	18.14	1.08	1.06	78	76	4.7	4.8	3.8	4.0	3.7	3.7	3.0	3.4	MG
Crystal 260	1	61.19	60.00	101	2124	2043	105	340	344	11808	11719	34.8	34.1	18.00	18.20	0.99	1.00	86	82	3.1	2.6	4.1	4.0	3.7	3.6	2.4	2.9	MG
Crystal 262	1	56.82	57.46	97	2055	1994	103	327	336	11821	11665	36.2	34.7	17.38	17.83	1.03	1.01	72	74	4.4	4.4	3.6	4.1	3.4	3.4	3.2	3.5	MG
Crystal 269	1	62.80	62.39	105	2139	2036	105	345	352	11768	11477	34.1	32.7	18.33	18.67	1.08	1.09	77	73	4.5	4.5	3.5	3.6	4.3	4.1	2.5	3.3	MG
Crystal 793	6	60.73	60.00	101	2092	2037	105	339	344	11657	11675	34.3	33.9	17.95	18.22	1.01	1.01	82	81	4.3	4.2	3.7	4.0	3.9	4.1	2.4	2.9	MG
Crystal 912	3	53.33	54.87	92	2035	2030	105	316	328	12049	12145	38.0	37.0	16.92	17.48	1.10	1.06	84	83	5.1	5.0	3.6	3.5	3.5	3.5	3.5	3.6	MG
Hilleshög HIL2386	2	56.84	57.01	96	1942	1889	97	327	335	11159	11098	34.1	33.2	17.45	17.82	1.09	1.07	77	78	4.9	4.6	4.5	4.4	4.3	4.1	3.1	3.6	MG
Hilleshög HIL2389	2	60.09	59.65	100	2062	2005	103	337	343	11541	11531	34.2	33.6	17.85	18.16	1.01	1.00	84	82	4.6	4.5	3.6	4.5	4.1	4.3	5.5	5.5	MG
Hilleshög HIL9920	6	58.88	58.75	99	1981	1930	99	333	340	11176	11154	33.4	32.8	17.74	18.07	1.08	1.06	76	76	5.1	5.1	4.1	4.8	4.6	4.5	6.3	6.2	MG
Maribo MA717	6	55.81	56.54	95	1978	1925	99	324	333	11477	11359	35.4	34.1	17.27	17.71	1.07	1.03	80	80	4.9	4.9	4.2	4.4	4.2	4.1	4.4	4.4	MG
SV 203	3	60.22	59.93	101	2070	2021	104	337	344	11581	11590	34.3	33.7	17.88	18.20	1.02	1.01	81	81	4.7	4.7	3.7	5.4	4.2	4.2	5.7	5.5	MG
SX 1815	2	60.37	60.04	101	2070	2033	105	338	344	11563	11653	34.2	33.9	17.90	18.21	1.02	1.00	83	82	4.7	4.7	4.0	5.1	4.3	4.3	5.5	5.6	MG
SX 1818	2	56.91	57.40	97	2004	1981	102	327	336	11521	11610	35.2	34.6	17.43	17.85	1.07	1.04	78	78	4.6	4.6	4.5	5.8	4.4	4.2	4.3	4.5	MG
Newly Approved																												
BTS 8328	NC	60.68	61.00	103	2045	2003	103	339	347	11420	11405	33.8	32.9	18.02	18.44	1.10	1.08	76	75	4.4	4.5	3.8	3.7	4.2	4.2	3.2	3.6	MG
BTS 8359**	NC	57.65	58.68	99	2009	1983	102	329	340	11490	11507	34.9	33.9	17.60	18.10	1.14	1.09	79	76	2.9	2.6	3.6	3.7	4.3	4.2	2.2	2.8	MG
BTS 8365	NC	64.51	63.88	107	2088	2034	105	350	356	11332	11337	32.3	31.8	18.46	18.77	0.94	0.95	81	78	4.2	4.2	3.9	3.7	3.6	3.6	2.1	2.8	MG
Crystal 360	NC	61.28	60.55	102	2008	1985	102	341	346	11134	11345	32.6	32.8	18.05	18.31	1.02	1.02	83	81	3.1	2.6	3.5	3.7	3.9	4.0	2.2	2.9	MG
Crystal 361	NC	61.10	61.51	103	2119	2065	106	340	349	11790	11717	34.7	33.7	18.00	18.44	1.01	0.99	80	78	3.3	2.8	3.8	3.6	3.8	3.7	2.0	2.6	MG
Crystal 364	NC	57.07	57.08	96	2081	2041	105	328	335	11951	11992	36.5	35.9	17.47	17.84	1.09	1.09	84	81	4.5	4.4	3.8	3.8	3.8	3.8	2.1	2.6	MG
Crystal 369	NC	60.59	60.73	102	2101	2043	105	338	346	11724	11653	34.6	33.7	18.04	18.44	1.13	1.11	81	80	4.0	3.9	3.5	3.7	4.7	4.4	2.3	2.7	MG
Hilleshög HIL2479	NC	60.58	60.47	102	1868	1865	96	338	346	10451	10669	31.0	30.9	17.97	18.32	1.07	1.05	77	77	4.2	4.2	4.8	4.6	4.2	3.8	4.6	4.5	MG
Hilleshög HIL2480**	NC	58.26	58.75	99	1886	1851	95	331	340	10727	10747	32.4	31.7	17.77	18.19	1.20	1.18	78	79	4.1	4.0	4.4	4.4	3.7	3.7	3.1	3.2	MG
SV 231	NC	56.57	57.45	97	2116	2040	105	326	336	12175	11929	37.2	35.5	17.38	17.86	1.07	1.04	82	80	4.8	4.8	4.4	5.3	3.7	3.7	4.6	4.4	MG
SX 1835**	NC	55.96	57.27	96	2060	2014	104	324	336	11937	11809	36.8	35.2	17.36	17.90	1.15	1.12	85	82	4.7	4.6	4.3	5.1	4.1	3.8	3.5	3.7	MG
Benchmark var. mean		59.65	59.44		2020	1940		336	342	11354	11176	33.8	32.7	17.83	18.19	1.05	1.06	84	80									

+++ 2024 Sites include Casselton, Averill, Ada, Hillsboro, Climax, Grand Forks, Scandia, Forest River, Alvarado, St Thomas, Hallock, and Bathgate

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+++ 2023 Sites include Casselton, Perley, Halstad, Reynolds, Climax, Grand Forks, Scandia, East Grand Forks, Stephen, St. Thomas, and Bathgate

++ 2024 Revenue estimate based on a $54.53 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses and 2023 Revenue estimate based on a $50.09 beet payment. Revenue does not consider hauling or production costs.

+ Emergence is % of planted seeds producing a 4 leaf beet.

** Does not meet Full Market Approval. Meets Aphanomyces and/or Rhizoctonia Specialty Approval .

* 2024 Cercospora from Saginaw MI, Randolph MN, Foxhome MN, Averill MN and Forest River ND (res.<4.4, susc>5.0). Aphanomyces ratings from Shakopee MN, Glyndon MN, and Perley MN (res.<4.0, susc>4.8).
Rhizoctonia from Saginaw MI, Moorhead MN and Crookston MN (res.<3.8, susc>5). Fusarium from Moorhead MN and Sabin MN (res.<3.0, susc>5.0). MG indicates muligenic resistance to Rhizomania.

* 2023 Cercospora ratings from Saginaw MI, Foxhome MN, and East Grand Forks, MN (res.<4.4, susc>5.0). Aphanomyces ratings from Shakopee MN (res.<4.0, susc>4.8).
Rhizoctonia ratings from Crookston MN and Saginaw MI (res.<3.8, susc>5). Fusarium ratings from Moorhead MN and Sabin MN (res.<3.0, susc>5.0). MG indicates muligenic resistance to Rhizomania.

Table 3. Performance Data of RR 2024 Approved Varieties Under Aphanomyces Conditions +++

	Yrs	Aph	Rev/Ton++				Rev/Acre++				Rec/Ton		Rec/Acre		Sugar		Yield		Cerc. *		Aphan. *		Rhizoc. *		Fusarium *	
Variety	Com	Spc +	2024	%Mn	2020	%Mn^	2024	%Mn	2020	%Mn^	2024	2020	2024	2020	2024	2020	2024	2020	24	2Yr	24	2 Yr	24	2Yr	24	2Yr
Number of locations →			1		3		1		3		1	3	1	3	1	3	1	3	5	8	3	4	4	6	2	4
Previous Approved																										
BTS 8018	3	Yes	59.33	99	40.59	108	1396	110	982	115	334.6	303.9	7861	7256	17.81	16.22	23.43	23.62	3.35	2.89	3.73	3.84	2.19	2.70	3.68	3.87
BTS 8034	3	Yes	59.65	99	35.57	95	1446	114	887	104	335.5	286.7	8117	7046	17.89	15.53	24.14	24.32	3.69	3.12	4.48	4.14	1.89	2.30	4.38	4.24
BTS 8156	2	Yes	61.11	102	--	--	1379	109	--	--	339.9	--	7678	--	18.06	--	22.60	--	3.87	3.20	4.27	4.12	2.15	2.48	4.28	4.10
BTS 8226	1	Yes	64.54	107	--	--	1409	111	--	--	350.3	--	7641	--	18.48	--	21.79	--	3.52	2.93	3.81	3.77	2.64	3.24	3.46	3.62
BTS 8270	1	Yes	62.52	104	--	--	1371	108	--	--	344.2	--	7542	--	18.23	--	21.89	--	3.32	2.87	3.76	3.83	2.41	2.93	3.86	3.76
BTS 8927	4	Yes	63.12	105	43.12	115	1298	102	985	115	346.0	312.6	7102	7070	18.33	16.58	20.46	22.44	4.45	4.42	4.41	3.84	2.10	2.59	3.57	3.78
Crystal 022	3	Yes	66.63	111	44.07	117	1453	114	1047	123	356.6	315.8	7782	7422	18.81	16.80	21.85	23.24	4.66	4.82	3.95	3.81	2.75	3.09	3.63	3.74
Crystal 130	2	Yes	58.82	98	--	--	1385	109	--	--	333.0	--	7839	--	17.72	--	23.53	--	3.56	3.08	3.72	3.86	2.76	3.15	3.54	3.61
Crystal 137	2	Yes	61.70	103	--	--	1395	110	--	--	341.7	--	7716	--	18.18	--	22.55	--	3.81	3.23	3.79	4.00	2.50	2.64	4.09	4.05
Crystal 138	1	Yes	64.24	107	--	--	1391	109	--	--	349.4	--	7576	--	18.50	--	21.77	--	4.73	4.75	3.84	3.95	2.98	3.37	3.68	3.75
Crystal 260	1	Yes	60.37	101	--	--	1364	107	--	--	337.7	--	7634	--	17.94	--	22.61	--	3.13	2.64	4.08	3.96	2.38	2.88	3.70	3.58
Crystal 262	1	Yes	52.88	88	--	--	1153	91	--	--	315.1	--	6844	--	16.85	--	21.63	--	4.36	4.36	3.57	4.09	3.22	3.52	3.39	3.35
Crystal 269	1	Yes	61.85	103	--	--	1405	111	--	--	342.2	--	7758	--	18.14	--	22.61	--	4.54	4.46	3.50	3.56	2.54	3.33	4.30	4.10
Crystal 793	6	Yes	61.18	102	37.97	101	1316	104	886	104	340.1	294.9	7324	6732	18.02	15.80	21.56	22.43	4.28	4.24	3.72	4.01	2.40	2.90	3.89	4.12
Crystal 912	3	Yes	53.61	89	35.21	94	1207	95	886	104	317.3	285.5	7142	7041	16.92	15.44	22.52	24.35	5.06	5.03	3.57	3.49	3.46	3.64	3.45	3.48
Hilleshög HIL2386	2	No	59.24	99	--	--	1024	81	--	--	334.3	--	5774	--	17.81	--	17.26	--	4.89	4.56	4.55	4.38	3.13	3.56	4.27	4.09
Hilleshög HIL2389	2	Yes	60.04	100	--	--	1301	102	--	--	336.7	--	7312	--	17.86	--	21.77	--	4.57	4.54	3.56	4.49	5.49	5.49	4.08	4.27
Hilleshög HIL9920	6	No	59.26	99	35.57	95	1174	92	706	83	334.4	286.5	6626	5606	17.75	15.37	19.80	19.33	5.07	5.11	4.11	4.80	6.28	6.15	4.57	4.50
Maribo MA717	6	No	55.88	93	34.86	93	976	77	731	86	324.1	284.0	5649	5834	17.30	15.24	17.42	20.22	4.85	4.95	4.18	4.39	4.36	4.44	4.19	4.15
SV 203	3	No	58.25	97	37.75	101	1195	94	829	97	331.3	294.1	6796	6380	17.65	15.78	20.48	21.48	4.66	4.72	3.71	5.43	5.74	5.47	4.16	4.21
SX 1815	2	No	62.01	103	--	--	1353	106	--	--	342.6	--	7471	--	18.16	--	21.78	--	4.70	4.72	3.96	5.05	5.54	5.57	4.30	4.33
SX 1818	2	No	57.76	96	--	--	1143	90	--	--	329.8	--	6523	--	17.55	--	19.79	--	4.65	4.59	4.54	5.82	4.32	4.46	4.38	4.22
Newly Approved																										
BTS 8328	NC	Yes	60.31	100	--	--	1410	111	--	--	337.6	--	7948	--	17.91	--	23.70	--	4.43	4.48	3.83	3.67	3.19	3.61	4.19	4.16
BTS 8359**	NC	Yes	57.12	95	--	--	1254	99	--	--	327.8	--	7206	--	17.53	--	21.94	--	2.91	2.58	3.65	3.66	2.20	2.84	4.26	4.17
BTS 8365	NC	Yes	65.38	109	--	--	1387	109	--	--	353.0	--	7498	--	18.66	--	20.96	--	4.18	4.17	3.87	3.75	2.15	2.79	3.60	3.64
Crystal 360	NC	Yes	60.00	100	--	--	1257	99	--	--	336.7	--	7035	--	17.90	--	20.66	--	3.05	2.61	3.52	3.69	2.24	2.88	3.94	3.99
Crystal 361	NC	Yes	60.40	101	--	--	1262	99	--	--	337.9	--	7080	--	18.03	--	21.01	--	3.33	2.79	3.80	3.62	2.02	2.63	3.78	3.66
Crystal 364	NC	Yes	55.79	93	--	--	1293	102	--	--	323.7	--	7556	--	17.23	--	23.38	--	4.46	4.36	3.78	3.79	2.12	2.62	3.77	3.78
Crystal 369	NC	Yes	60.53	101	--	--	1272	100	--	--	338.3	--	7128	--	18.01	--	21.06	--	4.03	3.91	3.45	3.74	2.25	2.75	4.72	4.35
Hilleshög HIL2479	NC	No	58.75	98	--	--	729	57	--	--	332.8	--	4074	--	17.82	--	11.93	--	4.25	4.17	4.76	4.57	4.59	4.51	4.24	3.84
Hilleshög HIL2480**	NC	No	60.05	100	--	--	963	76	--	--	336.8	--	5435	--	18.02	--	16.33	--	4.08	4.04	4.43	4.36	3.06	3.18	3.65	3.68
SV 231	NC	No	59.63	99	--	--	1191	94	--	--	335.5	--	6783	--	17.73	--	20.45	--	4.77	4.80	4.43	5.34	4.62	4.41	3.71	3.70
SX 1835**	NC	No	58.83	98	--	--	1124	88	--	--	333.0	--	6430	--	17.70	--	19.45	--	4.66	4.60	4.31	5.15	3.52	3.72	4.07	3.81
AP CK SUS RR#2			56.88	95	--	--	687	54	--	--	327.1	--	3975	--	17.45	--	12.40	--								
Trial mean (includes AP CK SUS RR#2)			60.04	100	--	--	1270	100	--	--	336.7	--	7117	--	17.89	--	21.11	--								
AP SUS RR#5			--	--	30.80	82	--	--	590	69	--	269.8	--	4984	--	14.75	--	18.00								
Trial mean (includes AP SUS RR#5)			--	--	37.55	100	--	--	853	100	--	293.4	--	6537	--	15.75	--	21.94								
Mean of specialty varieties			60.7	101	39.42	105	1354	107	946	111	338.8	304.8	7554	7199	17.98	16.28	22.29	23.41								

+++ 2024 Sites include Perley

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+++ 2020 Data from Climax, Perley, and Grandin

++ 2024 Revenue estimate based on a $54.53 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses. 2020 Revenue estimate based on $45.12 beet payment. Revenue does not consider hauling or production costs.

+ Yes indicates varieties that have met the current Aphanomyces Specialty requirement for 2024 with a 2 yr rating ≤ 4.0 or previously met Aphanomyces Specialty requirement maintaining a 3 year rating ≤ 4.3.

%Mn = Percent of 2024 trial mean (includes previously approved varieties and susceptable check AP SUS RR#2)

%Mn^ = Percent of 2020 trial mean (including susceptable check AP SUS RR#5)

** Does not meet Full Market Approval. Meets Aphanomyces and/or Rhizoctonia Specialty Approval.

* 2024 Cercospora from Saginaw MI, Randolph MN, Foxhome MN, Averill MN and Forest River ND (res.<4.4, susc>5.0). Aphanomyces ratings from Shakopee MN, Glyndon MN, and Perley MN (res.<4.0, susc>4.8).
Rhizoctonia from Saginaw MI, Moorhead MN and Crookston MN (res.<3.8, susc>5). Fusarium from Moorhead MN and Sabin MN (res.<3.0, susc>5.0).

* 2023 Cercospora ratings from Saginaw MI, Foxhome MN, and East Grand Forks, MN (res.<4.4, susc>5.0). Aphanomyces ratings from Shakopee MN (res.<4.0, susc>4.8).
Rhizoctonia ratings from Crookston MN and Saginaw MI (res.<3.8, susc>5). Fusarium ratings from Moorhead MN and Sabin MN (res.<3.0, susc>5.0).

Table 4. Performance Data of Conventional Varieties During 2017, 2018, 2019 Growing Seasons (All Locations Combined) +++

Variety	Yrs	Rev/Ton ++					Rev/Acre ++					Rec/Ton		Rec/Acre		Sugar		Yield		Molasses		Emergence *		Cerc. *		Aphan. *		Rhizoc. *		Fusarium *		Rzm *
	Com	19	2 Yr	2Y%	3Yr	3Y%	19	2 Yr	2Y%	3Yr	3Yr%	19	2 Yr	19	2 Yr	19	2 Yr	19	2 Yr	19	2 Yr	19	2 Yr	19	2 Yr	19	2 Yr	19	2 Yr	19	2 Yr	
Number of locations →		3	8		14		3	8		14		3	8	3	8	3	8	3	8	3	8	3	8	3	6	2	3	3	6	2	4	
Previous Approved																																
Crystal 620	NC	41.74	47.24	97	49.48	99	1394	1631	118	1656	104	311	326	10403	11312	16.59	17.38	33.7	34.9	1.07	1.06	54	67	3.95	4.13	4.7	4.2	5.1	4.6	2.5	3.0	MG
Crystal R761	10	38.62	43.53	89	46.06	92	1375	1582	115	1618	101	299	313	10742	11457	16.18	16.86	36.0	36.7	1.21	1.19	61	72	4.98	4.85	4.4	4.3	4.9	4.6	3.0	3.6	MG
Crystal 840	NC	39.30	45.48	93	30.32	60	1288	1585	115	NA	--	302	320	9916	11173	16.23	17.10	33.1	35.1	1.15	1.10	52	65	4.18	4.25	4.0	3.9	4.7	4.4	2.7	3.1	MG
Hilleshög HM3035Rz	13	43.77	49.17	101	50.89	101	1294	1379	100	1405	88	318	333	9439	9422	16.91	17.65	29.9	28.5	1.02	1.00	72	71	4.42	4.32	5.1	5.2	4.4	4.2	4.1	4.3	SG
Seedex 8869 Cnv	NC	40.88	45.47	93	48.33	96	1374	1617	117	1658	104	307	320	10388	11418	16.40	17.00	33.9	35.8	1.02	1.00	64	74	4.52	4.59	4.8	4.8	5.1	4.9	3.5	3.7	MG
SV 48777	NC	45.18	50.25	103	52.63	105	1452	1634	118	1656	104	323	337	10342	10954	17.08	17.78	31.8	32.5	0.94	0.93	63	73	4.10	4.33	4.9	5.0	5.0	4.7	4.3	4.4	MG
Newly Approved																																
Crystal 950	NC	41.21	--	--	--	--	1430	--	--	--	--	309	--	10719	--	16.49	--	34.7	--	1.06	--	62	--	4.72	--	4.8	--	4.8	--	2.9	--	MG
Benchmark var. mean		44.35	48.87		50.20		1427	1381		1595		320	332	10330	10887	17.07	17.68	32.4	33.0	1.08	1.09	66	75									

+++ 2019 Sites include Grand Forks, Scandia, and Bathgate

Created 10/29/2024

+++ 2018 Sites include Casselton, Ada, Grand Forks, Scandia, and St. Thomas

+++ 2017 Sites incllude Casselton, Hendrum, Grand Forks, Scandia, St. Thomas, and Humboldt

++ 2019 Revenue estimate is based on a $44.38 beet payment (5-yr ave) at 17.5% sugar and 1.5% loss to molasses. 2018 Revenue estimate is based on a $46.40 beet payment and 2017 Revenue estimate is based on a $48.49 beet payment.

+ Emergence is % of planted seeds producing a 4 leaf beet.

* 2019 Aphanomyces ratings from Shakopee MN (res<4.4, susc>5.0). Cercospora ratings from Randolph MN, Foxhome MN & Saginaw MI (res<4.5, susc>5.0). Fusarium ratings from Moorhead MN (res<3.0, susc>5.0).
Rhizoctonia from Moorhead MN, Crookston MN, and Saginaw MI (res<3.8, susc>5). MG (Multigenic) contains multiple genes for Rhizomania resistance. SG (Single gene) contians a single gene for Rhizomania resistance.

* 2018 Aphanomyces ratings from Shakopee MN and Georgetown MN (res<4.4, susc>5.0). Cercospora ratings from Randolph MN, Foxhome MN & Saginaw MI (res<4.5, susc>5.0). Fusarium ratings from Moorhead MN (res<3.0, susc>5.0).
Rhizoctonia from Moorhead MN and Saginaw MI (res<3.8, susc>5).

Table 5. ACSC Official Trial Disease Nurseries 2022-2024 (Varieties tested in 2024)
Cercospora, Aphanomyces, Rhizoctonia & Fusarium

Code	Description	< 4.5 Cercospora > 5.0 24 Mean	23 Mean	22 Mean	2 Yr Mean	3 Yr Mean	< 4.0 Aphanomyces > 4.8 24 Mean	23 Mean	22 Mean	2 Yr Mean	3 Yr Mean	< 3.82 Rhizoctonia > 5.0 24 Mean	23 Mean	22 Mean	2 Yr Mean	3 Yr Mean	< 3.0 Fusarium > 5.0 24 Mean	23 Mean	22 Mean	2 Yr Mean	3 Yr Mean	Rhizomania
	Previously Approved																					
532	BTS 8018	3.35	2.42	2.03	2.89	2.60	3.73	3.95	4.00	3.84	3.89	3.68	4.06	3.93	3.87	3.89	2.19	3.20	2.98	2.70	2.79	MG
551	BTS 8034	3.69	2.54	2.28	3.12	2.84	4.48	3.80	3.89	4.14	4.06	4.38	4.09	4.49	4.24	4.32	1.89	2.72	2.16	2.30	2.25	MG
535	BTS 8156	3.87	2.53	2.43	3.20	2.94	4.27	3.97	4.21	4.12	4.15	4.28	3.93	4.24	4.10	4.15	2.15	2.80	2.30	2.48	2.42	MG
554	BTS 8226	3.52	2.33	2.00	2.93	2.62	3.81	3.72	3.79	3.77	3.77	3.46	3.78	3.74	3.62	3.66	2.64	3.85	3.47	3.24	3.32	MG
534	BTS 8270	3.32	2.43	1.97	2.87	2.57	3.76	3.90	3.87	3.83	3.84	3.86	3.67	4.33	3.76	3.95	2.41	3.46	3.06	2.93	2.98	MG
538	BTS 8927	4.45	4.38	4.42	4.42	4.42	4.41	3.26	4.00	3.84	3.89	3.57	3.98	4.13	3.78	3.89	2.10	3.08	3.11	2.59	2.76	MG
518	Crystal 022	4.66	4.97	4.60	4.82	4.75	3.95	3.66	4.03	3.81	3.88	3.63	3.85	4.10	3.74	3.86	2.75	3.43	3.22	3.09	3.13	MG
514	Crystal 130	3.56	2.60	2.10	3.08	2.76	3.72	4.00	3.57	3.86	3.76	3.54	3.69	4.08	3.61	3.77	2.76	3.55	3.22	3.15	3.17	MG
503	Crystal 137	3.81	2.65	2.57	3.23	3.01	3.79	4.21	4.25	4.00	4.08	4.09	4.01	4.18	4.05	4.09	2.50	2.78	2.35	2.64	2.54	MG
539	Crystal 138	4.73	4.77	4.87	4.75	4.79	3.84	4.06	3.87	3.95	3.92	3.68	3.81	3.81	3.75	3.77	2.98	3.76	3.16	3.37	3.30	MG
516	Crystal 260	3.13	2.15	2.05	2.64	2.44	4.08	3.84	3.89	3.96	3.94	3.70	3.46	3.70	3.58	3.62	2.38	3.38	3.06	2.88	2.94	MG
528	Crystal 262	4.36	4.36	4.43	4.36	4.38	3.57	4.61	3.42	4.09	3.86	3.39	3.31	3.38	3.35	3.36	3.22	3.83	3.27	3.52	3.44	MG
524	Crystal 269	4.54	4.38	4.60	4.46	4.51	3.50	3.62	3.48	3.56	3.53	4.30	3.90	4.20	4.10	4.13	2.54	4.11	3.36	3.33	3.34	MG
519	Crystal 793	4.28	4.20	4.10	4.24	4.19	3.72	4.31	3.82	4.01	3.95	3.89	4.35	4.73	4.12	4.32	2.40	3.40	3.03	2.90	2.95	MG
521	Crystal 912	5.06	5.00	4.81	5.03	4.96	3.57	3.41	3.44	3.49	3.48	3.45	3.50	3.28	3.48	3.41	3.46	3.82	3.66	3.64	3.65	MG
526	Hilleshög HIL2386	4.89	4.23	4.54	4.56	4.56	4.55	4.21	4.31	4.38	4.36	4.27	3.91	3.51	4.09	3.90	3.13	3.99	3.73	3.56	3.62	MG
536	Hilleshög HIL2389	4.57	4.51	4.69	4.54	4.59	3.56	5.42	3.78	4.49	4.25	4.08	4.45	3.92	4.27	4.15	5.49	5.50	4.34	5.49	5.11	MG
544	Hilleshög HIL9920	5.07	5.15	4.92	5.11	5.05	4.11	5.49	4.33	4.80	4.64	4.57	4.42	4.58	4.50	4.52	6.28	6.03	5.66	6.15	5.99	MG
517	Maribo MA717	4.85	5.04	5.05	4.95	4.98	4.18	4.61	4.39	4.39	4.39	4.19	4.10	3.92	4.15	4.07	4.36	4.53	4.87	4.44	4.59	MG
548	SV 203	4.66	4.78	4.74	4.72	4.73	3.71	7.15	4.24	5.43	5.03	4.16	4.25	4.19	4.21	4.20	5.74	5.20	5.55	5.47	5.50	MG
507	SX 1815	4.70	4.74	5.07	4.72	4.84	3.96	6.15	4.28	5.05	4.80	4.30	4.35	4.12	4.33	4.26	5.54	5.60	5.32	5.57	5.49	MG
550	SX 1818	4.65	4.53	4.72	4.59	4.64	4.54	7.09	4.82	5.82	5.48	4.38	4.06	4.16	4.22	4.20	4.32	4.59	4.54	4.46	4.48	MG
	Newly Approved																					
540	BTS 8328	4.43	4.54	--	4.48	--	3.83	3.50	--	3.67	--	4.19	4.14	--	4.16	--	3.19	4.03	--	3.61	--	MG
512	BTS 8359**	2.91	2.26	--	2.58	--	3.65	3.67	--	3.66	--	4.26	4.08	--	4.17	--	2.20	3.49	--	2.84	--	MG
501	BTS 8365	4.18	4.15	--	4.17	--	3.87	3.62	--	3.75	--	3.60	3.69	--	3.64	--	2.15	3.43	--	2.79	--	MG
504	Crystal 360	3.05	2.17	--	2.61	--	3.52	3.86	--	3.69	--	3.94	4.04	--	3.99	--	2.24	3.51	--	2.88	--	MG
523	Crystal 361	3.33	2.24	--	2.79	--	3.80	3.45	--	3.62	--	3.78	3.54	--	3.66	--	2.02	3.24	--	2.63	--	MG
529	Crystal 364	4.46	4.26	--	4.36	--	3.78	3.79	--	3.79	--	3.77	3.79	--	3.78	--	2.12	3.12	--	2.62	--	MG
520	Crystal 369	4.03	3.78	--	3.91	--	3.45	4.02	--	3.74	--	4.72	3.98	--	4.35	--	2.25	3.24	--	2.75	--	MG
552	Hilleshög HIL2479	4.25	4.09	--	4.17	--	4.76	4.38	--	4.57	--	4.24	3.43	--	3.84	--	4.59	4.43	--	4.51	--	MG
537	Hilleshög HIL2480**	4.08	4.00	--	4.04	--	4.43	4.30	--	4.36	--	3.65	3.70	--	3.68	--	3.06	3.30	--	3.18	--	MG
506	SV 231	4.77	4.83	--	4.80	--	4.43	6.25	--	5.34	--	3.71	3.69	--	3.70	--	4.62	4.21	--	4.41	--	MG
522	SX 1835**	4.66	4.55	--	4.60	--	4.31	5.99	--	5.15	--	4.07	3.55	--	3.81	--	3.52	3.92	--	3.72	--	MG

Created 10/25/2024

** Does not meet full market approval. Meets Aphanomyces and/or Rhizoctonia Specialty approval.

Green font ratings indicate specialty or good resistance.

Red font ratings indicate level of concern for some fields.

-- indicates data not available

MG (Multigenic) = Contains multiple genes for Rhizomania resistance

Table 6. Root Aphid Ratings for RR Varieties During 2022-2024 Growing Seasons (All Locations Combined)
Approved for Sale to ACSC Growers in 2025

		Moorhead, MN[X] (1=Exc - 4=Poor)					Shakopee, MN[Y] (1=Exc - 4=Poor)					Longmont, CO[Z] (% Infested Plants)				
Code	Variety	2022*	2023*	2024	2 Yr	3 Yr	2022	2023	2024	2 Yr	3 Yr	2022**	2023***	2024	2 Yr	3 Yr
711	BTS 8018	--	--	1.17	--	--	1.00	1.16	1.00	1.08	1.05	--	--	5.00	--	--
725	BTS 8034	--	--	1.00	--	--	1.00	1.28	1.00	1.14	1.09	--	--	7.86	--	--
719	BTS 8156	--	--	1.00	--	--	1.00	1.20	1.04	1.12	1.08	--	--	3.00	--	--
706	BTS 8226	--	--	1.00	--	--	--	1.00	1.04	1.02	--	--	--	2.91	--	--
718	BTS 8270	--	--	1.00	--	--	--	1.08	1.04	1.06	--	--	--	4.79	--	--
701	BTS 8328	--	--	1.00	--	--	--	--	1.00	--	--	--	--	3.71	--	--
702	BTS 8359	--	--	1.00	--	--	--	--	1.00	--	--	--	--	1.76	--	--
729	BTS 8365	--	--	1.00	--	--	--	--	1.12	--	--	--	--	1.35	--	--
714	BTS 8927	--	--	1.00	--	--	1.04	1.12	1.08	1.10	1.08	--	--	3.97	--	--
731	Crystal 022	--	--	1.00	--	--	1.00	1.04	1.00	1.02	1.01	--	--	1.92	--	--
712	Crystal 130	--	--	1.00	--	--	1.13	1.00	1.12	1.06	1.08	--	--	5.10	--	--
716	Crystal 137	--	--	1.00	--	--	1.12	1.00	1.04	1.02	1.05	--	--	6.02	--	--
733	Crystal 138	--	--	1.00	--	--	1.00	1.04	1.00	1.02	1.01	--	--	2.45	--	--
717	Crystal 260	--	--	1.00	--	--	--	1.12	1.04	1.08	--	--	--	1.04	--	--
709	Crystal 262	--	--	1.00	--	--	--	1.04	1.08	1.06	--	--	--	1.25	--	--
732	Crystal 269	--	--	1.00	--	--	--	1.04	1.04	1.04	--	--	--	8.60	--	--
705	Crystal 360	--	--	1.17	--	--	--	--	1.00	--	--	--	--	5.89	--	--
715	Crystal 361	--	--	1.00	--	--	--	--	1.04	--	--	--	--	2.16	--	--
713	Crystal 364	--	--	1.00	--	--	--	--	1.08	--	--	--	--	3.58	--	--
708	Crystal 369	--	--	1.00	--	--	--	--	1.04	--	--	--	--	7.20	--	--
727	Crystal 793	--	--	1.00	--	--	1.04	1.08	1.12	1.10	1.08	--	--	5.00	--	--
722	Crystal 912	--	--	1.00	--	--	1.00	1.04	1.04	1.04	1.03	--	--	10.92	--	--
703	Hilleshög HIL2386	--	--	1.67	--	--	3.32	3.44	3.68	3.56	3.48	--	--	9.73	--	--
724	Hilleshög HIL2389	--	--	1.67	--	--	2.00	2.04	2.04	2.04	2.03	--	--	11.03	--	--
720	Hilleshög HIL2479	--	--	1.00	--	--	--	--	PE	--	--	--	--	1.52	--	--
723	Hilleshög HIL2480	--	--	1.00	--	--	--	--	1.20	--	--	--	--	3.33	--	--
710	Hilleshög HIL9920	--	--	2.17	--	--	3.48	3.24	2.52	2.88	3.08	--	--	0.00	--	--
730	Maribo MA717	--	--	1.67	--	--	3.56	3.40	3.12	3.26	3.36	--	--	5.86	--	--
704	SV 203	--	--	1.33	--	--	2.00	2.20	2.08	2.14	2.09	--	--	3.31	--	--
726	SV 231	--	--	1.67	--	--	--	--	2.04	--	--	--	--	0.00	--	--
707	SX 1815	--	--	1.00	--	--	2.40	2.36	1.76	2.06	2.17	--	--	3.01	--	--
721	SX 1818	--	--	1.33	--	--	2.00	2.08	1.44	1.76	1.84	--	--	3.75	--	--
728	SX 1835	--	--	1.83	--	--	--	--	1.64	--	--	--	--	2.78	--	--
734	Root Aphid Res CK#3	--	--	1.00	--	--	1.00	1.08	1.00	1.04	1.03	--	--	5.27	--	--
735	Root Aphid Susc CK#6	--	--	2.33	--	--	3.48	3.20	2.48	2.84	3.05	--	--	4.20	--	--
736	Root Aphid Susc CK#8	--	--	2.17	--	--	--	--	3.76	--	--	--	--	3.75	--	--
	Trial Mean			1.23					1.48					4.25		
	Sus. Check Mean			2.25					3.12					2.25		
	Mean LSD (0.05)			0.46					0.36					ns		

[X] Greenhouse assay based on a 1-4 rating scale (1 = no aphids, 4 = very susceptible), Moorhead, MN, ACSC

[Y] Greenhouse assay based on a 1-4 rating scale (1 = no aphids, 4 = very susceptible), Shakopee, MN, KWS

[Z] Field trial based on incidence (% infested plants), Longmont, CO, Magno Seed, LLC

* Greenhouse assay not conducted

** No data available due to low emergence

*** No data available due to wet conditions and low root aphid levels

PE = not evaluated due to poor emergence

Created 11/27/2024

Table 7. Planting & Harvest Dates, Previous Crop and Disease Levels for 2024 ACSC Official Trial Sites *

Yield Trials	District /		Planting	Harvest	Preceding		Diseases Present @						
Location	**Trial Type**	**Cooperator**	**Date**	**Date**	**Crop**	**Soil Type**	**Aph**	**Rhc**	**Rzm**	**Fus**	**Maggot**	**Rt Aphid**	**Comments**
Casselton ND	Mhd	Todd Weber Farms	5/6	10/8	Wheat	Medium/Light	N	L	N	N	N	N	Excellent overall
Averill MN	Mhd	Tang Farms	5/5	9/11	Wheat	Medium/Light	N	N	N	N	N	N	Range 4 dropped due to water damage
Perley MN	Mhd/Aph	TD Hoff Partnership	6/10	10/7	Corn	Heavy	M-V	N	N	N	N	N	Moderate to heavy Aphanomyces pressure
Ada MN	Hill	Corey Jacobson	5/5	10/4	Wheat	Light	N	N	N	N	N	N	Very good overall
Hillsboro ND	Hill	Hong Farms	4/21	9/12	Wheat	Medium	N	N	N	N	N	L	Some gappy stands, rows around grower's spray tracks not used
Climax MN	Crk	Knutson Farms	4/24	9/13	Wheat	Medium/Light	N	L	N	N	N	N	Some gappy stands
Grand Forks ND	EGF	Drees Farming Association	5/13	9/19	Wheat	Medium/Light	N	N	N	N	N	N	Excellent overall
Scandia MN	Crk	Deboer Farms	5/11	10/1	Wheat	Medium	N	N	N	N	N	N	Excellent overall
Forest River ND	EGF	Blair Farm & Seed	4/22	9/20	Wheat	Medium/Light	N	N	N	N	N	L	Very good overall
Alvarado MN	EGF	Iverson Farms	4/23	9/30	Wheat	Medium/Heavy	N	N	N	N	N	N	Some gappy stands
St Thomas ND	Dtn	Baldwin Farms	5/16	9/23	Wheat	Light	N	N	N	N	L-M	N	Very good overall, minor Verticillium wilt present
Hallock MN	Dtn	Prosser/Kuznia Beets	5/17	9/28	Wheat	Heavy	N	N	N	N	N	N	Excellent uniformity but smaller roots
Bathgate ND	Dtn	Landis McDonald	5/17	9/27	Wheat	Medium	N	N	N	N	N	N	Some gappy stands, excellent canopy uniformity

Disease Trials	District /		Planting	Rating	Preceding		Diseases Present @						
Location	**Trial Type**	**Cooperator**	**Date**	**Date**	**Crop**	**Soil Type**	**Aph**	**Rhc**	**Rzm**	**Fus**	**Maggot**	**Rt Aphid**	**Comments**
Moorhead Fus-N MN	Fus Nurs	Nelson Farms	5/14	Multiple	Wheat	Medium/Heavy	N	N	N	M	N	N	Moderate Fusarium pressure
Sabin Fus-S MN	Fus Nurs	Krabbenhoft & Sons Farm	5/9	Multiple	Wheat	Medium/Light	N	N	N	M	L	N	Moderate Fusarium pressure
Mhd Rhc-N MN	Rhc Nurs	Jon Hickel, ACSC	6/17	Multiple	Soybean	Heavy	N	L	N	L	N	N	Light Rhizoctonia pressure
Mhd Rhc-S MN	Rhc Nurs	Jon Hickel, ACSC	6/17	Multiple	Soybean	Heavy	N	V	N	L	N	N	Heavy Rhizoctonia pressure
NWROC MN	Rhc Nurs	Maureen Aubol, U of MN	5/11	8/8	Soybean	Medium/Heavy	N	M	N	N	N	N	Moderate Rhizoctonia pressure
Saginaw MI	Rhc Nurs	Linda Hanson, USDA & BSDF	5/2	8/9-8/12	--	--	L	V	N	N	N	N	Severe Rhizoctonia pressure
Shakopee MN	Aphanomyces	Patrick O'Boyle, KWS	5/13	8/22	--	--	M-V	L	N	N	N	N	Nice range of moderate Aphanomyces symptoms
Glyndon MN	Aphanomyces	Ryan Brady, Magno Seed	5/29	8/27	--	Light	M	L	N	M	N	N	Moderate Aphanomyces pressure
Perley MN	Aphanomyces	TD Hoff Partnership	6/10	8/28	Corn	Heavy	V	N	N	N	N	N	Heavy Aphanomyces pressure
Blanchard ND	Aphanomyces	Rust Farms	5/13	Abandon	Wheat	Medium	M	V	N	N	N	N	Significant interference from Rhizoctonia presence
Climax MN	Aphanomyces	Knutson Farms	4/24	Abandon	Wheat	Medium/Light	L	N	N	N	N	N	Lack of soil moisture to develop Aphanomyces
Shakopee MN	Root Aphid	Patrick O'Boyle, KWS	--	--	--	--							Greenhouse trial
Moorhead MN TSC	Root Aphid	ACSC	--	--	--	--							Growth chamber trial
Longmont CO	Root Aphid	Ryan Brady, Magno Seed	5/14	9/25	--	--	NA	NA	NA	NA	NA	L-M	Low to moderate root aphid pressure
Foxhome MN	Cercospora	NDSU/Kevin Etzler	5/14	Multiple	Wheat	Medium	N	N	N	N	N	N	Moderate to severe Cercospora pressure, inoculated
Saginaw MI	Cercospora	Linda Hanson, USDA & BSDF	4/25	Multiple	--	--	N	N	N	N	N	N	Very nice Cercospora pressure, inoculated
Randolph MN	Cercospora	Patrick O'Boyle, KWS	5/6	Multiple	--	--	N	N	N	N	N	N	Severe Cercospora pressure, inoculated
Averill MN	Cercospora	Tang Farms	5/5	Abandon	Wheat	Medium/Light	N	N	N	N	N	N	Severe Cercospora pressure, non-inoculated
Forest River ND	Cercospora	Blair Farm & Seed	4/22	Multiple	Wheat	Medium/Light	N	N	N	N	N	N	Moderate Cercospora pressure, non-inoculated

Created 10/03/2024

* Fertilizer applied in accordance with cooperative recommendations.

@ Disease notes for Aphanomyces, Rhizoctonia, Rhizomania, Fusarium, Root Maggot and Root Aphids were based upon visual evaluations (N=none, L=light, M=moderate, V=severe, NA=not observed)

Table 8. Seed Treatments Used on Varieties in Official Variety Trials in 2024

Description	Years in Trial	Years Comm.	Fungicide Seed Treatment (Damping-off)	Fungicide Seed Treatment (Rhizoctonia)	Fungicide Seed Treatment (Aphanomyces)	Insecticide (Springtails & Maggots)	Priming (Emergence)
ACSC Commercial							
BTS 8018	5	3	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8034	5	3	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8156	4	2	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8226	3	1	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8270	3	1	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8927	6	4	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
Crystal 022	5	3	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 130	4	2	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 137	4	2	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 138	4	1	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 260	3	1	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 262	3	1	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 269	3	1	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 793	8	6	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 912	6	3	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Hilleshög HIL2386	4	2	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2389	4	2	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL9920	8	6	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Maribo MA717	8	6	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
SV 203	5	3	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
SX 1815	4	2	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
SX 1818	4	2	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
Crystal 578RR (Check)	10	7	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
BTS 8815 (Check)	7	5	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
Crystal 803 (Check)	7	4	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
AP CK MOD RES RR#7	6	3	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
AP CK MOD SUS RR#8	5	3	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
ACSC Experimental							
BTS 8328	2	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8359	2	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8365	2	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8404	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8412	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8440	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8457	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8469	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8480	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8495	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
Crystal 360	2	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 361	2	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 364	2	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 369	2	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 470	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 471	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 473	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 475	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 479	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Hilleshög HIL2479	2	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2480	2	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2493	1	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2494	1	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2495	1	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2496	1	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
SV 231	2	NC	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
SV 343	1	NC	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
SV 344	1	NC	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
SV 345	1	NC	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
SV 347	1	NC	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
SX 1835	2	NC	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
SX 1849	1	NC	Apron XL/Thiram	Zeltera	Int Sol	NipsIt	Xbeet ®
Crystal 578RR (Check)	10	7	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
BTS 8815 (Check)	7	5	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
Crystal 803 (Check)	7	4	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
BTS 8927 (Check)	6	4	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
HIL2389 (Check)	4	2	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
AP CK MOD RES RR#7	6	3	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
AP CK MOD SUS RR#8	5	3	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
AP CK SUS RR#2	5	2	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
AP CK MOD SUS RR#6	10	8	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
RA CK SUS RR#7	10	7	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®

Created 2/20/2024

Table 9. 2024 Performance of Varieties - ACSC RR Official Trial
12 sites

		Rec/T		Rec/A		Rev/T		Rev/A		Yield	Sugar%			Na	K	AmN	Emerg.
Description @	Code	lbs.	%Bnch	lbs.	%Bnch	$ +	%Bnch	$ +	%Bnch	T/A	Gross	LTM	Rec	ppm	ppm	ppm	%
Commercial Trial																	
BTS 8018	113	336.0	100	11803	104	59.82	100	2101	104	35.13	17.81	1.01	16.80	214	1398	332	84.0
BTS 8034	118	324.1	97	11477	101	55.87	94	1978	98	35.43	17.35	1.15	16.20	289	1566	366	84.6
BTS 8156	105	331.8	99	11437	101	58.42	98	2015	100	34.43	17.66	1.07	16.59	230	1560	334	82.4
BTS 8226	122	346.2	103	11762	104	63.19	106	2146	106	34.00	18.27	0.96	17.31	200	1305	322	81.5
BTS 8270	107	337.5	101	11565	102	60.32	101	2064	102	34.30	17.92	1.04	16.88	208	1462	343	78.8
BTS 8927 (CommBench)	117	345.0	103	11680	103	62.78	105	2124	105	33.88	18.22	0.97	17.25	199	1299	333	85.2
Crystal 022	116	344.0	103	11253	99	62.44	105	2044	101	32.73	18.20	1.00	17.20	189	1381	341	79.9
Crystal 130	111	337.5	101	11615	102	60.31	101	2077	103	34.39	17.90	1.03	16.87	219	1423	337	80.8
Crystal 137	101	334.1	100	11272	99	59.19	99	1998	99	33.69	17.79	1.09	16.70	222	1572	342	82.0
Crystal 138	103	333.8	99	11424	101	59.07	99	2024	100	34.19	17.77	1.08	16.69	207	1439	378	77.8
Crystal 260	115	340.2	101	11808	104	61.19	103	2124	105	34.76	18.00	0.99	17.01	198	1419	320	85.5
Crystal 262	109	327.0	97	11821	104	56.82	95	2055	102	36.16	17.38	1.03	16.35	238	1329	356	72.2
Crystal 269	106	345.0	103	11768	104	62.80	105	2139	106	34.13	18.33	1.08	17.25	218	1472	363	77.0
Crystal 793	108	338.8	101	11657	103	60.73	102	2092	104	34.34	17.95	1.01	16.94	225	1360	337	81.9
Crystal 912	114	316.4	94	12049	106	53.33	89	2035	101	37.96	16.92	1.10	15.82	300	1320	392	83.6
Hilleshög HIL2386	119	327.0	97	11159	98	56.84	95	1942	96	34.07	17.45	1.09	16.36	264	1372	385	77.0
Hilleshög HIL2389	112	336.9	100	11541	102	60.09	101	2062	102	34.20	17.85	1.01	16.84	198	1421	334	83.6
Hilleshög HIL9920	110	333.2	99	11176	98	58.88	99	1981	98	33.44	17.74	1.08	16.66	263	1500	340	76.0
Maribo MA717	121	323.9	97	11477	101	55.81	94	1978	98	35.40	17.27	1.07	16.20	252	1408	367	80.2
SV 203	102	337.2	100	11581	102	60.22	101	2070	103	34.30	17.88	1.02	16.86	200	1422	341	80.7
SX 1815	120	337.7	101	11563	102	60.37	101	2070	103	34.19	17.90	1.02	16.88	200	1417	337	82.5
SX 1818	104	327.2	98	11521	101	56.91	95	2004	99	35.20	17.43	1.07	16.36	223	1446	360	77.9
Crystal 578RR (CommBench)	123	326.0	97	11160	98	56.51	95	1936	96	34.20	17.43	1.13	16.30	263	1494	380	85.4
BTS 8815 (CommBench)	124	335.5	100	11123	98	59.63	100	1981	98	33.10	17.83	1.05	16.78	230	1473	341	83.0
Crystal 803 (CommBench)	125	335.6	100	11452	101	59.68	100	2037	101	34.09	17.84	1.06	16.78	218	1432	360	84.1
AP CK MOD RES RR#7	126	318.6	95	11955	105	54.05	91	2029	100	37.50	17.03	1.10	15.93	314	1323	388	77.9
AP CK MOD SUS RR#8	127	340.8	102	11383	100	61.40	103	2050	102	33.36	18.07	1.03	17.04	206	1372	360	84.9
Experimental Trial (Comm status)																	
BTS 8328	225	338.6	101	11420	101	60.68	102	2045	101	33.77	18.02	1.10	16.93	230	1495	356	76.4
BTS 8359	221	329.4	98	11490	101	57.65	97	2009	99	34.87	17.60	1.14	16.46	225	1459	391	79.4
BTS 8365	228	350.3	104	11332	100	64.51	108	2088	103	32.34	18.46	0.94	17.52	175	1338	303	80.6
BTS 8404	211	341.1	102	11313	100	61.51	103	2041	101	33.19	18.05	0.99	17.06	183	1393	327	79.5
BTS 8412	205	334.3	100	11315	100	59.27	99	2008	99	33.78	17.75	1.02	16.72	225	1464	308	76.5
BTS 8440	213	341.6	102	11660	103	61.65	103	2105	104	34.19	18.02	0.95	17.07	185	1311	308	82.2
BTS 8457	201	341.9	102	11948	105	61.76	104	2159	107	34.95	18.02	0.93	17.09	212	1227	307	79.9
BTS 8469	206	332.6	99	11375	100	58.70	98	2005	99	34.24	17.67	1.03	16.63	227	1378	342	81.5
BTS 8480	230	337.9	101	11353	100	60.46	101	2026	100	33.74	17.92	1.03	16.89	194	1430	337	71.0
BTS 8495	214	340.4	101	11126	98	61.27	103	2004	99	32.62	18.04	1.01	17.03	216	1430	321	81.6
Crystal 360	218	340.5	101	11134	98	61.28	103	2008	99	32.64	18.05	1.02	17.03	189	1456	328	83.4
Crystal 361	227	339.9	101	11790	104	61.10	102	2119	105	34.73	18.00	1.01	16.99	232	1303	343	80.2
Crystal 364	232	327.7	98	11951	105	57.07	96	2081	103	36.48	17.47	1.09	16.38	253	1514	336	84.0
Crystal 369	231	338.3	101	11724	103	60.59	102	2101	104	34.62	18.04	1.13	16.92	242	1469	384	81.1
Crystal 470	203	332.6	99	12143	107	58.72	98	2145	106	36.44	17.65	1.01	16.63	218	1362	330	82.9
Crystal 471	229	343.7	102	11891	105	62.35	105	2157	107	34.57	18.17	0.99	17.18	203	1296	340	80.5
Crystal 473	207	331.9	99	11663	103	58.48	98	2058	102	35.09	17.57	0.97	16.59	248	1322	301	85.8
Crystal 475	224	336.9	100	11073	98	60.12	101	1976	98	32.88	17.86	1.02	16.84	182	1366	348	80.9
Crystal 479	226	336.6	100	11773	104	60.03	101	2098	104	35.02	17.91	1.09	16.83	238	1423	360	83.4
Hilleshög HIL2479	215	338.3	101	10451	92	60.58	102	1868	92	31.01	17.97	1.07	16.91	253	1355	357	77.0
Hilleshög HIL2480	217	331.3	99	10727	94	58.26	98	1886	93	32.43	17.77	1.20	16.57	266	1460	432	77.7
Hilleshög HIL2493	209	328.1	98	12334	109	57.19	96	2149	106	37.61	17.47	1.07	16.40	226	1442	344	80.8
Hilleshög HIL2494	223	332.7	99	12022	106	58.72	98	2123	105	36.14	17.74	1.11	16.63	214	1479	378	82.1
Hilleshög HIL2495	222	310.0	92	11587	102	51.23	86	1918	95	37.28	16.66	1.17	15.49	303	1517	374	79.9
Hilleshög HIL2496	204	323.7	96	11415	101	55.74	93	1969	98	35.24	17.32	1.14	16.18	306	1523	351	81.2
SV 231	219	326.2	97	12175	107	56.57	95	2116	105	37.23	17.38	1.07	16.31	227	1441	349	82.5
SV 343	216	314.1	94	11474	101	52.59	88	1927	95	36.41	16.82	1.12	15.70	273	1519	350	80.3
SV 344	208	315.4	94	10348	91	52.99	89	1737	86	32.84	16.93	1.16	15.77	277	1509	386	74.2
SV 345	210	321.8	96	12415	109	55.10	92	2129	105	38.52	17.16	1.08	16.08	243	1455	344	86.5
SV 347	212	336.5	100	11681	103	59.99	101	2085	103	34.65	17.87	1.04	16.83	198	1443	342	82.1
SX 1835	202	324.4	97	11937	105	55.96	94	2060	102	36.76	17.36	1.15	16.21	241	1498	391	85.2
SX 1849	220	314.7	94	11592	102	52.77	88	1951	97	36.69	16.86	1.13	15.73	298	1588	331	82.6
Crystal 578RR (CommBench)	233	329.4	98	11469	101	57.64	97	2008	99	34.74	17.60	1.12	16.48	265	1521	353	84.6
BTS 8815 (CommBench)	234	332.0	99	11371	100	58.51	98	2009	99	34.16	17.67	1.07	16.60	240	1486	332	83.1
Crystal 803 (CommBench)	235	337.1	100	11440	101	60.17	101	2044	101	33.88	17.89	1.03	16.86	212	1442	332	83.1
BTS 8927 (CommBench)	236	343.5	102	11135	98	62.28	104	2018	100	32.49	18.16	0.99	17.17	213	1343	327	81.3
Hilleshög HIL2389 (1stYearBench)	237	335.8	100	11711	103	59.75	100	2087	103	34.79	17.82	1.02	16.79	214	1404	335	80.9
AP CK MOD RES RR#7	238	319.9	95	11761	104	54.50	91	2003	99	36.76	17.10	1.12	15.98	311	1329	382	77.3
AP CK MOD SUS RR#8	239	343.7	102	11031	97	62.37	105	1998	99	32.17	18.19	1.01	17.18	201	1387	333	83.8
AP CK SUS RR#2	240	333.6	99	9696	85	59.04	99	1708	85	29.23	17.79	1.11	16.68	255	1421	370	65.4
AP CK MOD SUS RR#6	241	338.6	101	11290	99	60.68	102	2023	100	33.34	17.98	1.04	16.94	203	1398	354	84.1
RA CK SUS RR#7	242	329.7	98	10732	95	57.75	97	1877	93	32.61	17.55	1.07	16.48	259	1420	339	83.9
Comm Benchmark Mean		335.5		11354		59.65		2020		33.82	17.83	1.05		228	1425	353	84.4
Comm Trial Mean		334.0		11536		59.13		2043		34.54	17.75	1.05		229	1422	351	81.1
Coeff. of Var. (%)		2.6		5.5		4.8		6.7		5.2	2.2	8.1		19.6	4.7	13.3	10.4
Mean LSD (0.05)		4.8		257		1.60		59		0.75	0.22	0.05		28	38	25	2.7
Mean LSD (0.01)		6.4		339		2.11		77		0.99	0.29	0.06		36	51	33	3.6
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from 12 sites — Created 10/16/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 24ACSExp

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 10. 2024 Performance of Varieties - ACSC RR Official Trial
Casselton ND

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Rev/T $ +	Rev/T %Bnch	Rev/A $ +	Rev/A %Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	113	386.1	101	14853	104	76.39	102	2940	105	38.47	20.51	1.21	19.30	183	1679	426	90.4
BTS 8034	118	374.9	98	14564	102	72.69	97	2823	101	38.87	19.84	1.09	18.75	172	1721	325	90.4
BTS 8156	105	387.4	101	15133	106	76.83	102	3001	107	39.07	20.41	1.04	19.37	157	1674	305	91.3
BTS 8226	122	392.5	103	14556	102	78.53	105	2913	104	37.01	20.68	1.05	19.63	169	1469	361	87.9
BTS 8270	107	391.0	102	14648	102	78.01	104	2922	104	37.46	20.77	1.23	19.54	204	1711	421	83.7
BTS 8927 (CommBench)	117	386.6	101	14231	100	76.58	102	2818	100	36.82	20.41	1.08	19.33	172	1505	372	93.1
Crystal 022	116	397.1	104	14502	101	80.04	107	2921	104	36.56	20.99	1.14	19.85	171	1592	398	85.1
Crystal 130	111	392.9	103	14955	105	78.64	105	2991	107	38.10	20.69	1.05	19.64	158	1572	340	88.4
Crystal 137	101	400.8	105	15070	105	81.27	108	3054	109	37.66	21.04	1.00	20.04	127	1661	290	87.4
Crystal 138	103	384.9	101	14570	102	76.02	101	2876	102	37.86	20.33	1.08	19.25	127	1575	373	87.2
Crystal 260	115	380.6	100	14789	103	74.59	99	2898	103	38.87	20.12	1.09	19.03	161	1658	347	93.0
Crystal 262	109	371.7	97	15058	105	71.64	95	2897	103	40.63	19.67	1.08	18.59	148	1489	388	78.3
Crystal 269	106	399.7	105	15560	109	80.89	108	3148	112	38.91	21.09	1.11	19.98	155	1660	366	90.8
Crystal 793	108	391.8	102	15404	108	78.27	104	3078	110	39.32	20.59	1.01	19.58	122	1517	336	85.8
Crystal 912	114	368.2	96	15208	106	70.48	94	2915	104	41.25	19.56	1.14	18.42	185	1502	419	87.7
Hilleshög HIL2386	119	382.2	100	14256	100	75.10	100	2801	100	37.32	20.29	1.18	19.11	157	1568	440	71.4
Hilleshög HIL2389	112	380.4	100	14306	100	74.50	99	2799	100	37.70	20.04	1.02	19.02	150	1615	309	91.9
Hilleshög HIL9920	110	385.6	101	14083	99	76.24	101	2786	99	36.50	20.59	1.31	19.28	205	1730	482	83.0
Maribo MA717	121	374.8	98	14630	102	72.66	97	2832	101	39.15	19.93	1.19	18.74	154	1606	441	84.8
SV 203	102	383.0	100	14755	103	75.36	100	2907	104	38.47	20.23	1.08	19.15	155	1656	341	88.5
SX 1815	120	385.0	101	14394	101	76.02	101	2841	101	37.45	20.27	1.02	19.25	138	1575	324	85.5
SX 1818	104	379.9	99	14397	101	74.36	99	2811	100	38.01	20.19	1.19	19.00	161	1664	421	86.6
Crystal 578RR (CommBench)	123	376.1	98	14171	99	73.08	97	2754	98	37.71	19.96	1.16	18.80	186	1719	374	92.7
BTS 8815 (CommBench)	124	387.6	101	14268	100	76.90	102	2830	101	36.85	20.45	1.07	19.38	140	1601	353	89.0
Crystal 803 (CommBench)	125	378.7	99	14500	101	73.94	98	2828	101	38.32	20.06	1.12	18.94	171	1604	382	92.0
AP CK MOD RES RR#7	126	366.5	96	15237	107	69.90	93	2893	103	41.79	19.47	1.15	18.32	201	1487	422	85.3
AP CK MOD SUS RR#8	127	392.6	103	14526	102	78.56	105	2906	104	36.98	20.63	1.00	19.63	130	1463	343	90.8
Experimental Trial (Comm status)																	
BTS 8328	225	373.4	98	14587	102	72.23	96	2838	101	38.85	19.87	1.21	18.67	170	1664	391	81.8
BTS 8359	221	375.6	98	14152	99	72.95	97	2775	99	37.36	19.96	1.18	18.79	148	1699	372	82.4
BTS 8365	228	393.0	103	14053	98	78.66	105	2808	100	35.92	20.74	1.09	19.64	146	1589	326	84.9
BTS 8404	211	379.0	99	13834	97	74.04	99	2707	96	36.30	20.04	1.08	18.96	140	1582	320	83.6
BTS 8412	205	391.7	102	14202	99	78.24	104	2841	101	36.32	20.54	0.94	19.59	147	1513	242	77.7
BTS 8440	213	385.4	101	14900	104	76.16	101	2947	105	38.74	20.24	0.96	19.28	137	1457	274	85.4
BTS 8457	201	382.3	100	14575	102	75.16	100	2875	102	37.85	20.22	1.10	19.12	177	1492	344	83.2
BTS 8469	206	376.2	98	14053	98	73.14	97	2726	97	37.31	19.88	1.05	18.83	152	1547	306	85.6
BTS 8480	230	389.8	102	14400	101	77.58	103	2877	102	36.86	20.54	1.06	19.48	130	1620	297	79.8
BTS 8495	214	386.4	101	14473	101	76.49	102	2871	102	37.41	20.40	1.06	19.34	141	1616	308	83.7
Crystal 360	218	371.9	97	13968	98	71.71	95	2686	96	37.61	19.82	1.25	18.57	174	1732	381	82.2
Crystal 361	227	395.1	103	14902	104	79.35	106	3015	107	37.28	20.76	0.99	19.77	134	1370	311	80.0
Crystal 364	232	370.1	97	14859	104	71.12	95	2862	102	40.21	19.53	1.04	18.50	126	1648	285	88.4
Crystal 369	231	376.1	98	14686	103	73.12	97	2856	102	38.79	20.09	1.25	18.84	177	1629	429	83.3
Crystal 470	203	369.9	97	14756	103	71.05	95	2853	102	39.68	19.60	1.10	18.50	169	1582	341	88.0
Crystal 471	229	384.6	101	14697	103	75.91	101	2906	104	38.09	20.41	1.18	19.23	164	1528	395	82.0
Crystal 473	207	379.2	99	15408	108	74.12	99	3013	107	40.41	19.96	0.97	19.00	140	1452	276	88.8
Crystal 475	224	383.0	100	13518	95	75.39	100	2675	95	35.14	20.19	1.03	19.16	150	1540	300	84.0
Crystal 479	226	377.0	99	14245	100	73.41	98	2785	99	37.54	20.06	1.20	18.86	153	1670	390	88.1
Hilleshög HIL2479	215	388.0	102	13929	97	77.00	102	2762	98	35.55	20.65	1.23	19.42	183	1511	427	77.9
Hilleshög HIL2480	217	377.1	99	13411	94	73.44	98	2604	93	35.63	20.15	1.29	18.86	176	1673	445	87.7
Hilleshög HIL2493	209	369.1	97	14642	102	70.78	94	2821	100	39.56	19.61	1.17	18.45	158	1683	356	80.3
Hilleshög HIL2494	223	373.0	98	14170	99	72.09	96	2733	97	38.05	19.90	1.25	18.65	140	1725	415	82.0
Hilleshög HIL2495	222	356.6	93	14344	100	66.69	89	2696	96	39.96	19.09	1.24	17.85	176	1778	389	87.5
Hilleshög HIL2496	204	366.3	96	13774	96	69.90	93	2627	94	37.58	19.57	1.26	18.31	193	1792	383	83.2
SV 231	219	374.3	98	15199	106	72.51	97	2943	105	40.62	19.88	1.15	18.73	140	1665	364	83.4
SV 343	216	360.1	94	14302	100	67.83	90	2691	96	39.71	19.28	1.27	18.01	180	1822	390	83.1
SV 344	208	359.0	94	12364	87	67.47	90	2334	83	34.30	19.27	1.33	17.93	185	1803	434	85.5
SV 345	210	365.2	96	15583	109	69.54	93	2967	106	42.57	19.44	1.18	18.26	161	1634	371	88.7
SV 347	212	369.2	97	13754	96	70.83	94	2637	94	37.43	19.64	1.18	18.47	172	1678	374	87.6
SX 1835	202	367.2	96	14336	100	70.18	93	2749	98	38.83	19.65	1.28	18.37	177	1818	406	91.4
SX 1849	220	371.4	97	14582	102	71.54	95	2815	100	39.23	19.68	1.12	18.56	150	1804	294	84.9
Crystal 578RR (CommBench)	233	375.0	98	13959	98	72.74	97	2704	96	37.39	19.89	1.17	18.73	167	1710	337	93.2
BTS 8815 (CommBench)	234	381.3	100	14508	102	74.80	100	2843	101	38.02	20.18	1.11	19.07	154	1651	321	82.8
Crystal 803 (CommBench)	235	376.3	98	14704	103	73.18	97	2868	102	38.83	19.99	1.18	18.82	160	1637	363	82.4
BTS 8927 (CommBench)	236	396.4	104	13999	98	79.78	106	2815	100	35.46	20.82	0.98	19.84	141	1477	288	82.5
Hilleshög HIL2389 (1stYearBench)	237	377.5	99	14766	103	73.54	98	2892	103	39.02	19.94	1.05	18.89	151	1642	295	86.8
AP CK MOD RES RR#7	238	362.9	95	14886	104	68.76	92	2828	101	40.74	19.24	1.07	18.17	177	1440	342	82.2
AP CK MOD SUS RR#8	239	393.1	103	13753	96	78.70	105	2770	99	34.70	20.71	1.02	19.69	139	1514	305	84.6
AP CK SUS RR#2	240	391.3	102	12153	85	78.09	104	2447	87	30.54	20.82	1.23	19.59	165	1666	405	71.9
AP CK MOD SUS RR#6	241	388.8	102	14462	101	77.27	103	2881	103	37.16	20.53	1.08	19.45	134	1661	308	83.4
RA CK SUS RR#7	242	380.9	100	13133	92	74.66	99	2584	92	34.42	20.25	1.21	19.04	166	1545	420	68.3
Comm Benchmark Mean		382.3		14293		75.13		2808		37.43	20.22	1.11		167	1607	370	91.7
Comm Trial Mean		384.4		14690		75.83		2896		38.26	20.33	1.11		161	1603	374	87.5
Coeff. of Var. (%)		2.5		5.0		4.2		5.7		4.8	2.4	8.9		21.0	3.7	16.3	6.9
Mean LSD (0.05)		9.1		681		3.03		155		1.73	0.46	0.09		32	57	59	5.3
Mean LSD (0.01)		12.0		897		3.99		205		2.28	0.61	0.12		42	74	77	7.0
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Casselton ND — Created 10/10/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 248301

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 11. 2024 Performance of Varieties - ACSC RR Official Trial
Averill MN

		Rec/T		Rec/A		Rev/T		Rev/A		Yield	Sugar%			Na	K	AmN	Emerg.
Description @	Code	lbs.	%Bnch	lbs.	%Bnch	$ +	%Bnch	$ +	%Bnch	T/A	Gross	LTM	Rec	ppm	ppm	ppm	%
Commercial Trial																	
BTS 8018	113	326.6	101	9964	110	56.68	103	1726	112	30.57	17.59	1.27	16.32	419	1351	468	91.7
BTS 8034	118	315.4	98	9561	106	52.99	96	1601	104	30.45	17.21	1.44	15.77	535	1510	518	90.4
BTS 8156	105	326.4	101	9131	101	56.64	103	1588	103	27.89	17.66	1.34	16.32	421	1556	470	89.6
BTS 8226	122	339.9	106	9317	103	61.12	111	1670	108	27.53	18.25	1.26	16.99	393	1250	496	87.8
BTS 8270	107	343.7	107	9676	107	62.36	113	1746	113	28.30	18.40	1.21	17.19	321	1395	451	85.9
BTS 8927 (CommBench)	117	341.1	106	9566	106	61.50	111	1722	112	28.12	18.31	1.26	17.05	405	1252	496	84.7
Crystal 022	116	342.2	106	9011	100	61.86	112	1629	106	26.33	18.34	1.24	17.10	346	1367	467	87.9
Crystal 130	111	323.1	100	9012	100	55.53	101	1550	100	27.91	17.53	1.37	16.16	446	1362	539	83.3
Crystal 137	101	321.0	100	9038	100	54.85	99	1541	100	28.26	17.43	1.38	16.05	432	1504	512	87.9
Crystal 138	103	323.9	101	9268	103	55.81	101	1592	103	28.75	17.55	1.36	16.19	403	1410	528	85.2
Crystal 260	115	332.5	103	9772	108	58.66	106	1720	111	29.49	17.88	1.25	16.63	400	1311	475	85.9
Crystal 262	109	310.3	96	9607	106	51.31	93	1589	103	30.98	16.89	1.37	15.52	516	1286	529	74.3
Crystal 269	106	338.9	105	10010	111	60.76	110	1795	116	29.60	18.26	1.32	16.94	384	1433	499	85.3
Crystal 793	108	328.9	102	9603	106	57.47	104	1680	109	29.16	17.72	1.27	16.45	459	1305	472	89.3
Crystal 912	114	305.3	95	9917	110	49.63	90	1611	104	32.52	16.64	1.38	15.26	540	1189	553	90.6
Hilleshög HIL2386	119	306.8	95	9052	100	50.14	91	1477	96	29.58	16.66	1.32	15.34	556	1149	511	87.0
Hilleshög HIL2389	112	329.3	102	9050	100	57.58	104	1580	102	27.57	17.71	1.25	16.46	369	1318	485	89.9
Hilleshög HIL9920	110	307.6	96	8767	97	50.40	91	1435	93	28.54	16.74	1.37	15.37	559	1376	487	82.3
Maribo MA717	121	316.7	98	9541	106	53.43	97	1607	104	30.19	17.06	1.22	15.84	445	1225	458	84.1
SV 203	102	336.4	104	9242	102	59.94	109	1648	107	27.51	18.01	1.19	16.82	304	1302	467	87.4
SX 1815	120	324.8	101	9092	101	56.11	102	1564	101	28.14	17.50	1.26	16.24	381	1301	489	88.9
SX 1818	104	314.9	98	9468	105	52.82	96	1586	103	30.14	17.08	1.34	15.74	452	1391	503	80.9
Crystal 578RR (CommBench)	123	306.4	95	8833	98	50.01	91	1438	93	28.90	16.78	1.46	15.32	547	1420	552	89.5
BTS 8815 (CommBench)	124	314.9	98	8614	95	52.81	96	1443	93	27.41	17.16	1.41	15.75	547	1441	511	90.8
Crystal 803 (CommBench)	125	325.6	101	9081	101	56.35	102	1571	102	27.94	17.61	1.34	16.27	430	1337	522	83.1
AP CK MOD RES RR#7	126	302.8	94	10067	112	48.83	89	1623	105	33.29	16.72	1.58	15.14	612	1281	653	82.3
AP CK MOD SUS RR#8	127	338.2	105	9260	103	60.55	110	1650	107	27.52	18.22	1.32	16.90	371	1335	527	89.6
Experimental Trial (Comm status)																	
BTS 8328	225	336.1	104	9251	103	59.77	108	1643	106	27.63	18.15	1.46	16.69	365	1496	491	75.9
BTS 8359	221	318.9	99	10356	115	54.15	98	1759	114	32.51	17.35	1.44	15.91	383	1333	532	76.1
BTS 8365	228	342.8	106	9572	106	61.95	112	1731	112	27.89	18.35	1.24	17.11	316	1271	423	80.7
BTS 8404	211	331.4	103	9330	103	58.22	106	1643	106	28.13	17.81	1.26	16.55	332	1320	427	77.8
BTS 8412	205	322.5	100	9771	108	55.32	100	1681	109	30.25	17.43	1.32	16.11	417	1442	405	75.1
BTS 8440	213	338.8	105	9653	107	60.62	110	1727	112	28.55	18.10	1.22	16.88	310	1237	422	83.0
BTS 8457	201	327.9	102	10055	111	57.08	103	1755	114	30.67	17.65	1.27	16.38	423	1114	461	77.1
BTS 8469	206	325.5	101	10983	122	56.32	102	1922	124	33.37	17.59	1.39	16.19	390	1315	490	80.3
BTS 8480	230	332.1	103	9777	108	58.44	106	1725	112	29.44	17.84	1.21	16.64	290	1320	414	67.4
BTS 8495	214	336.6	105	8791	97	59.92	109	1567	101	26.11	18.01	1.24	16.77	337	1268	418	84.9
Crystal 360	218	342.7	106	9587	106	61.90	112	1737	113	27.96	18.32	1.21	17.11	258	1366	402	80.4
Crystal 361	227	326.4	101	10631	118	56.61	103	1849	120	32.55	17.69	1.33	16.37	408	1313	458	75.2
Crystal 364	232	313.7	97	9545	106	52.45	95	1601	104	30.40	17.16	1.52	15.64	476	1503	516	81.5
Crystal 369	231	313.5	97	10006	111	52.38	95	1670	108	32.07	17.04	1.39	15.65	386	1386	487	77.7
Crystal 470	203	330.6	103	10092	112	57.97	105	1774	115	30.50	17.83	1.35	16.48	350	1231	510	78.4
Crystal 471	229	340.1	106	10057	111	61.05	111	1805	117	29.58	18.21	1.26	16.95	349	1183	449	81.4
Crystal 473	207	320.0	99	9204	102	54.52	99	1568	102	28.77	17.23	1.32	15.91	490	1217	425	89.1
Crystal 475	224	322.8	100	8854	98	55.40	100	1526	99	27.40	17.35	1.29	16.05	333	1313	447	80.4
Crystal 479	226	317.6	99	10498	116	53.72	97	1761	114	33.38	17.27	1.47	15.80	452	1350	517	80.4
Hilleshög HIL2479	215	323.0	100	9180	102	55.47	101	1576	102	28.48	17.54	1.41	16.12	489	1202	512	72.5
Hilleshög HIL2480	217	322.9	100	8868	98	55.46	101	1526	99	27.45	17.56	1.47	16.09	412	1302	552	78.0
Hilleshög HIL2493	209	318.7	99	11080	123	54.06	98	1883	122	34.72	17.21	1.33	15.88	411	1361	430	74.8
Hilleshög HIL2494	223	315.5	98	11114	123	53.05	96	1877	122	35.09	17.18	1.48	15.70	355	1454	532	78.5
Hilleshög HIL2495	222	296.3	92	9649	107	46.78	85	1528	99	32.56	16.17	1.44	14.74	565	1366	451	79.3
Hilleshög HIL2496	204	291.0	90	9153	101	45.06	82	1418	92	31.46	16.14	1.64	14.49	702	1513	516	78.3
SV 231	219	316.4	98	10593	117	53.33	97	1786	116	33.50	17.10	1.32	15.79	375	1387	432	77.8
SV 343	216	294.0	91	8379	93	46.05	83	1317	85	28.43	16.09	1.47	14.62	539	1389	477	80.4
SV 344	208	300.6	93	9217	102	48.19	87	1475	96	30.70	16.46	1.46	15.00	525	1374	484	78.7
SV 345	210	304.9	95	11067	123	49.59	90	1804	117	36.23	16.63	1.42	15.20	398	1352	512	81.1
SV 347	212	330.2	103	9905	110	57.84	105	1737	113	29.98	17.86	1.48	16.38	340	1460	522	77.1
SX 1835	202	308.7	96	10667	118	50.83	92	1759	114	34.52	16.81	1.44	15.37	391	1421	498	82.9
SX 1849	220	281.1	87	8438	94	41.84	76	1256	81	30.04	15.58	1.62	13.96	705	1519	485	82.2
Crystal 578RR (CommBench)	233	309.3	96	9852	109	51.05	93	1630	106	31.81	16.89	1.50	15.38	534	1420	487	79.8
BTS 8815 (CommBench)	234	310.6	96	8899	99	51.47	93	1475	96	28.67	16.87	1.38	15.48	434	1431	441	80.4
Crystal 803 (CommBench)	235	322.3	100	9479	105	55.26	100	1625	105	29.39	17.46	1.39	16.07	412	1375	472	84.5
BTS 8927 (CommBench)	236	331.7	103	9792	109	58.33	106	1726	112	29.54	17.95	1.34	16.61	404	1289	479	76.9
Hilleshög HIL2389 (1stYearBench)	237	324.9	101	9288	103	56.11	102	1605	104	28.58	17.64	1.47	16.17	400	1348	531	78.6
AP CK MOD RES RR#7	238	295.7	92	9879	109	46.58	84	1560	101	33.31	16.31	1.61	14.70	633	1198	591	79.2
AP CK MOD SUS RR#8	239	326.2	101	9121	101	56.54	102	1580	102	27.97	17.70	1.40	16.30	386	1357	505	83.4
AP CK SUS RR#2	240	319.8	99	8394	93	54.47	99	1428	93	26.29	17.39	1.38	16.01	419	1302	494	66.1
AP CK MOD SUS RR#6	241	332.7	103	9130	101	58.65	106	1605	104	27.51	17.92	1.34	16.58	387	1293	459	80.1
RA CK SUS RR#7	242	309.2	96	9449	105	51.01	92	1560	101	30.59	16.85	1.35	15.50	529	1273	441	88.5
Comm Benchmark Mean		322.0		9024		55.17		1544		28.09	17.47	1.37		482	1363	520	87.0
Comm Trial Mean		323.8		9353		55.78		1607		28.99	17.52	1.33		444	1347	505	86.5
Coeff. of Var. (%)		2.8		5.1		5.4		6.8		4.5	2.3	6.9		15.6	3.7	9.6	8.0
Mean LSD (0.05)		9.0		486		2.99		112		1.30	0.39	0.09		69	49	49	5.9
Mean LSD (0.01)		11.9		640		3.94		148		1.72	0.52	0.12		91	65	64	7.7
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Averill MN   Created 09/27/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs.   Trial # = 248302

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 12. 2024 Performance of Varieties - ACSC RR Official Trial
Ada MN

		Rec/T		Rec/A		Rev/T		Rev/A		Yield	Sugar%			Na	K	AmN	Emerg.
Description @	Code	lbs.	%Bnch	lbs.	%Bnch	$ +	%Bnch	$ +	%Bnch	T/A	Gross	LTM	Rec	ppm	ppm	ppm	%
Commercial Trial																	
BTS 8018	113	373.8	100	12933	104	72.33	100	2505	104	34.62	19.48	0.79	18.69	151	1286	214	87.6
BTS 8034	118	361.0	96	12348	100	68.09	94	2324	97	34.43	18.95	0.90	18.05	203	1436	242	81.5
BTS 8156	105	365.8	98	11871	96	69.67	96	2260	94	32.49	19.11	0.82	18.29	155	1398	207	85.2
BTS 8226	122	383.0	102	12561	101	75.37	104	2471	103	32.79	19.88	0.73	19.15	121	1207	202	81.1
BTS 8270	107	361.3	97	11938	96	68.18	94	2256	94	33.04	18.94	0.88	18.06	171	1388	251	81.8
BTS 8927 (CommBench)	117	385.3	103	12819	103	76.14	105	2534	105	33.36	19.97	0.70	19.27	112	1154	196	86.2
Crystal 022	116	373.6	100	11943	96	72.27	100	2306	96	31.97	19.50	0.82	18.68	132	1274	250	80.6
Crystal 130	111	367.0	98	12193	98	70.07	97	2324	97	33.28	19.19	0.84	18.35	178	1307	236	84.9
Crystal 137	101	355.2	95	11797	95	66.17	91	2196	91	33.14	18.64	0.88	17.76	172	1448	237	84.9
Crystal 138	103	359.8	96	12108	98	67.69	93	2281	95	33.62	18.83	0.84	17.99	161	1362	231	78.7
Crystal 260	115	372.3	99	12666	102	71.83	99	2446	102	33.96	19.44	0.83	18.61	160	1312	234	88.1
Crystal 262	109	355.9	95	12250	99	66.39	92	2282	95	34.48	18.55	0.76	17.79	176	1170	219	75.2
Crystal 269	106	390.3	104	12872	104	77.78	107	2563	107	33.07	20.30	0.77	19.53	117	1309	211	80.8
Crystal 793	108	368.4	98	12615	102	70.55	97	2412	100	34.26	19.21	0.79	18.42	153	1253	221	85.6
Crystal 912	114	337.9	90	12875	104	60.45	83	2302	96	38.14	17.77	0.88	16.89	206	1263	270	85.7
Hilleshög HIL2386	119	358.9	96	11921	96	67.40	93	2238	93	33.22	18.80	0.85	17.95	181	1246	261	82.0
Hilleshög HIL2389	112	352.9	94	12743	103	65.40	90	2362	98	35.97	18.49	0.85	17.64	167	1341	241	89.2
Hilleshög HIL9920	110	358.9	96	12267	99	67.40	93	2306	96	34.14	18.74	0.79	17.95	163	1351	197	84.5
Maribo MA717	121	347.9	93	12265	99	63.74	88	2238	93	35.29	18.28	0.88	17.40	193	1359	250	82.0
SV 203	102	363.1	97	12793	103	68.78	95	2424	101	35.15	18.98	0.82	18.16	152	1299	234	84.5
SX 1815	120	371.4	99	13072	105	71.54	99	2517	105	35.28	19.36	0.79	18.57	141	1288	218	85.5
SX 1818	104	353.8	95	12799	103	65.72	91	2378	99	36.17	18.47	0.78	17.69	142	1276	213	81.2
Crystal 578RR (CommBench)	123	360.7	96	12097	97	67.98	94	2282	95	33.53	18.87	0.84	18.03	193	1351	220	90.8
BTS 8815 (CommBench)	124	379.2	101	12120	98	74.13	102	2374	99	31.98	19.69	0.73	18.96	124	1265	188	86.5
Crystal 803 (CommBench)	125	371.6	99	12603	102	71.59	99	2426	101	33.99	19.40	0.82	18.58	139	1314	236	90.9
AP CK MOD RES RR#7	126	343.0	92	12821	103	62.12	86	2317	96	37.40	18.04	0.88	17.16	231	1233	273	79.7
AP CK MOD SUS RR#8	127	376.1	101	12145	98	73.09	101	2359	98	32.27	19.61	0.80	18.81	154	1280	226	87.6
Experimental Trial (Comm status)																	
BTS 8328	225	378.0	101	12392	100	73.72	102	2449	102	32.76	19.73	0.81	18.92	177	1327	251	80.1
BTS 8359	221	372.7	100	13027	105	71.92	99	2520	105	34.88	19.50	0.85	18.64	164	1352	285	82.9
BTS 8365	228	402.4	108	12280	99	82.08	113	2511	104	30.46	20.81	0.70	20.12	136	1192	210	80.6
BTS 8404	211	375.8	100	12230	99	73.00	101	2396	100	32.25	19.53	0.72	18.81	140	1220	218	81.4
BTS 8412	205	361.6	97	12479	101	68.15	94	2350	98	34.74	18.88	0.79	18.09	181	1359	226	82.5
BTS 8440	213	376.4	101	12775	103	73.21	101	2505	104	33.85	19.51	0.68	18.83	137	1172	196	84.7
BTS 8457	201	388.4	104	14193	114	77.30	107	2843	118	36.45	20.10	0.68	19.42	154	1044	225	87.1
BTS 8469	206	384.5	103	12669	102	75.97	105	2510	104	33.31	19.96	0.75	19.21	174	1232	230	82.4
BTS 8480	230	388.5	104	12321	99	77.31	107	2475	103	31.85	20.15	0.72	19.43	112	1283	214	72.3
BTS 8495	214	387.8	104	11974	96	77.07	106	2378	99	31.24	20.09	0.71	19.38	163	1248	203	85.3
Crystal 360	218	389.7	104	12868	104	77.76	107	2576	107	32.95	20.25	0.75	19.50	142	1294	227	82.8
Crystal 361	227	380.6	102	13064	105	74.62	103	2586	108	34.20	19.82	0.77	19.05	160	1233	245	80.6
Crystal 364	232	364.5	97	13594	110	69.16	95	2593	108	37.38	19.01	0.78	18.23	173	1353	219	87.8
Crystal 369	231	397.7	106	13825	111	80.46	111	2798	116	35.03	20.68	0.80	19.88	166	1328	250	85.0
Crystal 470	203	367.9	98	13078	105	70.31	97	2495	104	35.71	19.10	0.71	18.39	186	1205	200	87.3
Crystal 471	229	388.0	104	12879	104	77.15	106	2572	107	33.30	20.12	0.72	19.40	148	1178	232	81.3
Crystal 473	207	360.5	96	13218	107	67.79	94	2498	104	36.88	18.77	0.74	18.03	218	1199	215	89.4
Crystal 475	224	386.0	103	11982	97	76.49	106	2390	99	30.78	20.01	0.70	19.31	131	1245	193	88.8
Crystal 479	226	379.5	101	13642	110	74.27	102	2678	111	36.09	19.78	0.80	18.98	169	1318	243	84.6
Hilleshög HIL2479	215	382.8	102	10775	87	75.36	104	2129	89	28.14	19.96	0.82	19.15	181	1278	272	77.2
Hilleshög HIL2480	217	383.2	102	11244	91	75.51	104	2219	92	29.53	20.03	0.86	19.16	181	1308	300	74.3
Hilleshög HIL2493	209	363.0	97	13707	110	68.61	95	2592	108	38.18	18.86	0.72	18.13	146	1294	200	87.2
Hilleshög HIL2494	223	380.6	102	14230	115	74.61	103	2807	117	37.37	19.81	0.77	19.04	160	1339	226	86.2
Hilleshög HIL2495	222	349.8	93	13172	106	64.14	89	2426	101	37.80	18.44	0.92	17.52	288	1463	264	83.1
Hilleshög HIL2496	204	372.0	99	12876	104	71.70	99	2479	103	34.80	19.42	0.81	18.61	217	1373	227	80.8
SV 231	219	360.3	96	14043	113	67.72	93	2641	110	38.86	18.83	0.81	18.03	194	1412	224	85.1
SV 343	216	358.2	96	12979	105	67.01	92	2429	101	36.23	18.75	0.83	17.93	214	1401	235	84.0
SV 344	208	364.5	97	11818	95	69.18	95	2241	93	32.31	18.99	0.75	18.24	151	1356	208	76.5
SV 345	210	365.7	98	14113	114	69.56	96	2694	112	38.66	19.06	0.78	18.28	189	1325	215	87.5
SV 347	212	371.3	99	13618	110	71.47	99	2622	109	36.69	19.39	0.83	18.57	176	1300	270	82.5
SX 1835	202	372.2	99	13547	109	71.80	99	2623	109	36.52	19.37	0.76	18.61	143	1339	220	87.2
SX 1849	220	363.3	97	13010	105	68.75	95	2458	102	35.86	18.92	0.76	18.16	168	1432	187	87.3
Crystal 578RR (CommBench)	233	376.4	101	12511	101	73.22	101	2436	101	33.42	19.55	0.73	18.82	163	1310	199	85.5
BTS 8815 (CommBench)	234	360.1	96	12195	98	67.64	93	2290	95	33.92	18.86	0.85	18.01	188	1405	255	82.1
Crystal 803 (CommBench)	235	372.0	99	12783	103	71.71	99	2459	102	34.37	19.37	0.78	18.59	152	1347	228	85.5
BTS 8927 (CommBench)	236	388.3	104	12150	98	77.27	107	2431	101	31.15	20.15	0.73	19.42	158	1185	226	83.9
Hilleshög HIL2389 (1stYearBench)	237	373.9	100	13246	107	72.37	100	2591	108	35.21	19.44	0.72	18.71	162	1257	202	80.5
AP CK MOD RES RR#7	238	351.6	94	12609	102	64.78	89	2341	97	35.96	18.37	0.77	17.60	213	1189	242	81.0
AP CK MOD SUS RR#8	239	393.5	105	11663	94	79.02	109	2349	98	30.01	20.36	0.70	19.65	143	1230	206	83.0
AP CK SUS RR#2	240	377.1	101	9768	79	73.46	101	1920	80	25.93	19.68	0.82	18.87	174	1345	248	68.0
AP CK MOD SUS RR#6	241	388.7	104	12693	102	77.39	107	2539	106	32.81	20.24	0.81	19.44	156	1338	252	86.6
RA CK SUS RR#7	242	385.9	103	12294	99	76.45	106	2455	102	31.93	20.09	0.79	19.30	191	1316	226	89.6
Comm Benchmark Mean		374.2		12410		72.46		2404		33.22	19.48	0.77		142	1271	210	88.6
Comm Trial Mean		364.7		12423		69.33		2359		34.11	19.05	0.82		161	1303	229	84.2
Coeff. of Var. (%)		2.9		5.3		5.0		6.3		5.2	2.5	8.0		20.4	6.2	12.4	7.8
Mean LSD (0.05)		9.7		589		3.21		135		1.58	0.44	0.06		31	74	27	5.5
Mean LSD (0.01)		12.8		776		4.22		177		2.08	0.58	0.08		41	97	36	7.2
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Ada MN Created 10/09/2024
@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.
%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.
+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. Trial # = 248304
Na, K, AmN, and Emergence not adjusted to commercial status.

Table 13. 2024 Performance of Varieties - ACSC RR Official Trial
Hillsboro ND

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Rev/T $ +	Rev/T %Bnch	Rev/A $ +	Rev/A %Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	113	322.8	98	10555	101	55.43	96	1812	99	32.71	17.27	1.13	16.14	200	1538	393	71.3
BTS 8034	118	325.1	98	10551	101	56.19	97	1822	100	32.50	17.41	1.16	16.25	210	1653	382	79.5
BTS 8156	105	317.4	96	10352	99	53.65	93	1752	96	32.60	17.09	1.23	15.86	215	1730	412	67.9
BTS 8226	122	337.5	102	10972	105	60.30	104	1961	107	32.46	17.94	1.07	16.87	203	1387	385	70.0
BTS 8270	107	326.7	99	10309	99	56.72	98	1790	98	31.54	17.50	1.17	16.33	196	1562	416	66.4
BTS 8927 (CommBench)	117	337.5	102	10371	99	60.31	104	1851	101	30.80	17.93	1.06	16.87	182	1374	388	74.8
Crystal 022	116	330.3	100	10131	97	57.92	100	1779	97	30.63	17.61	1.10	16.51	180	1470	395	71.8
Crystal 130	111	332.2	101	10460	100	58.56	101	1847	101	31.41	17.64	1.01	16.63	153	1456	341	74.9
Crystal 137	101	331.3	100	10339	99	58.25	101	1819	99	31.22	17.77	1.21	16.56	190	1738	409	72.5
Crystal 138	103	325.6	99	10211	98	56.35	97	1769	97	31.32	17.50	1.22	16.28	198	1513	472	66.5
Crystal 260	115	337.3	102	10693	102	60.23	104	1912	105	31.74	17.89	1.05	16.84	153	1554	343	78.6
Crystal 262	109	316.8	96	10659	102	53.46	92	1801	98	33.60	17.01	1.17	15.84	227	1432	441	64.5
Crystal 269	106	329.9	100	10263	98	57.80	100	1801	98	31.05	17.76	1.27	16.49	227	1587	478	58.4
Crystal 793	108	330.0	100	9843	94	57.83	100	1727	94	29.75	17.67	1.17	16.50	216	1460	440	75.5
Crystal 912	114	304.0	92	10958	105	49.21	85	1775	97	36.06	16.47	1.27	15.20	316	1394	498	74.0
Hilleshög HIL2386	119	326.9	99	10251	98	56.78	98	1782	97	31.32	17.59	1.25	16.34	230	1510	481	71.8
Hilleshög HIL2389	112	328.3	99	10046	96	57.25	99	1758	96	30.44	17.63	1.21	16.42	219	1573	439	75.6
Hilleshög HIL9920	110	332.9	101	10396	100	58.77	101	1835	100	31.26	17.75	1.11	16.64	198	1575	368	64.4
Maribo MA717	121	319.7	97	10597	102	54.41	94	1801	98	33.18	17.17	1.17	16.00	212	1500	435	78.8
SV 203	102	335.4	102	10655	102	59.62	103	1894	104	31.87	17.83	1.07	16.76	147	1562	366	71.1
SX 1815	120	331.8	100	10612	102	58.41	101	1870	102	31.92	17.69	1.10	16.59	157	1546	382	73.6
SX 1818	104	325.3	98	10013	96	56.26	97	1730	95	30.71	17.48	1.21	16.27	197	1606	437	64.4
Crystal 578RR (CommBench)	123	323.7	98	10491	101	55.73	96	1808	99	32.43	17.39	1.21	16.18	236	1589	430	79.6
BTS 8815 (CommBench)	124	332.0	101	10764	103	58.49	101	1895	104	32.46	17.70	1.10	16.60	171	1539	378	75.7
Crystal 803 (CommBench)	125	327.9	99	10114	97	57.14	99	1762	96	30.83	17.56	1.16	16.40	185	1465	440	72.0
AP CK MOD RES RR#7	126	314.8	95	10667	102	52.79	91	1791	98	33.86	16.86	1.13	15.73	249	1381	418	71.9
AP CK MOD SUS RR#8	127	325.8	99	9558	92	56.43	97	1652	90	29.30	17.53	1.23	16.30	215	1486	482	73.3
Experimental Trial (Comm status)																	
BTS 8328	225	338.3	102	10129	97	60.58	105	1811	99	30.01	17.97	1.07	16.90	136	1518	294	62.1
BTS 8359	221	327.0	99	10466	100	56.80	98	1807	99	32.32	17.56	1.25	16.31	160	1561	396	71.5
BTS 8365	228	345.3	105	9616	92	62.88	109	1752	96	27.70	18.35	1.06	17.28	120	1376	337	76.6
BTS 8404	211	334.1	101	9810	94	59.19	102	1751	96	29.29	17.86	1.16	16.70	140	1470	370	71.9
BTS 8412	205	341.6	103	9809	94	61.68	107	1770	97	28.80	18.11	1.04	17.07	123	1547	278	62.9
BTS 8440	213	339.7	103	10582	101	61.05	105	1904	104	31.06	18.00	1.00	17.01	129	1376	283	75.4
BTS 8457	201	336.1	102	10171	97	59.86	103	1804	99	30.45	17.82	1.04	16.78	132	1307	331	73.1
BTS 8469	206	319.4	97	10247	98	54.30	94	1769	97	31.60	17.10	1.15	15.95	147	1446	365	68.0
BTS 8480	230	331.4	100	10362	99	58.30	101	1811	99	31.59	17.71	1.17	16.54	135	1584	351	60.9
BTS 8495	214	323.5	98	10450	100	55.66	96	1794	98	32.42	17.31	1.17	16.14	150	1599	344	69.5
Crystal 360	218	338.1	102	10085	97	60.52	104	1805	99	29.75	18.03	1.13	16.90	157	1524	329	80.1
Crystal 361	227	335.1	101	10844	104	59.54	103	1915	105	32.66	17.79	1.05	16.74	145	1327	327	79.7
Crystal 364	232	316.1	96	10910	105	53.22	92	1833	100	34.59	16.91	1.13	15.78	165	1624	301	78.5
Crystal 369	231	337.4	102	10937	105	60.29	104	1947	106	32.75	18.05	1.24	16.81	137	1588	395	73.4
Crystal 470	203	330.3	100	10932	105	57.91	100	1916	105	33.17	17.55	1.04	16.51	152	1387	304	87.9
Crystal 471	229	337.0	102	10991	105	60.16	104	1963	107	32.59	17.87	1.02	16.85	141	1369	301	73.8
Crystal 473	207	330.3	100	11872	114	57.94	100	2088	114	35.91	17.53	1.02	16.51	149	1393	286	80.5
Crystal 475	224	330.4	100	10032	96	57.98	100	1762	96	30.48	17.60	1.09	16.52	98	1485	330	76.2
Crystal 479	226	327.2	99	9962	95	56.90	98	1731	95	30.49	17.50	1.15	16.35	136	1572	348	73.1
Hilleshög HIL2479	215	351.3	106	9215	88	64.89	112	1699	93	26.33	18.61	1.05	17.55	143	1462	296	68.4
Hilleshög HIL2480	217	338.0	102	9680	93	60.49	104	1725	94	28.81	18.13	1.26	16.87	158	1577	403	75.0
Hilleshög HIL2493	209	325.8	99	10592	102	56.42	97	1844	101	32.53	17.44	1.16	16.28	146	1552	344	81.6
Hilleshög HIL2494	223	332.5	101	10993	105	58.67	101	1939	106	33.23	17.77	1.19	16.59	140	1627	346	78.5
Hilleshög HIL2495	222	312.6	95	10900	104	52.06	90	1794	98	35.44	16.87	1.27	15.60	185	1763	357	68.8
Hilleshög HIL2496	204	320.9	97	10117	97	54.79	95	1725	94	31.75	17.25	1.24	16.01	158	1754	343	78.5
SV 231	219	327.6	99	11060	106	57.01	98	1925	105	33.79	17.50	1.15	16.35	124	1592	340	78.9
SV 343	216	321.2	97	9480	91	54.90	95	1615	88	29.63	17.28	1.25	16.03	181	1699	360	75.8
SV 344	208	318.5	96	9570	92	54.01	93	1628	89	29.96	17.18	1.27	15.91	187	1614	397	66.4
SV 345	210	332.2	101	11355	109	58.58	101	2004	110	34.39	17.83	1.24	16.59	167	1595	383	82.8
SV 347	212	330.3	100	10087	97	57.92	100	1771	97	30.72	17.72	1.26	16.46	142	1587	405	82.0
SX 1835	202	319.0	97	10727	103	54.17	94	1822	100	33.66	17.17	1.25	15.92	155	1606	391	80.1
SX 1849	220	312.5	95	10985	105	52.03	90	1830	100	35.19	16.82	1.21	15.61	169	1714	333	79.7
Crystal 578RR (CommBench)	233	319.8	97	10067	96	54.45	94	1707	93	31.60	17.19	1.22	15.97	169	1632	360	78.9
BTS 8815 (CommBench)	234	328.1	99	11143	107	57.17	99	1949	107	33.83	17.59	1.19	16.41	155	1590	353	73.8
Crystal 803 (CommBench)	235	333.6	101	10248	98	59.03	102	1809	99	30.79	17.75	1.07	16.68	144	1535	295	69.1
BTS 8927 (CommBench)	236	339.6	103	10282	99	61.02	105	1851	101	30.30	18.04	1.05	16.99	126	1464	301	69.9
Hilleshög HIL2389 (1stYearBench)	237	335.2	102	10540	101	59.56	103	1870	102	31.65	17.81	1.06	16.75	126	1448	310	78.9
AP CK MOD RES RR#7	238	319.7	97	11497	110	54.38	94	1955	107	36.15	17.04	1.09	15.95	181	1384	322	73.4
AP CK MOD SUS RR#8	239	329.0	100	10690	102	57.49	99	1874	102	32.46	17.60	1.14	16.46	116	1473	366	77.4
AP CK SUS RR#2	240	336.6	102	9349	90	60.02	104	1670	91	27.77	17.99	1.16	16.83	177	1510	346	59.0
AP CK MOD SUS RR#6	241	325.6	99	10302	99	56.35	97	1788	98	31.75	17.69	1.45	16.24	215	1645	504	72.7
RA CK SUS RR#7	242	332.5	101	10487	100	58.68	101	1843	101	31.89	17.70	1.11	16.60	159	1463	324	83.6
Comm Benchmark Mean		330.3		10435		57.92		1829		31.63	17.65	1.13		193	1492	409	75.5
Comm Trial Mean		327.0		10401		56.83		1807		31.81	17.51	1.16		203	1525	417	71.8
Coeff. of Var. (%)		2.4		6.3		4.5		7.3		6.0	1.8	10.2		23.6	4.8	16.2	15.8
Mean LSD (0.05)		7.4		620		2.43		126		1.75	0.30	0.11		46	69	65	9.7
Mean LSD (0.01)		9.7		817		3.21		166		2.30	0.40	0.15		60	91	86	12.8
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Hillsboro ND — Created 09/27/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 248305

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 14. 2024 Performance of Varieties - ACSC RR Official Trial
Climax MN

		Rec/T		Rec/A		Rev/T		Rev/A		Yield	Sugar%			Na	K	AmN	Emerg.
Description @	Code	lbs.	%Bnch	lbs.	%Bnch	$ +	%Bnch	$ +	%Bnch	T/A	Gross	LTM	Rec	ppm	ppm	ppm	%
Commercial Trial																	
BTS 8018	113	299.6	104	10815	108	47.76	108	1727	113	36.17	16.03	1.06	14.97	130	1183	455	72.9
BTS 8034	118	283.2	98	10507	105	42.33	96	1569	102	37.03	15.47	1.30	14.17	225	1393	556	78.4
BTS 8156	105	286.8	99	10470	105	43.50	98	1591	104	36.46	15.62	1.28	14.34	190	1371	556	72.4
BTS 8226	122	305.2	106	10917	109	49.60	112	1776	116	35.65	16.28	1.02	15.26	153	1091	444	67.5
BTS 8270	107	288.3	100	10652	106	44.00	100	1626	106	36.97	15.58	1.17	14.41	184	1244	504	68.4
BTS 8927 (CommBench)	117	300.1	104	10444	104	47.93	108	1666	109	34.79	16.10	1.09	15.01	161	1145	484	73.8
Crystal 022	116	303.4	105	10283	103	49.02	111	1662	109	34.04	16.34	1.17	15.17	152	1275	514	76.7
Crystal 130	111	299.3	104	10823	108	47.64	108	1721	112	36.21	16.14	1.18	14.96	151	1329	502	78.7
Crystal 137	101	289.1	100	10306	103	44.29	100	1582	103	35.49	15.77	1.30	14.47	200	1463	548	70.5
Crystal 138	103	285.8	99	9851	98	43.18	98	1487	97	34.48	15.61	1.32	14.29	172	1248	629	68.7
Crystal 260	115	292.3	101	10605	106	45.33	103	1651	108	36.06	15.79	1.17	14.62	151	1276	514	74.0
Crystal 262	109	288.4	100	10654	106	44.05	100	1620	106	37.07	15.58	1.16	14.42	193	1176	516	69.8
Crystal 269	106	294.6	102	10633	106	46.09	104	1661	108	36.12	16.05	1.32	14.73	171	1347	602	76.8
Crystal 793	108	294.6	102	10647	106	46.10	104	1672	109	35.89	15.87	1.14	14.73	173	1181	506	69.1
Crystal 912	114	287.1	99	10487	105	43.62	99	1600	104	36.39	15.56	1.21	14.35	209	1157	550	83.8
Hilleshög HIL2386	119	289.3	100	10491	105	44.33	100	1602	105	36.46	15.73	1.27	14.46	228	1188	585	64.6
Hilleshög HIL2389	112	293.7	102	10253	102	45.80	104	1596	104	34.95	15.88	1.20	14.68	155	1261	535	74.2
Hilleshög HIL9920	110	295.2	102	10227	102	46.31	105	1608	105	34.75	15.91	1.15	14.76	211	1329	463	61.3
Maribo MA717	121	287.1	99	10614	106	43.60	99	1617	106	36.81	15.63	1.27	14.36	209	1245	579	67.5
SV 203	102	294.0	102	10382	104	45.90	104	1621	106	35.35	15.89	1.20	14.69	154	1241	541	75.7
SX 1815	120	292.0	101	10346	103	45.25	102	1603	105	35.39	15.81	1.21	14.60	161	1258	543	77.4
SX 1818	104	287.3	99	10729	107	43.67	99	1625	106	37.61	15.55	1.19	14.36	153	1225	542	61.2
Crystal 578RR (CommBench)	123	276.9	96	9712	97	40.25	91	1407	92	35.20	15.11	1.27	13.84	189	1234	583	77.7
BTS 8815 (CommBench)	124	284.0	98	9215	92	42.60	96	1381	90	32.33	15.41	1.21	14.20	194	1277	527	73.1
Crystal 803 (CommBench)	125	294.5	102	10655	106	46.06	104	1671	109	36.13	15.98	1.25	14.73	174	1313	558	80.9
AP CK MOD RES RR#7	126	280.2	97	9889	99	41.32	93	1454	95	35.46	15.18	1.18	14.00	243	1129	521	65.2
AP CK MOD SUS RR#8	127	296.0	102	10493	105	46.54	105	1649	108	35.36	16.03	1.22	14.81	163	1266	550	74.9
Experimental Trial (Comm status)																	
BTS 8328	225	293.7	102	10074	101	45.75	103	1564	102	34.50	15.96	1.30	14.66	153	1416	510	78.6
BTS 8359	221	283.6	98	9680	97	42.53	96	1440	94	34.20	15.43	1.27	14.17	185	1282	509	74.4
BTS 8365	228	292.3	101	9758	98	45.28	102	1509	99	33.64	15.69	1.09	14.60	137	1188	422	75.4
BTS 8404	211	295.2	102	9470	95	46.26	105	1484	97	32.12	16.02	1.24	14.77	139	1376	494	75.5
BTS 8412	205	296.5	103	9946	99	46.64	105	1566	102	33.53	15.95	1.11	14.84	149	1304	408	76.8
BTS 8440	213	298.4	103	10167	102	47.25	107	1609	105	34.29	16.09	1.17	14.91	159	1231	470	84.3
BTS 8457	201	298.1	103	10588	106	47.17	107	1671	109	35.77	15.94	1.02	14.92	150	1075	401	77.0
BTS 8469	206	288.0	100	9998	100	43.94	99	1520	99	34.83	15.58	1.18	14.40	178	1269	451	78.7
BTS 8480	230	282.9	98	9815	98	42.31	96	1458	95	35.00	15.37	1.24	14.12	174	1288	490	62.2
BTS 8495	214	296.9	103	10042	100	46.77	106	1581	103	33.69	16.06	1.21	14.84	161	1346	473	85.3
Crystal 360	218	299.3	104	9524	95	47.54	108	1509	99	32.15	16.13	1.19	14.94	144	1368	442	76.6
Crystal 361	227	299.5	104	10599	106	47.59	108	1680	110	35.50	16.09	1.10	14.99	167	1189	421	78.2
Crystal 364	232	288.7	100	10812	108	44.16	100	1642	107	37.78	15.67	1.24	14.42	182	1399	464	83.4
Crystal 369	231	290.7	101	9765	98	44.81	101	1498	98	33.76	15.79	1.27	14.53	168	1305	502	76.5
Crystal 470	203	289.8	100	10233	102	44.52	101	1571	103	35.34	15.65	1.15	14.50	159	1241	449	75.7
Crystal 471	229	288.9	100	10539	105	44.21	100	1604	105	36.81	15.64	1.20	14.44	168	1126	506	85.4
Crystal 473	207	290.7	101	10017	100	44.79	101	1536	100	34.68	15.61	1.07	14.53	181	1224	391	83.9
Crystal 475	224	286.4	99	9533	95	43.41	98	1444	94	33.29	15.63	1.32	14.31	147	1270	565	77.0
Crystal 479	226	284.8	99	9880	99	42.93	97	1484	97	34.98	15.48	1.27	14.22	172	1293	507	79.2
Hilleshög HIL2479	215	281.1	97	9526	95	41.75	94	1401	91	33.99	15.33	1.28	14.05	242	1249	511	75.6
Hilleshög HIL2480	217	283.3	98	9103	91	42.41	96	1364	89	32.27	15.67	1.54	14.12	222	1314	695	77.2
Hilleshög HIL2493	209	273.7	95	10367	104	39.38	89	1493	97	37.89	15.06	1.39	13.67	209	1307	594	80.5
Hilleshög HIL2494	223	279.5	97	10277	103	41.22	93	1514	99	36.88	15.37	1.42	13.95	190	1419	591	85.2
Hilleshög HIL2495	222	265.4	92	9369	94	36.73	83	1298	85	35.28	14.64	1.38	13.25	234	1399	555	78.6
Hilleshög HIL2496	204	273.4	95	9614	96	39.28	89	1385	90	35.13	15.05	1.40	13.65	229	1450	557	85.6
SV 231	219	282.2	98	10272	103	42.08	95	1527	100	36.49	15.41	1.32	14.09	187	1343	537	80.2
SV 343	216	260.7	90	9094	91	35.24	80	1223	80	35.15	14.37	1.37	13.00	282	1376	528	78.7
SV 344	208	265.2	92	8513	85	36.67	83	1176	77	31.89	14.68	1.44	13.24	212	1364	623	65.7
SV 345	210	272.7	94	10593	106	39.07	88	1514	99	38.84	14.91	1.28	13.63	205	1281	516	88.2
SV 347	212	284.0	98	9778	98	42.68	97	1469	96	34.50	15.44	1.26	14.19	158	1228	525	78.0
SX 1835	202	279.5	97	10454	104	41.24	93	1533	100	37.30	15.37	1.40	13.96	160	1389	603	81.4
SX 1849	220	271.1	94	9504	95	38.54	87	1351	88	35.21	14.90	1.37	13.53	265	1549	495	82.0
Crystal 578RR (CommBench)	233	282.6	98	10095	101	42.20	95	1518	99	35.29	15.43	1.30	14.14	183	1322	538	89.5
BTS 8815 (CommBench)	234	277.9	96	9819	98	40.70	92	1441	94	35.12	15.10	1.21	13.89	191	1357	458	83.1
Crystal 803 (CommBench)	235	295.0	102	10068	101	46.16	104	1570	103	34.27	15.97	1.22	14.74	164	1331	472	82.1
BTS 8927 (CommBench)	236	300.1	104	10044	100	47.78	108	1597	104	33.76	16.09	1.09	15.01	159	1216	406	82.7
Hilleshög HIL2389 (1stYearBench)	237	295.5	102	10384	104	46.33	105	1629	106	35.09	15.96	1.18	14.78	150	1295	456	84.4
AP CK MOD RES RR#7	238	279.3	97	9885	99	41.17	93	1449	95	35.41	15.16	1.20	13.96	219	1240	466	70.1
AP CK MOD SUS RR#8	239	294.7	102	9670	97	46.05	104	1506	98	32.86	15.92	1.18	14.74	158	1344	452	78.1
AP CK SUS RR#2	240	284.9	99	8437	84	42.96	97	1255	82	29.83	15.51	1.28	14.23	224	1247	506	54.1
AP CK MOD SUS RR#6	241	289.3	100	9880	99	44.32	100	1518	99	34.30	15.67	1.21	14.45	142	1286	492	84.8
RA CK SUS RR#7	242	285.2	99	10106	101	43.05	97	1526	100	35.41	15.48	1.22	14.26	209	1302	468	86.5
Comm Benchmark Mean		288.9		10007		44.21		1531		34.61	15.65	1.21		180	1242	538	76.4
Comm Trial Mean		291.4		10411		45.04		1609		35.73	15.77	1.20		180	1254	534	72.4
Coeff. of Var. (%)		2.0		7.2		4.3		8.1		7.1	1.7	5.8		11.1	5.0	8.8	16.5
Mean LSD (0.05)		5.6		688		1.85		121		2.25	0.25	0.07		19	59	44	10.2
Mean LSD (0.01)		7.4		906		2.43		160		2.96	0.33	0.09		25	78	58	13.4
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Climax MN — Created 09/30/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. Trial # = 248306

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 15. 2024 Performance of Varieties - ACSC RR Official Trial
Grand Forks ND

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Rev/T $ +	Rev/T %Bnch	Rev/A $ +	Rev/A %Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	113	327.7	100	11939	105	57.08	99	2081	104	36.36	17.26	0.87	16.39	206	1322	245	89.6
BTS 8034	118	325.1	99	11821	104	56.19	98	2046	103	36.39	17.18	0.93	16.25	256	1422	247	94.5
BTS 8156	105	326.8	99	11350	100	56.78	99	1966	99	34.68	17.19	0.85	16.34	206	1398	213	93.8
BTS 8226	122	331.2	101	11649	102	58.22	101	2048	103	35.32	17.39	0.83	16.56	221	1222	236	91.4
BTS 8270	107	336.2	102	11558	101	59.89	104	2062	104	34.30	17.65	0.84	16.81	189	1364	218	91.9
BTS 8927 (CommBench)	117	339.7	103	11958	105	61.03	106	2146	108	35.31	17.73	0.75	16.98	164	1206	199	90.6
Crystal 022	116	334.5	102	11349	100	59.30	103	2013	101	33.97	17.59	0.87	16.72	186	1317	254	84.9
Crystal 130	111	326.3	99	11399	100	56.60	98	1981	99	35.06	17.20	0.88	16.32	252	1299	245	90.4
Crystal 137	101	328.0	100	11187	98	57.16	99	1945	98	34.11	17.33	0.93	16.40	218	1539	232	91.4
Crystal 138	103	335.6	102	11761	103	59.68	104	2092	105	35.29	17.60	0.81	16.79	161	1314	223	85.9
Crystal 260	115	335.8	102	11836	104	59.76	104	2107	106	35.46	17.59	0.80	16.79	180	1301	207	95.6
Crystal 262	109	326.8	99	12145	107	56.77	99	2110	106	37.19	17.15	0.81	16.34	210	1197	231	84.4
Crystal 269	106	334.1	102	11534	101	59.18	103	2037	102	34.37	17.59	0.88	16.71	212	1329	253	88.8
Crystal 793	108	329.2	100	11742	103	57.55	100	2051	103	35.62	17.29	0.83	16.46	223	1294	216	87.2
Crystal 912	114	309.5	94	12180	107	51.02	89	2001	100	39.57	16.35	0.87	15.48	276	1197	256	90.4
Hilleshög HIL2386	119	326.9	99	11347	100	56.80	99	1970	99	34.68	17.17	0.83	16.34	231	1221	232	87.0
Hilleshög HIL2389	112	337.5	103	11837	104	60.31	105	2115	106	35.07	17.64	0.77	16.87	164	1244	204	92.5
Hilleshög HIL9920	110	324.0	98	11369	100	55.82	97	1957	98	34.92	17.10	0.90	16.20	272	1379	230	82.6
Maribo MA717	121	324.0	98	11770	103	55.83	97	2021	101	36.40	17.04	0.84	16.20	227	1261	237	87.8
SV 203	102	327.2	99	11596	102	56.88	99	2020	101	35.34	17.23	0.87	16.36	191	1329	254	93.5
SX 1815	120	327.5	100	11492	101	57.00	99	2000	100	35.10	17.24	0.86	16.38	218	1243	259	91.7
SX 1818	104	327.4	100	11716	103	56.97	99	2038	102	35.86	17.23	0.86	16.37	204	1318	238	85.9
Crystal 578RR (CommBench)	123	323.7	98	11207	98	55.75	97	1932	97	34.55	17.10	0.92	16.18	246	1388	251	94.3
BTS 8815 (CommBench)	124	332.1	101	11157	98	58.53	102	1967	99	33.47	17.54	0.93	16.61	218	1376	277	91.4
Crystal 803 (CommBench)	125	320.5	97	11253	99	54.68	95	1923	97	34.99	16.90	0.88	16.02	211	1332	247	91.7
AP CK MOD RES RR#7	126	313.8	95	12141	107	52.45	91	2026	102	38.99	16.61	0.92	15.69	282	1193	296	85.7
AP CK MOD SUS RR#8	127	335.3	102	11760	103	59.57	104	2086	105	34.92	17.57	0.81	16.76	191	1253	227	91.4
Experimental Trial (Comm status)																	
BTS 8328	225	343.4	104	12246	107	62.45	109	2223	112	35.75	17.98	0.83	17.14	259	1412	253	77.3
BTS 8359	221	333.9	101	12147	107	59.17	103	2154	108	36.27	17.60	0.91	16.70	268	1448	296	84.4
BTS 8365	228	345.8	105	11019	97	63.26	110	2018	101	31.79	18.04	0.78	17.26	228	1261	258	85.9
BTS 8404	211	338.1	103	11424	100	60.60	105	2047	103	33.77	17.68	0.80	16.88	209	1317	263	88.3
BTS 8412	205	335.5	102	10969	96	59.71	104	1947	98	32.53	17.61	0.85	16.76	269	1459	252	81.6
BTS 8440	213	341.1	104	11643	102	61.67	107	2107	106	34.11	17.72	0.70	17.02	185	1166	225	84.0
BTS 8457	201	333.2	101	12125	106	58.95	103	2148	108	36.22	17.43	0.78	16.65	296	1179	253	83.6
BTS 8469	206	329.5	100	11638	102	57.68	100	2033	102	35.33	17.34	0.87	16.47	311	1292	299	84.0
BTS 8480	230	334.1	102	11549	101	59.25	103	2044	103	34.50	17.57	0.88	16.69	253	1441	283	78.9
BTS 8495	214	335.9	102	10888	96	59.86	104	1942	97	32.27	17.54	0.77	16.77	214	1410	216	82.4
Crystal 360	218	332.3	101	11261	99	58.62	102	1986	100	33.94	17.42	0.82	16.60	257	1386	243	85.9
Crystal 361	227	330.9	101	11781	103	58.15	101	2073	104	35.53	17.33	0.81	16.52	269	1203	276	85.9
Crystal 364	232	312.4	95	11230	99	51.78	90	1855	93	36.14	16.57	0.95	15.62	396	1442	298	87.1
Crystal 369	231	334.4	102	11727	103	59.35	103	2084	105	34.93	17.60	0.88	16.72	301	1371	290	87.5
Crystal 470	203	325.3	99	11921	105	56.19	98	2051	103	36.90	17.11	0.86	16.25	294	1344	279	89.1
Crystal 471	229	338.8	103	11946	105	60.85	106	2148	108	35.20	17.67	0.75	16.91	238	1233	236	86.7
Crystal 473	207	324.2	99	11748	103	55.85	97	2024	102	36.27	17.07	0.86	16.21	358	1241	280	86.7
Crystal 475	224	336.1	102	11730	103	59.93	104	2093	105	34.91	17.57	0.79	16.78	204	1293	263	84.4
Crystal 479	226	327.2	99	11293	99	56.84	99	1961	98	34.45	17.28	0.92	16.36	333	1340	319	86.3
Hilleshög HIL2479	215	333.9	101	9945	87	59.18	103	1757	88	29.68	17.54	0.86	16.68	327	1258	285	85.6
Hilleshög HIL2480	217	327.7	100	11007	97	57.01	99	1914	96	33.58	17.41	1.02	16.39	361	1393	378	82.4
Hilleshög HIL2493	209	324.6	99	12379	109	55.98	97	2130	107	38.28	17.05	0.83	16.21	285	1325	265	86.7
Hilleshög HIL2494	223	328.7	100	12086	106	57.40	100	2110	106	36.75	17.31	0.88	16.44	257	1401	290	86.3
Hilleshög HIL2495	222	305.9	93	11971	105	49.54	86	1958	98	39.00	16.21	0.91	15.30	370	1355	284	90.2
Hilleshög HIL2496	204	325.1	99	11734	103	56.13	98	2027	102	36.45	17.13	0.89	16.24	393	1481	227	85.9
SV 231	219	318.3	97	12273	108	53.81	94	2080	104	38.42	16.79	0.87	15.92	291	1361	280	86.3
SV 343	216	310.3	94	11499	101	51.05	89	1892	95	36.93	16.43	0.91	15.52	371	1344	291	80.1
SV 344	208	310.5	94	10391	91	51.14	89	1701	85	33.47	16.50	0.96	15.54	342	1518	296	81.6
SV 345	210	305.4	93	11901	104	49.38	86	1931	97	39.04	16.20	0.91	15.29	301	1399	310	89.8
SV 347	212	332.5	101	12058	106	58.69	102	2132	107	36.17	17.43	0.82	16.61	239	1404	245	92.2
SX 1835	202	320.0	97	12252	108	54.38	95	2085	105	38.17	16.87	0.87	16.00	316	1312	287	87.1
SX 1849	220	310.6	94	12277	108	51.18	89	2030	102	39.36	16.43	0.89	15.54	341	1503	239	89.1
Crystal 578RR (CommBench)	233	319.5	97	11336	99	54.23	94	1927	97	35.28	16.94	0.94	16.00	338	1514	290	92.2
BTS 8815 (CommBench)	234	321.2	98	11395	100	54.81	95	1948	98	35.49	17.01	0.93	16.07	318	1490	293	88.7
Crystal 803 (CommBench)	235	338.9	103	11759	103	60.91	106	2114	106	34.69	17.70	0.79	16.91	225	1329	249	89.5
BTS 8927 (CommBench)	236	336.4	102	11085	97	60.04	104	1978	99	32.86	17.62	0.82	16.81	269	1221	285	87.5
Hilleshög HIL2389 (1stYearBench)	237	326.0	99	11855	104	56.45	98	2060	103	36.22	17.16	0.85	16.31	268	1327	285	84.4
AP CK MOD RES RR#7	238	313.0	95	11897	104	52.00	90	1962	99	38.03	16.54	0.91	15.64	350	1209	332	83.6
AP CK MOD SUS RR#8	239	343.8	104	11593	102	62.59	109	2109	106	33.73	18.00	0.83	17.17	240	1340	267	89.1
AP CK SUS RR#2	240	338.5	103	10258	90	60.76	106	1835	92	30.12	17.74	0.83	16.90	262	1336	268	72.7
AP CK MOD SUS RR#6	241	339.4	103	11505	101	61.09	106	2073	104	33.84	17.77	0.83	16.94	204	1318	286	89.8
RA CK SUS RR#7	242	328.4	100	10522	92	57.28	100	1835	92	31.97	17.27	0.86	16.41	294	1340	281	88.3
Comm Benchmark Mean		329.0		11394		57.50		1992		34.58	17.32	0.87		210	1326	243	92.0
Comm Trial Mean		328.4		11632		57.29		2027		35.46	17.28	0.86		215	1306	238	89.9
Coeff. of Var. (%)		2.1		3.6		3.9		4.8		3.3	1.7	6.4		16.6	4.3	11.9	6.4
Mean LSD (0.05)		6.5		383		2.14		91		1.05	0.29	0.05		34	52	27	4.6
Mean LSD (0.01)		8.5		505		2.82		120		1.38	0.38	0.07		45	69	36	6.1
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Grand Forks ND — Created 09/30/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 248307

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 16. 2024 Performance of Varieties - ACSC RR Official Trial
Scandia MN

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Rev/T $ +	Rev/T %Bnch	Rev/A $ +	Rev/A %Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	113	351.2	102	11679	103	64.86	103	2157	105	33.33	18.50	0.93	17.57	153	1315	317	88.9
BTS 8034	118	337.7	98	11297	100	60.36	96	2013	98	33.59	18.10	1.21	16.89	275	1570	426	91.9
BTS 8156	105	354.1	102	12002	106	65.81	104	2238	109	33.88	18.78	1.08	17.70	204	1555	348	92.2
BTS 8226	122	357.6	103	11828	105	66.95	106	2212	107	33.04	18.79	0.92	17.87	168	1293	304	89.8
BTS 8270	107	341.4	99	11897	105	61.60	98	2144	104	34.87	18.17	1.09	17.08	205	1488	373	85.4
BTS 8927 (CommBench)	117	359.9	104	11576	102	67.74	107	2178	106	32.32	18.95	0.95	18.00	180	1286	330	92.0
Crystal 022	116	350.9	101	10888	96	64.74	103	2011	98	31.13	18.57	1.01	17.56	185	1414	339	83.4
Crystal 130	111	343.8	99	11616	103	62.41	99	2109	102	33.61	18.23	1.04	17.19	206	1414	360	85.0
Crystal 137	101	336.8	97	11479	102	60.08	95	2044	99	34.05	18.01	1.18	16.83	254	1564	405	89.8
Crystal 138	103	338.9	98	12092	107	60.76	96	2164	105	35.64	18.12	1.18	16.94	209	1455	452	83.9
Crystal 260	115	355.5	103	12210	108	66.27	105	2277	110	34.45	18.72	0.94	17.78	166	1385	305	90.9
Crystal 262	109	325.2	94	11967	106	56.23	89	2073	101	36.67	17.42	1.16	16.26	246	1425	430	78.3
Crystal 269	106	355.5	103	12193	108	66.27	105	2265	110	34.36	18.77	1.00	17.77	181	1359	347	85.1
Crystal 793	108	357.6	103	11917	105	66.97	106	2229	108	33.45	18.87	0.97	17.90	214	1296	335	89.0
Crystal 912	114	315.5	91	12492	111	53.01	84	2099	102	39.47	16.86	1.09	15.77	291	1337	381	85.9
Hilleshög HIL2386	119	348.4	101	11737	104	63.92	101	2155	105	33.76	18.49	1.07	17.42	219	1369	390	73.8
Hilleshög HIL2389	112	346.5	100	12152	108	63.27	100	2226	108	35.10	18.37	1.04	17.33	191	1448	353	91.7
Hilleshög HIL9920	110	337.0	97	10803	96	60.15	95	1923	93	32.05	17.95	1.11	16.84	242	1508	367	83.4
Maribo MA717	121	333.0	96	12063	107	58.81	93	2132	103	35.99	17.77	1.13	16.64	249	1446	402	88.6
SV 203	102	354.5	102	12381	110	65.94	105	2302	112	34.86	18.74	1.02	17.72	198	1355	362	85.7
SX 1815	120	349.6	101	12026	106	64.30	102	2212	107	34.38	18.53	1.06	17.47	218	1421	360	91.2
SX 1818	104	330.0	95	11806	105	57.82	92	2073	101	35.63	17.56	1.07	16.49	212	1422	372	85.0
Crystal 578RR (CommBench)	123	332.2	96	10683	95	58.54	93	1882	91	32.24	17.88	1.27	16.61	260	1504	482	93.0
BTS 8815 (CommBench)	124	347.4	100	11047	98	63.57	101	2026	98	31.94	18.44	1.06	17.38	192	1457	366	87.8
Crystal 803 (CommBench)	125	344.0	99	11879	105	62.45	99	2157	105	34.39	18.33	1.14	17.19	220	1448	420	90.9
AP CK MOD RES RR#7	126	328.9	95	12630	112	57.46	91	2202	107	38.58	17.50	1.05	16.45	281	1318	362	89.1
AP CK MOD SUS RR#8	127	356.2	103	11789	104	66.49	105	2199	107	33.19	18.88	1.06	17.82	193	1376	391	88.0
Experimental Trial (Comm status)																	
BTS 8328	225	336.2	97	11297	100	59.85	95	2004	97	33.66	18.03	1.21	16.82	243	1434	441	85.6
BTS 8359	221	329.8	95	11600	103	57.72	92	2046	99	34.89	17.70	1.26	16.44	249	1463	442	83.0
BTS 8365	228	356.3	103	11734	104	66.55	106	2193	106	32.89	19.01	1.20	17.81	197	1448	429	91.7
BTS 8404	211	358.3	104	11818	105	67.23	107	2213	107	33.03	18.98	1.05	17.92	193	1330	367	86.9
BTS 8412	205	337.2	97	11620	103	60.19	95	2079	101	34.45	18.06	1.18	16.88	246	1481	381	83.7
BTS 8440	213	346.5	100	12049	107	63.29	100	2202	107	34.54	18.47	1.17	17.30	204	1470	406	90.0
BTS 8457	201	348.7	101	11705	104	64.04	102	2158	105	33.20	18.59	1.17	17.42	212	1329	436	87.0
BTS 8469	206	351.5	102	11643	103	64.94	103	2155	105	33.00	18.61	1.02	17.59	200	1370	322	87.7
BTS 8480	230	345.4	100	12242	108	62.92	100	2226	108	35.42	18.45	1.19	17.26	228	1363	430	80.6
BTS 8495	214	348.2	101	11781	104	63.88	101	2160	105	33.73	18.65	1.18	17.48	256	1538	371	88.7
Crystal 360	218	344.8	100	11582	103	62.70	99	2110	102	33.62	18.52	1.26	17.26	245	1444	463	88.2
Crystal 361	227	337.4	98	10959	97	60.23	95	1942	94	32.55	18.13	1.25	16.88	326	1400	447	87.5
Crystal 364	232	345.9	100	13240	117	63.07	100	2416	117	38.01	18.56	1.24	17.32	225	1493	454	90.0
Crystal 369	231	348.4	101	11967	106	63.93	101	2194	106	34.34	18.64	1.23	17.41	267	1499	411	87.1
Crystal 470	203	348.9	101	12317	109	64.10	102	2270	110	35.16	18.59	1.14	17.46	219	1458	380	86.3
Crystal 471	229	358.0	104	11772	104	67.14	106	2203	107	32.85	19.04	1.13	17.91	221	1370	399	88.7
Crystal 473	207	341.7	99	11886	105	61.66	98	2147	104	34.65	18.17	1.07	17.09	235	1362	356	91.2
Crystal 475	224	363.0	105	11661	103	68.78	109	2205	107	32.06	19.26	1.09	18.17	160	1360	403	86.1
Crystal 479	226	358.3	104	12484	111	67.24	107	2331	113	34.96	18.98	1.05	17.92	180	1332	348	87.6
Hilleshög HIL2479	215	361.5	105	11903	105	68.29	108	2242	109	33.05	19.13	1.01	18.12	185	1361	319	88.1
Hilleshög HIL2480	217	349.0	101	11239	99	64.12	102	2061	100	32.34	18.59	1.16	17.44	235	1386	410	83.7
Hilleshög HIL2493	209	358.9	104	13875	123	67.42	107	2598	126	38.74	19.02	1.04	17.98	182	1375	348	91.0
Hilleshög HIL2494	223	357.7	103	13549	120	67.03	106	2547	124	37.65	18.95	1.06	17.88	170	1305	382	88.8
Hilleshög HIL2495	222	324.4	94	12428	110	55.91	89	2150	104	38.11	17.56	1.31	16.25	342	1485	436	84.6
Hilleshög HIL2496	204	356.4	103	11936	106	66.59	106	2238	109	33.27	18.98	1.15	17.83	211	1412	412	89.8
SV 231	219	338.6	98	12621	112	60.65	96	2266	110	36.97	18.08	1.12	16.96	196	1379	383	87.9
SV 343	216	339.8	98	12452	110	61.04	97	2228	108	36.71	18.23	1.19	17.04	236	1533	385	89.7
SV 344	208	353.2	102	11190	99	65.53	104	2073	101	31.78	18.78	1.11	17.68	189	1318	394	81.5
SV 345	210	341.9	99	12764	113	61.72	98	2308	112	37.20	18.22	1.14	17.08	242	1462	359	89.0
SV 347	212	363.2	105	12917	114	68.84	109	2446	119	35.73	19.11	0.92	18.19	158	1213	308	91.3
SX 1835	202	338.2	98	12281	109	60.51	96	2203	107	36.09	18.09	1.21	16.88	241	1449	423	89.7
SX 1849	220	338.1	98	12345	109	60.46	96	2199	107	36.78	18.16	1.21	16.95	256	1425	426	87.4
Crystal 578RR (CommBench)	233	337.8	98	11520	102	60.38	96	2067	100	34.03	18.15	1.24	16.91	282	1493	426	90.5
BTS 8815 (CommBench)	234	351.3	102	11592	103	64.86	103	2146	104	33.07	18.62	1.06	17.56	230	1328	363	91.2
Crystal 803 (CommBench)	235	341.6	99	11520	102	61.64	98	2087	101	33.63	18.13	1.07	17.05	230	1352	349	85.3
BTS 8927 (CommBench)	236	352.9	102	10553	93	65.43	104	1942	94	30.17	18.70	1.04	17.66	195	1410	335	87.3
Hilleshög HIL2389 (1stYearBench)	237	368.8	107	13018	115	70.72	112	2496	121	35.41	19.45	1.01	18.44	166	1285	361	87.1
AP CK MOD RES RR#7	238	346.5	100	13326	118	63.29	100	2432	118	38.34	18.40	1.08	17.32	220	1309	389	80.4
AP CK MOD SUS RR#8	239	353.7	102	10952	97	65.68	104	2023	98	31.04	18.77	1.08	17.69	175	1414	376	91.7
AP CK SUS RR#2	240	338.0	98	10327	91	60.45	96	1851	90	30.21	18.15	1.26	16.89	230	1523	444	76.3
AP CK MOD SUS RR#6	241	354.3	102	11819	105	65.88	104	2193	106	33.32	18.83	1.06	17.76	226	1373	324	90.2
RA CK SUS RR#7	242	349.1	101	10919	97	64.15	102	2006	97	31.13	18.62	1.16	17.47	212	1579	358	85.4
Comm Benchmark Mean		345.9		11296		63.08		2061		32.72	18.40	1.11		213	1424	400	90.9
Comm Trial Mean		344.0		11783		62.47		2137		34.30	18.27	1.07		215	1416	373	87.4
Coeff. of Var. (%)		2.9		5.9		5.3		7.2		5.6	2.4	9.4		20.4	5.1	15.7	8.0
Mean LSD (0.05)		9.4		628		3.13		141		1.68	0.42	0.10		42	66	56	5.7
Mean LSD (0.01)		12.4		827		4.12		186		2.22	0.55	0.13		55	87	74	7.5
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Scandia MN — Created 10/08/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 248308

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 17. 2024 Performance of Varieties - ACSC RR Official Trial
Forest River ND

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Rev/T $ +	Rev/T %Bnch	Rev/A $ +	Rev/A %Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	113	360.4	101	12634	107	67.88	101	2380	107	35.07	18.79	0.77	18.02	104	1348	198	86.8
BTS 8034	118	342.6	96	11917	101	62.00	92	2161	97	34.68	17.99	0.86	17.13	143	1465	224	81.5
BTS 8156	105	345.7	97	11718	99	63.01	94	2138	96	33.86	18.08	0.80	17.28	139	1369	207	81.9
BTS 8226	122	368.6	103	12539	106	70.61	105	2403	108	33.99	19.18	0.75	18.43	92	1282	205	80.0
BTS 8270	107	361.7	101	12036	102	68.32	102	2270	102	33.33	18.91	0.83	18.08	141	1406	219	79.6
BTS 8927 (CommBench)	117	366.8	102	12535	106	70.01	104	2393	108	34.18	19.07	0.73	18.34	109	1212	203	88.0
Crystal 022	116	364.9	102	11910	101	69.39	103	2264	102	32.65	19.00	0.75	18.25	111	1247	210	80.0
Crystal 130	111	356.4	100	12200	103	66.57	99	2279	103	34.22	18.59	0.76	17.83	118	1359	188	76.6
Crystal 137	101	355.3	99	11652	98	66.20	99	2171	98	32.79	18.53	0.76	17.77	131	1315	195	78.7
Crystal 138	103	355.3	99	11750	99	66.20	99	2187	99	33.11	18.56	0.79	17.77	132	1312	219	76.0
Crystal 260	115	355.6	99	12173	103	66.31	99	2273	102	34.18	18.63	0.84	17.79	139	1336	249	83.6
Crystal 262	109	349.0	97	12246	104	64.12	96	2247	101	35.15	18.16	0.71	17.45	116	1219	185	73.7
Crystal 269	106	370.9	104	11859	100	71.38	106	2279	103	32.02	19.49	0.95	18.54	165	1533	266	74.2
Crystal 793	108	360.2	101	12215	103	67.83	101	2298	104	33.95	18.83	0.82	18.01	136	1325	235	81.5
Crystal 912	114	348.0	97	12976	110	63.77	95	2379	107	37.27	18.15	0.75	17.40	143	1246	198	85.0
Hilleshög HIL2386	119	346.1	97	12014	102	63.17	94	2191	99	34.74	18.25	0.94	17.31	181	1355	304	75.4
Hilleshög HIL2389	112	357.6	100	12077	102	66.95	100	2262	102	33.76	18.67	0.80	17.87	114	1358	216	84.9
Hilleshög HIL9920	110	360.7	101	12108	102	68.00	101	2282	103	33.57	18.85	0.81	18.04	135	1459	193	76.0
Maribo MA717	121	347.6	97	11964	101	63.65	95	2189	99	34.46	18.20	0.82	17.38	138	1373	218	81.6
SV 203	102	358.2	100	11930	101	67.15	100	2236	101	33.33	18.67	0.76	17.91	103	1330	197	80.9
SX 1815	120	356.1	99	12125	102	66.47	99	2263	102	34.04	18.57	0.77	17.80	116	1336	198	82.7
SX 1818	104	344.9	96	11975	101	62.75	93	2177	98	34.75	18.04	0.79	17.25	129	1364	206	77.4
Crystal 578RR (CommBench)	123	347.5	97	11500	97	63.62	95	2104	95	33.13	18.23	0.86	17.37	146	1415	237	84.7
BTS 8815 (CommBench)	124	359.1	100	11579	98	67.45	100	2175	98	32.24	18.79	0.84	17.95	131	1444	217	82.7
Crystal 803 (CommBench)	125	359.1	100	11713	99	67.46	100	2201	99	32.60	18.83	0.87	17.96	133	1397	257	83.9
AP CK MOD RES RR#7	126	348.7	97	12583	106	64.02	95	2309	104	36.10	18.25	0.81	17.44	158	1286	232	74.3
AP CK MOD SUS RR#8	127	355.0	99	11858	100	66.11	98	2207	99	33.42	18.55	0.80	17.75	130	1272	232	88.2
Experimental Trial (Comm status)																	
BTS 8328	225	361.5	101	11708	99	68.21	102	2224	100	32.26	18.94	0.87	18.08	118	1492	191	75.0
BTS 8359	221	349.6	98	11663	99	64.33	96	2158	97	33.25	18.35	0.89	17.46	111	1372	237	83.2
BTS 8365	228	365.7	102	12147	103	69.61	104	2309	104	33.38	18.99	0.70	18.29	92	1204	160	78.1
BTS 8404	211	353.4	99	11732	99	65.57	98	2179	98	33.24	18.46	0.79	17.67	97	1272	203	82.4
BTS 8412	205	352.0	98	11536	97	65.12	97	2128	96	32.80	18.38	0.79	17.59	104	1338	174	70.7
BTS 8440	213	353.9	99	11862	100	65.73	98	2197	99	33.46	18.50	0.80	17.70	119	1218	207	79.3
BTS 8457	201	354.8	99	12253	104	66.04	98	2289	103	34.39	18.50	0.76	17.74	120	1219	183	81.3
BTS 8469	206	353.7	99	11692	99	65.66	98	2171	98	33.23	18.48	0.80	17.68	101	1246	214	81.3
BTS 8480	230	355.0	99	11557	98	66.09	98	2163	97	32.36	18.55	0.79	17.76	94	1322	190	75.4
BTS 8495	214	352.9	99	11534	97	65.42	97	2144	97	32.83	18.48	0.83	17.64	119	1336	211	81.3
Crystal 360	218	348.1	97	11246	95	63.82	95	2066	93	32.28	18.23	0.83	17.40	119	1362	197	89.1
Crystal 361	227	356.7	100	12249	104	66.68	99	2282	103	34.51	18.65	0.82	17.82	140	1230	216	84.8
Crystal 364	232	351.7	98	11869	100	65.01	97	2197	99	33.74	18.39	0.81	17.58	114	1356	185	84.8
Crystal 369	231	352.0	98	11825	100	65.12	97	2195	99	33.51	18.62	1.04	17.58	171	1474	299	81.6
Crystal 470	203	346.8	97	13178	111	63.40	94	2418	109	37.87	18.13	0.79	17.34	113	1263	194	78.9
Crystal 471	229	359.0	100	12766	108	67.41	100	2403	108	35.65	18.73	0.77	17.96	111	1198	202	78.1
Crystal 473	207	351.4	98	12540	106	64.93	97	2330	105	35.47	18.33	0.76	17.57	109	1212	187	85.9
Crystal 475	224	351.0	98	11897	101	64.80	97	2200	99	33.88	18.31	0.76	17.55	84	1253	183	87.5
Crystal 479	226	368.2	103	12165	103	70.42	105	2334	105	32.81	19.25	0.85	18.40	107	1388	207	86.3
Hilleshög HIL2479	215	354.5	99	9513	80	65.93	98	1772	80	26.79	18.52	0.81	17.71	112	1300	202	80.9
Hilleshög HIL2480	217	356.2	99	11668	99	66.50	99	2188	99	32.42	18.73	0.94	17.80	115	1426	263	85.2
Hilleshög HIL2493	209	351.0	98	12977	110	64.81	97	2406	108	36.94	18.37	0.81	17.56	103	1355	199	85.9
Hilleshög HIL2494	223	356.5	100	11875	100	66.60	99	2218	100	33.54	18.70	0.88	17.82	133	1413	209	85.6
Hilleshög HIL2495	222	334.2	93	12958	110	59.29	88	2302	104	38.83	17.60	0.90	16.70	120	1498	209	78.1
Hilleshög HIL2496	204	337.8	94	12665	107	60.47	90	2269	102	37.57	17.80	0.92	16.89	152	1500	213	85.9
SV 231	219	347.9	97	12414	105	63.74	95	2269	102	35.76	18.19	0.80	17.39	108	1386	172	89.1
SV 343	216	328.9	92	12609	107	57.54	86	2201	99	38.48	17.27	0.84	16.42	133	1452	173	81.6
SV 344	208	340.9	95	11159	94	61.49	92	2009	91	32.92	17.93	0.91	17.02	128	1453	222	72.3
SV 345	210	340.0	95	12742	108	61.16	91	2287	103	37.42	17.88	0.91	16.98	161	1448	212	85.2
SV 347	212	353.0	99	11602	98	65.45	97	2150	97	32.98	18.47	0.81	17.66	105	1397	180	80.5
SX 1835	202	347.0	97	12074	102	63.46	95	2211	100	34.97	18.18	0.83	17.35	122	1364	200	84.4
SX 1849	220	334.5	93	12754	108	59.39	88	2264	102	38.07	17.56	0.84	16.71	125	1495	168	84.4
Crystal 578RR (CommBench)	233	348.7	97	11638	98	64.06	95	2125	96	33.46	18.34	0.90	17.44	153	1423	223	87.1
BTS 8815 (CommBench)	234	356.0	99	11410	96	66.42	99	2125	96	32.17	18.61	0.82	17.78	111	1367	191	89.5
Crystal 803 (CommBench)	235	361.3	101	11994	101	68.17	102	2267	102	33.18	18.88	0.82	18.06	103	1371	197	84.8
BTS 8927 (CommBench)	236	366.5	102	12285	104	69.89	104	2355	106	33.34	19.09	0.76	18.33	112	1219	187	80.9
Hilleshög HIL2389 (1stYearBench)	237	345.2	96	11818	100	62.87	94	2166	98	34.19	18.07	0.81	17.26	90	1363	201	85.9
AP CK MOD RES RR#7	238	348.1	97	12136	103	63.86	95	2225	100	34.83	18.22	0.82	17.40	144	1267	211	78.1
AP CK MOD SUS RR#8	239	362.2	101	11597	98	68.45	102	2200	99	32.03	18.87	0.76	18.12	99	1209	196	80.9
AP CK SUS RR#2	240	365.5	102	9332	79	69.57	104	1786	80	25.25	19.13	0.85	18.28	102	1452	206	66.8
AP CK MOD SUS RR#6	241	347.0	97	11382	96	63.47	95	2079	94	32.65	18.23	0.88	17.35	137	1305	240	87.9
RA CK SUS RR#7	242	348.4	97	12021	102	63.96	95	2210	100	34.34	18.23	0.82	17.41	113	1379	186	88.7
Comm Benchmark Mean		358.1		11832		67.14		2218		33.04	18.73	0.83		130	1367	229	84.8
Comm Trial Mean		355.6		12066		66.31		2249		33.95	18.59	0.80		131	1347	219	80.7
Coeff. of Var. (%)		2.3		4.2		4.1		5.2		3.8	2.1	8.1		22.9	4.2	15.4	10.8
Mean LSD (0.05)		7.8		481		2.58		112		1.22	0.36	0.06		29	54	32	7.4
Mean LSD (0.01)		10.3		633		3.41		147		1.61	0.48	0.08		38	71	43	9.7
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Forest River ND — Created 10/01/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 248309

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 18. 2024 Performance of Varieties - ACSC RR Official Trial
Alvarado MN

		Rec/T		Rec/A		Rev/T		Rev/A		Yield		Sugar%		Na	K	AmN	Emerg.
Description @	Code	lbs.	%Bnch	lbs.	%Bnch	$ +	%Bnch	$ +	%Bnch	T/A	Gross	LTM	Rec	ppm	ppm	ppm	%
Commercial Trial																	
BTS 8018	113	331.1	99	13702	104	58.19	98	2403	103	41.47	17.50	0.95	16.55	155	1358	314	77.1
BTS 8034	118	321.7	96	13474	102	55.08	93	2311	99	41.86	17.07	0.98	16.09	157	1493	303	69.1
BTS 8156	105	323.6	97	12899	98	55.69	94	2224	95	39.85	17.16	0.98	16.18	137	1586	284	67.2
BTS 8226	122	339.7	102	13537	103	61.03	103	2431	104	39.84	17.88	0.89	16.99	193	1312	273	78.2
BTS 8270	107	332.7	99	12931	98	58.72	99	2282	98	38.81	17.59	0.94	16.65	114	1451	307	64.0
BTS 8927 (CommBench)	117	332.0	99	13396	102	58.48	99	2363	101	40.24	17.51	0.91	16.60	146	1316	306	80.2
Crystal 022	116	344.9	103	13332	101	62.76	106	2423	104	38.78	18.12	0.88	17.24	104	1339	284	69.8
Crystal 130	111	343.3	103	13837	105	62.23	105	2500	107	40.32	18.09	0.93	17.16	126	1419	300	73.2
Crystal 137	101	330.4	99	13073	99	57.94	98	2292	98	39.53	17.50	0.98	16.52	142	1500	311	76.0
Crystal 138	103	340.1	102	13485	102	61.17	103	2420	104	39.83	18.00	1.01	16.99	123	1426	353	69.5
Crystal 260	115	333.7	100	13478	102	59.04	100	2386	102	40.43	17.54	0.85	16.69	117	1338	262	84.1
Crystal 262	109	328.7	98	13691	104	57.40	97	2386	102	41.82	17.30	0.88	16.42	129	1255	298	60.8
Crystal 269	106	337.5	101	13317	101	60.30	102	2380	102	39.32	17.93	1.05	16.88	139	1535	358	66.0
Crystal 793	108	328.2	98	13293	101	57.23	96	2327	100	40.44	17.35	0.93	16.42	121	1371	315	75.5
Crystal 912	114	323.1	97	14057	107	55.53	94	2414	103	43.48	17.07	0.92	16.15	175	1245	314	73.0
Hilleshög HIL2386	119	332.4	99	12667	96	58.61	99	2230	96	38.21	17.59	0.97	16.62	148	1386	334	72.6
Hilleshög HIL2389	112	342.4	102	13067	99	61.92	104	2360	101	38.23	18.03	0.92	17.11	121	1405	296	74.2
Hilleshög HIL9920	110	343.9	103	13071	99	62.43	105	2370	102	37.99	18.18	0.98	17.20	148	1542	299	68.4
Maribo MA717	121	329.0	98	13031	99	57.48	97	2279	98	39.63	17.43	0.97	16.46	146	1432	320	70.2
SV 203	102	348.2	104	13350	101	63.86	108	2446	105	38.39	18.37	0.97	17.40	115	1451	318	75.6
SX 1815	120	342.3	102	13081	99	61.89	104	2368	102	38.25	18.09	0.98	17.11	128	1484	316	74.9
SX 1818	104	335.5	100	13196	100	59.65	101	2343	100	39.31	17.71	0.94	16.77	111	1478	292	76.1
Crystal 578RR (CommBench)	123	327.0	98	13097	100	56.82	96	2270	97	40.21	17.37	1.03	16.34	142	1500	344	81.3
BTS 8815 (CommBench)	124	341.1	102	12834	98	61.51	104	2314	99	37.74	17.98	0.93	17.05	120	1502	283	72.6
Crystal 803 (CommBench)	125	337.8	101	13308	101	60.42	102	2383	102	39.34	17.86	0.96	16.90	125	1449	316	74.9
AP CK MOD RES RR#7	126	323.7	97	13911	106	55.74	94	2402	103	42.81	17.12	0.93	16.19	145	1286	329	69.2
AP CK MOD SUS RR#8	127	337.9	101	13012	99	60.43	102	2329	100	38.29	17.86	0.96	16.90	129	1389	326	79.8
Experimental Trial (Comm status)																	
BTS 8328	225	341.4	102	13166	100	61.58	104	2392	103	38.28	18.07	1.00	17.06	109	1526	332	71.9
BTS 8359	221	325.1	97	13018	99	56.20	95	2247	96	40.25	17.26	1.01	16.24	146	1509	335	74.6
BTS 8365	228	348.7	104	13480	102	63.99	108	2484	106	38.33	18.24	0.81	17.43	94	1289	248	74.6
BTS 8404	211	339.7	102	13217	100	61.03	103	2376	102	38.74	17.88	0.90	16.99	110	1354	297	70.3
BTS 8412	205	326.4	98	13114	100	56.65	96	2262	97	39.85	17.25	0.93	16.32	122	1458	289	70.7
BTS 8440	213	330.5	99	14023	107	58.01	98	2466	106	42.02	17.41	0.89	16.53	130	1289	300	78.9
BTS 8457	201	339.9	102	13719	104	61.12	103	2462	106	40.12	17.81	0.81	17.01	117	1274	253	73.4
BTS 8469	206	326.3	98	13056	99	56.64	96	2267	97	40.24	17.24	0.92	16.32	124	1387	305	78.5
BTS 8480	230	336.1	100	12578	96	59.82	101	2241	96	37.46	17.81	1.01	16.80	129	1486	348	60.2
BTS 8495	214	340.4	102	13041	99	61.25	103	2345	101	38.32	17.97	0.96	17.02	125	1438	313	84.4
Crystal 360	218	341.5	102	13033	99	61.61	104	2360	101	37.94	18.00	0.93	17.07	93	1464	298	74.2
Crystal 361	227	334.6	100	14350	109	59.34	100	2542	109	43.18	17.58	0.87	16.72	124	1293	283	75.8
Crystal 364	232	322.3	96	14785	112	55.29	93	2534	109	45.94	17.12	1.00	16.11	151	1556	316	82.8
Crystal 369	231	342.9	103	13583	103	62.08	105	2471	106	39.51	18.12	0.97	17.14	132	1459	328	79.3
Crystal 470	203	333.8	100	14668	111	59.08	100	2597	111	44.24	17.51	0.84	16.68	127	1334	250	79.7
Crystal 471	229	346.5	104	14244	108	63.25	107	2585	111	40.54	18.28	0.95	17.33	152	1334	329	72.7
Crystal 473	207	330.8	99	13805	105	58.11	98	2427	104	41.47	17.41	0.88	16.54	143	1324	274	82.0
Crystal 475	224	337.3	101	13048	99	60.24	102	2320	99	38.87	17.79	0.93	16.87	114	1340	329	77.4
Crystal 479	226	329.6	99	13676	104	57.71	97	2393	103	41.11	17.54	1.04	16.50	155	1446	373	74.6
Hilleshög HIL2479	215	339.9	102	12796	97	61.11	103	2306	99	37.51	18.00	0.99	17.01	134	1370	364	73.1
Hilleshög HIL2480	217	340.5	102	12588	96	61.31	103	2248	96	36.86	18.09	1.06	17.02	141	1523	377	68.4
Hilleshög HIL2493	209	321.6	96	14340	109	55.08	93	2450	105	44.30	17.06	0.98	16.07	128	1446	334	71.9
Hilleshög HIL2494	223	328.9	98	13773	105	57.49	97	2391	103	41.67	17.55	1.10	16.45	124	1559	404	80.9
Hilleshög HIL2495	222	309.2	92	13506	103	50.99	86	2226	95	43.85	16.48	1.03	15.45	171	1639	303	77.7
Hilleshög HIL2496	204	327.1	98	13872	105	56.90	96	2415	104	41.98	17.34	0.98	16.35	151	1561	294	76.2
SV 231	219	332.0	99	14276	108	58.49	99	2505	107	42.64	17.57	0.97	16.60	135	1444	328	80.1
SV 343	216	315.8	94	13421	102	53.18	90	2248	96	42.33	16.86	1.06	15.79	128	1622	354	78.1
SV 344	208	312.2	93	11782	90	51.97	88	1966	84	37.51	16.78	1.17	15.61	159	1616	428	62.9
SV 345	210	321.9	96	14248	108	55.18	93	2434	104	44.08	17.09	0.99	16.09	131	1514	329	86.0
SV 347	212	349.8	105	13058	99	64.35	109	2398	103	37.35	18.47	0.98	17.48	114	1517	321	69.9
SX 1835	202	334.6	100	13496	103	59.35	100	2389	102	40.17	17.83	1.10	16.73	127	1601	384	81.7
SX 1849	220	310.8	93	13319	101	51.50	87	2184	94	42.47	16.59	1.07	15.52	187	1707	309	80.9
Crystal 578RR (CommBench)	233	338.8	101	13658	104	60.75	102	2438	105	40.33	17.87	0.94	16.94	126	1478	288	80.1
BTS 8815 (CommBench)	234	338.6	101	13694	104	60.67	102	2444	105	40.39	17.84	0.92	16.93	127	1483	272	71.5
Crystal 803 (CommBench)	235	329.1	98	12828	97	57.54	97	2238	96	38.87	17.51	1.06	16.45	153	1623	340	77.0
BTS 8927 (CommBench)	236	331.3	99	12454	95	58.28	98	2210	95	37.94	17.49	0.92	16.58	145	1342	313	68.0
Hilleshög HIL2389 (1stYearBench)	237	338.8	101	13897	106	60.74	102	2495	107	40.83	17.84	0.91	16.94	132	1413	278	73.8
AP CK MOD RES RR#7	238	329.1	98	14115	107	57.55	97	2470	106	42.59	17.35	0.90	16.45	161	1244	306	69.5
AP CK MOD SUS RR#8	239	338.9	101	13019	99	60.79	102	2340	100	38.41	17.94	0.99	16.95	167	1451	330	80.5
AP CK SUS RR#2	240	336.4	101	11921	91	59.93	101	2131	91	35.34	17.75	0.94	16.82	126	1385	313	62.1
AP CK MOD SUS RR#6	241	340.5	102	13365	102	61.31	103	2415	104	39.10	18.04	1.01	17.02	133	1475	352	82.4
RA CK SUS RR#7	242	320.5	96	12456	95	54.71	92	2122	91	38.74	16.97	0.95	16.02	153	1431	299	83.6
Comm Benchmark Mean		334.5		13159		59.31		2333		39.38	17.68	0.96		133	1442	312	77.2
Comm Trial Mean		334.5		13301		59.32		2357		39.79	17.67	0.95		135	1417	309	73.1
Coeff. of Var. (%)		2.5		5.5		4.7		6.7		4.9	2.2	7.8		30.8	6.4	11.7	13.4
Mean LSD (0.05)		7.8		644		2.58		142		1.77	0.36	0.07		38	84	35	8.7
Mean LSD (0.01)		10.3		848		3.40		187		2.33	0.47	0.09		51	110	46	11.5
Sig Lvl		0.01		0.01		0.01		0.05		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Alvarado MN — Created 10/04/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 248310

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 19. 2024 Performance of Varieties - ACSC RR Official Trial
St Thomas ND

		Rec/T		Rec/A		Rev/T		Rev/A		Yield	Sugar%			Na	K	AmN	Emerg.
Description @	Code	lbs.	%Bnch	lbs.	%Bnch	$ +	%Bnch	$ +	%Bnch	T/A	Gross	LTM	Rec	ppm	ppm	ppm	%
Commercial Trial																	
BTS 8018	113	316.7	99	12223	105	53.42	98	2075	104	38.67	16.78	0.94	15.84	239	1429	263	81.6
BTS 8034	118	300.0	94	11399	98	47.87	88	1821	91	37.85	16.05	1.06	14.99	327	1541	288	88.0
BTS 8156	105	316.1	99	11291	97	53.23	97	1894	95	35.77	16.79	0.98	15.81	227	1509	277	82.9
BTS 8226	122	333.8	104	12438	107	59.09	108	2212	111	37.22	17.50	0.81	16.69	180	1262	223	85.4
BTS 8270	107	322.2	101	11859	102	55.25	101	2035	102	36.89	17.01	0.90	16.11	208	1392	250	79.2
BTS 8927 (CommBench)	117	328.4	102	12071	104	57.29	105	2115	106	36.61	17.31	0.88	16.43	205	1272	270	88.4
Crystal 022	116	328.0	102	11449	98	57.17	105	1981	99	34.68	17.27	0.86	16.41	169	1300	263	78.5
Crystal 130	111	324.7	101	11812	101	56.05	102	2036	102	36.60	17.15	0.92	16.23	203	1451	255	75.9
Crystal 137	101	314.9	98	10940	94	52.80	97	1823	91	34.64	16.71	0.97	15.74	211	1567	259	80.6
Crystal 138	103	324.4	101	11751	101	55.98	102	2025	102	35.96	17.13	0.91	16.22	182	1441	258	81.2
Crystal 260	115	325.0	101	11841	102	56.16	103	2039	102	36.52	17.16	0.92	16.24	221	1414	253	84.1
Crystal 262	109	315.4	98	11911	102	52.98	97	1991	100	37.86	16.70	0.93	15.77	218	1302	294	71.5
Crystal 269	106	324.5	101	12018	103	55.99	102	2071	104	36.93	17.16	0.93	16.23	193	1440	269	82.0
Crystal 793	108	325.6	102	12108	104	56.38	103	2104	106	37.35	17.17	0.89	16.28	218	1354	252	82.3
Crystal 912	114	310.8	97	11983	103	51.47	94	1980	99	38.34	16.51	0.97	15.54	257	1298	309	78.2
Hilleshög HIL2386	119	312.9	98	10379	89	52.17	95	1737	87	33.33	16.54	0.89	15.65	218	1280	270	79.0
Hilleshög HIL2389	112	328.2	102	11787	101	57.23	105	2059	103	36.18	17.28	0.87	16.41	167	1273	274	82.8
Hilleshög HIL9920	110	322.2	101	11019	95	55.24	101	1890	95	34.35	17.05	0.94	16.11	231	1403	273	74.9
Maribo MA717	121	307.0	96	10659	92	50.21	92	1724	87	34.58	16.30	0.95	15.35	274	1356	274	85.9
SV 203	102	316.8	99	11610	100	53.45	98	1955	98	36.59	16.76	0.92	15.84	212	1350	279	74.8
SX 1815	120	329.4	103	11969	103	57.63	105	2092	105	36.68	17.30	0.83	16.47	156	1294	243	77.1
SX 1818	104	309.3	96	11667	100	50.97	93	1917	96	37.90	16.38	0.91	15.47	206	1336	278	82.3
Crystal 578RR (CommBench)	123	317.4	99	11551	99	53.63	98	1956	98	36.38	16.83	0.96	15.87	240	1442	270	75.2
BTS 8815 (CommBench)	124	314.7	98	11301	97	52.76	96	1899	95	35.87	16.69	0.96	15.73	220	1428	282	82.0
Crystal 803 (CommBench)	125	321.8	100	11668	100	55.10	101	2001	100	36.53	16.97	0.88	16.09	173	1371	256	83.4
AP CK MOD RES RR#7	126	302.7	94	11653	100	48.78	89	1867	94	38.23	16.15	1.01	15.14	307	1310	325	76.0
AP CK MOD SUS RR#8	127	327.5	102	11875	102	57.00	104	2069	104	36.52	17.26	0.88	16.38	154	1328	275	83.9
Experimental Trial (Comm status)																	
BTS 8328	225	314.9	98	11730	101	52.89	97	1977	99	36.95	16.73	0.98	15.75	213	1531	269	77.5
BTS 8359	221	310.4	97	11643	100	51.42	94	1919	96	37.73	16.50	0.97	15.53	183	1495	279	83.6
BTS 8365	228	339.6	106	11499	99	60.77	111	2050	103	33.89	17.85	0.86	16.99	136	1396	235	83.1
BTS 8404	211	328.4	102	12155	104	57.21	105	2113	106	37.17	17.31	0.87	16.44	127	1400	244	77.2
BTS 8412	205	311.2	97	11548	99	51.67	94	1925	97	36.66	16.47	0.91	15.56	198	1502	225	79.8
BTS 8440	213	321.7	100	11812	101	55.03	101	2027	102	36.57	16.91	0.82	16.09	158	1274	235	80.9
BTS 8457	201	320.0	100	12113	104	54.53	100	2054	103	38.02	16.83	0.81	16.03	193	1161	242	78.9
BTS 8469	206	310.3	97	11852	102	51.39	94	1969	99	37.96	16.45	0.92	15.53	177	1414	268	84.0
BTS 8480	230	313.3	98	11637	100	52.36	96	1954	98	36.81	16.56	0.89	15.68	177	1422	240	77.5
BTS 8495	214	323.5	101	11154	96	55.63	102	1928	97	34.30	17.04	0.85	16.19	151	1456	213	78.2
Crystal 360	218	321.1	100	11101	95	54.86	100	1918	96	34.22	16.92	0.86	16.06	167	1432	220	90.3
Crystal 361	227	328.2	102	11798	101	57.13	104	2056	103	35.97	17.28	0.87	16.41	208	1249	259	81.1
Crystal 364	232	311.6	97	11755	101	51.84	95	1953	98	37.66	16.55	0.96	15.60	181	1538	265	82.8
Crystal 369	231	321.9	100	11786	101	55.09	101	2013	101	36.63	17.16	1.08	16.08	213	1571	330	85.7
Crystal 470	203	318.6	99	12293	106	54.06	99	2086	105	38.96	16.78	0.83	15.95	153	1385	214	87.4
Crystal 471	229	327.2	102	11925	102	56.79	104	2080	104	36.45	17.18	0.82	16.37	143	1275	236	83.9
Crystal 473	207	310.8	97	11411	98	51.56	94	1881	94	36.94	16.44	0.88	15.56	199	1399	231	82.7
Crystal 475	224	315.8	99	10922	94	53.16	97	1836	92	34.58	16.67	0.87	15.80	158	1375	246	76.5
Crystal 479	226	319.6	100	11796	101	54.38	99	2001	100	37.06	17.03	1.04	15.99	237	1510	311	86.4
Hilleshög HIL2479	215	312.2	97	9933	85	52.00	95	1652	83	31.66	16.51	0.88	15.63	210	1309	250	75.6
Hilleshög HIL2480	217	300.6	94	10307	88	48.29	88	1636	82	34.53	16.09	1.06	15.03	262	1410	339	80.2
Hilleshög HIL2493	209	308.8	96	11636	100	50.92	93	1910	96	37.81	16.39	0.94	15.45	188	1429	272	73.6
Hilleshög HIL2494	223	307.1	96	10422	89	50.39	92	1692	85	34.43	16.36	0.98	15.38	212	1456	291	73.4
Hilleshög HIL2495	222	290.4	91	11350	97	45.02	82	1769	89	39.17	15.47	0.95	14.52	266	1456	242	76.2
Hilleshög HIL2496	204	297.1	93	11589	99	47.17	86	1837	92	39.26	15.79	0.92	14.87	270	1420	230	81.9
SV 231	219	306.0	95	11913	102	50.06	92	1948	98	38.95	16.24	0.93	15.32	194	1459	255	79.0
SV 343	216	290.6	91	11753	101	45.12	82	1822	91	40.37	15.46	0.93	14.53	223	1486	237	78.8
SV 344	208	290.8	91	10982	94	45.14	83	1708	86	37.45	15.54	1.00	14.54	241	1506	279	72.2
SV 345	210	308.1	96	12357	106	50.68	93	2045	103	40.08	16.32	0.91	15.41	181	1517	227	89.0
SV 347	212	310.8	97	11776	101	51.56	94	1943	98	38.19	16.47	0.91	15.56	163	1435	257	83.3
SX 1835	202	300.7	94	11609	100	48.35	88	1860	93	38.84	16.03	1.00	15.03	221	1507	281	82.4
SX 1849	220	292.0	91	11804	101	45.53	83	1858	93	40.25	15.57	0.98	14.59	230	1601	242	79.6
Crystal 578RR (CommBench)	233	311.6	97	11743	101	51.83	95	1960	98	37.69	16.52	0.95	15.58	209	1499	249	81.0
BTS 8815 (CommBench)	234	322.5	101	11434	98	55.30	101	1967	99	35.41	17.05	0.93	16.12	194	1477	245	85.0
Crystal 803 (CommBench)	235	322.5	101	11592	100	55.33	101	1996	100	35.84	17.01	0.86	16.15	163	1426	225	85.3
BTS 8927 (CommBench)	236	325.6	102	11822	101	56.32	103	2048	103	36.44	17.22	0.95	16.27	186	1414	280	89.2
Hilleshög HIL2389 (1stYearBench)	237	310.7	97	11030	95	51.53	94	1833	92	35.50	16.45	0.90	15.55	201	1368	253	84.5
AP CK MOD RES RR#7	238	296.2	92	11726	101	46.90	86	1851	93	39.29	15.87	1.05	14.82	278	1415	330	80.5
AP CK MOD SUS RR#8	239	324.2	101	11219	96	55.84	102	1936	97	34.65	17.10	0.87	16.23	153	1405	243	89.5
AP CK SUS RR#2	240	308.3	96	9662	83	50.75	93	1605	81	30.83	16.38	0.96	15.42	231	1356	297	65.9
AP CK MOD SUS RR#6	241	318.2	99	11291	97	53.92	99	1919	96	35.49	16.81	0.90	15.92	164	1384	267	83.8
RA CK SUS RR#7	242	305.4	95	9451	81	49.82	91	1531	77	31.25	16.22	0.93	15.29	208	1423	261	82.8
Comm Benchmark Mean		320.6		11648		54.70		1993		36.35	16.95	0.92		209	1378	269	82.3
Comm Trial Mean		319.3		11638		54.27		1977		36.48	16.89	0.92		215	1376	270	80.6
Coeff. of Var. (%)		2.4		4.8		4.6		6.1		4.5	2.1	5.8		17.5	4.7	10.4	9.8
Mean LSD (0.05)		7.1		480		2.36		108		1.47	0.33	0.05		36	60	26	7.0
Mean LSD (0.01)		9.4		633		3.11		142		1.94	0.44	0.07		47	80	35	9.2
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from St Thomas ND — Created 10/01/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. Trial # = 248311

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 20. 2024 Performance of Varieties - ACSC RR Official Trial
Hallock MN

		Rec/T		Rec/A		Rev/T		Rev/A		Yield	Sugar%			Na	K	AmN	Emerg.
Description @	Code	lbs.	%Bnch	lbs.	%Bnch	$ +	%Bnch	$ +	%Bnch	T/A	Gross	LTM	Rec	ppm	ppm	ppm	%
Commercial Trial																	
BTS 8018	113	332.4	101	9456	97	58.61	101	1664	98	28.87	17.82	1.21	16.61	247	1652	406	91.6
BTS 8034	118	312.2	94	9556	98	51.92	90	1589	93	30.55	17.13	1.53	15.60	375	1990	516	89.5
BTS 8156	105	328.4	99	10064	103	57.30	99	1759	103	30.61	17.77	1.34	16.43	289	1949	420	89.7
BTS 8226	122	338.1	102	9477	97	60.51	104	1701	100	28.83	18.18	1.28	16.90	232	1662	469	89.5
BTS 8270	107	330.5	100	10325	106	57.98	100	1807	106	31.25	17.79	1.26	16.53	250	1766	419	89.5
BTS 8927 (CommBench)	117	337.1	102	9540	98	60.17	104	1677	98	28.15	18.18	1.32	16.86	242	1681	484	89.3
Crystal 022	116	340.5	103	9892	101	61.31	106	1788	105	29.11	18.27	1.25	17.02	215	1683	440	88.0
Crystal 130	111	328.6	99	10600	109	57.37	99	1854	109	31.65	17.77	1.34	16.43	274	1798	457	87.1
Crystal 137	101	336.7	102	9850	101	60.05	104	1767	104	29.32	18.15	1.32	16.83	267	1979	397	89.0
Crystal 138	103	323.8	98	9647	99	55.78	96	1665	98	30.11	17.58	1.40	16.18	265	1868	490	85.7
Crystal 260	115	343.3	104	10755	110	62.24	107	1940	114	32.07	18.34	1.18	17.16	195	1732	384	92.2
Crystal 262	109	330.2	100	10508	108	57.90	100	1845	108	32.47	17.80	1.29	16.51	291	1721	440	80.4
Crystal 269	106	351.0	106	10661	109	64.78	112	1947	114	30.69	18.73	1.17	17.56	212	1753	366	82.2
Crystal 793	108	334.6	101	9560	98	59.35	102	1697	99	28.37	18.02	1.29	16.73	291	1704	441	86.5
Crystal 912	114	300.9	91	10479	107	48.20	83	1687	99	34.36	16.61	1.56	15.05	428	1716	594	89.3
Hilleshög HIL2386	119	303.8	92	10009	103	49.16	85	1610	94	32.52	16.67	1.47	15.20	386	1853	506	88.1
Hilleshög HIL2389	112	336.0	102	10356	106	59.80	103	1857	109	31.22	18.01	1.21	16.80	211	1833	376	86.9
Hilleshög HIL9920	110	323.7	98	10038	103	55.74	96	1743	102	30.63	17.60	1.41	16.19	333	1922	460	83.4
Maribo MA717	121	309.6	94	10484	107	51.08	88	1730	101	33.73	16.92	1.43	15.49	362	1865	482	81.8
SV 203	102	333.3	101	10132	104	58.91	102	1783	104	30.35	17.92	1.25	16.67	224	1817	408	81.6
SX 1815	120	331.3	100	9709	100	58.25	100	1707	100	28.90	17.88	1.32	16.56	245	1846	439	89.3
SX 1818	104	319.9	97	10006	103	54.48	94	1715	101	30.94	17.47	1.47	16.00	286	1917	525	81.6
Crystal 578RR (CommBench)	123	321.5	97	9870	101	55.01	95	1689	99	30.36	17.52	1.44	16.08	343	1877	492	90.2
BTS 8815 (CommBench)	124	325.9	99	9595	98	56.47	97	1681	99	29.51	17.66	1.36	16.30	316	1903	436	90.7
Crystal 803 (CommBench)	125	337.5	102	10013	103	60.32	104	1778	104	29.43	18.11	1.22	16.89	233	1794	385	91.2
AP CK MOD RES RR#7	126	314.7	95	11183	115	52.75	91	1860	109	35.69	17.13	1.40	15.73	436	1684	473	88.4
AP CK MOD SUS RR#8	127	334.2	101	9833	101	59.23	102	1738	102	29.39	17.98	1.27	16.71	244	1749	428	88.9
Experimental Trial (Comm status)																	
BTS 8328	225	335.8	102	9690	99	59.80	103	1697	99	28.98	18.04	1.26	16.79	300	1791	484	79.5
BTS 8359	221	319.2	97	9821	101	54.17	93	1672	98	30.36	17.45	1.46	15.98	311	1816	660	83.6
BTS 8365	228	343.9	104	9601	98	62.52	108	1715	101	27.86	18.33	1.14	17.19	251	1755	418	81.7
BTS 8404	211	348.1	105	10468	107	63.93	110	1946	114	30.43	18.48	1.13	17.35	183	1767	442	82.8
BTS 8412	205	334.2	101	10305	106	59.26	102	1804	106	30.83	18.03	1.32	16.72	347	1941	486	77.6
BTS 8440	213	343.2	104	9981	102	62.29	107	1787	105	29.39	18.29	1.15	17.14	258	1717	422	82.4
BTS 8457	201	344.3	104	10305	106	62.66	108	1862	109	29.77	18.23	1.04	17.19	261	1538	383	75.3
BTS 8469	206	328.9	100	9548	98	57.44	99	1659	97	29.31	17.66	1.23	16.43	233	1764	507	78.5
BTS 8480	230	337.0	102	10261	105	60.18	104	1824	107	31.01	18.11	1.26	16.84	237	1866	503	73.6
BTS 8495	214	327.9	99	9600	98	57.11	98	1660	97	28.61	17.66	1.25	16.41	343	1780	477	86.5
Crystal 360	218	330.6	100	8819	90	58.05	100	1551	91	26.36	17.81	1.28	16.53	258	1856	503	87.9
Crystal 361	227	333.7	101	9603	98	59.07	102	1674	98	29.78	18.00	1.33	16.68	306	1691	587	79.6
Crystal 364	232	329.2	100	10686	110	57.57	99	1869	110	32.01	17.71	1.25	16.46	329	1824	451	83.6
Crystal 369	231	330.2	100	10317	106	57.88	100	1803	106	31.35	17.91	1.39	16.52	342	1873	583	82.6
Crystal 470	203	323.5	98	10804	111	55.61	96	1880	110	33.16	17.44	1.27	16.16	328	1687	526	83.9
Crystal 471	229	338.5	102	10199	105	60.69	105	1797	105	29.56	18.13	1.19	16.93	248	1669	488	82.5
Crystal 473	207	333.8	101	9502	97	59.12	102	1683	99	28.21	17.80	1.13	16.67	299	1687	404	86.9
Crystal 475	224	324.5	98	9301	95	55.98	97	1596	94	28.43	17.60	1.35	16.25	278	1800	575	80.1
Crystal 479	226	334.7	101	10560	108	59.41	102	1857	109	32.36	17.87	1.17	16.70	259	1739	455	83.5
Hilleshög HIL2479	215	333.9	101	9831	101	59.13	102	1721	101	29.81	18.01	1.33	16.69	390	1850	503	84.1
Hilleshög HIL2480	217	315.0	95	9809	101	52.77	91	1636	96	31.01	17.21	1.44	15.78	386	1899	581	79.7
Hilleshög HIL2493	209	326.7	99	11019	113	56.72	98	1907	112	33.24	17.64	1.30	16.34	307	1854	506	84.1
Hilleshög HIL2494	223	337.8	102	11483	118	60.46	104	2058	121	33.62	18.13	1.26	16.87	234	1922	481	84.1
Hilleshög HIL2495	222	292.4	88	10276	105	45.13	78	1580	93	34.91	16.24	1.56	14.68	471	1976	647	85.8
Hilleshög HIL2496	204	326.0	99	9876	101	56.50	97	1703	100	30.44	17.64	1.34	16.30	378	2006	480	78.2
SV 231	219	307.2	93	10615	109	50.13	86	1745	102	33.57	16.81	1.42	15.39	382	1810	584	81.9
SV 343	216	312.0	94	10618	109	51.77	89	1743	102	33.10	16.96	1.32	15.64	338	1926	500	82.8
SV 344	208	296.7	90	8986	92	46.58	80	1396	82	29.66	16.36	1.48	14.88	456	1948	590	75.7
SV 345	210	327.2	99	11016	113	56.86	98	1891	111	33.18	17.60	1.23	16.37	282	1816	471	83.5
SV 347	212	338.8	103	10711	110	60.78	105	1922	113	31.01	18.12	1.18	16.93	221	1832	444	83.2
SX 1835	202	317.1	96	10631	109	53.50	92	1774	104	33.06	17.37	1.46	15.90	299	1944	636	85.8
SX 1849	220	318.8	96	10319	106	54.02	93	1745	102	32.08	17.26	1.30	15.95	379	2037	448	82.9
Crystal 578RR (CommBench)	233	328.2	99	10469	107	57.21	99	1827	107	31.68	17.88	1.45	16.43	396	1992	572	87.0
BTS 8815 (CommBench)	234	324.6	98	10276	105	55.99	97	1798	105	30.62	17.61	1.36	16.25	337	1950	525	87.7
Crystal 803 (CommBench)	235	332.2	101	9368	96	58.56	101	1627	95	28.19	17.93	1.31	16.62	286	1826	528	83.0
BTS 8927 (CommBench)	236	337.1	102	8905	91	60.22	104	1573	92	26.96	18.04	1.21	16.83	254	1723	495	82.0
Hilleshög HIL2389 (1stYearBench)	237	325.7	99	9927	102	56.36	97	1689	99	30.31	17.67	1.36	16.31	311	1806	568	79.5
AP CK MOD RES RR#7	238	309.1	94	10273	105	50.77	88	1661	97	33.29	17.00	1.51	15.49	510	1750	629	75.3
AP CK MOD SUS RR#8	239	343.3	104	9229	95	62.31	107	1646	96	27.46	18.36	1.21	17.15	262	1781	474	85.8
AP CK SUS RR#2	240	313.1	95	9347	96	52.08	90	1573	92	29.84	17.09	1.43	15.67	433	1805	588	63.3
AP CK MOD SUS RR#6	241	323.5	98	9668	99	55.61	96	1670	98	29.65	17.53	1.35	16.18	265	1717	588	81.9
RA CK SUS RR#7	242	317.3	96	9619	99	53.56	92	1604	94	30.62	17.28	1.39	15.88	404	1836	555	88.3
Comm Benchmark Mean		330.5		9755		57.99		1706		29.36	17.87	1.34		283	1814	449	90.3
Comm Trial Mean		328.2		10059		57.21		1751		30.71	17.74	1.33		285	1804	449	87.5
Coeff. of Var. (%)		2.9		8.1		5.5		9.3		7.5	2.2	8.3		18.3	3.3	13.8	7.9
Mean LSD (0.05)		9.1		695		3.01		149		1.85	0.38	0.11		50	56	60	5.8
Mean LSD (0.01)		12.0		915		3.97		197		2.44	0.50	0.14		66	74	79	7.6
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Hallock MN — Created 10/03/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 248312

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 21. 2024 Performance of Varieties - ACSC RR Official Trial
Bathgate ND

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Rev/T $ +	Rev/T %Bnch	Rev/A $ +	Rev/A %Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	113	303.4	98	10761	99	49.02	97	1733	97	35.47	16.18	1.01	15.17	379	1305	293	78.7
BTS 8034	118	289.8	94	10674	98	44.51	88	1637	91	36.97	15.79	1.31	14.48	593	1612	363	81.3
BTS 8156	105	303.5	98	10864	100	49.06	97	1758	98	35.60	16.33	1.15	15.18	428	1614	304	74.2
BTS 8226	122	329.4	107	11160	102	57.62	114	1956	109	34.15	17.35	0.89	16.46	276	1215	264	71.2
BTS 8270	107	314.4	102	11044	101	52.65	104	1845	103	35.26	16.72	1.00	15.72	312	1380	292	69.6
BTS 8927 (CommBench)	117	324.4	105	11698	107	55.98	110	2022	113	36.02	17.13	0.91	16.22	312	1199	274	80.0
Crystal 022	116	318.0	103	10502	96	53.86	106	1779	99	33.07	16.86	0.96	15.90	319	1307	276	72.2
Crystal 130	111	312.8	101	10569	97	52.13	103	1763	98	33.97	16.62	0.98	15.64	360	1319	280	71.4
Crystal 137	101	310.6	101	10642	98	51.41	101	1761	98	34.14	16.63	1.09	15.54	323	1597	305	73.9
Crystal 138	103	309.4	100	10445	96	51.01	101	1721	96	33.89	16.47	1.00	15.47	341	1314	299	66.0
Crystal 260	115	318.6	103	10905	100	54.05	107	1850	103	34.27	16.91	0.98	15.93	321	1405	272	76.4
Crystal 262	109	304.8	99	10927	100	49.48	98	1773	99	35.81	16.24	1.00	15.24	386	1268	296	55.9
Crystal 269	106	312.0	101	10509	96	51.88	102	1745	97	33.68	16.73	1.13	15.60	448	1389	340	54.4
Crystal 793	108	314.7	102	10917	100	52.74	104	1823	102	34.70	16.71	0.97	15.74	384	1269	272	76.5
Crystal 912	114	287.1	93	11078	102	43.61	86	1680	94	38.60	15.53	1.17	14.36	566	1280	360	81.0
Hilleshög HIL2386	119	286.7	93	9914	91	43.48	86	1500	84	34.24	15.41	1.07	14.34	441	1340	310	70.3
Hilleshög HIL2389	112	311.4	101	10726	98	51.65	102	1776	99	34.24	16.57	0.99	15.58	345	1372	279	69.6
Hilleshög HIL9920	110	307.3	100	9951	91	50.32	99	1638	91	32.39	16.40	1.04	15.36	460	1413	260	67.4
Maribo MA717	121	292.7	95	10228	94	45.46	90	1583	88	35.20	15.61	0.98	14.63	410	1209	289	67.7
SV 203	102	297.4	96	10248	94	47.03	93	1625	91	34.50	15.96	1.09	14.87	439	1361	323	70.5
SX 1815	120	310.4	101	10742	99	51.34	101	1773	99	34.74	16.52	1.00	15.52	347	1397	279	73.6
SX 1818	104	297.4	96	10320	95	47.02	93	1629	91	34.88	15.92	1.05	14.87	430	1356	299	70.9
Crystal 578RR (CommBench)	123	297.0	96	10696	98	46.90	93	1696	95	35.82	15.98	1.13	14.85	432	1478	325	74.9
BTS 8815 (CommBench)	124	305.3	99	10562	97	49.65	98	1713	96	34.53	16.31	1.04	15.27	389	1438	281	73.9
Crystal 803 (CommBench)	125	306.8	99	10610	97	50.15	99	1740	97	34.39	16.41	1.06	15.35	423	1365	308	73.5
AP CK MOD RES RR#7	126	284.0	92	10808	99	42.58	84	1625	91	37.88	15.40	1.20	14.20	622	1292	359	65.9
AP CK MOD SUS RR#8	127	314.4	102	10453	96	52.66	104	1750	98	33.25	16.75	1.02	15.73	393	1277	310	80.6
Experimental Trial (Comm status)																	
BTS 8328	225	310.2	101	10596	97	51.23	101	1747	97	34.40	16.60	1.09	15.52	388	1330	315	56.3
BTS 8359	221	304.0	99	10737	99	49.27	97	1741	97	35.49	16.30	1.10	15.20	305	1275	346	66.5
BTS 8365	228	322.7	105	10930	100	55.25	109	1871	104	33.53	16.96	0.79	16.17	198	1150	210	71.5
BTS 8404	211	301.0	98	9979	92	48.34	95	1591	89	33.11	16.20	1.13	15.07	354	1389	342	68.4
BTS 8412	205	310.3	101	10553	97	51.30	101	1754	98	33.28	16.54	1.01	15.52	313	1366	266	63.1
BTS 8440	213	316.1	103	10860	100	53.12	105	1837	102	34.27	16.71	0.91	15.80	243	1219	235	71.5
BTS 8457	201	313.9	102	11113	102	52.42	103	1857	104	35.05	16.60	0.87	15.73	277	1107	251	74.9
BTS 8469	206	288.1	93	9926	91	44.21	87	1521	85	34.09	15.57	1.16	14.41	418	1341	353	75.2
BTS 8480	230	300.1	97	10028	92	48.02	95	1613	90	33.34	16.04	1.05	15.00	304	1302	302	54.6
BTS 8495	214	307.2	100	10288	94	50.29	99	1690	94	33.15	16.40	1.04	15.37	355	1296	290	59.4
Crystal 360	218	320.9	104	11062	102	54.65	108	1881	105	34.21	16.99	0.91	16.08	203	1307	270	80.1
Crystal 361	227	314.4	102	11055	102	52.56	104	1858	104	34.82	16.70	0.96	15.74	306	1192	262	74.0
Crystal 364	232	296.4	96	10627	98	46.87	93	1683	94	35.82	15.95	1.13	14.82	430	1489	275	71.9
Crystal 369	231	312.6	101	10999	101	52.04	103	1840	103	34.60	16.68	1.02	15.66	314	1260	312	65.4
Crystal 470	203	316.6	103	11533	106	53.28	105	1952	109	36.09	16.75	0.91	15.84	240	1246	245	77.0
Crystal 471	229	308.4	100	11029	101	50.68	100	1820	102	35.06	16.38	0.93	15.45	284	1152	286	65.3
Crystal 473	207	305.9	99	10946	100	49.88	98	1789	100	35.38	16.31	0.98	15.32	351	1255	270	73.3
Crystal 475	224	300.4	97	10620	98	48.11	95	1711	95	35.21	16.03	1.01	15.01	263	1269	291	68.0
Crystal 479	226	310.9	101	11023	101	51.47	102	1834	102	35.22	16.62	1.08	15.55	376	1298	303	78.1
Hilleshög HIL2479	215	301.7	98	9003	83	48.53	96	1439	80	29.81	16.12	1.02	15.10	368	1226	309	55.7
Hilleshög HIL2480	217	297.1	96	10094	93	47.07	93	1610	90	33.75	16.11	1.29	14.82	432	1432	389	58.3
Hilleshög HIL2493	209	295.2	96	11375	104	46.47	92	1797	100	38.06	15.84	1.09	14.75	370	1407	286	74.2
Hilleshög HIL2494	223	292.0	95	10867	100	45.47	90	1698	95	36.99	15.72	1.13	14.59	383	1314	328	72.2
Hilleshög HIL2495	222	281.9	91	9875	91	42.26	83	1484	83	34.71	15.13	1.02	14.10	339	1333	287	58.3
Hilleshög HIL2496	204	285.3	93	10043	92	43.30	85	1533	85	34.34	15.39	1.12	14.27	473	1260	315	67.5
SV 231	219	301.6	98	11435	105	48.52	96	1852	103	37.01	16.04	0.93	15.12	284	1206	266	76.3
SV 343	216	283.7	92	10465	96	42.80	84	1599	89	36.17	15.27	1.10	14.17	387	1344	292	66.2
SV 344	208	270.9	88	9025	83	38.74	76	1301	73	33.20	14.71	1.19	13.52	485	1363	322	62.1
SV 345	210	286.1	93	11645	107	43.55	86	1782	99	40.36	15.35	1.06	14.29	410	1259	293	83.2
SV 347	212	300.8	98	10642	98	48.27	95	1720	96	34.35	16.14	1.09	15.05	331	1436	306	76.4
SX 1835	202	283.2	92	11334	104	42.64	84	1714	96	39.53	15.32	1.17	14.15	451	1368	338	81.4
SX 1849	220	274.0	89	10405	96	39.72	78	1515	84	37.53	14.89	1.20	13.68	496	1402	324	66.9
Crystal 578RR (CommBench)	233	298.2	97	10738	99	47.46	94	1708	95	35.74	16.01	1.09	14.92	359	1541	254	66.3
BTS 8815 (CommBench)	234	308.0	100	11236	103	50.56	100	1847	103	36.33	16.48	1.09	15.39	360	1413	298	72.2
Crystal 803 (CommBench)	235	319.3	104	11167	103	54.13	107	1893	106	34.85	16.91	0.92	16.00	270	1219	260	75.0
BTS 8927 (CommBench)	236	307.9	100	10425	96	50.52	100	1723	96	33.83	16.43	1.05	15.39	311	1219	306	71.5
Hilleshög HIL2389 (1stYearBench)	237	298.1	97	10708	98	47.37	93	1706	95	35.91	15.95	1.05	14.90	323	1338	280	65.9
AP CK MOD RES RR#7	238	286.2	93	10489	96	43.61	86	1599	89	36.38	15.53	1.24	14.30	503	1300	373	69.9
AP CK MOD SUS RR#8	239	308.8	100	10594	97	50.79	100	1755	98	34.02	16.43	1.00	15.43	308	1215	289	76.2
AP CK SUS RR#2	240	294.0	95	8559	79	46.11	91	1345	75	29.23	15.76	1.08	14.69	437	1225	293	53.9
AP CK MOD SUS RR#6	241	305.4	99	10295	95	49.69	98	1681	94	33.50	16.31	1.04	15.27	293	1275	311	74.4
RA CK SUS RR#7	242	292.1	95	9213	85	45.50	90	1442	80	31.80	15.57	0.96	14.61	385	1180	241	73.5
Comm Benchmark Mean		308.4		10892		50.67		1793		35.19	16.46	1.04		389	1370	297	75.6
Comm Trial Mean		306.1		10665		49.90		1737		34.88	16.35	1.05		403	1362	300	71.9
Coeff. of Var. (%)		2.7		4.8		5.5		6.6		4.3	2.3	7.5		16.9	4.8	12.1	13.5
Mean LSD (0.05)		7.9		479		2.63		110		1.35	0.36	0.08		66	61	35	8.2
Mean LSD (0.01)		10.5		631		3.46		145		1.78	0.47	0.10		86	81	46	10.8
Sig Lvl		0.01		0.01		0.01		0.01		0.01	0.01	0.01		0.01	0.01	0.01	0.01

2024 Data from Bathgate ND — Created 10/03/2024

@ Statistics and trial mean are from Commercial trial including benchmark means. Experimental trial data adjusted to commercial status.

%Bnch = percentage of four commercial benchmark (CommBench) varieties used for approval of second year entries.

+ Revenue estimates are based on a $54.53 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 248313

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 22. Calculation for Approval of Sugarbeet Varieties for ACSC Market for 2025

			Rec/Ton					Rev/Acre++				R/T + $/A	Cercospora Rating ^				
Description	Approval Status		2023	2024	2 Yr	% Bench		2023	2024	2 Yr	% Bench	% Bench	2022	2023	2024	2 Yr Mean	3 Yr Mean
Previously Approved (3 Yr)																	**<=5.30**
BTS 8018	Approved		348.4	336.0	342.2	99.9		1960	2101	2031	104.2	204.1	2.03	2.42	3.35	2.89	2.60
BTS 8034	Approved		338.6	324.1	331.4	96.8		1896	1978	1937	99.4	196.2	2.28	2.54	3.69	3.12	2.84
BTS 8156	Approved		348.1	331.8	340.0	99.3		1890	2015	1953	100.2	199.5	2.43	2.53	3.87	3.20	2.94
BTS 8226	Approved		355.3	346.2	350.8	102.4		1945	2146	2046	105.0	207.4	2.00	2.33	3.52	2.93	2.62
BTS 8270	Approved		352.3	337.5	344.9	100.7		1966	2064	2015	103.4	204.1	1.97	2.43	3.32	2.87	2.57
BTS 8927	Approved		353.5	345.0	349.3	102.0		1948	2124	2036	104.5	206.5	4.42	4.38	4.45	4.42	4.42
Crystal 022	Approved		358.1	344.0	351.1	102.5		1975	2044	2010	103.1	205.7	4.60	4.97	4.66	4.82	4.75
Crystal 130	Approved		353.3	337.5	345.4	100.9		2009	2077	2043	104.9	205.7	2.10	2.60	3.56	3.08	2.76
Crystal 137	Approved		349.6	334.1	341.9	99.8		1922	1998	1960	100.6	200.4	2.57	2.65	3.81	3.23	3.01
Crystal 138	Approved		349.4	333.8	341.6	99.8		1983	2024	2004	102.8	202.6	4.87	4.77	4.73	4.75	4.79
Crystal 260	Approved		348.0	340.2	344.1	100.5		1962	2124	2043	104.9	205.3	2.05	2.15	3.13	2.64	2.44
Crystal 262	Approved		345.7	327.0	336.4	98.2		1932	2055	1994	102.3	200.5	4.43	4.36	4.36	4.36	4.38
Crystal 269	Approved		358.1	345.0	351.6	102.7		1932	2139	2036	104.5	207.1	4.60	4.38	4.54	4.46	4.51
Crystal 793	Approved		349.4	338.8	344.1	100.5		1981	2092	2037	104.5	205.0	4.10	4.20	4.28	4.24	4.19
Crystal 912	Approved		340.3	316.4	328.4	95.9		2025	2035	2030	104.2	200.1	4.81	5.00	5.06	5.03	4.96
Hilleshög HIL2386	Approved		342.7	327.0	334.9	97.8		1836	1942	1889	96.9	194.7	4.54	4.23	4.89	4.56	4.56
Hilleshög HIL2389	Approved		349.2	336.9	343.1	100.2		1948	2062	2005	102.9	203.1	4.69	4.51	4.57	4.54	4.59
Hilleshög HIL9920	Approved		347.4	333.2	340.3	99.4		1878	1981	1930	99.0	198.4	4.92	5.15	5.07	5.11	5.05
Maribo MA717	Approved		343.0	323.9	333.5	97.4		1871	1978	1925	98.8	196.1	5.05	5.04	4.85	4.95	4.98
SV 203	Approved		350.6	337.2	343.9	100.4		1972	2070	2021	103.7	204.2	4.74	4.78	4.66	4.72	4.73
SX 1815	Approved		350.9	337.7	344.3	100.5		1996	2070	2033	104.3	204.9	5.07	4.74	4.70	4.72	4.84
SX 1818	Approved		345.0	327.2	336.1	98.2		1958	2004	1981	101.7	199.8	4.72	4.53	4.65	4.59	4.64
Candidates for Approval (2 Yr)																**<=5.00**	
BTS 8328	Approved		356.1	338.6	347.4	101.4		1961	2045	2003	102.8	204.2	--	4.54	4.43	4.48	--
BTS 8359	Not Approved		350.9	329.4	340.2	99.3		1957	2009	1983	101.8	201.1	--	2.26	2.91	2.58	--
BTS 8365	Approved		362.2	350.3	356.3	104.0		1980	2088	2034	104.4	208.4	--	4.15	4.18	4.17	--
Crystal 360	Approved		351.2	340.5	345.9	101.0		1963	2008	1986	101.9	202.9	--	2.17	3.05	2.61	--
Crystal 361	Approved		357.9	339.9	348.9	101.9		2012	2119	2066	106.0	207.9	--	2.24	3.33	2.79	--
Crystal 364	Approved		342.5	327.7	335.1	97.9		2000	2081	2041	104.7	202.6	--	4.26	4.46	4.36	--
Crystal 369	Approved		354.6	338.3	346.5	101.2		1984	2101	2043	104.8	206.0	--	3.78	4.03	3.91	--
Hilleshög HIL2479	Approved		353.0	338.3	345.7	100.9		1861	1868	1865	95.7	196.6	--	4.09	4.25	4.17	--
Hilleshög HIL2480	Not Approved		349.4	331.3	340.4	99.4		1817	1886	1852	95.0	194.4	--	4.00	4.08	4.04	--
SV 231	Approved		346.4	326.2	336.3	98.2		1965	2116	2041	104.7	202.9	--	4.83	4.77	4.80	--
SX 1835	Not Approved		347.3	324.4	335.9	98.1		1968	2060	2014	103.4	201.4	--	4.55	4.66	4.60	--
Benchmark Varieties		2022	2023	2024			2022	2023	2024								
BTS 8337 (Check)	Benchmark	334.8					1322										
Crystal 578RR (Check)	Benchmark	313.1	346.1	326.0			1339	1907	1936								
BTS 8815 (Check)	Benchmark	324.9	344.7	335.5			1320	1703	1981								
Crystal 803 (Check)	Benchmark	331.6	350.5	335.6			1433	2003	2037								
BTS 8927 (Check)	Benchmark		356.0	345.0				1897	2124								
					2yr	3yr				2yr	3yr						
Benchmark mean		326.1	349.3	335.5	342.4	337.0	1354	1877	2020	1948	1750						

Variety approval criteria include: 1) Two years of official trial data, 2) Cercospora rating must not exceed 5.00 (1982 adjusted data), AND 3a) R/T >= 100% of Bench OR 3b) R/T >= 97% and R/T + $/A >= 202% of Bench. Three years of data may be considered for initial approval.

Created 10/22/2024

To maintain approval, the three-year Cercospora rating must not exceed 5.30 (1982 adjusted data).

++2024 Revenue estimate based on a $54.53 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses and 2023 Revenue estimate based on a $50.09 beet payment. Revenue does not consider hauling or production costs.

^ All Cercospora ratings 2022-2024 were adjusted to 1982 basis.

Table 23. 2024 First Year Experimental Varieties
New Benchmark Comparison
Projected Calculation for Approval of Sugarbeet Varieties for ACSC Market

		Rec/Ton		Rev/Acre ++		R/T + $/A	CR Rating ^^
	Approval ^		%		%	%	
Description	Likely	2024	Bench	2024	Bench	Bench	2024
Candidates for Retesting (1 Yr)							
BTS 8404	On Track	341.1	101.2	2041	100.1	201.3	4.38
BTS 8412	Not On Track	334.3	99.2	2008	98.5	197.6	3.47
BTS 8440	On Track	341.6	101.3	2105	103.2	204.6	2.90
BTS 8457	On Track	341.9	101.4	2159	105.9	207.3	3.55
BTS 8469	Not On Track	332.6	98.7	2005	98.3	197.0	3.46
BTS 8480	On Track	337.9	100.2	2026	99.3	199.6	4.44
BTS 8495	On Track	340.4	101.0	2004	98.3	199.2	3.89
Crystal 470	On Track	332.6	98.7	2145	105.2	203.8	3.71
Crystal 471	On Track	343.7	102.0	2157	105.8	207.7	3.49
Crystal 473	Not On Track	331.9	98.5	2058	100.9	199.4	4.61
Crystal 475	Not On Track	336.9	99.9	1976	96.9	196.8	4.28
Crystal 479	On Track	336.6	99.9	2098	102.9	202.7	4.84
Hilleshög HIL2493	On Track	328.1	97.3	2149	105.4	202.7	4.82
Hilleshög HIL2494	On Track	332.7	98.7	2123	104.1	202.8	4.60
Hilleshög HIL2495	Not On Track	310.0	92.0	1918	94.0	186.0	3.92
Hilleshög HIL2496	Not On Track	323.7	96.0	1969	96.5	192.6	4.06
SV 343	Not On Track	314.1	93.2	1927	94.5	187.7	3.99
SV 344	Not On Track	315.4	93.6	1737	85.2	178.7	3.17
SV 345	Not On Track	321.8	95.5	2129	104.4	199.9	4.93
SV 347	On Track	336.5	99.8	2085	102.2	202.1	4.81
SX 1849	Not On Track	314.7	93.4	1951	95.7	189.0	4.45
Benchmarks *							
BTS 8815 (Check)		332.0	98.5	2009	98.5		
Crystal 803 (Check)		337.1	100.0	2044	100.2		
BTS 8927 (Check)		343.5	101.9	2018	98.9		
HIL2389 (Check)		335.8	99.6	2087	102.4		
Benchmark Mean		337.1		2039			

Variety approval criteria include: 1) Two years of official trial data, 2) Cercospora rating must not exceed 5.00 (1982 adjusted data), AND 3a) R/T >= 100% of Bench OR 3b) R/T >= 97% and R/T + $/A >= 202% of Bench.

Created 10/22/2024

++ 2024 Revenue estimate based on a $54.53 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses.
Revenue does not consider hauling or production cost

* 2024 benchmark varieties for first year entries dropped Crystal 578RR and added HIL 2389

^^ All Cercospora ratings from 2024 were adjusted to 1982 basis.

^ Not on Track = data is not tracking for potential approval. On Track = data is tracking for potential approval.

Table 24. Calculation for Approval of Sugarbeet Varieties for ACSC Aphanomyces Specialty Market for 2025

	Approval	Aphanomyces Root Rating					Cercospora Rating *				
Description	Status	2022	2023	2024	2 Yr	3 Yr	2022	2023	2024	2 Yr	3 Yr
Previously Approved (3 Yr)						**<=4.30**					**<=5.30**
BTS 8018	Approved	4.00	3.95	3.73	3.84	3.89	2.03	2.42	3.35	2.89	2.60
BTS 8034	Approved	3.89	3.80	4.48	4.14	4.06	2.28	2.54	3.69	3.12	2.84
BTS 8156	Approved	4.21	3.97	4.27	4.12	4.15	2.43	2.53	3.87	3.20	2.94
BTS 8226	Approved	3.79	3.72	3.81	3.77	3.77	2.00	2.33	3.52	2.93	2.62
BTS 8270	Approved	3.87	3.90	3.76	3.83	3.84	1.97	2.43	3.32	2.87	2.57
BTS 8927	Approved	4.00	3.26	4.41	3.84	3.89	4.42	4.38	4.45	4.42	4.42
Crystal 022	Approved	4.03	3.66	3.95	3.81	3.88	4.60	4.97	4.66	4.82	4.75
Crystal 130	Approved	3.57	4.00	3.72	3.86	3.76	2.10	2.60	3.56	3.08	2.76
Crystal 137	Approved	4.25	4.21	3.79	4.00	4.08	2.57	2.65	3.81	3.23	3.01
Crystal 138	Approved	3.87	4.06	3.84	3.95	3.92	4.87	4.77	4.73	4.75	4.79
Crystal 260	Approved	3.89	3.84	4.08	3.96	3.94	2.05	2.15	3.13	2.64	2.44
Crystal 262	Approved	3.42	4.61	3.57	4.09	3.86	4.43	4.36	4.36	4.36	4.38
Crystal 269	Approved	3.48	3.62	3.50	3.56	3.53	4.60	4.38	4.54	4.46	4.51
Crystal 793	Approved	3.82	4.31	3.72	4.01	3.95	4.10	4.20	4.28	4.24	4.19
Crystal 912	Approved	3.44	3.41	3.57	3.49	3.48	4.81	5.00	5.06	5.03	4.96
Hilleshög HIL2389	Approved	3.78	5.42	3.56	4.49	4.25	4.69	4.51	4.57	4.54	4.59
Candidates for Approval (2 Yr)					**<=4.00**					**<=5.00**	
BTS 8328	Approved	--	3.50	3.83	3.67	--	--	4.54	4.43	4.48	--
BTS 8359	Approved	--	3.67	3.65	3.66	--	--	2.26	2.91	2.58	--
BTS 8365	Approved	--	3.62	3.87	3.75	--	--	4.15	4.18	4.17	--
Crystal 360	Approved	--	3.86	3.52	3.69	--	--	2.17	3.05	2.61	--
Crystal 361	Approved	--	3.45	3.80	3.62	--	--	2.24	3.33	2.79	--
Crystal 364	Approved	--	3.79	3.78	3.79	--	--	4.26	4.46	4.36	--
Crystal 369	Approved	--	4.02	3.45	3.74	--	--	3.78	4.03	3.91	--
Hilleshög HIL2386	Not Approved	4.31	4.21	4.55	4.38	4.36	4.54	4.23	4.89	4.56	4.56
Hilleshög HIL2479	Not Approved	--	4.38	4.76	4.57	--	--	4.09	4.25	4.17	--
Hilleshög HIL2480	Not Approved	--	4.30	4.43	4.36	--	--	4.00	4.08	4.04	--
Hilleshög HIL9920	Not Approved	4.33	5.49	4.11	4.80	4.64	4.92	5.15	5.07	5.11	5.05
Maribo MA717	Not Approved	4.39	4.61	4.18	4.39	4.39	5.05	5.04	4.85	4.95	4.98
SV 203	Not Approved	4.24	7.15	3.71	5.43	5.03	4.74	4.78	4.66	4.72	4.73
SV 231	Not Approved	--	6.25	4.43	5.34	--	--	4.83	4.77	4.80	--
SX 1815	Not Approved	4.28	6.15	3.96	5.05	4.80	5.07	4.74	4.70	4.72	4.84
SX 1818	Not Approved	4.82	7.09	4.54	5.82	5.48	4.72	4.53	4.65	4.59	4.64
SX 1835	Not Approved	--	5.99	4.31	5.15	--	--	4.55	4.66	4.60	--
Approval Criteria new varieties					4.00					5.00	
Criteria to Maintain Approval						4.30					5.30

* All Cercospora ratings 2022-2024 were adjusted to 1982 basis. Created 10/24/2024

Aphanomyces approval criteria include: 1) Cercospora rating 2 year mean must not exceed 5.00 (1982 adjusted data), 2) Aph root rating 2 year mean <= 4.00.

Three years of data may be considered for initial approval.

To maintain Aphanomyces approval, criteria include: 1) Cercospora 3 year mean must not exceed 5.30, 2) Aph root rating 3 year mean <= 4.30.

Previously approved varieties not meeting current approval standards may be sold in 2025.

Table 25. Calculation for Approval of Sugarbeet Varieties for ACSC Rhizoctonia Specialty Market for 2025

Description	Approval Status	Rhizoctonia Root Rating 2022	2023	2024	2 Yr Mn	3 Yr Mn	Cercospora Rating 2022	2023	2024	2 Yr Mn	3 Yr Mn
Previously Approved (3 Yr)						**<=4.12**					**<=5.30**
BTS 8226	Approved	3.74	3.78	3.46	3.62	3.66	2.00	2.33	3.52	2.93	2.62
Crystal 022	Approved	4.10	3.85	3.63	3.74	3.86	4.60	4.97	4.66	4.82	4.75
Crystal 138	Approved	3.81	3.81	3.68	3.75	3.77	4.87	4.77	4.73	4.75	4.79
Crystal 260	Approved	3.70	3.46	3.70	3.58	3.62	2.05	2.15	3.13	2.64	2.44
Crystal 262	Approved	3.38	3.31	3.39	3.35	3.36	4.43	4.36	4.36	4.36	4.38
Crystal 912	Approved	3.28	3.50	3.45	3.48	3.41	4.81	5.00	5.06	5.03	4.96
Hilleshög HIL2386	Approved	3.51	3.91	4.27	4.09	3.90	4.54	4.23	4.89	4.56	4.56
Candidates for Approval (2 Yr)					**<=3.82**					**<=5.00**	
BTS 8018	Not Approved	3.93	4.06	3.68	3.87	3.89	--	2.42	3.35	2.89	--
BTS 8034	Not Approved	4.49	4.09	4.38	4.24	4.32	2.28	2.54	3.69	3.12	2.84
BTS 8156	Not Approved	4.24	3.93	4.28	4.10	4.15	2.43	2.53	3.87	3.20	2.94
BTS 8270	Approved	4.33	3.67	3.86	3.76	3.95	1.97	2.43	3.32	2.87	2.57
BTS 8328	Not Approved	--	4.14	4.19	4.16	--	--	4.54	4.43	4.48	--
BTS 8359	Not Approved	--	4.08	4.26	4.17	--	--	2.26	2.91	2.58	--
BTS 8365	Approved	--	3.69	3.60	3.64	--	--	4.15	4.18	4.17	--
BTS 8927	Approved	4.13	3.98	3.57	3.78	3.89	4.42	4.38	4.45	4.42	4.42
Crystal 130	Approved	4.08	3.69	3.54	3.61	3.77	2.10	2.60	3.56	3.08	2.76
Crystal 137	Not Approved	4.18	4.01	4.09	4.05	4.09	2.57	2.65	3.81	3.23	3.01
Crystal 269	Not Approved	4.20	3.90	4.30	4.10	4.13	4.60	4.38	4.54	4.46	4.51
Crystal 360	Not Approved	--	4.04	3.94	3.99	--	--	2.17	3.05	2.61	--
Crystal 361	Approved	--	3.54	3.78	3.66	--	--	2.24	3.33	2.79	--
Crystal 364	Approved	--	3.79	3.77	3.78	--	--	4.26	4.46	4.36	--
Crystal 369	Not Approved	--	3.98	4.72	4.35	--	--	3.78	4.03	3.91	--
Crystal 793	Not Approved	4.73	4.35	3.89	4.12	4.32	4.10	4.20	4.28	4.24	4.19
Hilleshög HIL2389	Not Approved	3.92	4.45	4.08	4.27	4.15	4.69	4.51	4.57	4.54	4.59
Hilleshög HIL2479	Not Approved	--	3.43	4.24	3.84	--	--	4.09	4.25	4.17	--
Hilleshög HIL2480	Approved	--	3.70	3.65	3.68	--	--	4.00	4.08	4.04	--
Hilleshög HIL9920	Not Approved	4.58	4.42	4.57	4.50	4.52	4.92	5.15	5.07	5.11	5.05
Maribo MA717	Not Approved	3.92	4.10	4.19	4.15	4.07	5.05	5.04	4.85	4.95	4.98
SV 203	Not Approved	4.19	4.25	4.16	4.21	4.20	4.74	4.78	4.66	4.72	4.73
SV 231	Approved	--	3.69	3.71	3.70	--	--	4.83	4.77	4.80	--
SX 1815	Not Approved	4.12	4.35	4.30	4.33	4.26	5.07	4.74	4.70	4.72	4.84
SX 1818	Not Approved	4.16	4.06	4.38	4.22	4.20	4.72	4.53	4.65	4.59	4.64
SX 1835	Approved	--	3.55	4.07	3.81	--	--	4.55	4.66	4.60	--
Approval Criteria new varieties					3.82					5.00	
Criteria to Maintain Approval						4.12					5.30

+ Root Rating based on a scale of 0 (healthy) to 7 (dead). Candidates must have 2 yr Rhizoctonia rating less than or equal to 3.82. Created 10/24/2024

To maintain approval, 3 yr Rhizoctonia rating must be less than or equal to 4.12.

Rhc and CR ratings were adjusted based upon check performance.

Previously approved varieties not meeting current approval standards may be sold in 2025.

Table 26. 2024 Aphanomyces Ratings for Official Trial Entries
ACSC (Perley, MN) - KWS (Shakopee, MN) - ACSC (Glyndon, MN)

			Unadjusted ^^				Adjusted @									
			Perl	Clim	Shak[Z]	Glyn	Perl	Clim	Shak[Z]	Glyn						Trial
Chk	Code	Description	8/28	NA	8/21	8/27	8/28	NA	8/21	8/27	2024	2 Yr	3 Yr	2023++	2022++	Yrs $$
	532	BTS 8018	4.03		3.86	2.95	4.13		3.53	3.53	3.73	3.84	3.89	3.95	4.00	5
	551	BTS 8034	4.57		4.24	4.10	4.68		3.87	4.90	4.48	4.14	4.06	3.80	3.89	5
	535	BTS 8156	5.06		3.85	3.44	5.18		3.52	4.11	4.27	4.12	4.15	3.97	4.21	4
	554	BTS 8226	4.09		3.34	3.50	4.19		3.05	4.18	3.81	3.77	3.77	3.72	3.79	3
	534	BTS 8270	4.29		3.28	3.26	4.39		3.00	3.90	3.76	3.83	3.84	3.90	3.87	3
	540	BTS 8328	4.06		4.00	3.09	4.16		3.65	3.69	3.83	3.67	--	3.50	--	2
	512	BTS 8359	4.12		3.54	2.92	4.22		3.23	3.49	3.65	3.66	--	3.67	--	2
	501	BTS 8365	4.17		4.19	2.94	4.27		3.83	3.51	3.87	3.75	--	3.62	--	2
	525	BTS 8404	4.38		3.50	3.01	4.48		3.20	3.60	3.76	--	--	--	--	1
	542	BTS 8412	4.49		4.62	3.38	4.60		4.22	4.04	4.29	--	--	--	--	1
	511	BTS 8440	4.12		4.35	3.25	4.22		3.97	3.88	4.03	--	--	--	--	1
	549	BTS 8457	4.42		4.90	3.35	4.53		4.48	4.00	4.33	--	--	--	--	1
	553	BTS 8469	4.04		4.12	3.02	4.14		3.76	3.61	3.84	--	--	--	--	1
	527	BTS 8480	4.31		4.17	3.09	4.41		3.81	3.69	3.97	--	--	--	--	1
	546	BTS 8495	3.98		4.12	3.34	4.07		3.76	3.99	3.94	--	--	--	--	1
	538	BTS 8927	4.45		5.10	3.37	4.56		4.66	4.03	4.41	3.84	3.89	3.26	4.00	6
	518	Crystal 022	3.91		3.66	3.78	4.00		3.34	4.52	3.95	3.81	3.88	3.66	4.03	5
	514	Crystal 130	4.39		3.22	3.12	4.49		2.94	3.73	3.72	3.86	3.76	4.00	3.57	4
	503	Crystal 137	4.32		3.30	3.29	4.42		3.01	3.93	3.79	4.00	4.08	4.21	4.25	4
	539	Crystal 138	4.28		3.38	3.39	4.38		3.09	4.05	3.84	3.95	3.92	4.06	3.87	4
	516	Crystal 260	4.13		3.78	3.82	4.23		3.45	4.56	4.08	3.96	3.94	3.84	3.89	3
	528	Crystal 262	3.90		3.85	2.67	3.99		3.52	3.19	3.57	4.09	3.86	4.61	3.42	3
	524	Crystal 269	4.01		3.26	2.85	4.11		2.98	3.41	3.50	3.56	3.53	3.62	3.48	3
	504	Crystal 360	4.26		3.10	2.81	4.36		2.83	3.36	3.52	3.69	--	3.86	--	2
	523	Crystal 361	4.49		3.37	3.11	4.60		3.08	3.72	3.80	3.62	--	3.45	--	2
	529	Crystal 364	4.09		3.63	3.22	4.19		3.32	3.85	3.78	3.79	--	3.79	--	2
	520	Crystal 369	3.88		3.37	2.77	3.97		3.08	3.31	3.45	3.74	--	4.02	--	2
	509	Crystal 470	4.06		3.63	2.96	4.16		3.32	3.54	3.67	--	--	--	--	1
	502	Crystal 471	4.36		4.22	3.06	4.46		3.86	3.66	3.99	--	--	--	--	1
	530	Crystal 473	3.75		3.80	2.99	3.84		3.47	3.57	3.63	--	--	--	--	1
	533	Crystal 475	3.91		3.52	2.78	4.00		3.22	3.32	3.51	--	--	--	--	1
	547	Crystal 479	3.82		3.86	2.97	3.91		3.53	3.55	3.66	--	--	--	--	1
	519	Crystal 793	3.93		3.89	2.99	4.02		3.55	3.57	3.72	4.01	3.95	4.31	3.82	8
	521	Crystal 912	4.21		3.86	2.41	4.31		3.53	2.88	3.57	3.49	3.48	3.41	3.44	6
	526	Hilleshög HIL2386	4.55		5.38	3.40	4.66		4.92	4.06	4.55	4.38	4.36	4.21	4.31	4
	536	Hilleshög HIL2389	4.09		3.64	2.65	4.19		3.33	3.17	3.56	4.49	4.25	5.42	3.78	4
	552	Hilleshög HIL2479	4.92		5.41	3.61	5.04		4.94	4.31	4.76	4.57	--	4.38	--	2
	537	Hilleshög HIL2480	4.55		5.44	3.07	4.66		4.97	3.67	4.43	4.36	--	4.30	--	2
	543	Hilleshög HIL2493	4.17		4.94	3.07	4.27		4.51	3.67	4.15	--	--	--	--	1
	505	Hilleshög HIL2494	3.85		4.95	3.21	3.94		4.52	3.84	4.10	--	--	--	--	1
	531	Hilleshög HIL2495	4.94		6.55	3.51	5.06		5.98	4.19	5.08	--	--	--	--	1
	541	Hilleshög HIL2496	4.54		6.70	5.31	4.65		6.12	6.35	5.70	--	--	--	--	1
	544	Hilleshög HIL9920	4.41		4.72	2.92	4.51		4.31	3.49	4.11	4.80	4.64	5.49	4.33	8
	517	Maribo MA717	4.51		4.98	2.82	4.62		4.55	3.37	4.18	4.39	4.39	4.61	4.39	8
	548	SV 203	3.96		3.68	3.10	4.05		3.36	3.70	3.71	5.43	5.03	7.15	4.24	5
	506	SV 231	3.95		5.41	3.60	4.04		4.94	4.30	4.43	5.34	--	6.25	--	2
	513	SV 343	4.55		6.26	4.89	4.66		5.72	5.84	5.41	--	--	--	--	1
	510	SV 344	4.37		4.50	3.91	4.47		4.11	4.67	4.42	--	--	--	--	1
	508	SV 345	3.64		5.03	3.58	3.73		4.60	4.28	4.20	--	--	--	--	1
	515	SV 347	4.11		4.68	3.50	4.21		4.28	4.18	4.22	--	--	--	--	1
	507	SX 1815	4.23		3.96	3.28	4.33		3.62	3.92	3.96	5.05	4.80	6.15	4.28	4
	550	SX 1818	4.50		4.88	3.82	4.61		4.46	4.56	4.54	5.82	5.48	7.09	4.82	4
	522	SX 1835	3.71		5.43	3.48	3.80		4.96	4.16	4.31	5.15	--	5.99	--	2
	545	SX 1849	4.89		6.48	4.30	5.01		5.92	5.14	5.35	--	--	--	--	1
1	1001	AP CK#32 CRYS981	4.43		2.70	3.77	4.54		2.47	4.51	3.84	3.97	3.92	4.10	3.83	16
1	1002	AP CK#43 BTS80RR32	4.54		5.57	4.33	4.65		5.09	5.17	4.97	5.07	4.98	5.17	4.79	15
1	1003	AP CK#45 CRYS986	4.34		4.16	3.38	4.44		3.80	4.04	4.09	4.05	4.12	4.01	4.25	16
1	1004	AP CK#51 CRYS246	4.30		5.42	4.27	4.40		4.95	5.10	4.82	4.70	4.74	4.58	4.81	13
1	1005	AP CK#52 HIL4094RR	4.88		6.08	3.81	5.00		5.55	4.55	5.03	5.04	5.02	5.04	4.98	17
1	1006	AP CK#55 CRYS247	4.35		5.29	4.60	4.45		4.83	5.50	4.93	4.69	4.77	4.46	4.91	13
1	1007	AP CK#56 BTS8363	4.75		6.04	5.60	4.86		5.52	6.69	5.69	5.36	5.23	5.03	4.98	12
1	1008	AP CK#57 CRYS578	4.59		4.64	3.69	4.70		4.24	4.41	4.45	4.39	4.45	4.33	4.56	10
1	1009	AP CK#58 CRYS572	4.14		4.71	3.79	4.24		4.30	4.53	4.36	4.49	4.49	4.63	4.49	10
1	1010	AP CK#59 BTS8606	4.74		4.81	3.79	4.85		4.39	4.53	4.59	4.51	4.44	4.43	4.29	9
1	1011	AP CK#61 HIL9708	4.88		6.03	3.09	5.00		5.51	3.69	4.73	4.83	4.70	4.93	4.45	10
1	1012	AP CK#62 HIL2368	4.70		5.78	2.69	4.81		5.28	3.21	4.44	4.73	4.70	5.02	4.63	5
12		Check Mean	4.55		5.10	3.90	4.66		4.66	4.66	4.66					
		Trial Mean	4.29		4.55	3.41	4.39		4.16	4.07	4.21					
		Coeff. of Var. (%)	8.55		13.8	13.4										
		Mean LSD (0.05)	0.49		0.76	0.69										
		Mean LSD (0.01)	0.64		1.01	0.91										
		Sig Lvl	**		**	**										
		Adjustment Factor					1.024		0.914	1.195						

[Z] Trial mean and statistics for Shakopee include four extra filler entries (not shown)
^^ 2024 Root Rating was taken in early fall (1=healthy, 9+=severe damage).
@ Ratings adjusted to 2003 basis. (2000-2002 Aph nurseries). Ratings adjusted on the basis of checks.
Climax(Clim) not rated due to lack of Aphanomyces pressure
Aphanomyces Specialty Approval criteria is based upon a 4.00 as of 2024.
Ratings in green font indicate good resistance.
Ratings in red font indicate a level of concern.

Table 27. 2024 Cercospora Ratings for Official Trial Entries
KWS (Randolph, MN) - BSDF (Saginaw, MI) - NDSU (Foxhome, MN) - AC South (Averill, MN) - AC South (Forest River, ND)

			Unadjusted					Adjusted @										
			Randolph	BSDF	Foxhome	Averill	F. River	Randolph	BSDF	Foxhome	Averill	F. River	2024					Trial
Chk	Code	Description	7 Dates+	5 Dates+	6 Dates+	5 Dates+	5 Dates+	7 Dates+	5 Dates+	6 Dates+	5 Dates+	5 Dates+	5 loc	2 Yr	3 Yr	2023	2022	Yrs $$
	532	BTS 8018	2.07	3.47	3.33	4.60	1.91	2.10	3.67	4.12	4.44	2.44	3.35	2.89	2.60	2.42	2.03	5
	551	BTS 8034	2.50	4.21	3.44	4.72	2.09	2.53	4.46	4.25	4.56	2.67	3.69	3.12	2.84	2.54	2.28	5
	535	BTS 8156	2.68	4.07	3.56	5.38	2.14	2.71	4.31	4.40	5.20	2.73	3.87	3.20	2.94	2.53	2.43	4
	554	BTS 8226	2.36	3.83	3.40	4.66	1.93	2.39	4.05	4.20	4.50	2.46	3.52	2.93	2.62	2.33	2.00	3
	534	BTS 8270	1.79	3.46	3.28	4.58	2.08	1.81	3.66	4.05	4.42	2.66	3.32	2.87	2.57	2.43	1.97	3
	540	BTS 8328	3.98	4.54	3.51	4.64	3.51	4.03	4.81	4.34	4.48	4.48	4.43	4.48	--	4.54	--	2
	512	BTS 8359	1.59	3.30	2.71	3.94	1.78	1.61	3.49	3.35	3.81	2.27	2.91	2.58	--	2.26	--	2
	501	BTS 8365	3.68	4.08	3.38	4.20	3.63	3.73	4.32	4.18	4.06	4.64	4.18	4.17	--	4.15	--	2
	525	BTS 8404	3.81	4.49	3.60	4.32	3.65	3.86	4.75	4.45	4.17	4.66	4.38	--	--	--	--	1
	542	BTS 8412	2.53	3.39	3.29	4.81	1.95	2.56	3.59	4.07	4.65	2.49	3.47	--	--	--	--	1
	511	BTS 8440	1.46	3.50	2.85	3.80	1.67	1.48	3.70	3.52	3.67	2.13	2.90	--	--	--	--	1
	549	BTS 8457	1.99	3.73	3.61	4.86	2.05	2.02	3.95	4.46	4.69	2.62	3.55	--	--	--	--	1
	553	BTS 8469	1.85	3.48	3.61	4.45	2.35	1.87	3.68	4.46	4.30	3.00	3.46	--	--	--	--	1
	527	BTS 8480	3.89	4.71	3.48	4.64	3.52	3.94	4.98	4.30	4.48	4.50	4.44	--	--	--	--	1
	546	BTS 8495	3.47	4.20	3.09	3.93	3.04	3.51	4.45	3.82	3.80	3.88	3.89	--	--	--	--	1
	538	BTS 8927	4.25	4.71	3.49	4.32	3.52	4.30	4.98	4.31	4.17	4.50	4.45	4.42	4.42	4.38	4.42	6
	518	Crystal 022	4.30	4.76	3.41	4.77	4.00	4.35	5.04	4.22	4.61	5.11	4.66	4.82	4.75	4.97	4.60	5
	514	Crystal 130	2.11	3.89	3.65	4.78	1.91	2.14	4.12	4.51	4.62	2.44	3.56	3.08	2.76	2.60	2.10	4
	503	Crystal 137	2.47	4.04	3.53	5.02	2.38	2.50	4.28	4.36	4.85	3.04	3.81	3.23	3.01	2.65	2.57	4
	539	Crystal 138	4.31	4.78	3.90	4.54	3.93	4.36	5.06	4.82	4.39	5.02	4.73	4.75	4.79	4.77	4.87	4
	516	Crystal 260	1.78	3.55	2.88	4.22	1.92	1.80	3.76	3.56	4.08	2.45	3.13	2.64	2.44	2.15	2.05	3
	528	Crystal 262	3.83	4.34	3.27	4.63	3.77	3.88	4.59	4.04	4.47	4.81	4.36	4.36	4.38	4.36	4.43	3
	524	Crystal 269	4.10	4.60	3.67	4.62	3.68	4.15	4.87	4.54	4.46	4.70	4.54	4.46	4.51	4.38	4.60	3
	504	Crystal 360	1.42	3.53	3.11	4.07	1.81	1.44	3.74	3.84	3.93	2.31	3.05	2.61	--	2.17	--	2
	523	Crystal 361	1.94	3.65	3.47	4.33	1.85	1.96	3.86	4.29	4.18	2.36	3.33	2.79	--	2.24	--	2
	529	Crystal 364	3.96	4.35	3.52	4.78	3.69	4.01	4.60	4.35	4.62	4.71	4.46	4.36	--	4.26	--	2
	520	Crystal 369	3.36	4.02	3.56	4.07	3.26	3.40	4.25	4.40	3.93	4.16	4.03	3.91	--	3.78	--	2
	509	Crystal 470	2.15	3.66	3.63	5.11	2.41	2.18	3.87	4.49	4.94	3.08	3.71	--	--	--	--	1
	502	Crystal 471	1.80	3.62	3.53	4.51	2.39	1.82	3.83	4.36	4.36	3.05	3.49	--	--	--	--	1
	530	Crystal 473	3.95	4.59	4.01	4.62	3.72	4.00	4.86	4.96	4.46	4.75	4.61	--	--	--	--	1
	533	Crystal 475	3.73	4.17	3.77	4.33	3.40	3.78	4.41	4.66	4.18	4.34	4.28	--	--	--	--	1
	547	Crystal 479	4.39	4.34	4.37	4.90	3.95	4.45	4.59	5.40	4.73	5.04	4.84	--	--	--	--	1
	519	Crystal 793	3.73	4.23	3.74	4.33	3.39	3.78	4.48	4.62	4.18	4.33	4.28	4.24	4.19	4.20	4.10	8
	521	Crystal 912	4.70	4.78	3.83	5.08	4.56	4.76	5.06	4.73	4.91	5.82	5.06	5.03	4.96	5.00	4.81	6
	526	Hilleshög HIL2386	5.14	5.01	3.75	4.91	3.58	5.21	5.30	4.64	4.74	4.57	4.89	4.56	4.56	4.23	4.54	4
	536	Hilleshög HIL2389	4.47	4.11	3.96	4.45	3.74	4.53	4.35	4.89	4.30	4.78	4.57	4.54	4.59	4.51	4.69	4
	552	Hilleshög HIL2479	3.76	4.23	3.56	4.57	3.24	3.81	4.48	4.40	4.41	4.14	4.25	4.17	--	4.09	--	2
	537	Hilleshög HIL2480	3.90	4.38	2.94	4.38	3.09	3.95	4.64	3.63	4.23	3.95	4.08	4.04	--	4.00	--	2
	543	Hilleshög HIL2493	4.47	4.53	4.10	5.10	3.76	4.53	4.79	5.07	4.93	4.80	4.82	--	--	--	--	1
	505	Hilleshög HIL2494	4.13	4.20	3.94	4.91	3.71	4.18	4.45	4.87	4.74	4.74	4.60	--	--	--	--	1
	531	Hilleshög HIL2495	2.52	3.64	3.97	5.59	2.25	2.55	3.85	4.91	5.40	2.87	3.92	--	--	--	--	1
	541	Hilleshög HIL2496	2.48	3.96	3.91	5.78	2.49	2.51	4.19	4.83	5.58	3.18	4.06	--	--	--	--	1
	544	Hilleshög HIL9920	4.90	4.50	3.88	5.43	4.37	4.96	4.76	4.80	5.25	5.58	5.07	5.11	5.05	5.15	4.92	8
	517	Maribo MA717	4.85	4.57	3.64	5.18	3.92	4.91	4.84	4.50	5.00	5.01	4.85	4.95	4.98	5.04	5.05	8
	548	SV 203	4.75	4.25	4.03	4.66	3.52	4.81	4.50	4.98	4.50	4.50	4.66	4.72	4.73	4.78	4.74	5
	506	SV 231	4.60	4.36	4.00	5.11	3.69	4.66	4.61	4.94	4.94	4.71	4.77	4.80	--	4.83	--	2
	513	SV 343	2.83	3.93	3.77	5.61	2.23	2.87	4.16	4.66	5.42	2.85	3.99	--	--	--	--	1
	510	SV 344	1.57	3.49	2.96	4.69	1.86	1.59	3.69	3.66	4.53	2.38	3.17	--	--	--	--	1
	508	SV 345	4.42	4.51	4.08	5.03	4.32	4.48	4.77	5.04	4.86	5.52	4.93	--	--	--	--	1
	515	SV 347	4.59	4.01	4.34	4.69	4.11	4.65	4.24	5.36	4.53	5.25	4.81	--	--	--	--	1
	507	SX 1815	4.68	4.24	3.90	4.68	3.87	4.74	4.49	4.82	4.52	4.94	4.70	4.72	4.84	4.74	5.07	4
	550	SX 1818	4.63	4.27	3.94	4.72	3.61	4.69	4.52	4.87	4.56	4.61	4.65	4.59	4.64	4.53	4.72	4
	522	SX 1835	4.28	4.32	3.85	4.94	3.82	4.33	4.57	4.76	4.77	4.88	4.66	4.60	--	4.55	--	2
	545	SX 1849	3.14	3.94	4.75	5.95	2.58	3.18	4.17	5.87	5.75	3.29	4.45	--	--	--	--	1
1	1101	CR CK#41 CRYS981RR	5.58	4.78	4.10	5.43	4.01	5.65	5.06	5.07	5.25	5.12	5.23	5.13	5.18	5.04	5.28	16
1	1102	CR CK#43 CRYS246RR	4.78	4.66	3.44	4.90	3.73	4.84	4.93	4.25	4.73	4.76	4.70	4.66	4.71	4.62	4.82	13
1	1103	CR CK#44 BETA80RR32	5.31	4.58	4.33	5.13	3.62	5.38	4.85	5.35	4.96	4.62	5.03	5.07	5.14	5.10	5.28	15
1	1104	CR CK#45 HIL4448RR	5.81	5.20	4.45	5.71	4.28	5.88	5.50	5.50	5.52	5.47	5.57	5.58	5.49	5.58	5.31	13
1	1105	CR CK#48 MARI504	5.12	4.73	4.25	5.37	3.98	5.19	5.01	5.25	5.19	5.08	5.14	5.01	4.98	4.87	4.94	10
1	1106	CR CK#49 CRYS578RR	4.58	4.56	4.29	5.21	3.46	4.64	4.83	5.30	5.03	4.42	4.84	4.81	4.87	4.77	4.99	10
1	1107	CR CK#51 CRYS355RR	4.37	4.57	4.16	4.84	4.10	4.43	4.84	5.14	4.68	5.24	4.86	4.82	4.70	4.77	4.45	12
1	1108	CR CK#52 MARI717	5.02	4.66	3.57	5.02	3.85	5.08	4.93	4.41	4.85	4.92	4.84	4.77	4.75	4.70	4.72	8
1	1109	CR CK#53 CRYS684RR	3.96	4.36	3.66	4.33	3.54	4.01	4.61	4.52	4.18	4.52	4.37	4.35	4.43	4.34	4.59	9
1	1110	CR CK#54 CRYS912	4.41	4.53	3.83	4.97	3.96	4.47	4.79	4.73	4.80	5.06	4.77	4.89	4.86	5.00	4.81	6
1	1111	CR CK#55 HIL2366	4.63	4.59	3.51	5.47	4.31	4.69	4.86	4.34	5.28	5.50	4.93	4.98	4.99	5.02	5.00	5
1	1112	CR CK#56 SES203	4.59	4.43	4.06	4.59	3.28	4.65	4.69	5.02	4.43	4.19	4.60	4.69	4.71	4.78	4.74	5
12		Check Mean	4.85	4.64	3.97	5.08	3.84	4.91	4.91	4.91	4.91	4.91	4.91					
		Trial Mean	3.61	4.21	3.69	4.79	3.19	3.66	4.46	4.56	4.63	4.07	4.27					
		Coeff. of Var. (%)	10.7	6.69	11.0	4.9	10.6											
		Mean LSD (0.05)	0.46	0.44	0.64	0.32	0.42											
		Mean LSD (0.01)	0.61	0.58	0.84	0.42	0.55											
		Sig Mrk	**	**	**	**	**											
		Adj Factor						1.01271	1.05838	1.23608	0.96603	1.27708						

* Lower numbers indicate better Cercospora resistance (1-Ex,9=Poor).
@ Ratings adjusted to 1982 basis (5.5 equivalent in 1978-81 CR nurseries). Ratings adjusted on the basis of checks.
Chk = varieties used to adjust CR readings to 1982 basis. Ratings * (Adj. factor) = Adj Rating.
$$ Trial years indicates how many years the entry has been in the official trials.
\+ Average rating based upon multiple rating dates.
Ratings in green font indicate good resistance.
Ratings in red font indicate a level of concern.

Table 28. 2024 Fusarium Ratings for Official Trial Entries
ACSC (North Moorhead, MN) - ACSC (Sabin, MN)

			Unadjusted		Adjusted @							
			N Mhd	Sab	N Mhd	Sab						
Chk	Code	Description	4 Dates+	4 Dates+	4 Dates+	4 Dates+	2024	2 Yr	3 Yr	2023	2022	Years
	532	BTS 8018	1.81	1.24	2.41	1.97	2.19	2.70	2.79	3.20	2.98	5
	551	BTS 8034	1.40	1.20	1.86	1.91	1.89	2.30	2.25	2.72	2.16	5
	535	BTS 8156	1.70	1.28	2.26	2.04	2.15	2.48	2.42	2.80	2.30	4
	554	BTS 8226	2.25	1.43	3.00	2.28	2.64	3.24	3.32	3.85	3.47	3
	534	BTS 8270	1.68	1.62	2.24	2.58	2.41	2.93	2.98	3.46	3.06	3
	540	BTS 8328	2.67	1.77	3.56	2.82	3.19	3.61	--	4.03	--	2
	512	BTS 8359	1.77	1.28	2.36	2.04	2.20	2.84	--	3.49	--	2
	501	BTS 8365	1.79	1.20	2.38	1.91	2.15	2.79	--	3.43	--	2
	525	BTS 8404	2.28	1.39	3.04	2.21	2.63	--	--	--	--	1
	542	BTS 8412	3.31	2.28	4.41	3.63	4.02	--	--	--	--	1
	511	BTS 8440	2.54	1.61	3.38	2.56	2.97	--	--	--	--	1
	549	BTS 8457	1.94	1.33	2.58	2.12	2.35	--	--	--	--	1
	553	BTS 8469	2.08	1.45	2.77	2.31	2.54	--	--	--	--	1
	527	BTS 8480	2.65	1.70	3.53	2.71	3.12	--	--	--	--	1
	546	BTS 8495	2.65	1.91	3.53	3.04	3.29	--	--	--	--	1
	538	BTS 8927	1.51	1.37	2.01	2.18	2.10	2.59	2.76	3.08	3.11	6
	518	Crystal 022	2.14	1.66	2.85	2.64	2.75	3.09	3.13	3.43	3.22	5
	514	Crystal 130	2.07	1.73	2.76	2.75	2.76	3.15	3.17	3.55	3.22	4
	503	Crystal 137	1.97	1.49	2.62	2.37	2.50	2.64	2.54	2.78	2.35	4
	539	Crystal 138	2.17	1.93	2.89	3.07	2.98	3.37	3.30	3.76	3.16	4
	516	Crystal 260	1.87	1.42	2.49	2.26	2.38	2.88	2.94	3.38	3.06	3
	528	Crystal 262	2.26	2.15	3.01	3.42	3.22	3.52	3.44	3.83	3.27	3
	524	Crystal 269	2.05	1.48	2.73	2.36	2.54	3.33	3.34	4.11	3.36	3
	504	Crystal 360	1.73	1.37	2.30	2.18	2.24	2.88	--	3.51	--	2
	523	Crystal 361	1.52	1.26	2.02	2.01	2.02	2.63	--	3.24	--	2
	529	Crystal 364	1.54	1.37	2.05	2.18	2.12	2.62	--	3.12	--	2
	520	Crystal 369	1.73	1.38	2.30	2.20	2.25	2.75	--	3.24	--	2
	509	Crystal 470	1.74	1.37	2.32	2.18	2.25	--	--	--	--	1
	502	Crystal 471	1.60	1.30	2.13	2.07	2.10	--	--	--	--	1
	530	Crystal 473	2.05	1.48	2.73	2.36	2.54	--	--	--	--	1
	533	Crystal 475	1.98	1.23	2.64	1.96	2.30	--	--	--	--	1
	547	Crystal 479	2.16	1.63	2.88	2.60	2.74	--	--	--	--	1
	519	Crystal 793	1.72	1.58	2.29	2.52	2.40	2.90	2.95	3.40	3.03	8
	521	Crystal 912	2.31	2.42	3.08	3.85	3.46	3.64	3.65	3.82	3.66	6
	526	Hilleshög HIL2386	2.32	1.99	3.09	3.17	3.13	3.56	3.62	3.99	3.73	4
	536	Hilleshög HIL2389	4.10	3.46	5.46	5.51	5.49	5.49	5.11	5.50	4.34	4
	552	Hilleshög HIL2479	3.17	3.12	4.22	4.97	4.59	4.51	--	4.43	--	2
	537	Hilleshög HIL2480	2.19	2.01	2.92	3.20	3.06	3.18	--	3.30	--	2
	543	Hilleshög HIL2493	2.60	3.76	3.46	5.99	4.72	--	--	--	--	1
	505	Hilleshög HIL2494	2.26	2.58	3.01	4.11	3.56	--	--	--	--	1
	531	Hilleshög HIL2495	3.53	2.68	4.70	4.27	4.48	--	--	--	--	1
	541	Hilleshög HIL2496	3.25	2.69	4.33	4.28	4.31	--	--	--	--	1
	544	Hilleshög HIL9920	4.51	4.11	6.01	6.54	6.28	6.15	5.99	6.03	5.66	8
	517	Maribo MA717	3.29	2.72	4.38	4.33	4.36	4.44	4.59	4.53	4.87	8
	548	SV 203	4.19	3.70	5.58	5.89	5.74	5.47	5.50	5.20	5.55	5
	506	SV 231	2.69	3.55	3.58	5.65	4.62	4.41	--	4.21	--	2
	513	SV 343	2.67	2.44	3.56	3.88	3.72	--	--	--	--	1
	510	SV 344	3.39	2.50	4.52	3.98	4.25	--	--	--	--	1
	508	SV 345	2.36	3.49	3.14	5.56	4.35	--	--	--	--	1
	515	SV 347	3.00	3.14	4.00	5.00	4.50	--	--	--	--	1
	507	SX 1815	4.02	3.60	5.35	5.73	5.54	5.57	5.49	5.60	5.32	4
	550	SX 1818	3.17	2.78	4.22	4.43	4.32	4.46	4.48	4.59	4.54	4
	522	SX 1835	2.04	2.71	2.72	4.31	3.52	3.72	--	3.92	--	2
	545	SX 1849	3.43	2.96	4.57	4.71	4.64	--	--	--	--	1
1	1201	FS CK #18 CRYS768RR	3.18	2.78	4.24	4.43	4.33	4.26	4.33	4.19	4.46	16
1	1202	FS CK #29 CRYS875RR	3.49	2.64	4.65	4.20	4.43	4.59	4.66	4.76	4.79	17
1	1203	FS CK #30 BTS8337	2.36	2.14	3.14	3.41	3.28	3.49	3.64	3.71	3.93	12
1	1204	FS CK #31 SXMarathon	3.68	3.01	4.90	4.79	4.85	4.99	4.99	5.13	5.01	10
1	1205	FS CK #32 CRYS574	1.86	1.47	2.48	2.34	2.41	2.69	2.59	2.96	2.41	10
1	1206	FS CK #33 SES375	3.34	3.42	4.45	5.45	4.95	5.10	5.21	5.25	5.43	8
1	1207	FS CK #34 SES265	4.37	3.29	5.82	5.24	5.53	5.58	5.58	5.62	5.59	9
1	1208	FS CK #35 SES203	4.84	4.12	6.45	6.56	6.50	6.05	5.88	5.59	5.55	5
1	1209	FS CK #36 SES285	5.17	4.00	6.89	6.37	6.63	6.07	5.87	5.51	5.47	7
1	1210	FS Ck#37 HIL2317	4.31	3.75	5.74	5.97	5.86	5.84	5.78	5.83	5.65	6
10		Check Mean	3.66	3.06	4.88	4.88	4.88					
		Trial Mean	2.62	2.23	3.49	3.55	3.52					
		Coeff. of Var. (%)	13.5	14.8								
		Mean LSD (0.05)	0.44	0.45								
		Mean LSD (0.01)	0.58	0.59								
		Sig Mrk	**	**								
		Adj Factor			1.3320	1.5921						

@ Ratings adjusted to 2007 basis. (2005-2006 FS Nurseries). Ratings adjusted on the basis of checks.
+ Average rating based upon multiple rating dates. Lower numbers indicate better tolerance (1=Ex, 9=Poor).
Ratings in green font indicate good resistance.
Ratings in red font indicate a level of concern.

Table 29. 2024 Rhizoctonia Ratings for OVT Entries

BSDF (Saginaw, MI) - ACSC (NWROC) - ACSC (TSC N) - ACSC (TSC S)

			Unadjusted				Adjusted @									
			BSDF	TSC-S	TSC-N	NWROC	BSDF	TSC-S	TSC-N	NWROC						
Chk	Code	Description	8/12	8/21	9/4	8/8	8/12	8/21	9/4	8/8	2024	2 Yr	3 Yr	2023	2022	Years
	532	BTS 8018	5.27	3.97	2.76	2.69	3.84	3.52	3.63	3.71	3.68	3.87	3.89	4.06	3.93	5
	551	BTS 8034	5.95	4.41	3.44	3.44	4.34	3.91	4.53	4.75	4.38	4.24	4.32	4.09	4.49	5
	535	BTS 8156	6.10	4.67	3.02	3.30	4.45	4.14	3.97	4.56	4.28	4.10	4.15	3.93	4.24	4
	554	BTS 8226	5.08	3.93	2.47	2.45	3.71	3.48	3.25	3.38	3.46	3.62	3.66	3.78	3.74	3
	534	BTS 8270	5.53	4.43	3.14	2.41	4.03	3.93	4.13	3.33	3.86	3.76	3.95	3.67	4.33	3
	540	BTS 8328	5.66	4.92	2.77	3.35	4.13	4.36	3.65	4.62	4.19	4.16	--	4.14	--	2
	512	BTS 8359	5.33	4.73	3.45	3.19	3.89	4.19	4.54	4.40	4.26	4.17	--	4.08	--	2
	501	BTS 8365	5.49	4.24	2.61	2.33	4.00	3.76	3.43	3.22	3.60	3.64	--	3.69	--	2
	525	BTS 8404	5.10	3.68	2.42	2.63	3.72	3.26	3.18	3.63	3.45	--	--	--	--	1
	542	BTS 8412	5.82	4.54	3.12	2.63	4.24	4.03	4.11	3.63	4.00	--	--	--	--	1
	511	BTS 8440	5.55	4.13	2.69	2.50	4.05	3.66	3.54	3.45	3.68	--	--	--	--	1
	549	BTS 8457	6.14	3.95	2.64	2.45	4.48	3.50	3.47	3.38	3.71	--	--	--	--	1
	553	BTS 8469	5.33	4.15	2.87	2.67	3.89	3.68	3.78	3.69	3.76	--	--	--	--	1
	527	BTS 8480	5.47	4.26	2.65	2.64	3.99	3.78	3.49	3.64	3.72	--	--	--	--	1
	546	BTS 8495	5.80	5.04	3.06	2.74	4.23	4.47	4.03	3.78	4.13	--	--	--	--	1
	538	BTS 8927	5.08	4.03	2.71	2.48	3.71	3.57	3.57	3.42	3.57	3.78	3.89	3.98	4.13	6
	518	Crystal 022	4.96	3.91	2.52	2.99	3.62	3.47	3.32	4.13	3.63	3.74	3.86	3.85	4.10	5
	514	Crystal 130	5.00	3.95	2.48	2.72	3.65	3.50	3.26	3.75	3.54	3.61	3.77	3.69	4.08	4
	503	Crystal 137	5.74	4.65	2.90	3.08	4.19	4.12	3.82	4.25	4.09	4.05	4.09	4.01	4.18	4
	539	Crystal 138	5.27	4.19	2.53	2.77	3.84	3.71	3.33	3.82	3.68	3.75	3.77	3.81	3.81	4
	516	Crystal 260	5.68	4.03	2.53	2.72	4.14	3.57	3.33	3.75	3.70	3.58	3.62	3.46	3.70	3
	528	Crystal 262	5.07	3.77	2.22	2.62	3.70	3.34	2.92	3.62	3.39	3.35	3.36	3.31	3.38	3
	524	Crystal 269	5.62	4.87	3.41	3.10	4.10	4.32	4.49	4.28	4.30	4.10	4.13	3.90	4.20	3
	504	Crystal 360	5.68	4.46	2.89	2.80	4.14	3.95	3.80	3.87	3.94	3.99	--	4.04	--	2
	523	Crystal 361	5.22	4.05	2.96	2.77	3.81	3.59	3.90	3.82	3.78	3.66	--	3.54	--	2
	529	Crystal 364	5.91	3.95	2.39	3.00	4.31	3.50	3.15	4.14	3.77	3.78	--	3.79	--	2
	520	Crystal 369	5.73	4.96	3.64	3.99	4.18	4.40	4.79	5.51	4.72	4.35	--	3.98	--	2
	509	Crystal 470	5.57	4.36	2.85	2.71	4.06	3.87	3.75	3.74	3.85	--	--	--	--	1
	502	Crystal 471	4.97	4.18	2.95	2.56	3.62	3.71	3.88	3.53	3.69	--	--	--	--	1
	530	Crystal 473	5.47	4.34	3.05	2.20	3.99	3.85	4.01	3.04	3.72	--	--	--	--	1
	533	Crystal 475	5.27	4.14	2.60	2.43	3.84	3.67	3.42	3.35	3.57	--	--	--	--	1
	547	Crystal 479	5.41	4.28	3.05	3.24	3.95	3.79	4.01	4.47	4.06	--	--	--	--	1
	519	Crystal 793	5.09	4.77	3.01	2.66	3.71	4.23	3.96	3.67	3.89	4.12	4.32	4.35	4.73	8
	521	Crystal 912	5.19	3.47	2.17	2.97	3.79	3.08	2.86	4.10	3.45	3.48	3.41	3.50	3.28	6
	526	Hilleshög HIL2386	5.80	4.93	2.85	3.43	4.23	4.37	3.75	4.73	4.27	4.09	3.90	3.91	3.51	4
	536	Hilleshög HIL2389	5.80	4.74	2.83	3.01	4.23	4.20	3.72	4.16	4.08	4.27	4.15	4.45	3.92	4
	552	Hilleshög HIL2479	5.59	4.34	3.20	3.50	4.08	3.85	4.21	4.83	4.24	3.84	--	3.43	--	2
	537	Hilleshög HIL2480	5.32	4.09	2.52	2.74	3.88	3.63	3.32	3.78	3.65	3.68	--	3.70	--	2
	543	Hilleshög HIL2493	5.74	4.34	2.79	2.61	4.19	3.85	3.67	3.60	3.83	--	--	--	--	1
	505	Hilleshög HIL2494	5.68	4.29	2.94	2.94	4.14	3.80	3.87	4.06	3.97	--	--	--	--	1
	531	Hilleshög HIL2495	5.98	5.09	3.04	3.51	4.36	4.51	4.00	4.85	4.43	--	--	--	--	1
	541	Hilleshög HIL2496	5.58	5.81	3.31	4.07	4.07	5.15	4.36	5.62	4.80	--	--	--	--	1
	544	Hilleshög HIL9920	5.58	5.48	3.29	3.64	4.07	4.86	4.33	5.02	4.57	4.50	4.52	4.42	4.58	8
	517	Maribo MA717	5.72	4.94	3.46	2.66	4.17	4.38	4.55	3.67	4.19	4.15	4.07	4.10	3.92	8
	548	SV 203	5.92	4.73	2.79	3.23	4.32	4.19	3.67	4.46	4.16	4.21	4.20	4.25	4.19	5
	506	SV 231	5.44	4.11	2.86	2.52	3.97	3.64	3.76	3.48	3.71	3.70	--	3.69	--	2
	513	SV 343	5.92	5.04	3.00	3.40	4.32	4.47	3.95	4.69	4.36	--	--	--	--	1
	510	SV 344	5.88	5.17	3.39	3.88	4.29	4.58	4.46	5.36	4.67	--	--	--	--	1
	508	SV 345	5.12	3.99	2.43	2.50	3.73	3.54	3.20	3.45	3.48	--	--	--	--	1
	515	SV 347	5.66	4.98	2.85	3.49	4.13	4.42	3.75	4.82	4.28	--	--	--	--	1
	507	SX 1815	6.26	4.84	2.77	3.41	4.57	4.29	3.65	4.71	4.30	4.33	4.26	4.35	4.12	4
	550	SX 1818	5.87	5.13	3.04	3.41	4.28	4.55	4.00	4.71	4.38	4.22	4.20	4.06	4.16	4
	522	SX 1835	5.45	4.31	2.80	3.47	3.97	3.82	3.68	4.79	4.07	3.81	--	3.55	--	2
	545	SX 1849	6.24	5.49	3.11	3.47	4.55	4.87	4.09	4.79	4.58	--	--	--	--	1
1	1301	RH CK#49 CRYS247	6.20	5.10	3.15	3.35	4.52	4.52	4.15	4.62	4.45	4.38	4.36	4.31	4.31	13
1	1302	RH CK#51 SXWinchester	5.86	5.63	3.78	3.53	4.27	4.99	4.97	4.87	4.78	4.64	4.61	4.51	4.55	12
1	1303	RH CK#52 CRYS573	6.13	5.08	3.43	3.07	4.47	4.50	4.51	4.24	4.43	4.33	4.39	4.22	4.52	10
1	1304	RH CK#53 BTS8500	6.31	4.80	2.85	3.01	4.60	4.26	3.75	4.16	4.19	4.22	4.28	4.24	4.39	10
1	1305	RH CK#54 CRYS574	6.05	4.81	3.33	2.87	4.41	4.26	4.38	3.96	4.26	4.33	4.31	4.40	4.28	10
1	1306	RH CK#55 CRYS803	5.33	5.19	3.57	3.47	3.89	4.60	4.70	4.79	4.49	4.48	4.54	4.47	4.66	7
1	1307	RH CK#56 MARI504	6.12	5.03	3.70	2.84	4.46	4.46	4.87	3.92	4.43	4.43	4.35	4.44	4.18	10
1	1308	RH CK#57 BTS8606	5.69	4.70	3.34	3.70	4.15	4.17	4.40	5.11	4.46	4.60	4.53	4.75	4.37	9
1	1309	RH CK#58 CRYS793	5.74	4.51	3.34	2.99	4.19	4.00	4.40	4.13	4.18	4.17	4.28	4.17	4.49	8
1	1310	RH Ck#59 SEED1818	5.89	4.93	2.84	3.15	4.30	4.37	3.74	4.35	4.19	4.12	4.13	4.06	4.16	4
1	1311	RH Ck#60 CRYS913	NA	4.53	3.11	2.76	NA	4.02	4.09	3.81	3.97	4.08	4.13	4.19	4.23	6
1	1312	RH Ck#61 HIL2386	NA	4.25	3.01	2.87	NA	3.77	3.96	3.96	3.90	3.90	3.77	3.91	3.51	4
12		Mean of Check Varieties	5.93	4.88	3.29	3.13	4.33	4.33	4.33	4.33	4.33					
		Trial Mean	5.62	4.54	2.95	3.00	4.10	4.03	3.88	4.14	4.04					
		Coeff. of Var. (%)	9.1	7.3	13.9	15.1										
		F Value	2.22	10.4	4.2	3.85										
		Mean LSD (0.05)	0.67	0.44	0.49	0.60										
		Mean LSD (0.01)	0.89	0.58	0.65	0.80										
		Sig Lvl	**	**	**	**										
		Adjustment Factor					0.7294	0.8866	1.3160	1.3804						

@ Ratings adjusted to 2009 basis (2007-2009) RH nurseries. Ratings adjusted on the basis of checks

Lower numbers indicate better tolerance (0=Ex, 7=Poor).

Rhizoctonia Specialty Approval criteria is based upon a 3.82 as of 2023.

Ratings in green font indicate good resistance.

Ratings in red font indicate a level of concern.

Table 30. Pesticides Applied to ACSC Official Trials

	Herbicide				Cercospora Fungicides	
Location	Pre-emerge	Spray Date	Post	Spray Dates	Fungicide Used	Spray Dates
Casselton	N1	5/10	RU1, RU2	5/23, 8/2	CR1, CR2, CR3, CR4, CR5	7/3, 7/17, 7/31, 8/20, 9/6
Averill	N1	5/10	RU1, RU2	6/10, 6/27	CR1, CR2, CR3, CR4, CR5	7/9, 7/22, 8/6, 8/19, 8/27
Perley	N1	6/13	RU1	6/13	CR2, CR3, CR4, CR5	7/29, 8/12, 8/20, 9/6
Ada	N1	5/10	RU1, RU2	6/10, 7/10	CR1, CR2, CR3, CR4, CR5	7/3, 7/16, 7/30, 8/19, 8/27
Hillsboro	Grower[A]		RU1	5/20	CR1, CR2, CR3, CR4, CR5	7/3, 7/22, 8/6, 8/20, 9/3
Climax	N1	4/25	RU1, RU2	5/20, 6/27	CR1, CR2, CR3, CR4, CR5	7/3, 7/16, 7/30, 8/20, 8/27
Grand Forks	N1	5/15	RU1	6/27	CR1, CR2, CR3, CR4, CR5	7/8, 7/23, 8/9, 8/20, 8/27
Scandia	N1	5/11	RU1, RU2	6/7, 7/10	CR1, CR2, CR3, CR4, CR5	7/8, 7/22, 8/9, 8/19, 8/27
Forest River	N1	4/24	RU1	6/7	CR1, CR2, CR3, CR4, CR5	7/8, 7/22, 8/6, 8/19, 9/3
Alvarado	N1	4/24	RU1	6/7	CR1, CR2, CR3, CR4, CR5	7/8, 7/23, 8/6, 8/19, 9/3
St. Thomas	N1	5/17			CR1, CR2, CR3, CR4, CR5	7/9, 7/23, 8/7, 8/19, 9/4
Hallock			RU1, RU2	5/29, 7/10	CR1, CR2, CR3, CR4, CR5	7/9, 7/23, 8/7, 8/19, 9/4
Bathgate	N1	5/18	RU1	6/13	CR1, CR2, CR3, CR4, CR5	7/9, 7/23, 8/7, 8/19, 9/4

Ground applications made by Official Variety Trial personnel from ACSC Tech. Services Center. Created 12/10/2024

Counter 20G (8.9 lbs./A) applied at all locations.
Mustang Maxx (4 fl oz/A) applied post at Ada, Grand Forks, and St Thomas.
Azteroid (5.7 fl oz/A) applied in-furrow at all locations.
Quadris (10 fl oz/A) applied in a 7-inch band to 6-10 leaf beets at all locations.

N1 = Nortron (6 pt/A)
[A] Grower applied Dual Magnum (0.5 pt/A) PPI
RU1 and RU2 = Roundup PowerMAX 3 (25 fl oz/A), ClassAct (2.5 gal/100 gal of water).

CR1 = Inspire XT + Manzate Max
CR2 = Agritin + T-Methyl
CR3 = Proline + Manzate Max
CR4 = Manzate Max
CR5 = Priaxor + Agritin